

By GEORGE RICKS B.Sc. (Lond.)

NATURAL HISTORY OBJECT LESSONS

A Manual for Teachers and Pupil Teachers

OBJECT LESSONS AND HOW TO GIVE THEM

First Series for Primary Schools

OBJECT LESSONS AND HOW TO GIVE THEM

Second Series for Intermediate and Grammar
Schools

OBJECT LESSONS

AND HOW TO GIVE THEM

First Series

FOR PRIMARY SCHOOLS

By GEORGE RICKS B.Sc. (Lond.)

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INTRODUCTION.

OUR knowledge of the material world is obtained through the senses. The organs of sense are the eye, the ear, the nose, the tongue and palate, and the nerves of touch located in the skin. The special nerves of these organs are acted on by things external to the body; the effect is conveyed to the brain; and mental impressions or ideas are the result. Thus a red colour acting on the retina, the sound from a whistle acting on the auditory nerves, or the smell of an onion on the olfactory nerves produces a definite mental impression. The five sensory organs, then, are so many doors and windows by which knowledge enters the mind.

There is, however, another source of knowledge of material bodies. In this case the mental impressions are derived from within the body, and are due to muscular exertion. It is by muscular feeling that we estimate the amount of force required to overcome resistance. Thus we get ideas of elasticity and weight from the amount of active energy put forth by the muscles to overcome inertia in the one case and gravitation in the other. If a weight is placed in the hand we are conscious of a certain amount of force expended to keep it from falling; if the weight is increased we are conscious of an increased expenditure of muscular energy.

The mental impressions, formed by and through the senses, including muscular feeling, are called *sensations*.

By the organs of sense we are said to *perceive*, or to make mental notes of external bodies, and these mental notes we

call *perceptions*. Perception is the first step in knowledge: attentive perception leads to *observation*; observation is the forerunner of *comparison*; while comparison is the basis of *classification*; and these together constitute the foundation of all knowledge.

The primary purpose of lessons on common objects and natural phenomena is to cultivate the senses, to train to habits of attention, intelligent observation, and accurate comparison, and so to lead up to the higher processes of the mind—reason and judgment. Of course the acquisition of information is an important aim; but the object lesson is designed to assist and guide the child to discover properties of things, and thus acquire knowledge for himself, rather than to pour information into his mind like wheat into a sack.

Mental impressions are formed at a very early period of childhood. A bright light or a shining object attracts attention before the child has acquired the power of taking hold with its hands; and a certain amount of discrimination, enabling it, for instance, to distinguish the face of its mother from that of a stranger, quickly follows. The power of recognising resemblances and differences rapidly increases, new ideas are as rapidly acquired; and when the child enters school, he enters it with his perceptive faculties, to a certain extent, cultivated, and with his mind a treasury of simple ideas.

The natural course for the teacher would seem to be to gather up into something like order, and to perfect, that which has been so far imperfectly accomplished; and then, starting from this as a basis, to evolve a systematic course of training, proceeding step by step in a natural order, each step being a logical sequence of the preceding. Further, the teacher who would best succeed must take childhood's method of imbibing knowledge and adapt it to her own use. Restless activity, insatiable curiosity, and love of imitation

characterize childhood. What the child sees he wants to know about, to handle, and examine, and, if possible, to take to pieces, or otherwise experiment upon; what he sees done he wants to do, and if opportunity be not found for the indulgence of his natural activity, he will find the opportunity for himself. An object lesson, then, besides fulfilling some definite purpose in training the perceptive faculties, should provide something for the children to *do* to satisfy their innate activity, something to *examine* and *discover* to arouse their curiosity, and something to *copy* to gratify their desire for imitation. Herein lies the secret of securing attention, of begetting a state of vigorous mental activity, and of associating pleasure with instruction.

The selection of lessons, and their adaptation to the capacities of the scholars, or to their different stages of advancement, is another point of fundamental importance. A child of four years of age is a different being, intellectually, from a child of seven; and a lesson suited to the capacity of the one must be totally unsuited to the mental condition of the other. The mental faculties of a child are strengthened and invigorated by proper exercise, but are weakened and depressed by being exercised on subjects beyond his powers of comprehension. To graduate the lessons to the mental condition and previous training of the scholars necessitates a complete system. It is not sufficient to select a lesson at random, no matter how skilfully it may be handled. Each lesson, whilst fulfilling its own special purpose, must form a link in the chain, a unit in the whole.

Nor is the *method* of giving the individual lessons of less importance than their selection and adaptation. Occasional information given about things of every-day life does not serve the distinctive aim of object lessons. To be a passive recipient of information gives no pleasure to a child. To hold an object before it, and enumerate its general properties—what it is composed of, or where or how it is made—and

then to get the information returned by questioning, is at best but a mere exercise of the memory ; it does nothing in the way of exercising and developing the more important mental powers.

"To *tell* a child this, and to *show* the other, is not to teach it how to observe, but to make it a mere recipient of another's observations—a proceeding which weakens rather than strengthens its powers of self-instruction, which deprives it of the pleasure resulting from successful activity, which presents this all-attractive knowledge under the aspect of formal tuition, and which thus generates that indifference and even disgust with which these object lessons are sometimes regarded. On the other hand, to pursue the true course is simply to guide the intellect to its appropriate food, and to habituate the mind from the beginning to that practice of self-help which it must ultimately follow. Children should be led to make their own investigations and to draw their own inferences. They should be *told* as little as possible, and induced to *discover* as much as possible."*

Having formed new ideas of things by the method of observation and experiment under the guiding hand of the teacher, our next step is to endeavour to fix these ideas in the minds of the children by means of language. But in every case words must *follow* ideas ; in fact, terms should not be given till the necessity for them is felt. Thus, suppose "a liquid" to be the subject of the lesson. The children are led by experiment on several liquid bodies to note that they all have certain common properties—such as flowing in a stream, finding the lowest level, spreading out and filling up hollows, easily flowing in drops, having no definite shape, but taking the shape of the vessel into which they are poured—and the necessity is felt for one term which at once embodies all these properties. The extension of the children's vocabulary in this way is one of the minor advantages of object lessons ;

• Herbert Spencer.

and further, to secure freedom and accuracy in speech, the children should be encouraged to answer all questions, as far as possible, in complete sentences, or at any rate in complete phrases.

The teacher may commence object lessons by taking some familiar object—such, for instance, as the black-board—and lead the children to observe its colour, shape, substance, surface, and so on ; but then we have so many properties in combination that the scholars are not likely to get very clear notions of any. It is desirable, therefore, if not actually necessary, that lessons on objects should be preceded by a special training in colour, form, size, weight, hardness, and others of the more conspicuous properties of bodies. Lessons on objects may then be introduced gradually, and, to a large extent, they may be made to constitute simple practice in the application of previously acquired knowledge.

In dealing with the properties or qualities of objects, those only should be dwelt upon which render the objects valuable for the several uses in which they are employed. Thus, all children are alive to the fact that we cannot see through sponge, cork, india-rubber, or leather ; but to stop to describe these objects as *opaque* is a waste of time. On the other hand, although the children know equally well that we can see through glass, its property of transparency must be made a cardinal point in a lesson on glass, because it is this property which makes glass specially useful.

FIRST STAGE.

SHORT, simple, pleasing, and attractive should be the characteristic qualities of the first object lessons; so short as never to weary, so simple as to call for scarcely an appreciable effort, and as pleasant and attractive as play itself.

To train the senses, to cultivate habits of observation, to note, to compare, to contrast should be their aim.

Their method should be conversational. The conversations, however, should not take a desultory form; but should have a definite object and serve a definite purpose.

The lessons should form the first step in a complete system, the foundation on which future lessons are to be constructed, the key-note for other subjects of a similar character.

The subjects should be selected from simple "every-day things," with which the children are most familiar, and which are likely to prove the most interesting.

The little scholars should be encouraged not only to look at, to feel, to taste, to compare; but they should be led to talk about the things, and ask questions concerning them.

At this early stage, where the powers of concentration are so feeble, the object should be placed *as far as possible* in the hands of all the children. If this is impracticable, then the specimens should be of sufficient bulk to be seen distinctly by every member of the class; but whatever may require to be done by way of experiment, such as feeling, tasting, &c., should be done by the pupils themselves. "It is what the child *does*, that it learns to *know*."

The lessons of this *first* are offered as illustrations of

OBJECT LESSONS.

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the sort of object lessons suitable to children of from *four* to *five* years of age. They have for their definite aim and purpose to train the children,—

(1.) To discriminate between the following colours: white, black, red, yellow, and blue.

(2.) To distinguish and name the following lines and forms: straight line (perpendicular, horizontal, and oblique), bent line, crooked line, square, oblong, and ball-shape.

(3.) To discriminate between sweet, salt, and sour tastes.

(4.) To appreciate the general differences between rough and smooth, hard and soft, long and short, broad and narrow, thick and thin, heavy and light.

It is important that the children should not pass to the next stage till the subjects of this course are thoroughly mastered, not only by a few of the more clever scholars, but by the bulk of the class. The lessons need not be repeated in the same form, nay, should not; for the thoughtful teacher can exercise her class on the various ideas herein involved in an almost infinite variety of ways. Neither should the teacher slavishly follow the order of the different points in the lessons here given, much less confine herself to the identical questions in the text. Notes of object lessons can never be anything more than general guides to the careful teacher. They may assist her to confine herself to the definite purpose of the lesson, and point out the way in which she should strive to guide the thoughts of the children; but the actual questions to be asked and explanations to be given must always depend to a very great extent on the answers given by the children. The highest kind of teaching is that wherein the teacher by skilful questioning leads her scholars to imagine that they have discovered something new for themselves.

NOTE.—It is assumed that for *every* lesson the teacher will have a table and black-board before her class; and both so placed that *all* the scholars can see distinctly. Slates and pencils also should always be ready to hand.

LESSON I.

COLOUR.—WHITE AND BLACK.

For this lesson the teacher will require, in addition to the black-board and chalk, a sheet of drawing-paper, and a stick of charcoal or black crayon. Each child should have a slate, a small piece of chalk, and strips of black and white paper.

The attention of the children may be at once secured by drawing something attractive on the black-board—the outline of a tea-cup and saucer for instance.



Then the teacher will proceed somewhat as follows:—

“What have I been doing?” *Making a tea-cup and saucer*

“Could you drink from this tea-cup and saucer?” *No.*

“Why not?” *Because it is not a real tea-cup and saucer.*

“It is not real; it is a *picture* of a tea-cup and saucer.”

“Now answer me again; what have I made on the black-board?” *A picture of a tea-cup and saucer.*

“What did I make the picture with?” *With chalk.*

“What is the colour of the chalk?” *White colour.*

“What is the colour of the picture?” *White colour.**

“What have I made the picture on?” *On the black-board.*

* Of course, white is a combination of colours, and black denotes the absence of colour; but, as in ordinary life, we always speak of white and black as colours, there can be no need, in the Infant School at least, to depart from the common acceptation.

“Why do you say the *black-board*?” *Because the colour of the board is black.*

“Here is a piece of paper which I will pin on the black-board. Watch me while I make another picture of a tea-cup and saucer.”

[Make a similar outline with the black crayon.]

“What is the colour of the picture now?” *Black colour.*

“What have I made the picture on?” *A piece of paper.*

“What is the colour of the paper?” *White colour.*

“You have two strips of paper; show me the one which has the same colour as the black-board. In the right hands, please. Now hold up your white paper. Now hold up the black paper in the right hand, and the white paper in the left hand.”

The teacher draws a line on the black-board. “What have I made now?” *A line.*

“And now” [drawing a second line] ? *Two lines.*

“And now” [drawing a third line] ? *Three lines.*

Direct the children to take their pieces of chalk in their right hands. “Now make one line on your slates.”

“What colour is the line?” *White colour.*

“Make two lines. Make three lines. Make one more. How many have you now?” *Four lines.*

“Count them.” *One, two, three, four.*

“Now look about the room and on the table* and give me the names of any things which you can see of a black colour.” *Coal, boy's coat, teacher's dress, girl's hair.*

* It will be an advantage for the teacher to have on the table a few specimens—as a lump of coal, a strip of black cloth or velvet, a lump of sugar or salt, or any other object easily procurable, for further illustration.

"Name some white things which you can see." *The walls, paper, pinafore.*

"What do your mothers put into your tea which has a white colour?" *Milk.*

"What do you sometimes see spread all over the ground in very cold weather?" *Snow.*

"What colour has snow?" *White colour.*

"What animals have you seen with white coats?" *Cats, dogs, horses, cows, &c.*

"And what animals have you seen with black coats?" *Cats, dogs, horses, cows, &c.*

LESSON II.

COLOUR.—RED, YELLOW, BLUE.

For this lesson the teacher will require a sheet of drawing-paper, and red and yellow paints * or crayons of the best standard colours. The children to have strips of coloured paper to match. Balls of cotton, silk, or worsted, or skeins of wool, or any articles having pretty nearly the standard primary colours, should lie on the table.

The teacher, having fastened the paper to the black-board, proceeds:—

"What is the colour of this sheet of paper?" *White colour.*

"I will make a very pretty colour on this white paper." [Makes a broad band of red.]† "Perhaps some little child can tell me the name of this colour. If not I will tell you. Its name is *red*. Hold up your paper of this colour. What colour is this paper?" *Red colour.*

* Carmine or Chinese vermilion, chrome-yellow or gamboge, and ultramarine or cobalt blue may be taken as the best standard primary colours.

† The colours should have been prepared beforehand. The coloured bands should be placed about four inches apart, and the same paper will then serve for use in the First Lesson of Stage II.

"Now I will put another colour on the paper by the side of the red." [Makes a broad band of yellow.] "Its name is *yellow*."

"Show me your yellow papers. Hold up the yellow paper in your right hands, and the red in the left."

"Here is another pretty colour." [Makes a stripe of blue.] "Its name is *blue*. Hold up your blue papers."

"How many colours have I now shown you on this paper?" *Three colours.*

"What is the colour of the paper?" *White colour.*

"What is the colour of the board?" *Black colour.*

"How many colours then have I shown you in all?" *Five colours.*

Individual children should now be called to the table to select objects having colours similar to their papers, in other words to "match" the colours, and then to pick out articles having the particular colour named by the teacher.

LESSON III.

FORM.—POSITION OF LINES,* STANDING UP, LYING DOWN, LEANING.†

For this lesson each child should be provided with a short stick and a slate and pencil. The teacher should have a piece of string, and a "form" should be placed in the front of the class.

Draw two straight lines on the black-board, the one vertical, the other horizontal.

* Children before entering school will have acquired some idea of the shape of objects; but it is desirable so to perfect this knowledge that they may be able readily to classify objects by the prominent resemblances and differences in their forms.

† The terms "vertical" or "perpendicular," "horizontal," and "oblique" are better introduced at a later stage.

"What do you call these marks I have made on the black-board?" *Lines.*

"Are they placed alike?" *No.*

"I want two boys to come here. I will stand John on this chair, and Harry shall lie down on the form. I want Jane to point on the black-board to the line that *stands* upright like John. Now point to the line that is *lying down* like Harry. Then I may say that this line (pointing to the perpendicular line) like John is *standing upright*, and this line (pointing to the horizontal) like Harry is *lying down*. Take your sticks in your right hands. Show them standing up. Now lying down."

"Harry shall go to his seat, and John shall lean against the table with his arm resting on it."

"Is John standing straight up now?" *No.*

"Is he lying down like Harry was?" *No.*

"How is he standing?" *Leaning against the table.*

"Here is another line." [Teacher draws an oblique straight line.] "It does not stand upright and it is not lying down. It looks like John as he is *leaning* against the table."

"What name shall we give this line then?" *Leaning line.* "Take your sticks again. Make them *stand upright*. Now make them *lean*. Place them *lying down* on your desks."

"Here is a piece of string. I will stretch it between my hands."

"What line does it make now —?" *Lying down.*

"And now |?" *Standing upright.*

"And now /?" *Leaning.*

"And now \?" *Leaning.*

The children should lastly be directed to draw these lines on their slates, first as a copy from the black-board and then

to the order of the teacher. No matter how imperfect the result, it will serve its purpose to fix the *ideas* of vertical, oblique, and horizontal direction in their minds.

NOTE.—After what has been said previously (p. 7), it should be almost unnecessary to warn teachers that these brief notes of lessons afford no indication whatever of the rate of speed at which new ideas should be introduced. The principal colours might give material for half-a-dozen lessons instead of two; add so with regard to straight and curved lines. The teacher must be guided entirely by the rate at which she finds her young pupils able to absorb and appropriate fresh ideas.

LESSON IV.

FORM.—SHAPES OF LINES, STRAIGHT, BENT, AND CROOKED.

For this lesson the teacher should provide herself with a long flexible flat ruler or a piece of whalebone, and a yard of string. If possible the children should have short rulers.

The teacher taking the flat ruler and holding it by its ends in a horizontal position bends it thus  and asks—

"What have I done to the ruler?" *You have bent it.*

Then allowing the ruler to straighten itself.

"Is it bent now —?" *No.*

"What is it now —?" *It is straight.*

"Now ?" *It is bent.*

"Now —?" *Straight.*

"What do I use the ruler for?" *To draw straight lines with.*

"I will draw a line with the ruler —. What shape is this line?" *It is a straight line. A lying down line.*

"Yes, both answers are correct. We will say a lying down straight line."

"Here is another line." [Teacher draws vertical line.]

"What can you say about this | ?" *It is a standing upright straight line.*

"And these \ / ?" *Leaning straight lines.*

Draw a curved line with "chalk compasses," or with the aid of a piece of string.

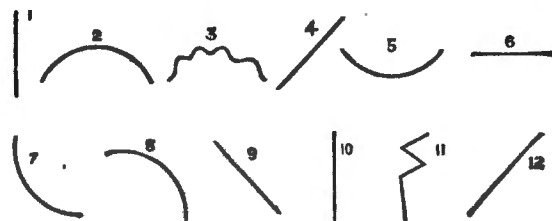
"I have drawn another line . It looks like the ruler when I had bent it. What shall we call it?" *A bent line.*

"Here is a stick. Is it straight?" *No.*

"What then?" *Crooked.*

"And what name will you give to this line  ?" *Crooked line.*

"I will now make on the black-board a number of lines.



Name them as I point to them."*

The terms "straight," "bent," and "crooked" may also be illustrated with a piece of string. When stretched between two boys it is straight; when hanging loosely it is bent; when laid across objects of various heights it is crooked.

The attention of the children should now be directed to any objects in the room which have straight or bent sides and edges, as the doors, windows, table, black-board, chairs, &c.

As a further exercise, lines may be drawn on the slates as a copy from the black-board, or to the order of the teacher.

* Individual scholars may be called to the front of the class to point to lines as named by the teacher.

LESSON V.

THE SQUARE.

Each child should be provided with a square, cut from a sheet of stiff paper or cardboard, four sticks* of equal lengths sharpened at the ends, and a few soft† peas. The teacher should have a large sheet of paper of square form, and strips of coloured paper (say red) to make a frame for the square.

Pointing to the black-board the teacher may proceed:—

"How many sides has this black-board?" *Four sides.*

"Count them." *One, two, three, four.*

"How many corners has the black-board?" *Four corners.*

"Count them." *One, two, three, four.*

"Take your slates. Count the corners. How many corners have your slates?" *Four corners.*

"And how many sides?" *Four sides.*

"You will learn about other kinds of corners by-and-by. At present I want you to try and remember the name we give to all corners like those of the black-board and slate. We call them *square corners*."

"There are other things in the room with square corners. Give me the names of some." *Table, door, picture, &c. &c.*

"Here is a sheet of paper which I will fix on the black-board. How many sides has it?" *Four sides.*

"How many corners?" *Four corners.*

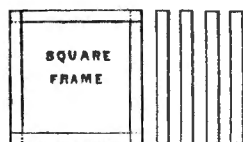
"What kind of corners are they?" *Square corners.*

* The sticks of the Kinder-garten used for peas-work will be found very convenient.

† The peas should be soaked about twelve hours in water, and be allowed to dry for an hour previous to being used.

"What do you call the wood placed round the outside of your slates?" *Frames.*

"Watch me while I make a *frame* to this sheet of paper."



"What colour have these strips of paper?" *Red.*

"How many strips must I use to make the frame?" *Four strips.*

"I will now take off the frame and put the strips of paper side by side on the black-board,—so."

"Can you tell me which is the longest strip?" *No.*

"Why not?" *They are of the same length.*

"Yes, and this tells me that the sides of my sheet of paper are all of the same—*length.*"

"Once more. How many sides has my sheet of paper?" *Four sides.*

"And what about their lengths? Is there one longer than the other?" *No, they are all of the same length.*

"How many corners has my sheet of paper?" *Four corners.*

"And what do we call the corners?" *Square corners.*

"I want you now to remember that this piece of paper, because it has four square corners and four sides of the same length, is said to be of a *square shape.*"

"You have a piece of paper of a square shape. Show it to me."

"Why do I say it is square?" Repeat after me—*Because it has four square corners and four sides of the same length.*

"I will now draw a square on the black-board, using the ruler."

"Here is the first line |."

"What kind of line is it?" *A straight line. A standing up line.*

"Here is the second line L."

"What kind of line is this?" *A straight line. A lying down line.*

"Now I will finish the square .

"How many straight sides has it?" *Four straight sides.*

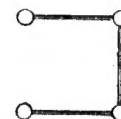
"What name do we give to the corners?" *Square corners.*

"And what is the shape called?" *A square shape.*

"Take your sticks. Put them together. Have they the same length? Lay them down again. Take one stick and fasten a pea at each end, thus .

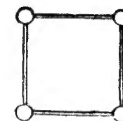
"Now take a second stick and put two other peas on in the same way .

"Take another stick and join these two as I have done."



"Then join the other ends with the remaining stick."

"See that you have square corners like the black-board."



Now tell the name of the shape of the frame you have made." *A square frame.*

LESSON VI.

AN OBLONG.

THE children should be provided with the necessary sticks and peas to make an oblong frame.

This lesson may be introduced (as indeed nearly all lessons should) by a few questions on the previous lesson, as a connecting link.

"How many corners has a square?" *Four corners.*

"What kind of corners are they?" *Square corners.*

"How many sides has a square?" *Four sides.*

"What can you tell me about the sides?" *They must be of the same length. They must be straight sides.*

"Here is another sheet of paper which I will fix on the black-board."

"How is it like a square?" *It has four square corners. It has four straight sides.*

"How is it unlike a square?" *Its sides are not all of the same length.*



"I will pin a frame to this paper as I did to the square. Here are two long strips for the long sides."

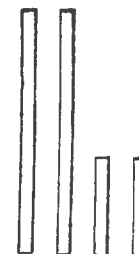
"What colour are they?" *Blue colour.*

"And here are two short strips for the short sides."

"What colour are they?" *Yellow colour.*

"I now take off the frame and place two long blue strips

side by side, and the two short yellow strips side by side, thus—



"Which of the blue strips is the longer?" *Neither. They are of the same length.*

"And of the yellow strips?" *They are of the same length.*

"Now I shall draw a figure on the black-board having four square corners and four straight sides, the two standing up lines shall be short, but of the same length; and the two lying down lines shall be long, but of the same length, and I shall ask you to remember its name. Here it is, and its name is *oblong* .

"Here is another oblong with the standing up lines longer than the lying down lines .

"And here is another leaning .

"Take your slates. How many long sides have they?" *Two long sides.*

"How many short sides have they?" *Two short sides.*

"Hold your slates up by the long sides, so . Now by the short sides, so .

"Of what shape are your slates?" *Oblong shape.*

The children should now be directed to make an oblong frame with the sticks and peas, as in the case of the square.

Lastly, they should be asked to point out things in the room, or select objects on the table, which have oblong shapes.

LESSON VII.

BALL-SHAPE,* SURFACE.

ARTICLES for illustration :—Balls of wood or india-rubber, marbles, oranges, shot of different sizes, apples, the coloured Kinder-garten balls, or any other spherical objects.

The teacher holding up, say, an india-rubber ball, asks—

“What is this I hold in my hand?” *A ball.*

“What is its shape?” *Round.*

“Here is a penny. What is its shape?” *Round.*

“But is the penny round like the ball?” *No.*

“Name some things you know which are round like the ball.” *An orange, a marble, &c. &c.*

“You may say that things which are of the same shape as the ball are of *ball-shape*.”

“Here is a marble. What is its shape?” *Ball-shape.*

“Here is an orange. What is its shape?” *Ball-shape.*

“How can I see what is *inside* this orange?” *Cut it with a knife. Peel it.*

“You say peel it. Where is the peel, on the inside or the outside?” *On the outside.*

* The preceding lessons on lines and shapes will probably be found sufficient for the *first stage*; but as spherical objects are more familiar to children than any other regular solid bodies, and as in some of the first-stage lessons reference is made to *ball-shaped* objects, this lesson is here introduced out of its logical order.

“What am I holding in my hand?” *An apple.*

“What part of the apple can you see?” *The outside.*

“Here is a painted ball. On what part of the ball is the paint put?” *On the outside.*

“I will now give you another word which means the same thing as outside, it is *surface*.”

“John shall come to the table and show me the *surface* of the orange and the apple, and Mary shall write on the *surface* of the black-board. You may all of you make a line on the *surface* of your slates.”

“Now look at the surface of this ball, and the surface of this slate. Are they alike?” *No; one is flat, the other is round.*

“This piece of wire you see is straight. I bend it over the ball. What shape has it now — ?” *It is bent.*

“You may say, then, that the surface of the ball is a *bent surface*.”

“Now tell me the names of some things which you see in the room that have *flat surfaces*.” *Table, wall, book, window-pane, &c. &c.*

“Tell me the names of things you can think of, which have *bent surfaces*.” *Balls, hats, &c. &c.*

“I cut this apple in two. What kind of surface is this” (pointing to the plane surface)? *A flat surface.*

“And this” (pointing to the curved surface)? *A bent surface.*

“How many flat surfaces has a penny?” *Two.*

“How many bent surfaces has a penny?” *One.*

“By which surface am I holding this penny?” *By the flat surface.*

“And now?” *By the bent surface.*

LESSON VIII.

FORM AND COLOUR (A Test Lesson).

A box may be placed on the table containing any or all of the following articles, or any other similar ones ready to hand:—Balls of coloured * worsted or wool, squares and oblongs of coloured * cloth or ribbon, a square envelope, an oblong envelope, a flat ruler, a book, an egg, a tea-cup, a half-crown.

"I have in this box a number of different things. I am going to take them out one at a time and ask you to tell me all you can about them."

"What is this?" *An egg.*

"What is the outside of the egg called?" *The shell.*

"By what other name may we call the outside?" *The surface.*

"What kind of surface has the egg?" *A bent surface.*

"What is the colour of the shell?" *White colour.*

"What are eggs useful for?" *To eat.*

"Here is a bunch of balls of cotton. How many are there? Count them." *One, two, three, four, five.*

"What is the colour of this one?" *White.*

"And this?" *Blue.*

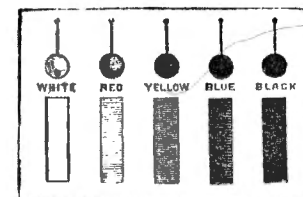
"And this?" *Yellow.*

"And this?" *Red.*

"And this?" *Black.*

The teacher may now hang these balls in a row over a sheet of paper on the black-board. Then, producing five strips of paper, or cloth, or ribbon of similar colours, require the children to match the colours. The strips may be pinned on beneath the balls.

• White, black, red, yellow, and blue only.



"Here is an envelope. What colour is it?" *White colour.*

"How many sides has it?" *Four sides.*

"How many corners?" *Four corners.*

"What kind of corners?" *Square corners.*

"What kind of sides has it?" *Straight sides.*

"Are all the sides of the same length?" *No.*

"How many are long?" *Two.*

"How many are shorter?" *Two.*

"What shape is the envelope?" *Oblong shape.*

"Here is another envelope. What shape is this?" *Square shape.*

Any other articles can be dealt with similarly, care being taken to introduce only such colours and forms as have been introduced in the previous lessons.

LESSON IX.

SWEET AND SALT TASTES.

The children should be provided with small pieces of loaf-sugar, salt, chalk, and liquorice, and the teacher should have larger specimens on the table.

The black liquorice and the white chalk, sugar, and salt will serve to form a connecting link with the preceding lessons on colour, &c.

Thus, holding up a piece of liquorice, the teacher may commence:—

"Of what colour is this liquorice?" *Of a black colour.*

"And of what colour is this chalk?" *Of a white colour.*

"How many white pieces have you?" *Three white pieces.*

"How many more white have you than black?" *Two.*

"What do you taste with?" *The tongue.*

"Your mother puts sugar in your tea—why?" *To make it sweet.*

"Place the chalk on one side, and put the other two white lumps to the tip of your tongue. Can you tell me which of the two is sugar?"

"How do you know that?" *Because it is sweet.*

"Show me the sugar."

"Can you tell me what the other lump is?" *Yes, it is salt.*

"How do you know it is salt?" *Because it tastes salt.*

"What is the colour of sugar?" *White colour.*

"What is the colour of salt?" *White colour.*

"Then sugar and salt have the same colour. Now taste the sugar and salt again. Have they the same taste?" *No.*

"Then sugar and salt have not the same taste."

"Repeat after me:—*Sugar and salt have the same colour, but not the same taste.*"*

"Taste the liquorice. Does it taste like the salt or the sugar?" *Like the sugar.*

"What taste has the liquorice?" *A sweet taste.*

"Are the liquorice and the sugar alike in colour?" *No; the liquorice is black, the sugar is white.*

* "All knowledge finally resolves itself into differences and agreements"
BAIN.

"Then sugar and liquorice are alike in taste,* but they are unlike in colour."

"Repeat after me:—*Sugar and liquorice are alike in taste, but unlike in colour.*"

The children may now be called on to name some of the uses of sugar and salt, and also to name any sweet substances such as milk, fruits, &c.

Lastly, the teacher may elicit from the children that chalk is without taste.

LESSON X.

SWEET AND SOUR TASTES.

A LEMON, some clear water, a little vinegar, and solutions of sugar and salt, and a mixture of lemon-juice and water—the solutions and mixture in clear glass bottles—will be wanted for this lesson.

Recapitulation of the preceding lesson should form the introduction to this.

"What is the taste of sugar?" *It is a sweet taste.*

"What is the taste of salt?" *It is a salt taste.*

"How are loaf sugar and salt alike?" *In colour.*

"In what are they unlike?" *In taste.*

"What taste has liquorice?" *A sweet taste.*

"What colour is liquorice?" *Black colour.*

"How are sugar and liquorice alike?" *In taste.*

"In what are they unlike?" *In colour.*

"How are salt and chalk alike?" *In colour.*

"How are they unlike?" *In taste.*

"What is the taste of chalk?" *Chalk has no taste.*

* Of course at this stage it is only broad similarities that can be noticed.

