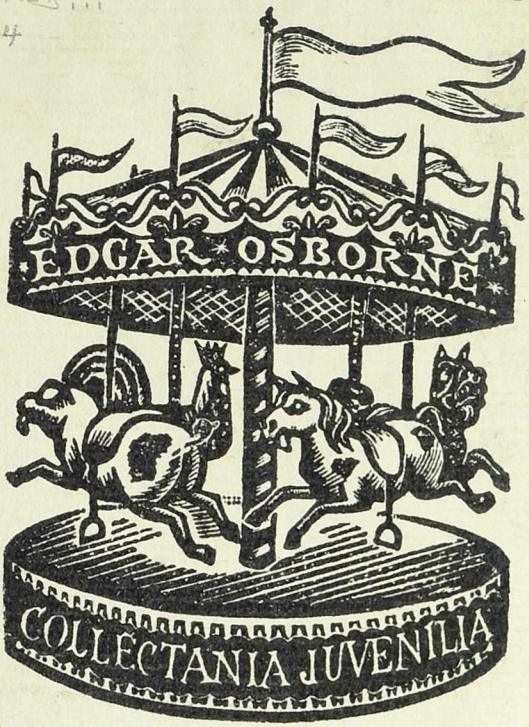

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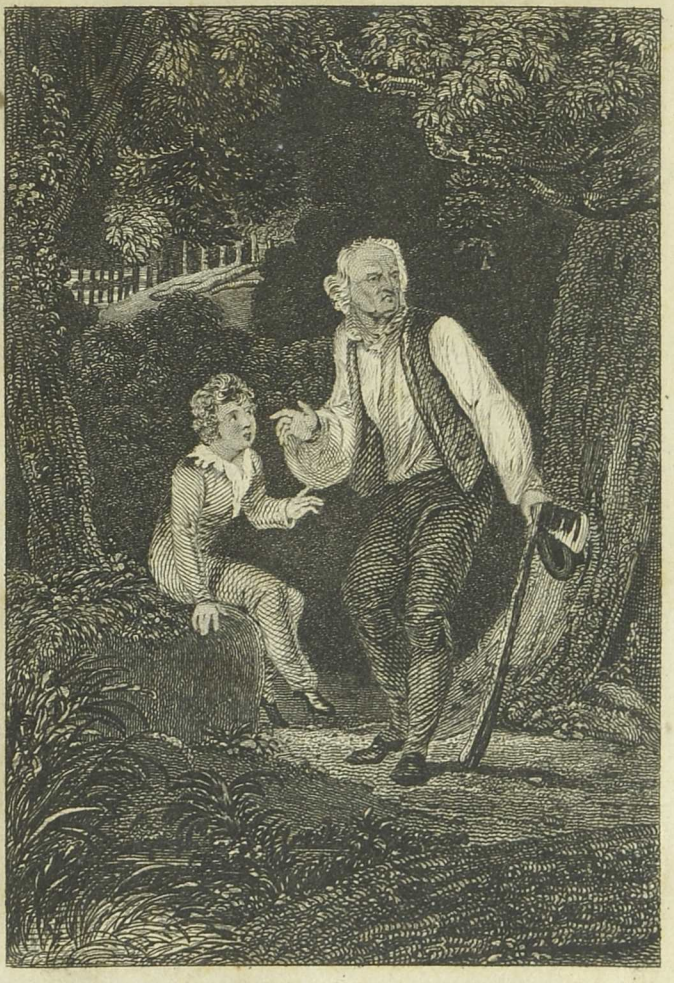

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THE OLD WOODMAN.

p. 82

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ALFRED;

OR THE

YOUTHFUL ENQUIRER.

IN WHICH MANY OF THE

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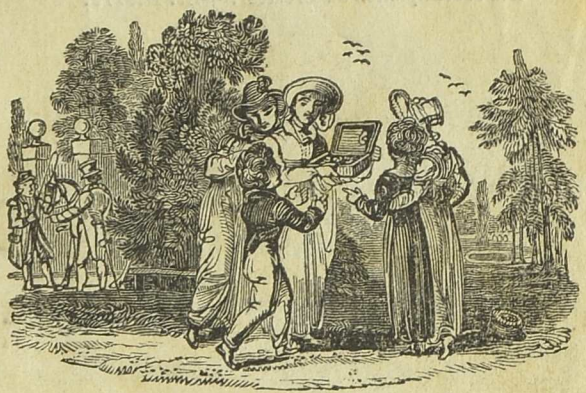
ARE FAMILIARLY EXPLAINED, AND ADAPTED TO

THE COMPREHENSION OF CHILDREN.



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1824.

" La contemplation de la Nature conduit toujours le vrai savant à la contemplation du Créateur."—*St. Pierre.*

T. C. HANSARD, Paternoster-row Press.

CONTENTS.

ALFRED

OR

THE YOUTHFUL ENQUIRER.

The Ivy-leafed Crowfoot.

ALFRED was a thoughtful child. The works of nature afforded him ever new delight; and he had so long accustomed himself to reason and reflect upon any subject that excited his surprise, and to endeavour to trace effects to their causes, that few things passed unnoticed by his penetrating eye: few days elapsed in which some little event was not

deemed worthy of inquiry and observation.

He would frequently sit on a bench in the garden for an hour together to watch

> "The little traveller
> Who toils so cheerfully from flower to flower
> For ever singing as she goes:"

or would follow her with sensations of unfeigned delight to the hive in which she deposited her honey, and there examine the fairy fabric raised by the persevering industry of her little help-mates. Sometimes he would linger in the fields for an hour or two beyond the limited time, in order to observe the young birds busily engaged about their nests, or to bend over some meandering rivulet and watch the course of the little minnows as they glided ra-

pidly down the stream. Frequently would he seat himself upon a rustic stile, at the end of a lane near his father's house, to gaze upon the beautiful fleecy clouds as they chased each other successively away; or to watch the progress of the declining sun, and follow it with a wistful eye into the vales of glory, which appeared to open around its setting beams: wondering, in the mean time, why every object upon which they shone was tinged with such a brilliant golden hue, why every shrub and every tree—the village spire and the cottage casement—were tipped with a yellow lustre—and the distant mountains so gaily illuminated by its departing rays. Why, would he say to himself,

"Why do those cliffs of shadowy tint appear
More bright than all the landscape smiling near?"

and then, almost as soon as the sun is actually gone, why are they immediately clothed in a dark gray hue? The motions of various plants was another object of interest to his thoughtful mind; some flowers, he would observe, turn towards the sun, whilst others twine their voluble stems in another direction. There was a double scarlet anemone, in his father's garden, which was regularly looking towards the house every morning, and as regularly turned towards the south-west every evening; and this circumstance had first led his attention to the subject. The opening of the blossoms of the evening primrose, the daily unfolding of the delicate flowers of the gum cistus and the rapid expansion of a passion-flower, were also objects of the

greatest interest to him:—the astonishing growth of some flowers likewise excited his wonder and surprise, and he would frequently draw a line with a pencil upon the wall of the summer-house, against which a purple clematis was trained, in order to know the exact progress it had made in one week; this little experiment awakened a new train of thought—in seven short days another pencil-mark proved that it had grown nine inches in that short space of time. How astonishing! exclaimed our little philosopher, but his reflections did not end here; he appeared for a time lost in meditation, and at length it was found that he was calculating whether he had increased his acquisition of useful knowledge in proportion to the growth of the plant.

Few children would have even thought of such a comparison, and we mention these particulars, with the hope of exciting in our young readers a *habit of observation* like that which our little Alfred so successfully exercised; it is one that ought to be instilled into every youthful bosom:—observation will inevitably lead to reflection, and while *reflecting* upon the various sources from whence effects so wonderful and so beautiful proceed, it is natural to suppose that the thoughts will still be carried forwards to that First Great Cause, from whom alone every blessing we enjoy, every pleasure we can experience, is derived.

