BREAKFAST TABLE SCIENCE

1840.

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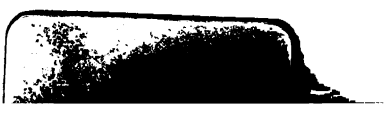

A DIAGRAM OF LIFE.

Pryer del.

This Diagram shews that Death encircles all existence; and the Path of Life must finally reach this dread circumference, beyond which is Eternity. Also showing the different paths of life conducting to Death; some in Infancy, some in Youth, in Manhood, in Middle Age, and Old Age; some narrowly escaping Death in infancy, and youth, yet leading on to full age; others exhibiting an erring tortuous course, ending in sudden death, and contrasted with this, is shown, the even tenour of a well spent life, gradually approaching death, and ending in old age.

LONDON. PUBLISHED BY THOMAS TEGG, Nº 73, CHEAPSIDE. 1840.

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FOR THE

AMUSEMENT AND INSTRUCTION

OF

YOUNG PEOPLE.

BY J. H. WRIGHT,

SURGEON

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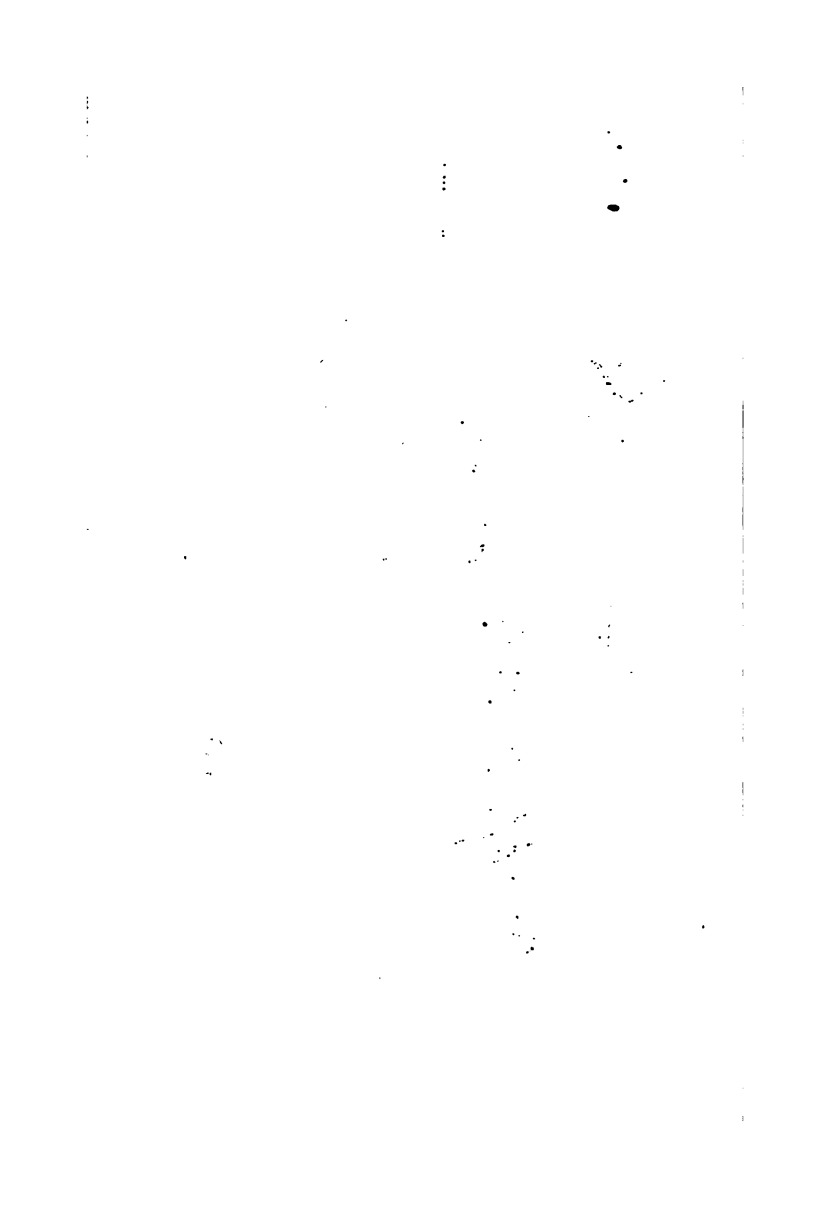

BREAKFAST-TABLE SCIENCE:

WRITTEN EXPRESSLY

For the Amusement and Instruction

OF

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BY J. H. WRIGHT,

SURGEON.

"Nihil dictum, quod non dictum prius; *methodus* sola artificem ostendit."
GAUBIUS.

LONDON:
PRINTED FOR THOMAS TEGG, 73, CHEAPSIDE.

1840.

LONDON:
BALNE BROTHERS, PRINTERS, GRACECHURCH STREET.

TO

THOMAS PETTIT,
AMELIA,
ELLA,
KENNETH,
ESTHER,
CEDRIC—AND
ALBERT
} WRIGHT,

AND TO

THEIR MOTHER,

This Little Volume

IS AFFECTIONATELY PRESENTED BY

THE AUTHOR.

CHATTERIS, ISLE OF ELY,
Nov. 24th. 1839.

PREFACE.

In writing a Boy's Book, it is well to bear in mind the sage advice of Mrs. Glasse, touching the roasting of a hare—"First catch your hare, and then," &c.

Now, there are a thousand modes of instructing boys and girls; but the art of "catching boys" is in its infancy.

The authors of many admirable books for children, have entirely overlooked this: their books contain much that is valuable, but they fail in

"catching" the careless and frolicsome boy.

Others have attempted "to catch their boy" with pictures: these have been very successful, in storing the memory with facts; but they cannot, they do not, make him think.

I have endeavoured to "catch" my readers by the adoption of a quaint, and rather affected, table of contents. Ask a boy "Why animals can wrinkle their skins?" or, "How great is the atmospheric pressure upon an object?" and, if he be well-trained, he will pay you the compliment of looking at you, while you explain them; but, as they interest him not, your explanation is forgotten. Put the inquiry in another

form. Ask a group of merry urchins "Why a fly cannot ride on horseback?" or, "If a fly had a sore toe, what would happen?" and they feel interested in the inquiry, and begin to think. In educational matters, we are not half so rational as the showman, who paints the "animal that cannot live on the land, and dies in the water," in glowing colours, outside, to tempt the young gentlemen to "walk in."

TABLE OF CONTENTS.

BREAKFAST-TABLE SCIENCE

FOR

YOUNG PEOPLE.

CHAPTER I.

THE EARWIG.

Mr. Ward. Tom!—what have you been studying so very attentively? Is it some rare and very beautiful insect?

Tom. Neither, father. It is very common and very ugly.

Mr. W. And pray what might this "very common and very ugly" little creature be, that could rivet your attention so closely, that I must call twice before you heard me?

Tom. Oh! nothing, father.

Mr. W. A "very common and very ugly thing," called nothing! Children, let us

run out, and see if we can catch a glimpse of this little creature.

Tom. If you must know, it was nothing but a common earwig.

Amelia. O you nasty boy, to touch an earwig!

Ella and *Kenneth.* Tom! but, did you really hold an earwig in your hand?

Mr. W. Silence, if you please, while Tom tells us why he caught an earwig, and why he examined it.

Tom. Yesterday morning you told us how foolish we were to fear rats or mice, spiders or earwigs, and such harmless little things. Now, though I never was afraid of rats and mice, and spiders, yet, as the gardener said he had known several people who had died from earwigs getting into their ears, I thought he must be right.

Mr. W. And, of course, that I was wrong.

Tom. But, father, he had seen the people who died.

Mr. W. Very convincing evidence, Tom, if the gardener were a philosopher, reverencing truth, instead of being somewhat

given to fibbing—a fault that rather damages his shocking account of earwigs.

Amelia. But, father, he told Tom that he had known the people who died. He could not say so if he had not known them.

Mr. W. Well, well, my dears, we will question the gardener to-morrow—or, better still, he shall bring in some fruit at breakfast, and we will cross-examine him: but now, let us hear Tom.

Tom. I thought it so very foolish to be afraid of an earwig, if it would not hurt me, that I caught one very gently. I soon found he was very harmless. I then let it run over my coat; and, when you called me, it was running up my face, and I could not speak, for fear of disturbing it. I felt it run towards my ear, and I had my hand just ready to throw it off, if it went too near; but I soon found, that when it approached the ear it ran off in an opposite direction, until, at last, it crept into a fold of my jacket, and lay snug and quiet.

Mr. W. Well done, my little philosopher! If men and women would but test all these

terrible accounts of noxious reptiles and insects, as you have done, what a vast amount of cruelty and uneasiness would be avoided!

Ella. Well! I am sure I shall never like earwigs.

Mr. W. There may be nothing in an earwig to make us love it, but it is surely wrong, on that account, to hate and kill it. But when we look more closely at this matter, which Tom has so courageously began, we shall find much to admire. Fruits and flowers are sent for man first, and then for earwigs: the more trouble the fruits give us, the more we value them. In America, where peaches grow without cultivating, they give them to pigs. The earwig, with the fly and worm, were sent to consume what man cared not for, and, by attacking all, giving him some trouble to preserve any.

Tom. Oh! I think I understand you. When our plum-trees were overladen with fruit, I pelted the boys with them. Last year, there were but thirty-four on them, and they were most delicious. Had the earwigs eaten ninety-nine hundredths the year

before, the remainder would have been more valued.

Mr. W. Another use of these despised earwigs is, by consuming every fruit and flower, to enrich the soil at a distance from the tree, which would not be the case if they became rotten, and fell. In this, it is helped by the worm, who drags the leaf into his hole, and brings up rich and new earth to the surface—making fruit more plentiful, and flowers more beautiful.

Amelia. I think I could almost like an earwig.

Mr. W. One word more, and we will finish the subject. Can any one of you tell me why the earwig did not go into Tom's ear? You know they love to crawl to the top of trees, and lie snug: now, he would have been very snug in Tom's ear.

Kenneth. Perhaps he could not get in.

Mr. W. But perhaps he could.

Ella. Perhaps Tom's ear moved, and frightened him.

Mr. W. Indeed, Miss! Asses and horses can move their ears—little boys and girls

cannot. I'll tell you why, some day. Guess again.

Tom. I think I have read that the wax in the ear is so exceedingly bitter and offensive to all insects, that, if put in, they would try to escape. Is that the cause?

Mr. W. Just so; and it shows the wisdom and goodness of God, that an opening, which never closes when we sleep, should be protected from all insects, by a substance that makes us hear better, and drives them all away.

CHAPTER II.

DANDELION CLOCKS.

Amelia. Oh! father, we have seen the gardener, about the people who died of earwigs, and he says, it is so many years since, he has forgot their names.

Mr. W. Just as I expected. I dare say he

has forgotten where they lived. They lived in Europe, I hope; or perhaps in that remote country, called "No-where."

Ella. I wish he had told us, that we might have known if it was true.

Mr. W. Let us forget him. What shall we talk about this morning?

Ella. Oh, pray do tell us about dandelion clocks.

Tom. Dandelion clocks!—pray what are they?

Mr. W. Why, there are some young gentlemen, and a few young ladies, who are so very anxious to know what o'clock it is, when they walk, that they have invented clocks. One little flower goes to bed at one, and another shuts up its petals at three, and so on; but, by far the best clock is made by blowing the downy seed of the dandelion.

Kenneth. I saw Ella and Amelia, yesterday, blowing one.

Mr. W. Ay, and so did I; and, considering that they had to blow ten times, before the last seed flew off, when it was only three by the sun, you must all agree, with me,

that such clocks must be very useful to young ladies.

Ella. Father! father! you are laughing at us.

Mr. W. No, my dears, laughing with you —not at you. But if we do laugh at it as a clock, we must admire it as teaching this truth—that, so careful is the Creator, of even the seed of a dandelion, that he has furnished it with wings, which carry it over hill and dale; and, I dare say, that Ella little thought that she was sowing a hundred seeds, when she was blowing three o'clock on a dandelion.

Tom. Is not the giving wings to seeds, one of the six modes of sowing them?

Mr. W. Let us leave that for some future time.

Tom. I wonder what can be the use of sowing so many weeds!

Mr. W. Probably, there was a time when children wondered why such weeds as wheat, or barley, or rye, grew—they now feed a world. Lettuces, pease, beans, and cabbages were the weeds of our great-grandfathers.

Tom. Everything, then, may be called a weed, until its use is known?

Mr. W. Just so. But, when you and your sisters speak of a dandelion, or a daisy, as a worthless weed of no use, remember, that as we are fed and kept healthy by a variety of food, so may animals be kept healthy by taking some part of these weeds. A leaf of dandelion may be the medicine for one of those beautiful lambs with black heads and legs, you so much admired; and, as every part of the earth is covered with grass for sheep and cattle, it is a beautiful contrivance to give each seed wings, so that every sheep may have medicine when it needs it.

Tom. Does not cultivation change the nature of these weeds?

Mr. W. It does indeed! It changes the tough covering of the almond, into the soft and melting flesh of the peach. It converts the sour sloe into the delicious plum, and the austere crab of our woods, into the golden pippin. Like the wonders of Fairy-land, cultivation has caused the acid and disagreeable weed to spring up into a delicious vege-

table. The celery, of which we are all so fond, was a species of wild parsley—the *apium graveolens;* and the common colewort, by culture continued through many ages, appears under the improved and more useful forms of cabbage, savoy, and cauliflower.

Amelia. How very wonderful!

Mr. W. All that we require, is more knowledge of their properties and uses; and, for anything we know to the contrary, in the root or leaf of this dandelion, when cultivated, may be found a remedy for that most dreadful of all diseases, caused by the bite of a mad dog.

CHAPTER III.

WHY OUR DOG'S TEETH ARE SO WHITE.

Tom. PRAY, father, will you tell us, this morning, why our dog's teeth are so white and clean?

Mr. W. My dear boy, this important secret lies in a nutshell. Ponto sets a very high value upon his teeth, and little girls and boys set none whatever upon theirs. Ponto never goes into a blacksmith's shop to gnaw the files; nor did I ever detect him in the act of chewing small pieces of steel or iron. He thereby keeps his teeth sound and good, until he arrives at a good old age.

Amelia. But we do not eat iron, nor chew files.

Mr. W. Certainly not; but you file off the enamel, or outside, with sugar and sweetmeats, and you break them with cracking nuts and plum-stones; so that they decay,

and are as useless as if you did both. How is that, my masters and mistresses?

Kenneth. Because our teeth are not dogs' teeth.

Mr. W. They are just like dogs' teeth. We have teeth to bite our food, teeth to tear it, and teeth to grind it. Pray what has Ponto more? He has all his now, and a beautiful set they are. I will not say anything about the colour of yours, my children, because I hope to see them, after to-day, pearly white; but, alas! some of you have decayed teeth, which can never be remedied.

Kenneth. Oh! do tell us how Ponto managed his teeth.

Mr. W. When Ponto was a baby-dog, he lived wholly on milk; and, when his teeth were strong enough, he began to pick a bone for himself. If his mother had then cut his meat with a knife, and fed him with a fork, his front teeth, for want of something to do, would have become tender and loose. The first bone he picked, one tooth would drop out, all the others would give way a bit, the food would then get fixed between them,

and they would decay and ache, like children's.

Tom. I do not see how feeding him with a knife and fork should loosen his teeth.

Mr. W. But I do. Just remember:—both your teeth and his are broad behind, and sharp and narrow in front. If all your food or his is cut, and put into your mouth, the broad back teeth grind it, but the front ones have nothing to do.

Tom. I should, therefore, think they would not wear out so soon as the back ones.

Mr. W. My dear Tom, if I could make your right, or strongest arm, an idle gentleman's, having nothing to do but to walk about and swing a cane; and your left, or weakest arm, a blacksmith's, what should we see?

Ella. Why, one would be white, and the other black.

Mr. W. Very true, Miss Pert; but the left, or weaker arm, would not only be able to lift greater weights, and strike harder blows; but it would be larger, and harder, and stronger; now this is just the case with

the teeth. If the front teeth have nothing to do, they become discoloured and loose, and the gums grow spongy and unhealthy.

Amelia. Then the reason why Ponto's teeth are so white and good, is because he uses all his teeth—front as well as back?

Mr. W. Precisely so.

Ella. But why are they white?

Mr. W. Because every mouthful of food, torn off, is his tooth-brush. If he had one tender tooth in front, they would soon lose their whiteness. Feed him with small pieces of meat for a month, and they will be anything but white.

Tom. Oh! now I see! We ought not to eat with a knife and fork, or spoon, but gnaw the meat off the bones. I cannot help laughing at the thought of all our boys scrambling for a bite at a boiled leg of mutton!

Mr. W. Laughable as all this seems, it is more rational than the boy or girl, or man or woman, who cuts all his food and keeps his front teeth in perfect idleness, and, shall I add—dirtiness.

Amelia. I should think that cannibals, sit-

ting round a fire, and eating one another, have white teeth.

Tom. And the Tartars or Abyssinians, who eat half-cooked steaks.

Mr. W. I dare say they have; but you need neither be Tartars, nor cannibals, nor dogs, and yet have sound and white teeth. This may be done by removing every impurity from the teeth, and scrubbing the gums well, daily, with the tooth-brush. Remember, that although you may whiten your teeth with tooth-powders, yet, unless you do as Ponto does with his tooth-brush—brush, ay, and brush roughly, too, both tooth and gum—you may have white teeth, but they cannot be sound and healthy.

CHAPTER IV.

BREATHING LUCIFER MATCHES.

MR. WARD had scarcely opened the door, when he saw smoke ascending from the breakfast-table. "Hollo! hollo! my little masters," said he, "what smoke is this?"

Altogether. Tom is trying an experiment.

Mr. W. Rather on a large scale, I think, for he has burnt all my lucifers.

Amelia. Tom has told us he could make us breathe a bunch of matches.

Mr. W. Breathe matches! Pray, sir, how is that to be performed?

Tom. Just as you came in, father, we were beginning to breathe a piece of wood, called matches.

Ella. Nonsense, Tom! I know I don't breathe a piece of wood.

Mr. W. This time, Ella, you are wrong, and Tom is right.

Ella. Oh! father! do tell us how.

Mr. W. Let me try an experiment on this bread and butter, and then we will talk about this strange notion of Master Tom's.

Tom. Father, I have discovered two or three things in a cup of tea, which—

Mr. W. (Interrupting him.) My dear fellow, one thing at a time. To-morrow we can listen to all you have to say about a cup of tea.

Tom. I should think we have breathed up the whole box of lucifers by this time.

Amelia. Is not Tom talking nonsense, father?

Mr. W. No, my dear; on the contrary, it is very good sense. You see this wooden match: now we will light it; there, it burns; now the flame is out, but it still burns like charcoal; now it is out, and what is left is as light as a spider's web. Where is the match gone to?

Ella. It is burnt.

Mr. W. But where is the match now?—nothing can be lost, you know.

Kenneth. We cannot tell.

Mr. W. Then I will. You have seen the

gas-lights in the streets. If you turn the stop-cock, you may smell the gas; but you cannot see it. You have seen Tom put small-coal in the bowl of a pipe, and put it in the fire: if you hold a candle to the end, a spire of flame shoots out; but you can see nothing until it is lighted. This is hydrogen gas. Again, when you burn charcoal in a room, people die when they breathe the air —they cannot see it: that is another gas, called carbonic acid gas; and when you blew the fire with the bellows, that was another gas, called oxygen, that made it burn so brightly. Now, then, my wooden match, and many other things that burn, are composed of these airs or gases, compressed and squeezed into the form of a match; when fire is held to it, like the Genii out of the barrel, they escape from their imprisonment, and fly about the room, and, mixing with the air, we breathe them: and now, you see, you may actually breathe wooden matches.

Amelia. How very curious! When you have time, father, will you tell us more about these curious gases?