"I have here [showing a lemon] something which most of you know. What is it?" *A lemon.*

"What colour has the lemon?" *A yellow colour.*

"I will cut it into small pieces on this plate, and several of you shall taste the juice."

"Has it a sweet taste?" *No.*

"A salt taste?" *No.*

"No, it is neither sweet nor salt. We call the taste of the lemon-juice a *sour* taste."

"Here I have some vinegar in a bottle. I want a girl to taste it."

"Does it taste like the sugar or the lemon?" *Like the lemon.*

"What kind of taste did we say the lemon had?" *A sour taste.*

"Then what taste has the vinegar?" *A sour taste.*

"Then how are lemon-juice and vinegar alike?" *They both have a sour taste.*

An unripe apple, a crab-apple, an unripe orange, a Seville orange, or any unripe fruit, will serve for further illustration of sour taste.

The following experiment will serve as a test, and will prove interesting to the children, as it gives them something to find out for themselves.

Provide four clear glass bottles. Fill the first with clear water, the second with a clear solution of sugar, the third with a clear solution of salt, and the fourth with a clear mixture of essence of lemon or lemon-juice and water.

By merely looking at the bottles the children are unable to distinguish the one from the other.

Pour a little of the liquid from the bottles into saucers or plates, and the scholars may be called upon to find out which is water, having no taste, which is the salt solution, and so

on, by dipping the tip of the finger into the saucers and applying it to the tongue.

LESSON XI.

SIZE.

PROVIDE a number of objects of various sizes, such as large and small balls of india-rubber, cotton, worsted, or wool, marbles, oranges, apples, books, stones, sheets of paper, or any other articles which come readily to hand.

The teacher will proceed somewhat as follows:—

"You see I have a number of things on the table. Here are oranges. What shape have the oranges?" *A ball shape.*

"Here are marbles. What shape have they?" *A ball shape.*

"You know some things are large and some things are small. Here is an india-rubber ball, an orange, and a marble. Which is the largest?" *The orange.*

"And which is the smallest?" *The marble.*

"I want James to come to the table and pick out a small book. Grace shall find me a large book. Harry shall choose a small marble, and William shall look out for me the smallest orange."

"Here is a book. I want Tom to find me another of the same size."

"Name some large things in the room." *Stove, table, black-board, cupboard, door, window, &c. &c.*

"Name some small things." *Books, pencil, ink-wells, &c. &c.*

"Which is the smaller, the slate or the black-board?" *The slate.*

"What is the shape of the slate?" *An oblong.*

"I will draw an oblong on the black-board." [Draws a small oblong.]

"Is it small or large?" *Small.*

"Then what will you call this?" [Drawing a larger figure.] *Large.*

The teacher may then draw on the black-board, or exhibit, various vessels of different sizes, and proceed thus:—

"What is this?" *A basin.*

"And this?" *A tea-cup.*

"Which will hold the most water?" *The basin.*

"Why?" *Because it is larger than the tea-cup.*

"And what is this?" *A tumbler.*

"And this?" *A wine-glass.*

"Which will hold the most water?" *The tumbler.*

"Why?" *Because it is larger than the wine-glass.*

"I will fill the wine-glass with water and pour it into the tumbler. Is the tumbler full?" *No.*

"We will put in another wine-glassful, and another. How many wine-glassfuls have I put in?" *Three.*

"Now the tumbler is full. How much larger is the tumbler than the wine-glass?" *Three times as large.*

"Some animals are large, others are small. Give me the names of some small animals you know?" *Mouse, fly, beetle, bird, &c. &c.*

"Now some large animals you have seen?" *Horse, sheep, cow, &c. &c.*

"Which is the larger—a cow or a sheep?" *A cow.*

"Which is the smaller—a sheep or a cat?" *A cat.*

LESSON XII.

LENGTH.

EACH child should be provided with half-a-dozen strips of tape, or sticks of different length.

Place three boys of different heights in front of the class and proceed thus:—

"Which is the tallest of these three boys, Tom, Harry, or James?" *Tom.*

"Which is the shortest?" *Harry.*

"We will measure their heights with this long ruler, and draw lines on the black-board to show how tall the boys are."

"Which line shows how tall Tom is?" *The top line.*

"Which shows how tall Harry is?" *The bottom line.*

"And which shows how tall James is?" *The middle line.*

"Which is the longest line?" *The top one.*

"And the shortest?" *The bottom line.*

"Here are two pieces of tape. What is the colour of this?" *Red.*

"And this?" *White.*

"Which is the longer?" *The red.*

"I will pin these two pieces of tape on the black-board."

"Here is a ruler. I put it by the side of the white tape. Which is the longer?" *They are of the same length.*

"Now let us see how many times the red tape is longer than the ruler. Count as I measure." *One, two, three.*

"Then the red tape is how many times longer than the ruler?" *Three times longer.*

"And how many times longer than the white tape?" *Three times.*

In same way measure black-board, table, &c., and compare lengths.

"You have a bundle of sticks.* Show me the shortest. Now the longest. Now place them all in a row beginning with the longest, then the next longest, like I draw these lines on the black-board."



The children may now be directed to name long and short things in the rooms, the longest maps or pictures on the walls, the longest pointers, &c. &c.

Lastly, they may draw long and short lines on their slates to the teacher's order.

LESSON XIII.

BREADTH.

THIS lesson should be given in a manner precisely similar to the preceding. The teacher should provide strips of coloured paper or ribbon of different widths, and the children should first be exercised in selecting the broad and narrow pieces. Then pieces may be selected of the same width as others shown. Broad and narrow lines may be drawn on the black-board. Parallel lines may be drawn at different distances apart, and the children may be required to tell the wide and narrow spaces. Lastly, the children may be directed to measure certain things for themselves in order to find the wider and the narrower; or they may be instructed to draw lines wider apart or closer together on their slates.

* Or ribbons, or strips of paper.

LESSON XIV.

THICKNESS.

In the same way as in Lesson XII., the lesson on thickness will necessitate the provision of a number of objects for comparison of different thicknesses—such as different papers, from tissue to cardboard, pieces of glass, bits of boards, &c. Thick and thin "bread-and-butter" may be contrasted; as also the peel of an orange with the skin of an onion or a boiled potato, thick and thin shoes, clothing, &c. &c. An occasional question on the subjects of the foregoing lessons must not be forgotten. A comparison of the length, breadth, and thickness of different objects may well form the subject of another lesson to come in here.

LESSON XV.

WEIGHT.

For this lesson provide small specimens of any or all of the following or similar articles: cork, india-rubber, sawdust, sand, woods, stones, metals, &c., and three tumblers each two-thirds full of water.*

"I have a little sand in this paper, and a little sawdust in this, and here I have two glasses partly filled with water, and you must watch me while I put the sand in one glass and the sawdust in the other."

"I put in the sand first. Where does it go?" *To the bottom.*

"Now the sawdust in the other glass. Where do you see it?" *On the top of the water.*

* If possible, each child should be provided with a bit of cork, wood, and metal of about the same size.

"Why does the sand sink to the bottom of the water?"
Because it is heavy.

"And why does the sawdust remain at the top?" *Because it is light.*

"I now put a stone and a cork in the other glass. Where is the stone?" *At the bottom of the water.*

"And where is the cork?" *At the top of the water.*

"Then what shall we say about the stone because it sinks to the bottom?" *It is heavy.*

"And what may we say about the cork because it swims at the top?" *It is light.*

"Here is a small piece of india-rubber, and here an iron nail. I put them in the water. Which is the heavier?"
The nail.

"How do you know that?" *Because it sinks to the bottom.*

"Here is a piece of wood; it swims near the top of the water. What will you say about the wood?" *It is lighter.*

"Now tell me how cork, sawdust, and india-rubber are alike?" *They are light. They all swim on the water.*

"Repeat after me:—

"Things that are heavier than water sink to the bottom.

"Things that are lighter than water float near the top."

"This penny sinks to the bottom; is it heavier or lighter than water?" *Heavier.*

"This paper floats on the top; is it heavier or lighter than water?" *Lighter.*

"I have here a bottle with a little water in it. What colour have I made the water?" *Red.*

"Yes, I have made the water red for you to see it better. Now I will pour in some oil. Where do you see the oil?"
At the top of the water.

"Why is it at the top?" *Because it is lighter than the water.*

"I shake the bottle and so mix the water and oil; but when I put the bottle on the table you may see the oil going to the top again because it is lighter than the water."*

"Suppose I put a cork at the bottom of the water, will it remain there when I remove my hand?" *No, it will rise to the top.*

"Why?" *Because it is lighter than the water.*

"We can tell heavy and light things by holding them in our hands. You have bits of cork, wood, and iron. Hold them in your hands and say which you think is the heavier, and which the lighter."

Further illustration may be had by bringing individual scholars to the table to test weight of lead, stone, iron, &c., by holding in the hand.

LESSON XVI.

HARD AND SOFT.

PROVIDE objects as in the last lesson: also a piece of bread and a boiled potato or turnip.

"What have I on this plate?" *A piece of bread.*

"What do you call the outside?" *The crust.*

"And the inside?" *The crumb.*

"When you bite the crust how does it feel?" *Hard.*

"And how does the crumb feel when you bite it?" *Soft.*

* If a little quicksilver be at hand, the experiment may be made more interesting by showing how it remains beneath the water because it is heavier. Three distinct layers are thus shown.

"What does your mother put on your bread before she gives it to you to eat?" *Butter.*

"Is the butter hard or soft?" *Soft.*

"Tell me something you eat for dinner besides bread which is soft?" *Potatoes, cabbage, turnips, &c.*

"Here is a boiled potato. I want a girl to squeeze it. How does it feel?" *It feels soft.*

"Here is a piece of wood. Squeeze it. Which is the harder, the potato or the wood?" *The wood.*

"You see I can cut the potato easily with my knife; I can also cut the wood, but not so easily."

"Can I cut this stone?" * *No.*

"Why not?" *It is too hard.*

"Which is the hardest, the stone, wood, or potato?" *The stone.*

"Tell me some other things which are so hard that I cannot cut them with my knife?" *Iron, glass, &c.*

"Here is a piece of cork. Can I cut this?" *Yes.*

"Then what will you say about it?" *The cork is soft.*

"You may say that *things which I can cut easily with a knife are soft, and things which I cannot cut with a knife are hard.*"

Experiments in cutting may be made on other substances, such as an iron nail, a piece of glass, lead, india-rubber, slate, hard and soft wood, a turnip, &c.

The children may then further test by squeezing with the fingers.

* An old knife can be used for trial on stone, iron, glass, &c.

LESSON XVII.

ROUGH AND SMOOTH.

SMALL strips of sand-paper, brown paper, and smooth writing-paper may be given to the children.

"How many strips of paper have I given you?" *Three.*

"Pass your forefinger along each strip. Do they feel alike?" *No.*

"This piece [holding up the sand-paper] is called sand-paper. How does it feel when you rub it?" *It feels rough.*

"Now try the white paper. How does that feel?" *It feels smooth.*

"Now the brown paper?" *It feels rough.*

"Which feels the rougher, the sand-paper or the brown paper?" *The sand-paper.*

"What do we call the outside of a thing?" *The surface.*

"What kind of surface has the sand-paper?" *A rough surface.*

"Pass your fingers across your slates. What kind of surface have your slates?" *A smooth surface.*

Children may now be called to the table to feel any other substances which the teacher may have provided, such as wood, polished and rough, marble, cloth, apple, orange, pencil, &c. &c.

The teacher will note that in the preceding lessons the leading idea has been not so much to impart new information as to cultivate habits of observation, comparison, and discrimination, and to gather up the scattered and uncertain knowledge acquired before entering school, for the purpose of applying them in the systematic examination of the more common objects which we see around us.

We are now in a position to give simple lessons on particular objects; but the teacher's sole aim should be to lead the children to apply the ideas brought out in the preceding lessons to the examination of new objects. The succeeding lessons should in fact serve to *test* and *increase* the powers of observation, and the knowledge already acquired.

LESSON XVIII.

A SLATE-PENCIL BOX.

THE teacher may have on the table any other small boxes* for comparison and illustration.

Teacher [holding the box before the class] will proceed:—

"What is this I hold in my hand?" *A box.*

"You have seen teacher take something from boxes like this; what was it?" *Slate pencils.*

"What is the box made of?" *Wood.*

"What is this I am drawing out?" *The lid.*

"We will look at the lid first. How many sides has it?" *Four sides.*

"How many corners?" *Four corners.*

"What kind of corners are they?" *Square corners.*

"How many long sides has the lid?" *Two long sides.*

"How many short sides?" *Two short sides.*

* If the children use the Kindergarten "Gifts," the box of Gift III. may be substituted for the pencil-box, and each child can have a box placed before it.

"What name do we give to a figure which has two long sides and two short sides and four square corners?" *An oblong.*

"Then what is the shape of this box lid?" *Oblong shape.*

"Now look at the box itself. What do you call this part of the box [pointing to the bottom]?" *The bottom.*

"And these two pieces [pointing to the sides]?" *The sides.*

"Of what shape is the bottom?" *Oblong shape.*

"And what shape have the sides?" *Oblong shapes.*

"Now look at the ends. What is the shape of this end?" *Square shape.*

"Why do you say it is of a square shape?" *Because it has four sides of the same length and four square corners.*

"Now count all the corners of the box. How many are there?" *Eight corners.*

"And of how many pieces of wood is the box made, without the lid?" *Of five pieces.*

"What are they?" *Two sides, two ends, and the bottom.*

"You said the box was made of wood. Is the wood hard or soft?" *Soft.*

"How can you tell that?" *Because we can cut it with a knife.*

"Is the wood very soft?" *No.*

"Tell me something which is much softer?" *Butter, cake, bread, &c.*

"Now James shall pass his finger across the surface. How does it feel, rough or smooth?" *Rough.*

The teacher may now lead the children to compare the pencil-box with any other boxes she may have on the table.

LESSON XIX.

A BASKET OF VEGETABLES.

ANY or all of the following vegetables should be placed in the basket: potatoes, long and short carrots, onions, radishes (long and short, white and red), turnips, and parsnips. A boiled potato and turnip will also be useful.

Attention may first be directed to the basket, the bent handle and its use, the bent sides, the uses of a basket, and the substance of which it is made.

The vegetables should now be removed from the basket one by one, and a little conversation carried on about each. Thus on the turnip:—

"Here is a turnip. What is its shape?" *Ball shape.*

"What colour is it?" *White colour.*

"Squeeze it. Is it hard or soft?" *Hard.*

"Is it very hard?" *No.*

"Why do you say so?" *Because you can cut it with a knife.*

"How could I make it softer?" *By boiling it.*

"What is the outside part of the turnip called?" *The skin or peel.*

"What are turnips used for?" *For us to eat.*

"What does mother do with the turnips before she boils them?" *Washes them. Peels them.*

Again on the onion:—

"Smell this. What is it?" *An onion.*

"How can you tell an onion from a turnip?" *By its smell.*

"Mary shall come to the table and shut her eyes. I have the turnip in one hand and the onion in the other, and she shall tell me which is the onion by smelling each."

"What is this on the outside of the onion?" *The skin.*

"What is the colour of the onion when I have removed the skin?" *White colour.*

The other vegetables* may be treated in a similar manner, and the children may select those they eat only when boiled or only when raw, they may tell how the boiled vegetables differ from the raw, the colours may be contrasted, the long and short selected, and so on.

LESSON XX.

SCHOOLROOM TABLE AND CHAIR.

THE teacher directs the children to look at the table and tell her anything they can about it.

First child.—*It has four legs.*

Second child.—*It is made of wood.*

Third child.—*The top is flat.*

Fourth child.—*The top has four corners.*

Fifth child.—*The top is oblong in shape.*

"Now look at this chair which I will place on the table. Tell me anything in which they are both alike."

First child.—*They are both made of wood.*

Second child.—*Each has four legs.*

"Now I want you to give the names of some of the parts of the chair."

Pointing to seat. "What is this part called?" *The seat.*

"Why do you think it is called the seat?" *Because it is the part we sit on.*

Touching the back. "What is this part called?" *The back.*

"What is the use of the back?" *To lean against.*

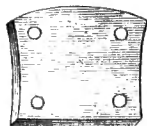
* Of course, if the names are not known, they must be given, and the children must be exercised in selecting at sight until they can readily distinguish the one from the other.

"If the seat had no legs where should we be sitting?"
On the floor.

"Then what is the use of the legs?" *To keep the seat off the floor.*

"These cross pieces of wood [pointing to the bars] are called *bars* or *rounds*, and I must tell you what they are for. They are to keep the legs firm. How many bars has this chair?"
Three bars.

"Look at the seat again. How many sides has it?" *Four sides.*



"What is the shape of three of the sides?" *Bent or curved.*

"What is the shape of the top of the back?" *Bent or curved.*

"How many pieces is the back made up of?" *Of five pieces.*

"How many are upright pieces?" *Two pieces.*

"And how many are lying down?" *Three pieces.*

The teacher should now exercise the children in comparing this chair with another of a different kind.

Other lessons in this stage (if necessary) may be given on a door, window, slate, book, and black-board.

SECOND STAGE.

THE lessons of the second stage* are constructed on the lines of the first stage. A few ideas, probably new to the majority of the class, and a few new names are introduced; but the object in this, as in the first stage, is rather to train to habits of observation and comparison than to impart information.

The following are the definite subjects dealt with:—

- (1.) Colour.—The secondary colours—orange, green, and purple.
- (2.) Form.—Angle, triangle, circle, cube, brick-shape.
- (3.) Sweet, sour, and bitter tastes.
- (4.) Measures of length—the inch, foot, and yard.
- (5.) Properties of bodies—adhesive, porous, transparent, opaque, brittle, flexible, tough.
- (6.) Common objects—brick, orange and lemon, egg, cabbage, cocoa-nut, and glass.

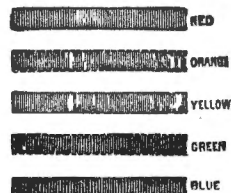
LESSON I.

THE SECONDARY COLOURS.—ORANGE AND GREEN.

FOR this lesson the teacher will require red, yellow, and blue paints or crayons as in Lesson II., Stage I.; also a ripe orange, a bunch of green grass, and a few green leaves. The children should be supplied with strips of red, orange, yellow, green, and blue papers.

Pin the sheet of paper used for Lesson II., Stage I., on the black-board. Ask for the names of the colours there shown.

* Suitable for children of from about four-and-a-half to five-and-a-half years of age.



Direct the children to watch carefully while you make another colour by mixing red and yellow.* [The teacher will draw a band of orange between the red and yellow.]

"What two colours have I mixed to make the new colour?" *Red and yellow.*

"What is this I am holding in my hand?" *An orange.*

"Now look at the new colour on the paper and the colour of the orange. What do you notice?" *The colours are alike.*

"Then you may call this new colour orange colour."

"Why do I call it orange colour?" *Because it is of the same colour as an orange.*

"How did I make orange colour?" *By mixing red and yellow colours.*

"You may also call orange a *mixed colour* because it is made by mixing red and yellow."

"Show me your orange-coloured paper."

"Hold up the two colours which made the orange."

Next, take a bunch of grass and a few green leaves and ask for the names of these objects, and perhaps some little scholar will tell the colour; and proceed—

"Now I shall mix the yellow and blue paints,† and you may tell the name of the new colour which I make on the paper." [Draw a band of green between the yellow and blue.]

* Three parts red to five parts of yellow will produce a good orange colour. The teacher should practice the mixing before giving the lesson, so as to ensure the proper colour.

† Eight parts of blue to five of yellow will produce a good green.

"What is the name of this colour?" *Green colour.*

"How did I make it?" *By mixing yellow and blue.*

"What kind of colour may I call green because I got it by mixing?" *A mixed colour.*

"Name two mixed colours." *Orange and green.*

"What colour will red and yellow make?" *Orange colour.*

"And what colour will yellow and blue make?" *Green colour.*

"Show me your green paper. Hold up the two colours which make the green."

"Now the two which make the orange."

"What colours is green made of?" *Of yellow and blue.*

"What colours is orange made of?" *Of red and yellow.*

"What colour must I mix with red to make orange?" *Yellow colour.*

"What colour must I mix with blue to make green?" *Yellow colour.*

If the teacher has crayons the children will be interested in making the mixed colours themselves.

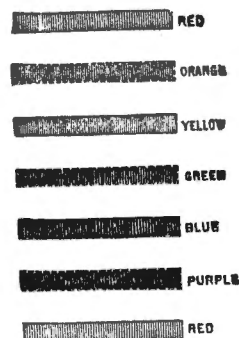
The coloured Kindergarten balls and skeins of coloured wools will serve for further illustration.

LESSON II.

THE SECONDARY COLOURS.—ORANGE, GREEN, AND PURPLE.

PAINTS or crayons and coloured papers, as in the preceding lessons. The same sheet of paper with the coloured bands to be placed on the black-board.

Commence by recapitulation of the last lesson. Draw another band of red beyond the blue.



"We have mixed red with yellow, and blue with yellow; we have now to make one more mixture. Look on the paper and say which two colours we have not yet mixed?" *Red and blue.*

"Right. We will now mix them." [Teacher draws a broad purple* line between the red and blue.]

"The name of this new colour is *purple*."

"What colour must I mix with red to make purple?" *Blue colour.*

"How did I make the purple colour?" *By mixing blue and red.*

"What kind of a colour is purple?" *A mixed colour.*

"How many mixed colours have we made?" *Three colours.*

"What are their names?" *Orange, green, and purple.*

"How many colours does it take to make these three mixed colours?" *Three colours.*

"What are their names?" *Red, yellow, and blue.*

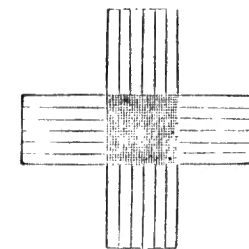
"Take your papers. Show me the purple colour. Hold up the two colours which make purple."

The teacher should continue these and similar exercises

* Equal parts of red and blue will produce a good purple.

until all her scholars can distinguish the six different colours, and tell how to produce the mixed colours.

An interesting experiment may be made with crayons as a further illustration. Make crosses with parallel lines, as in the sketch. The horizontal band to be of one primary colour,



and the vertical band of another. If the part intersected be rubbed the secondary colour will be produced.

As a test exercise, to occupy the time, probably, of another lesson, take skeins of Berlin wool of the proper colours, cut into short lengths, mix, and give to each child a small bundle. The children to separate and arrange the colours in the order indicated by the teacher.

LESSON III.

ANGLES, TRIANGLES.

RIGHT-ANGLED, scalene, and equilateral triangles cut from cardboard to be given to each child.

Teacher [holding up a slate]. "How many corners has this slate?" *Four corners.*

"What kind of corners are they?" *Square corners.*

"Of what shape is the slate?" *Of an oblong shape.*

"How many square corners has an oblong?" *Four square corners.*

"How many sides has a square?" *Four sides.*

"How many square corners has a square?" *Four square corners.*

"Now I will make a square corner on the black-board by



drawing two straight lines. What kind of lines are they?" *Straight lines.*

"What do you call this line [pointing to the horizontal]?" *A lying down line.*

"And this [pointing to the perpendicular]?" *An upright line.*

"What kind of corner do these lines make when they meet?" *A square corner.*

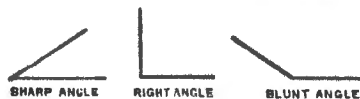
"I shall now give you another name for the point or square corner made by two lines where they meet. It is *angle*."

"And I want you to remember, too, that the point or angle made by a lying down and an upright line is called a *right angle*."

[Showing a finely-pointed pencil.] "What kind of point has this pencil?" *A sharp point.*

"And this one [showing pencil with blunt point]?" *A blunt point.*

"Now some angles are *sharp* and some are *blunt* angles."



"Here are three angles. What is the name of the middle angle?" *A right angle.*

"Which is the sharp angle?" *The top angle.*

"And which is the blunt angle?" *The bottom angle.*

"I want you to call all angles less than the right angle *sharp* angles, and all angles greater than the right angle *blunt* angles. Or you may call them *small* angles and *large* angles."

"Here I have a piece of cardboard. How many corners has it?" *Three corners.*

"What kind of corner is this [pointing to right angle]?" *A square corner.*

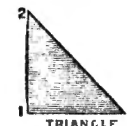
"And what can you say of these [pointing to the acute angles]?" *They are sharp corners.*

"I make a figure on the black-board like the cardboard."

"What kind of angle is this [pointing to 1]?" *A right angle.*

"And these [pointing to 2 and 3]?" *Sharp angles.*

"How many angles has this figure?" *Three angles.*

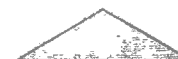


"Yes, and we may call the figure a *three-angle*, but there is a little word *tri* which means three, and we call the figure a *triangle*."

"How many sides has a triangle?" *Three sides.*

"And how many angles?" *Three angles.*

"Here is another triangle. How many sharp angles has it?" *Two sharp angles.*



"And what kind of angle is the other?" *A blunt angle.*

"Here is another triangle. What kind of angles has it?"
Sharp angles.



"I want you now to say *acute* for sharp, and *obtuse* for blunt."

Exercise with the forms held by the children thus—
Point to acute angle, right angle, obtuse angle. Show triangle with a right angle, with three acute angles, &c.

LESSON IV.

CURVED LINE, CIRCLE, RING.

ARTICLES for illustration:—Circles and rings cut from cardboard for the scholars, and any circular objects and rings for the teacher's use.

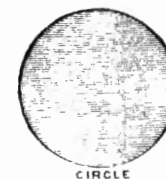
"I draw a square on the black-board. How many sides has it?" *Four sides.*

"How many sides has a triangle?" *Three sides.*

"What kind of lines are the sides of squares, oblongs, and triangles?" *Straight lines.*

"What name did we give to a line like this ?" *A curved line.*

"I will now, with this piece of string, show you how to make a figure quite unlike the square or the triangle. You see I press one end of the string on the black-board with the forefinger of my left hand, and with the opposite end of the string and a piece of chalk in my right hand I make a curved line *with both ends meeting.*"



"How many lines have I made?" *One line.*

"And what kind of line?" *A curved line.*

"You may call this figure I have made a *circle.*"

"Now, how many lines are there round a circle?" *One line.*

"What is the shape of the line?" *A curved line.*

"How many angles has a circle?" *No angles.*

"Now tell me the names of some things which are of the same shape as this circle?" *Penny, button, plate, &c.*

"What is the shape of the side of this box?" *Oblong shaped.*

"And what is the shape of the end?" *Square shaped.*

"And what may I call the shape of this biscuit?" *Circle shaped.*

"And this penny?" *Circle shaped.*

"What name do you give this thing I have on my finger?"
A ring.

"Show me the paper ring I have given you."

"I will show you how to make paper rings. Or, perhaps, you can show me. Here is a circle-shaped piece of paper. How can I make a ring?" *Cut out the middle.*



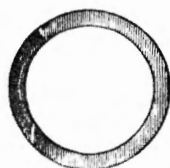
"Very well, I will cut out the middle; here it is. Will that do?" *No.*

"Why not?" *It is not round.*

"You may say it is not circle-shaped instead of not round."

"Which side is not circle-shaped?" *The inside.*

"Very well, I will cut it circle-shaped."



"Now tell me what toy girls and boys often play with in the streets like this ring." *A hoop.*

Exercise with the cardboard forms, and then let the children draw circles and rings on their slates. Of course the drawings will be very imperfect, but that is of little consequence so long as the results show that the scholars have grasped the ideas of the lesson.

LESSON V.

CUBE AND BRICK-SHAPE.

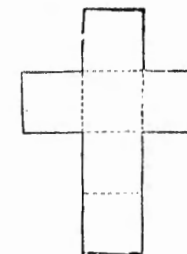
THE cubes and "bricks" of the Kindergarten gifts will serve for this lesson. If these are not at hand, a cube and brick can be cut from a turnip, a potato, or a piece of soap or wood, or can be made with a lump of stiff putty.

The children taking up their cubes will have their attention directed to the corners and the sides or faces.

"Count the number of corners. How many are there?" *Eight.*

"Count the sides or faces. How many?" *Six.*

Where the Kindergarten materials are not in use, a cubical box will be of great advantage because of its size. It can be made with a piece of cardboard as represented in the figure. The dotted lines show how the card is to be folded.



"Look at each face and tell its shape." *Square shape.*

"Look again at the faces and show me the largest and the smallest." *They are all of the same size.*

"We call this piece of wood, which has six square faces, a cube."

"Now, how many faces has a cube?" *Six faces.*

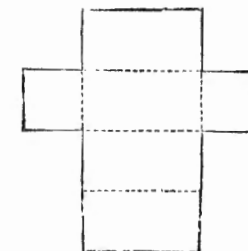
"And what is the shape of each face?" *Square.*

"And what name do we give to an object which has six square faces?" *A cube.*

Next, the attention of the children may be directed to the brick-shaped solid either in their hands or in the hands of the teacher. They should be called to note the number of faces and their oblong shapes. The pieces may then be compared with a building-brick, and the children told that things having the same shape as a brick may be called *brick-shaped*. Questions should then follow, such as:—

"How many faces has a brick?" *Six faces.*

The brick-shaped box can be made from cardboard as here shown.



"What is the shape of each face?" *Oblong.*

"What is an oblong?" *A figure with two longer and two shorter sides and four square corners.*

Lastly, the children may be shown how to make a box of cardboard of the same shape as the brick.

LESSON VI.

A TEST LESSON.—FORM AND COLOUR COMBINED.

PROCURE a packet of thin cards* about four inches long and three inches wide; also sheets of coloured papers, good representatives of the six colours—red, orange, yellow, green, blue, and purple.

Cut each of the following plane figures—square, oblong, triangle, and circle—three times from *each* coloured paper, and paste neatly on the centre of the cards. This will give 72 cards, of which one of each form and colour (24 cards) will be retained by the teacher, and the remainder (48) will be distributed among the scholars.†

The lesson may be conducted in various ways.

(1.) The teacher may show a card and direct all children to stand up that have a card containing, first, the same shape, and, secondly, the same colour. All the forms and colours may be gone through in this way.

(2.) The children may be called on to show forms and colours to order of teacher. Children who have triangles show them. Now blue triangles only, now red, now yellow, and so on for all the forms and colours.

* Say one hundred; they will be useful in the succeeding stages.

† If there are more than forty-eight scholars in the class, of course more cards must be prepared.

(3.) The children may be called on individually to describe the colour and form, thus, "The shape on my card is an (oblong), and its colour is (green)." "The shape on my card is a (circle), and its colour is (yellow)," and so on.

This lesson should be repeated in a varied form until all the scholars are perfectly familiar with the forms and colours included in the First and Second Stages.

LESSON VII.

SWEET, SOUR, AND BITTER TASTES.

FOR this lesson the teacher should provide a leaf of rhubarb, and some at least of the following or other bitter substances: rue, hops, quinine, wormwood, quassia, tansy, gentian.