Children! the best volume of instruction is that which is offered to your view in every walk you take.

In every thing around you, from the humble moss that grows upon the thatched cottage of the labourer to the majestic oak that adorns the extended park of his more wealthy neighbour, are objects of pure and innocent delight to be found; and always remember that

> "Nature is but the name for an *effect*
> Whose cause is God."

Although Alfred was a thoughtful boy he was uncommonly fond of play, and no one could enter with more avidity than he did into the sports of childhood; nor, during the time allotted to his lessons, could any one attend with greater assiduity than he did to the instructions of his beloved preceptor.

He had a little garden of his own

in one corner of the kitchen garden; it was well stocked with annuals of various descriptions raised from the seeds he had sown in the spring, and one side of it, originally appropriated to vegetables, was plentifully furnished with French beans, peas, and potatoes. In time, however, the young potatoes were dug, the peas and beans were ready for gathering, and, as Alfred remarked, when the beautiful scarlet flowers of the latter were over, as there was no inducement to leave its wild tendrils and withered stems climbing round the sticks and making a litter, it seemed as well to dig them all up and level the ground and turn it into a shrubbery.

"If I had but shrubs to stock it with, I would begin directly, mamma," said he. "Perhaps you will be

so kind as to give me some shrubs. There is a little arbutus at the end of the lawn, mamma, which has long been a great favourite of mine. Can you afford to give it me."

"If you are willing to do something for me, that I wish to have done, the arbutus shall be your reward, Alfred," said his mother.

"What is that, dear mamma?" said Alfred. "If it be any thing that I can do I will do it, not only for the sake of getting the shrub but also for the pleasure of pleasing you."

"I never ask you to do any thing unless I know that you *can* do it if you try, my dear," said his mother. "It is to tie up all the lettuces in the lettuce bed."

"What, to tie them up to sticks with bits of string?"

"No, not to sticks, but merely to enclose the leaves by tying a bit of matting, which you will find in the root-house, round the whole of the lettuce."

"But for what purpose is this done, mamma?—and where about is the matting, and how many lettuces do you think there are?"

"As to the exact number of lettuces upon my lettuce bed I cannot answer you," said his mother, "but you will find plenty of matting in the drawer, under the shelf upon which the garden-pots stand, in the root-house, and as to the reason *why* the lettuces are better tied up, I leave that to your own discernment."

Away went Alfred to the root-house, fetched the matting, examined, on his return, the favourite arbutus

that was to grace his own little garden, and set to work with more than usual ardour.

In the course of two hours his task was completed, and the assistance of Francis, the gardener, was required in moving the shrub, but Alfred had not yet discovered why the lettuces should be tied up with matting when they needed no support.

Alfred had several sisters. Some of them were botanists, and they occasionally made little excursions in a pony-chaise into the country in order to procure specimens of various plants; on such occasions it was customary with them to carry a tin box, in which to place the flowers as soon as they were gathered, (for flowers will keep fresh much longer in a tin box, than when carried in the

hand,) and by this means they retained their natural appearance until Louisa and Caroline were at leisure to copy them.

One day, just as they were setting out for a ride to a delightful spot a few miles distant, where they had been told many rare and beautiful plants might be found, the tin box was missing, and, after many researches, and a rather longer detention than they liked, Alfred discovered it under the seat of a grotto in the garden. "See!" said he, holding it up in his hand in triumph, as he ran across the lawn, "here it is! I have actually found it, and, what is more wonderful than any thing I ever heard of, here is a plant growing in it which is white, quite white, stem, leaves, flowers and all;—neither flow-

ers, leaves, nor stem have a particle of colour in them."

"That is very extraordinary, indeed," said Caroline. "Oh! I see it is the ivy-leafed crowfoot which we gathered by the spring in the common three or four weeks ago, intending to show it to Dr. B.; and I recollect putting it, stem, leaves, roots and all, into the tin box, and leaving it under the bench in the grotto, meaning to show it to him another time, as he was busily engaged in conversation with papa just then, but something happened to put it off —*frustrate* do you call it—to frustrate my intention, and I had really forgotten all about it."

"All this may be very true," said Alfred, "but was your ivy-leaved crowfoot green when you gathered

it, or had it the same appearance then that it has now?—you see it is perfectly white."

"Oh no, no, it was green," said Caroline. "It had little white blossoms and green leaves, as green as the leaves of this rose-bud I hold in my hand."

"How very extraordinary!" said Alfred. "Let us try to discover the cause of so wonderful a change:—why your ivy-leaved crowfoot should turn white when shut up in this tin box I cannot conceive. Do other flowers turn white on being put into it?"

"Never before," said Louisa. Indeed we have never before left a plant in it for so long a time."

Alfred looked lost in thought, and, after forming many and various con-

jectures respecting this apparently singular phenomenon, he was informed by his father that when plants are *deprived of light* they turn *white*. "The powerful effect of light upon the vegetable kingdom has long been known," said he. "The green colour of leaves is owing to it, for plants raised in darkness are invariably white, like the crowfoot, which has assumed this appearance from having been shut up in a box and kept in the shade for so long a time. We may compare a plant that grows in darkness to a mind enveloped in ignorance and destitute of cultivation, for we can form no judgment either of the one or the other. Now consider, my dear Alfred, and see if you cannot give me some instances of the effects of light as it regards plants."

"I never thought upon the subject before, papa, but I will try," said Alfred. "Indeed I never heard, before, that plants did become white in the shade, although I have often noticed that many flowers, the sun-flower and anemone for instance, unfold their blossoms to the sun, follow his course by turning on their stems, and close themselves as soon as he is set. I suppose this is the effect of their fondness for light. I have observed also that the leaves of the geraniums which stand on the bench in the hall window, always have their right sides turned towards the window, where the light enters, you know; there are two windows in the hall, but they direct their course towards the window that is nearest them."

"Very well, my dear," said his

father, "can you give me any other example?"

"Yes, papa," replied Alfred, after a little reflection, "I have sometimes noticed, when we have been walking in the wood, that the trees that grow *there*, where they only receive light from above, you know, direct their shoots upwards, and consequently become much taller and less spreading than those of the same sort which stand single in other places; they grow very thick together and they seem to want to get as high as they can in order to gain light."

"Very well, my love, your remark affords a convincing proof that you *have* thought upon the subject. Can you give me any other instance?"

"Ah, mamma, I see you smile:— I recollect that the lettuces we had

at dinner to-day, contained fine *white hearts*, as you call them; the inner leaves were white and blanched, and much better than the green outside leaves:—I know now why you desired me to tie matting round them—they became *white* when deprived of light. Caroline, I have learned something from your ivy-leafed crowfoot!"

"Never neglect an opportunity of gaining useful knowledge," said his father. "When you are older and can comprehend the nature of light itself, I will tell you why it is requisite to the colours of plants; at present, you may rest satisfied with knowing that they cannot retain them without it."

The Kaleidoscope.

"WHAT are you so busy about, Caroline?" said Alfred, peeping over his sister's shoulder one morning, and examining some little bits of amber, lace, spar, and glass, which she was sorting from among a larger collection, and placing in a small paper tray. "What are you going to do with all those little things?—bits of amber, and little shells, and dragon-flies' wings, and glass beads, and pink bugles—what can you be about, Caroline?"

"You know very well what a kaleidoscope is, I believe," replied his sister, "well, papa is making one, and these little *morceaux* which excite your curiosity so much are to be put into it."