CHAPTER V.

THE DIRTY DUCK.

Mr. Ward. WHO can tell me why one of those ducks in the street looks so dirty?

Amelia. He is a lazy duck.

Mr. W. Ducks are never indolent.

Ella. Perhaps he did not awake in time to clean himself?

Mr. W. Ducks never oversleep themselves. Look at him; although it rains, and all his companions are enjoying themselves, he sits huddled up, and alone.

Kenneth. Perhaps he is sulky and ill-tempered?

Mr. W. Ducks never sulk.

Esther. Then what is the matter with him?

Mr. W. He is very ill, and will probably die.

Tom. Have you felt his pulse, or looked at his tongue?

Mr. W. Neither.

Tom. Then how do you know?

Mr. W. Simply by the fact of his being drabbled and dirty. This is not only true of ducks, but of all birds, and almost all animals. If you were to drive him into the water, what would happen?

Tom. I have often driven dirty ducks into the water: I mean ducks that have been kept up to feed; and I find they soon wish to come out.

Mr. W. If they were kept in by force, they would be benumbed with the cold water, and drown—just as this poor object now before us would, if he was thrown into a pond, and kept there.

Tom. I have remarked, that ducks, kept from water, swim deeper than other ducks—the one swimming gaily along, like an empty barge—the other lagging wearily on, like an overladen collier. How is this?

Mr. W. Tom, you and I sometimes go out in the rain, without our hats: how is it that our hair becomes so much more wet than Amelia's or Ella's?

Tom. Because their hair has oil put upon it every day, and ours has not.

Mr. W. This is just the reason why the poor duck before the window is dirty—why the other ducks swim deep—why the others are benumbed and drown. Their feathers require oiling.

Tom. I see it all. I knew there was a little pimple, or gland, that formed oil, near the tail, and that this was rubbed over all the feathers.

Mr. W. And I believe that birds are so formed by the beneficent Creator of all things, that their greatest pleasure consists in cleaning and arranging their feathers, and rubbing them with this oily fluid. I wish some of my little people had this instinct of cleanliness.

Tom. I know who you mean. But does this love of cleanliness leave ducks and other birds when they are ill?

Mr. W. I think not. There are two causes; one, I think, you may readily guess; the other I will try to explain to you.

Tom. Is it because they are feeble? When

I was ill with scarlet fever, I could not wash my own hands and face.

Mr. W. I have known young gentlemen who could not wash their own hands and face, several years after the scarlet fever was gone. It must be a very weakening complaint, to last so many years: I believe feebleness is one, but not the chief reason.

Tom. I can think of no other—especially as you say ducks are never lazy, nor sleepy, nor sulky.

Mr. W. Amelia, do you remember having fever?

Amelia. I do indeed.

Mr. W. From what did you suffer most?

Amelia. Oh! above all other things from thirst, and from a parched tongue and mouth.

Mr. W. What made your mouth parched and dry?

Amelia. The fever.

Mr. W. How did that cause it?

Amelia. I do not know.

Mr. W. Just under the ear there are two little bodies called glands; there are others under the tongue: these are the spittle or

salivary glands; and, in health, they pour out a large quantity of spittle, to moisten our mouths. When we are ill, these glands make no spittle, and the mouth must be dry for the want of it.

Tom. And when a duck is ill, he has no oil in his oil-gland?

Mr. W. Exactly so. We will finish this subject to-morrow.

CHAPTER VI.

OF A MAN WHO CRIED, WITHOUT CEASING, SEVENTY-THREE YEARS.

Mr. Ward. DID you ever hear of a man who cried, without ceasing, seventy-three years?

Amelia. Do you mean, he cried actual tears?

Mr. W. Yes; that he actually shed tears, for seventy-three years.

Tom. Without ceasing?

Mr. W. Without ceasing.

Ella. I cannot believe it: I never, never can.

Mr. W. Why not?

Ella. Only think the time—seventy-three years! Was that all his life?

Mr. W. Yes; he cried the moment he was born, he shed tears all his life, and he cried till within six hours of his death.

Kenneth. If I had cried so many years, I would have cried to the last minute.

Mr. W. He would have done so, if he could, but he could not.

Tom. Why could he not?

Mr. W. Ah! there's the mystery. How many tears have you shed to-day?

Amelia. None.

Ella. None.

Kenneth. None, father—not a drop.

Mr. W. I cannot believe it: I have shed tears all day and all night.

Amelia. Why, your eyes do not look red!

Mr. W. That is because I have been crying. Let me look in your eyes—and yours: you have all been shedding tears.

Tom. I have not—of that I am quite certain.

Mr. W. And I am equally certain that you, and your sisters, have cried ever since you were born, and are actually doing so now.

Tom. We cannot tell what you mean.

Mr. W. Did you ever see the eye of a dead sheep or cow?

Tom. Often: it has lost its clearness and brightness.

Mr. W. What causes it to lose its transparency?

Tom. It is exposed to the air.

Mr. W. And so has your eye been; and yet it is very bright and clear.

Tom. How is it kept from drying?

Mr. W. By the most simple and beautiful contrivance. Under the outer edge of the bone, upon which the eyebrow is placed, is a little gland.

Tom. Like the spittle-gland?

Mr. W. Yes, but very small; and this is the little tear manufactory. Every time we shut our eyes, this is pressed upon, and a

tear is squeezed out, and is made to wash the whole eye.

Tom. I have often wondered why everybody I saw kept winking. I see now—it is to make the eyeball clear and bright.

Mr. W. Has it no other use?

Tom. None that I know of.

Mr. W. Think. If a small fly get into your eye, what takes place?

Tom. I rub the eye violently.

Mr. W. That is to kill him; and then there is a gush of tears, enough to drown him, if he lives, and to carry him into the corner of the eye. But the great use of this constant flow of tears, is to wash every particle of dust from the delicate eye, and carry it through the nose.

CHAPTER VII.

WHY A MAN WHO CANNOT CRY, CANNOT SMELL.

Tom. I CANNOT see what crying has to do with smelling—seeing and smelling are so very different.

Mr. W. Of course they are. Suppose, now, you had to make the eyes and nose—you would hardly know how to keep them free from dust and dirt, seeing that they are almost always open, like the ear, and not shut, like the mouth.

Tom. The structure of the eye is so beautiful, that I should be quite unable to keep it free from dust: I know the tears do that.

Mr. W. But what is to be done with the tears, laden with dust and dirt?

Amelia. Do they flow down the cheek?

Mr. W. They do, when they run over; but that would soon leave a red furrow down the cheek.

Amelia. Where do they go to?

Mr. W. Come here, Kenneth;—now look at the inner corners of his eyelids: you see two very small openings, one in the top lid, and another in the bottom?

Tom. I see them perfectly: there is one, and—

Kenneth. You need not feel them, Tom.

Tom. I did not mean to hurt you, Ken.

Mr. W. Now, these are the openings through which the tear, that has washed the eye, is forced by the closing of the eyelids.

Tom. How very beautiful! By closing the eyelids, we force out a tear from the gland on the temple side of the eyelid, which moistens the eyeball; by the same motion, we force it through two little openings—

Mr. W. Into the nose.

Tom. But, if that is the case—if the eye was for ever crying, might not the nose be for ever dropping?

Mr. W. Ah! now you've caught me!

Ella. Oh! I'm so glad! Tom's caught father!

Esther. Father can't answer Tom! Father can't answer Tom!

Mr. W. Let me see—let me see! How stands this most difficult question?

Tom. If the eye of a man be perpetually crying—

Mr. W. Or, to be rather more correct—if the two eye-glands be perpetually forming tears—

Tom. Thank you, father—for seventy-three years, ought not the nose to keep dropping water or tears all that time?

Mr. W. You saw it rain yesterday?

Tom. Yes.

Mr. W. You saw the streets very wet?

Tom. Yes.

Mr. W. And you heard the wind blow, soon after the rain?

Tom. I did certainly hear it.

Mr. W. And yet the streets are dusty to-day. Where is the rain gone to?

Tom. The wind has dried it up.

Mr. W. What is the wind, Tom?

Tom. A strong current of air.

Mr. W. Just the thing. There are two

strong currents of air rushing up a man's two nostrils, from the time he is born, to the time he dies. If there was no moisture, the air would dry up the inside of the nose, and it would become horny and insensible—

Tom. And therefore unfit for smelling. But still, when a child or man cries much, does it not happen—

Mr. W. It does: if there is more tear-water than can pass into the nose, it runs down the cheek; if more than the air can dry up, as it passes through the nostrils, then we must use our pocket-handkerchiefs. When grown up children hear anything very affecting, they always blow their noses—

Amelia. To make room for more tears from their eyes, lest they should run over, and be seen crying.

Mr. W. In a few words, the eye could not see, nor the nose smell, if it were not for crying: it carries hurtful matter from the delicate eye, into the almost unfeeling nose. From which you may learn the necessity of paying great attention to the nose.

CHAPTER VIII.

WHICH IS THE BOILED EGG?

Mr. W. Now, Tom—there are six eggs, two boiled yesterday, and four unboiled. Which are the boiled?

Tom. Let me see!

Mr. W. Oh! ah! let the light shine through them, by all means.

Tom. This is a boiled one.

Mr. W. You must go out of the room, while I examine my private mark.

All. We will go out. (*All go out.*)

Kenneth. May we come in?

Mr. W. Yes.

Tom. Well, am I right?

Mr. W. No—your egg is an unboiled one: let the others try. Shake them well, Ella.

Ella. I believe this does not shake. This must be one of the boiled ones.

Mr. W. Turn your faces to the wall, while I examine my mark. No, it won't do; this, too, is an unboiled one.

Ella. Are you sure, father? I can see no private mark.

Mr. W. But I can, Miss; and there can be no mistake.

Tom. May I try once more, father?

Mr. W. O yes. What are you doing, boy?

Tom. I have heard that the end where the future chick is to be, is warmer. This is cold at both ends. The chick must be dead here.

Mr. W. Turn again—mind you do not cheat. Wrong again—this, too, has not been boiled.

Esther. I wish I could see father's mark!

Mr. W. There is no mark on the egg, by which I know it.

Amelia. There must be something. Will you let me rub them all with water?

Mr. W. Oh yes, and with ink, too, if you please.

Tom. Now, Milly, do you rub them, and I will paint them all black with Indian ink.

Esther. Now, father can't tell which, I know.

Mr. W. (Taking them up singly.) It is indeed difficult to see any mark now; and I can hear nothing. Suppose I act the part of Monsieur Testot, the conjuror, and set these six black eggs to spin round together, as he does his six plates. There goes one—there another—now they are all going.

Tom. They all go, certainly; but four make a sort of lame waddling turning round.

Amelia. But these two spin round beautifully.

Mr. W. They are the boiled eggs.

Tom. Let me try. I cannot make the four spin, but the two run round like tops.

Mr. W. Do you know what the ballast of a ship is?

Tom. It is a weight placed in her bottom, to steady her.

Mr. W. Does it matter whether the ballast be solid or liquid?

Tom. I should think not.

Mr. W. Then a hold full of water would do for ballast?

Tom. Yes.

Mr. W. When she rolled on one side, what would take place?

Tom. I am wrong; the water would rush to that side, and she would roll over, as little boats do when all the people in them run to one side.

Mr. W. Tom, you would never expect a top to "go to sleep," in spinning, if the peg was loose and shifting; and it would be as absurd to expect a liquid egg to spin on a moveable centre. A boiled egg is solid, and spins like a solid top.

CHAPTER IX.

WHY A FLY CANNOT RIDE ON HORSEBACK.

Mr. Ward. We have not far to look for a reason. Do you see those four sheep hanging up in the butcher's shop?

Amelia. Perfectly well.

Mr. W. What do you see?

Amelia. Four dead sheep.

Mr. W. With their heads, and tails, and skins on?

Amelia. No, but with their heads, and tails, and skins off.

Mr. W. Well, that is rather more descriptive. What colour may they be, now their skins are off?

Ella. Meat-colour.

Tom. Red and white, father.

Mr. W. Be particular about the red; never mind the white. Where is the red situated?

Tom. Upon the back, down the sides, and upon the shoulders.

Mr. W. Well, now; this red part, which is seen when the skin is removed, is the cause why a fly cannot ride on horseback.

Amelia. How very ridiculous!

Mr. W. And how very true! I have shown you a dead sheep, because it was at hand; but there are the same appearances in the ox and horse. Be so good as to consider one of these dead sheep a living horse.

Kenneth. I'll try.

Mr. W. Suppose a fly, wishing to take a ride, or his breakfast, alights upon this horse, on some of the red part, what takes place? If the horse had hands, he would knock him off; but, as he has not, what does he do?

Tom. He wrinkles up his skin, the moment he settles upon him, and gives him a good shake.

Mr. W. Exactly so; and this red part is the beautiful contrivance that enables him to do so: it is called the *panniculus carnosus*, or fleshy covering. In man and monkeys there is no such structure, because they have hands. Put a fly on the back of your hand, Kenneth, and try to shake him off by wrinkling your skin.

Kenneth. I cannot stir it. But why have not these animals this red covering all over their bodies?

Mr. W. That would be unnecessary. Examine the sheep again. Wherever he is white behind, the tail could sweep it off; wherever it is wanting before, the head or horns could knock it off. In these places it would be as unnecessary to give this cover-

ing, as giving it to man and monkeys, who have hands, with which they can remove every annoyance. You now see "why a fly cannot ride on horseback."

Tom. Oh, perfectly:—if he ride before, the head will knock him off; if he ride behind, the tail will switch him off; and if he ride anywhere else, this *panniculus* will give him such a shaking, that he will soon be glad to fly away.

Mr. W. From all this we may learn the cruelty of cutting the sweeping tail of the horse, which is as useful as it is ornamental.

CHAPTER X.

THE RECIPE SIX THOUSAND YEARS OLD.

Mr. Ward. Let us, this morning, consider a subject of great importance.

Tom. What is it to be about?

Mr. W. About the reason why this ginger beer is not the same as the last.

Tom. It was made just in the same manner.

Mr. W. It is a singular thing, Tom, that, with all our care and attention, no two bottles of ginger beer are ever precisely alike.

Tom. How do you account for that?

Mr. W. In no other way than that every product of man is necessarily imperfect. But I have a bottle of fluid here, made from a recipe six thousand years old; and, although millions and millions of hogsheads are made daily, it never varies in its taste or qualities.

Tom. How strange, that we should never have heard of this fluid!

Amelia. Do, pray, let us see it?

Ella. And taste. I wonder how it looks!

Mr. W. (Holding up a bottle.) Well, here it is.

Tom. Why, there is no cork in the bottle!

Mr. W. It needs none.

Tom. (Turning the bottle upside down.) Why, father, your fluid has all run out.

Mr. W. That cannot be, for it is one of its

peculiar properties, that it cannot be poured out of this bottle: it may be turned out, by putting another fluid in, but it will not pour out.

Esther. But there is nothing in—indeed, there is not.

Mr. W. Indeed, Miss, it is full—quite full.

Ella. Oh! father, do not talk such nonsense!

Mr. W. Nonsense! forsooth; I never talked better sense. This fluid—ah! you may laugh—this fluid, in this bottle, is the true elixir of life: whoever uses it, in its pure state, has neither ache nor pain. It puts new life into the sickly boy, reddens his cheek, and makes him sleep; and it is a certain remedy against drowning, if boys do but carry enough of it into the water with them. What a set of little infidels! Cannot you see it now?

Tom. You certainly are laughing at us, father.

Mr. W. This fluid was made so perfect, six thousand years ago, that the recipe has never been altered. The three ingredients of which it is composed—

Tom. The three ingredients composing nothing!

Mr. W. Peace! malapert boy. I repeat it —the three ingredients of which it is composed, were mixed by the Maker of it, in such proportions as made it agree with every constitution. It is equally pleasant to the old and young—to the rich and poor. Your little brother, Albert, is very fond of it, and, judging by the quantity you have all been taking since you have stood here, you all seem to relish it. Even our old dog wags his tail with delight, when a dose of it is given to him, pure and unadulterated.

Altogether. How tiresome you are, father! We cannot drink nothing. Do look at the bottle now!

Mr. W. I see—I see;—it is still full of this precious fluid, more precious to all who use it, than gold, or food, or raiment. Tom—fill this bottle with water.

Tom. Quite full?

Mr. W. Yes, quite full. There now—you have poured out and spilt this precious fluid, and have left nothing but water in the bottle.

Tom. We have driven nothing out of the bottle but the atmospheric air.

Mr. W. Ay!—and that is my precious fluid—my elixir of life!

Tom. Oh! I see it now. It is the air we breathe: *that* was in the bottle—*that* is used by everybody—*that* would save a drowning man's life. How stupid I must have been, not to see it before!

Mr. W. Is it not astonishing, my children, that this aerial and elastic fluid should be composed of three gases, or airs, which, from the beginning of time to the present moment, have been mixed in the same proportions—in the plains of Quito—in the crowded city—in the desolate wilds of the pathless desert,

" Where Andes, giant of the western sphere,
Looks from his throne of clouds o'er half the world!"

In all, the proportion is the same. How puny is man, compared to his Maker! He cannot make two bottles of ginger beer alike; while He has, from the remotest era, mixed these three gases in such exact proportions, that no difference can be detected!

At our next meeting, we will say something about the great workshop in which this air is made—about the apparatus for using it, *i. e.* the lungs—and about the purifying means employed to keep it pure, *i. e.* the plants and trees.

CHAPTER XI.

IF A FLY HAD A SORE TOE, WHAT WOULD HAPPEN?

Amelia. FATHER, your questions grow more and more ridiculous. Who ever heard of a fly with a sore toe?

Mr. W. And pray, Miss, who ever heard of "that tribe who threw stones into their machines," and many other wonderful events?

Tom. I cannot imagine a sore toe would be of any very great consequence to him. He could fly, and crawl up and down.

Mr. W. I rather doubt the crawling up and down. He might fly up, and fly down, but not crawl.

Tom. I do not see that at all.

Mr. W. Probably not: it is wonderful how very little, boys and girls do see, in anything, until their eyes are opened.

Tom. But why cannot a lame fly crawl?

Mr. W. Did you ever see what boys call a sucker, made of leather, softened? It is put flat upon a stone, the centre is pulled up, and the sucker pulls the stone up with it.

Tom. How does it do that?

Mr. W. I'll try to explain that, in a paper called "How a Calf sucks a Cow." What we have to do with now, is the fly's foot, and the sucker. If the edge of the leather were notched and uneven, what would take place?

Tom. It would not fit close to the stone.

Mr. W. And of course the stone would not stick to the sucker.

Tom. Certainly not.

Mr. W. Well, that is just the reason why a fly with a sore toe cannot crawl up and

down. You remember, I never said he could not crawl.

Tom. But, my dear father, what has a fly's foot to do with a sucker?

Mr. W. Everything. If its foot did not act as this sucker, it could not walk up and down the smooth panes of glass, nor with its head downwards upon the ceiling.

Tom. Then you think, if it had a sore toe, it would not press hard enough upon the pane to hold on?

Mr. W. Just so; and a more beautiful contrivance is not to be found in bird or beast. Can any of you tell me what you think is the use of flies?

Esther. To fly about the window?

Mr. W. That is their play-ground, little Missy.

Kenneth. To eat the sugar out of the basin?

Mr. W. That is their bull's-eyes and lolly-pops.

Ella. Are they to eat peaches, and other fruit?

Mr. W. That is very near it.

Tom. Is it not to eat up everything that is useless to man, and would be offensive to his sight or smell?

Mr. W. I do verily believe it is. When food becomes putrid, and unfit for use, it is highly relished by the epicure fly. Near our dwellings the fly, and the maggot, and the wasp, act as the vultures of the wilderness, and feed and fatten upon the refuse, at home, as they do upon the unburied carcasses of the wilderness and the solitary place.

CHAPTER XII.