Introduce this lesson by questions on the "taste" lessons in the First Stage.

"What is the taste of sugar?" *A sweet taste.*

"Of a ripe apple?" *A sweet taste.*

"Of a green apple?" *A sour taste.*

"When are plums sour?" *When they are not ripe.*

"What is the taste of a lemon?" *A sour taste.*

"Tell me something else which has a sour taste." *Vinegar*

"What is this I am holding in my hand?" *A leaf.*

"Yes, it is a rhubarb leaf. Is it a large leaf or a small one?" *A large one.*

"What is the colour of this leaf?" *Green colour.*

"What is this part called [pointing to the stalk]?" *The stalk.*

Teacher cuts off the leaf and begins to strip the skin off the stalk. "What is this I am taking off?" *The skin.*

"Is it a thick or thin skin?" *A thin skin.*

"Now I shall cut the stalk into small pieces and give each of you a piece for you to taste it."

"Now tell me which is it most like in taste, a lump of sugar or a lemon?" *It is like the lemon.*

"Then what taste has the rhubarb?" *A sour taste.*

"When you have rhubarb pie or pudding what does your mother put over it?" *Sugar.*

"Why?" *To make it taste sweet.*

"I have something else I want you to taste." [A little quinine.]

"Here it is, try it. Do you like the taste?" *No.*

"Has it a sweet taste?" *No.*

"Does it taste like the rhubarb?" *No.*

"You may call the taste *bitter*."

Individual children may now be called to the table to taste other bitter substances, and exercised until they can readily distinguish *bitter* from *sour* taste.*

LESSON VIII.

LENGTH.—A FOOT.

For this lesson the children may be provided with strips of cardboard or paper one *foot* in length, and divided into *inches* by short lines. The teacher should have, in addition, pieces of *string*, *tape*, or *ribbon* of different lengths.

"You see," says the teacher, "I have placed a black-board on the table. I want a boy to stand on it, but he must have his shoes off."

"Now, which is the longer, the boy's foot or the black-board?" *The black-board.*

* In the country there will be no difficulty in procuring a sprig of rue, for instance; and in towns it can be purchased in a dried state.

"We will see how many times the black-board is longer than the boy's foot."

The teacher here measures the length of the black-board by the boy's feet, assisting the boy to put one foot in front of the other lengthways, and marking the space of each foot with chalk.

"I will place the black-board on the easel. You may count and see how many times longer the black-board is than the boy's foot." *One, two, three, four, five, six.*

"The black-board, then, is how many times as long as the boy's foot?" *Six times.*

"Tell me which is the longer, a man's foot or a boy's foot?" *A man's foot.*

"You have each of you a strip of cardboard. Which is the longer, the boy's foot or the cardboard?" *The cardboard.*

"Yes, and the cardboard is about as long as the foot of a tall man, and we always call that length a *foot*."

"Why do we call this length [showing cardboard] a foot?" *Because it is about as long as the foot of a tall man.*

"Now I want a little girl to measure the black-board with her foot-length of cardboard."

Teacher assists the girl to measure, and the black-board is found to be three times the length of the cardboard.

"The black-board is how many times as long as the cardboard?" *Three times.*

"And as the cardboard measures *one foot*, how many feet does the black-board measure?" *Three feet.*

The children will now be interested in using their foot measures to find the length of pieces of string, tape, &c., but for this lesson the pieces should measure an even number of feet.

LESSON IX.

LENGTH.—A YARD.

Foot measures and pieces of string or tape, &c., as in the last lesson and a three-foot flat ruler or a yard measure, should be provided.

"James allowed us to measure the black-board with his feet in our last lesson. We will now ask him to measure the black-board for us with his cardboard foot-measure."

"How many feet long is the black-board?" *Three feet long.*

"Here is a long ruler. I will place it on the black-board. Which is the longer?" *They are both of the same length.*

"Then how many feet does the ruler measure?" *Three feet.*

"You may call a length of *three feet a yard*. How long is the black-board?" *Three feet. One yard.*

"How many feet make a yard?" *Three feet.*

"What name do we give to a length of three feet?" *A yard.*

"I will mark the foot measures on this ruler to show you that *three feet* and *one yard* stand for the same length."

"We will call our ruler a yard measure, and with it we will see how many yards wide our school-room is. Count while I measure." *One, two, three, four, five, six, seven.*

"There is a little piece over. John, bring your foot measure and tell us how long it is." *One foot.*

"Then our school-room is how many yards wide?" *Seven yards.*

"And how much more?" *One foot.*

"Yes, in all, seven yards and one foot."

The class should now be exercised in measuring with the yard and the foot measures in a variety of ways.

LESSON X.

LENGTH.—THE INCH.

MATERIALS required as in the preceding lesson.

In this lesson the attention of the children should first be directed to the divisions on their foot measures; they should then be told that each space between the lines is called an *inch*. By counting, the children can discover for themselves how many inches there are in a foot, and also in half a foot.

In the second place, the scholars may be set to measure small objects, the width and length of their slates, sticks, pencils, &c., and the practice should be continued till it becomes pretty accurate.

After the children have become familiar with the inch, foot, and yard, and are able to gauge them with tolerable accuracy from memory, they may be trained to measure lengths with the aid of the eye and the memory only.

Thus, objects may be held before the children who may be invited to *guess* the length in inches, feet, or yards, the correct length being afterwards ascertained by actual measurement.

The time of several lessons may be occupied in thus guessing at lengths, heights, depths, widths, and thicknesses, and then measuring to see how nearly correctly the children have guessed. The practice, amusing in itself, forms an admirable exercise in training the eye and the judgment. The extent to which it can be carried must, of course, depend on the proficiency of the class.

LESSON XI.

PROPERTIES OF BODIES.—STICKY OR ADHESIVE.

ANY or all of the following substances will be useful for this lesson gum, glue, paste, wax, a letter, and an envelope.

Teaching [showing a letter] may proceed thus:—

"What is this I hold in my hand?" *A letter.*

"What is this on the corner?" *A stamp.*

"I want Henry to come here and take off the stamp. He cannot do it. Why not?" *It is stuck on firmly.*

"Now, Henry, try and open the letter without tearing the paper. He cannot. Why not?" *Because the envelope is stuck firmly.*

"There is something put on the stamp to make it stick to the envelope, and something put on the envelope to fasten it up firmly. Here is an envelope not shut up. You can see stuff shining on it. If I wet this and press it down what does it do?" *It sticks the paper together.*

"I want you to remember that things which stick other things together we call *sticky*, or *adhesive*."

"What have you stuck on the walls of your rooms at home?" *Paper.*

"Here is a piece of paper and here is the stuff we can stick it on with: it is called *paste*. I will stick the paper on the black-board to show you how men stick the paper on walls."

"What am I putting on the paper with this brush?" *Paste.*

"What do I say about the paste because it sticks the paper on the black-board?" *It is sticky.*

"Here is a piece of wax. I melt it in the flame of this match and let it drop on a piece of paper. Now I press

another piece of paper on it. You see the pieces of paper are stuck together."

"What can you say about the wax?" *It is sticky.*

"Here I have a little gum in a bottle. I stick two pieces of paper together with it."

"What do you say about the gum?" *It is sticky.*

"Name the three things I have shown you which are sticky." *Paste, wax, gum.*

"I have two pieces of wood. I want to stick them together. Let us try the paste, then the wax, then the gum. Neither of these hold the wood firmly together. We must try something else. Here it is. I will put it on the fire to melt. It is called *glue*."

"We now stick the pieces of wood together with the glue, and when the glue is dry you shall try and pull the pieces apart."

"Tell me how glue is like paste?" *It sticks things together. It is sticky.*

"When do you say things are sticky?" *When they stick or hold things together.*

"Is water sticky?" *No.*

"Why not?" *It does not hold things together.*

The children should be allowed to stick things together, naming the substance they use.

LESSON XII.

PROPERTIES OF BODIES.—POROUS.

FOR this lesson distribute small pieces of cane, stick, and sponge.

The following experiment will form an excellent introduction to this lesson. Take a wide-mouthed bottle, and half fill it with spirits of turpentine. Into this insert a short length of cane and a stick of some ordinary English wood. In a few minutes the turpentine will have ascended through the pores of the cane to the upper end, and on the application of a lighted taper will burn with a smoky flame. The application of the lighted taper to the upper end of the stick of course produces no result.

It will interest the children to discover the cause for the difference; and the *little holes* in the cane will not easily be forgotten.

Tell the children that the turpentine has run up the cane to the top and is burning; at the same time the turpentine cannot get up the stick.

Direct them to examine the bits of cane and stick they have in their hands, and the cause will strike them at once—the cane is full of little holes.

Another experiment may follow. Pour a little coloured water into a plate and in the centre of the plate stand a piece of loaf-sugar. The children will see the coloured water gradually rising.

Tell the children that the water rises in the sugar in the same way that the turpentine rose in the cane—through *little holes*.

“We call these little holes *pores*, and when anything is full of these little pores we say it is *porous*.”

“What does porous mean?” *Full of little holes.*

“Why does sugar suck up water?” *Because sugar is porous.*

“And cane?” *Because it is porous.*

“Many other things are porous. Here is a piece of sponge. You see how it sucks the water up. Where does the water go to?” *Into the little holes.*

“Then what can you tell me about sponge?” *It is porous.*

“What does porous mean?” *Full of little holes.*

“What do you eat for breakfast which is porous?” *Bread.*

“How do you know it is porous?” *It sucks up milk or tea.*

“You can see the pores in the bread, and the sponge, and the cane, and other things, but sometimes the pores are so small that you cannot see them.”

With a piece of chamois leather and a little quicksilver a pretty experiment may be performed to show this. The quicksilver may be squeezed through the leather in fine drops.

LESSON XIII.

PROPERTIES OF BODIES.—TRANSPARENT AND OPAQUE.*

ARTICLES for illustration :—Glass, water, milk, marble.

The children will have no difficulty in arranging classes of transparent and opaque objects.†

Take a piece of glass and a slate. Hold a piece of chalk behind the glass and ask, “What am I holding behind the glass?” *A piece of chalk.*

“How do you know it is chalk?” *We can see it.*

“I will now hold the chalk behind the slate. Can you see the chalk now?” *No.*

* These terms are difficult for little children to remember, and may be postponed till a later stage.

† “Translucent” should come in later on.

"Why not?" *We can't see through the slate.*

"How is it you can see the chalk behind the glass?"
We can see through the glass.

Take a glass of water, a cup of water, and a glass of milk. Place in each a glass marble or other suitable object without the knowledge of the children, and ask, "What have I in this glass of water?" *A marble.*

"How do you know it is a marble?" *We can see it.*

"What do you see the marble through?" *The glass and the water.*

"I have placed something in the water in this cup. Can you tell me what it is?" *No.*

"Why not?" *We cannot see through the cup.*

"Jane shall come to the table and look through the water. What do you see now?" *A marble.*

"Then you can see through the—*glass*, but not through the—*cup*."

"What have I put in this glass [pointing to the glass of milk]?" *Milk.*

"Can you see through the milk?" *No.*

"I have placed a marble in the milk. Can you see it?"
No.

"I will lean the glass a little and bring the marble to the side nearest to you. Can you see the marble now?" *Yes.*

"Why?" *Because the marble is close to the glass, and we can see through the glass.*

"I will give you two hard words, one means *can be seen through*, and the other *cannot be seen through*. They are *transparent* and *opaque*."

"When is a thing said to be transparent?" *When it can be seen through*

"Tell me some things which are transparent?" *Glass and water.*

"Why do we use glass for our windows?" *Because it lets the light in. Because we can see through it.*

"When do we say a thing is opaque?" *When it cannot be seen through.*

"Is your slate transparent or opaque?" *Opaque.*

"Why do you say it is opaque?" *Because we cannot see through it.*

The teacher should continue this kind of questioning until the term calls up the idea and the idea the term in the minds of the children.

LESSON XIV.

PROPERTIES OF BODIES.—BRITTLE, FLEXIBLE, AND TOUGH.*

A VARIETY of articles to illustrate these qualities, such as chalk, glass, small dry sticks, slate-pencils, paper, copper and iron wire, leather, cloth, whalebone or cane, &c., should be provided.

To assist the children to compare the qualities of *flexible* and *brittle*, take a cane and a stick of slate-pencil. Showing the cane bent the teacher will ask, "What have I done to the cane?" *You have bent it.*

"Now I take a stick of pencil and try to bend it as I did the cane; what has happened?" *The pencil is broken.*

"You see I have on the table a stick of chalk, a strip of glass, a small stick of wood, some copper and some iron wire. I want a boy and girl to come to the table and bend all these

* It is undesirable at this stage to attempt to develop the ideas of brittle, flexible, and tough to their fullest extent. For our present purpose it is sufficient for the children to learn that *brittle* means "easily broken," that *flexible* means "bends easily without breaking," and that *tough* means "not easily torn."

things. Those which bend without breaking we will put on one side, and those which break we will put on the other side. Now together name the things which have broken, as I show them?" *Chalk, glass, stick, slate-pencil.*

"Now name the things which bend without breaking?"
Cane, whalebone, copper wire, iron wire.

"You may repeat after-me, Things which break easily are said to be *brittle*; things which bend without being broken are said to be *flexible*."

The teacher will now ask questions on these two qualities; such as: Name things which are flexible. Name things which are brittle. When are things said to be brittle? When are things said to be flexible? Why do you say that chalk is brittle? Why do you say that a cane is flexible?

The teacher should next encourage the children to name other articles which are brittle, as *crust of bread; biscuits, loaf-sugar*; and flexible, as the *flat ruler, a strip of lead, a book-cover*.

The idea of *toughness* may be elicited by taking different substances, such as paper, calico, leather, &c., and directing the children to try to tear them.

LESSON XV.

A BRICK.

BRICKS of any sort readily obtained to be placed on the table. A bucket and basin with water should also be provided.

The teacher may first call attention to the shape of the brick (see Lesson V. Stage II.), the number of corners, of

straight edges, the number of faces, the shape of the faces, and so on.

One or more children may be called upon to measure the length, breadth, and thickness of a brick, or, if several bricks are provided, they may be handed—together with the cardboard strips used for Lesson VII. I.—to as many children, who may measure independently and the results be compared.*

The bricks may now be passed on to other children, and questions like the following may be asked:—

"Hold the bricks in your hands; how do they feel?"
Heavy.

"Squeeze them; how do they feel?" *Hard.*

"Rub your fingers over them; what can you say about the surfaces?" *They are rough.*

"You say a brick is heavy; if I place it in this bucket of water, will it swim or sink to the bottom?" *It will sink to the bottom.*

"I want you to find out something else about bricks. Here I place this one standing upright in a basin, and then fill the basin with water up to the brim. We will look at it again in a few minutes. Meanwhile you may tell me all you can about a brick."

The teacher may now call a child to look at the water in the basin; she finds the basin is not now full.

"Perhaps," proceeds the teacher, "some little child may guess where the water has gone?" *It has gone into the brick.*

"Right; then what may I say about bricks?" *They are porous.*

"When do we say a thing is porous?" *When it is full of little holes.*

* Ordinary building bricks measure 9 inches in length, 4 inches in width, and 2½ inches in thickness.

"Here is a piece of wood cut into a cube. Look at this and the brick."

"How are they alike?" *Each has eight corners and six faces.*

"How are the faces unlike?" *The faces of the cube are squares. The faces of the brick are oblongs.*

LESSON XVI.

ORANGE AND LEMON

THREE or four ripe oranges and a lemon should be provided for this lesson.

Holding up an orange the teacher asks, "What is this I hold in my hand?" *An orange.*

"What is the shape of the orange?" *Ball shape.*

"What is its colour?" *Orange colour.*

"How did we make orange colour?" *By mixing yellow and red.*

"What is the name of this I am now showing you?" *A lemon.*

"What is the colour of the lemon?" *Yellow.*

The teacher now cuts the orange and the lemon into halves.

"What is this on the outside of the orange?" *The peel.*

"What is the colour of the peel inside?" *White colour.*

"Feel it." *It feels soft.*

"What is there on the outside of the lemon?" *The peel.*

"How is the peel of the lemon like that of the orange on the inside?" *It is white and soft.*

"Is the peel of the orange and lemon thick or thin?" *Thick.*

"Name some things which have thin skins?" *Potatoes, apples.*

"I will cut an orange and the lemon into small pieces for you to taste."

"First let me squeeze a piece of orange; what is it that drops out?" *The juice.*

"And now I squeeze a bit of lemon?" *The juice runs out.*

"Now you may taste the orange and the lemon. What taste has the lemon?" *Sour taste.*

"What taste has the orange?" *Sweet taste.*

"I want you to think over all we have said about the orange and the lemon, and first to tell me how they are unlike." *They are unlike in colour and in taste.*

"And now how they are alike?" *They are alike in having a thick peel, white and soft inside; and they both have juice which runs out when we cut or squeeze them.*

An apple may also be introduced for comparison with the orange and lemon.

LESSON XVII.

AN EGG.

ONE raw and one hard-boiled egg will be sufficient for this lesson. It will interest the children if the egg can be boiled over a spirit-lamp on the table.

This lesson forms a good example of how a teacher may make a new subject the medium for a recapitulation of ideas developed in previous lessons, and thus serve as a test of success in what has so far been attempted.

"What is this I hold in my hand?" *An egg.*

"What is the outside of the egg called?" *The shell.*

"What is the colour of the shell?" *White colour.*

"If you pass your finger over the shell how does it feel?"
It feels smooth.

"What is the outside of the shell called?" *Its surface.*

"Is the surface flat like the table?" *No, it is bent or curved.*

"When I put the egg in the water it sank to the bottom;
what does this tell me about the egg?" *It is heavy.*

"Now that the egg is boiled, I tap the shell with a spoon;
what has happened to the shell?" *It is broken.*

"What do you say about the shell because it broke easily?"
It is brittle.

"Look at these small pieces; what can you say about the
thickness of the shell?" *It is thin.*

"Just inside the shell you see something else. I will take
a piece off. What is it?" *The skin.*

"What do you see about the skin?" *It is thin. It is white.*

"Feel it." *It feels soft.*

"Now I have taken off the shell and the skin. What
comes next?" *The white.*

"Why do we call it white?" *Because it has a white colour.*

"I remove the white. What comes next?" *The yellow
—the yolk.*

"What colour has the yolk?" *Yellow colour. Orange colour.*

"I now break the raw egg. You will see the white and
the yellow run out into the plate. I put a little of the
white on this sheet of paper, press another sheet on the top
and dry over the lamp. You see the papers are stuck to-
gether. Now what else can you say about the white of
egg?" *It is sticky.*

As a further exercise the children may be asked to tell
all they can about an egg without any assistance; in other
words, they should be encouraged to talk about it.

LESSON XVIII.

A CABBAGE.

A COUPLE of cabbages, one of which may be of the purple kind used
for pickling, and a few green leaves of different kinds should lie on
the table.*

The teacher may commence this lesson by comparing the
two cabbages as to their colour, and the cabbages again with
the leaves. Advantage may be taken of the introduction of
green and purple colours to test the memory of the children
on the composition of these colours.

In the next place the teacher may remove the leaves one
by one, at the same time directing the attention of the chil-
dren to the way in which they are placed one over the other,
to the manner in which the leaves are fixed to the stalk, and
to the change in the colour of the leaves as we get nearer
the middle.

Thirdly, a comparison should be made between the cabbage-
leaves and other leaves as to *size, shape, hardness*, and the
ease with which the blades are *torn*, as to the comparatively
thick, soft, and juicy leaf-stalk of the one, and the thin
harder stalk of the other.

Fourthly, the stalk of the cabbage may be cut across, and
the children may be led to note the circular shape of the
section, and the difference in hardness between the external
and internal portions of the stalk.

The use of the stalk to support the plant, and of the
plant itself for food when boiled, may be elicited from the
children.

* If a cabbage showing its flower or seed-stalk can be obtained, the lesson
can be made more complete.

LESSON XIX.

A COCOA-NUT.

A COCOA-NUT in its natural state—viz. with the fibrous outer husk adhering—a hammer, a penknife, and a cup or glass, will be all that is necessary for this lesson.

Introduce by telling the children that this lesson is to be about a large nut, called a cocoa-nut, and that cocoa-nuts grow in hot countries very far away from where we live.

Show the cocoa-nut and invite the children to comment on its different parts as it is taken to pieces.

The outside rind is *thin* and *smooth*.

Then follows a thick *husk*, consisting of threads matted together.

Experiments will show that these threads are *flexible* and *tough*.

Remove the husk. The shell is *shown* to be *rough* and *hard*, and in *shape* somewhat like an egg.

The three black scars are now pointed out, one of which is *shown* to be *soft* by cutting through with a penknife.

The "milk" is next poured into a glass and the children are invited to *taste* it.

The shell is broken with a hammer. It is *shown* to be thick and strong, and the kernel to be fixed like a thick coating on the inside of the shell. A knife will demonstrate that the kernel is soft, and assist in its division into small pieces for tasting.

LESSON XX.

GLASS.

ANY specimens of glass or of glass articles will be useful in this lesson.

The introduction to this lesson may be a short recapitulation of Lesson XIII. Experiments may then be made with pieces of glass to show that it is not only *transparent*, but *smooth*, *hard*, and *brittle*.

The children may next be assisted in telling about some of the uses to which glass is put. Questions like the following, for instance, may be asked:—

"How do we get the light in this room?" *Through the windows.*

"What part of the window does the light come through?" *The glass.*

"Tell me some other use of the glass in the window?" *We can see through it.*

"But a hole in the wall would let the light in, and we could also see through it. Would a hole do as well as the glass window?" *No.*

"Why not?" *It would let in the rain and the cold wind.*

"Then, whilst the window lets in the light, what does it keep out?" *The wind and rain.*

Other uses of glass may be similarly dealt with.

THIRD STAGE.

THE lessons* of the Third Stage follow naturally on those of the First and Second Stages; but they demand closer attention, and call for more extended powers of observation and comparison. Experiment is also more largely employed on some of the most familiar objects to bring out the special properties on which their uses depend. The following are the chief subjects dealt with :—

- (1.) Colour.—Light and dark colours.
- (2.) Form.—Perpendicular, horizontal, oblique, and parallel lines.
- (3.) Measures of weight—the pound and ounce.
 ,, ,, capacity—the gallon, quart, and pint.
- (4.) Properties of bodies—solid, liquid, fusible, soluble, inflammable, elastic, &c.
- (5.) Common objects—india-rubber, sponge, cork, leather, &c.

LESSON I.

DARK AND LIGHT COLOURS.

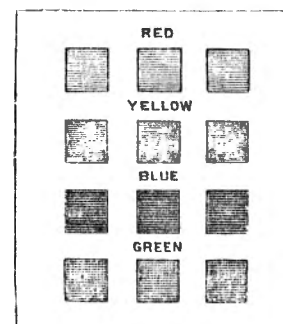
SMALL squares of standard and dark and light reds, yellows, blues, and greens, should be given to the children; and the teachers should have on the table, in addition, triangles, circles, rings, squares, and oblongs of the various colours.

As an introduction to this lesson, the teacher may put a series of questions on Lessons I. and II. Stage II., recalling

* Suitable for children of about five to six years of age.

to the minds of the children the secondary colours and how they are formed. The sheet on which the coloured bands were drawn should be fixed on the black-board.

On a clean sheet of paper fix squares or circles of the standard red, yellow, blue, and green, as in the sketch. Call the attention of the children to the fact that you are



about to show them other colours something like those of which they have already learnt the names, and proceed :—

“I will place another red on each side of the first. Look at them. Can you see any difference?” *One is darker and the other is lighter.*

“Which is the darker?” *That on the left side.*

“And which is the lighter?” *That on the right side.*

“You may call the square on the left side *dark red*, and that on the right side *light red*.”

“Take your papers. Show me a *light red*. Now the *dark red*.”

Deal with the other colours somewhat in the same way, and direct the children to arrange their squares on the desks as they are placed on the black-board, but take one set of colours only at a time.

The children may next arrange all the light colours in a row, then all the dark colours.

An excellent exercise may now be introduced on form and colours combined, of course using only the forms and colours with which the children are now supposed to be familiar.

Teacher [holding up, say, a triangle of light green].
 "What colour is this?" *Light green.*

"What shape is it?" *A triangle.*

"Why is it called a triangle?" *Because it has three angles.*

Holding up an oblong of dark blue,—“What is the shape of this card?” *An oblong.*

"What kind of angles has an oblong?" *Right angles.*

"What colour is it?" *Dark blue.*

Holding up a square of light yellow,—“What colour is this?” *Light yellow.*

"What shape is it?" *Square shape.*

"What is a square?" *A figure with four equal sides and four right angles.*

Similarly deal with circles, and rings, and squares, and oblongs, and triangles of other colours.

Let the changes be made rapidly from shape to colour and colour to shape, so as to secure watchful attention and prompt reply.

A second, and even a third, exercise may be given on form and colour combined similar to the above, and the children may now be led to apply the appropriate names to the colours in articles of dress, flowers, &c.

LESSON II.

PERPENDICULAR, HORIZONTAL, AND OBLIQUE LINES.

FIVE minutes' rapid questioning on Lesson III. Stage I., and Lesson III. Stage II., will form an appropriate introduction to this lesson.

Tell the children that we are now about to give *upright*, *lying down*, and *slanting lines* new names, viz. *perpendicular*, *horizontal*, and *oblique*, and exercise somewhat as follows:—

"I will draw straight lines on the black-board, and you



shall tell me, as I make them, what position they are in." *Perpendicular, oblique, horizontal, &c.*

"I will now take a pointer, and as I hold it in different positions you shall tell me what they are."

"In what position am I holding the pointer now —?" *Horizontal.*

"Now —?" *Oblique.*

"Now |?" *Perpendicular.*

"Yes, or you may say *vertical*."

"What do you mean by perpendicular?" *Standing upright.*

"What do you mean by horizontal?" *Lying down or along.*

"Now hold your arms in a horizontal position. Now in a vertical position. Now in an oblique position."

"In what position are you when standing up?" *Vertical or perpendicular.*

"In what position are you when lying in bed?" *Horizontal.*

"In what position are the walls of this room?" *Perpendicular or vertical.*

"Name some things in the room which are in a horizontal position." *Floor, ceiling, top of table, seats, &c.*

The children may now be instructed to place their slates in different positions.

As a further and interesting exercise, the teacher may

make three or four of the simpler letters of the alphabet on the black-board and question thus:—

“What is the name of this letter (I)?” *I.*

“Of how many lines is the *I* made?” *Of one line.*

“In what position is this line?” *Perpendicular.*

“What is the name of this letter (L)?” *L.*

“Of what lines is it made?” *Of one perpendicular and one horizontal line.*

“What angle do these two lines make?” *A right angle.*

“What is the name of this letter (V)?” *V.*

“Of what lines is it made?” *Of two oblique lines.*

“What kind of angle do these lines make?” *An acute angle.*

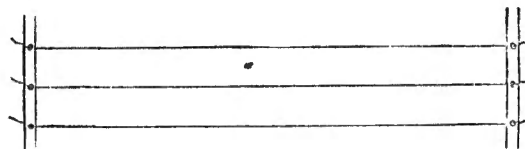
The letters **T**, **H**, **A**, **X** may be similarly dealt with.

LESSON III.

PARALLEL LINES.

ARTICLES for illustration:—pieces of wood, string.

Parallel lines may be introduced by drawings on the black-board; but a more vivid illustration, and therefore more likely to be impressed on the minds of the children, may be obtained by tying two or three pieces of string (say twelve feet long and six inches apart) to two pieces of wood, as in the sketch.



Two children should be called to the front of the class to hold the strings tightly stretched between them in a hori-

zontal position, and another child should be directed to measure the distance between the strings in several places [See Lesson X. Stage I.]. The class may now be told that the strings, which lie side by side and everywhere at the same distance apart, are said to be *parallel*.

In a similar manner perpendicular and oblique parallel lines may be introduced to the children.

Turn now to the black-board for further illustration and exercise.

Draw lines as in Fig. 1. Pointing to these lines the teacher asks,



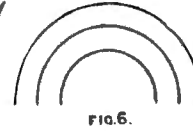
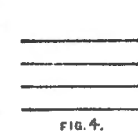
“Do these lines lie side by side? Are they the same distance apart at each end? Are they parallel?”

“Now look at these lines (Fig. 2). Are they parallel?”
No.



“Why not?” *They do not lie side by side, and they are not the same distance apart at all points.*

“Here are other lines.”



[Pointing to Fig. 3.] “What can you tell me about these lines?” *They are parallel. They are straight. They are perpendicular.*

"Why are they said to be parallel?" *Because they lie side by side at the same distance apart.*

Similar questions should be asked of the *horizontal, oblique, and curved* parallel lines.

Objects in the room—the walls, windows, window-panes, door, pictures, table, black-board, &c.—will afford ample illustration of things having parallel sides.

LESSON IV.

LINES AND ANGLES (a Test Exercise).

For this lesson use such letters of the alphabet as are built up of straight lines, viz. **L, T, V, A, H, F, E, N, M, W, K, Y, X, Z.**

We take **V** and **W** as *examples*.

"What letter is this (**V**)?" *V.*

"How many lines are there in this **V**?" *Two.*

"Are they perpendicular?" *No.*

"Well, what are they?" *They are oblique.*

"What kind of angles do they make between them?"
An acute angle.

"Are the lines parallel?" *No.*

"Why not?" *Because they are not placed side by side, and they are not the same distance apart at all points.*

"What can you say of these lines **V**?" *They are parallel and oblique.*

"And of these **W**?" *They are parallel and oblique.*

"I will put them together thus—**W**. What letter do they make?" *W.*

"How many pairs of parallel lines form the **W**?" *Two.*

"How many angles do these lines make, and what kind of angles?" *Three acute angles.*

LESSON V.

MEASURES OF WEIGHT.—The lb., $\frac{1}{2}$ lb., $\frac{1}{4}$ lb., and oz.

It is of great importance that children should early acquire definite ideas of the more common measures of weight and capacity as well as of length, and every school should be provided with some apparatus for weighing. In this lesson we deal with the lb., $\frac{1}{2}$ lb., $\frac{1}{4}$ lb., and oz., leaving the cwt. and ton for a future stage.

The scales and weights being placed on the table the teacher may introduce the lesson with a little conversation. She may ask what children have been sent by their mother to the shop, and what for. How the shopman found out how much was a lb. or $\frac{1}{2}$ lb. of sugar, or butter, or cheese. Having got from the children the names lb., $\frac{1}{2}$ lb., $\frac{1}{4}$ lb., and oz., show them the weights, and let some of the scholars handle them to discover for themselves that the lb. is heavier than the $\frac{1}{2}$ lb., the $\frac{1}{2}$ lb. than the $\frac{1}{4}$ lb., and so on.