"A kaleidoscope! a kaleidoscope!" exclaimed Alfred in a tone of delight, "is my dear papa really making a kaleidoscope?—the very thing of all things that I should like to see! Where is he?—I will beg of him to explain its construction to me. I have often wondered how such a variety of beautiful figures could be formed by little things like those in your tray, and I shall be very glad to know and understand all about it. Where is papa?"

"He is engaged in his study just now, I believe," said Caroline, "and you had better restrain your curiosity till by-and-by, my dear."

Alfred put all his patience into requisition and exerted a noble self-denying resolution, for he knew that it is only selfish people who will

allow others to leave their own pursuits in order to gratify *their* caprices, and Alfred was of too generous a temper to expect, or even to wish, such a thing. At length his father's step was heard in the hall, and he advanced to meet him.

"Are you at liberty to talk to me now, papa, or are you engaged?" said he, taking him by the hand.

"I am looking for Caroline," replied his father. "I wish to know whether she has sorted some little articles I gave her for that purpose, and which I want to put into the kaleidoscope I am making."

"Yes, they are quite ready, papa, and will you allow me to watch you —will you explain the construction of a kaleidoscope to me?"

"Certainly, if you desire it. You

know, my love, I am always willing to give you pleasure, I am always glad to give you an opportunity of acquiring useful information. In the first place, look into this kaleidoscope, which is perfectly finished, and tell me what you see."

"Beautiful figures, papa, which vary as fast as I move the glass. There, now there is one pattern—and now another,—oh, that is pretty, far prettier than the last. I wish I could understand the construction of this wonderful glass. May I pull it into pieces?"

"That kaleidoscope is not mine," said Alfred's father, "it is Louisa's. We must remember the motto, 'Do as you would be done by;' I think we have no right to spoil what belongs to another, without first asking

leave to do so. Besides, as I am just about to construct one on a similar plan, it would be but a needless experiment. Now look into it again, and tell me of how many parts the figure consists—how many sides it appears to have."

"Ten, papa."

"Very well," said his father. "In order to make my kaleidoscope, I am going to place these three bits of glass, each of which is about seven inches in length and one inch in breadth, into the form of a triangle, which I can easily manage by wrapping a bit of black paper round them; I choose black paper because when so dark an object is placed behind a bit of glass that glass forms a reflecting mirror—a looking-glass, if you please. There, now peep through it and tell me what you see."

"Oh, papa, is it possible! really possible! I see that your kaleidoscope is made already; there, you hold the seal of your watch before it and I see directly ten seals; there is only one seal in reality, but that one is multiplied by reflection, and a perfect figure consisting of ten seals is formed; now it is before mamma's brooch, and I see ten brooches;—but I do not quite understand why it is so—or—oh, now—now I begin to have some little idea—I see your eye turned towards the looking-glass, papa—I recollect that you said something about looking-glasses—I think that this *long thing* is a sort of three-sided—triangular, I believe you call it—a sort of triangular looking glass, and that each object which we see as we look through it, being *thrown*

back—reflected, I mean—reflected to the opposite side, and *that* being reflected back again, and so on, causes the perfect and beautiful and regularly formed figure that we see on looking through a real kaleidoscope. But then instead of looking at a seal or a brooch we look at a number of little things, such as bits of glass, and beads, and bugles, which are placed for the purpose in a little glass case, and, from their number and variety, produce the different patterns which are seen every time the kaleidoscope is moved."

"Your definition is very correct, my dear boy," said his father. "This triangular glass is a very common optical instrument, and is called a *prism*. By fixing this prism in a tin tube, for the sake of convenience,

and placing the little glass box that contains the beads, and bugles, and bits of glass, which Caroline has been sorting, at the bottom of the tube, we shall have a perfect kaleidoscope.

"Thus you see that causes perfectly simple in themselves often produce effects which, to the uninformed, appear most extraordinary. What can be more simple than to place three bits of glass together in a triangular form, and yet how many people have been at a loss, on peeping into a kaleidoscope, to guess how such a beautiful variety of figures were formed—how many moments have been spent in vainly endeavouring to account for their appearance!"

"I have often puzzled myself about it to no purpose," said Alfred, "and I am very glad, papa, that I now

understand its construction perfectly and need not puzzle myself any more. I am very glad that I know what is meant by a *prism*, and more especially that I know the use of that instrument."

"A prism is used by opticians for a variety of purposes," said his father, "you will hear, at some future time, how our great and illustrious philosopher, Sir Isaac Newton, made some of his most extraordinary discoveries by means of a simple prism.

"But at present I think your time may be as usefully occupied in learning this little poem upon a kaleidoscope. When you can repeat it quite correctly, I will make you a present of that which I have been making."

Alfred thanked his father, stationed himself in his favourite seat, the

library chair, and began to learn the following lines:

"Mystic trifle! whose perfection
Lies in multiplied reflection,
Let us from thy sparkling store
Draw a few reflections more!
In thy magic circle rise
All things men so dearly prize,
Stars and crowns, and glittering things,
Such as grace the courts of kings;
Beauteous figures ever twining,
Gems with brilliant lustre shining—
Turn the tube—how quick they pass!
Crowns and stars prove broken glass!

Trifle! let us from thy store
Draw a few reflections more.
Who could from thy outward case
Half thy hidden bounties trace?
Who from such exterior show,
Guess the gems within that glow?
Emblem of the mind divine
Cased within its mortal shrine.
Once again the miser views
Thy sparkling gems, thy golden hues;
And ignorant of thy beauty's cause,
His own conclusion sordid draws:

Imagines thee a casket fair
Of gorgeous jewels, rich and rare ;
Impatient his insatiate soul
To be the owner of the whole,
He breaks thee ope, and views within
Some bits of glass—a tube of tin !
Such are riches, valued true ;
Such the illusions men pursue !"

The Globe of Gold Fish.

Louisa and Caroline had had some gold fish given them and they lived in a large glass globe of water, which stood on a little bench, originally intended for plants, in one of the window seats of the dining-room. It was a favourite amusement with all the children to watch these fish and to feed them with flies and crumbs, to see them dart to the sur-

face of the water and to observe the dexterity with which they would seize an insect if it happened to hover within their reach.

Alfred had been thus employed for a long time one morning, until his attention was at length arrested by a new object, and his mother observed him looking with fixed and earnest attention upon the floor,; she found he was amusing himself with what he called a rainbow on the carpet; he placed himself in various positions, first on one side and then on the other, to prove its identity, and begged his sister Caroline to look at it, wondering in the mean time what could make it—how it came there—what could cause so strange a phenomenon as a rainbow

upon the carpet.* It was one of those delightful mornings when every object appears clothed in beauty, and the sun shone brightly through the open window. Alfred moved several things in the room so as to place them sometimes between the light and the colours he saw on the floor, and sometimes in a corner of the room where the sun did not shine, and as he moved the things he whispered to himself—"This is not it, I believe—this is not the cause of the rainbow on the carpet—nor yet this —this has not any thing to do with it." At last, with Caroline's assist-

* It will be perceived that the subject of this chapter was suggested to the writer by an experiment made by one of Miss Edgeworth's little pupils, and noticed in her excellent work on "Practical Education."

ance, he lifted the globe out of the place where it stood, and his rainbow immediately disappeared.

"Oh, I have found it out! I have discovered it!" exclaimed Alfred, in a triumphant voice. "The rainbow was caused by the water in the globe, and the colours were, no doubt, produced by the beautiful golden scales of the fish that are in it."

Then he put the globe again into its place, and the rainbow was again seen on the carpet. "I wish," said he, "that I could take the fish out of the water, in order to see what effect the water would produce without them." But as this was not easily practicable, he looked round the room for something that would supply the place of the globe. A tumbler of hearts-eases stood on the side-

board; they had been gathered by little Matilda on account of their beauty. Alfred placed the tumbler where the globe had stood, so as for the sun to shine upon the water which it contained. The rainbow remained as bright as ever.