HOW A CALF SUCKS A COW.

Mr. Ward. SURELY, this morning I shall have nothing to do but to sit still and listen: —How does a calf suck a cow?

Tom. She puts the teat in her mouth, and pulls it down.

Mr. W. Is that all?

Tom. Yes.

Mr. W. And the milk runs down its throat, because it is pulled?

Tom. Yes.

Mr. W. Then I should think there is a sort of trap-door that opens when it pulls, and shuts when it gives over.

Amelia. I know nothing about the trap-door; but I tried to milk, one day, and could not get a drop to run out; and I am sure I pulled hard enough.

Mr. W. Then it cannot be pulling that makes the milk come into the calf's mouth.

Ella. It is sucking.

Mr. W. Ay! now we have it. But what is sucking?

Ella. Sucking milk.

Mr. W. In other words, it sucks because it sucks. Tom, bring me a wine-glass, or, what is better still, a cupping-glass, with a pipe fixed into the bottom. Now, Ella, lend me your cheek.

Ella. But will it hurt me?

Mr. W. Do you think I would hurt you?

Now, I put this glass flat upon your cheek, and suck the pipe.

Ella. Oh! how it pulls!

Mr. W. Turn the stop-cock. There! the glass and pipe hang to Ella's cheek!

Esther. Let me try. Oh! I cannot pull it off!

Tom. Let me look inside the glass. The cheek swells up inside, like a round ball, and the blood seems ready to fly out of the skin!

Mr. W. Well; now suppose Ella to be the cow, and the blood in her cheek the milk, and the pipe and glass the teat, and me the—no—no—Tom the calf.

Altogether. No, no, father—you are the calf.

Mr. W. Well, well, I'll be the calf, and you shall all be the wise people, to tell us about it. Go on.

Tom. No, father—you must.

Mr. W. If I am "calf" I cannot; because I cannot suck and talk at the same time.

Kenneth. Let me be calf.

Mr. W. Now, Ken, suck away. See, it

swells more and more. Now, if this cheek, and blood, and pipe, were actually the bag, and milk, and teat, what would take place?

Tom. Why, the milk would run into Kenny's mouth.

Mr. W. Exactly so. Now, you see it is not pulling. What is it?

Tom. I think I know. Do not laugh at me if I am wrong. The air, you know, presses equally upon every part of the cow; there are many hundreds of pounds weight of air upon her.

Ella. How can that be?

Tom. Why, Ella, you know, a balloon has carried people two or three miles high; and, if there was no air there, they could not breathe. Now, all this two or three miles of air, above the cow, press upon her equally. Will you help me out, father?

Mr. W. Bless you, my dear boy, that I will. Suppose there was one part of the cow where this vast weight of air did not press upon, what must take place?

Tom. Why, all the fluids and solids would be squeezed and forced out there.

Mr. W. Just as in this basin of water;—if I press a lesser basin down to the bottom, that pressure drives and forces the water over the sides.

Tom. Precisely so.

Mr. W. Now, we will suppose this one part, from which the pressure of this vast weight of air is taken, is Ella's cheek, or the cow's teat. What must take place?

Tom. Why, milk must run out; and the blood and flesh of her cheek must rush into the glass.

Mr. W. Then, if asked "How a calf sucks a cow?" you say, "By taking off the pressure of the air."

Tom. Now I know why a sucker draws, and a fly can walk upon the ceiling. How delightful it is to know all these things thoroughly!

Mr. W. This is my great object, in conversing with you on such subjects. It is in science, as it is in journeying through a hilly country—the climbing up is difficult; but what glorious views burst upon us, when we have climbed over all the difficulties! Almost all

the boys and girls of my acquaintance, keep, all their days, in the valley of science, because they stumble at the commencement. But why does a sucker draw?

Tom. Because it is pressed flat upon the stone; by which all the air between it and the stone is pressed out: the string is pulled; by which the centre of the leather is pulled from the stone: no air is there—it is a vacuum. All the miles of atmosphere press upon the sucker, and try to force an entrance into the space between the stone and the sucker: this it cannot do; but it presses the leather, at the rim, a thousand times closer to the stone.

CHAPTER XIII.

WHAT IS TO BE SEEN IN A CUP OF TEA.

Tom. FATHER, I think I have made a discovery.

Mr. W. A discovery! In what?

Tom. I'll show you. May I take a lump of sugar?

Mr. W. Certainly.

Tom. Then look: there—there—see! Now, I just dip the end of the sugar in the tea; see —it rises—it mounts up to the very top!

Mr. W. Alas! Tom, it is no discovery: you may see it in linen cloth dipped in water; you may feel it every time you are wet with rain. Every damp wall shows it. You know, our old parlour paper never stuck to the wall.

Amelia. I remember; it turned the crimson paper a bluish white.

Ella. Oh! pray, father, do tell us how it does this.

Mr. W. My dear girl, we know nothing about *how* it does it: as you grow older, this *how* will often puzzle you. We know it is so, because we see it in Tom's sugar; and we must be satisfied. I take this small glass tube—a hair could scarcely be put up the opening. If it be put in coloured water, it rises in it; if it were narrower, it would rise higher. If I procure a larger tube, and

suck the air out, the coloured fluid would rise in that: but the air keeps in this, and still it rises. This is called the "attraction of small tubes," or capillary attraction. You see it rise in the sugar. There are, probably, small tubes formed in the sugar, when it grows solid. If I take a basin of water, and put a piece of cloth in it, and hang it over the edge, it all climbs up the tubes of the cloth, and drops over: so, if I get my coat rather wet in a shower, I feel nothing of it until I have sat down for half an hour; it then becomes damp inside. Is this by capillary attraction? In some walls the damp rises.

Tom. Is it by the same invisible tubes?

Mr. W. Certainly; and the only way to prevent the damp rising, is to cover the first course of bricks, above ground, with sheet lead.

Amelia. But, father, how does the damp turn the crimson paper purplish white?

Mr. W. The damp acts upon the lime of the walls, and produces liquid lime, which destroys the crimson colour. Tom—fetch

in some rose leaves, and put them in this cup of boiling water. It is pale red. Put in a little acid, such as oil of vitriol. Now it is bright red. If you now put in a piece of lime, it changes to blue or green. Now, the red paper is acted upon by the lime in the same way.

Tom. Then I should think, if, instead of canvass, and lead, and such contrivances, they soaked the wall with diluted oil of vitriol, it would prevent its taking off the red colour.

Mr. W. A most admirable remedy, Tom, if all paper hangings were red; but what would happen to the blue colours? Put a few drops of acid into this bluish liquid.

Kenneth. Oh! what a bright red it has turned it to!

Mr. W. You see, my dear boy, this discovery is very beautiful till it is tried. You will find it is no easy thing to discover anything. Let us talk again, to-morrow morning, about what else is to be seen in a cup of tea.

CHAPTER XIV.

WHAT ELSE IS TO BE SEEN IN A CUP OF TEA.

Ella. I CANNOT find anything else in a cup of tea.

Amelia. Nor can I.

Esther. Nor I.

Mr. W. Tom! Can you see nothing?

Tom. I find, if I drop a wetted lump to the bottom of the cup, no bubbles rise up; if I drop a dry lump, some do. How is that?

Mr. W. In lump-sugar, these little bubbles are shut up in little prison-cells; the hot tea sets them all at liberty, by bursting open their prison doors.

Ella. Oh dear! how very strange! How can it be so?

Mr. W. Tom, my dear, bring that bladder here—blow it full—quite full of air. Now hold it to the fire. What is the matter?

Tom. It has burst!

Mr. W. Just so with the sugar. The hot tea has heated and swelled out the air-bubbles in the sugar, and they have burst from their cells, and now swim at the top. What makes them all keep in the middle of the tea-cup?

Tom. Attraction.

Amelia. And what is attraction, Tom?

Tom. Why, Milly, one little bubble likes another, and so they all cluster together. See, if one bursts, how they all rush to fill up his place.

Mr. W. All that is right; but why do they keep in the centre?

Tom. Each side of the cup would like to have them; but when they all attract equally, they must keep in the middle.

Mr. W. Put the spoon in, and what takes place?

Kenneth. They all run to that side, and hold fast to the spoon.

Tom. That side is now the strongest side; it attracts or draws them, more than the opposite. See how they cling to one another;

that is, by attraction: see how they follow the spoon; that is, by a greater attraction.

Mr. W. These attractions are the most wonderful of all God's works. By the first —the capillary—the moisture rises from the depths of the earth, to refresh the parched root or plant; by it, probably, the sap rises in the sap-vessels of the tree; running to the very topmost bough—making them gladden the eye and heart, with bloom and foliage. By the last—invisible attraction—all the planets and comets have rolled on, for ages, in their appointed orbits. By it every solid keeps its solid form. Deprived of it, for one minute, the sun, and moon, and stars, would rush through space, with accelerated speed; and the whole of this beauty, and order, and harmony, would cease; and Death would stalk, with giant strides, over the gigantic remnants of shivered and shattered worlds! The whole creation would be one vast Mausoleum, in which all the living beings of this earth would be entombed! Pray what else is to be found in a cup of tea?

Amelia. There can be nothing else.

Mr. W. Yes, there is: look at the vapour, or steam, as you call it, that rises from it.

Ella. We see it; but there is nothing in that but smoke.

Mr. W. Let the sun's rays fall upon this smoke, as you term it. Now, blow upon it. What see you?

Ella. Oh! ten thousand thousand little balloons.

Amelia. How very pretty! What are they?

Tom. They are steam, or vapour.

Mr. W. My learned little Theban, steam is not vapour, nor vapour steam.

Tom. I always thought they were the same.

Mr. W. You cannot see steam—you can see vapour.

Kenneth. Is not that steam that comes out of the kettle-spout, when it boils?

Mr. W. Yes—no.

Ella. Yes! no!—What do you mean?

Mr. W. I mean it is, and it is not. Do you know now?

Tom. Not at all.

Mr. W. Lend me your finger. Now look

at the kettle-spout, about half an inch from the spout; nothing can be seen: beyond that distance is what you call steam, and I vapour. Mind you do not put your finger in the vapour, as that may scald you. What can be the matter with you?

Tom. Why, it is hotter than hot boiling water, father.

Mr. W. Then it must be the steam, for that can be heated higher than water.

Tom. I do not mind the burn. I know now—steam is invisible, and vapour is visible steam, or condensed steam.

Mr. W. Just so: and at some future time we will talk about a contrivance, called Papin's Digester, in which he dissolved bones by heated steam. But we have forgotten Ella's ten thousand thousand little balloons. What are they?

Tom. We none of us can tell.

Mr. W. They are nothing more than heated air, in a coating composed of tea, sugar, and milk. Let us now break up.

CHAPTER XV.

PEWTER SIXPENCES.

Kenneth. Oh! what a beautiful sixpence has just dropt from the fire.

Mr. W. Let me see: it is indeed round, and flat, and shining, like a sixpence.

Kenneth. May I have it?

Mr. W. Oh! certainly; but of what use will it be to you?

Kenneth. I shall buy six pennyworth of cakes and sugar-plums.

Mr. W. Well, you had better go now; there, shut the door after you.

Tom. Father, father, how could you send him with that pewter sixpence?

Mr. W. What is that to you, if he get six pennyworth of cakes for it?

Tom. But the shop people will know it to be pewter.

Mr. W. And send him back. See, here he comes.

Kenneth. She says it is a bad sixpence

Mr. W. How can it be bad? it is bright, and shining, like silver. What would the woman have?

Kenneth. She says it is not silver.

Mr. W. Not silver! and pray why must every sixpence be silver?

Tom. Is it because silver, like gold, is a very rare metal, whereas pewter is a very cheap and a very common one?

Mr. W. Oh! then the mistake we have made is, we have not sent her a pewter sixpence large enough?

Tom. Just so: a silver sixpence has as much silver in it, as can be bought anywhere for sixpence.

Mr. W. And, consequently, is of a more convenient size to put in the pocket, than cheaper or bulkier metal. Now, Tom—I know you have six pennies in your pocket: scratch, upon this pewter sixpence of Kenneth's, "I promise to pay, on demand, the sum of sixpence—Thomas W——." Would she take it up?

Kenneth. Do let me try?

Mr. W. Write it plainly, and sign your name. There, Kenneth—I wish you better luck this time.

Ella. I hope she will take it. Here he comes, with his pockets quite full.

Esther. I wish another sixpence would drop out of the fire.

Amelia. Did she take it? What did she say?

Kenneth. She looked at it, and said she knew it to be Tom's writing; and then she gave me all these cakes, and plums, and apples.

Mr. W. Now, Tom—remember you have opened a bank, and that you have issued a sixpenny pewter note. Take care you always keep sixpence in your pocket, to be ready when it is presented to you.

Tom. Oh, that will not matter much; Mrs. A. knows me, and will wait.

Mr. W. I have no doubt of that; but she may give it, instead of sixpence, to an apple-woman; and she again to a milk-woman; and, some morning, when you little expect it,

the milk-woman will bring it, and want six pennies for it.

Tom. And if I have not got sixpence, what then?

Mr. W. Why, the milk-woman will take it to the apple-woman, and the apple-woman to Mrs. A., who will have to give her a silver sixpence of her own, and she will then bring your pewter one back to you.

Tom. And I shall pay her; so there's no harm done to anybody.

Mr. W. No harm done, certainly; but she has lost her confidence in you, and will take no more of your pewter sixpences. In future, she will have silver sixpences, or you may go without your cakes and plums.

Tom. And this is banking!

CHAPTER XVI.

THE SMOKY ROOM.

Mr. Ward. PRAY, Tom, my dear boy, do open the window, and let out the smoke.

Tom. Why should this chimney smoke? Of all days in the year, to smoke on my birthday!

Mr. W. It smokes because it is your birthday.

Kenneth. How could the chimney know it was Tom's birthday?

Mr. W. That is the chimney's business—not mine; it is sufficient for me to know, that it smokes because it is his birthday.

Amelia. I never knew before, that a chimney could think.

Mr. W. I did not say so; I said it smoked because it knew this was Tom's birthday.

Ella. How could it know that?

Esther. I wonder whether it would know mine!

Mr. W. No—it would not know yours.

Esther. Why not mine, as well as Tom's?

Mr. W. Because yours is in summer, and his in winter.

Tom. It is certainly a very wise chimney!

Mr. W. Oh, not at all; every chimney knows as much. I think the window may be shut; perhaps, when we put some more coal on, the fire in the other room will not be burning so fiercely.

All. What has the other room fire to do with the smoke?

Mr. W. It causes all this smoke. To tell you a very great secret—these two chimneys are enemies, and do each other all the injury they can.

Tom. But what has all this to do with my birthday? It seems as if the other chimney knew it was my birthday.

Mr. W. And so it does.

Tom. I cannot see.

Mr. W. Nor I neither, for the smoke is pouring down upon us again. Pray open the window in the other room, so that the fire in it may not use our chimney.

Tom. I wish you would explain yourself.

Mr. W. Well; you know that smoke will go up the chimney, if nothing stops it.

Tom. I know it will.

Mr. W. If the wind blows down the chimney, the smoke cannot go up.

Amelia. Certainly not.

Mr. W. Now, I think you know fire cannot burn without plenty of fresh air; it must and will have air—under the doors, through the key-hole, through crevices in the window—anywhere: nothing can stop it—it will rush into the fire, especially when it is large, and burns brightly.

Kenneth. I can hear it now, whistling through the key-hole.

Mr. W. Throw some coals on the fire.

Amelia. Oh, how it smokes!

Mr. W. Open the window in the other room.

Amelia. Now it goes up the chimney very well.

Mr. W. You now see that it is the other fire that makes this smoke.

Tom. Very clearly: when that fire has

burnt all the air in that room, it borrows some from this; and, as our doors and windows fit very closely in winter, it cannot get it fast enough from those openings; but have it, it will. Down the air rushes, pushes the smoke in this chimney before it, and rushes into the other room. If there were no fire here, we should hear nothing but a roaring noise in the chimney, which would be the air rushing down.

Amelia. I can understand that; but why should it smoke on Tom's birthday, and not on Esther's?—I cannot tell.

Mr. W. Why, you little goose, Tom's birthday is in cold weather, and Esther's is in the hottest part of summer, when no fire is needed.

CHAPTER XVII.

WHY A YOUNG MAN MAY BREAK HIS HEAD, AND WHY AN OLD MAN MAY NOT.

Mr. Ward. CAN any of you tell me why Tom may tumble down and break his head, without injuring him, and your father may not?

Amelia. Is Tom's head thicker than yours?

Mr. W. Very likely; but that is not the reason. Guess again.

Ella. Is it softer?

Mr. W. That may also be true; but still, I want a better reason.

Tom. Is it owing to its being rounder?

Mr. W. The roundness of the head of every man, woman, and child, is its great safeguard. Why is a round head stronger than a square one?

Tom. Because it is a series of arches, which are the strongest forms; but, as your

head and mine are both round, why should not an injury to mine be as hurtful as an accident to yours?

Mr. W. There is a beautiful provision in the young skull, which saves the life of many an adventurous boy;—in fact, there are two —one for your youngest brother, and one for you.

Tom. Indeed!

Mr. W. His little head is composed of six or eight pieces. If you were so cruel to him as to squeeze his head, all the bones would overlap one another, and then fall into their places again; but in your head, all these bones have grown together, and you have now two skulls—an inner and an outer one. Between these two is a network of bone; so that, if you fall and fracture the outer, the crack is stopped by the network. In my head, on the contrary, these two skull-caps, and this middle substance, have all become solid bone; and, if I fall violently, I fracture the whole.

Amelia. I never thought I had two heads.

Mr. W. Not exactly two heads, Miss, but

one head, with two layers of bone. What may we learn from this?

Tom. First, that our Creator saw that, when young, we should be in greater danger of injury, and provided a remedy.

Mr. W. In our earliest infancy, when sleeping in a mother's arms, the brain is unprotected by bone, in several parts of the head. If it were solid and bony, the soft brain could not grow as rapidly as it does; and in this stage of our life, we are protected by the sleepless watching of a mother. As we advance in years, from infancy to manhood, perils and dangers surround us; and it is during this age that the contrivance, just described, is especially needed. With increase of age comes increase of wisdom. The infant is secure in its mother's arms; the young man rushes heedlessly into danger, and his brain is protected by this *diploë*, as it is called; but the man has reason given to him, that he may foresee impending danger, and avoid it.

CHAPTER XVIII.

OF A TRIBE THAT SPOILT THEIR MACHINERY BY THROWING STONES IN IT.

Mr. Ward. AMELIA! Where is the coffee?

Amelia. We could not grind it this morning; Cedric had put a stone in the coffee-mill.

Mr. W. Poor little fellow! he knew no better. But did you never hear of a whole tribe, or nation, who, possessing a most beautiful machine, far more exquisitely put together than a coffee-mill, could never keep it in order, owing to the strange whim that possessed every man, woman, and child in the island, to throw stones into it.

Ella. What tribe was it, father?

Mr. W. I think they were descendants from the ancient Celts.

Tom. Was it a machine in constant use?

Mr. W. Daily and hourly. They set

watchmen, who burnt lights in the night, and cried out, "Throw no stones," in the day time; but still, the engineers were always repairing, and it never went well for a week together.

Tom. What a set of foolish people they were! I would have hung the first man caught in the fact.

Mr. W. Tom, you remember that little piece of Latin—*Mutato nomine de te fabula narratur;*—translate it for your sisters.

Tom. "The name being changed, of thee the tale is told." I am sure I am neither the machine nor the people.

Mr. W. You are both.

Esther. Tom, you are a machine, and you throw stones at yourself.

Amelia. I should say, father, you are making fun of us, if we had not seen that you are always right, and we always wrong; so I won't laugh. But do tell us all about this tribe, at once—do—there's a good father!

Mr. W. Well, Tom is a machine, and throws stones down his throat; and so are you all, and so do you all.