To show the children the real comparative value of each weight it will be convenient to use sand. Weigh 1 lb. of sand, then two $\frac{1}{2}$ lbs., and then show that two $\frac{1}{2}$ lbs. have the same weight as 1 lb. In a similar way show by experiment that two $\frac{1}{4}$ lbs. have the same weight as the $\frac{1}{2}$ lb., and that 4 ozs. have the same weight as the $\frac{1}{2}$ lb.

The children may now be directed and assisted to weigh for themselves, and the practice should be continued until the class, as a whole, can distinguish the different weights and appreciate their value.

Questions such as the following will show how far the lesson has been a success.

"What is the name of this weight?" $\frac{1}{4}$ lb. weight.

"And this?" One oz. weight.

"How many ozs. make $\frac{1}{4}$ lb.?" Four ozs.

"How many $\frac{1}{4}$ lb. weights are the same as the $\frac{1}{2}$ lb. weight?" Two $\frac{1}{4}$ lb. weights.

"Then how many ozs. make $\frac{1}{2}$ lb.?" Eight ozs.

"How many $\frac{1}{2}$ lbs. make 1 lb.?" Two half lbs.

"How many ozs. make 1 lb.?" Sixteen ozs.

"The $\frac{1}{2}$ lb. contains how many ozs.?" Eight ozs.

"How many $\frac{1}{4}$ lbs. in 1 lb.?" Four quarter lbs.

NOTE.—Looking at the proficiency of her scholars, the teacher must decide how far her teaching on this subject may be carried; but probably the time of another lesson may be usefully employed with the above weights.

LESSON VI.

MEASURES OF CAPACITY.—THE HALF-PINT, PINT, QUART, AND GALLON.

RANGE a half-pint, a pint, a quart, and a gallon measure on the table.

The teacher may introduce the lesson by asking for the names of some of the articles we buy by weight and by measures of length (Lessons VIII., IX., and X., Stage II.), and then by reference to the purchase of milk or other liquid lead the children to see the necessity for some other kind of measure for liquids.

Next call the attention of the children to the vessels on the table, give their names, and then, by actual experiment (using sand or water) * show that—

* As far as practicable let the children do the work.

2 half-pints make 1 pint,
2 pints make 1 quart,
4 quarts or 8 pints make 1 gallon.

Lastly, question thus:—

"How many half-pints in one pint? How many pints in one quart? How many pints in two quarts? How many half-pints in two quarts? How many quarts in a gallon? How many pints in a gallon? How many pints in a quart and a gallon? How many pint measures can I fill from two gallons? How many half-pints in a pint and a quart together?" and so on.

LESSON VII.

PROPERTIES OF BODIES, LIQUID AND SOLID.—I.

GLASS vessels containing liquids, such as water, milk, oil, and quick-silver, should be placed on the table.

This is a lesson in which the attention of the children must be particularly directed to note the results of *experiment*.

Pour a little water on a slate slightly tilted. "Which way does the water run?" *Down the slate.*

"When it rains, in what direction does the water run on the roof of a house?" *Down the roof.*

"Which way does the rain water in the street run?" *Down the street.*

"In what direction does water always run?" *Downwards.*

"Now I want you to find out for me where water always runs to. Look at this slate again. Mary shall come to the

table and show me the lowest part of the slate.* Right. Now where does the water run to on the slate?" *To the lowest place.*

"I place the black-board on the table, but raise it a little at one end. Now let us see to which part of the black-board the water runs. What do you say?" *It runs to the lowest part.*

"I want you to remember that water always runs, when it runs at all, down, down, down to the lowest place it can find."

Repeat the experiment on the slate with milk, oil, and quicksilver, and so lead the children to observe that these bodies are all alike in *running down to the lowest place.*

Next place the slate in a horizontal position and pour a little water gently on to it near the centre, of course taking care as usual that the children are observing. Take another slate and on it pour gently a little sand. The children will at once see that whilst the sand makes a heap, the water *spreads out.*

In the same way show that milk, oil, and quicksilver *spread out*, and in this respect are like the water. /

* Ascertain by questioning whether the children have grasped the two ideas that water, milk, oil, and quicksilver run down to the lowest place they can, and spread out when poured on to a level surface.

• A slate on which the frame is closely fixed will hold a little water.

LESSON VIII.

PROPERTIES OF BODIES, LIQUID AND SOLID.—2

The same liquids as in the last lesson to be placed on the table.

Fill a sponge with water, hold it up so that the children may see how it flows out first in a stream and then in *drops*. Water may be made to flow in drops from the neck of a bottle and in various other ways.

The "pipette" is a simple little instrument for making liquid fall in drops.



It consists of a *tube* open at both ends, but having one end nozzle shaped.

Place it in the liquid as shown in the figure. Press the thumb firmly on the upper end and withdraw it. So long as the pressure is maintained the liquid remains in the tube;



but when the pressure is relaxed and a little air allowed to enter, the liquid falls out in drops.

The other liquids may be shown to fall in drops from the neck of a bottle, but the pipette as described above will be a more convenient instrument.

"We have seen how all these things which I have in the glasses on the table may be made to flow in drops. But what is the shape of these drops? You shall find out for me. John and Jane come here. I will pour a little drop of this shining stuff (quicksilver) into the palms of your hands. Here it is. Take care or it will run away. Now look at it, what is its shape?" *Ball shape.*

"Now I will sprinkle a little water on the dusty floor. Can you see the drops? What shape are they?" *Ball shape.*

"Now tell me what you learnt about these things (water, &c.) in your last lesson?" *They run to the lowest place they can find. They spread out when poured on a level surface.*

"And what have you learnt about them in this lesson?" *They flow in drops.*

"And what shape have these drops?" *Ball shape.*

"I want you to remember that all those things which flow to the lowest place they can, which spread out when poured on to a level surface, and which can be made to flow in drops, are called *liquids*."

Question and call on the children to name other liquids, as vinegar, wine, ink, &c.

"In the next lesson I shall ask you to find out something more about liquids."

LESSON IX.

PROPERTIES OF BODIES, LIQUID AND SOLID—3.

SAMPLES of liquids as in the two preceding lessons, and two or three vessels of different shapes.

"To-day I want you to learn something more about liquids; but first you must tell me what you already know about them."

"If I pour water very slowly from a bottle how does it flow?" *In drops.*

"What is the shape of the drops?" *Ball shape.*

"When I pour water on a slate placed in a horizontal position, where does the water flow?" *It spreads out on every side and covers the whole surface of the slate.*

"We will try this over again. Here is the slate, and I pour water on it. See, it spreads out and covers the whole slate. What prevents the water running over?" *The frame of the slate.*

"What is the shape of the slate?" *Oblong shape.*

"Then what is the shape of the surface of the water on the slate?" *Oblong shape.*

"Suppose the slate to be square instead of oblong, and I pour water on it to cover it, what shape will the surface of the water take then?" *Square shape.*

"Here is a dinner-plate. What is its shape?" *A circle.*
 "Yes; but you had better say circular, which means like a circle.

"Of what shape is the plate inside the rim?" *Circular.*

"Then if I fill the middle part of the plate with water up to the rim, what shape will the surface of the water take?" *Circular.*

"Once more, here is a box; what is its shape?" *Brick shape.*

"Now I fill the box with water; what shape does the water take?" *Brick shape.*

"What is the shape of the lid?" *Oblong shape.*

"And what shape does the surface of the water take?" *Oblong shape.*

"And the bottom and the sides?" *Oblong shape.*

"Now I pour water into this tumbler, and you will see that the water takes the same shape as the tumbler; and so if I pour into a bottle or a tea-cup the water takes the same shape as the bottle or the tea-cup. I pour in sand, but you see the sand lies in a heap and does not of itself spread out and take the same shape as the vessel."

"And this is the new fact which I want you to remember about water and other liquids. Repeat after me, *A liquid takes the same shape as the vessel in which it is placed.*"

"Here are pieces of wood, pencil, coal, and sugar; if I put them into a tumbler or basin will they take the shape of the tumbler or basin?" *No.*

"Can you make them flow in drops like water?" *No.*

"Are they liquids?" *No.*

"You see the wood has its own shape and so has the pencil; and all things which have shapes of their own we call solids. Name all the solid things you can see in the room." *Book, desk, wall, door, &c.*

"I am now going to show you again, by a very pretty experiment, that liquids take the same shape as the vessel into which they are poured. Here I have a small piece of lead. No doubt some of you have seen lead before. Is the lead a solid or a liquid?" *A solid.*

"Why do you say it is a solid?" *Because it has its own shape.*

"I am about to make it into a liquid. I put it into this large iron spoon, and place the spoon in the fire where it is very hot. Whilst the lead is being changed to a liquid I will fix this thimble into a hole I have made in this piece of wood. Now the lead has become a white liquid like the quicksilver you have seen. I pour it gently into the thimble. Now it is cool I take it out, and you see it has taken the same shape as the thimble."

When snow or ice is easily procurable, another and perhaps more interesting experiment than the preceding may be substituted or added. Fill a small medicine-bottle with water, cork it and place in a large basin, cover with a mixture of about equal quantities of snow or broken ice, and salt. In about ten minutes the water in the bottle will be frozen. Break the bottle and show the ice to be of the same shape as the bottle.

LESSON X.

PROPERTIES OF BODIES.—FUSIBLE AND INFUSIBLE.

As many as possible of the following articles should be ready on the table: ice, sugar, wax, lead or tin, india-rubber, glass, alum, salt, camphor, chalk, marble.

A spirit-lamp, tripod-stand, evaporating-dish, and test-tubes of different sizes will be found most useful, if not indispensable, in this and very many of the lessons which follow.

Three ideas need to stand out clearly and distinctly in

this lesson: that some solids may be changed to liquids by the application of *heat*, that the change is called *melting* or *fusing*, and that solids which can be melted are said to be *fusible*.

The teacher will take any of the fusible solids she may have at hand, and by the application of heat change them to liquids—of course under the observation of the children. A running commentary and fire of questions should be kept up the whole time.

Thus suppose *ice* to be the first fusible solid to be submitted to experiment.

"I want Harry to hold this piece of ice for me. How does it feel? Look! what is that dropping on to the floor from Harry's hand? What has made the ice change to water? What do you say of water because it flows in drops? What do you say about ice because you can see through it?"

Or suppose *butter* to be the object.

"Here is butter; is it a solid or a liquid? How can I make it into a liquid? I will melt it in the dish over the spirit-lamp. Here is the liquid; what colour is it? When it gets cold again will it be solid or liquid?"

Or take *lead*.

"How shall I melt this lead? What colour is the lead when liquid? If I take it away from the fire, how will it change?"

Or take *salt*.

"James shall taste this white solid and tell me what it is. I place it in the dish over the lamp; it does not melt. Many other solids will not melt, as chalk, flint, marble. We will try one or two more."

Or take *camphor*.

"Mary shall smell this and taste it; what is it? We will try to melt it. Look, the lump is getting smaller, but

there is no liquid. Now there is nothing left, the camphor is all gone. Camphor does not melt, it goes away into the air."

The attention of the children should now be directed to the fact that butter requires more heat to melt it than ice, and that lead requires more heat than butter; and they should then be told that other substances, such as iron, copper, and gold, can only be melted with a very great heat.

"We cannot melt glass in the dish over the flame; but you see, by holding this little glass tube in the flame, the glass gets soft and we can bend it."

The class may now be told that solids which can be melted or fused are said to be *fusible*, and those which cannot be melted are said to be *infusible*;* and the children may be exercised in classifying substances under one head or the other.

LESSON XI.

PROPERTIES OF BODIES.—SOLUBLE AND INSOLUBLE.

ARTICLES for illustration:—Soluble and insoluble substances, as sugar, salt, soda, alum, camphor, chalk, marble, broken glass, lead, &c., also test-tubes, evaporating-dish, and spirit-lamp.

Place half-a-dozen test-tubes or other glass vessels on the table. Also small quantities of, say, sugar, salt, alum, camphor, chalk, and broken glass.†

* These terms are to a certain extent relative. Most substances ordinarily infusible, as rocks, are probably fusible under a higher temperature than we can produce.

† Of course other substances at the convenience of the teacher will answer equally well.

Bring children in turn to the front of the class to name the different substances after testing by sight, taste, and smell. Having got the names, half fill the test-tubes with water and place a little of each substance in each in order as above. Warm the water in the flame of the spirit-lamp, if necessary, to hasten solution of the soluble substances. During the operation the attention of the children must be kept up by commentary and questions.

The idea of solubility may now be brought out somewhat as follows:—

"I want you to look very carefully at these glasses."

"What did I put in the first glass?" *Sugar.*

"And in the second glass?" *Salt.*

"And in the third?" *Alum.*

"Can you see the sugar, salt, and alum now?" *No.*

"Then can you tell me what has become of them?" *They are melted.*

"No, they are not melted. It is very difficult to melt salt. I put a little in this pan over the spirit-lamp, and you see it does not melt as butter or lead melts."

"What do you mean by melting?" *Changing from a solid to a liquid.*

"Yes, and when we melt a solid we can see the liquid which it makes."

"Right, but we have not to-day changed these solids to liquids."

"You can tell me where the sugar and salt and alum are?" *Yes, in the water.*

"Can you see the sugar in the water, or the salt or the alum in the water?" *No.*

"If you are not quite certain, you may come to the table some of you and taste."

"You are quite sure they are in the water, because although you cannot see them you can taste them."

"I must now tell you that many solids when put in water, and especially in hot water, break up into the tiniest little pieces, so small that you cannot see them, and spread about all through the liquid, and you must please to remember that we say that such solids *dissolve* (not melt) in the water; and because they dissolve we say they are *soluble*."

The teacher may now show the class that the substances held in solution may be recovered. Take, for instance, the solution of salt; make it as strong as possible, and evaporate a little over the spirit-lamp. The salt may be seen, handled, and tasted over again.

Lastly, attention may be directed to the solids which have not dissolved in the water, and the children must be told that substances which do not dissolve are said to be *insoluble*.

NOTE 1.—Some of the salts of copper—green and blue vitriol—give beautiful coloured solutions in water.

NOTE 2.—Some solids insoluble in water are soluble in other liquids: *e.g.* india-rubber in coal-naphtha and camphor in spirits of wine. Advantage may be taken of the latter fact to make a very pretty experiment, showing how solids may exist in liquids although we cannot see them. Pour water into a solution of camphor; the camphor at once becomes insoluble in the mixture of spirit and water, and floats about in white flakes.

LESSON XII.

PROPERTIES OF BODIES.—INFLAMMABLE.

ANY or all of the substances named below may be used in illustration

Substances "burning" are so attractive and familiar that one example simply to attract attention will suffice before

the children are told that things which *burn* are said to be *inflammable*.

An interesting lesson may now be given in arranging the substances used in illustration into three classes: (1) those which burn readily; (2) those which burn with difficulty; and (3) those which do not burn at all (at least in any ordinary fire). The substances may be tested in the flame of the spirit-lamp.

The result will appear thus:—

(1)	(2)	(3)
Cotton-wool.	Wool.	Glass.
Cotton goods.	Woollen goods.	Stones.
Paper.	Sponge.	Clay.
Cork.	Leather.	Chalk.
Dry wood.	Whalebone.	Metals.
Camphor.		
India-rubber.		
Coal.		
Sulphur.		

The children must be called on to exercise their powers of observation during the experiment on each substance, and to note any striking likenesses and differences exhibited.

Thus, cotton-wool and wool resemble each other in colour, lightness, &c., but the one burns fiercely, the other with difficulty. Paper and thin leather (say a finger of an old kid glove), india-rubber and sponge, splinters of dry wood and whalebone, sulphur and chalk, coal and stone, may all be compared with advantage. The smell and smoke given off by the different burning substances should also be noted.

When the various substances have been experimented on and classified, attention may be called to the fact that all the substances in the first class (except sulphur) come from

plants, all the articles in the second class come from animals, while all those in the third class belong to inorganic nature.

The teacher should now encourage the children to name any uses to which burning bodies are put, and lastly, she should impress on the children the danger of playing with fire.

LESSON XIII.

PROPERTIES OF BODIES.—ELASTIC.

THE teacher should be provided with india-rubber, sponge, and a piece of whalebone or steel spring to illustrate the three kinds of elasticity.

See that the children know the names of the objects. Then, taking up the whalebone and bending it, proceed by questions to elicit the idea of the first kind of elasticity.

"See, I am bending this whalebone. What happens now I let it go?" *It goes back again. It flies back again. It springs back.*

"We will say *it springs back to its own shape again.*"

"What is this I am stretching?" *India-rubber.*

"What will happen if I let one end go?" *It will spring back again.*

"Yes, *it springs back to its own shape again.*"

"Here is a piece of sponge. What am I doing with it?" *Squeezing it.*

"What will happen if I let it go?" *It will go back to its own shape again.*

"I will now give you one word which means springing back,—it is *elastic*."

"What does the word *elastic* mean?" *Springing back.*

"Why do we say whalebone is elastic?" *Because it will spring back after being bent.*

"Why do we say india-rubber is elastic?" *Because it will spring back after being stretched.*

"Why do we say sponge is elastic?" *Because it will spring back after being squeezed.*

"When do we say a thing is elastic?" *When it will spring back after being bent, or stretched, or squeezed.*

"John shall take this cane and bend it. Is it elastic?" *Yes, because it springs back again.*

"Here is a strip of lead. Jane may bend it. Is it elastic?" *No, it does not spring back again.*

"Here is a cork. It looks too large to go into the neck of this bottle. How shall I get it in?" *Squeeze it in. Press it in.*

"I take it out again. What do you notice about it?" *It has gone back to its shape again.*

"Then what can you say about cork?" *Cork is elastic.*

"Here is a piece of cotton-wool. What shall I do to it to find out if it is elastic?" *Squeeze it.*

"Mary shall try it. Is it larger or smaller now that Mary is squeezing it?" *It is smaller.*

"When Mary opens her hand what will happen to the cotton-wool?" *It will get larger.*

"Is cotton-wool elastic?" *Yes.*

"Why do you say it is elastic?" *Because after being squeezed it goes back to its own shape again.*

The property of *flexibility* or *pliability* may be taught in conjunction with *elasticity*. Whalebone and india-rubber

are *elastic*, but they are also *flexible*, because they can be *easily bent without breaking*.

Leather, cord, paper, lead, copper are all flexible, but not elastic.

LESSON XIV.

INDIA-RUBBER.*

ARTICLES for illustration:—A piece of bottle india-rubber, bottle containing india-rubber dissolved in naphtha, and any waterproof articles.

This lesson should be partially a review of what the children have already learnt about this useful substance. The teacher may therefore introduce it by means of questions such as the following:—

"What can you tell me about india-rubber? Why do we say it is elastic? Is india-rubber heavy or light? How can you find that out? What else can you say about india-rubber? With what kind of flame does india-rubber burn? Can you tear it easily? What do you call it because it does not tear easily? What do you call it because it bends easily?"

"You have remembered about india-rubber, then, that it is *elastic, flexible, light, tough, and inflammable*."

The teacher may then proceed. "To-day I want you to find out for yourselves something more about india-rubber; but first I must tell you something about it which you could not find out for yourselves. India-rubber is the juice of a tree. Cuts are made in the bark of the india-rubber tree;

* In this and the following three lessons the teacher should aim to show how the particular uses of india-rubber, sponge, &c., follow from their special properties.

thick creamy-looking juice flows out, and this gets solid as it dries."

"Here is a piece of this solid juice. I will put it into this tumbler of water. Is it soluble or insoluble?" *Insoluble.*

"Why do you say insoluble?" *Because it does not dissolve.*

"You remember perhaps the other day I showed you that camphor dissolves in spirit, but not in water; and so we can dissolve india-rubber in turpentine or naphtha. It dissolves, however, very slowly. Here is some in this bottle which I put in yesterday, it is only partly dissolved now."

"One thing more about india-rubber. Here are pieces of cloth on which india-rubber has been spread when dissolved. Four children shall hold one piece by the corners, making a basin. I pour in water; you see it does not pass through. Perhaps you can tell me about some articles of clothing on which india-rubber has been spread to keep off the rain. Here is a hollow india-rubber ball. I fill it with water. Does the water get through the india-rubber as it would through cloth? No. That is another very important fact about india-rubber, water will not pass through it—it is *waterproof*."

LESSON XV.

SPONGE.

ARTICLES for illustration:—Sponge, india-rubber.

All children are familiar with sponge and its use in washing; the teacher may therefore commence this lesson by asking the children to enumerate the uses, and then

elicit from them the particular properties which render suitable for the special purposes to which it is put.

"What do we use sponge for?" *To wash our faces. To clean our slates. Teacher washes the writing off the blackboard with the sponge.*

"Yes, we will say it is used for washing purposes."

"Can you wash your faces with a dry sponge?" *No, it must have some water.*

"You see, as I put this dry sponge in this basin of water it floats on the top like cork. What do we say of it on that account?" *It is light.*

"I put this piece of india-rubber in the water. Can you wash your faces with it?" *No, it is too hard. It does not hold water.*

"You like the sponge rubbed over your face because it is—?" *Soft.*

"Here is a saucer half full of water. I put this sponge in the saucer. Look, the water is gone from the saucer. Where is it?" *The sponge has sucked it up.*

"How is it that the sponge can suck up water when the india-rubber cannot?" *The sponge is full of little holes, and the india-rubber has no holes.*

"Well, when anything is full of little holes like this what do we call it?" *We call it porous.*

"What does porous mean?" *Full of little holes.*

"Can you remember anything else which is porous and which sucks up water?" *A brick.*

"Then how are sponge and a brick alike?" *They are both porous, and both suck up water.*

"Now can you tell me anything in which the sponge and a brick are not alike?" *The sponge is elastic, the brick is not.*

"Why do you say the sponge is elastic?" *Because it springs back after being squeezed.*

"Why do people very often squeeze sponge?" *To get the water out.*

"When the sponge is pressed, how is its size altered?" *It is made smaller.*

"If you press a brick can you make it smaller?" *No.*

"We have seen, then, that sponge is *light*, and *soft*, and *elastic*, and *porous*, that it sucks up water, and that it can be pressed into a smaller size. I want you to remember two new words. Things that suck up water are said to be *absorbent*. Things that can be squeezed or pressed into a smaller space are said to be *compressible*."

"One more thing about sponge. William shall try and tear it to pieces. You see it does not tear easily like paper. What do we say about a thing when it does not tear easily?" *It is tough.*

"You shall now tell me again all you have learnt about sponge."

"What do you say of it because it floats on the water?" *It is light.*

"Because it does not hurt your face when rubbed over it?" *It is soft.*

"Because it is full of holes?" *It is porous.*

"Because it sucks up water?" *It is absorbent.*

"Because it can be made smaller by pressing?" *It is compressible.*

"Because it springs back after being squeezed?" *It is elastic.*

"You can see now how the properties of sponge make it useful for washing."

"If it were not *porous* and *absorbent* it could not suck up the water."

"If it were not *compressible* we could not squeeze out the dirty water."

"If it were not elastic it would not open out again and be ready to take up fresh water."

"If it were not soft it would hurt the skin of the body."

"If it were not tough it would tear to pieces and soon be worn away."

The teacher should now lead the children to compare sponge and india-rubber with regard to their properties.

LESSON XVI.

CORK.

A NUMBER of old bottle-corks, a piece of the bark of the cork-tree, a piece of bark of some other tree, a small wooden doll, and a glass vessel of water should be to hand for this lesson.

Pieces of cork should be distributed to all members of the class, and the teacher should guide the children in exercising their perceptive faculties to discover the more prominent qualities of cork. It is *light*, *soft*, *elastic*, *compressible*, and *impervious* to water.

Secondly, a piece of uncut cork should be compared with the bark of an ordinary tree and the similarity pointed out, and the children may then be told that cork is the outer covering or *bark* of a tree; but that the cork-tree does not grow in this country.

Thirdly, the teacher will show how its special properties adapt it for certain uses.

"Why do people very often squeeze sponge?" *To get the water out.*

"When the sponge is pressed, how is its size altered?" *It is made smaller.*

"If you press a brick can you make it smaller?" *No.*

"We have seen, then, that sponge is *light*, and *soft*, and *elastic*, and *porous*, that it sucks up water, and that it can be pressed into a smaller size. I want you to remember two new words. Things that suck up water are said to be *absorbent*. Things that can be squeezed or pressed into a smaller space are said to be *compressible*."

"One more thing about sponge. William shall try and tear it to pieces. You see it does not tear easily like paper. What do we say about a thing when it does not tear easily?" *It is tough.*

"You shall now tell me again all you have learnt about sponge."

"What do you say of it because it floats on the water?" *It is light.*

"Because it does not hurt your face when rubbed over it?" *It is soft.*

"Because it is full of holes?" *It is porous.*

"Because it sucks up water?" *It is absorbent.*

"Because it can be made smaller by pressing?" *It is compressible.*

"Because it springs back after being squeezed?" *It is elastic.*

"You can see now how the properties of sponge make it useful for washing."

"If it were not *porous* and *absorbent* it could not suck up the water."

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Secondly, a piece of uncut cork should be compared with the bark of an ordinary tree and the similarity pointed out, and the children may then be told that cork is the outer covering or *bark* of a tree; but that the cork-tree does not grow in this country.

Thirdly, the teacher will show how its special *properties* adapt it for certain *uses*.

a. As stoppers for bottles.

It is *compressible*, and can thus, when properly cut, be pressed or forced in. Show this by experiment.

Let the children notice that the cork is larger than the opening of the bottle, and then press it in.

It is *elastic*. Show that the neck of the bottle increases in size from the mouth downwards, and how the cork presses out and fills the neck. This fixes the cork in tightly and prevents the liquid inside from getting out. An old champagne cork will show this admirably.

It is *impervious* to water and other liquids, hence these cannot escape from the bottle.

b. Its *lightness* makes it valuable for the construction of life belts and jackets to keep people from sinking in the water and being drowned. Also for making lifeboats and floats for fishing-nets.

This property and use may be prettily illustrated by taking a wooden doll and weighting it a little in the feet just sufficient to make it sink, and then supporting it by a ring of cork used as a life-belt, or strips of cork tied round the body illustrating a cork jacket.

c. Its *lightness* and *warmth* make it suitable for inner soles of boots.

The children will readily appreciate light boots and warm feet.

Advantage may be taken here to inculcate carefulness in keeping the feet warm and dry to prevent illness.

LESSON XVII.

LEATHER.

PIECES of leather of different kinds and thicknesses, an old "kid" glove, an old leather purse, and an old shoe or boot, will be useful for this lesson.

The teacher may proceed somewhat as follows:—

"Here are some pieces of leather. I will give each of you a small piece. Take the leather in your right hands. Shut your eyes and hold the leather near your noses."

"How can you tell leather with your eyes shut?" *By its smell.*

"Bend the leather. What can you say about leather because it bends easily?" *It is flexible.*

"Can you tear it? Try." *No.*

"Then what else can you say of leather?" *It is tough.*

"I put my piece in this glass of water. It does not sink. Then what can you say of it?" *It is light.*

"Repeat again the three things you have told me about leather?" *It is flexible, tough, and light.*

"Why do we say it is tough?" *Because it does not tear easily.*

"And why do we say it is flexible?" *Because it is easily bent*

"Here is an old shoe. What is it made of?" *It is made of leather.*

"Why do we wear shoes?" *To keep the feet warm.*

"And for what else?" *To keep the feet dry.*

"What did we say of india-rubber because it does not allow water to pass through?" *It is waterproof.*

"And what did we say of cork because it does not allow liquids to pass through?" *Cork is impervious to water.*

"You may remember that *impervious to water* and *waterproof* mean the same thing."

"Boots and shoes, when not too much worn, keep out the water. What more, then, can you say about leather?" *It is waterproof.*

"That is not true of leather when very thin; for water will pass through a kid glove and wet the hand; but it is true of the leather we use for making boots and shoes."

"You have now told me that leather is *flexible, tough, light, and waterproof*. Now let us see how these properties of leather make it so useful for making boots and shoes."

"Leather is flexible; but so is the stuff my dress is made of. Why would not that do to make boots and shoes?" *Because it would let in the water.*

"Yes, but then I might make the shoes of iron, they would not let in the water?" *They would be too heavy.*

"Well, then, why not use wood?" *They would not bend and would hurt the feet.*

"Paper is flexible and light. Why not use paper?" *Because it would not keep the water out. It would tear easily.*

"Now tell me the several reasons why leather is good for making boots and shoes?" *Because it is flexible, and does not hurt the feet. Because it is tough, and does not wear out very quickly. Because it is light, and does not tire the feet. Because it is waterproof, and keeps the feet dry and warm.*

There is one other property of leather to which attention should be drawn; that is, that when placed on or near the fire it frizzles up, and presently burns. The children may be taught a lesson from this, not to put their boots or shoes too near the fire when they wish to dry them, or to warm their feet.

The teacher may deal with its usefulness for gloves, &c., in a similar way.

The children may also be told that leather is made from skins of animals, but the process of manufacture should be reserved for a later stage.

LESSON XVIII.

INDIA-RUBBER, SPONGE, CORK, AND LEATHER
(A Comparison).

THE time of one lesson may now be occupied in the comparison of the properties of india-rubber, sponge, cork, and leather, not only as a special exercise in comparison and classification, but also as a test as to how far the teaching has been effective.

In no case should the scholars be told how these substances are alike or unlike; but, if necessary, recourse must be again had to examination and experiment.

The following are the chief points of likeness which should be elicited from the children:—

All the four substances are *light*; but sponge and cork are lighter than india-rubber and leather.

India-rubber, sponge, and cork are alike in being *elastic and compressible*; but sponge is more compressible than cork, and cork than india-rubber.

India-rubber, sponge, and leather are alike in being *tough and flexible*.

India-rubber, cork, and leather are like in being *water-proof or impervious* to water.

India-rubber and cork are vegetable substances, and are very *inflammable*.

Sponge and leather are animal substances; they frizzle up when placed on the fire and do not burn easily.

The following among others are points of difference which may be brought forward:—

Sponge is *absorbent*, the other substances are not absorbent.

Sponge is *porous*, but india-rubber and leather are non-porous.*

* Cork is porous also; but, as it is non-absorbent, liquids do not pass through

Cork differs from the other substances in not being *tough*.
Leather is *non-elastic*, the other substances are elastic.

LESSON XIX.

WATER, MILK, PARAFFIN OIL, ETC. (A Comparison).

THE agreements and differences to be elicited as before by observation, examination, and experiment, as far as necessary.

The three substances are alike in being *liquids*.

Water.

Transparent.
Colourless.
Tasteless

Milk.

Opaque.
White colour.
Sweet.

Water.

Transparent.
Colourless.
Without smell.
Non-inflammable.

Paraffin Oil.

Transparent.
Colourless.
Strong unpleasant smell.
Highly inflammable.

Paraffin oil may be shown to be lighter than water by pouring a little of both into a test-tube; the oil will rest on the top.

Milk.

Opaque.
Sweet.
Slight odour
Non-inflammable.

Paraffin Oil.

Transparent.
Burning, and should not be tasted.
Strong unpleasant smell.
Highly inflammable.