"Perhaps," said he, "the hearts-eases may be the cause of the colours on the floor, as I fancied the gold fish were just now."

He then took the flowers out of the water; but the colours to his surprise remained on the floor. Caroline suggested that it might be the water. Alfred emptied the glass; the colours still remained, but they were fainter. He immediately observed that it was the water and glass together, that made the rainbow. "But," said he, "there is no glass in

the sky when there is a rainbow, so that I think the water alone would do if we could but contrive to *hold it together* without the glass. Oh, I know now how I can manage!"

He then poured the water very slowly out of the tumbler into a basin, which he had placed for the purpose on the bench in the window-seat, and he saw the colours on the floor twinkling behind the water as it fell. This delighted him exceedingly, but he asked why they disappeared when the sun did not shine, for the sun went behind a cloud whilst he was trying his experiments.

"Think for yourself, my dear," said his father.

"I *have* thought, papa," said our little philosopher, after a few moments' consideration. "A rainbow is

caused by the reflection of the sun's rays on drops of rain or water."

"You are right; by means of your little experiment with the rainbow on the carpet you have discovered the cause of a phenomenon to account for which was once considered beyond the comprehension of philosophy. You may, and doubtless will, observe in future that the rainbow is *always opposite to the sun*, and is never seen unless the sun shines at the same time that it is raining, which is another convincing proof of the truth of your conclusion, that the appearance is occasioned by the rays of the sun shining upon the falling drops of rain or water."

"But," said Alfred, "the beautiful arch that we sometimes see bending across the sky is of all colours—

blue, green, red, and yellow: there is no colour in water you know, papa."

"Very true;" said his father, "*water* is totally destitute of colour. Consider a little."

"I believe the colours must be in the *sun's rays*." said Alfred.

"You are right, my dear. All colours are produced by some property in rays of light. Sir Isaac Newton was the first to explain the nature and properties of rays of light, and he was the author of a theory upon the subject as novel as it was just and beautiful. This was his favourite and unremitting pursuit for thirty years; he was remarkable for a perseverance which no obstacles could baffle—no difficulties could overcome; and he has himself allowed

that all his wonderful attainments were owing to the union of observation, industry and perseverance. It was by noticing the rainbow, that he was first led to suppose that its colours, as well as colours in general, were produced by some property in rays of light. In order to convince himself that he was right, in concluding that light is not one simple colour but composed of many, he made a beam of sunshine pass through a hole in a window-shutter and fall on a common glass prism, so as to be *refracted*, or broken in its course towards the ground, and thrown upwards on the opposite wall. He then found, to his great satisfaction, that the beam of light was regularly coloured, that it in fact consisted of seven colours, placed beside each

other in regular order; and these are called the *primary* colours. Look at your little rainbow on the carpet, and name them to me in succession."

"Red, orange, yellow, green, blue, indigo and violet, papa."

"Very well. Every ray of light that has ever travelled from the sun consists of these colours. They are thus described by my favourite Thomson, in his poem to the memory of Sir Isaac Newton:

"He from the whitening, undistinguished, blaze
Collecting every ray into his kind;
To the charmed eye educed the gorgeous train
Of parent colours. First the flaming *red*
Sprung vivid forth; the tawny *orange* next;
And next delicious *yellow;* by whose side
Fell the kind beams of all-refreshing *green.*
Then the pure *blue,* that swells autumnal skies,
Ethereal played; and then of saddened hue
Emerged the deepened *indigo,* as when
The heavy-skirted evening droops with frost:
While the last gleamings of refracted light,
Dy'd in the fainting *violet* away."

"I like those lines very much," said Alfred, "for I understand them, and when one *understands* poetry it always appears much more beautiful than it could do if one did not understand it."

"Yes," said his father, "It is with poetry as with almost every thing else, the better able we are to form an estimate of its merit, the higher is the place it holds in our scale of excellence. Much of the beauty of poetry consists in its truth; I do not mean to say, however, that truth is necessary to poetic beauty; but we should accustom ourselves to distinguish between truth and fiction, and, when we can do so with propriety, prefer the former. Thomson, for instance, is a poet whose descriptions of natural scenery are so cor

rect, that he is universally admired and designated as the 'Bard of Nature.' Cowper is likewise beloved by all who prefer truth and just delineations to the airy flights of some of our more modern poets, as you, who have read with such delight some parts of his 'Winter's morning walk,' and of his 'Sofa' can testify. But we are wandering far from Sir Isaac and his theory.

"Alfred, my dear, you will find a glass prism in the desk in my study, I will thank you to fetch it."

"Here it is, papa."

"Now that I have closed the window-shutters," said his father, "I will fasten this large sheet of brown paper before the crack, or opening, in order that the light may be totally excluded."

"But if you make the room so dark, so very dark, papa, we shall not see your experiments."

"Caroline, can you lend me a pin?" said her father, without noticing Alfred's observation.

"Now," continued he, "I will bore a little hole in this sheet of brown paper, just in that part that comes before the light between the shutters, and then I will place my prism in such a manner as for the ray of light, that is admitted through that hole, to fall upon it. You will then observe that this ray suffers different degrees of refraction, as it is termed, and by that means is divided into different rays, which, being received upon a sheet of white paper I shall place for the purpose, will

show the seven primary colours in regular order."

The experiment was tried, and succeeded. Alfred jumped with joy around his father, exclaiming, "I see it! I see it! There, there are all the colours on your sheet of white paper: —red, orange, yellow, green, blue, indigo and violet! Oh, papa! what a nice thing it is to try experiments for one-self! and I like this experiment even better than the rainbow experiment; it is as convincing a proof that *light is composed of colours*, as that was of a rainbow being occasioned by the sun's rays shining on drops of rain. It is far better to prove the truth of a thing for one-self than to read a book upon the subject twice through. How one thing

springs out of another; this long conversation, upon rainbows and rays of light, was occasioned by my dropping a crumb of bread upon the carpet, which I had intended for one of Louisa's gold fish!"

"The *crumb* had something to do with it, I grant," said his father, smiling—"but there is another cause to which our conversation is chiefly indebted; you look surprised; the *observation* you exercised on first noticing the colours on the floor awakened your curiosity, my dear boy; —it led you to think and to reflect—to ask reasons, and to make remarks. Patience of thought and a habit of observation are essential towards the accomplishment of any useful undertaking, as well as requisite for the success of any new invention which

requires ingenuity and skill. You can in some degree appreciate their value, but not to its full extent. It was the *habit of observation* that led Franklin to his greatest discoveries, and that taught Newton to 'unveil the shining robe of day;' to the same useful habit we are indebted for various discoveries in nature, and for almost every improvement in art."

The Fruitful Vine.

ALFRED had a pony of his own, and he was sometimes allowed to accompany his father in his morning rides. One fine day tempted them to extend their excursion beyond its usual length, in order to visit a gentleman who resided at a very delightful spot, called Widcomb, a few

miles from their own home. Here Alfred met with much to interest and amuse him; the extensive park was laid out with exquisite taste; the bowers and grassy walks and murmuring water-falls with which it was interspersed, proved the proprietor to be a man of taste and genius; the herds of deer as they grazed under the shade of the spreading beech-trees, or bounded in gay herds across the smooth turf, delighted our little Alfred; the aviary excited his attention; the well-arranged green-house was visited again and again, for there were objects of infinite variety—the sensitive plant, with its delicately fragile leaves shrinking from the approach of every finger, and forming as it were a connecting link between the animal and vegeta-

ble kingdom, &c. &c. awakened fresh ideas in his ever active mind. There was one circumstance, however, which seemed to attract his attention more than any thing else.