Ella. I am sure I never put stones down my throat.

Mr. W. Perhaps not actual stones, but plum-stones, cherry-stones, nuts, walnuts, and other things as hard as stones. You recollect the boy who had vomited something as black as a crow, although his stomach had not ejected "three black crows." Those of you who think you have not thrown stones into the machine, have all thrown something as hard as stones.

Tom. I wish you would describe this beautiful machine to us: I have read about it, but I remember very little.

Mr. W. Well; suppose yourself a gas-house, containing a furnace, a receiver, a purifying-house, a reservoir, or gas-tar pits, and pipes:—the whole human machine may be illustrated by this gas-house.

Ella. Where is the mouth of our furnace?

Mr. W. That may represent your mouth. In both, food is put—coal in the one, and everything into the other. What should we think of the gas-man who puts stones, and bricks, and lumps of clay into his furnace?

Ella. We should think him rather crazy.

Tom. Mind what you say, Ella: you don't see what is coming.

Mr. W. What should you say, if, instead of breaking the coal into small pieces, he put in large lumps, and crammed it so full, that it could not burn, to form gas?

Esther. I should say he was very silly.

Mr. W. What should you say, if, after he had crammed it full, he was to send for an engineer, to pull it all out again?

Tom. That he was very foolish.

Mr. W. What a number of crazy, and silly, and foolish people there is in this world!

Tom. Why?

Mr. W. Because they act in this very manner: they put all sorts of indigestible food into their mouths—they eat it, without properly masticating it—and then they send for a medical engineer (the doctor,) to relieve them.

Tom. But cannot the fire turn all that is put in the retort into gas?

Mr. W. No more than your stomach can turn everything into nutriment. Both are

consumed, it is true; but the waste is the same in both, and the results the same. So you see there is a large tribe who damage their machinery, by their own folly. We will talk, to-morrow, of the machinery itself.

CHAPTER XIX.

OF A TRIBE THAT SPOILT THEIR MACHINERY BY THROWING STONES IN IT, CONTINUED.

Mr. Ward. I NEED scarcely ask you, this morning, what tribe it is.

Ella and *Kenneth*, together. It is all of us —we are the tribe.

Mr. W. At our last meeting, you were all convicted of throwing stones into the beautiful machinery of your bodies. We then convinced you, I hope, that, as the best gas was made from simple coal, so the best

human gas is made from the simplest and plainest food.

Tom. I am sure I understand that thoroughly; but what do you mean by "human gas?"

Mr. W. Why do you eat food?

Esther. Because we like it.

Ella. Because we are hungry.

Mr. W. Very good reasons. Tom, what say you?

Tom. Is it to nourish the body, and make it grow?

Mr. W. Just so: but what nourishes and supports the body? That apple you are now eating, must be converted into something, before it can nourish your body. What is that something?

Tom. Is it blood?

Mr. W. Yes; the object of all our eating is to form blood: this is my "human gas;" and, upon its being made from good materials, and also upon its complete purification, depends the working of the machinery.

Tom. Pray, tell us more about this machinery.

Mr. W. Our gas-man, you remember, had made his gas; or, in other words, he had driven all the gas out of the coal, by the retort, or large pot, in which the gas coal was put, by applying fire to the bottom of it—just the same as if you put a saucepan, filled with small coal, on the fire, with the lid fastened tightly on, and then made a small hole in the lid, for the gas to escape out. What must he do next?

Tom. He must collect the gas, and purify it.

Mr. W. Which he does by passing it through lime-water.

Tom. What does he do with the coke, and gas-tar?

Mr. W. They are both removed: if either the one or the other were to remain, they would render useless the whole apparatus.

Tom. I can easily understand, from this, that a great deal of our food is waste, and must be carried off, when the blood has been taken from it; and I can understand gas going through lime-water, to purify it; but how our blood is purified, I cannot guess.

Mr. W. From what does the blood want purifying?

Tom. I cannot tell.

Mr. W. From its diamonds, and soda-water bubbles.

Amelia. Nonsense! father.

Mr. W. From its burnt wood—from its choke-damp—from its poison.

Tom. Are you really serious? Does the blood—my blood—really contain diamonds, bubbles, burnt wood, choke-damp, poison?

Mr. W. Really, truly and seriously, your blood, my blood, and the blood of every human being, and of every breathing animal, contains these; and if the human purifying-house is out of order—if one little stone is thrown into that, so that this process stops for one minute, it is all over—death is certain and inevitable. In our next I will tell you what this poison is.

Tom. (Musing.) Diamonds, and poison!

CHAPTER XX.

OF A TRIBE THAT SPOILT THEIR MACHINERY BY THROWING STONES IN IT, CONCLUDED.

Tom. I AM so glad it is morning!—I am so very anxious to know all about our purifying-house.

Mr. W. Let us talk, first, about the impurity, and then about the purifying. Why should hydrogen gas be purified?

Tom. Otherwise it might cause some obstruction in the gas-pipes:—is that the case with the circulation of the blood?

Mr. W. In many cases there is great danger from that; but the diamonds and poisonous stuff must be cleared off from the blood, or the man falls dead at our feet in a minute.

Tom. In your last conversation you said there was poison in the blood. Why are we not poisoned with it?

Mr. W. I have before said, we should be, if our purifying apparatus was out of order.

Tom. The quantity must be small, or it must be very weak; for the smallest portion of the poison of some of the venomous serpents, causes death.

Mr. W. On the other hand, its quantity is enormously great—I dare not say how many pounds in the year; and, when thrown off from our blood, it is as deadly as the bite of a rattle-snake. It is called carbonic acid gas, or charcoal gas—and the bright gas, oxygen, mixed together.

Amelia. How does it get into the blood?

Mr. W. Almost everything we eat has carbon or charcoal in it.

Ella. But are diamonds charcoal?—the same charcoal we burn in our stove?

Mr. W. Sir H. Davy says they are nothing but crystallized charcoal. He made some that would cut glass, but they had none of the beauty of the diamond.

Ella. I wish I could make diamonds out of charcoal.

Tom. What would you do with them?

Ella. Sell them for money.

Mr. W. Well, set your wits to work: you may not actually make diamonds, but you may make many important discoveries, as was the case in the search for the philosopher's stone—though that was never found. The "human gas," or the blood, therefore, is full of this poisonous gas, or charcoal. How is it purified?

Esther. By letting it run through lime-water.

Mr. W. And where may this lime-water be kept, Miss Tetty?

Esther. In their stomachs.

Mr. W. I rather think not. The purifying-house for the blood, is placed in the chest of a man. Its construction is so beautiful, that I hope you will try to understand it.

Tom. Is it anything like the gas passing through the lime-water?

Mr. W. Not at all. Come here, Ella. Eat this piece of bread. While she is eating it, Tom, can you tell me why she bites it in pieces, and chews it?

Tom. To break it up into fragments, for the stomach.

Mr. W. Is that all? What is the saliva or spittle for?

Tom. To be mixed with the food.

Ella. I have eaten the bread.

Mr. W. Now, remember that this bread contains the poison—the carbon of the blood.

Tom. May I interrupt you?—If bread has charcoal-poison in it, why does it not poison us?

Mr. W. You may have a pound of charcoal in your stomach, but you must not keep a dram of it in your blood. Ella's bread is now in her stomach, and is mixed with a peculiar juice, called the stomach, or gastric juice.

Tom. I have read very wonderful accounts of this juice.

Mr. W. Not more wonderful than true. It has, by this time, reduced Ella's bread to a pulpy mass; but it could dissolve bones or sinews almost as readily.

Tom. How is it that it does not dissolve the stomach itself?

Mr. W. That is one of the most astound-

ing proofs of the wisdom and goodness of God. It attacks and overcomes dead bone, but leaves untouched everything that has life.

Tom. Then, if I swallowed a live frog, he might live comfortably.

Mr. W. He might live, because many have lived in stomachs, for a short time. It was a custom once, among the ignorant, to swallow young frogs, with the view of their eating away some impurity in the stomach.

Tom. But if I bit him, and killed him, he would soon be dissolved by this stomach juice.

Mr. W. We are forgetting Ella's bread. It is now a pulp. It will soon reach the second stomach, and then it is mixed with bile or gall; and here, again, the most wonderful changes take place. A white milky fluid separates from the rest: this is the future blood. Ten thousand little sucking-pumps take up this precious lymph, as it is called, and it is carried, by one of the blood-pipes, into a larger pipe, near the shoulder. We will say where it goes to, to-morrow.

CHAPTER XXI.

THE MAN WITH TWO HEARTS.

Mr. Ward. WHERE had Ella's bread got to when we left off?

Ella. It was going into a large vein, against my shoulder.

Mr. W. Very good: and, although it enters, a white fluid, it becomes instantly red blood.

Amelia. How very wonderful!

Mr. W. Now, remember, that as the bread was chiefly carbon, or charcoal, this white lymph has some of this in it, and that it has carried the poison into the blood.

Ella. Oh! father, you almost frighten me, with talking of that piece of bread poisoning me.

Mr. W. It is very near the purifying-house. Remember, that it runs now straight into one of your hearts.

Ella. Have I two hearts?

Mr. W. Oh yes; but they are joined together. Now, what do you think the heart does with this bread-blood of Ella's?

Tom. I cannot tell. I hope it will not keep it long.

Mr. W. That it will not. So anxious is this one heart to do its duty well, that the moment this poisonous blood touches it, it shuts itself up, and throws it into the purifying-house, with a force equal to many pounds: this it does about eighty times every minute, from the moment we are born, to the moment we die.

Amelia. There, Ella!—now you are safe.

Mr. W. Let me feel your arm. I do believe this bread-blood is now running down your arm—I can feel it beating.

Tom. What beats?—do you mean the pulse?

Mr. W. I do. Every time this side of the heart throws the impure blood out, you may feel the stroke at the wrist.

Tom. I have often laid hold of the pipe of a fire-engine, and have felt every stroke of the engine.

Kenneth. And so have I, of our leaden pipe that goes from the kitchen pump.

Mr. W. Tom, did you ever see a sheep's head, and several other things, hanging in a butcher's window?

Tom. Do you mean what is called a sheep's head and pluck?

Mr. W. I do. This pluck is our purifying-house, as the gas-men call it.

Tom. What! that light spongy substance, that floats in the bucket of water?

Mr. W. The same: it is our lungs, or lights, as they are called. Directly Ella's dark-coloured, poisoned bread-blood touched the heart, it was forced into these lungs, to be purified. I told you before, they were in your chest: the heart is placed between them. When we have killed a pig, you must have noticed some very light substance, which, when cut, was full of little cells: this was these purifying lungs.

Tom. Is the poison-blood forced into these cells?

Mr. W. No, no. It is forced into little pipes, smaller than hairs, that run all round

these cells. These little pipes all have to get rid of the poisonous charcoal; it cannot run out. How does it, then, get out?

Tom. Does not the air we breathe go into the cells, and fill them?

Mr. W. It does. What is air? You all know this.

Ella. It is oxygen, or bright-burning gas, and azote, or nitrogen.

Mr. W. Now, Ella, you have breathed in as much as your lungs can hold, of this air —your cells are full; now breathe out again: there it comes—now, the poison from the bread is come out with that breath.

Ella. I am sure I breathed the same air out, that I breathed in.

Mr. W. No, no, my dear; the air you have just breathed out, is full of poison, and would kill us all, if we were to be shut up in this room, and compelled to breathe it.

Ella. What, then, has become of the oxygen, or pure air?

Mr. W. When it got into these cells, and found the charcoal in the little pipes, it was so fond of it, that it took the whole of

it away from them, and, the moment the air and the poison were mixed together, the lungs, glad to get rid of it, breathed it out; and the blood, now bright and red, rushed into the second heart; where we will leave it till to-morrow.

CHAPTER XXII.

THE SECOND HEART.

Mr. Ward. LET us rehearse the matters connected with Ella's bread; or, what is better—Tom, do you give us it in a few words.

Tom. The bread, having carbon in it, was bitten by the teeth, and, mixed with the spittle, then swallowed; it was mixed with gastric juice in the stomach, touched with bile or gall in the second stomach, became separated from the refuse, appeared as chyle or

white blood, was sucked up by sucking-pumps, carried by pipes or veins into a large vein near the shoulder, became dark-red blood, run down into the first heart, was forced out of that, in a moment, into the lungs or lights, where it gave up its poison to the oxygen of the air, which was breathed out of the lungs, and then became vermilion blood, which ran down again into the second heart.

Mr. W. Excellent! excellent! We have now arrived at the second heart.

Tom. Has the second heart anything to do with the poisonous or dark blood?

Mr. W. Nothing whatever; but it dislikes the red blood quite as much as the first heart does the dark blood. No sooner does this purified blood touch this heart, than it contracts, or closes itself up, and forces it with such violence into the pipes or arteries, that it is distributed to every part of the body.

Tom. Then what do you mean by the circulation of the blood?

Mr. W. You recollect the gas-house. The

gas goes from the retort to the purifying-house, and from that to the gasometer, by which it is forced into the pipes all over the town. Bring me a pipe full of small-coal.

Tom. Shall I cover the coal with clay?

Mr. W. Now I will put this pipe in the fire, which is our furnace; the pipe is the retort; a mug with some lime-water, having a funnel placed upon it, shall be our purifying-house. Let there be a hole cut in the funnel, to admit the pipe. Do you smell the gas?

Amelia. Very strong, indeed.

Mr. W. All we want now is a gasometer, to receive the gas from the funnel top.

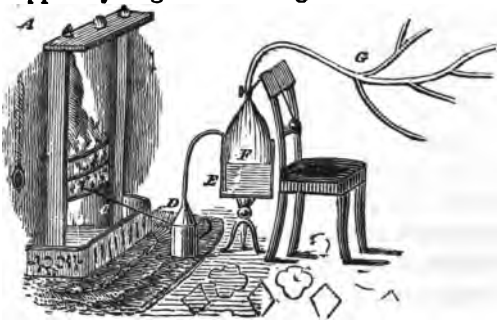
Tom. I can make one. Here is a cupping-glass, with a stop-cock in the top, and a quart mug with some water at the bottom of it. If I tie a string to the stop-cock, and tie a stone to the end of it, and throw it over a chair-back, it would make a gasometer.

Mr. W. And a very good one, too. The stone is a sort of pulley, I presume, to suspend the cupping-glass?

Tom. Yes; and as the gas enters from the

bent funnel, it pushes up the glass, and, when the stop-cock is turned, the weight of the glass causes it to descend in the mug, and forces the gas through the pipe at the top.

Mr. W. As you have learnt drawing, Tom, suppose you give us a rough sketch.



A. The Chimney-piece.
B. The Fire.
C. The Retort, (a Pipe.)
D. The Purifying-house, (a Mug of Lime-water, with a funnel.)
E. The Gasometer-tank, (a Jug of Water.)
F. The Gasometer, (a Cupping-glass, with stop-cock.)
G. The Pipes.

Tom. What do you think of that?

Mr. W. Oh! it will do pretty well. What with the description and the drawing together, they must, indeed, be stupid who do not comprehend it.

CHAPTER XXIII.

THE SECOND HEART, CONTINUED.

Mr. Ward. We have now got the blood into the large pipes going from the second heart. Where does it go to?

Tom. Into smaller veins.

Mr. W. And how small are they?

Tom. As small as hairs.

Mr. W. Into whatever part of the body you might thrust a needle, from that minute opening blood would issue; but there are blood-vessels smaller than this—so small that red blood cannot circulate in them.

Tom. How can you tell that?

Mr. W. By observing the human eye. If you look at Esther's eye, you see no red blood-vessels running across the clear white of her eye. If I was to drop a piece of lime into her eye, in a few minutes it would be what is called bloodshot; that is, there would be a network of veins and arteries, filled with red blood. These must have been there before, although we could not see them.

Tom. The beauty of the eye would be lost, if these vessels carried red blood.

Mr. W. I merely mentioned this, to show you how very small they must be. You know, when the gas is sent down the main-pipes in the streets, it never comes back—it is consumed or burnt in the shops and streets; but it is not so with the blood; the second heart has to force it, not only into every part of the whole body, through many thousands of pipes, called arteries, or vessels for carrying purified blood, but it has also to force it through as many thousand return-pipes, called veins, or impure blood-pipes, with a power sufficiently great to force all the blood into the first heart again.

Tom. What does the blood circulate for?

Mr. W. For everything. Without fresh and pure blood the brain cannot act, and a man dies, as if strangled. It carries life and warmth to every part. Is a toe bitten by the frost?—a double portion of blood is sent, to warm and restore it; if it be past recovery, by the action of the blood-vessels, it is cast off, as a useless member. Is a portion of flesh carried away?—the blood has, within itself, all the material for repairing the breach, and is the workman, too. Are the bones broken?—new bone is carried in the blood, and the blood-vessels mend it so effectually, that it becomes stronger than before. Thus, all that is noxious that passes into the blood, is thrown out by the blood. It is ever running up and down, to warm, to invigorate, to build up: it is, emphatically, *the life.*

CHAPTER XXIV.

PERPETUAL MOTION DISCOVERED AND EXPLAINED.

Mr. W. I HAVE made a discovery—I have found out perpetual motion.

Tom. Is it the moon or planets?

Mr. W. Oh no!—I have put it in my pocket—here it is.

Kenneth. Oh! what a little bottle it is in! May I take the paper off, and untie the cork?

Mr. W. Take care what you do: if this room be very hot, it will burst the bottle; and if the heat were very intense, it would even destroy the whole premises, and alarm the neighbourhood, for miles, with the violence of the explosion.

Amelia. Tom! Tom! don't go near it—I am frightened at the very sight of it.

Mr. W. It is perfectly harmless, so long

as it is moderately cold: it would be quite as dangerous if it were intensely cold.

Ella. Take it away, will you, father? I dare not stay, for the room is becoming hotter and hotter.

Kenneth and *Esther.* Pray take it away—do!

Mr. W. With care, it is very harmless.

Tom. Oh! father, do not untie the string—the heat of your hand may explode it.

Mr. W. There is no danger; this room is neither intensely hot, nor intensely cold, and, without these, it is as harmless as a sleeping infant.

Tom. Where did you procure this terrible and dangerous mixture?

Mr. W. It is indeed a mixture. A portion of it was found, in the form of vapour, when the Nassau balloon passed over Liege; Mr. Auldjo met with another portion on the very top of Mont Blanc; the pearl-divers of Ceylon contributed a part; and the remainder came up with Colonel Pasly's diving-bell, when he was engaged in blowing up the Royal George, at Spithead.

Tom. I wish I durst take it in my hand, and look at it.

Mr. W. You may very safely do so.

Kenneth. I dare believe my father:—here goes. Why, it looks like water!

Amelia. Exactly. I don't believe this would hurt anybody.

Tom. I believe I see you laughing, father. Now, is not there some trick? How could this blow houses down?

Mr. W. Pull the cork out, and taste it.

Ella. Don't, Tom! Pray don't! If you do, I will run out of the room.

Mr. W. Well, if he won't, I will. Give me a glass. How sparkling bright it looks! Dare any of you taste, before I drink it up?

Tom. I dare.

Mr. W. Let us see. What now?

Tom. Why, I believe it is water.

Mr. W. Can water exert such terrible power, when hot, or cold?

Tom. I believe it can: I think I have read that it does.

Amelia. But how could plain simple water come from the clouds about the Nassau bal-

loon, or Mont Blanc, or the pearl-divers, or Colonel Pasley and the Royal George?

Mr. W. I merely meant that it was universal—as a vapour, in the cloud—as snow, on the mountain-top—as water, to the pearl-fisher—and as sea-water, in the diving-bell.

Tom. But we are forgetting the perpetual motion.

Mr. W. So we are. Let us put some water in a flat dish. There is just one ounce, by measure. Let us return to this subject to-morrow morning.

CHAPTER XXV.

PERPETUAL MOTION DISCOVERED AND EXPLAINED, CONTINUED.