Other liquids, such as spirits, vinegar, ink, &c., may also be compared with the foregoing and with each other.

LESSON XX.

LOAF SUGAR, ALUM, SODA, CAMPHOR, CHALK, STARCH
ETC. (A Comparison).

THE agreements and differences to be elicited as before, by observation, examination, and experiment.

Loaf Sugar.

White colour.
Brittle.
Sweet taste.
Granular.
Soluble.
Fusible.
Rough.

Chalk.

White colour.
Brittle.
Tasteless.
Crumbles to powder.
Insoluble.
Non-fusible.
Smooth.

Alum.

Colourless, but white in
powder.
Transparent.
Soluble in water.
Rough taste.
Odourless.
Infusible.
Does not burn.

Camphor.

White colour.
Opaque.
Insoluble in water.
Burning taste.
Strong odour.
Infusible.
Highly inflammable.

Soda.

Colourless.
In powder, white colour and
opaque.
Soluble.
Infusible.
Brittle.
Saline taste.

Alum.

Colourless.
In powder, white colour and
opaque.
Soluble.
Infusible.
Brittle.
Rough taste.

Other substances may be similarly compared.

FOURTH STAGE.*

OBSERVATION and comparison are the dominant feature in this as in the preceding stages; but more new facts are introduced and useful information is imparted about some of the common necessities of life. In the "first lessons on manufactures" only such subjects are taken as can be illustrated without difficulty.

It is probable that by the time this stage is reached the children will have learned to read, and the chief points of the lesson should be written on the black-board as they are brought out.

The subjects dealt with are—

- (1.) Colour: shades and tints of colours.
- (2.) Form: the circle, sphere, and cylinder.
- (3.) Measures for dry goods.
- (4.) Properties of bodies: malleable, tenacious, ductile.
- (5.) Common objects: common salt, soda, alum, camphor, sulphur, snow and ice, wool and cotton, and pins and needles.
- (6.) Manufactures: bread, butter, cheese, starch, paste, &c.

LESSON I.

COLOUR.—SHADES AND TINTS.—I.

THE children should be provided with cards, or paper, or threads of wool of the following colours: carmine, yellow, blue, crimson, scarlet, pink, rose, and flesh colour.

The children at this stage are supposed to be able to distinguish all the primary and secondary colours, and to tell

* Suitable for children of from about 5½ to 6½ years of age.

how the latter are produced from the former. They have learned, moreover, that colours may be light or dark.

The teacher may now proceed to show the composition, and to give the names of some of these light and dark colours. But as the varying "shades" and "hues" and "tints"* are innumerable, while the names given them are very limited in number, and not very exact, it will be best for her to confine her attention to a few of the more common.

The general effect of mixing darker or lighter colours with any particular colour must first be shown by experiment. The resulting colours are seen to be darker or lighter.†

Teacher, holding up the standard red [*carmine*] asks:—

"What colour is this card?" *Red colour.*

"Here is another red. Is it darker or lighter?" *Darker.*

"Which is the darker colour, blue or red?" *Blue colour.*

"If I mix a little blue with the bright red it makes this darker colour, which we call *crimson*.

"Show me your red card. Now the crimson.

"How is crimson made?" *By mixing a little blue with bright red.*

"Show me your yellow card. Which is the darker colour, yellow or red?" *Red colour.*

"If I mix a very little yellow with bright red it makes this new colour, which we call *scarlet*.

"How do I say scarlet is formed?" *By mixing a little yellow with bright red.*

"Now place the three red cards in a row, the darkest first, then the bright red, then the lightest.

* A *shade* is sometimes understood to be a colour made darker by the addition of another and darker colour, while a *tint* is a colour made much lighter by the addition of another and lighter colour. When a slight colour is seen in addition to the principal colour it is called a *tinge* or a *hue*. But in practice these terms are used indiscriminately.

† The production of the particular shades and tints required will be found somewhat difficult, and paper or card patterns, or threads of wool, may be used instead of paints.

"What is the name of the lightest?" *Scarlet.*
 "And of the darkest?" *Crimson.*

"Now if I take a little crimson and make it very light by mixing white with it we get another very pretty colour. Here it is; we call it *pink*."

"In the same way if I mix white with a little bright red we get *rose* colour, and if I mix white with a little scarlet we get *flesh* colour."

"How can we make a pink colour?" *By mixing white with a little crimson.*

"How can we make a rose colour?" *By mixing white with a little bright red.*

"How can we make a flesh colour?" *By mixing white with a little scarlet.*

"Show me your scarlet card. Now the colour which we make from scarlet by mixing plenty of white with it."

"Now the bright red colour and the light colour we make from it. And now the crimson card and the light colour we make from it."

The teacher must continue to exercise the children in "matching" and selecting these colours until satisfactory results are achieved.

LESSON II.

COLOUR.—SHADES AND TINTS—2.

THE time of this, and probably one other lesson, may be occupied with distinguishing and naming the more common shades and tints of yellow, blue, and green. The extent, however, to which this subject is pursued must depend very

much on the intelligence and previous training of the scholars. The method to be followed will be similar to that of the last lesson, and cards, paper, or threads of wool must be provided according to the colours brought under notice.

The following are among the more common shades of yellow, blue, orange, green, and purple:—

YELLOW, a primary colour.

Chrome, a rich bright pure yellow.

Saffron, the colour of the saffron flower, a deep yellow with a tinge of red.

Sulphur, the colour of sulphur, a yellow with a bluish tinge.

Canary, the colour of the canary bird, a light chrome.

Lemon, the colour of the lemon, a yellow with a blue tinge.

Straw, the colour of straw, a pure light yellow.

Primrose, the colour of the primrose flower, a very light yellow.

Flaxen, the colour of flax, a pale tint of yellow.

BLUE, a primary colour.

Ultramarine, a fine rich deep blue.

Indigo, a deep blue with a tinge of red.

Prussian blue, a deep blue with a tinge of green.

Violet, the blue of the rainbow or spectrum.

Sky-blue, a light blue, the colour of the cloudless sky.

ORANGE, a secondary colour, a mixture of yellow and red, the colour of a ripe orange.

Auburn, a dark red orange.

Buff, a light yellowish orange.

Salmon, the colour of the flesh of the salmon, a light orange with a golden tinge.

GREEN, a secondary colour, a mixture of blue and yellow,
the brightest grass green.

Olive-green, the colour of the olive, a dark green.

Bottle-green, a dark yellowish-green.

Pea-green, the colour of the pea, a light green.

PURPLE, a secondary colour, a mixture of red and blue.

Lavender, a purple made light by mixing white with it.

Lilac, a purple made lighter by mixing white with it.

LESSON III.

FORM.—CIRCLE, CIRCUMFERENCE, CENTRE, RADIUS,
DIAMETER.

THIS lesson should be introduced by a few questions calling to mind the lessons on *form* in the previous stages. Thus, using the black-board :—

“What is the name of this figure  ?” *A square.*

“What kind of angles are the angles of a square ?” *Right angles.*

“Give me the name of another figure which has four right angles ?” *An oblong.*

“How many sides has an oblong ?” *Four sides.*

“What kind of lines are the sides of a square or of an oblong ?” *Straight lines.*

“What is the name of this figure  ?” *A circle.*

“How many lines has a circle round it ?” *One line.*

“What kind of line is it ?” *A curved line.*

“To-day I am about to teach you something more about the circle. We will first draw one. I place the black-board flat on the table, drive in a small nail near the centre, and tie a piece of string loosely on the nail. Mary shall

now take the other end of the string and a piece of chalk in her right hand, and, walking round the table, make a large circle.

“I will next draw three or four straight lines from the nail to the curved line which forms the outside of the circle. Can you tell me anything about these lines? Let us measure them. Now tell me?” *They are all of the same length.*

“In what part of the circle is the nail ?” *In the middle.*

“Yes, and we call the middle by another name—the *centre*.

“The line which goes round the circle we call by a long name—the *circumference*.

“Each line which we have drawn from the centre to the circumference is called a *radius*.

“I will now take out the nail and make the centre of the circle with the chalk, and then draw a line through the centre from one side of the circle to the other. This line, because it goes quite *through* the circle, is called the *diameter*. The word *diameter* means *measure through*.

“One more point. We sometimes say that the line which forms the edge of a figure *bounds* the figure; that is, it shows how far the figure extends. The walls of this room show how far the room extends, they are said to *bound* the room.

“How many sides *bound* a square ?” *Four sides.*

“What name do we give to the line which *bounds* the circle ?” *The circumference.*

“Where does the line called the *diameter* begin ?” *It begins at the circumference.*

“And where does it end ?” *It ends at the circumference.*

“And what point does it always pass through ?” *It passes through the centre of the circle.*

“Where does the line called the *radius* begin ?” *It begins at the centre*

"And where does it end?" *It ends at the circumference.*
 "What part of the diameter is the radius of a circle?"
The radius is one-half the diameter.

"Look at the clock-face. What is its shape?" *The shape of a circle.*

"Yes, and when a thing is of the shape of a circle we say it is *circular*.

"What shape then is the clock-face?" *The clock-face is circular.*

"And what can you see on the clock-face which looks like the radius of a circle?" *The hands.*

"Where are the hands fixed?" *In the centre of the clock-face.*

"You see a black line drawn round just outside the figures. What name do we give to that line?" *The circumference.*

"What is the shape of this penny?" *Circular.*

"And of this biscuit?" *Circular.*

"And of the top of this inkstand?" *Circular.*

"Of this plate?" *Circular.*

The lesson may be further illustrated, if necessary, by a drawing of a cart-wheel, the box, spokes, and rim representing respectively the centre, radii, and circumference of a circle.

Lastly, the children should make circles on their slates and draw diameters and radii.

• They may be measured by a scholar.

LESSON IV.

FORM.—SPHERE, CYLINDER.

As many spherical and cylindrical bodies as can conveniently be obtained should be placed on the table.

"Here are marbles, oranges, and balls of sewing-cotton. How are they all alike?" *They have all the same shape.*

"And what shape have they?" *They are ball shaped.*

"I will give you another word which means *round like a ball*; it is *sphere*. And when we want to say *sphere shape*, we use the word *spherical*. Therefore you may say that the marbles and oranges are *spherical* in shape.

"Give me the names of other objects which are spherical in shape." *India-rubber ball, apples, cherries, currants, &c.*

"Here is an apple. I will cut it into halves. Now, if the whole apple is a sphere, what must the half be?" *A half-sphere, or the half of a sphere.*

"I will give you a new name for *half of a sphere*; it is *hemi sphere*. *Hemi* means half; then *hemisphere* means *half of a sphere*, or half of a ball.

"What is the shape of the half of an orange?" *Hemisphere.*

"How many hemispheres does it take to make a sphere?" *Two hemispheres.*

"What is this [holding up a cylindrical ruler]?" *A round ruler.*

"You say round ruler. Is it round like a ball?" *No, it is round and long.*

"Look at the ends and tell me their shapes." *The ends are flat and circular.*

"Here is a sheet of paper. Can any little boy or girl make this paper look something like the round ruler? No one!

Well, how do people manage to carry home large sheets of paper?" *They roll them up.*

"Now, roll up this sheet of paper. You see it looks like the ruler in shape, and I can use it for drawing lines.

"We use a long word to describe the shape of things which look as if they were rolled up, like this ruler for instance; it is *cylinder*. When we wish to say things are of the shape of a cylinder, we say they are *cylindrical*.

"These are not easy words, but you must try and remember them, because we find so very many things of this shape.

"Let us look about the room to find things cylindrical in shape. The legs of the table, the legs of the chair, the gas-pipes, the stove pipe, lead pencils, pen-holders, the poker.

"Now think of things you have seen at home which are cylindrical in shape." *Broom-handle, candle, blind-roller, some bottles, pins and needles, &c.*

LESSON V.

MEASURES FOR DRY GOODS.

PINT, quart, gallon, peck, and bushel measures are necessary for this lesson. If these cannot be procured for the occasion, it will be better to postpone the subject till a later period.

This lesson should be introduced by a rapid recapitulation of Lesson VI. Stage III., and the measures then used for liquids, viz. the pint, quart, and gallon, should again be brought under the notice of the children.

The corresponding measures made of wood will next be shown, and the children may be led to see why wooden

measures are most suitable for measuring *solid* bodies, and earthenware, glass, or metal for *liquids*.

Wooden measures are less liable to be broken than earthenware or glass, and are much cheaper than metal, and may be kept sufficiently clean for measuring seeds, &c., without much washing.

On the other hand, wooden measures cannot well be kept sufficiently clean for measuring liquids, whilst earthenware, glass, and metal are cleansed with but very little trouble.

The next higher measure for dry goods—viz. the peck—should now be introduced, and the children must learn from actual experiment that two gallons make one peck.

The bushel will next be dealt with, and in a similar manner.

Questions should follow to strengthen and test knowledge, thus: A peck is equal to how many gallons? How many gallons make a half-peck? How many pecks make one bushel? How many gallons make a bushel? How many quarts in a bushel? How many pecks in a half-bushel? How many gallons in a half-bushel? and so on. Recourse should be had to experiment where necessary.

If the teacher can now introduce basket measures so much the better; and the children may easily be led to see why basket measures, which are cheaper than wooden, suffice for measuring peas and beans in pods, apples, potatoes, &c., whilst they are unsuitable for measuring flour, wheat, peas, seeds for birds, and so on.

Lastly, the teacher may ask the children to enumerate articles sold by measure and by weight. Of course the answers will depend very much on local custom.

LESSON VI.

PROPERTIES OF BODIES.—MALLEABLE AND TENACIOUS.

PIECES of lead, copper, iron, gold-leaf and tin-foil, glass, marble, and flint, or as many as possible of these substances, should be provided. Also a large stone, or block of wood, to serve as an anvil and a hammer.

Take the piece of lead, and, after asking the children to note its shape, give it three or four smart blows with the hammer. The change in form will be at once evident to the scholars; it is *spread out or flattened*.

[If the necessary appliances are within reach, red-hot iron may be treated in the same way.]

Next try to flatten a piece of flint.* It breaks into a number of sharp jagged pieces; it is *brittle*. The lead which does not break into pieces, but which spreads out under beating, is said to be *malleable*, a word which means *can be beaten out with a mallet or hammer*.

A copper vessel—a saucepan or a kettle—will serve to show the malleability of copper; and tin-foil, silver-foil, and gold-leaf will illustrate the extreme malleability of tin, silver, and gold.

Secondly, the malleability of gold, silver, tin, iron, lead, &c., depends on another property which these objects possess in common—they hold together firmly, and so are said to be *tenacious*, a word which means *to hold fast*.

Thirdly, the teacher should direct the attention of the children to the particular uses to which these objects are put following on the property of malleability, such as zinc and

* Care must be taken to protect the children from the flying splinters.

lead for covering houses, lead for making water-pipes and gas-pipes, copper and silver for drinking and other vessels, iron for making kettles, saucepans, nails, &c., gold and silver for covering other articles, such as drinking-vessels, forks, picture-frames, and tin for making tin-foil for wrappers.

Recapitulation, as usual, by question and answer should follow.

LESSON VII.

PROPERTIES OF BODIES.—DUCTILE AND TENACIOUS.

As many different kinds of wire of various sizes as can readily be obtained will be useful in illustrating this lesson.

“What do we say of gold, silver, lead, tin, and iron because they can be beaten out into thin leaves?” *They are malleable.*

“How is it that these bodies can be beaten out when chalk and glass and stones cannot?” *Because they hold together.*

“What word means holding together?” *Tenacious.*

“There is another property which these bodies possess which I want you to learn about to-day. Can you give me the name of these pieces which lie on the table?” *They are pieces of wire.*

“Here is a piece made of copper. Two little boys shall come to the table and try and break it. You see they cannot break it either by pulling or twisting. What can you say of it?” *It is very strong.*

“Yes, the copper holds together very firmly, it is—?” *Tenacious.*

“Here is another piece of wire. What is its colour?” *White colour.*

"Yes, it is made of silver.

"And here is another piece which I can cut with a pair of scissors or a knife. What can you say of it because we can easily cut it?" *It is soft.*

"This soft wire is made of zinc.

"Here are several more wires of different thicknesses; they are all made of a kind of iron called *steel*. They are very strong.

"Tom shall come and find the stoutest wire, and James the thinnest or finest.

"I must now tell you that all these wires are made by pulling the copper and silver and steel through holes. You will learn how it is done in a future lesson. But I want you to remember now that all those bodies which can be drawn out into wires are said to be *ductile*."

"Looking at the steel wires, what property can you say steel has?" *Steel is ductile.*

"What do we mean when we say steel is *ductile*?" *It can be drawn out into wire.*

"What three properties do silver and copper and steel possess in common?" *They are malleable, tenacious, and ductile.*

"Gold is also very ductile, and lead and tin are *ductile*; but lead, zinc, and tin are not so *tenacious*, and so the wire made of these metals is not strong."

The teacher should now elicit from the children some of the uses to which wire is put, and why; and then recapitulate as usual.

LESSON VIII.

COMMON SALT.

ARTICLES for illustration:—Table salt and rock-salt, with the spirit-lamp and evaporating-dish.

A large lump of clean white salt should be placed in full view of the class, and the scholars should be directed in the first place to tell all they have learned in previous lessons about this important and necessary article of food.

"To-day our lesson is on salt. Let me hear how much you already know about salt.

"What can you learn about salt from looking at it?" *It is of a white colour.*

"By tasting it?" *It has a taste which we call salt.*

"By feeling it?" *It is hard and rough.*

"Can you tell me what makes it feel rough?

"I will hand you some small pieces. Look at them very closely. How does the salt differ from chalk?" *Salt is made up of tiny bits.*

"Yes, and we call these tiny pieces *grains*, and salt is said to be *granular* because it is made up of tiny grains.

"Give me the name of another white substance which is granular." *Loaf sugar.*

"Why do you say loaf sugar is granular?" *Because it is made up of little grains.*

"If you look at the little grains of sugar and salt again you may see that they "shine" or sparkle, and salt and sugar are said to be *sparkling*.

"If I strike this lump of salt with a hammer what will happen?" *The salt will break in pieces.*

"What property do we say salt possesses because it breaks into pieces when struck with a hammer?" *Salt is brittle.*

"As I go on hammering the salt you see the pieces get smaller and smaller, and now it is fine like dust. This we call a *powder*.

"We use powdered salt to eat with our meat and potatoes.

"Suppose I put a piece of salt into water, what happens to the salt?" *It dissolves.*

"What do you mean by dissolves?" *Breaks up into such small pieces that we cannot see them.*

"What do you say of salt because it dissolves in water?" *It is said to be soluble.*

"How can I tell that there is salt in this water?" *By tasting the water.*

"Do you remember how in a former lesson we got the salt back again in little grains?" *Yes, by driving away the water.*

"How did we drive away the water?" *By boiling.*

"I wonder if you have ever thought 'where does salt come from?' I will tell you: it comes from under the surface of the ground. In some places there are thick beds of salt underground as thick, or thicker, than the school-room is high. This kind of salt is called rock-salt. Here is a piece of rock-salt. It is not clean and white, but you can tell by tasting it that it is salt. You know how often it rains. Well, a good deal of the rain-water soaks into the ground, and where there are beds of rock-salt the water dissolves some of the salt. To get salt, then, people either dig out the rock-salt or pump up the salt water.

"You can tell me how the salt is got from the water?" *The water is boiled away from the salt.*

"I dare say many of you little boys and girls have heard of the sea, perhaps some of you have seen the sea. If you were to taste sea water you would not like it, because it is very

salt and not nice to the taste. People get salt from sea water by driving away the water."

"You can tell me what salt is used for?" *To eat with our food.*

"Can you eat as much salt as you eat potatoes?" *No.*

"How does it make you feel when you eat much salt?" *Thirsty.*

"Salt is used to mix with our food to make it taste nice; but there is another reason why we eat salt, we should soon be ill if we ate no salt.

"What are the two reasons then for our eating salt?" *To make our food taste nice, and to keep us well.*

"Salt has another use; when rubbed on meat it keeps it sweet and fit to eat for a long time.

"Can you tell me the names of some things we eat which have been salted?" *Fish, beef, bacon, &c.*

"One thing more I want you to remember. Sheep, and cows, and horses, and other animals are very fond of salt; and it is good for animals to have their food salted, just as it is good for us to eat salt with our food."

LESSON IX.

SODA.

A SUFFICIENT quantity of soda, the spirit-lamp and evaporating-dish, a little grease or oil, a basin of water and a towel should be provided.

As in the previous lesson, the children should be led to discover the more obvious properties of soda by the exercise of the senses, aided by simple experiment. Thus it is *transparent** and *colourless*, it is *hard*, *brittle*, and *smooth* and

* The white powder on the outside must be removed by washing.

very *unpleasant* to the taste. It is very *soluble* in water ; but is not *fusible*.

When exposed to the air a *white opaque powder* forms on the outside. This is *dry soda*. The transparent colourless article contains a large quantity of water.

An interesting experiment will show this. Placed in the evaporating-dish over the spirit-lamp, the soda appears to melt ; in reality it is dissolving in its own water. If this water be slowly evaporated off, the white dry powder is left.

It is not advisable here to enter into the question of the manufacture of soda, or of its uses in the arts and manufactures, but the teacher will be able to elicit from the children its use for cleansing purposes. Its power of removing grease may be illustrated. Allow a child to rub a little grease over its hands and then try to remove it by washing in water only. Add a little soda to the water, and the grease is easily removed.

LESSON X.

ALUM.

SUFFICIENT alum should be provided for each scholar to have a small lump.

The teacher may take a piece of alum and a piece of soda from which the white opaque powder has been removed, and lead the children to institute a comparison between the two substances.

"To-day our lesson is to be on a substance very much like soda. You shall find out for me presently in what ways they are alike : but first you must tell what you learnt about soda.

"What did you learn by looking at it?" *Soda is transparent and colourless.*

"What by feeling it?" *Soda is hard and smooth.*

"What by tasting it?" *The taste of soda is not nice.*

"What by hammering it?" *Soda is brittle.*

"What by putting it in water?" *Soda is soluble.*

"What by heating it?" *The soda boiled : the water was driven off and a white powder was left behind.*

"What did we call the powder?" *Dry soda.*

"Now taste a little of the pieces I have given you. Does it taste like soda?" *No.*

"Eat a little more. How do the tongue and the roof of the mouth feel?" *Rough.*

"Who can tell me the name of this stuff?" *Alum.*

"Right ; now I want you to remember that the particular taste of alum is called *astringent*. You will find out other things by-and-by which have an *astringent* taste."

"How are soda and alum then unlike?" *They are unlike in taste.*

"Now you shall tell me how they are alike. First look at the pieces. They are both *transparent* and *colourless*.

"Feel the alum. Like soda, alum is *hard* and *smooth*. I hammer a piece. Like soda, alum is *brittle*.

"I put a little in water. Like soda, alum is *soluble* in water.

"Now we heat some over the spirit-lamp. Like soda, it *boils*, the water is driven off, and *dry* alum is left behind.

"Look at this dry alum ; feel it. It is hard. This dry alum is sold under the name of *burnt alum*."

The teacher may now show by experiment two other interesting facts about alum.

1st. Articles of clothing, such as cloth and calico, steeped in alum water and then dried, are very difficult to burn.

2nd. That alum dissolves* much more freely in hot than in cold water. Hence, if boiling water saturated with alum be left to cool, alum deposits in crystals. If the cooling be slowly conducted large crystals may be obtained.†

Reference will be made to the uses of alum in tanning, dyeing, calico printing and paper making, in future lessons.

LESSON XI.

CAMPBOR.

ARTICLES for illustration: a piece or two of camphor and a little "spirits of wine."

The more obvious properties of camphor can readily be elicited from the children.

By sight. It is *white* in colour. It is not quite opaque and yet not transparent like soda or alum. It is *half* or *semi-transparent*.

By feeling. It is *hard*.

By taste. It is *bitter* and *unpleasant*.

By smell. It has a strong peculiar *odour*.

By hammering. It is *tough*.

By placing in water. It is *light*, and *insoluble*‡ in water.

By contact with a flame. It *burns* readily, giving off much smoke.

Heated in the evaporating-dish. It does not *melt*. It is *infusible*. But it flies off into the air like steam from boiling

* A pound of boiling water will dissolve a pound of alum, while it requires about eighteen pounds of quite cold water to dissolve the same weight of alum.

† Take some small article made of wire, such as a basket, cover the wire with worsted, place the basket in a hot saturated solution of alum, and leave it to cool slowly. In a day or two a pretty crystal basket will be the result.

‡ Although apparently insoluble in water, sufficient of the camphor dissolves to give to the water its peculiar odour and bitter taste.

water. It is said to be *volatile*, a word which means *flying off*.

The experiment suggested in a former lesson [Stage III. Lesson XI.] may be repeated here. It will impress on the minds of the children the fact that substances may be held in solution although we cannot see them.

LESSON XII.

SULPHUR.

A STICK of sulphur, and sulphur matches are the requisite articles.

This lesson should be dealt with in a manner precisely similar to those immediately preceding.

Sulphur is of a *bright yellow* colour, it is *tasteless* and without *smell* except when rubbed, it is *hard* and *brittle*, *heavy* and *insoluble*.

Sulphur is *fusible*; but there is a peculiarity in the process of fusion which gives an interesting experiment. Heated in a test tube, at a little above the boiling-point of water it changes to an orange liquid; heated a little more it thickens to the consistency of treacle and its colour changes to a deep red. In this state, if poured into cold water, it forms soft and elastic but solid threads, which after a time become brittle.

Sulphur is *inflammable*.* It burns with a blue flame, and a suffocating poisonous gas is the result.

This gas possesses the power of *bleaching* many articles.

* Only a small particle of sulphur should be burnt to show the colour of the flame and the peculiar smell.

A red rose will lose most of its colour if held in the fumes of burning sulphur for a minute or two.*

NOTE.—The time of another lesson may be well occupied in comparing salt, soda, alum, camphor, and sulphur, as to points of agreement and difference in their properties.

LESSON XIII.

SNOW AND ICE.

THE occasion for this lesson should be selected—a wintry day when snow covers the ground and the ponds and lakes are frozen over.

The lesson may be introduced by a simple conversation on what the children have seen on coming to school—the trees, houses and fields covered with snow, boys sliding on the ponds, others throwing “snow-balls,” &c.

From this conversation the teacher may lead the children to compare snow and ice with regard to their properties. Both feel *cold*; both *melt* in the hand and become water, so that we may call ice *solid* water, or water *liquid* ice. Snow is *soft* and *light* and *compressible*, hence its suitability for making snow-balls. Ice is *light* and *hard* and *brittle*. Snow is of a pure *white* colour. Ice is *transparent* and *colourless*, and looks like glass. Ice is also *smooth* and *slippery*; hence when there is ice on the roads we must be careful how we walk. Boys should not make *slides* on the roads and paths because they may cause people to fall down and hurt themselves.

The special uses of snow and ice may now be pointed out. The snow, although cold in itself, keeps the cold wind from

* This experiment should only be attempted at the end of the lesson, when the room may be emptied, and the windows and doors opened for a few minutes.

the plants; and the ice which covers the water serves a similar purpose for the fish and other animals which live in the water.

The children will be interested to learn that in some very cold countries the people live in houses made of snow, and that lumps of ice serve for windows.

A rough sketch of a snow-house may be drawn on the black-board, and the children may be asked to describe how these houses differ from our houses.

LESSON XIV.

COTTON AND WOOL.

ARTICLES for illustration: Raw cotton and wool, sewing-cotton and worsted, calico, flannel, cloth, together with any other articles made of cotton or wool ready to hand.

The teacher may in the first place lead the children to institute a comparison between raw cotton and raw wool.

Both are *white* in colour, *soft*, *light*, *elastic*, and *absorbent*, and both feel *warm*.

They differ, however, in the facility with which they can be burned. Cotton burns readily; wool frizzles up and burns with difficulty.

The sources of cotton and wool will form the second division of the lesson.

The children will know that wool is obtained from the sheep, and they must be told that cotton is the soft covering of the seed in the pod of the “cotton-plant.” If in season, a pod of the “broad bean” may be taken to illustrate the pod, the seed, and the woolly material which lines the pod. Or an illustration of the cotton pod may be shown.

The teacher may here describe, in the form of a simple story, "sheep-washing" and "sheep-shearing," and this may be followed by a series of questions, such as the following:—

"Why are the sheep washed before they are sheared?"
To make the wool clean.

"I told you that the shearing took place at the beginning of summer; why would it not be right to shear the sheep in winter?" *Because the sheep would feel very cold.*

"When do you wear great coats and warm cloaks?" *In the winter.*

"And when do you leave them off?" *In the summer.*

"When you want a new coat how can you get it?" *By buying it at the shop.*

"How does the sheep get her new coat for the winter?"
It grows on the sheep.

"Can you tell me what would become of the sheep's great coat in summer if it were not shorn off?" *No.*

"Then I will tell you: it would come off bit by bit, and so be wasted."

In the third place the teacher may show some of the chief articles made of cotton and wool, as enumerated at the head of the lesson, and inquire as to their uses.

LESSON XV.

PINS AND NEEDLES.

EACH child should have a pin and a needle.

Showing a large pin, the teacher may proceed.

"What is this I am holding in my hand?" *A pin.*

"What do we use pins for?" *To pin or fasten things together.*

"How is it that the pin goes into the cloth and calico so easily?" *Because it has a sharp point.*

"What is there at the other end of the pin which prevents it from hurting your finger when you stick it in?" *The head.*

"Look at the pin I have given you. What else can you tell me about it?" *It is shining. It is straight. It is smooth. It is hard. It has a white colour.*

"Why must the pin be smooth?" *To make it go through the cloth, &c., easily.*

"The pin has a head and a point, and the part between the head and the point we call the body; what is the shape of the body of the pin?" *Round.*

"I want a more correct answer than that. What is the shape of this ruler?" *Cylindrical.*

"And the pin, although smaller, is of the same shape. Now what is the shape of the body of the pin?" *Cylindrical.*

"Tell me how a needle differs from a pin." *It has an eye; but no head.*

"What is the eye?" *A small hole through the needle.*

"Where is the eye?" *Near the end opposite to the point.*

"What is the use of the eye?" *To hold the thread when it is being pulled through the stuff in sewing.*

"What is the shape of the body of the needle?" *Cylindrical.*

"What sort of a point has a needle?" *A sharp point.*

"I can bend a pin, but if I try to bend a needle what happens to it?" *It breaks.*

"Then what do you say about the needle because it breaks when you try to bend it?" *It is brittle.*

"And what about the pin?" *It is tough.*

"What do we use for fastening your clothes together besides pins?" *Strings and buttons.*

"Which do you think is the better to use, pins or buttons?"

Buttons.

"Why?" *Because we may prick our fingers with the pins, or they may be bent and the clothes come unfastened.*

LESSON XVI.

MANUFACTURES — BREAD.