"Papa," said he, as they rode towards home, "I was very much struck, whilst walking in the kitchen garden at Widcomb, with the appearance of a vine growing out in the open air, and trained against a brick wall which had been painted black, for what purpose I cannot tell, but the grapes that grew upon it were finer than any I ever saw growing out of doors before; they were unusually large, and hung in beautiful clusters among its bright green leaves and curling tendrils, whilst those that grew upon another vine a little way off, with

just the same aspect, only against a *red* brick wall, were not half so fine, nor indeed, any thing out of the common way. Will you explain the reason of this circumstance? You know I am very fond of finding reasons for any thing that surprises me —or, as you would say, of tracing *effects* to their *causes*."

"Put your right hand upon your coat, and hold it there for a moment; your coat is black you know," said his father. "Now place your left hand upon your hat, which is made of white straw, and tell me whether you perceive any difference between the warmth of the coat, and the warmth of the hat; as the sun is shining, I dare say they will both possess some—some warmth, I mean."

"My coat is much warmer than my

hat," said Alfred, doing as his father had desired him, "my hat is almost cool, but my coat is quite warm."

"Very well," said his father, "now leave your coat and your hat for the present, and attend to what I have to say.

"You know that a ray of light may be separated into the seven primary colours."

"Yes, papa."

"Well, so by a mixture of these seven colours, in due proportion, may *white* be produced; white therefore is the mixture of all the colours, as black is the absence or deprivation of them. Hence white bodies are cool in the sun, and black ones are hot, because white surfaces reflect all the light and black ones absorb it; and this is the reason that your hat re-

mains so cool, while your coat is quite warm—the sun shines upon both with equal power, but both have not the property of absorbing its rays.

" Now tell me why the vine which you saw trained against the black wall, in the garden at Widcomb, was so much more luxuriant than the other vines, and why the grapes which it produced were so much finer than those which grew upon the other vines."

" Oh, papa !—I can explain it now in a minute. You have the art of making the most extraordinary things appear simple and easy:—I know very well, because Francis has frequently said so, that as vines are the natives of a warm country, so they are much more productive when reared in a warm situation; and as that part of the wall against which

this vine was trained is painted *black*, it is much warmer than any other part of the wall, and the vine which grows against it is consequently much more luxuriant.

"But, father, I should be glad to try some little experiment which would prove that white *is* a mixture of the seven primary colours; I do not mean that I doubt your word, papa, but you know it is so delightful to try experiments for one-self."

"I will see about it by-and-by," said his father.

The conversation was here interrupted by their arrival at home; company was soon after announced, and it did not appear as though Alfred would be able to gain the wished-for interview with his father in his own study, that delightful retreat, all day. At length, however,

tea time came, and after Alfred had cast many a wishful glance at his father, as much as to say—" I wish you would make an experiment—I wish you would satisfy my curiosity, by proving that white is composed of colours"—his father turned towards his mother, and said,

" My dear, is there such a thing as a spinning-wheel in the house?"

Louisa, Caroline and Alfred, laughed aloud when they heard this question—" What are you going to do, papa?—what can you possibly want a spinning-wheel for?—are you going to spin flax, or are you going to make thread?" exclaimed they.

Their father smiled, and repeated the question.

" I am thinking," said their mother, " I have some idea that I once had one, but, if I recollect right, it is

now in Alice's possession; however, you can easily have it brought up if you wish."

Alice was an old woman who lived in the lodge at the entrance to the grounds, and as nothing could be thought of that would answer the intended purpose so well as this spinning-wheel, one of the servants was despatched for it, with the assurance that Alice should have it again in the course of a short time.

"Now," said Mr. A., "can you furnish me with some bits of cloth of the seven primary colours."

Mrs. A. thought for a short time, and at last she recollected that she had a number of little pieces of square cloth, on a tailor's pattern card, of various colours—of all the colours except yellow.

"Oh, I know where there is some

yellow cloth," said Alfred, "for when I went into the root-house to look for some matting the other day, I saw some bits of yellow cloth, in the drawer where the matting is kept, which I supposed the gardener had put there against he wanted some shreds to nail up the trees. I will run and fetch the bits of yellow cloth, papa, and then you will be in possession of the seven primary colours; but what you are going to do with them, and with old Alice's spinning-wheel, I cannot imagine." Alfred left the room as he spoke, and soon returned with the shreds of yellow cloth in his hand; his father then cut a piece of it into a little square, about the same size as the rest, and, as he was now in possession of seven pieces of cloth of the seven primary colours,

he fixed them side by side, in regular order, upon the broad rim of the spinning-wheel; then seating himself before it, and putting it in motion with his foot, he desired Alfred and his sisters to watch it, whirling it round at the same time as swiftly as possible.

"Now tell me whether you can distinguish the colours," said he.

"Oh no, no papa!" exclaimed Alfred, "I cannot distinguish them at all; that part of the rim of the wheel upon which are fixed, appears, as it goes swiftly round, white—perfectly white."

"This experiment then," said his father, stopping the wheel, "proves, simple as it is, that *white is composed* of the seven primary colours, and that the whiteness of the sun's light is owing to a mixture of them."

"Yes, papa, I am convinced of the fact."

"Now," said his father, "Alice may have her spinning-wheel again, it has answered the purpose for which I wanted it; but I have just thought of another experiment, which will afford a permanent proof of the truth of my assertion respecting colours. Alfred, I believe you have a large humming-top. Do you know where it is?"

"Yes, papa, I will fetch it, my uncle gave it me a few months ago, when he came from London; the wood of which it is made is white, for it is Tunbridge-ware.

"Here it is, papa."

"Now," said his father, "spin it upon the carpet."

Alfred did as his father had desired him.

"It looks white, quite white," said he, "for the wood of which Tunbridge-ware toys is made is generally box or holly, both of which are of a light colour, approaching to white."

"Now give it to me, my dear, and go and read the chapter, which I wished you to read, to your mother."

His father left the room, but in the course of half an hour returned, bringing with him the Tunbridge-ware humming-top.

"I have been painting your top, my dear Alfred," said he, "I have painted it with the seven primary colours —a band of each of those colours is placed round it in regular order."

"I see you have, papa; I should scarcely have known it to be the same top that it was an hour or two ago."

"Now spin it again, and tell me

whether you perceive any difference between its present appearance and the appearance it made last time you spun it.

Alfred again untwirled the string and spun the top upon the carpet, according to his father's request.

"No papa," said he, "I see no difference; it looks exactly as white as it did before; I am *quite* convinced now, beyond all doubt, that as rays of light consist of seven colours so does white, which is in fact light, consist of a union of them."

"Very well," said his father, "this is all I have to tell you, at present, unless, indeed, I repeat what I said before, that as white is a mixture of all colours it reflects the light or heat of the sun, whilst black, which is an absence of all colours, absorbs it. This is the reason why my intel-

ligent friend at Widcomb had the wall, against which his favourite vine was trained, painted black; it, in consequence, receives so much heat from the sun in the day-time, as to continue warm in some degree through the night, and thereby preserves the fruit from frosts and forwards its growth; for, as Francis has told you, vines require a considerable degree of heat to bring them to perfection. Now I must leave you."

"Stay one minute—only one minute, papa. Is it not for the same reason that you wear a white hat in the summer, and a black hat in winter?"

"It is," said his father. "Now go and try some experiments for yourself. The theme—the subject is as inexhaustible as it is interesting.

The Morning Walk.

"ALFRED, my dear," said Mr. A., tapping at his room door early one delightful morning, "I am going a walk—will you accompany me?"