Mr. Ward. BRING in the dish, and let me measure the fluid.

Tom. It is all dried up.

Mr. W. And pray what may you mean by "drying up?"

Amelia. That the dish is dry.

Mr. W. But where is the water gone?—it was not spilt, I suppose.

Tom. Certainly not.

Mr. W. Who or what is the thief, and who the receiver of the stolen goods?

Tom. Are the wind and cloud thief and receiver?

Mr. W. They are, indeed. The wind evaporates or steals the water, and it becomes our air: it rises up, helps to form the clouds, is wafted from place to place, by every wind that blows; cloud rushes into cloud, until they can hold no more; rain then falls; it then either evaporates again, or waters and refreshes the roots of every plant and tree.

Tom. But the motion, you said, was perpetual.

Mr. W. And so it is. That which falls upon the ground here, reascends, and is blown to other regions, which it waters; that which penetrates the ground, gives life and vigour to the leaf, which falls, in its turn,

is exposed to the wind, "dries up," as you express it, or, to speak more plainly, parts with its water, and remains a dry and withered leaf. Thus, you see this fluid is ever in motion—restless and turbulent in the sea, slowly stealing away by evaporation, or quietly murmuring in the brook. All this is expressed with such surpassing beauty, by Dr. Macculloch, in his thirty-second chapter on Water, that I cannot resist the temptation to repeat it:—"It is the poet of nature," says he, "who should write the history of water. Familiar, even to neglect, this is a wonderful substance, and we forget to admire; beautiful, and we do not note its beauty. Transparent, and colourless, it is the emblem of purity: in its mobility it is endued with the spirit of life: a self-acting agent, a very will, in the unceasing river, the dancing brook, the furious torrent, and the restless ocean: speaking with its own voice, in the tinkling of the dropping cavern, the murmuring of the rill, the rush of the cascade, and the roar of the sea-wave; and, even in the placid lake, throwing its own

spirit of vitality over the immoveable objects around.

" Its singular oppositions of character are not less striking. Yielding to every impulse, unresisting, even to light, it becomes the irresistible force before which the ocean promontory crumbles to dust, and the rocky mountain is levelled with the plain below; a mechanical power, whose energy knows no bounds. Of an apparently absolute neutrality, without taste, without smell—a powerless nothingness—that deceptive innocence is the solvent of everything, reducing the thousand solids of the earth to its own form. Again, existing at one instant, in the next it is gone, as if it were annihilated: to him who knows not its nature, it has ceased to be. It is a lake, and, in a short time, it is nothing: again, it is that lake, and it is a solid rock. It is rock crystal at one instant, and, in the next, it is invisible; while the agent of its invisibility transports it beyond the earth. Thus sailing the heavens, it descends again, unchanged, again to renew the same ceaseless round: for ever roaming be-

tween the earth and the vacant regions of space; wandering about the earth below, in the performance of its endless duties, and, though appearing at rest, resting nowhere. This, and more, is water: powerful in its weakness, and powerful in its strength: an union of feebleness and force, of incessant activity and apparent tranquillity, of nullity and ubiquity, of insignificance and power—a miracle of creation!" To-morrow we will talk about its dangerous properties, when too hot or too cold.

CHAPTER XXVI.

WHY A CANDLE GOES OUT WHEN WETTED.

Mr. Ward. If I dip my finger in this water, and let a drop fall upon the wick of this candle, now burning in the socket, what takes place?

Kenneth. Why, it spirtles and goes out.

Mr. W. But what makes this spirtling, as you call it? See! see what that single drop of water is doing! it is acting like a pigmy congreve rocket or shell, scattering hot shot in every direction. Look at the top of the candlestick—it is covered with shot.

Tom. I have often tried the experiment, but cannot account for the explosions.

Mr. W. Nothing so simple—nothing so easy; but first let me ask you, Tom, of what is water composed?

Amelia. Why, father?—is water anything but water?

Mr. W. Yes, it is. You recollect, when we talked about breathing lucifer matches, we said one gas was found in coal; and then Tom made some in a tobacco-pipe, and we could see nothing, although, when we put our noses to the pipe, we smelt something very disagreeable; and when we held a lighted candle to it, it burnt with a blue flame.

Kenneth. I remember; for I got a pipe, to make some; but mine would not burn.

Mr. W. Indeed! and did you cover your coal with clay?

Kenneth. No, father.

Mr. W. Oh! you little goose!—why should your gas come up the pipe, when it could, so much more readily, get into the fire? Well, this hydrogen, or offensive-smelling gas, that blows up coal pits; lights our streets; helps to form the jack-o'lantern, or *ignis fatuus;* that causes the balloon to ascend, and is the probable cause of the lightning-flash, is found to compose more than half the water, and all the things made with water, in the whole world—whether that water be hard or soft—from the river or the sea.

Ella. And do we drink that filthy-smelling stuff?

Mr. W. Yes, my dear, and your milk and tea, this morning, were, more than half of them, hydrogen or smelling gas.

Kenneth. Esther—Don't let any of us drink any more milk or tea.

Mr. W. Recollect, before you promise, that every fluid, such as milk, wine, beer, tea, and water, all contain hydrogen.

Tom. I wonder we don't explode!

Mr. W. Hydrogen, you know, burns with

a blue flame: it explodes when mixed with the bright burning gas, called oxygen.

Tom. It is fortunate that there is no oxygen in water. What else is it composed of?

Mr. W. This very oxygen.

Tom. Impossible! Why, when you mixed these two gases in a bladder, and held a lighted candle to it, it exploded with terrific violence.

Mr. W. And that produced what?

Tom. I do not know.

Mr. W. Simple water. When you light an argand gas-light, you will see a fluid on the top, by the side of each hole: this is water, produced by the hydrogen, and the oxygen of the air. In a few minutes the burner becomes hot, and then the heat drives it off as fast as it is formed. Tom, what does oxygen do, and where is it found?

Tom. It composes part of the air we breathe: without it in the air, candles would not burn, and every animal and man would instantly die: it is that part of the air that makes the fire burn, when blown; and it turns sugar and water into vinegar.

Amelia. And so we drink hydrogen and oxygen, when we drink a glass of water!

Mr. W. Ay, indeed you do. If the whole of the water we have drank the last seven days, were put into a red-hot cannon, there would be as much hydrogen as would float a good-sized balloon, and as much oxygen as would have saved the lives of every poor wretch who died in the Black Hole of Calcutta. But enough for this morning. Some other morning we will pursue this subject.

CHAPTER XXVII.

WHAT JACK FROST DID LAST WINTER.

Tom. TELL us, father, how the frost is a worm? and how it ploughs and harrows?

Mr. W. Have you never remarked clayey soils left rough in winter-time, and seen how carefully the new clay-bricks are covered from the frost?

Tom. I have.

Mr. W. Or, what is nigh at hand—the brick wall we built last winter? See, the mortar is gone from the cracks, as completely as if some mischievous boy had picked it out.

Tom. I knew the frost did all this, but I could never have guessed how.

Mr. W. It is by this very law. Both the clay and the mortar had water in them, and were swelled out by the expansion of the water.

Esther. But the worm—what has the frost to do with the worm?

Mr. W. Just remember, for a moment, that every man, every animal, every wheel, press the soil more solidly together. The worm helps to lighten the solid earth, by working its way through—moistening its track with slime. Another, and a larger species of worm, approaches the surface, leaving an opening, through which the water enters: the frost now finishes what the worm began—expands the water in every worm-track, and blows up the surrounding soil, into a thousand powdery fragments. Thus

the worm prepares the mine, the water is the gunpowder, and the frost explodes it; and now it is rendered fit to receive the roots and fibres of every plant and tree, and the sunshine and the rain descend and fertilize, instead of being shut out by solid soil.

Tom. How very singular!—the worm to be a sapper and miner, and the water the gunpowder!

Mr. W. A few years since, at Quebec, a bomb-shell, of immense size and thickness, was filled with water, and, when plugged up with iron, was frozen: it was burst with the greatest ease. But we need not go to Quebec, to see its tremendous power. Every winter shows that, when whole pavements are lifted up, and leaden pipes of great magnitude are burst. There is a fitness, and a beauty, and a perfection in all this, that needs but to be pointed out, to fill us with awe and admiration at the magnitude of the results of this hitherto unconsidered agent. God designed to clothe the earth with verdure; and, to effect this, he employs water as the prime agent. By water, the soil of the hill is

carried into the valley. By water, swollen into ice, the slaty rock is shattered, and becomes penetrable by the roots of the mountain tree. The worm now takes up the business, and pierces the soil with a thousand holes; into these the water enters, is burst by frost, and renders it fit for the growth of every plant and every tree.

Tom. Thank you, father. We do really thank you. But you said the water was a coverlid to keep fishes warm.

Mr. W. Have we not as much as we can well remember, this time? Come, Tom, you know a very pretty piece of poetry: when you learnt it, you little thought it would ever be used for the present purpose: it is by Miss Gould.

The Frost look'd forth, one still clear night,
And he said, "Now I shall be out of sight;
So over the valley and over the height,
In silence I'll take my way.
I will not go on like that blustering train,
The wind and the snow, the hail and the rain,
Who make so much bustle and noise in vain,
But I'll be busy as they!"

Then he went to the mountain, and powder'd its crest;
He climb'd up the trees, and their boughs he dress'd
With diamonds and pearls; and over the breast
  Of the quivering lake he spread
A coat of mail, that it need not fear
The downward point of many a spear
That he hung on its margin, far and near,
  Where a rock could rear its head.

He went to the windows of those who slept,
And over each pane, like a fairy he crept.
Wherever he breathed, wherever he stept,
  By the light of the moon were seen
Most beautiful things. There were flowers and trees,
There were bevies of birds, and swarms of bees—
There were cities, thrones, temples, and towers! and
    these
  All pictured in silver sheen.

But he did one thing that was hardly fair:—
He went to the cupboard, and, finding there,
That all had forgotten for him to prepare—
  "Now, just to set them a thinking,
I'll bite this basket of fruit," said he;
"This bloated pitcher I'll burst in three;
And the glass of water they have left for me,
  Shall tell them what I am drinking."

CHAPTER XXVIII.

WHAT JACK FROST DID LAST WINTER, CONTINUED.

Esther. Oh, father, do tell us what Jack Frost did last winter!

Mr. W. He did so much, that I can only remember a part of it. Sometimes he was with the worm, sometimes with the mole, throwing up earth; at another time, he was a coverlid to keep the fishes warm. He ploughed and harrowed the land, and made it as powdery and fine as our gardener's flower-beds.

Amelia. I thought all Jack Frost did was to freeze the rivers, that we might slide, and boys skate.

Mr. W. Ah! your Jack Frost is a pitiful fellow, with an icicle at his nose, having woollen mittens on; mine is a giant, clad in a coat of icy mail, leaping from crag to crag.

One moment he topples over an avalanche of snow; in another, he bursts asunder mighty fragments of rock, and hurls them into the valley beneath.

Tom. This is more wonderful than all the other wonders. I wish I could understand how it does this.

Mr. W. Nothing more simple and easy, if we go step by step, and begin at the beginning—the best rule I can lay down for understanding anything thoroughly. You know what water is?

Ella. Oh! yes—water is water.

Tom. But water is composed of two gases—hydrogen and oxygen.

Mr. W. Thank you, Tom. But, for our present purpose, a lady's definition is better—water is water. At what temperature does it boil and freeze?

Tom. It boils at two hundred and twelve degrees, and freezes at thirty-two.

Mr. W. We have nothing to do with the boiling. Here is a long tapering ale-glass: fill it with boiling water; put it in a basin of cold water, to cool it. What do you see?

Ella. Oh! it is not quite so full.

Tom. Let me put some colder water to that in the basin. See! it falls still more rapidly.

Mr. W. There you see, that, as water cools, it takes up less room.

Tom. So that, the colder it becomes, it becomes less and less bulky. I should think the cold acts by making the particles go nearer to each other.

Mr. W. If this were true—if water did really occupy less space the colder it grew, England would become as cold as Greenland; the rivers and lakes would become solid masses of ice, and the tides would rise higher and higher—one huge unthawed iceberg.

Tom. Well; but father, you see it is so. Look at the ale-glass—it is not full; therefore, cold water fills less space than hot.

Mr. W. Down to a certain temperature it certainly does; but woe betide us all, if it lessened in bulk below that: nor furs, nor stoves, could keep us warm.

Amelia. How tiresome you are! Why don't you tell us what difference it would make?

Mr. W. Difference! Miss? Why, a mighty difference. Pray, does ice sink or swim?

Kenneth. It swims. At Mepal Bridge, last winter, the ice swam down in such large masses, that it knocked down the guide-posts.

Tom. And in Parry's voyages, the vessels were nearly crushed by floating icebergs.

Mr. W. Suppose ice sank to the bottom, as it was formed, what then?

Tom. All our lakes, and rivers, and ponds, would become masses of solid ice—which the sun of the hottest summer could never thaw.

Mr. W. Now, this is all owing to this simple law in water:—that is, that water grows less and less in bulk, until it is eight degrees above the freezing point, viz. forty degrees; it then increases in bulk as it becomes colder, so that a pound of water at thirty-two degrees is more bulky than a pound at forty degrees, and it therefore swims at the top.

Tom. Well, this is beautiful! But you say it is a worm.

Mr. W. We will talk of that, to-morrow.

CHAPTER XXIX.

WHAT CAN BE SEEN UNDER A DISH-COVER.

Mr. Ward. You remember, Amelia, when we took the covers off the meat and pudding, yesterday, how much water ran out of the cover over the pudding, and how little from that over the meat?

Amelia. I remember it well; but I cannot tell why.

Mr. W. You have seen the spangled dew-drops upon the rose-leaves, early in the morning; they may also be seen, but not so plainly, on the grass—scarcely at all on a wooden fence, or a door, or a window-frame: the cause is the same, whether in-doors, with the meat-covers, or out of doors, with dew.

Amelia. When I held the inside of the cover up, it was very much like dew.

Tom. Tell us, first, why one cover had more dew or water in it than another.

Mr. W. The meat-cover was hot, when put upon the meat—the one over the pudding, cold from the shelf.

Tom. And when the moisture was flying off, in the form of vapour, the cold cover condensed it into drops like dew, just as the cold air does the breath on a pane of glass.

Mr. W. And the hot one did not condense it. I have told you before, that all the moisture that falls upon the earth, either sinks into it, or rises up into the clouds: in a cold night this vapour descends. There is a beautiful contrivance for catching it, and converting it into drops of dew, so large as to answer the purpose of rain.

Tom. I have read of dew, but I never saw anything about this contrivance.

Mr. W. It has been proved by philosophers, that all vegetables and grasses become several degrees colder in the night-time, than the surrounding objects. In a damp night, everything is surrounded with water, in the form of mist or vapour; and it falls upon tiles, and stones, and earth, as it did upon our cover that was warm; but the grasses

and plants being, like the other cover, cold, it falls upon them in great abundance.

Tom. In countries where rain seldom falls, the dews are very abundant.

Mr. W. How wise and how good is the Creator! By this simple law, each plant and leaf has the power of drawing water from the air that surrounds it, by which its life is preserved. I often think, that more special care has been bestowed upon vegetables, than upon animals. I have told you how, in one case, the seeds are furnished with wings: in another, they are covered with a husk or shell; in another, surrounded with a glutinous substance, to enable them to adhere to some rock in the midst of the ocean. All this is wonderful; but that the simple power of becoming colder than the air and earth, should be the means employed to water and nourish vegetation, in the midst of a parched and sandy desert, should not only fill us with wonder, but with a constant feeling of thankfulness.

CHAPTER XXX.

THE WOUNDED FINGER.

Mr. Ward. WHO has broken this pane of glass? There is blood, too, upon the pieces of glass. Where is the wounded man?

Kenneth. I broke it, father, and cut my finger.

Mr. W. Who has been the doctor?

Tom. We allowed it to bleed, and, when the blood was dry upon it, we bound it up with linen cloth.

Mr. W. Is it quite easy?

Kenneth. Quite so.

Mr. W. And do you expect it will heal, without plaister or dressing?

Kenneth. It is quite easy, and I think it will heal.

Mr. W. And I hope so. Do you think there is any glass in it?

Kenneth. Oh! we never thought of that.

Mr. W. The whole process of healing a wound, or repairing an injury, is so very beautiful, that we will seize the present opportunity of talking about it. We have often seen beautiful clock-work and machinery, and we have wondered how it could be made to work; but who ever saw a machine, that, when wounded, can heal itself up; or when shot, can extract its own bullet—all its own inward machinery going on at the same time?

Tom. Oh! do tell us about it.

Mr. W. If Kenneth prick his finger with a pin, what happens?

Tom. It bleeds.

Mr. W. It bleeds, but it hurts him first—first pain, and then blood. What does the pin touch, to give him pain?

Tom. A nerve.

Mr. W. Right. The body is all over nerves, and all the nerves go to the brain. If there were parts of the body without nerves, or without feeling, a man might have his nose cut off, or his ears notched, in his

sleep, and know nothing about it till he awaked. One use of nerves is to give intelligence to the brain, when a part is wounded.

Tom. And what is the blood for?

Mr. W. The first use of the blood is to wash the wound out—the second, to glue it up; and the glue of the blood is the most wonderful matter in the world. Just let us look at Kenneth's finger.

Ella. Let me untie it.

Mr. W. Do not displace the blood.

Ella. Why not?

Mr. W. Because it binds the two edges together, and forms a covering, to keep the air and dirt out. Suppose the glass had cut a piece out—what then?

Tom. It would have been painful, and bled.

Mr. W. In a case like this, the doctor would wash the blood off, and put a poultice or plaister on—for which he would be a great simpleton. Two or three hundred years since, wounds were managed better than they are now.

Tom. I thought I had often heard you say, the treatment was more rational.

Mr. W. Ay, so I did. Fifty years since, every wound was filled with lint; and the old women now, love to put a piece of tobacco, or a little salt, or cobweb, or what they call fuz-ball. Now, every wound is closed with plaister; but Sir Kenelm Digby's mode was the most rational. He would have bound Kenneth's finger up in the blood, and applied several very nice dressings to the pieces of glass: this he would have done daily, until a week had elapsed—and then the finger would have been cured.

Amelia. And would it not, if he had left the glass alone?

Mr. W. That is a matter requiring consideration. My own private opinion is, that it would.

CHAPTER XXXI.

HARD AND SOFT WATER.

Amelia. No rain again! What are we to do for soft water?

Tom. You must make it soft, with soda or potash.

Ella. What is soda or potash?

Mr. W. Burn sticks, and the ashes will be potash. Soda is found almost all over the world, in the greatest abundance. But the real potash and soda are bright and shining metals, like quicksilver, buried in the bowels of the earth, probably in immense quantities, and, like the imprisoned genii, doomed to remain there for ages to come.

Tom. Do these metals never see the light?

Mr. W. Not as metals, unless they are shut up in the naptha we burn in lamps. The moment they are exposed to the air, or

water, or ice, they burn with a bright light, and turn to potash or soda.

Tom. How very extraordinary!

Mr. W. If I should say that these metals (potassium and sodium) are the probable causes of the soil being productive—if they are not the chief causes of the soil itself—and that they are the great agents in placing the iron and the gold, the silver and the copper, in places where man can reach them —you would not believe me.

Tom. Oh! yes, we would believe you, because you understand these things, and have already told us things quite as astonishing.

Mr. W. What do you think is the first thing required, to make a country fruitful?

Ella. Rain?

Amelia. A good soil?

Mr. W. Both are requisite, and both are, in a great measure, probably, dependant upon the action of these metals.

Tom. How can metals, buried in the depths of the earth, produce rain and soil?

Mr. W. You have seen me put gunpowder in a gun-barrel: the moment the spark

touches the grains of powder, they take fire, and the shot is driven out with violence. What drives the shot out?