WHEAT, flower, salt, yeast, sugar, warm water, dough and the necessary basins, spoons, &c., should be at the disposal of the teacher.

Attention should be called to the articles on the table, and the children may be asked to name such as they know. The teacher should then give the subject of the lesson, viz. "How bread is made."

First, the preparation of flour from wheat must be illustrated. One child may crush a little wheat with the pestle and mortar, and two others may sift the mixture through coarse muslin. The flour will pass through, and the coarse bran will be retained.

Secondly, the necessary ingredients are to be mixed in proper order, and the process should be accompanied by conversation and question and answer, thus:

"I put the flour into this basin. Here is another white powder in this saucer. Jane shall taste it and then give me its name. Yes, it is salt. Take a little and mix it with the flour. Stir well with the spoon.

"Here is something else. James shall taste it and then give you its name." *It is sugar.*

"And here is another substance which perhaps you have never seen before. It is called *yeast*. Feel it. It is soft.

It has rather a sour smell too. Mary shall mix a little bit of this yeast with a little bit of sugar. Now we must add the water. But the water must not be quite cold.

"Now we have mixtures in two basins. What have we in the first one?" *Flour and a little salt.*

"And in the second one?" *A little yeast and sugar in lukewarm water.*

"Sarah may now pour the mixture of yeast and sugar and water into the basin containing the flour, and mix all together with the large spoon. And now I want a little girl who has very clean hands to come and mix it with them. Look at her. She is *kneading*, and the mixture is now called *dough*.

"Now the dough is well kneaded, and it should be put by for about two hours in a warm place. If we could wait so long for it and watch it, we should see it get larger and larger and higher in the basin until perhaps it ran over. It is the yeast we put in which makes the dough *rise* and swell in the basin. We cannot wait to see the dough rise; but I have a piece in this plate, which I got from the baker's. The baker put it to *rise* this morning. I cut it across. What do you see?" *The dough is full of little holes. It is porous.*

"I will sprinkle it with flour and knead it again. Now I cut the dough into two pieces, roll the pieces into balls, set the smaller ball on the larger, press the balls together and the *loaf* is made.

"But look at this loaf of bread: it is like the loaf of dough?" *No.*

"What must be done with the loaf of dough to make into bread?" *It must be baked in an oven.*

"Name all the things we used for making dough." *Flour, water, salt, yeast, and sugar.*

"Of which of these did we use a very little?" *Salt, yeast, and sugar.*

- "Which did we mix first?" *The flour and salt.*
 "And what kind of water did we put the yeast and sugar into?" *Warm water.*
 "What is the mixing with the hands called?" *Kneading*

If time permit, the teacher may elicit from the scholars the properties of bread, and contrast the properties of the crust with those of the crumb.

LESSON XVII.

MANUFACTURES.—BUTTER.

ARTICLES for illustration: Milk with cream on its surface, cream, and butter.

"Before we begin our lesson to-day I want you to give me the names of some of the things you had for breakfast this morning." *Bread, butter, tea, coffee, eggs, milk, sugar.*

"That will do; now those who had butter for breakfast tell me where it was put?" *It was spread on the bread.*

"And where was the milk put?" *Into the tea.*

"What is the colour of butter?" *Light yellow.*

"Can you see any yellow butter in this milk?" *No, the milk has a white colour.*

"And yet I must tell you that this milk has butter in it, yes, and cheese too. And to-day I am going to show you how people get butter out of milk. Another day I will show you how cheese is made.

"First of all look at the milk in this glass. Can you see anything on the surface of the milk?" *Yes, cream.*

"Why do you think the cream rises to the top of the milk?" *Because it is lighter than the rest of the milk.*

"When people want to make butter, they set the milk, that

is, allow it to remain quite still in shallow* pans for some hours, and all the nice cream *rises* to the top. This is skimmed. I have some in this tea-cup. Here it is. You see it is thicker than milk.

"We will try to get a little butter from this cream. First of all I must warm it a little; this I can do by standing the cup in hot water. I now take this little bunch of twigs and *beat* the cream for some little time. Perhaps some little girl would like to help to make butter. Now we have some little lumps of butter swimming about in a thin liquid. The thin liquid is called *buttermilk*. People sometimes drink buttermilk, and sometimes it is given to pigs to drink."

The teacher may now lead the children to see how inconvenient and what hard work it would be to beat large quantities of cream by the hand only, and so the cream is put into a machine called a churn, where it is shaken about until the butter comes. The buttermilk is pressed out of the butter, the latter is washed in fresh cold water, and salted, and is then fit for use.

Lastly, the teacher, by the help of experiment, may elicit from the children the special properties of butter, together with its chief uses.

LESSON XVIII.

MANUFACTURES.—CHEESE.

ARTICLES for illustration: Sour, skimmed, and unskimmed milk, and a little rennet.

Milk, if left to itself for a short time, becomes sour, and a part of it *curdles* or becomes a kind of white jelly, which we

* Explain by comparing a saucer with a tea-cup.

call *curds*. The liquid in which the curds float is called *whey*.

The sour milk should be exhibited to show this, and the curds may be separated from the whey by straining through a cloth. The children may then be told that this mass of curds, when pressed into a hard lump and all the whey squeezed out, is called cheese.

Cheese made from the curds of sour milk is not nice to the taste, and so we get the milk to curdle in another way. The milk is first warmed a little, and then a liquid* is added which causes the milk to curdle at once.

The teacher will illustrate this by experiment, and separate the curds and whey.

On testing, the whey will be found to be sweet, showing that it contains sugar.

A comparison of curds and cheese will show that a colouring matter and salt have been added to the curds.

Skimmed and unskimmed milk may be experimented upon, and the teacher will point out that the curds in the latter case take the butter with it, and so the cheese will be rich or *fat*. The cheese from skimmed milk may be called *poor* cheese.

A recapitulation of the *chief* ingredients in milk, and a comparison of the properties of butter and cheese, will complete the lesson.

* Rennet, made from the inner skin of a calf's stomach, is commonly used. Dilute acids will answer the same purpose, although of course the acids will render the curds and whey unfit for food.

LESSON XIX.

MANUFACTURES.—STARCH.

ARTICLES for illustration : Flour, a potato, starch, water, and pieces of muslin.

Show the children a cuff or a collar which has been made stiff and smooth by means of starch, and compare with another which has been washed and ironed without starch. Dust and dirt do not stick so much to the one as the other, and so it keeps clean longer.

Ask the children what their mothers use to make the collars, &c., stiff and look so nice and smooth, and then proceed to show by experiment how starch is made.

"Here is some white powder; you saw it the other day when I showed you how bread is made. What is it?" *Flour*.

"And here is some starch. How are starch and flour alike?" *They are both of a white colour*.

"And how do they differ?" *The flour is in a powder and the starch is in small lumps*.

"What is flour made from?" *It is made from wheat*.

"Yes, and flour is also made from rice. People make starch from the flour of wheat and of rice. I am going to show you how it is done."*

Tie a small quantity of flour in a muslin bag. Place in a basin of water, and work it well with the fingers. The starch passes out into the water and gradually settles on the bottom of the vessel. A little of the starch prepared in this way beforehand and allowed to dry will appear as a bright white granular powder.

The chief property of starch, and that on which its use

* The teacher may also show how starch is made from potatoes. Take a clean potato, rasp into fine shreds, mix well with water, and place on a piece of stretched muslin. The milky liquid which passes through contains the starch.

in the laundry depends, viz. its solubility in hot water and its becoming hard and dry under the hot iron, must next be shown. It will add to the interest of the lesson if the teacher can prepare a little starch and show its application on a piece of linen or other suitable material.*

LESSON XX.

MANUFACTURES.—PASTE, GUM, GLUE.

ARTICLES for illustration: Flour, gum, British gum, glue, a piece of wall paper and a few pieces of wood.

Exhibit a piece of wall paper and ask the children where they have seen paper something like it, and thus elicit the use of this kind of paper and how it is fastened to the wall.

Tell the children that the paper is fastened to the wall with *paste* made from flour, and then proceed to show how paste is made,† and to illustrate its use by pasting the paper on to the black-board. As the paste dries it hardens and fastens the paper to the wall.

When we wish to stick small pieces of paper together we use *gum*. Show the specimen of dry gum and tell the scholars whence it is obtained. It oozes out from certain trees, and on drying becomes hard and looks like beads of glass. Show how the gum is prepared, and illustrate its use by experiment.

* The iron must be sufficiently hot to dry the starch at once or it sticks, but not overheated so as to scorch the material.

† The flour must be mixed with cold water; the water must be added gradually, and the flour well stirred until it assumes the consistency of thick cream. Then slowly pour on boiling water, stirring vigorously the whole time. On cooling, the paste thickens and looks like jelly.

Next show British gum. British gum (or dextrine) is simply starch baked in an oven which is not hot enough to scorch it. Gum prepared from dextrine has an unpleasant smell.

Paste and gum do not hold firmly enough for sticking together such things as wood, and we use *glue*. Glue is made from hoofs and horns and skins of animals by long boiling and then drying. Prepare glue, and illustrate its use in making furniture, &c., by sticking pieces of wood together. Let the children try to separate two pieces of wood fastened together by glue which has become hard.

Lastly, call attention to the common property of paste, gum, and glue, of being *sticky*, and holding things firmly together as they get dry.

FIFTH STAGE.*

THE Fifth Stage completes the course of "Systematic Object Lessons" for infant schools; but with the assistance of similar lessons, and a recapitulation of some of the preceding lessons (due regard being had to the different ages and capacities of the scholars), will suffice for Standard I, and in poor neighbourhoods and in village schools even for Standard II. It will be seen that the lessons on minerals, metals, and textile fabrics are suggestive rather than exhaustive.

The following are the subjects of this stage:—

- (1.) Colour—irregular colours.
- (2.) Form—rhombs, rhomboid, pentagon, &c., prisms, pyramids, and cone.
- (3.) Time, and how we measure it.
- (4.) Minerals, coal (coal gas), graphite (lead pencils), clay (bricks, pottery, &c.). Limestone (lime and mortar).
- (5.) The common metals, their properties and uses.
- (6.) Textile fabrics.

LESSON I.

IRREGULAR COMMON COLOURS.†—BROWN AND GREY

PIECES of paper, silk, cloth, and threads of Berlin wool and any other articles giving the necessary shades, hues, or tints of *brown* and *grey*, may be brought into use for illustrating this lesson.

* Suitable for children of from six to seven years of age.

† See introductory note, Lesson II. Stage IV.

The teacher should introduce this lesson with a rapid recapitulation of the lessons on colours in the previous stages, and then call attention to the various articles on the table, or in the hands of the children, having colours different from any previously considered.

Brown is composed of *red*, *yellow*, and *black*, or *red*, *yellow*, and *blue* in various proportions. In *dark brown*, the black or the blue predominates; in *deep brown* the red; and in *light brown* the yellow.

Grey is made by mixing *white* and *black* and adding a little *red*, *yellow* or *blue*.

The following are the more common of these colours; they may be dealt with in a way similar to that indicated in former lessons on colour.

BROWNS.

Chestnut, a dark shade of brown, the colour of a chestnut.

Chocolate, a dark reddish brown, the colour of chocolate.

Snuff, a dull yellow-brown, the colour of snuff.

Claret, a purplish, light red brown, the colour of claret.

Drab, a very light dull brown with a yellow tinge.

Stone colour, a very light tint of brown.

GREYS.

Slate, a bluish-grey, sometimes reddish, the colour of the stone.

Steel, or iron colour, a dark bluish-grey.

Pearl, a very light silvery grey.

LESSON II.

FORM.—THE RHOMB AND RHOMBOID.

A "Box of Forms" should form a portion of the apparatus of every infant school; but lacking this, rhombs, pentagons, &c., may be cut from cardboard or paper.

Taking the square and the oblong, already well known as starting-points for other plane figures, the teacher may proceed as follows:—

"I have here two forms [showing square and rhomb] which I wish you to look at carefully.

"Are these forms alike?" *No.*

"How many sides has this form (showing square)?"
Four sides.

"How many sides has this form (showing rhomb)?"
Four sides.

"Then how are these two forms alike?" *They both have four sides.*

"What can you tell me about the sides of the square?"
They are all of the same length.

"Observe whilst I measure the sides of the other form. Now what can you say also about these four sides?" *They are all of the same length.*

"Then you see these two forms are alike in having the same number of sides, and the sides are of equal length. Now why do you say these figures are not alike?" *The square has four right angles, the other figure has not.*

"How many angles of this figure (the rhomb) are larger than right angles?" *Two angles.*

"What do we call these angles?" *Obtuse angles.*

"And how many angles has this figure which are less than right angles?" *Two angles.*

"And what name do we give to angles which are less than right angles?" *Acute angles.*

"This form, which has four equal sides, and two obtuse and two acute angles, is called a *rhomb*. You may spell the word and write it on your slates."

The children may now be directed to draw *squares* and *oblongs* and *rhombs*, and write their names below: or the exercise may be varied by making the outlines of these forms with pointed sticks and softened peas.

The *rhomboid* may now be compared with the oblong, as the rhomb with the square; and the children led to see that a rhomboid has two equal long sides, two equal shorter sides, two obtuse angles, and two acute angles.

LESSON III.

FORM. PENTAGON, HEXAGON,* HEPTAGON, AND OCTAGON.

PROVIDE these forms from the "Box of Forms," or cut them from cardboard or paper.

Taking the pentagon, the teacher may request the children to count the corners and sides.

"How many sides has this form?" *Five sides.*

"How many angles has it?" *Five angles.*

"A flat figure which has *five sides* and *five angles* is called a *pentagon*. *Pente* means *five* and *gon* means an angle; therefore the word *pentagon* means *having five angles*.

* The most important form of the polygons is the *hexagon*. The cells of the honeycomb may be shown to illustrate how beautifully hexagons fit and join together. Or the same may be shown by a drawing on the black-board.

"Here is another form having five sides and five angles. How is it unlike the other?" *Its sides and angles are not equal.*

"I want you to remember that a pentagon with equal sides is called a *regular pentagon*."

The children may now make the outlines of pentagons with the pointed sticks and peas, or draw them roughly on their slates, imitating the teacher on the black-board.

The other forms will now be taken in order and dealt with as above; and exercises on form and colour combined may be introduced as in Lesson VI. Stage II.

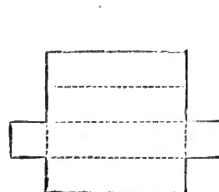
LESSON IV.

FORM.—PRISMS.

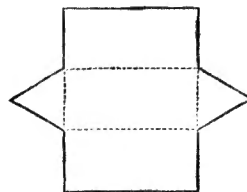
SQUARE, triangular, and hexagonal prisms should be shown. If not otherwise provided, the two former can be made from cardboard.*

Hitherto only four *solid* forms—the *sphere*, *cylinder*, *cube*, and *brick shape* have been brought under review. With these as starting-points, the teacher may now proceed to

* The figures below represent the shape in which the cardboard must be cut, and the dotted lines show where it has to be folded.



Square Prism.



Triangular Prism.

develop ideas of other common solid forms, viz. *prisms*, *pyramids*, and *cones*.

"How many faces has this cube?" *Six faces.*

"What is the shape of each of the faces?" *Square shape.*

"Here is another block of wood. How many faces has it?" *Six faces.*

"How do the faces of this form differ from the cube?" *In this form two faces only are squares, the other four are oblongs.*

"Where are the square faces?" *At the ends.*

"And where are the oblong faces?" *At the sides.*

"Compare the square ends as to size." *They are equal.*

"And the oblong sides?" *They are equal.*

"Here is another form. How many faces has it? Count them." *One, two, three, four, five.*

"What is the shape of the ends?" *They are triangles.*

"And of the sides?" *They are oblongs.*

"How many equal oblong sides are there?" *Three.*

"How many faces has this figure [showing an hexagonal prism]? Count them." *One, two, three, four, five, six, seven, eight.*

"What is the shape of each side?" *Each side is oblong in shape.*

"What is the shape of the ends of this form?" *Hexagons.*

"I will now give you a name for solids which have *equal oblong sides* and *equal ends*. They are called *prisms*."

"But I have shown you three prisms, and they are not alike; how shall we know the one from the other?" *By their ends.*

"Look again at the end of the first prism I showed you. What is its shape?" *Square.*

"Then we may call this form a square prism."

"And what is the shape of the end of the second prism you have seen?" *A triangle.*

"Then how can you name this prism?" *A triangular prism.*

"And what name shall we give to the prism whose ends are hexagons?" *Hexagonal prisms.*

Recapitulation by question and answer should follow.

LESSON V.

FORM.—PYRAMID AND CONE.

ARTICLES for illustration: Triangular, square, and other pyramids and the cone.

Showing a square pyramid, the teacher may ask, "How many faces has this figure?" *Five faces.*

"How many sides has it?" *Four sides.*

"What is the shape of each side?" *A triangle.*

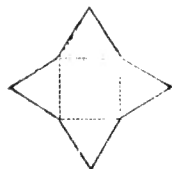
"And what is the shape of the end on which it stands?" *A square.*

"We sometimes call the end on which a thing rests its base.

"Here is another form. What is the shape of its base?" *Triangular.*

"And of its sides?" *Triangular.*

• Square and triangular pyramids may be formed from cardboard thus:



Square Pyramid.



Triangular Pyramid.

"Now how are these forms like *prisms*?" *They have bases alike in shape.*

"And how do they differ from the prisms?" *They have triangular instead of oblong sides, and the triangles meet in a point at the top.*

"I will now tell you that these forms which have triangular sides meeting in a point at the top are called *pyramids*, and the meeting-point is called the *apex*.

"What is the shape of the base of the first pyramid I showed you?" *It is square.*

"Then what kind of pyramid may I call it?" *A square pyramid.*

"And what shall I call the pyramid with a triangular base?" *A triangular pyramid.*

"There are other pyramids, as there are other prisms, having more sides; but I want you now to look at this form. What is the shape of its base?" *Circular.*

"And how is it like a pyramid?" *It comes to a point at the top.*

"Have you seen anything of this shape?" *Yes, loaf sugar.*

"But we do not call it a pyramid; we call it a *cone*. Remember then that a pyramid with a circular base has a shorter name than any other sort of pyramid. It is a cone."

LESSON VI.

TIME. AND HOW WE MEASURE IT.—DAY, HOUR, MINUTE, SECOND.

THE day may be taken as the starting-point in the divisions of time.

A few questions such as the following will serve to introduce the day of twenty-four hours as a measure of time

"When there are no clouds what may we see shining in the sky?" *The sun, or moon and stars.*

"When does the sun shine?" *In the daytime.*

"And when do the moon and stars shine?" *At night.*

"When do you see the sun first?" *In the morning.*

"Yes, we say the sun *gets up* or *rises* in the morning. When does it go away?" *In the evening.*

"We say it *sets* in the evening.

"Of what use is the sun to us?" *It gives us light and heat.*

"What follows the day?" *The night.*

"What difference is there between day and night?" *It is dark at night, and very often colder.*

"When is it very dark at night?" *When it is cloudy, and the moon and stars are not to be seen.*

"You say the sun shines in the day-time; does it always shine into the school-room through the same window?" *No.*

"Look where it is shining now, and then to-morrow at this same time we will look again to see where it is shining. We shall find that every day at the same time it shines through the same window. Now I want you to remember that when we talk about a *day of time* we mean the time from the shining of the sun through any one window on one day till it shines through the same window the next day. Or, to be more exact, the time the sun takes in making his journey from any one point in the sky back again to the same point is one *day of time*.

"How many times do you come to school each day?" *Twice—in the morning and again in the afternoon.*

"What does afternoon mean? You don't know; well, what does after-school mean?" *When school is over.*

"And what does after nine o'clock mean?" *When nine o'clock has passed.*

"And just in the same way after-noon means when noon

is over or passed. But what does noon mean? I will tell you; it means *middle of the day*.

"Now what does afternoon mean?" *It means after the middle of the day.*

"At what time do you leave 'morning school?'" *At twelve o'clock.*

"Yes, and that is noon; and I may tell you it is just the moment when the sun is highest in the sky.

"If we call the time after the middle of the day afternoon, what may we call the time before the middle of the day?" *Before noon.*

"Yes, or shortly, it is called *fore-noon*. Sometimes noon or the middle of the day is called *mid-day*, which means middle of the day. What may we call the middle of the night then?" *Mid-night.*

"Can you give me the names of some of the smaller divisions of time?" *Hours, minutes, seconds.*

"Which is the longer time, the hour or the minute?" *The hour.*

"And which is the shorter, the minute or the second?" *The second.*

"At what time do you come to school in the morning?" *At nine o'clock.*

"At what time do you leave school to go home to dinner?" *At twelve o'clock.*

"How many hours from nine till twelve o'clock?" *Three hours.*

"How many hours from twelve till two o'clock?" *Two hours.*

"And from two till four?" *Two hours.*

"Then how many hours do you attend school each day?" *Five hours.*

"How many hours are there between nine and four o'clock?" *Seven hours.*

"I want you to remember that it takes twenty-four of these hours to make up one day ; that is, we divide the day of time into twenty-four parts, and each part is called an hour."

The children may be led to appreciate the shorter divisions of time by counting. The teacher should first herself ascertain the proper *rate* for counting sixty in a minute. Following the lead of the teacher, the children will quickly learn to count at the desired rate ; and then individual scholars may be encouraged to try.

When a fair idea of the duration of time which we call a minute has been obtained, the children may be told that sixty of these minutes make up an hour, or that the hour is divided into sixty minutes. Next, that each count takes a second of time, and thus sixty seconds make up a minute.

Lastly, the children may be practised in the table—

60 seconds make one minute,

60 minutes make one hour,

24 hours make one day.

NOTE.—Further exercises, at the discretion of the teacher, may be devised for training the children to observe and measure time, thus :—(a) They may close their eyes at a given signal and try to keep them closed for a half minute, or one, or two minutes. (b) A child may be sent to another part of the building for a book or other object, and the class may be directed to find out—counting for themselves—how long the messenger has been gone.

LESSON VII.

TIME, AND HOW WE MEASURE IT.—THE CLOCK FACE.—I.

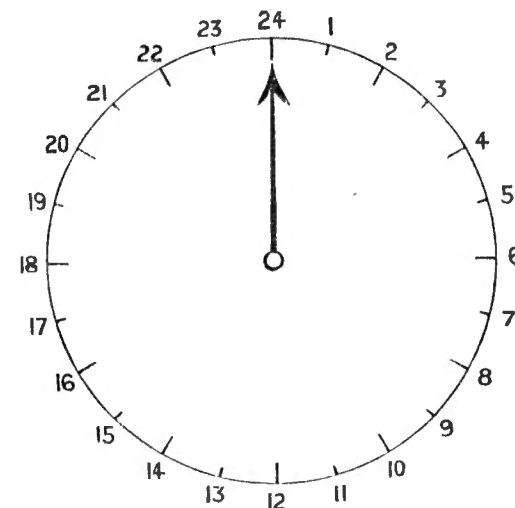
BEFORE proceeding to deal with the longer divisions of time, it will be well to face the problem over which children are always more or less puzzled, viz. *how to tell the time by the clock.*

In this, as indeed in all lessons, the secret of success lies in mastering one step at a time.

In the first place the children must grasp the idea that we measure the duration of time by noting how long it takes a certain thing to be done, or how long it takes a certain object to travel over a measured distance.

"Suppose, for instance, we make a candle sufficiently long to burn for a day of twenty-four hours, viz. whilst the sun appears to make one journey, and then divide it into twenty-four parts by notches ; the time taken for the candle to burn from one notch to the next will be one hour. And our forefathers long ago used to measure time by notching their rush candles. But this was not a very convenient or very correct plan ; and, by-and-by, it was found out that time can be measured by using weights, and wheels, and chains to make a long finger of iron travel round and round a face.

"This new machine was called a clock, and now we always measure time by means of clocks and watches.



"Here is a clock face drawn on a sheet of paper. A little strip of black cardboard serves for the pointer or finger. I

fix this finger in the centre of the face by a drawing-pin, so that I can turn it round and round.

"The weights and wheels and chains in the clock can be so arranged as to make the pointer, called the hand, go once round the face (travelling at the same rate) in twenty-four hours. I have divided the circumference of the face on the paper into twenty-four parts.

"How long then will it take the hand to travel from one figure to the next?" *One hour.*

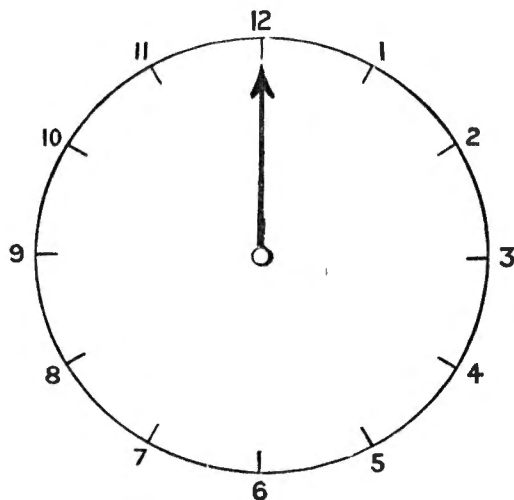
"And from the figure one to three?" *Two hours.*

"And from four to eight?" *Four hours.*

"Clocks are sometimes made like this; but it is found more useful to make the hand go round *twice* in twenty-four hours.

"How long then will it take the hand to go round once?" *Twelve hours.*

"Then into how many parts must I divide the circumference of the face?" *Into twelve parts.*



"Here is another face so divided into twelve parts, and numbered 1, 2, 3, &c., up to 12."

"How long will it take the hand to go from one figure to the next?" *One hour.*

"Towards which figure is the hand pointing now?" *Towards the figure Twelve.*

"Yes, and when the hand points to the figure Twelve, we say it is twelve of the clock, or by the clock, or, in short, twelve o'clock. Do you remember from your last lesson what other names we give to this time?" *Noon, and mid-day.*

"Now the hand points to the figure One; what time is it?" *One o'clock.*

"Now to the figure Two?" *Two o'clock.*

"Now to the figure Six?" *Six o'clock.*

"I must tell you that this hand, because its business is to point out the hours, is called the *hour-hand*."

Of course the children can have no difficulty in telling the hours by this clock face and hour-hand, and the teacher may go a little farther and explain the terms *past* and *to*, which are almost invariably used in naming the time by the clock.

Roughly, they may be taught to say *past* the hour when the hand is half way, or less than half way, between two figures. When the hand is more than half way towards the next figure they should say *towards*, or *to* the hour indicated by the latter, e.g. "*a quarter to*."

This practice must be continued till all the children can tell the time as thus far indicated.

During the practice the Arabic numerals may be replaced by the Roman.

LESSON VIII.

TIME, AND HOW WE MEASURE IT.—THE CLOCK FACE.—2.

"Look at the school clock. How many hands do you see?" *Two hands.*

"Are they of the same length?" *No, one is longer than the other.*

"Yes, and the shorter one is the one you have been learning about. What is it called?" *The hour-hand.*

"Why is it called the hour-hand?" *Because it points to the hours.*

"How long does it take the hour-hand to go from one figure to the next?" *One hour.*

"And how long does it take to go once round the face?" *Twelve hours.*

"And how many times does it travel round in a day of twenty-four hours?" *Twice.*

"Now look carefully at the hands for a minute or two and tell me whether they are travelling at the same rate." *No, the long hand goes much faster than the hour-hand.*

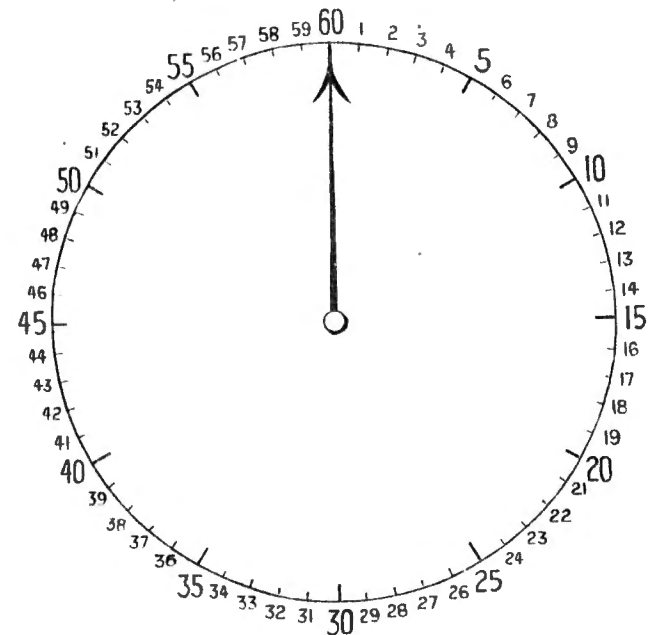
"Quite right, and to-day I want to teach you all about this long hand, why it goes faster than the other, and how long it takes to go round once.

"But we must have it by itself for a little while.

"Here is another face which I have made for the long hand only.

"You remember how many minutes make one hour?" *Yes, sixty.*

"And I have divided the clock face into sixty parts. Now, if we make this long hand go once round in an hour, what time will the little spaces between the figures stand for?" *Minutes.*



"This long hand has to point to the minutes; what may we call it?" *The minute-hand.*

"Do you see that I have made some figures larger than the others? Repeat these, beginning with the figure Five." *Five, ten, fifteen, &c.*

"I have made these figures larger, because they come just where the figures which show the hours are placed. I fix the other face on the black-board by the side of this, and you will see that this is so."

The children must now be practised on this clock face in telling the number of minutes *past* the hour until quite perfect; but special stress should be laid on the larger figures

Next they must be shown that

35 minutes *past* is the same as 25 minutes to the hour

40	"	"	"	20	"	"
45	"	"	"	15	"	"
50	"	"	"	10	"	"
55	"	"	"	5	"	"

and that, when the hand has passed the figure Thirty, it is more common to say so many minutes *to* the next hour. Practise on this until the children can answer promptly so many minutes *past* or *to* the hour wherever the teacher places the hand. During this practice the children may be shown that as the figure Fifteen stands at a quarter of the distance round the circle, *fifteen minutes past* is often called *quarter past*; and so of *half-past*, and a *quarter to* the hour.

In the third place remove the figures on the face and practise the class with the division marks only.

Lastly, substitute the numerals which mark the hours, and practise again, of course still keeping to the minute-hand.

Not until the scholars are quite perfect with the minute-hand on the ordinary clock face must the teacher proceed to the next lesson.

LESSON IX.

TIME, AND HOW WE MEASURE IT.—THE CLOCK FACE.—3.

WE assume that the children are now in a position to answer all questions on the hours, using the hour-hand only, and on the minutes, using the minute-hand only. It remains for the teacher to show the use of the two hands on the clock face. For this purpose the cardboard fac-simile of a clock face with two movable hands, to be found in most infant schools, may be used.

Set the hands, say, to mark twelve o'clock. Now move the minute-hand to thirty minutes past

"Look at the minute-hand: what does it say?" *Half-past, or thirty minutes past.*

Move the hour-hand midway between twelve and one.