Alfred was already dressed; he gladly joined his father, and they proceeded hand-in-hand down a lane near their own house.

"It was a lovely morning, all was calm,
As though creation, thankful for repose,
In renovated beauty breathing balm
And blessedness around, from slumber rose."

The birds sang songs of joy, and carolled their hymns of praise and gratitude on many a trembling spray; the young lambkins frisked about the

meadows, and seemed as if rejoicing in their own innocence; the aged woodman whistled loudly as he bent his steps towards the destined grove where his axe was to destroy the produce of many revolving years; the gray mists retired from the distant hills; the nearer objects were illuminated by the bright beams of the newly risen sun, and the trees were tinged with a still more brilliant hue than usual; the leaves of the gay birch and aspen quivered as if full of life and animation, the majestic oak reared its venerable head as loftily as ever, and gladness seemed the nature of every living thing. Alfred's bosom beat with sympathetic pleasure, and, full of admiration and joy, he noticed first one object and then another; he knew how to appreciate the beauties

of nature; for nature, in her enchanting variety, presented objects ever new and interesting to his youthful mind.

"Cannot you recollect any poetical description of morning, my dear?" said his father.

Alfred thought for a little time, and then he said,

"Yes, papa, there is a very beautiful, and what mamma calls accurate, description of morning in the 'Minstrel,' shall I repeat it?"

"Do, my love."

"But who the melodies of morn can tell?
The wild brook babbling down the mountain side;
The lowing herd; the sheepfold's simple bell;
The pipe of early shepherd dim descried
In the lone valley; echoing far and wide
The clamorous horn among the cliffs above;
The hollow murmur of the ocean tide;
The hum of bees, the linnet's lay of love,
And the full choir that wakes the universal grove.

"The cottage curs at early pilgrim bark;
Crowned with her pail the tripping milk-maid sings;
The whistling ploughman stalks afield; and hark!
Down the rough slope the ponderous waggon rings;
Through rustling corn the hare astonished springs;
Slow tolls the village clock the drowsy hour;
The partridge bursts away on whirring wings;
Deep mourns the turtle in sequestered bower,
And shrill lark carols clear from her aërial tour."

"Oh, papa!—I have often thought this passage extremely beautiful, but I never liked it half so well before as I do now. It is so natural, so true, so descriptive. We hear the 'sheep-fold's simple bell,' and the 'linnet's lay of love;' we see the 'wild brook babbling down the mountain's side,' and the tripping milk-maid, crowned with her pail of nice new milk. Indeed, papa, I think beauty does consist in truth, at least when that truth is prettily expressed."

"I am very glad you do think so, my dear," said Mr. A., "and that you prefer poetry which describes real objects, to that which is intended merely to charm the ear and please the imagination."

Alfred's father had taken particular care that he should never read any poetry which he could not fully understand, or which was above his comprehension. He had never read the whole of the 'Minstrel,' and had learned those parts only which, from their beautiful simplicity, are perfectly adapted to the capacity of so young a reader. He had read passages likewise, selected by his father, from Cowper, Thomson, Milton, and most of our eminent poets; he had perused just enough to taste their beauties, and had a rich store in reserve against

the time when he should be able to appreciate still more highly all their hidden treasures.

"Your quotation is very *apropos*, my dear," said his father, when Alfred had a little exhausted his admiration; "but there are a few lines preceding those you have repeated, which may, I think, be applied to *Alfred*, as well as to Edwin.

"Even now his eyes with smiles of rapture glow,
As on he wanders through the scenes of morn;
Where the fresh flowers in living lustre blow,
Where thousand pearls the dewy lawns adorn,
A thousand notes of joy in every breeze are borne."

"They are beautiful—those lines are very beautiful, papa," said Alfred, repeating the line,

"Where thousand pearls the dewy lawns adorn."

"See, how every blade of grass is covered with little drops of dew;

they glitter like diamonds now the sun shines; every leaf and every blossom display a 'thousand pearls,' as the poet is pleased to call them; I wish, papa, you would tell me what dew is. I have often noticed that the lawn, the trees, and shrubs and flowers are covered with it almost every morning, when we are quite sure that there has been no rain in the night, and I shall be very glad to know where it comes from, or what produces it."

"I will endeavour to satisfy your laudable curiosity, my love," said his father.

"In the first place, what are clouds and fogs? Can you tell me?"

"I know that when the clouds fall they cause rain," said Alfred, "but I do not know where the clouds them-

selves come from nor how they are produced."

"All clouds," said his father, "are produced by evaporation."

"*Evaporation!* what is that, papa?"

"Heat, whether caused by the sun or fire, causes the particles of water to fly off or disperse into the air, and this is called *evaporation.* By the heat of the sun a constant process of evaporation is carried on; that is, the particles of water contained in seas, lakes, and rivers, are constantly being raised into the air or atmosphere, and when they have ascended to a certain height they become *clouds.* These clouds are increased by a continual addition of vapours, and their particles are driven close together by winds and other causes, which makes them run into drops heavy enough to fall down in *rain.*"

"So clouds are in reality nothing but vapours floating in the air—vapours raised by the process of evaporation," said Alfred.

"Nothing more," said his father. "And you see, my dear, that as this is the case, there is a constant round of the waters—they are raised from the sea chiefly, are carried by the winds over the land in the form of clouds, fall in rain, and then return again to the sea in rivers."

"Then as much rain falls as is evaporated," said Alfred. "But, papa, you have said nothing about dew."

"I thought it better that you should understand what is meant by evaporation first," said his father, "and now we will talk about dew."

"There is, besides the evapora-

tion from the seas, lakes, and rivers, a continual and very large evaporation from the surface of the earth, at all seasons of the year, of water in the form of vapour, and the warmer the ground the greater will be the evaporation. As I have already told you, evaporation is occasioned by heat, and the moisture that is in the earth being raised, or evaporated by the heat of the sun during the day, is condensed or formed into small drops of water during the night, which rest upon the surface of bodies near the ground—upon grass, and trees, and shrubs, and flowers, and these drops, from their transparency and beauty, are poetically termed *pearls;* Beattie is not the only poet who has thus designated them. Our favourite Milton says—

"Now morn her rosy steps in th' eastern clime
Advancing, strewed the earth with orient pearl."

You comprehend the justness of this simile, but do you comprehend the cause of dew?"

"I believe I do, papa; and the principal difference, between rain and dew, is, that the drops of rain have to fall a considerable space before they reach the earth (because the clouds of which they are formed are so high in the air) whilst the drops of dew are produced by the condensation, as I suppose you would say, of vapour nearer the ground."

"Very well explained," said Alfred's father, "you are now acquainted with the origin or cause of clouds, and of dew. Do you wish to know any thing else?"

"To know any thing else, papa?

Oh yes, indeed, I do! I am never tired of gaining information; you know I am perpetually asking mamma and yourself fresh questions; I should not ask questions if I did not intend to acquire knowledge by that means. There are so many things that I wish to know that I really cannot tell with which to begin—snow, hail, ice, and frost, papa—begin with which you please."

"Snow," said Mr. A. "is formed by the clouds becoming frozen *before* their particles are gathered into drops, that is, while in a state of vapour, the vapour falls in frozen flakes instead of drops of water; *flakes of frozen vapour* are what constitute snow:

"Then from aërial treasures downward pours,
Sheets of unsullied snow in lucid showers;

Flake after flake, through air, thick wavering flies,
Till one vast shining waste all nature lies.
Then the proud hills a virgin whiteness shed,
A dazzling brightness glitters from the mead;
The hoary trees reflect a silver show,
And groves beneath the lovely burthen bow."

"What is hail, papa?"