Tom. Each grain of gunpowder is converted into an air or gas, many thousand times more bulky than itself. One of two things must happen—the shot must fly out, with deadly force, or the gun-barrel must burst.

Mr. W. Now, if water finds its way into these masses of potassium and sodium, what takes place?

Tom. The water acts as the spark did to the gunpowder—causes them to take fire.

Mr. W. What becomes of the water? The metal seizes hold of the oxygen of the water, leaving the hydrogen, or inflammable gas, ready to explode, which it instantly does; the sulphur and the bitumen continue to burn with a smouldering heat: this constitutes the grumbling and agitation of the ground, which is, in fact, the earthquake. By this, rocks are rent asunder, more water is poured in, until, at last, the potash and soda, the brimstone and the granite, with

bitumen and sulphur, are driven, like the discharge of ordnance, through some vast rent, and fall in the vicinity: this is the volcano. More and more water is supplied, fresh earthquakes are felt, fresh showers of burning matter are thrown out, the crater becomes more and more enlarged, and the surrounding flat country elevated. In a few ages this volcano becomes a mountain, like Vesuvius or Ætna, and the sodium, the potassium, the barium, the calcium—all being exhausted, it becomes an extinct volcano; in other words, a mountain;—which we will talk about another day.

CHAPTER XXXII.

WHAT THE MOUNTAIN DID.

Tom. I CAN hardly think all you said about the mountain can be true.

Mr. W. Why? you young Pagan—why?

Tom. It seems to me incredible that the streams of water should bring soil, and leaves, and twigs down from the mountain, in sufficient quantity to cover the desert soil.

Mr. W. A Cockney, or a "High-country boy," might doubt the truth of this; but, for a regular fen-born boy, with this very soil, and leaves, and twigs under his nose, to doubt, is most wonderful!

Tom. What do you mean?

Mr. W. When I was a boy, whenever an old lady wanted some specially rich soil, for a geranium or a balsam, I brought her a fine black-looking soil from an old hollow willow-tree. When I came into the fens, I lifted up my eyes with astonishment at the sight of the black fen earth: it was precisely like that from my old willow-tree.

Tom. But they could not be the same.

Mr. W. I thought they were, then; but I am sure they are, now.

Tom. The soil in the willow-tree must be woody. How can the fen soil be so?

Mr. W. Remember all I said about the

mountain, and its rain-cloud, and its torrents and streams. At one period, perhaps remote, Cambridgeshire might be a desert and barren waste; but the hills of Northamptonshire and Buckinghamshire poured down their waters, richly laden with leaves and twigs, upon the low-lands, until, at last, a crust of peaty, woody earth was formed, in many places, several feet deep. As these waters subsided, or scooped out for themselves river channels, or were aided by the hand of man, in their journey to the sea, they covered the land with a rich black fertile soil, exceedingly productive.

Tom. I must believe this to be true, for I have seen it; but, in the midst of this fen soil there is found clay, or a sort of sea-mud.

Mr. W. This is easily to be accounted for. When the earlier waters had covered the land, their approach to the sea would be crooked and twisted. At some part of the year, when the tides are very high, they would drive back the upland waters, and inundate the land with sea-water, which, in

its turn becoming stagnant upon the land, would deposit sea-mud or clay.

Tom. Is this the clay that is dug up, and brought to the surface?

Mr. W. The very same. When the fen soil at the top is exhausted, by bringing up some of the clay, and scattering it on the surface, the soil is more productive than ever.

CHAPTER XXXIII.

WHAT THE MOUNTAIN DID, CONTINUED.

Mr. Ward. BEFORE we talk of converting burnt-out volcanoes into mountains, let me ask you if you know, that one of the most fertile countries in the world, Sicily, is entirely volcanic, and that the most productive soil of France shows that it is the product of volcanic action, myriads of ages since?

Tom. I did not know that; but I always before thought volcanoes terrible things.

Mr. W. Wiser men than you, Tom, have thought earthquakes and volcanoes marks of God's displeasure. I quite agree with Sir W. Hamilton, in thinking "subterraneous fires to be the great vehicle used by Nature to extract virgin earth out of the bowels of the globe, and repair the exhausted surface." Now for the mountains. Instead of living in happy England, suppose we were in the midst of the great desert of Zahara, what would you wish for?

Esther. I should wish for a nice horse.

Mr. W. But there would be no grass to feed him upon.

Ella. I should like a fine house.

Mr. W. There would be nothing to build it with.

Kenneth. I should like a camel, to ride all over the desert.

Mr. W. That would do for a day or two; but a camel would want food and water.

Amelia. I should wish for plenty of apricots and grapes.

Mr. W. You all forget it is a desert, where nothing could be had but what Kenneth fetched on his camel.

Tom. I should wish for a full and brimming river, that would overflow its banks, and make the desert fertile.

Mr. W. This is as impossible as the other wishes.

Ella. Now, father, it is your turn—you shall wish.

Mr. W. Let me see. Oh! I should wish for a mountain, as high as Chimborazo, in the midst of the desert; and if Chimborazo would bring a volcano, the size of Ætna, so much the better.

Amelia. Nonsense! father; what could a mountain do in the desert?

Mr. W. Do! my dear—it would convert this wild and desolate region into smiling and happy valleys. On its sides would flourish the vine and the fig-tree, and, at its foot, would be abundance of corn and oil.

Tom. How would Chimborazo set about this work?

Mr. W. Firstly, by attracting all the rain-

clouds that came near; and then, by thrusting his lofty head into the midst of them, rob them of their rain. This rain would rush down the sides of the mountain into the valley, where it would cut out for itself a channel; this would become a river; more and more rain-clouds would be attracted; more rain would fall; the desert would become flooded with water.

Tom. But what good could the water do the land, if it covered it?

Mr. W. Every gallon of water that ran down the mountain-side, would carry with it soil or dead leaves, and twigs of trees, or rock shivered into dust by frost: this would rest for ages on the land; and when it had overran the whole desert, and had covered the dry and arid sands with the richest soil, it would run off to the nearest sea, and leave the high lands, near the foot of the mountain, dry.

Ella. Then you would build us a house near the bottom of the mountain?

Mr. W. If we are still to wish, I would; but ages and ages must roll over our

heads, before man could inhabit the desert.

Tom. I always thought mountains were like the warts on my hand—ugly and unsightly things; but now I see they are grand instruments in the hands of Him who made the heaven and the earth, for making the earth fruitful, and man happy.

CHAPTER XXXIV.

CORKING THE KETTLE-SPOUT UP.

Mr. Ward. Tom, have you brought the small cork I told you to bring?

Tom. Yes, father; here it is.

Mr. W. Put it in the kettle-spout.

Tom. Why, it blows it out again, as soon as it is in.

Mr. W. You did not half press it in. Hold it fast—press with all your strength.

Tom. See there—the lid is blown off!

Mr. W. Blown off! How is this?—nobody has put gunpowder into the kettle!

Ella. I am sure there is nothing but clean water; I saw it put in.

Mr. W. But, is it not very extraordinary that simple, clean water, should blow the kettle-lid off?

Tom. Not at all, father. When you told us about the expansion of cold water below forty degrees, we wondered, because we could not think ice was more bulky than water; but there seems no reason to doubt, that the hotter water becomes, the more room it takes up.

Mr. W. How does the heat of the fire do this?

Tom. By expanding it.

Mr. W. We know that; but how?

Tom. By driving the particles of steam farther and farther asunder.

Mr. W. Precisely. The moment the particles of a drop of water become steam, they occupy eighteen hundred times as much room as they did before.

Tom. And press the lid eighteen hundred times more forcibly than water.

Mr. W. Its force is altogether irresistible. If this kettle were composed of iron, an inch thick or more, if steam could not escape, it would burst it with ease.

Tom. Is that the reason why steam-boilers burst?

Mr. W. It is one reason, but not the principal one. If all the water in this kettle were all boiled out, and it was full of steam, and we corked it tightly up, and soldered the lid down, and still kept the fire blazing fiercely about it, it would burst at the weakest part: perhaps the lid would fly off, or the side burst: the steam would rush out, and, if we were very near, we might be scalded.

Tom. Then, when a boiler grows old and thin, if the pressure is very great, it bursts in the weak part?

Mr. W. Just so; and ingenious men have made some portion of the boiler of a weaker metal—so that, if it burst from the pressure of the steam, it should hurt no one.

Amelia. I cannot understand what you mean.

Mr. W. You see this kettle on the fire:—if we cork up the spout, and fasten the lid down, and let it boil, it will, probably, blow the cork out, and hit some one of you; but if, at the back part of the kettle, that touches the chimney, we have a part of it made of lead, or tin, it will explode there.

Amelia. Oh! I see now.

Tom. But, father, this cannot account for the tremendous explosions, by which the boiler itself is thrown a great distance, and even factories are blown down.

Mr. W. I think not. I will try to make you understand this, to-morrow.

CHAPTER XXXV.

CORKING THE KETTLE-SPOUT UP, CONTINUED.

Mr. Ward. I NEED not tell you, who read newspapers, of any particular accidents from steam-boilers bursting. There is hardly a week without an accident. Bring us in the kettle again.

Tom. It boils, and the steam is escaping from both lid and spout.

Mr. W. You recollect, I dare say, when we explained what the little explosions* were, that were heard when the red-hot wick of a candle was wetted?

Tom. O yes—perfectly. The water, you told us, was composed of two gases—oxygen and hydrogen—and that the heat of the candle converted the drops of water into these gases.

* See " Why a Candle goes out when Wetted."

Mr. W. Quite correct: and I also explained, that whenever oxygen became mixed with hydrogen, and a light was applied, the explosion was loud and violent.

Amelia. I recollect well, being stunned by the explosion of a bladderful of oxygen and hydrogen.

Mr. W. Well, I believe steam-boilers burst simply from the pressure of steam; but when lives are lost, and pieces of the boiler are hurled with the violence of artillery, I believe that the same thing takes place as when a drop of water falls into a candle.

Tom. This might happen if the boiler was nearly empty, and the fire very fierce; but how could it happen when water was in the boiler? If there was only a table-spoonful of water left in the kettle, it would boil away, or be turned into steam.

Mr. W. All very good; but I believe it is not the water that is turned into these exploding gases, but the heated steam. You know the water is never hotter than two hundred and twelve degrees; after this, it becomes steam.

Tom. And, what is very wonderful—the water keeps the kettle bottom from becoming hotter than itself.

Mr. W. But steam may be heated up to almost any height. In Papin's Digester, which is only a steam-kettle, with enormously strong and thick iron sides, the steam will rise to the height of six hundred degrees —a heat that converts solid bone into jelly.

Tom. I think I see it:—so long as there is water in the kettle, the bottom cannot become red hot; but there is nothing to prevent the sides, if the fire be fierce enough.

Mr. W. Certainly not.

Tom. Then why may not the red-hot side of the kettle convert the steam into hydrogen and oxygen, and, at last, having filled the boiler with this decomposed water, it glows with a heat sufficiently intense to explode hydrogen? And, when I remember the violence of a small bladderful, when I fired them, I could believe the explosion of a boilerful would be tremendous.

Mr. W. And so could I; and I firmly believe this to be the chief cause. Notwith-

standing all these accidents, and all this power, it has done for man what no other agent ever has equalled. It is his patient, unfed, untiring slave—requiring neither wages, nor food, nor raiment: of power sufficient to overturn a mountain, and yet sinking, powerless, into utter nothingness, at the touch of a little cold water.

CHAPTER XXXVI.

OF A MAN WHO COULD NOT BE BAKED.

Mr. Ward. Do you remember, I told you that a living frog would be uninjured in the human stomach, but that a dead frog would be destroyed and digested?

Tom. We recollect perfectly well.

Mr. W. What was the reason why the juice of the stomach could not destroy a living body?

Tom. Because it was alive.

Mr. W. We will talk, to-day, of another power given to the live body, still more wonderful. If you were to put a sucking live pig in the oven, when heated for baking, he would not suffer much, if you put flannel socks on him, to prevent his toes touching the hot bricks; but if you were to put him in when dead, his skin would turn brown and crackly.

Amelia. A pig, perhaps, might walk round our oven, when hot, but I am sure I could not.

Mr. W. It is well you are not one of the oven-girls of Saxony, who are sent into ovens, where they have to endure, for a short period, a heat of three hundred degrees—eighty-eight degrees hotter than boiling water.

Tom. Did not Dr. Fordyce stay, some time, in a room heated to two hundred and sixty degrees?

Mr. W. Yes; and the lock of the door, and his keys and watch, lying on the table, could not be touched—an egg became hard. Notwithstanding this great heat, when a

thermometer was put into his mouth, it was found to be less than a hundred degrees—only two or three degrees hotter than ordinary.

Ella. How is it?

Mr. W. You have seen a hare roasting?

Ella. Oh, yes—many times.

Mr. W. Did you never remark, that as long as it is basted with hot water, it does not roast nor burn?

Ella. I know it does not.

Mr. W. Well, this is the great secret. The Saxon girls, and Dr. Fordyce, were bathed (or basted, if you like it better) with perspiration; it ran down in streams from every part of the body: if any part of their bodies had been covered with varnish or glue, that part would have burnt, because it could not sweat.

Tom. How admirable!—how beautiful! From all I see, I learn this truth—that all God's contrivances are simple—all man's complicated, and difficult to be understood.

Mr. W. It is ever so. By the simple apparatus for covering the body with moisture,

man becomes, literally, a citizen of the world. Bring the elephant, or the lion, or the ourang-outang from their homes, and, under the greatest care and nursing, they die from cold; they were never designed to roam from clime to clime; and, by being unable to bear cold, they are kept at home, as securely as if walled in. But man and plants were designed to inhabit every zone—the latter needing some acclimating—man infinitely less. Born in the desolate snow-hut, the Esquimaux can bear the scorching sun of India; and plants that bloomed, stunted and dwarfish, half a century ago, in the conservatory and green-house, now blossom and fruit in the open air. But His goodness ends not here: He has given to man the power of improving the climate in which he lives. The climate of the cold and cheerless prairie-home of the red man, has become improved under the axe and the plough of the white.

CHAPTER XXXVII.

OF A WOUNDED MACHINE THAT EXTRACTED ITS OWN BULLET.

Mr. Ward. When I lived at Nottingham, many years since, I went to see two automata flute-players; their fingers rose and fell as the notes varied; and, that the sound was produced by their breath, was proved by placing a card before their respective lips, when the playing instantly ceased.

Tom. They must have been exquisite specimens of machinery.

Mr. W. They were, indeed. I have, since then, thought if I had fired a pistol through the cheek of the one, and the fingers of the other, how long they would have continued playing, and what steps would have been taken to extract the balls.

Tom. It must have stopped the machinery altogether.

Mr. W. Ay; and cunning men must have been brought from afar, to take the complicated machinery to pieces; and, perhaps, when they had done all this, it would never have played the tune accurately again. Now, I know a piece of machinery that can be shot through and through, and all its beautiful mechanism still keeps going; and, what is more wonderful is, that, by a process peculiar to itself, it can extract its own balls—the balls with which it was shot—without the aid of a doctor!

Amelia. Do, pray, tell us if we can see this machine anywhere.

Mr. W. The cost is a mere trifle. In fact, you may see it in all its beauty, for nothing.

Ella. I wish it would come here! I would give anything to see it. Can it play any tunes?

Mr. W. Tunes! Very small machines of the same sort are to be seen in large towns, that can whistle, with great accuracy, a very difficult overture, or several airs from the last opera.

Kenneth. When will it come here?

Mr. W. It has been here some time.

All. Has been here! Where? Where?

Mr. W. I have met it in the streets, many times.

Amelia. Met it in the streets!

Mr. W. Yes, Miss—met it, and talked with it; and a very sensible machine I found it, too.

Tom. I really believe you mean us—the human body.

Mr. W. I do; and I know no machine so perfectly fitted for its work—so beautifully adapted for its end. Talk of your flute-player, playing, perhaps, three tunes!—I will bring you a boy that shall play you thirty, with no other clock-work than his lips and tongue. He shall forget these, and learn thirty others—a rather difficult task, I guess, for your automata.

Tom. But supposing your machine was shot, what would happen?

Mr. W. Well, supposing the ball entered a fleshy part, the first process would be to surround it with blood, which would glue it to all the neighbouring parts. In many

cases, having formed a pouch of this sort for itself, it would remain there for years; but in others it takes a different course: the inside of the pouch, containing the bullet, becomes filled with a fluid, which distends it more and more, until it bursts, and the bullet drops out.

Tom. And what becomes of the opening, and the pouch?

Mr. W. They grow together, and every part is as useful as before.

CHAPTER XXXVIII.

WHY A ROTTEN APPLE IS BITTER.

Mr. Ward. How many of these apples and pears are decaying! You should shut your eyes when you eat them, and then you would not see the rotten parts.

Esther. But it is so very bitter!

Mr. W. Bitter! why should a rotten apple be bitter?

Amelia. That we may not eat it.

Mr. W. And why should you not eat it?

Tom. Because we should spoil the seeds.

Mr. W. And so you believe that apples rot, and become bitter, so that some, at least, may be thrown away, and, when they reach the ground, may become trees of new species and varieties.

Tom. It seems to me to be reasonable.

Mr. W. And so it does to me, although it never struck me before. And, now I think of it, we see something of the same sort in the seed-stalk of some of the grasses.

Tom. I have read that the seed-stalk is bitter, and I have seen that animals invariably reject them.

Mr. W. This is only one of a series of wonderful modes of preserving seeds. If the apple and pear did not quickly rot, they would all be eaten, either by man or beast, and God's great design of covering the earth with flowers and fruits would be frustrated.

Tom. It seems to me that the seed of the

apple is covered with such a delicious covering, that man may be induced to carry it from place to place, so that the seeds may be dispersed over the world.

Mr. W. The flesh of the apple is tempting, that it may be eaten; the seed is surrounded with a core, that it may be rejected. It is necessary that the fruit should decay, that the seed may grow. Did you ever think, Tom, of the many things that make fruit decay?

Tom. Let me remember—Frost shall be first, for he destroys apple-life wholesale. The next is a bruise or hurt.

Mr. W. In what manner are ripe apples like old men?

Amelia. Because they are wrinkled.

Ella. Because their skins are rough.

Mr. W. Neither one nor the other. If you bruise or injure an old man, he may recover slowly, but more frequently dies. If you injure a young one, he soon gets well: it is just so with apples and with pears.

Tom. Did you ever watch a young apple when it was bruised?

Mr. W. Look into this basket of apples. Almost every apple has either a black spot or a red one upon it: these are the scars of wounds and bruises, received when young. Here are others with fresh bruises upon them, and they will decay in a few days.

Tom. What does this prove?

Mr. W. It proves this—that the great object in causing the apple-tree to blossom and bear fruit, has been the preservation and ripening of the seed; that, until the seed is ripe, the apple is hardy, and cares nothing for all its knocks and thumps; that, when ripe, there is a grateful juicy fruit, to tempt man to carry the seed to other climes; but, by an inevitable law, it must be consumed or thrown away—which is only another name for sowing the apple-seeds.

CHAPTER XXXIX.

SOWING SEEDS.

Mr. Ward. SINCE last evening we have received a present of cocoa-nuts.

Ella. What can be the use of a cocoa-nut?

Mr. W. If you had been shipwrecked upon some desolate island, where there was nothing but cocoa-nuts, you would be thankful for a nut that would supply you with food and drink. To me, there is no tree more wonderful than this.

Tom. Was not the cocoa-nut tree one of the first trees found to grow upon the newly emerged coral island?

Mr. W. If by newly emerged you mean the coral island that has just raised its head above the water, I say yes.

Tom. How could it get there? No bird could carry it.

Mr. W. Are you sure of that?

Tom. Yes—quite sure.