"Look at the hour-hand: what does it tell?" *That the time is between twelve and one.*

"And the minute-hand shows you how much past twelve?" *Half-past.*

"Now what time does the clock face show?" *Half-past twelve.*

Next set the hands to show, say, ten minutes past six.

"What does the minute-hand show?" *Ten minutes past.*

"And what does the hour-hand point to?" *Between six and seven.*

"Then what time does the clock face show?" *Ten minutes past six.*

Set the hands to show, say, twenty minutes to two o'clock.

"What does the minute-hand show now?" *Twenty minutes to the hour.*

"And where does the hour-hand point?" *Between one and two.*

"Then what time does the clock face show now?" *Twenty minutes before two.*

This kind of exercise must be continued until the children are fairly perfect in their answers, and then the teacher may call individual scholars to set the hands to show particular times as specified by the teacher.

Lastly, they may be directed to draw (roughly) a clock face on their slates, and place the hands to indicate times as directed.

NOTE.—The children should have five minutes' practice with the clock face occasionally; and advantage may be taken of any odd moment to repeat the names of the days of the week and the months of the year. The number of days in a week, and in each particular month, and the number of days and weeks in a year, will naturally follow.

LESSON X.

MINERALS.

For this lesson the teacher should be provided with specimens of as many of the common minerals as possible, such as—coal, rock-salt, clay, chalk, limestone, granite, sand, sandstone, flint, slate, marble, and any ores of metals.

"I have," says the teacher, "a number of objects lying on the table, some of which you all know, and others which perhaps you have not seen before. To-day I wish to teach you something about all of them. In other lessons we will take them one or more at a time, and learn something more about them.

"Here is a lump, the name of which you all know; what is it?" *Chalk.*

"Where do we find chalk?" *Underground.*

"And what is this?" *Rock-salt.*

"And where do we get rock-salt from?" *From underground.*

"Can you tell me why it is called *rock-salt*? Well, what does it look something like?" *A piece of stone.*

"Yes, and another name for stone is rock, and rock-salt is so named because it is found in great stony or rocky masses.

"Here is a piece of clay; where do we get clay from?" *From underground.*

"Here is a black lump; what is its name?" *Coal.*

"Yes, and like chalk, and rock-salt, and clay, we get it from underground.

"And I may tell you that all the things which you see on the table were got from under the surface of the ground.

"Here are *sand* and *flint* and *slate*, which you all know;

and here is a beautiful white stone called *marble*; and here is another very hard stone called *granite*; and here is a very heavy stone—it contains iron, although you cannot see it—it is called *ironstone*; and here is yet one more heavy still—it contains *lead*."

"All these and many other stones we get from underground, and we give them all one name—they are all *minerals*.

"But potatoes grow in the soil, and the roots of plants and trees spread about underground; yet these are not minerals; these live and grow, but minerals have no life.

"Just think how badly off we should be without minerals.

"What do we use coal for?" *To make fires to keep us warm.*

"And what is the use of clay?" *To make bricks.*

"And of hard stones?" *To build houses and make roads.*

"Yes, and iron, and lead, and tin, and copper serve hundreds and hundreds of useful purposes. We could not do very well without minerals.

"We must next inquire how the minerals are arranged underground. If we dig a deep hole in the garden or field nearest the school, shall we find chalk, and rock-salt, and coal, and ironstone, and other minerals all mixed up together? Certainly not. You may perhaps find sand, or a mixture of sand and pebbles called *gravel*, for a little way down; and then perhaps clay, and perhaps below this a hard stone; and these lie the one on the other like the bed lies on the mattress; hence they are called beds. Most of the minerals, such as clay, chalk, limestone, rock-salt, gravel, coal, and ironstone, are placed in beds, and these sometimes spread out so far that it would take a little boy weeks and even months to walk across them. Other minerals, such as

gold, silver, lead, tin, and copper, are mixed up in hard rocks.

"Look again at these minerals. What do your eyes teach you about them?" *They are not of the same colour.*

"Harry shall feel them. What can he tell you about them?" *Some are hard, others are soft.*

"Tom shall lift them in his hand. What can he tell you?" *Some are heavier than others.*

"If I put them on the fire, one of them will burn; which is it?" *The coal.*

"If I put them in water, one will dissolve; which is it?" *The rock-salt.*

"If I hammer them, one will flatten out; which is it?" *The clay.*

"All the rest will break, if I strike them hard enough, into sharp pieces. What do we say of them?" *They are brittle.*

"Which of them will break easily?" *The chalk, rock-salt, and coal.*

"Some of them I can cut with my knife." *They are soft.*

"Some I cannot cut?" *They are hard.*

"As I told you, you will learn more about these minerals and their uses in future lessons. I want you to remember what minerals are, that they vary very much in their properties—in hardness, in brittleness, in weight, in colour—and that a few will burn, and some dissolve in water."

LESSON XI.

COAL.—I.

A LUMP of common household coal, a piece of anthracite, and a bit of jet should be provided; a few other minerals should lie on the table for comparison.

"To-day our lesson is to be on the most valuable, because the most useful of all minerals—*coal*."

"You shall first of all tell me all you know, or can find out about it, by looking at it, handling it, and hammering it."

"By looking at it?" *It is of a black colour.*

"Yes, that is quite plain; but look again more closely as I move it about." *It shines.*

"Many minerals shine in the same way, and we say that they possess *lustre*, a word which means *brightness*."

"That is an interesting fact about coal; but this mineral possesses one property on which all its value depends. What is it?" *It burns. It is inflammable.*

"Can you tell me why coal is not suitable for making the walls of our houses?" *It is not strong enough. It breaks to pieces too easily. It would make our fingers and clothes black and dirty.*

"Yes, it is too easily broken to be used for building purposes; but brittleness is just its next most useful property after inflammability."

"You all know whence coal is obtained?" *From underground.*

"Supposing coal were as hard as granite or sandstone, what then?" *Men would not cut it out so easily.*

"Just so, and if it took more time and more labour to get the coal, it would be dearer for us to buy, so that the brittleness of coal makes it cheaper."

"There is another reason which you did not tell me why coal would not do for the walls of our houses. You know houses sometimes take fire. What would be the effect, in such case, of the walls being of coal?" *They would burn and increase the fire.*

"Now I wish you to look at two other kinds of coal which I have here on the table.

"If you put the common coal of which we have been talking on the fire, what happens?" *It burns.*

"And what do you see when it burns?" *Flame and smoke.*

"Here is another kind of coal called by a long name, *anthracite*, which simply means coal. This burns with a clear flame and gives off very little smoke.

"Tom shall hold a piece in his hand. It does not soil the fingers so much as common coal.

"Try to break it with the hammer. It is harder than ordinary coal.

"There are several other kinds of coal. One is so hard and close that it does not soil the fingers at all, and it can be polished and made to look something like black glass. This is called *jet*. Jet is made into ornaments, such as brooches, necklaces, &c. I will hold this piece in the flame of our lamp. You see it burns; but it does not burn so readily as common coal.

"Do you remember how the coal is arranged underground?" *In beds or layers.*

"In the next lesson I shall show you how the coal is got out.

"But perhaps some little boy or girl may be curious to ask, 'How did the coal get there?' You are not old enough to understand much about this yet; but I may just tell you

that wood, including trunks, roots, branches, and leaves, when buried for a long time in the earth changes to coal. It sounds like a fairy story; but it is true that the woods and forests which grew thousands and thousands of years ago, somehow got buried in the earth and changed to coal, which we dig out now to supply us with light and heat."

LESSON XII.

COAL—2.

ARTICLES for illustration: A large tumbler, different coloured sands, and a little small coal.

"Before I explain to you how coal is got out of the earth I must show you how it lies there. I can only do it in a very tiny way.

"Here is a large tumbler. I put a little rough sand at the bottom. That forms one bed. Now I sprinkle a little small coal over the rough sand. That stands for a *bed* of coal. Now we will have a thin layer of brown earth, next one of white sand, and now another of small coal a little thicker than the last. This represents another bed of coal. And now we will fill up to the top with layer upon layer of brown, yellow, and white sand.

"When men dig for coal they find beds just like the beds in the glass; but you must not think the beds there are fine sand like that I have been using, they may be hard rocks, or firm clays, some of them as thick or thicker than the school is long, and there may be twenty, thirty, or forty layers before we get down to the coal beds. There may be several coal beds, varying in thickness; some coal beds are only a few inches thick, others are four or five feet, and occasionally

they are as much as thirty or forty feet thick, and they spread out many miles every way.

"You see how the coal is placed underground. How is it got out? Perhaps some little boy or girl can tell me how to get at the layers of coal in the glass?" *Turn the glass up.*

"Yes, but I can't turn the earth topsy-turvy and shake out the coal. Try again?" *Dig out the layers on the top.*

"That certainly might be done; but just think of the amount of work to dig out hard rocks and clays several hundred yards thick, and then only to find two or three layers of coal four or five feet thick. Why the coal when got out would be worth more than its weight in gold.

"Just for a moment suppose the layers of sand in the glass to be clay. We can make a hole down to the coal with a large needle. If we could persuade some tiny ants to work for us they could show us how men get out the coal. You must provide them with tiny baskets and give them spiders' webs for rope. Then some of the ants will get into the basket, and others will let them down the hole we have made as far as the coal. These ants will fill the basket and a tiny load of coal will be drawn up to the top.

"This is just how the coal is got out. A hole is made some ten or fifteen feet wide through the hard rocks and stones and clays down to the coal. Through this hole, which is called the *shaft*, the men are let down in cages and the coals are brought up. The men work away in all directions with pickaxes and shovels, and the coal is taken in little trucks or waggons to the bottom of the shaft.

"You may perhaps wonder that when the layer of coal is taken out the earth above does not sink down and crush the men; but all the coal is not taken out, enough is left standing to keep the rocks from falling.

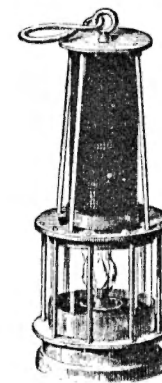
"The place whence the coal is taken is called a *mine*, and the men who work in the mine are called *miners*. Most

mines have more than one shaft, and some mines extend from the shaft for a mile or more. In some of the large mines several hundred men work at one time, and as many as fifty or sixty ponies to draw the coal from where it is cut out to the bottom of the shaft.

"Should you think it is light or dark in a coal mine?" *Dark.*

"Why do you think it is dark?" *Because the sun cannot shine there.*

"Yes, it is quite dark, darker than the darkest night you ever saw; but the men have candles placed in lamps made of wire woven in and out like this.



"The miners who work in coal mines are always in danger; but I must tell you about this, and why the gauze lamp is used, in our next lesson.

"I will now ask you some questions about what I have been telling you to day.

"I daresay some one can tell me why we call coal a mineral?" *Because it is taken from a mine.*

"And what are the men called who work in mines?" *Miners.*

"What is the hole called up and down which the miners go, and where the coals are brought out?" *The shaft.*

"How is the coal found in the earth?" *In beds or layers.*

"And about how thick are these beds?" *Some only a few inches, some five or six feet, and some as much as forty feet.*

LESSON XIII.

COAL.—3.

ARTICLES for illustration: Clay pipe, small coal, coal gas, soda-water bottle.

"To-day I have to tell you about the dangers of the coal-mine; and to help you to understand better about them, I am going to show you two very pretty experiments.

"Here is a long clay tobacco-pipe, and here is a little fine coal, and here a little soft clay. I nearly fill the bowl of the pipe with small coal, and then stop it with clay pressed in firmly. I now put the bowl in the fire, or hold it in the flame of the spirit-lamp.

"You must watch the thin end of the stem. Do you see anything coming out?" *Yes, smoke.*

"Most of that is steam from the moist clay and coal.

"Now the bowl is red-hot, and there is nothing to be seen coming out; but there is something, as I will show you. James shall put a light to the end. There, it takes fire, you see, and burns like a candle.

"Have you ever seen anything else burn like this?" *Yes, gas.*

"And this is gas. We have, in fact, been making our own gas on a small scale.

"And now for the second experiment.

"I have here a soda-water bottle. You cannot see anything inside, but there is a mixture of coal-gas and the air of the room. I wrap the bottle in a duster, because it may

possibly break, and were it not for the duster the glass would most likely cut my hand. William may hold this lighted taper, and the moment I take out the cork put the flame to the mouth of the bottle.

"You heard the noise, it was almost like a gun going off.

"If this room were filled with a mixture of coal gas and air, and we brought in a light, there would be an explosion, the windows would be blown out, and some of you would be very much hurt.

"You may learn a very important lesson from this. Many of you, no doubt, have gas in your houses, and sometimes it escapes. You can tell it by its strong smell. Now if enough gas escapes to form the proper mixture with the air, you have only to carry in a lighted candle, or strike a match, to have an explosion. Therefore, when you find by its smell that there is gas in a room, throw open the doors and windows to let it escape, and keep all lights away till the room is clear.

"Let us see what facts we can learn from our two experiments.

"How did we make gas?" *By heating coal in a pipe.*

"Where did the gas come from?" *The coal.*

"What does this show us?" *That coal contains gas.*

"That is the first fact I want you to remember. Now for the second.

"What did I tell you I had in the bottle?" *Coal gas and air.*

"And what happened when William put the light to the mouth of the bottle?" *There was an explosion.*

"Then what fact have you learned from the second experiment?" *That a mixture of coal-gas and air will explode.*

"Now we will go to the mine and see what sometimes happens there.

"Firstly, the owners of a coal-mine get all the air they can into the mine, or the men could not breathe and would die.

"Secondly, gas often escapes in large quantities from the coal in the mine without any heat.

"Thirdly, it is dark, and the men must have lights to see to work.

"It may happen that there is just the mixture of air and gas to explode, and it only wants the light; but fortunately, when the light is in the lamp made of wire gauze, it will not set fire to the mixture. Sometimes the men are not careful, and take out the candles, perhaps to light their pipes, and then there may be, and sometimes there is, a terrible explosion, and scores and even hundreds of men may be killed.

"But this is not all; the *fire-damp*, as the miners call the coal-gas, when it burns, makes another gas, called by the miners *choke-damp*. When the men breathe this *choke-damp* they lie down, and soon die.

"There is another danger, too, in the mine. Sometimes the rocks from above fall on the men and crush them."

The teacher should now question as in the last lesson, and some of the uses of coal may be elicited. Other uses will appear in the succeeding lessons.

LESSON XIV.

GRAPHITE.

A ROUGH lump of graphite in its natural state, or, failing this, a cake of Nixey's black-lead, and a piece of lead, scraped clean, will be necessary.

"When your mother 'cleans' the grate in the morning what does she put on it?" *Black-lead.*

"What does she do next?" *Brushes the grate.*

"Why does she brush it?" *To make it shine.*

"Now tell me what black-lead is used for besides 'cleaning' grates and stoves?" *For making black-lead pencils.*

"And what do we use black-lead pencils for?" *For writing on paper.*

"What colour must the paper be to show the writing best?" *White paper.*

"To day our lesson is to be on the mineral called black-lead.

"I have called black-lead a mineral, tell me then whence we get it?" *From underground.**

"I must show you first of all that this mineral is wrongly named. It is not lead at all, neither has it a black colour.

"Here is a lump (or a cake) of black-lead and here a piece of lead.† I want you to look at them and tell me how they are alike?" *They both shine.*

"When speaking of coal what name did we use instead of shining?" *Lustre.*

"Again, how are black-lead and lead alike?" *They both possess lustre.*

"I take this piece of white paper and draw first the black-lead and then the lead across it.

"How are these minerals alike in the second place?" *They both mark the paper.*

"Now you can see why this mineral has been called *lead*. Can you tell me?" *Because it has a lustre like lead, and because like lead we can write with it on white paper.*

"Then as to its colour. Is it black like this piece of coal?" *No.*

"How does it differ in colour from coal?" *It is lighter in colour than coal.*

* It is undesirable to confuse young children with minerals not found underground.

† The lead should be clean.

"How does it differ from lead in colour?" *It has a darker colour than lead.*

"And because of its darker colour no doubt it got its name, black-lead; but its colour is dark grey.

"I must tell you that black-lead has two other names; they are *plumbago* and *graphite*. Plumbago is another name for lead, and graphite means something to write with. Graphite is the best name for it, because it points out its very useful property of making a mark on paper.

"We will compare these minerals still further, and you will see how different graphite is from lead, and you will find out at the same time other properties of this useful mineral.

"Mary shall try them as to weight. Well?" *The lead is heavier.*

"Now I will cut slices off each with my knife.

"How do the pieces of lead come off?" *In slices.*

"And the graphite?" *It breaks to bits, or crumbles.**

"You can tell me something else that crumbles when cut?" *Chalk.*

"It is this property which makes chalk and graphite useful for writing. Tiny little bits come off and stick to the black-board or the paper.

"Next I hammer the two minerals.

"What do you say about the graphite?" *It is brittle.*

"And the lead?" *It hammers out flat. It is malleable.*

"Lastly, we will try to melt each. The lead melts into a bright shining liquid. The graphite cannot be melted.

"What do we say of things which can be melted?" *They are fusible.*

"And of those that cannot be melted?" *They are infusible.*

"Repeat for me the chief properties of graphite?" *It is*

* The term *friable* may be given.

of a dark-grey colour, it shines, it is brittle, it crumbles and it is infusible.

"If you feel it you can tell me one other property. What is it?" *It feels smooth and greasy.*

"I must tell you that graphite does not lie in the earth like coal and clay in beds. It is found in lumps of various size, mixed up with hard rocks, but not in large quantities, nor in very many places."

LESSON XV.

A BLACK-LEAD PENCIL.

ARTICLES for illustration: Black-lead pencil, uncut. Another split to show groove and the glueing. Also strips of wood to illustrate the manufacture.

"What is this I am holding in my hand?" *A black-lead pencil.*

"What are the two parts of the pencil?" *The wood and the black-lead.*

"Give me the best name for black-lead." *Graphite.*

"Why is it called graphite?" *Because the word graphite means something to write with, and graphite is used for writing purposes.*

"Where is the graphite in the pencil?" *It is placed along the centre.*

"What is the shape of the pencil?" *It is cylindrical.*

"What is the shape of the ends of the pencil?" *They are flat and circular.*

"Look at the end of the graphite, what is the shape?" *It is square shape.*

"How do you think the graphite is put down the middle of the pencil?" *A hole is made and the black-lead put in.*

"No, that would take too long a time.

"I will show you. Here is a stick with oblong ends

Observe—*oblong*, not square. The breadth of the stick is greater than its thickness, so that its ends are oblong. To make the ends square, you would have to increase the thickness, and that we will do presently. The stick is about long enough to make three pencils. A little gutter or groove is cut down the middle by a saw, and the graphite which has been cut to fit the groove is put in.* Then another piece of wood of the same shape as the first piece, but not so thick, is fastened on the top.

"What do we use when we want to stick two pieces of wood together?" *Glue.*

"And the pieces are glued together. The stick now has square ends, but it is cut by a machine into a cylindrical shape. Lastly, it is cut into pencils of the proper length.

"Now I must tell you something about getting the graphite ready to put in the wood. Sometimes little pieces of graphite are found quite pure, that is, there is nothing else mixed up with it. It has then only to be cut with fine saws into strips and placed in the grooves.

"But pure graphite is very scarce, and too dear for making cheap pencils. Hence, impure graphite, that is, graphite mixed with other minerals, has to be used. To get rid of some of these minerals which would prevent the graphite from writing so well, the mineral has to be crushed to a fine powder. Then to get it again into a hard solid for cutting, it is mixed with ground clay and made into a paste. This paste is put into a mould and baked. The cakes are then cut with fine saws into strips ready for the grooves.

"When you want to write with a black-lead pencil what is the first thing you have to do?" *Cut it to a point.*

* The teacher will show the groove by splitting a pencil and taking out the "lead." The same pencil will serve to illustrate the fastening together of the strips of wood.

"What kind of wood will cut the easiest?" *Soft wood.*

"A soft wood, called *cedar*, is mostly used; you can tell it by its pleasant smell and reddish colour when wetted.

"Can you tell me why the graphite is put into wood?" *To prevent it from breaking.*

"Yes, and yet another reason?" *To prevent it marking the fingers as well as the paper.*

The recapitulation questions should embrace the preceding as well as the present lesson.

LESSON XVI.

CLAY.

ARTICLES for illustration: Pieces of both moist and dry clay, bits of burnt clay (ballast) or broken bricks dried in an oven or fire, tumblers of water and a hammer.

"Our lesson to-day is to be on a mineral very different from either coal or graphite. Here are lumps of it. Can you tell me its name?" *Clay.*

"Are these pieces of clay quite alike?" *No, they differ in colour.*

"Tell me some of the colours?" *Blue, brown, reddish yellow.*

"I may tell you that pure clay is white in colour. The colours are given to clay mostly by iron rust.

"Clay is very plentiful. It is found in great beds spreading for many miles, and many of the beds are close to the surface of the ground, so that there is but very little trouble to dig it.

"Clay is one of the most useful of the minerals. When I tell you that bricks, drain-pipes, tiles for roofing houses, crockery ware, china, and a great number of other articles are all made from clay, you will see how useful it is.

"I wish you first to find out for me what are the special properties of clay which make it so useful, and to help you I will pass round little pieces for you to handle.

"Squeeze it between your forefinger and thumb; what does this teach you?" *That clay is soft.*

"Is it soft like the crumb of bread, or like cake?" *No, it does not break into pieces.*

"Let me see what you can make of the clay. Some of you try to make bricks, some balls, some cakes, others may make a basin.

"Here you learn the first important property of clay. It can be made into any shape or form. It is said to be *plastic*, a word which means capable of being made or *moulded* into any shape or form.

"Tell me something else that is plastic besides clay." *Dough.*

"What does the baker *mould* the dough into?" *Loaves.*

"Here are small lumps of clay which have been dried in the sunshine. Feel them and tell me what they teach you about clay." *Clay, when dried, is hard and rather brittle.*

"If I take one of these little lumps and crush to powder, by adding a little water I can knead it into plastic clay again.

"Here are other lumps which have been baked till they were red-hot.* These are very hard and brittle, and you cannot make them into plastic clay again.

"All these articles which you see on the table were made

* See lesson.

from clay. Bricks and tiles and drain-pipes are made of common clay; but plates and jugs and cups and saucers are made from the purer clay, and the clay used for making these articles is mixed with flints heated red-hot and then ground to powder. Clay is very useful then, because it is plastic and easily made into any shape, and the articles when baked become hard and keep or retain their forms.

"Clay has one other property which makes it useful in another way. I take this lump of soft clay and make it into a very rough basin. I put water in the basin. What does this teach you?" *That clay holds water.*

"Yes, in other words, clay does not allow water to pass through it.

"Clay is useful in this way. It forms the beds of lakes and ponds, and so the water does not soak away.

"Do you remember a substance which is very much used because it does not allow water to pass through?" *Yes, india-rubber.*

"Anything else?" *Yes, cork.*

"Lastly, I will show you how this property of clay is changed in the baking.

"Here is a small lump of hard clay, and here is a piece of brick which I have dried in the fire. I put them into tumblers half-filled with water. Watch the water in the glasses. What do you notice?" *The water in one glass gets less.*

"In which glass?" *The one in which you put the piece of brick.*

"Can you tell me where the water has gone?" *The brick has sucked it up.*

"Yes, we say that bricks *absorb* water.

"Now we require some drain-pipes which will *not* absorb water, and so when they are being baked, salt is put in the

oven and this melts or *fuses** and forms a thin coating over the pipes which will not allow the water to pass through. Here is a bit of pipe. See, it looks like glass on the outside. This covering is called a *glaze*."

LESSON XVII.

LIMESTONE AND LIME.

ARTICLES for illustration: Specimen of common limestone, chalk and marble, a few lumps of quick-lime and a little diluted sulphuric acid [oil of vitrol] in a glass stoppered bottle.

"Our lesson to-day will be an interesting one, because I shall show some very pretty experiments. It is on another mineral named limestone.

"Why is it called limestone? Divide the word into two parts and we get lime and stone. You know what stone is, and here is some lime. I will show you more about the lime presently. Well, limestone is so named because it is a stone which is in great part made up of lime.

"There are many kinds of limestone; some are hard, and make good building stones. Chalk is a kind of limestone, and so is this pretty marble.

"What do the miners call the gas which sometimes explodes in coal mines?" *Fire-damp*.

"And what do they name the gas which the fire-damp makes when it burns, and which they cannot breathe?" *Choke-damp*.

* It should be explained that in a former lesson salt was called infusible because it does not melt except under a very great heat.

"Limestone is made up of lime and of this gas, which the miners call choke-damp.

"You will think it strange that a stone is partly made up of a gas which you cannot see. But I will show you that this is so. I put some pieces of chalk into this basin, and pour on it some liquid from this bottle.* I will bring the basin near you, and you can see the bubbles made by the gas as it comes away from the chalk. But perhaps you will say, 'I can see the bubbles, but where is the gas?' It is in the basin; the basin is full of it. A candle or a match will not burn in this gas, so if I light a match and hold it over the chalk in the basin and the flame goes out, you will know the gas is there. Amy shall try. You see the light is put out. John may try again.

"You have seen that the gas is in the limestone. I will now show you how men get rid of the gas from many waggon-loads of limestone at a time while the lime is left behind. They do it by burning the limestone in a large oven called a *lime-kiln*.

"I will make a drawing of one on the black-board."

[The teacher here sketches a simple outline of a lime-kiln, showing the opening where the fire is lighted.]

"Wood and coals for lighting the fire are placed at the bottom. Then limestone is thrown in at the top, then coals, then limestone again, then more coals, then limestone again, until the kiln is full. The fire is then lighted, the stone becomes red-hot, and the gas is driven out at the top.

"When the fire is burnt out, the kiln is allowed to cool, and the lime is taken out at the bottom.

"I have read of men having gone, on a cold day, into a lime-kiln just emptied for the sake of the warmth. They

* Use the sulphuric acid with care.

they are as much as thirty or forty feet thick, and they spread out many miles every way.

"You see how the coal is placed underground. How is it got out? Perhaps some little boy or girl can tell me how to get at the layers of coal in the glass?" *Turn the glass up.*

"Yes, but I can't turn the earth topsy-turvy and shake out the coal. Try again?" *Dig out the layers on the top.*

"That certainly might be done; but just think of the amount of work to dig out hard rocks and clays several hundred yards thick, and then only to find two or three layers of coal four or five feet thick. Why the coal when got out would be worth more than its weight in gold.

"Just for a moment suppose the layers of sand in the glass to be clay. We can make a hole down to the coal with a large needle. If we could persuade some tiny ants to work for us they could show us how men get out the coal. You must provide them with tiny baskets and give them spiders' webs for rope. Then some of the ants will get into the basket, and others will let them down the hole we have made as far as the coal. These ants will fill the basket and a tiny load of coal will be drawn up to the top.

"This is just how the coal is got out. A hole is made some ten or fifteen feet wide through the hard rocks and stones and clays down to the coal. Through this hole, which is called the *shaft*, the men are let down in cages and the coals are brought up. The men work away in all directions with pickaxes and shovels, and the coal is taken in little trucks or waggons to the bottom of the shaft.

"You may perhaps wonder that when the layer of coal is taken out the earth above does not sink down and crush the men; but all the coal is not taken out, enough is left standing to keep the rocks from falling.

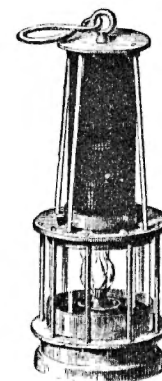
"The place whence the coal is taken is called a *mine*, and the men who work in the mine are called *miners*. Most

mines have more than one shaft, and some mines extend from the shaft for a mile or more. In some of the large mines several hundred men work at one time, and as many as fifty or sixty ponies to draw the coal from where it is cut out to the bottom of the shaft.

"Should you think it is light or dark in a coal mine?" *Dark.*

"Why do you think it is dark?" *Because the sun cannot shine there.*

"Yes, it is quite dark, darker than the darkest night you ever saw; but the men have candles placed in lamps made of wire woven in and out like this.



"The miners who work in coal mines are always in danger; but I must tell you about this, and why the gauze lamp is used, in our next lesson.

"I will now ask you some questions about what I have been telling you to day.

"I daresay some one can tell me why we call coal a mineral?" *Because it is taken from a mine.*

"And what are the men called who work in mines?" *Miners.*

"What is the hole called up and down which the miners go, and where the coals are brought out?" *The shaft.*

"How is the coal found in the earth?" *In beds or layers.*

"And about how thick are these beds?" *Some only a few inches, some five or six feet, and some as much as forty feet.*

LESSON XIII.

COAL.—3.

ARTICLES for illustration: Clay pipe, small coal, coal gas, soda-water bottle.

"To-day I have to tell you about the dangers of the coal-mine; and to help you to understand better about them, I am going to show you two very pretty experiments.

"Here is a long clay tobacco-pipe, and here is a little fine coal, and here a little soft clay. I nearly fill the bowl of the pipe with small coal, and then stop it with clay pressed in firmly. I now put the bowl in the fire, or hold it in the flame of the spirit-lamp.

"You must watch the thin end of the stem. Do you see anything coming out?" *Yes, smoke.*

"Most of that is steam from the moist clay and coal.

"Now the bowl is red-hot, and there is nothing to be seen coming out; but there is something, as I will show you. James shall put a light to the end. There, it takes fire, you see, and burns like a candle.

"Have you ever seen anything else burn like this?" *Yes, gas.*

"And this is gas. We have, in fact, been making our own gas on a small scale.

"And now for the second experiment.

"I have here a soda-water bottle. You cannot see anything inside, but there is a mixture of coal-gas and the air of the room. I wrap the bottle in a duster, because it may

possibly break, and were it not for the duster the glass would most likely cut my hand. William may hold this lighted taper, and the moment I take out the cork put the flame to the mouth of the bottle.

"You heard the noise, it was almost like a gun going off.

"If this room were filled with a mixture of coal gas and air, and we brought in a light, there would be an explosion, the windows would be blown out, and some of you would be very much hurt.

"You may learn a very important lesson from this. Many of you, no doubt, have gas in your houses, and sometimes it escapes. You can tell it by its strong smell. Now if enough gas escapes to form the proper mixture with the air, you have only to carry in a lighted candle, or strike a match, to have an explosion. Therefore, when you find by its smell that there is gas in a room, throw open the doors and windows to let it escape, and keep all lights away till the room is clear.

"Let us see what facts we can learn from our two experiments.

"How did we make gas?" *By heating coal in a pipe.*

"Where did the gas come from?" *The coal.*

"What does this show us?" *That coal contains gas.*

"That is the first fact I want you to remember. Now for the second.