"Hail is caused by the freezing or congealing of the drops of rain *after* they have begun to fall, occasioned, perhaps, by their passing through a region of cold air."

"Then, according to that," said Alfred, "frost is occasioned by cold. Indeed, this seems likely, and needs no proof, as we only find frost in the winter when the weather is so very severe, and when my sisters like to sit still by a warm fire in the parlour all day as though they were afraid of moving. What occasions frost, papa? what occasions that vapour,

of which you tell me snow is formed, to become frozen? what occasions the hailstones to freeze as they fall?"

"What art thou, frost? and whence are thy keen stores
Derived, thou secret, all invading power,
Which e'en the illusive fluid cannot fly?"

"I do not wonder at your inquiries," continued his father. "Wonderful, astonishing indeed, are the operations of frost! How different is a winter morning from the present scene! then the bright emerald green, with which the fields are now clothed, is exchanged for one vast sheet of ice; the 'babbling brook' which now charms you with its gentle murmur, is stopped in its career, and its formerly flowing surface is chained to the banks; the trees now so green and beautiful are then incrusted with

shining particles, and little white transparent icicles hang pendant from the leafless branches; the rapid river becomes a solid road, and groups of merry children slide and skate along the crystal pavement. What can be the cause of all these wonderful transformations? What can cause effects so surprising?—well, my love, may you inquire how they are produced. I will, however, endeavour to give you as simple an answer as I can, to an apparently simple question. We say they are occasioned by *freezing*, and hundreds of people rest satisfied with this solution without making any farther inquiries about the matter. Are *you* contented?"

"Not by any means, papa, I wish to know what *freezing* is. I see you

smile; I am all attention. 'The first to listen and the last to speak,' as mamma says that I ought to be, and as I generally try to be."

"In the first place, do you know what a fluid is?" said his father.

"Yes, papa, any thing that we can pour from one vessel into another, as water, milk, beer, cider, and wine."

"The fixing of a fluid body," continued his father, "into a firm or solid mass, by the action of cold, is called freezing or congelation, in which sense the terms are applied to water when it becomes ice. The process of freezing is always attended with the emission or loss of heat. There is in most fluids and other things an element or simple substance, the chemical name of which is *caloric*, and

which produces the sensation of heat when it is passing from one body to another. Ice is water deprived of its *caloric;* when the caloric returns the ice is again converted into water. Tell me how I might prove this."

"Oh, I know very well, papa. When we accidentally left the water-pot, with some water in it, out on the lawn one cold night last winter, we found the water frozen in the morning; it was changed into a cake of ice; you desired Francis to place it before the kitchen fire for a short time; he did so, and I recollect that in the course of an hour the ice was melted by the heat of the fire, by the return of caloric I suppose you would say, and was again become water."

"Very well," said his father, "you

could not have fixed upon a better instance to prove the effect that heat has upon ice.

"All frost is occasioned by the deprivation of caloric, or heat, whether it be from water, rain, dew, clouds, or vapours."

"But, papa, will you tell me *why* this is the case."

"Ah, my little philosopher, now *you* have puzzled *me!* This is more than I can tell, or at least more than I can explain to you."

The Old Woodman.

THERE was a large wood near the house in which Mr. A. lived, and Alfred was very fond of rambling about in it; sometimes climbing the trees

in search of nuts for his sisters, and sometimes creeping carefully along among the low underwood in search of birds-nests ; not that he wanted to rob the poor birds, bu the delighted to notice the tender care with which they watched over their little ones, and to examine the curious structure of their various abodes ; he would often observe with surprise and astonishment how admirably each was provided with what would be most likely to promote the comfort of its little inmates ; as he was one day wandering in this manner, lost in thought, and reflecting upon the order and harmony of creation, his attention was arrested by a beautiful little animal of a brown colour, with a fine long bushy tail and dark sparkling eyes, which ran up a fir-tree

with singular rapidity, and proved to be a squirrel; though it was soon lost among the thick branches. On farther research, however, a nest was found in the hollow of an old oak just by, composed of moss and dry leaves, and secured from the rain by means of a little canopy over-head composed of the same materials. This warm and comfortable nest was found to contain two or three little squirrels, and in compliance with Alfred's warm entreaties, he was allowed to take one in his possession; to tame it, and feed it, and regard it entirely as his own property.

So much by way of introduction. The squirrel soon became a great favourite of course, and its young master amused himself during many a leisure moment in watching its little

antics, and observing it dress its fur. He fed it with milk, and bread, and apples, but had peculiar gratification in seeing the manner in which it would set up on its hind feet and ingeniously crack the nuts which he gave it. After having wandered for a long time in the wood one day, in search of nuts for his little Brunette, but without much success, he came to an old hazel, which hung its pendant branches, loaded with fine fruit, over a small stream that trickled down a little ascent below it. What was to be done? the nuts looked very tempting, but they were far out of Alfred's reach, and, after making every attempt in his power to procure them by jumping and leaping, and endeavouring to draw down the bough with a long hooked stick, he sat down upon

the green bank by the side of the rivulet to consider what was to be done. In the course of a few minutes, he fancied he heard the sound of a woodman's axe in the wood, and recollected to have seen an old man engaged in felling some of the timber trees at the end of the wood a day or two before: this old man lived in the village, and was well known to Alfred. He jumped up directly, and was about to call to him, when he imagined that he heard the sound of the axe in another direction, and in a different part of the wood, and consequently that it might not proceed from the quarter he wanted. He, however, listened for a moment, and not hearing it again, shouted "Peter Rose," which was the name of the old man, as loudly as he could,

when, to his astonishment, "*Peter Rose*" was repeated loud and distinctly. Alfred thought at first, that it was some one imitating him in play, but he shouted again, "Peter Rose, Peter Rose, I want your assistance in gathering some nuts;" and in an instant after heard the sounds repeated again very clearly and distinctly, "Peter Rose, Peter Rose, I want your assistance in gathering some nuts!" Full of astonishment and surprise, he scarcely knew what to make of this wonderful, or, at least, apparently wonderful phenomenon. He listened once more for the axe, and found that as fast as the sound of the blow reached his ear in one direction, it was repeated in another; he judged correctly in thinking that the same axe must produce

it, as it was only repeated every time that the sound of thereal axe was heard. His astonishment and curiosity increased, and he hastened down a little winding path towards the spot where he had seen the woodman a few days before, felling some trees; there was the old labourer as busy as ever. Alfred informed him of what had passed, and begged to know if it was he who had repeated the sentence that he had heard in the wood —"Peter Rose, Peter Rose, I want your assistance in gathering some nuts?"

"No, indeed, my little master," said the old man, "for if I had heard your voice, I should have answered it properly, and not in that there odd way. I do not think that there is any other woodman at work in the wood,

and I cannot tell, I am sure, what were them there strange sounds that you heard. However, I will go with ye now if ye please."

As the good-natured old woodman spoke, he laid down his axe and followed Alfred to the spot where he had discovered the hazel loaded with such fine nuts. As soon as they arrived there, the latter ascended a little eminence above the brook, which was shaded by two old oaks, that bent together in the form of an arch above it, and shouted "Alfred, Alfred," as loudly as he could.

"There, did you hear something say Alfred, Alfred, just as I spoke, Peter?" said the youthful inquirer.

"I heard it, sure enough, but please you, my little master, I think

it will be easier for me to reach down the nuts, than to tell you what made it."