Mr. W. Well, then, suppose it swam there. It seems beautifully formed for swimming. Had the nut been solid, it might, and probably would, have sunk to the bottom; but, being hollow within, it swims like wood. There is another contrivance for conveying seeds from place to place, so unexpected, that I could hardly bring myself to believe, until I saw it; and that is the wrapping up of the sea-seeds in a sort of glue, that cannot be dissolved in water.

Tom. Why is this glue placed around them?

Mr. W. For two purposes. One, to make them stick to every object they come near, but specially to enable them to be transported from one ocean to another, at the bottoms of ships.

Tom. Did not Sir H. Davy invent something to prevent the salt water corroding the copper bottoms of ships?

Mr. W. He did; and he saved the copper, but he would have sunk the ship.

Tom. How could that be?

Mr. W. All ship bottoms are troubled with adhering matters; but the noxious nature of the copper kept many from growing to it. When the great chemist had prevented this, immense masses of this jelly clung to the bottom, and would soon have rendered her unable to sail.

Tom. Do not some seeds pass through the stomachs of animals?

Mr. W. Oh, yes, and pass without injury. You are able now to tell me, how it is they are not digested and destroyed.

Tom. Because they are alive—the stomach-juice cannot attack anything having life.

Mr. W. Another mode of carrying seeds is by hooks, which cause them to stick to the clothing; and there is another, more extraordinary still.

Tom. There can be nothing more extraordinary than these just mentioned.

Mr. W. It is now a quarter of a century since I felt how some seeds were sown.

Amelia. Felt seed sowing!—Did a cocoa-nut fall upon your head?

Mr. W. No; but I was sitting upon the top of a high hill in Yorkshire, in the midst of many acres of broom; as the sun shone brightly, the pods were bursting every minute, and, as I stood up to listen, now and then I was hit by one of these flying shot.

CHAPTER XL.

WHO FILLED THE COAL-HOLE?

Amelia. I HAVE got a curiosity. Who can tell me where it came from—from air, or earth, or sea?

Tom. Let me see it. Oh! I know it came from the bottom of the sea.

Amelia. That it did not, Master Tom. With all your knowing, you are wrong this time;—it came out of the fire, last night.

Ella. I know it did, for I heard a great noise in the fire, and this piece flew out.

Tom. I still say it came from the bottom of the sea.

Amelia. Father, will you look at this piece of something, that Ella has picked up, and tell us where it came from?

Mr. W. About sixty thousand years ago—it might be more or less—this little fragment was carried by fresh water into the salt sea, or inland lake.

Tom. Sixty thousand years! Why, father! the earth is but six thousand years old.

Mr. W. Prove that, my learned Theban.

Tom. Were not Adam and Eve created six thousand years since?

Mr. W. The Bible tells us so, and I believe it.

Tom. Well, then, five days before that event, the earth was formed, with all its birds, and beasts, and fishes.

Mr. W. No one has a greater reverence for that sacred book than I have; and until Cuvier, and Sedgwick, and Buckland, published their books, I believed, as you do, that the earth was but six thousand years old. God could have created it in a second;

but I think, that an examination of the different strata, as they are called, proves that he did not. So much for the age of your curiosity, Amelia. Let us see what we can make of it. The outer portion of it is a sort of white cinder—the centre, unburnt coal. It is about an inch thick. Examine the edges closely, and tell me what you see.

Ella. It looks like the leaves of a little book.

Tom. May I try if it will split with my penknife?

Mr. W. Certainly. But do it carefully.

Tom. It splits beautifully. I can divide it into scales, as thin as writing-paper.

Mr. W. What does that prove?

Tom. That it was slowly deposited.

Mr. W. What makes you think so?

Tom. Last year, when we dug our turf, I saw this very thing, and you told me that it was owing to the vegetable matter being slowly deposited.

Mr. W. Before we proceed, fetch up a piece of the said turf: there are some in the cellar, wet—they will show it best.

Tom. Here is one.

Mr. W. Now, you all know that this was dug out of the earth.

Ella. We saw it.

Mr. W. And you know this turf is composed of twigs, and leaves, and flags, and branches of trees.

Ella. Oh yes: I have seen them a thousand times.

Mr. W. Now, Tom, try to split this turf this way.

Tom. It will not split.

Mr. W. Then try the other way.

Tom. I can pull it into thin plates, and with my knife I can divide it into very thin sheets.

Mr. W. Now, Amelia's "curiosity" is composed of vegetables, similar to this piece of fen-turf.

Tom. Then all coal is vegetables.

Mr. W. Not all. Bring me the microscope. Let us examine a layer. Oh! how very beautiful! I can distinctly trace the veins of a leaf.

Ella. Oh! let me see!—do let me see! I can see little twigs.

Mr. W. Having proved it to be partly vegetable, the next question is, how it was carried to its bed? Kenneth, what carried my turf into the Isle of Ely?

Kenneth. Nobody—it grew there.

Mr. W. Not much of it. Some reeds and flags grew through it, but the great bulk was carried there. Guess again.

Kenneth. Was it water?

Mr. W. It was. Time was, when England was one vast forest. Every leaf and twig that fell was floated by the mountain torrent, to the nearest sea or lake. The Isle of Ely, being low, had large quantities of these dead vegetables brought to it every winter. How it came to pass that it kept them there, shall be told you at our next meeting.

CHAPTER XLI.

WHO FILLED THE COAL-HOLE? CONTINUED.

Mr. Ward. THERE are certain parts of England, called Fens, or Lowlands. What do you understand by Fen?

Tom. The low part of a country, through which water from the higher land runs.

Mr. W. Your definition is good, but not very good. "A low part, through which water runs from the higher lands," is a better definition of a large river than a fen. Try again.

Tom. A fen is the natural channel for the overflowings of rivers, or, in other words, for floods.

Mr. W. That will do. Now, when the autumnal frosts have killed the leaves, and the winds have blown down the rotten twigs, the coal begins to run down the hills by a thousand little streamlets.

Amelia. Oh! what nonsense!

Mr. W. Thank you, Miss: it is not the first time my sense has been called nonsense. I repeat it—when the leaves fall, and the rains come down in torrents, then the full and brimming river runs over, and the coal begins its travels.

Ella. Then the coal does not grow in the coal-pits?

Mr. W. No, Ella. This piece of coal grew on a tree.

Kenneth. Coal grow on a tree!

Mr. W. Yes, grew on a tree—at least, a good part of it: and this piece of turf also grew on trees: but, as our coal has commenced its travels, we must sail down with it. Where do you think the greatest supply of coal came from—from the mountain or the valley?

Amelia. From the valley.

Ella. From the mountain.

Mr. W. Ella is right: it is almost wholly from the mountain-forests. Tom, tell me why?

Tom. Because the leaves of the trees in

the valley remain where they fall, sheltered from the roaring wind, and untouched by the mountain cataract.

Mr. W. Very true, but rather fine. It requires a strong and rapid current to carry twigs, and branches, and leaves; and, as the streams of a valley are sluggish, they are left to die where they fall, to form the future soil.

Tom. The greatest coal-beds ought, therefore, to be found in the vicinity of mountains.

Mr. W. And so they are. Cumberland, and Wales, are not very flat countries. But we must still pursue our coal. When the rivers, laden with mountain-twigs and leaves, have overflowed their banks, they deluge the adjacent country, and the waters becoming stagnant, the leaves and twigs are left upon the land, as the waters subside, and enrich it.

Tom. Do they become fens?—and can turf be dug there?

Mr. W. No. A fen, like the Isle of Ely, is a large flat slope, where the waters ran so slowly, that the twigs and leaves rested there in large quantities.

Tom. Then our turf would have been at the bottom of the sea, in the state of coal?

Mr. W. It would have been at the bottom of the sea, certainly; but I presume it requires many thousand years to convert it into coal. It requires the pressure of many millions of tons of water per square yard. How many glutinous sea-weeds must die, and how many dead fish may mingle with the mass, ere it becomes coal, I know not; but when it is actually coal, the past tells us that there are mighty heavings underneath, and the setting free some imprisoned matter, and the breaking asunder of coal-seams, yards thick; and this is all that man may enjoy the luxury of warmth.

Tom. Do not animals require it?

Mr. W. Never, except they are brought by man from their natural climate. "The fool hath said in his heart, There is no God"—none other could. Of all the objects in nature, that tell us how God cared for man, there are none more vast, more astonishing, than the coal-fields. We look upon the forest, and love it for its beauty; autumn

throws an increased loveliness over the landscape; winter brings down the withered leaf, the frail emblem of human life, and we sigh over the shortness of its duration; it is borne away by the torrents, and is, by us, forgotten. But it is not forgotten. It has gladdened our eye, and nourished its parent stem: it now becomes subservient to the wants of millions yet unborn; and, for aught we know, of millions born after the lapse of millions of years. Astronomy has nothing more wonderful than this.

CHAPTER XLII.

WHY OUR BLACK PONY BEAT OUR WHITE DOG.

Tom. FATHER, you told me yesterday, when we were riding to Mepal, that you would tell me why our dog lagged so lazily behind, although we were going very slowly.

Mr. W. Let your sister guess.

Esther. I believe he is growing lazy.

Mr. W. A dog never grows lazy, if properly managed.

Ella. He has eaten too much.

Amelia. And worked too little.

Mr. W. Worked too little—that is the true secret:—Peter has worked too little for the food he has taken, and has grown fat.

Tom. Then, when a dog does but little work, he ought to eat less.

Mr. W. Certainly. We have now had Peter for three years, and I have found, that, if he stays at home one week, he cannot keep up with the black pony, who goes out every day; whereas, if he goes out every day, he frisks and runs about, as if he were beside himself. Call him in, and let him answer for himself.

Tom. Peter, come here. Oh! how fat he is!—how many pounds of fat has he gained, that it should be such a burden to him?

Mr. W. That is a mistake, Tom. If Peter had lived well, and taken exercise daily, he could run as fast as we could drive, if he

carried twice the weight of his fat upon his back.

Tom. If it is not the weight of the fat, what is it that causes him to be so distressed, as he was yesterday, and to need whistling up so often? And when he did come, his tongue was out of his mouth. I thought he was "hanging it on," as we say, from sheer laziness.

Mr. W. Depend upon it, dogs never are hypocrites.

Tom. But you know a lap-dog in Chatteris, that sleeps half the day, and cannot be induced to stir abroad.

Mr. W. There is no hypocrisy there; overfeeding, and under-working, have made moving about very painful to him. Why should he move, if it hurts him to do so?

Tom. But how does fat hinder a dog from taking exercise, if it does not overload him?

Mr. W. In a variety of ways. Firstly, it acts as a clog to all the beautiful machinery within. It overloads the heart, and makes it beat twice as quickly as it would without it; it enlarges the size of the bowels, by

covering them with fat; and these, again, press upon the chest, so that it breathes with difficulty.

Amelia. I never thought it acted in that way.

Mr. W. That is not all: it weakens every fleshy part of the body, by laying itself between the little fleshy strings, called muscles. Did anybody ever see the thigh of a hare fat, or the leg of a lion? Look how weak and tottering the fat-stalled beasts are, as they go by to market: they are not weak because they are fat, but because they have taken no exercise. I remember, when a boy, seeing a great fat farmer's boy beaten soundly by a diminutive gipsey's boy, not half his size. I wondered how this could be. Fat is no hindrance to man or dog, if accompanied with great bodily exercise.

CHAPTER XLIII.

LIGHTING THE CANDLE.

Mr. Ward. WHAT are you performing, my little masters and misses?

Kenneth. I am trying to light the candle.

Esther. And so am I.

Amelia. I'll tell you what they were doing, really. Kenneth said he had often seen you light a candle, by holding a piece of lighted paper an inch above the wick; and so he brought one up from the kitchen, to try.

Mr. W. I love to see young experimenters, but I wish they were not quite so fond of explosions and fire. Of course they did light the candle?

Tom. No, indeed, they did not. Esther tried first, and held the lighted paper six inches higher than the wick; and then Kenneth brought it down to half an inch; but the candle was as obstinate as the young king of Greece, and would not be enlightened.

Mr. W. Whew! that wit is rather greasy. But the candle would not light, you say?

Ella. No, and they both say, they do not believe you can light a candle, if the light does not touch the wick.

Mr. W. Oh! the little infidels! I presume they are beginning to believe nothing but what they see. Light the candle. Blow it out. Now hold the lighted paper an inch above it.

Kenneth. Oh! it won't light! It won't light!

Esther. I am so glad! Father's won't light!

Mr. W. Tom, did you expect it would?

Tom. No, father.

Mr. W. And why not?

Tom. Because the outer surface of the wick was in a state of combustion.

Mr. W. Or, in other words, there had not been time to form a red-hot wick. Try again.

Ella. Oh! the flame ran from the paper, down to the candle, in a moment. Let me try. Oh! it did just as well, again.

Mr. W. You recollect Kenneth's experi-

ment with the coal in a tobacco-pipe. Suppose he had forgotten to put the pipe in the fire, there would have been no gas; so, from a cold candle-wick there is no gas, and there can be no flame run down from the light to the candle.

Tom. Is not this one great cause of the dreadful fires we read of, such as the great fire of London, or the more recent ones in America?

Mr. W. It is; and hence is shown the necessity of being quick, when a fire breaks out. Some people cannot comprehend why water will not always put out a fire; and others are astonished at houses on the opposite side of a street taking fire. I hope my children comprehend both. If my house was a large body of glowing fire, Mr. Brown's house would soon be heated up to the point when it would give out gas, like this heated wick; and you know, I hope, that water is composed of two explosive gases, which heat sets free. The first object, then, is to be prompt—the second, to pull down the nearest buildings.

CHAPTER XLIV.

WHY CEDRIC CANNOT WALK.

Mr. Ward. Tom! have you seen the gardener, and has he nailed the matting over the passion-flower?

Tom. He has, father; but I cannot understand why nailing a mat over a tree should preserve it from the frost.

Mr. W. You recollect I have before explained to you, that a handkerchief placed on four sticks will prevent anything freezing that is underneath, if the frost be slight: this it does by preventing the heat from flying off, or radiating, as it is called: this the matting does.

Tom. Does it not, also, cut off the sun's rays?

Mr. W. It does; but how does that act?

Tom. By keeping the sap from rising.

Mr. W. I believe this is most important. A sapless stem may be frozen with impunity; but if the sap be tempted to ascend, by the genial influence of a few warm days in winter, the tree dies, like the toes of a drunken man, who lives in a state of excitement, from drink, or of debility, for the want of it.

Tom. You talk of the toes of a drunken man dying from exposure to frost. Why does he not die in some other part?

Mr. W. Because they are farthest from the heart, and the blood is most prone to stop there. The fingers, and the tip of the nose, freeze first.

Tom. It is just the same with some trees. I have seen walnut-shoots, and laburnam flowers, die from frost, when the leaves and twigs were unharmed.

Mr. W. But we need not go far for an example. Cedric's swollen and painful feet are a proof of a want of constant matting.

Amelia. His feet were never matted.

Mr. W. Were they not? I maintain they were; and if I were to do with my passion-

flower as Cedric has done with his feet, the same results would follow: it would die.

Ella. But his feet are not dead.

Mr. W. They are in the first stage of death, which is chilblain: more exposure would kill them outright. It is by exposing the naked feet to fire, that chilled and mortified feet come. A passion-flower cannot take exercise, and therefore must be covered in winter; but when the feet are cold, or, what is the same, when the blood has left the feet, to warm them by the fire is as stupid an act as that of a boy who burns paper in his shoes, to warm his feet.

CHAPTER XLV.

WHAT IS CREEPING UP THE POST?

Kenneth. Oh, father! I do believe Cedric has poisoned himself by eating toadstools.

Mr. W. I hope not: show me where they are.

Kenneth. They grow on a post at the bottom of the garden.

Mr. W. Oh! they are not poisonous, neither are they toadstools: they are a sort of fungous excrescences, or warts, and very useful they are: they cause the wood to decay.

Tom. There is no great utility in that; is there, father?

Mr. W. Perhaps not in this post; but this is one of the great agents employed in covering the earth with the richest soil; that is to say, the conversion of living wood into dead vegetable matter.

Tom. How does it do so?

Mr. W. Let us stoop down, and examine into this little matter. You will find they are tough and leathery, like old mushrooms, and they stick to the wood like barnacles.

Kenneth. I can scarcely break them off.

Mr. W. Look at the wide-spreading, umbrella-like top—how well calculated to stop the progress of the water, as it flows down the post! It acts, firstly, by keeping the wood almost constantly wet. What other changes do these fungous bodies effect?

Tom. I cannot tell.

Amelia. Nor I.

Mr. W. Their root penetrates into the wood, and allows the moisture to enter there; and now the work of destruction begins. As it becomes decayed, more roots enter and flourish, and more wet enters the post, until at last it falls, like touchwood, and is soon mixed with the soil.

Tom. I never before thought of the uses of these little fungi.

Mr. W. Everything has a use, if we could but discover it. A plant that can adhere to the dead post, like the mistletoe to the oak—that can penetrate the solid substance, and, by directing the rain into its very heart, cause its decay, is another proof of the wisdom of Him who has clothed the smiling valley with verdure: and it ought to teach us this lesson —that however humble the agent employed, yet the magnitude of the results produced, ought to cause us to view the most misshapen monster—the most worthless and insignificant plant—as created solely that man might be happy.

CHAPTER XLVI.

WHAT IS THE MAN WRAPPED UP IN?

Mr. Ward. Tom! What is your brother Kenneth wrapped up in?

Tom. In his clothes.

Mr. W. Guess again.

Amelia. I do not know what you mean.

Mr. W. Why, in his skin, to be sure.

Tom. I never heard of anybody being wrapped up in their skins.

Mr. W. Never mind what you have heard. Do you know anything about it? that is what I want to know.

Tom. I know that the skin is—is—the skin.

Mr. W. That definition makes the matter very clear, Suppose you made a machine, and wished to cover it over with a covering: could you have ever thought of anything so soft and beautiful as skin?

Tom. I do not see anything so very extraordinary about it.

Mr. W. Indeed!—I do. How could you invent a covering that lets out the perspiration when we are hot, and that allows vapour to escape from every part, constantly; and that is so elastic, that, if it has been stretched for fifty years, it will return to its natural dimensions? What do you think the hairs are?

Tom. I know not.

Mr. W. They are skin—and so are the nails; and, what will astonish you more—the outer skin—the scarf-skin, or cuticle, runs in at your mouth and nose, and runs all over the inside of the body.

Tom. Does not the skin grow very hard in some parts?

Mr. W. It does; and that is one of the most extraordinary proofs of the wisdom of the Contriver. Do you know that man is covered all over with a dead skin, and then two or three living ones?

Ella. A dead skin! father?

Mr. W. Yes, a dead skin. Wo betide us

if our outermost skin were not dead: everything that touched us rudely, would give exquisite pain. You may see this dead skin, when a blister is applied.

Tom. Then this dead skin forms corns.

Mr. W. No part of the human frame shows a wiser adaptation of means to ends, than this. In the skin of the delicate and blooming girl, this skin is thin and transparent; in the brawny hand of the ploughboy, it thickens and protects him from injury—thus fitting all for their respective stations; and, by the simple process of laying layer upon layer of this cuticle, those who are suddenly reduced from affluence to want, suffer but little pain from the change.

CHAPTER XLVII.

WHY THE SOLDIER DID NOT DIE.

Kenneth. FATHER, did you ever see anybody bleed to death?

Mr. W. Yes.

Tom. But Kenneth does not mean "anybody;" he means any soldiers who had been wounded.

Mr. W. If he mean, "Have I been in battle, and seen soldiers wounded there?" I say, no.

Tom. I told him yesterday, that a man might be shot, or have his leg or arm torn off, and yet not bleed to death, and he said he would not believe me; for, if he only cut his finger with a glass bottle, he could scarcely stop the bleeding.

Mr. W. I suppose he thinks the blood-vessels of a man are like gas or water-pipes

—the larger the opening, the more gas or water flows out. Do you think so?