"What did I tell you I had in the bottle?" *Coal gas and air.*

"And what happened when William put the light to the mouth of the bottle?" *There was an explosion.*

"Then what fact have you learned from the second experiment?" *That a mixture of coal-gas and air will explode.*

"Now we will go to the mine and see what sometimes happens there.

"Firstly, the owners of a coal-mine get all the air they can into the mine, or the men could not breathe and would die.

"Secondly, gas often escapes in large quantities from the coal in the mine without any heat.

"Thirdly, it is dark, and the men must have lights to see to work.

"It may happen that there is just the mixture of air and gas to explode, and it only wants the light; but fortunately, when the light is in the lamp made of wire gauze, it will not set fire to the mixture. Sometimes the men are not careful, and take out the candles, perhaps to light their pipes, and then there may be, and sometimes there is, a terrible explosion, and scores and even hundreds of men may be killed.

"But this is not all; the *fire-damp*, as the miners call the coal-gas, when it burns, makes another gas, called by the miners *choke-damp*. When the men breathe this *choke-damp* they lie down, and soon die.

"There is another danger, too, in the mine. Sometimes the rocks from above fall on the men and crush them."

The teacher should now question as in the last lesson, and some of the uses of coal may be elicited. Other uses will appear in the succeeding lessons.

LESSON XIV.

GRAPHITE.

A *ROUGH* lump of graphite in its natural state, or, failing this, a cake of Nixey's black-lead, and a piece of lead, scraped clean, will be necessary.

"When your mother 'cleans' the grate in the morning what does she put on it?" *Black-lead.*

"What does she do next?" *Brushes the grate.*

"Why does she brush it?" *To make it shine.*

"Now tell me what black-lead is used for besides 'cleaning' grates and stoves?" *For making black-lead pencils.*

"And what do we use black-lead pencils for?" *For writing on paper.*

"What colour must the paper be to show the writing best?" *White paper.*

"To day our lesson is to be on the mineral called black-lead.

"I have called black-lead a mineral, tell me then whence we got it?" *From underground.**

"I must show you first of all that this mineral is wrongly named. It is not lead at all, neither has it a black colour.

"Here is a lump (or a cake) of black-lead and here a piece of lead.† I want you to look at them and tell me how they are alike?" *They both shine.*

"When speaking of coal what name did we use instead of shining?" *Lustre.*

"Again, how are black-lead and lead alike?" *They both possess lustre.*

"I take this piece of white paper and draw first the black-lead and then the lead across it.

"How are these minerals alike in the second place?" *They both mark the paper.*

"Now you can see why this mineral has been called lead. Can you tell me?" *Because it has a lustre like lead, and because like lead we can write with it on white paper.*

"Then as to its colour. Is it black like this piece of coal?" *No.*

"How does it differ in colour from coal?" *It is lighter in colour than coal.*

* It is undesirable to confuse young children with minerals not found underground.

† The lead should be clean.

have quietly gone to sleep never to wake again; the gas left in the kiln has choked them.

"We must now look at the lime as it comes from the kiln. You see it in rough lumps. It is not pleasant to handle, for if you happen to have a scratch or cut on your finger, the lime would burn, and of course cause great pain. You must be careful when passing a place where men are handling lime not to get any lime dust in your eyes, for it would hurt them very much.

"I put a lump of this lime in a basin and pour water on it.

"What do you notice?" *It cracks and swells, and gives off steam, and falls into a powder.*

"Lime in this condition is called *quick-lime*. Why? Not because it moves quickly, nor because it changes quickly, but because it seems alive. We sometimes speak of 'the quick and the dead.' Here 'quick' means living. Well, because lime in this state stirs so and steams, and works at the touch of water, it is called '*quick-lime*.'

"When we pour water on the lime and thus cause it to swell and crack and fall to a powder, we are said to *slack* the lime, that is, to loosen it.

"Lime like that which I have in the basin is used for many purposes, but the chief one is for making mortar. Do you know what mortar is, and what it is used for?

"Look at the wall of the school-room. What is it built of?" *Bricks.*

"And what is that which you see between the bricks?" *Mortar.*

"And what is the mortar used for?" *To fasten the bricks together.*

"And why is mortar used? I will tell you. It is because, as it dries, it gets very hard, sometimes harder than the

bricks themselves, and it also holds firmly to the bricks, and so makes the walls strong.

"Here is a piece of old dry mortar. It is as hard as a stone.

"But how is mortar made? I will make some, and then you will not forget how it is made."

The teacher may now make a little slacked lime into a thin paste with water, and add a little sand, working the mixture together until the proper consistency is obtained. Its use may further be illustrated by using two or three bricks.

LESSON XVIII.

THE METALS.

SPECIMENS of the common metals and manufactured articles, and as many of their ores as can be obtained, should lie on the table.

The teacher will direct the attention of her class to the various specimens of the common metals on the table, and ask for names, thus:—

"Here is a sovereign, what is it made of?" *Gold.*

"Give me the names of some other articles made of gold." *Rings, brooches, watch-cases, chains, pencil-cases, &c.*

"What is this half-crown made of?" *Silver.*

"Name other articles made of silver." *Chains, brooches, lockets, necklaces, &c.*

"What is the name of the metal of which common nails are made?" *Iron.*

And so on of the other metals.

"Like limestone and coal, gold, silver, iron, &c., are all

got from underground. What name, then, may we give them?" *Minerals.*

"Yes, they are all minerals; but because they are all alike in some ways, and very different from other minerals, we put them in a *class* or *group* by themselves, and give them the special name of *metals*.

"In this and the following lessons I shall ask you to help me to point out the many different uses to which these metals are put, and the special properties which fit them for these particular uses.

"But I must first explain to you how they are found in the earth. Can we dig gold and lead and tin as we dig coal or clay? Certainly not. A few of the metals are found *pure*, that is, without any other substances being mixed up with them. Gold, silver, and copper are found pure, but only in small quantities. Metals found in a pure state are termed *native*.* But metals are usually found mixed up with many other things. These mixtures are called *ores*. Ores are not often like metals at all. Here is a piece of what is called ironstone. It bears no likeness to the iron which it contains.

"How was lime got from limestone?" *By heating in a lime-kiln or furnace.*

"And metals are melted out from their ores something in the same way, but you will better understand how this is done when you are older.

"What are native metals?" *Metals found in a pure state.*

"Of the metals on the table which are sometimes found native?" *Gold, silver, and copper.*

"In a former lesson you saw a bright metal in a liquid state; what was it?" *Quicksilver.*

* Gold usually contains a small proportion of silver; but not sufficient to change its character, and the mixture is called native gold.

"Quicksilver is sometimes found native.

"What are ores?" *Mixtures of metals with other substances.*

The teacher will here show any ores and direct the attention of the children to some of the differences between the metals and their ores.

"I must tell you that there are other metals besides those which I have asked you to look at; but many of them are very scarce and dear, because it is so difficult to get them from their ores, and others are of little value compared with such metals as iron and copper. I will show you one or two of them as we go on.

"Now for one particular in which all metals are alike, and one in which they all differ.

"Here are two iron nails, what difference do you observe in them?" *One is rusty, the other shines.*

"What colour is the rusty one?" *Reddish-brown.*

"How can I make a rusty nail to shine?" *By cleaning off the rust.*

"Here is a piece of copper and here a piece of fine sand-paper; I want a little boy to make the copper shine more. How will he do it?" *Rub it well.*

"Try the lead and the zinc with the sand-paper, what is the result?" *They shine better.*

"Now take this gold ring, this silver shilling, the piece of tin foil, and the bits of iron, copper, lead, and zinc which you have cleaned, and tell me how all these metals are alike?" *They all shine.*

"In speaking of coal shining what was the name we used?" *Lustre.*

"And the shining of metals is spoken of as the *metallic lustre*. Coal is said to have a metallic lustre, because it shines like the metals.

"Here are wires of iron, copper, zinc, and lead. We will try to cut them through. I cannot cut the iron; why not?" *Because it is too hard.*

"Which cuts the easiest?" *The lead.*

"Why can you cut lead easier than iron?" *Because the lead is softer.*

"Now for the point in which metals vary?" *In hardness.*

"We shall see in another lesson that the uses to which metals are put depend very much on their hardness.

"Here is one of the curious metals I promised to show you. It is got from common table-salt. You see I have to keep it in a bottle in a liquid. The liquid is naphtha. I dare not try to keep it in water. You will soon see why. I take out a small piece and cut it across. You see it is quite soft, and has a beautiful metallic lustre. I put a piece in this basin of water. You see the pretty ball how it runs about, and gradually gets less and less.

"You can tell me something else about this metal?" *It floats on the water, it is light.*

"Yes, and if I left it in the air it would very soon rust away."

Children should not be allowed to touch sodium, and the teacher should cut it in a saucer into which a little naphtha has been poured. Of course it must not be put into the water with the fingers. Use the point of a knife.

Placed on blotting paper on the water, it soon takes fire, and usually explodes. Potassium, under similar circumstances, burns with a violet flame, but this metal is much more expensive than sodium.

LESSON XIX.

THE METALS.—RUST AND PLATING.

ARTICLES for illustration: Specimens of metals as in last lesson. Tin and zinc plate, and if possible some gold and silver plated articles.

"In what respect did you find, in your last lesson, that all metals were alike?" *In having the metallic lustre.*

"How did we make some of the metals shine brighter?" *By rubbing them with sand-paper.*

"Here is an old knife, what do you see on the blade?" *Rust.*

"Then if I rub the knife with sand-paper, or better still, with a steel file, what do I remove?" *The rust.*

"Now let us look at the pieces of lead, copper, and zinc. Neither of them are bright. They are each of them dull on the outside, but the sand-paper or the file will show you the shining metal beneath.

"Some metals rust very much more than others. Gold, silver, and quicksilver do not rust. Hence they are always bright. Tin, zinc, and copper, when exposed to the air, tarnish, that is, lose their lustre, but do not rust away. Lead forms a *thin* coating of rust which protects the metal from further injury. Not so iron and steel. If these metals are left in a damp place the rust soon 'eats' them completely away. Hence all bright iron and steel goods must be kept *dry*, if we wish them to remain bright.

"Have you ever seen a saucepan or a kettle made of lead?" *No.*

"Can you give me the reason?" *Lead is too soft. It melts too easily.*

"Yes, both answers are correct; but there is another

reason. Any *acid*, such as vinegar or the juice of a lemon, or that of an unripe apple, makes a rust with lead which is poisonous, hence vessels for holding food are never made of lead.

"Again, zinc will not answer for frying-pans and sauce-pans, because it burns away very easily, and gold and silver are too dear.

"What metals, then, have we left to choose from?"
Iron, copper, and tin.

"I dare say you have seen copper kettles and saucepans. They last longer than any others, and when kept clean look very nice; but they are very dear, and what is of more consequence, any acid, and even cold water when allowed to stand in them, makes a green rust which is very poisonous. For these two reasons copper is not much used.

"What kinds of saucepans and kettles do you know besides those made of copper?" *Those made of iron and tin.*

"It is not quite correct to say saucepans, kettles, &c., are made of tin, as I will show you directly; tin is too dear; but many are made of iron. Those made of iron are thick and heavy, and all the best are lined with a hard white substance called *enamel*.

"Can you tell me why they are lined?" *To keep the iron from rusting away.*

"But these articles are dear, and we want something cheaper.

"Thin sheets of iron will not do alone, because rust would soon destroy them. But a thin coating of tin prevents the iron from rusting.

"Here, then, we get just what we wanted. The iron is cheap and strong, and the fire does not easily injure it, and the tin on the outside prevents the water from making it rust away.

"Iron plates coated with tin are called *tin-plates*, and the common kitchen vessels are made of tin-plates and not of solid tin.*

"Iron plates are also coated with zinc to prevent the iron rusting; would these plates do for making saucepans?"
No, the zinc would burn away.

"But it will do for buckets and pans which are not put near the fire, and *zinc-plate* is now much used for such things.

"Iron wire, which has to be exposed to damp, is often coated with zinc. Why?" *Because the zinc keeps the iron from rusting.*

"Tin and zinc, then, are put over iron to preserve it, and the iron so coated is said to be plated; but other metals are plated for another purpose. Silver and gold are very dear, but they look very bright and pretty, and require but very little cleaning; hence they are put on cheaper metals, which are thus made to look like silver and gold. Articles so covered are said to be silver or gold-plated. Rings, chains, watch-cases, brooches, necklaces, &c., are usually coated with gold; and tea-pots, coffee-pots, forks, spoons, &c., with silver. The metal coverings are put on in different ways which I cannot explain now, but instead I will do a little plating, so that you may see at least that it can be done."†

* Pins are made of brass wire coated with tin.

† Dissolve a few crystals of blue vitriol (copper sulphate) in a little water. Immerse a bit of bright iron or steel—such as the blade of a knife—in the solution, and the article immersed will be plated with copper in a few seconds.

LESSON XX.

THE METALS.—HARDNESS, ALLOYS.

ARTICLES for illustration: Specimens of metals as in the last lesson, coins and any articles made of brass or other alloys.

"In our first lesson on metals we noted one particular in which all metals are alike; what is it?" *They all have the metallic lustre.*

"And we noted one particular in which they varied very much. What is that?" *They vary in hardness.*

"In the last lesson we saw how some metals tarnish and rust, and how the rusting of iron is prevented by coating it with tin or zinc.

"To-day I want you to look again at the hardness of metals, how the softer metals are made harder, and some of the uses which follow from the hardness of metals.

"Which is the softest of the common useful metals?" *Lead.*

"And which is the hardest?" *Iron.*

"I have a piece of iron wire here, and, using the file, I cut it through; what does that tell us about the file?" *It is harder than the iron.*

"The file is made of a kind of iron called *steel*, which is very hard indeed. Knives, saws, chisels, and all cutting tools are made of steel.

"I want to nail two pieces of wood together; what kind of nails do I use?" *Nails made of iron.*

"Why wouldn't nails made of lead do?" *They would be too soft.*

"Too soft for what?" *To go into the wood.*

"I can cut gold, silver, tin, zinc, and copper with a

knife; what does this teach me?" *That these metals are softer than steel.*

"Which metals do you think wear away the quickest, the hard or the soft?" *The soft metals.*

"Yes; and now I want you to remember something about metals which will seem very curious to you. Metals, when fused, will mix together, the mixture being called an *alloy*; and the curious fact is, that the alloy may show properties quite different to the properties of the metals which form it.

"You know that gold can be hammered into extremely thin sheets, and that lead is also malleable; but the addition of the least bit of lead with gold makes the gold *brittle*. Again, a little copper mixed with gold and silver makes these metals so much harder that they wear for a much longer time. And, once more, tin is softer than copper, but a mixture of tin and copper, called *bronze*, is much harder even than the copper.

"I heard a boy say this morning, 'Please, sir, have you got a copper?' What did he mean?" *Have you got a penny or a halfpenny.*

"Why did he call a penny a copper?" *Because pennies are made of copper.*

"No; some years ago pennies and half-pennies were made of copper, but now they are made of bronze.

"Why do you think they are now made from bronze?" *Because bronze is harder and wears longer than copper.*

"What can I put with gold and silver to make these metals harder, and so prevent them from wearing away so quickly?" *Copper.*

"Yes, and a very little copper will do. Sovereigns and half-sovereigns are made from gold which has had a little copper mixed with it. Eleven parts gold and one part

copper is the mixture. Silver for half-crowns, shillings, &c., requires less copper than this to make it hard.

"All the gold and silver used for making ornaments have copper mixed with them, and many of the gold rings, watches, &c., contain nearly one-half of copper. You may learn from this that 'gold' articles of similar size are not always of the same value. Those that contain more copper are cheaper than those that contain less.

"There are many other alloys,* but the most useful of all is *brass*, a mixture of copper and zinc."

LESSON XXI.

THE METALS—FUSION, CASTING.

ARTICLES for illustration: Specimens as in preceding lessons, a lump of clay well kneaded to make a mould, and any specimens of cast articles.

"We have already seen that all the common metals can be melted or fused. Some can be fused easily, some with great difficulty.

"One metal which in this country is always in a liquid state, what is its name?" *Quicksilver.*

"I said in this country, because if you were to go to very cold countries in winter you would find the quicksilver hard and solid like silver. When the summer comes the quicksilver melts, so that we may say that quicksilver fuses with a very little heat indeed compared with the other metals.

"We will now try some of the other metals. Here is a

* The teacher may introduce any other alloys of which she has specimens, such as *bell-metal*, a mixture of copper and tin; *German silver*, a mixture of copper, zinc, and nickel; *pewter*, a mixture of copper and tin; *solder*, a mixture of tin and lead.

lump of lead, I put it over a bright fire in an iron shovel. You see it melts or fuses very quickly, even before the shovel gets red hot.

"What do we learn about the fusibility of lead compared with iron?" *That lead fuses with less heat.*

"Why do you say so?" *Because the lead was fused and the iron was not fused.*

"Now for tin. Here is a piece of tin foil. We will try it as we did the lead. You see it does not melt so quickly, nor till the iron shovel gets quite red hot. It is the same with zinc, it melts when the iron gets red hot.

"If I try gold and silver and copper I cannot melt it in the shovel, nor can I melt the shovel itself. It requires a much stronger heat than I can get in the grate to fuse these metals.

"Iron is the most difficult to fuse; but I can make it softer in the fire, soft enough to be hammered into different shapes just as I can hammer cold lead.

"In this lesson I want you to learn some of the uses we make of metals by fusing them."

To illustrate the principle of "casting" metals, take the following or some similar experiment. Pour a little molten lead into a mould prepared by pressing a glass marble into clay.

"Look at the glass marble and the marble made of lead, how are they alike?" *They have the same shape.*

"How did I manage to make the lead marble of the same shape as the glass marble?" *You pressed the glass marble into the clay.*

"And when I took the marble away a hollow place was left having the same shape as the marble. We may call the clay then the *shape* for the marble. But when we shape a thing we are sometimes said to *mould* it, and so the hollow

place into which the metal is poured is always called the *mould*.

"How did I get the lead into the mould?" *You poured it in.*

"Another word which means the same as pour is *cast*, and you may say that I *cast* the lead into the mould. You must remember that all articles made by pouring molten metal into moulds are said to be *cast*.

"The metal most used for casting is iron, but many articles are cast from the alloys—brass, bronze, and bell-metal.

"The iron got from the ores in the furnace is allowed to run into *moulds* made of sand. Hence it is called *cast* iron.

"This is the iron of which very many common articles are made such as the legs which support the desks, grates, many nails, kettles, saucepans, bolts, bars, &c. The cast iron is brittle, and so of course are the articles made from cast iron.

"Bells are cast from bell-metal, statues* from bronze, and many ornamental articles from brass."

LESSON XXII.

THE METALS.—MALLEABLE, DUCTILE, TENACIOUS.

ARTICLES for illustration: Specimens of metals in sheet and wire, cast and wrought-iron nails, and a strip of ribbon-wire magnesium.

"In the last lesson you saw how articles are made from

* The teacher will explain and illustrate.

metals by casting in moulds. To-day we have to find out other ways in which articles are made from metals.

"Metals when cast are usually brittle. Thus cast iron although hard is brittle; and for many purposes we want metals to be tough or tenacious. Cast iron when re-melted and well stirred and then hammered becomes tough. It is then called *worked* or *wrought* iron.

"Wrought iron does not melt easily, but it becomes soft in the fire and can then be hammered and rolled into such shapes as are wanted. In some towns in England nearly all the men women and children are employed in making wrought iron into nails, chains and other small articles which require to be strong.

"Here are *wrought* and *cast*-iron nails. I will hammer them. Which will break?" *The cast-iron nails.*

"And what is the effect of hammering the *wrought* iron nails?" *They bend without breaking.*

"Steel is made by heating together bars of wrought iron and charcoal.* Steel may be made soft or very hard. All cutting tools are made of hard steel.

"Would a knife made of lead be of any use for cutting?" *No, it would not cut.*

"Why not?" *We could not give it an edge thin enough to cut, and if we could the edge would twist and bend instead of cutting.*

"For the same reason wrought iron would not do, and cast iron would be too brittle. Wrought iron and all the other common metals can be cut with steel tools, and many articles are shaped in this way.

"What metal is this [showing tin foil]?" *Tin.*

* Show a piece of charcoal and explain that it is charred or partially burnt wood.

"How was it made so thin?" *By beating with a hammer.*

"And what is this [showing gold leaf]?" *Gold leaf.*

"And how was this made so thin?" *By beating with a hammer.*

"What do we say of these metals because they spread out on being hammered?" *They are malleable.*

"All the common metals are malleable, but some of them can be beaten out and rolled into sheets easier when heated, than when cold. Zinc is brittle, and requires to be heated, though only a little, to make it *malleable*. Gold is the most malleable of all metals.*

"Here are wires of different metals. What do we say of metals because they can be drawn out into wire?" *They are ductile.*

"Would lead wire be of much use?" *No, it would not be strong, and it would break if bent.*

"What other property must metals possess to make strong wire?" *They must be tough or tenacious.*

"Steel makes the strongest wire; wrought iron, gold, silver and copper wire are also strong. Zinc wire is soft and easily bent but it is not strong. It is sometimes used instead of string for tying shrubs and trees in the garden.

"All the common metals have one other property which you can tell me at once by taking them in your hands. They are heavy. Gold is the heaviest metal. Then follow quicksilver, lead, and silver. You saw one curious metal which was so light that it floated on the water, so that all metals are not heavy.

"Which of the common metals burns away when put on the fire for some time?" *Zinc.*

* The uses of gold-leaf for gilding should be pointed out.

"There is one metal* which burns very brightly indeed. So bright is its light that it dazzles the eye to look at it."

The time of one lesson will be well occupied in a recapitulation by question and answer of the lessons on metals.

LESSON XXIII.

TEXTILE MATERIALS.—I.

ARTICLES for illustration: Small pieces of coarse linen, pins, and short lengths of string.

Give to each child a pin and a small piece of some woven material the structure of which is easily demonstrated, such as very coarse linen.

Set the class to discover how it is made up, viz. of threads; then how the threads are arranged. Tell them that the long threads are called the *warp* and the cross threads the *woof*.

Illustrate the arrangement of the warp by tying small string lengthways at equal intervals across a frame (a slate frame will answer very well), and then threading strings across to represent the woof. The process here represented is called *weaving*.† The materials made are usually called *tertile*, but textile means simply woven.

The children will next be directed to examine the threads to see how they are made. They will soon discover that

* The teacher may burn a piece of magnesium wire. If the room can be darkened so much the better.

† The machinery used in weaving is so complicated that to attempt to describe it to young children would be so much waste time.

each thread consists of a number of very tiny hair-like threads, twisted together; or, if the thread of the linen selected be not large enough, use ordinary string. This will be found to consist of smaller threads twisted, and these, again, of hair-like threads twisted. In the manufacture the twisting of the threads is called *spinning*, and the threads are called *yarn*.

Spinning may be illustrated by twisting a thread from a bunch of hemp.

LESSON XXIV.

TEXTILE MATERIALS.—2.

ARTICLES for illustration: Specimens of raw materials and manufactured articles. One or two of Judson's dyes.

Attention should now be directed to the chief *raw* materials used in making textile articles, viz., wool, cotton, silk, and flax. Specimens of these should be shown and compared, as also specimens of some of the principal manufactured articles.

Wool.—Cloth, stuff (for dresses), hosiery, flannel, blankets, carpets, worsted* for sewing and darning, Berlin wool.

Cotton.—Calico, print, sewing cotton.

Silk.—Piece silk, ribbons, and sewing silk.

Flax.—Linen, damask, flax-thread for sewing.

Questions on the special properties common to the raw materials used in weaving will naturally follow.

For facility in weaving the articles must be *tough, fairly strong, and flexible*.

* So called because first made in a town called Worsted, in Norfolk.

For suitability for clothing they must be *warm, soft, light, flexible, and durable*.

In the third place, some information should be given on the sources of the raw material.

Dyeing may be illustrated by using one or two Judson's dyes.

Lastly, the inflammability of the various articles may be tested—all burn freely except wool; and a useful warning against playing with the fire may be given.

APPENDIX.

THE following sketches are intended to serve as frameworks on which the teacher may construct other lessons. If the necessity arises for the use of extra lessons they should be introduced in their proper places in the series. Thus the lesson on boots and shoes naturally follows the lesson on leather—those on nails, bells, a thimble, and the smithy should follow the lessons on metals, and so on.

SEALING WAX.

WHY so called; hard and very brittle; easily fused; when placed in a flame it burns easily and falls in drops; in fused state sticks firmly to paper, but not to polished metal or stone. [Show its uses, viz. to stick paper together and to make seals.] Why are seals placed on letters, &c. Sealing wax is soluble in spirit [illustrate.]

If the materials can be obtained readily the manufacture of this useful substance may be illustrated. The best sealing wax is made by gently heating together three parts of shellac and one of resin; a little colouring matter, vermilion

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or lamp-black, &c., is added. When the ingredients are thoroughly mixed the mixture is poured into moulds or rolled into sticks.

OLIVE OIL.

ITS PROPERTIES.—Liquid, but thicker than water; semi-transparent; yellowish colour; floats on the top of water and is therefore lighter than water [illustrate]; does not mix with water. [Rub a little on the hand and then plunge into water, the water is only seen on the hand in drops here and there.] It is inflammable, it could be used to burn in a lamp through a wick [illustrate this], but is too expensive. It is soft and greasy to the touch.

WHENCE OBTAINED.—Pressed from the green plum-like fruit of the olive-tree.

USES.—Purest kinds used chiefly in the preparation of food.

[Compare with other oils, both as to properties, sources and uses.]

BOOTS AND SHOES.

A LESSON on boots and shoes will lead to the consideration of most of the following points:—

Why do we wear boots and shoes? Of what are they made? What parts are sometimes made of cloth? Where is cork sometimes put, and why? Why is thin leather used for the uppers and thick leather for the soles? Why

are sometimes fastened on, and what driven into, the soles, and why? How ought boots and shoes to be fastened firmly to the feet? What is the use of the tongue? Why is leather the best material for making boots and shoes? Why should the feet be kept dry and warm? How are boots and shoes cleaned? In making what kinds of shoes is carpet sometimes used?

CHARCOAL.

ITS PROPERTIES.—Black colour; light; porous; brittle; easily reduced to powder; burns without flame; is infusible and insoluble.

ITS NAME.—Wood, used as fuel, was formerly called *cole*, or *coal*; anything partially burned is said to be charred, hence partially burnt wood is charred coal, or *charcoal*.

HOW MADE.—Small logs and short branches of hard wood are piled in a stack and nearly covered with a layer of earth. Small openings are left at the sides and one on the top. Stack is lighted below. After a time all the openings are closed and the wood is only partly burned, or charred.

ITS USES.—In some countries as fuel; for cleansing water (filtering); for cleaning sugar; for making crayons, &c.

A THIMBLE.

WHAT MADE OF.—Brass, steel, or silver. Brass the cheapest, steel the strongest, silver the prettiest, but dearest. Why made of hard substances?

SHAPE AND PARTS.—Bell-shape; hollow; forms a little cup which fits on the top of the finger. Smooth on the inside; rough on the outside; covered with little hollows or *cells*; cells stamped in rows. What is the use of the hollows and the *rim*?

Thimbles used by tailors have no tops, why? They use only the side of the thimble.

USE OF THIMBLE.—When are thimbles used? On which finger are they worn? Why wear a thimble at all?

BELLS.

WHAT MADE OF.—Bell-metal [an alloy consisting of three parts copper and one part tin]. The alloy is hard and brittle, and when struck vibrates* and gives clear musical sound.

SHAPE AND PARTS.—Shaped something like tea-cup; shape called *bell-shape*. Many flowers are bell-shaped, as the blue-bell, canterbury-bell, hare-bell, &c.

Handles to some bells; made of wood; why?

Clapper or tongue; its use; why hung in the middle of the cup.

KINDS OF BELLS.—*Church-bells*, large *school-bells*; hung high up in the building and pulled by means of ropes.

House-bells, pulled by wires.

Hand-bells, swung by hand.

USES.—For what purpose is the bell rung in school?

* Illustrate with tuning-fork, and show that the sound ceases as the vibration is stopped by contact with any substance.

Why are church-bells rung? Why are bells fixed in houses?
Why are bells fixed on bicycles?

NAILS.

A LESSON on nails must to some extent depend on the varieties of nails at the command of the teacher. The principal points for consideration will be the materials of which they are made, the special properties and uses of the various kinds, and a comparison of shapes and sizes.

Some nails are made of cast iron; what is cast iron? Cast nails are made by machinery; they are brittle. Some are made by hand; they are of wrought iron. What is wrought iron, and how does it differ from cast iron? Some nails are made of copper, others of brass.

Compare the shape of the heads, the bodies, and the points of nails; all taper more or less, some from the head to the point, others only a little way from the point; why so made; the use of the head and of the pointed and chisel-like ends. Compare nails as to sizes and their various uses. What are tacks, and why some are called tin-tacks; (coated with tin like pins to keep them from rusting).

THE SMITHY.

A SERIES of interesting lessons may be constructed from imaginary visits to various shops. The teacher will draw attention to the striking properties of the various articles therein, and the special uses for the same.

Thus in the Blacksmith's shop—

THE FIRE.—Where placed; how made to burn fiercely; its use; why heat the iron?

THE ANVIL.—A block of iron; the uses of the anvil; why wood or marble would not do.

THE HAMMER.—Use; the noise made in striking; the sparks from the hot iron; how things are shaped with the hammer on the anvil.

THE WATER-TROUGH.—Its use; how the hot iron makes the water hiss and send off steam; use of the water.

THE SMITH.—His appearance; his dress; his apron; why made of leather?

LEAD.

ITS PROPERTIES [to be discovered by experiment]; heavy; soft as compared with other metals; can be easily cut or scratched; pliable; readily fusible; malleable.

USES.—For water and gas pipes; for making shot; in thin sheets for lining tea-chests; in thicker sheets for making gutters, putting on roofs of houses; for making alloys.*

Similar lessons may be given on the other common minerals.

* Solder is an alloy of tin and lead; pewter is an alloy of tin, lead, and copper.

FLINT.

A MINERAL.—Why? Found in gravel-pits; in pebbles on the sea-shore; in chalk beds.

PROPERTIES.—Hard, brittle, smooth, heavy, variously coloured, but mostly black; when burnt or calcined becomes white, and is then easily crushed to white powder.

Edges of broken flint very sharp; when struck with steel sparks of fire seen. [Show by experiment how it was formerly used for lighting tinder, and also for igniting the gunpowder in the old "flint guns."]

USES.—For making roads; sometimes used for building walls of houses; calcined and crushed, it is used for mixing with clay for making pottery.

PUMICE STONE.

GREY or white stone; harsh and rough to the touch; porous, and sufficiently light to float on water; brittle, but hard enough to scratch glass or steel.

Used for polishing; employed in smoothing wood, glass, stone, marble, &c.; painters use it for smoothing before painting. Sometimes used for smoothing the skin of the hand.

Compare with other stones.

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