Kenneth. Yes.

Mr. W. In a pipe, it is of no consequence whether the hole be torn with a blunt instrument, or cut with a sharp one—the water runs out according to the size of the opening. It is not so in man; and it is well for soldiers it is not so, or all the wounded in the field of battle would die.

Tom. Do you mean, that one of the large blood-vessels would not bleed a man to death, if it were torn asunder, just the same as if it were cut?

Mr. W. I mean, that a man may have both his legs torn off by a splinter of wood, in a naval engagement, and lose but little blood; and the same man would die in a few minutes, if his arm were cut off at the wrist.

Tom. That is very extraordinary. I cannot see why it should not bleed in the one case as well as the other.

Mr. W. Is that the only extraordinary thing you cannot see? What takes place when blood has been exposed to the air for

a few minutes? Come, Kenneth, you have seen it often enough. Tell us.

Kenneth. It sets in a hard lump.

Mr. W. And why does it not set in a hard lump in the blood-vessels?

Tom. I do not know.

Mr. W. It is because the blood-vessel or artery is alive. It has been tried a thousand times, and it has always been found, that if you kill only the inside lining of this tube, the blood thickens—coagulates, forms a clot, which stops up the torn mouth of the vessel, and checks the bleeding. I hope you now begin to see the difference between a cut and a torn artery.

Tom. Oh! perfectly. In the case of the water-pipe, the water and the pipe are both dead, whereas the blood and the artery are both alive.

Mr. W. Do not be quite sure that the blood is alive: it is indeed "the life;" for, without it, the whole machinery of man stands still. But go on with your parallel.

Tom. There is nothing in the pipe to make the opening less, and there is nothing

in the water to make it less fluid; whereas, in man, the torn artery retracts—the blood thickens, becomes solid, and life is preserved.

CHAPTER XLVIII.

IS OUR CANARY HAPPY?

Mr. Ward. A FEW days since, when I asked Esther to let a robin out of a cage, one of you asked me why it might not remain, as you would keep it warm, and feed it well.

Amelia. I said so; but I have been sorry ever since, for the poor little thing died before morning.

Tom. Do you think we have a right to imprison any bird in a cage, for the gratification of our eye or ear?

Mr. W. I think not.

Tom. But canary birds, and goldfinches, seem very happy.

Mr. W. How would you judge of the happiness of a caged bird?

Tom. By his singing. Birds always sing when they are healthy and happy.

Mr. W. And some, I fear, sing in spite of their unhappiness. I believe birds and animals are constituted as man is;—however galling the chains at first, in time they are scarcely felt. A horse that resists the yoke at first, in a short time thrusts his head through the collar.

Tom. And is not the horse as happy as he would be in a wild state?

Mr. W. With a kind master, I believe he is happier; but this is a digression. We were admiring the wisdom of the Divine Being, in enabling all animated beings to bear pain with cheerfulness. For an example:—Take the poor African boy, torn from home, and all that make home dear to him; mark the intense agony when torn from his sister, in the slave-market. In one year he will dance and sing as cheerily as if he was in his own native land. But who had the right to tear him from his father's

arms? Who had a right to give him a month of misery and pain? Who had a right to give him one hour—one moment? It is very poor reasoning, to point to that canary, and say he is happy, because he sings. How much did he, and how much does every animal endure, when first deprived of their liberty! What do you think constitutes the great pleasure of the young of all birds and animals, and even the young of the human species?

Amelia. Eating?

Ella. Drinking?

Kenneth. Sleeping?

Mr. W. All very agreeable things; but still, not the one great pleasure of young existence. Guess again.

Tom. Flying, or running about?

Mr. W. Movement—free, unrestrained motion—the liberty of the eagle, that eats his breakfast on a British hill, and sups on the mangled fragments of a young gazelle, upon an Alpine crag. I firmly believe, that the free and unlimited power to swim, or fly, or run, constitutes the chief happiness of the young. Is it a little thing to deprive them

of this? What a poor compensation, to admire his song—to throw him a few crumbs! We have cut off his chief source of enjoyment, and now we mock him by endeavouring to prove how happy he must be.

CHAPTER XLIX.

THE DEVILLED LEG.

Mr. Ward. WHAT did one of you ask me, when we had the turkey's legs boiled?

Tom. I asked you what those white shining substances were, in the very middle of the flesh.

Mr. W. I now recollect: they are leaders, as they are commonly called; but, with more propriety, tendons.

Tom. What are their uses?

Mr. W. To move the legs of the turkey: in short, to enable it to walk.

Tom. I cannot understand how they can make it walk.

Mr. W. These tendons are not the causes of the movement; the white flesh which you ate is the moving power: the tendons are the parts joined to the bone at one end, and to the flesh at the other. Have you never seen the leg of a fowl cut off, with two or three white, silvery, glistening little straps hanging out?

Amelia. Oh yes, many times. If you pull one, it bends one toe; if you pull another, it bends the foot; if both together, you pull both foot and toes. My fingers pull them now, but what pulls them in the living fowl?

Mr. W. The flesh which is called muscle: it is red in man and beasts—white in birds and fishes.

Amelia. But how does it do it?

Mr. W. By a peculiar power of its own, called contraction. When the fowl wanted to walk, the muscle in the upper part of the leg contracted, and pulled the tendon up, which caused the leg to move. If the flesh were united to the bone, without the tendon,

it would often be torn. You have no idea how strong these sinews or tendons are.

Tom. I think I have, father; for, when Damien was sentenced to be pulled into four quarters by four young wild horses harnessed to his limbs, and flogged in four opposite directions, they were unable to pull him asunder.

Ella. What! four horses not able to pull a man in pieces!

Mr. W. No; and they had to cut the tendons before it could be done.

Tom. How dreadfully cruel! We are less cruel in the present day—are we not?

Mr. W. We are more refined. It would give us pain to witness this shocking mode of putting one man to death; but we still mangle a man with splinters of wood, stab him with the lance, hew him down with the sword, lop off his limbs with cannon shot, crush him with monster shells, leaving hundreds dead, and thousands languishing with festering wounds. I cannot believe in the humanity of the age, in which war is looked upon as glorious, and the destruction of the human body necessary.

CHAPTER L.

WHY THE COACH CAME IN LATE.

Ella. WHAT can have happened to the coach?—it is now four hours past its time.

Tom. I should think it has been overturned.

Mr. W. Perhaps the road was flooded. I believe I can hear it—I can see it. It is our coachman and guard; but the coach is a Southampton one. Pray, Tom, go and ask?

Tom. (Returning.) One of the wheels caught fire at Royston.

Esther. Nonsense! Tom; a wheel cannot take fire.

Amelia. Can it, father?

Mr. W. What do you think, Miss?

Amelia. I think it cannot.

Ella. I think it can; for I have read of some Indians, who lighted all their fires by rubbing one piece of wood violently against another.

Mr. W. Can you give us a familiar illustration?

Tom. Yes, very readily; for, when I ran down stairs yesterday, with my hand upon the mahogany hand-rail, it became so warm that I thought I had burnt myself.

Mr. W. There can be no doubt of the fact. I suppose they forgot to oil or grease the wheels.

Tom. Could not a joint be contrived, that should contain oil? Might not the axletree rotate in a sort of socket full of oil?

Mr. W. I believe such things are made: but, leaving the coach and its wheel, how is it that the human joints never become hot from friction?

Tom. Oh, do tell us something about ourselves! I do love to hear about joints, or bones, or sinews.

Mr. W. The joints of the whole animal creation have often filled me with wonder and admiration; they are of every sort and every kind, from the simple ball and socket of the shoulder-joint, to the more complicated movements of the spine, or back bone.

There are two or three contrivances in every joint, that defy all human imitation.

Tom. Will you tell us about the shoulder? for that seems never at rest.

Mr. W. If I take the leg bone of a sheep, and strike it hard against another bone, I chip a piece off, or split one or both. When I recollect how many falls all of you, especially Amelia and Cedric, have had, and how violently the bones of your shoulder joints must have been driven together—if there had not been something placed there for the purpose, your joints must have been useless to you both. What is this substance?

Tom. Is it fat?

Mr. W. No. When veal bones are boiled, you must have noticed a white shining substance, that falls off the ends of the bones: this is cartilage, and this is the material that covers the ends of bones: nothing can be smoother.

Tom. But the smoothness does not prevent the injury.

Mr. W. Certainly not; it is its second property—its elasticity—that prevents the

shock. When you see it again on the table, observe the difference between it and bone, by trying to perforate them with a pin. But the most beautiful contrivance is the apparatus for oiling a human joint. The whole is enclosed in a bag, the inside of which secretes joint oil, or synovia, just as the spittle-gland does saliva, or the eye-gland a tear.

CHAPTER LI.

WHO RAN?—THE MAN OR THE TREE?

Mr. Ward. SING that little song again, Cedric—sing it again, my darling boy.

Cedric. I cannot.

Mr. W. What was he singing, Ella, when I entered the room?

Ella.—

Twinkle, twinkle, little star,
How I wonder what you are:
Up, above the world so high,
Like a diamond in the sky!

Mr. W. Very pretty indeed! Have you not all felt the same wonder, when you have seen the blue vault of heaven studded with these little stars?

Tom. I have, very frequently, father; and I find it very difficult to understand how it is that these stars do not move. I watched them last night, and could see them rising, one after another, above the horizon. Still, I know it is our earth that moves, and not the stars.

Amelia. You may say what you please, but I know the stars move, for I have seen them. I stood at our window last night, looking at the seven stars, called Ursa Major; they were just above the weathercock of the church. In half an hour they were two or three yards above it.

Ella. And I watched three pretty little stars over a chimney, and they soon were above it.

Mr. W. And I once sat in a gig, whilst the horse was running away; and all the trees took fright, and ran away too.

Ella. Father! father!

Mr. W. And I, at another time, sat in a railway carriage, and the steeples and lamp-posts all rushed past us, at the rate of twenty miles per hour.

Ella. But they only seemed to run away.

Mr. W. I recollect, this very winter, riding my black pony into a running stream of water, and, turning her head up the stream, was astonished to find that, as she was drinking, I was riding down the stream, tail first; and I only discovered that I was standing still, by taking my eyes off the running water, and fixing them on the bridge.

Amelia. What have all these to do with the stars?

Mr. W. Just this:—that if I, at nine-and-thirty years of age, could not tell whether the trees, and steeples, and lamp-posts were running or standing still, little girls may learn, that the little twinkling stars, like my trees, never move, but that it is the earth on which they are placed, as I was in the gig, and the railway carriage, that causes the appearance of motion.

CHAPTER LII.

FOLDING UP.

Mr. Ward. At our last meeting, we each agreed to fold a sheet of paper up, in the form of a letter; and I promised a reward to those whose sheet was most neatly folded up. Tom, let me see yours.

Tom. Here is mine.

Mr. W. Very well; but it has one unseemly wing. Now, Amelia.

Amelia. I cannot fold it up nicely.

Mr. W. That I see in a moment—two wings, and three or four creases. Now, Ella, yours. Oh! worse and worse! I have seen such specimens of folding up this morning, as would put you all to the blush.

Tom. Where were they?

Mr. W. In the garden. There were hundreds, nay, thousands—and, what was most

extraordinary, was, that all the red ones were folded one way, the white ones another, and the green ones still more curiously.

Amelia. What time in the morning was it? I was in the garden very early, and I saw no green, nor white, nor red letters there.

Mr. W. The old blindness again! Young eyes see that the sky is blue, and the grass green, and the moon yellow, and they see nothing besides. I repeat it—I saw at least a thousand specimens, folded up in the most perfect manner—not a wing, not a crease—and all were enclosed in an envelope, to protect them from injury.

Tom. You are so fond of mysteries, father! We cannot guess.

Mr. W. Mysteries indeed, to people who walk through a garden with their eyes shut. You remember the passion-flower. It is said no one ever saw one in the very act of bursting open.

Ella. Oh! I see now; your thousand specimens of beautiful folding up, are the

buds of the leaves and flowers—the green leafy bud of the rose-bush, the white, of the pear and plum—and the red, of the peach.

Mr. W. You are quite right, Ella. But let me call your attention to the passion-flower; and, when the mat is taken off, and the buds are ready to open, let me recommend each one to examine how this beautiful flower is packed up in its bud. I have examined very many, and have been astonished at the wisdom shown in the process. What is more wonderful is, that every passion-flower is folded up precisely in the same manner.

CHAPTER LIII.

FOLDING UP, CONTINUED.

Mr. Ward. It is a fine sunny morning: let us go into the garden, and look at these beautiful specimens of packing up. The first thing that arrests our attention is—

Amelia. A crocus.

Mr. W. Let us pull one up.

Ella. I can see no flower.

Mr. W. Let us cut open this sheath. Ah! there is the flower, closely packed together. You now see that some flowers are folded up in a sheath, to protect them from wet.

Tom. I should have thought the great use of the sheath here, would be to defend it from cold.

Mr. W. No; I consider all flower-buds would be more injured by wet than by cold; and there are many beautiful contrivances to

keep them from being injured by it. Here is a gum cistus—you recollect its beautiful flowers; they live but a day; but so careful is He who made them, that they should live even that short time, that there is a special protection for them.

Tom. Is it the gummy matter that covers them?

Mr. W. It is. And I should very much like to know whether this gummy substance, that causes the water to run off the bud of the gum cistus, be the same as that gelatinous substance in which seeds are found floating in the middle of the sea, ready to cling to any rock or timber that is near.

Tom. I have pulled one of the buds from the apricot tree. How shall I see how the leaves are packed together?

Mr. W. By cutting it across: but before you do so, observe the outer covering—it has a bright varnish upon it—for what, Kenneth?

Kenneth. To keep it from the wet.

Tom. I have cut it through. How beautifully they are folded up! Here is a lime-

tree bud. Oh! wonderful!—here is the future branch, with all its leaves packed up in one little bud.

Mr. W. I wish I could persuade every child who has hitherto walked through a garden, without eyes, without thought, to take into his hand these little flower-buds, and examine them as the works of a Being who cares for the safety and life of these, his beautiful, but his lowest children. If we love a parent for her watchfulness and care, ought we not also to love Him, who guards the seeds of the minutest moss, and who watches over the lilies of the field, that not one should perish from his land?

CHAPTER LIV.

THE ARRIVAL OF THE PACKET.

Mr. Ward. THERE!—What think you of that? Seventy-two pages of real printing, from the Post-office, for two-pence!

Tom. Why, father! they are our Breakfast Papers in print! Who can have printed them? Oh! how ridiculous the titles look in print! "Why a Fly cannot ride on Horse-back!" How the people will laugh at us!

Mr. W. The ignorant and the ill-natured will laugh—let them, if it afford them any gratification; but I hope there is a large class of boys and girls who will be as much interested and amused by them as you have been.

Amelia. But why did you put all our real names in? Any other names would have done as well.

Mr. W. Remember, these papers were written for you specially, and the names and titles were adopted, for the sole purpose of rendering them more emphatic and striking.

Tom. But you have made us talk so much nonsense.

Mr. W. My dear boy, when you grow older, you will find it one of the most difficult things in the world to write good nonsense. Scientific nonsense, that can be comprehended by children, is a very rare commodity. Besides, although you, my children, do generally talk sense, yet, now and then, there is as much nonsense uttered in my hearing, as in any other father's.

Tom. What do you think will be said of the composition?

Mr. W. That, Tom, is my last consideration. You know they were commenced in October, and I know they were in the hands of the printer by Christmas, and penned amidst the turmoil and bustle of active professional duties—many of them in the midst of half a dozen children at play. Bearing

in mind these matters, he who cavils at the composition, will have more of the cur than the critic in his composition.

Tom. But what most astonishes me is the extreme correctness of the printing—page after page, without an error: and, if I recollect rightly, some of the originals were like the handwriting of a celebrated counsel, whose penmanship was said to be of three sorts—one of which he could read, but his clerk could not; a second, that his clerk could read, but he could not; and a third, that could not be deciphered by either.

Mr. W. Printing is a wonderful art, and is one of the greatest boons ever bestowed upon mankind. Like the sun, whose cheering beams cause the weeds to grow more luxuriantly than the grain, it produces good and evil. As the farmer spares no labour to destroy every luxuriant weed that would injure the growth of his corn, so is it my wish, and it ought to be the wish of every one having the care of youth, not only to implant new ideas, but to eradicate all that is worthless and vile. For this purpose, the

press is all-powerful; and I shall rejoice if my children, as they grow in years, prove to the world that a father's fondest wishes have been realized.

CHAPTER LV.

TOM'S DAY DREAM.

Tom. SINCE we last met together I have tried to write a paper, and I do not find it so difficult as you predicted or I expected.

Mr. W. May I see it?

Tom. I have it with me. I do not object to your seeing it; but I should not like any one beside to know.

Mr. W. "The Dropt Crystal."—A very pretty title! There is nothing would gladden my heart more than a second series of "Breakfast-Table Science," by J. H. W. and his son Tom. Let me read:—

"*The Dropt Crystal.*

"*Tom.* I have before me a pound of Glauber's salt, or sulphate of soda—a common salt. I have brought a saucepan, into which I put the salt and two pounds of boiling water: it is now dissolved, and we will pour it into a flat pan, to cool, and place it out in the open air.

"*Amelia.* What is it to do, Tom? I have not seen a crystal to drop.

"*Tom.* Thank you, Milly: I had forgotten one very important thing; and that is, I ought to have filled this bottle with the fluid, before I took it out of doors. I will fill it now. Here it is, quite full, and well corked.

"*Ella.* But, Tom, you are so tiresome! Where is the dropt crystal you talk about?

"*Tom.* Here it is.

"*Amelia.* It is only a little lump of salts. I thought it was a diamond, or an emerald, or at least a mock diamond, that somebody had dropt.

"*Tom.* You are all too impatient to learn anything. Let us go and see what has taken place in the flat pan.

"*Amelia.* Oh! how beautiful! how very beautiful!

"*Ella.* It is as beautiful as the frost-flowers on the window this morning; and they were more beautiful than I ever beheld.

"*Tom.* The process is the same in both cases: the window-pane was covered with water-crystals—this pan is filled with crystals of salts.

"*Amelia.* How straight they shoot from the outside to the centre!

"*Tom.* I will pour the water off. What are they like?

"*Ella.* Oh! they are just like this crystal on the table—one, two, three, four sides—just the same number of sides. How very odd, that when we melt these salts in hot water, and leave them to cool, that they should come again in just the same forms!

"*Tom.* It is indeed 'very odd,' and very unaccountable too; but so it is—not only in Glauber's, but every other salt.

Even the crystals of water, called snow, have all the same ray-like figure, (as you may see if you examine the first snow that falls upon your clothes,) before they have been driven by the wind into snow-flakes. Snow, as we see it, is water-crystals clinging together. But we are forgetting the bottle.

"*Amelia.* It is as liquid as when you put it in.

"*Tom.* Give me the crystal. Pull the cork out. There!

"*Amelia.* The moment it touched it, it became a solid mass!

"*Tom.* Well, that is my Dropt Crystal."

Mr. W. Excellent—very excellent! better than some of mine. We must print it; and if my readers approve of your Paper, as we hope they will do mine, we will endeavour to gratify them with a second series of "Breakfast-Table Science." But you have stopt at the very threshold of your "Dropt Crystal." Everything beneath the crust of the earth, tells that at its first formation it existed in a liquid form. The calcareous

spar—the variegated marble—the quartz—even the granite hills—were fluid as the ocean waters! What a gigantic thought, that, at the fit time, one solitary crystal, dropt upon a liquid world, gave solidity to the mass, and formed, in an instant, a habitation for man!

The Author of "Breakfast-Table Science" now launches this little Volume, as the boy does his paper boat. If the breath of popular favour waft it along, his young readers shall hear from him again, at no very distant period.

THE END.

Baine Brothers, Printers, 88, Gracechurch Street