Alfred thought so too by this time, and he determined to restrain his curiosity respecting this *indescribable something* till he should see his father, who was his oracle upon all such occasions. So, instead of saying any thing more about it, he assisted old Peter, and, between them both, they had presently stripped the venerable hazel-tree of its load of fine nuts; and the latter, after thanking the kind-hearted old man, returned in triumph towards home, with an abundant supply for his squirrel, meditating, during his walk, upon the sounds which had so strongly excited his curiosity; for, as we have said before, Alfred was a thoughtful boy, and

always liked to trace effects to their causes. Having related the little circumstance to his father, his astonishment in some degree subsided on being told that the *air alone produces all the noise that we hear*, that is, that without the assistance of air, sounds cannot be produced, as all the varieties of sound that we hear depend entirely upon a certain motion of the particles of air.

"When the wind blows," said his father, "do you not hear different noises, different degrees of sound?—the wind is nothing but air in motion, and it is loud and tempestuous, or soft and gentle, according to the rapidity with which it moves."

"Ah! ah! I am glad you have told me what wind is, papa, I never knew before that the wind was nothing

more than air in motion; but with what astonishing force it must sometimes move, for I recollect, when we were at Widcomb, hearing Mr. —— say, that twenty-six of the largest elm-trees in the park were blown down during that very windy night last winter. But I interrupt you, I believe you were going to tell me something more about sound."

"I think it best to give you a simple definition of the cause of sound, before I proceed to the cause of the sounds you heard in the wood," said his father. "It is better to proceed gradually from one thing to another, and to have a right and clear comprehension of each as we go on. The element called air is a fluid mass, nearly like water, which presses and floats upon the whole surface of

the earth, and as this is the case, it follows, that as soon as any one of the particles of which it is composed is put in motion, and urged forwards by any cause, it must propel, or send forward, the particle next before it; this second particle in the same manner moves a third, and so on successively, and by these means a motion is communicated at a greater or less distance to all the air around, similar to those circular waves which you may observe extending by degrees over a pond when you throw a stone into it. Have you ever noticed the effect thus produced?"

"Oh yes, papa. Those little circular waves become larger and larger, until they reach the side of the pond."

"And what then, my dear?"

"The bank obstructs their pro-

gress, papa, and they return again towards the spot whence they set out —towards the spot in which the stone was thrown—at least, if they have force enough remaining."

"Very well. Now think about sound."

Alfred stood in a thoughtful attitude.

"I have thought, papa, I have considered;" said he, at last. "I think that when sound is once produced in the air it must do the same; I mean that if the circular waves in the air produced by a single sound—"

"It will be better to say *undulations* of sound," said his father.

"Well, then, papa, I mean that if the undulations of sound, as you call them, meet with any object in their progress, as a mountain or a build-

ing, that they must strike against that object, and be forced to return to us, as the little circular waves in the fish-pond are sent back—perhaps reflected would be a better word—reflected back when their progress is stopped by the bank. I think that I now understand the cause of those sounds which puzzled me so much in the wood."

"You have given a very good and ingenious definition of the phenomenon, my love," said Mr. A., "and I am glad to find you have obtained so clear a comprehension of my definition of sound. You are quite right in your supposition as to the cause of the repetition of the sound of your voice in the wood, and this repetition is called an *echo*. When you pronounced the name

of Peter Rose, the sound of your voice met with some obstacle that obstructed its progress, probably the hill on the opposite side of the wood, and was, of course, as you properly observe, reflected, or obliged to turn back; by doing so it arrived again at the place whence it set out, at the bank by the hazel-tree, and produced upon your ear the double sound, called an *echo:* it sometimes happens that the words repeated are pronounced not only once, but several times; a good deal depends upon the situation of the person who speaks."

"I will go to the hazel-tree in the wood and make my voice echo again," said Alfred, "and then I will try it in another part of the wood; if it is only to be heard when I am standing opposite to the hill, I shall be quite

convinced of the truth of what we have been saying."

"Do, my dear; it is right and laudable to make little experiments for yourself, especially when those experiments are calculated to aid you in the acquisition of useful knowledge."

"I suppose you would call air a conductor of sound, papa."

"Yes, certainly: water is also a conductor of sound, indeed, it has lately been proved that it conducts sound more than any other body whatever. A conversation, delivered in no very loud tone, has been distinctly heard on water at the distance of a mile, and a whisper has been heard at the distance of two hundred yards. Wood is a conductor of sound; next time we walk by a carpenter's yard, I will

draw a pin across the end of one of the long planks of wood, and you will find, by putting your ear to the other end of the plank, even if it be fifty feet in length, that you may hear the sound of the pin as distinctly as though you were close to me, which will be both a plain and simple proof that wood is a conductor."

"I think, papa, that sound must travel very quickly, for I had no sooner spoken, than I heard the echo of my voice."

"The velocity with which sound travels, is very astonishing," said Mr. A. "It moves one thousand, one hundred and forty-two feet in one second, or ——— can you calculate how far that is in a minute?"

Alfred was a good arithmetician, and he presently replied, "About thirteen miles in a minute, papa.

How astonishing!" continued he, "thirteen miles in one minute!"

"Light, however, moves with much greater, with almost inconceivable velocity," said his father; "perhaps you will scarcely credit me when I tell you that it travels at the rate of twelve millions of miles in one minute!"

"Then the reason why we see a flash of lightning before we hear the thunder, I suppose, papa," said Alfred, when his surprise was a little exhausted, is that "light travels so much faster than sound?"

"It is," said Mr. A., "and this is also the reason why we see the flash of light from a gun before we hear the report."

A knowledge of the progression of sound is in many instances useful, for by this we are enabled to deter-

mine the distance of ships, or other moving bodies. Suppose, for example, that a vessel in distress fires a gun, the sound of which is heard five moments after the flash is seen; as sound moves one thousand, one hundred and forty feet in one moment, this number being multiplied by five will give the distance ——"

"The distance of five thousand seven hundred and ten feet," said Alfred—"more than a mile. And I suppose that this is the manner in which you calculate about the distance of thunder. When Caroline was alarmed at the loud thunder last summer, I recollect seeing you take out your watch, and hearing you tell her not to be alarmed, for that it was nearly a mile off, and consequently not attended with danger. I did not then know how you managed to cal-

culate, but I suppose you counted the number of seconds by the moment hand of your watch, and then multiplied one thousand one hundred and forty-two, the number of feet sound travels in one moment, by the number of moments that elapsed between the flash of lightning and the report of the thunder."

"You are quite right in your conjecture; and now, my love, I must leave you, as business requires my attendance. You may, if you please, go into the wood and try some more experiments. I am always glad to see you desirous of obtaining useful knowledge, and of adding to your stock of information. Go on, my dear boy, in laying up a store for future use: knowledge distinguishes civilised from savage life, its cultiva-

tion in youth promotes virtue, and virtue is the true foundation of happiness. You may gain knowledge from every object around you; use the habit of observation, reason and reflect, and improve your understanding, while you rectify your heart."

The Stick of Sealing-wax.

"THERE now, I have finished my letter," said Alfred's little sister, as she folded up a neatly-written sheet; "will you seal it for me, papa?"

"Oh, let me seal it, do let me seal it for Fanny," said Alfred, taking up some sealing-wax that lay on the table, "I am so fond of sealing letters."

"If it will afford you any gratification, you may certainly," said his father, "shall I lend you my seal?"

"No, I thank you, papa, the letter is to be sealed with my own little seal, if you please," said Fanny, because of the motto that is upon it—"*Repondez vite*," *reply quickly*. I am writing to mamma, to tell her that I hope she will come home next week, and that I wish her to write to me before she comes home. There, now I have lighted the little wax-taper, and there is my seal, brother, the seal that papa bought for me when we were at Cheltenham last summer."

The letter, being quite completed, was presently sealed with Fanny's favourite seal.

"See how cleverly Alfred has

done it!" said she, holding it towards her father. But her father was engaged in looking in his writing-desk for something else; he presently turned to Alfred and desired him to rub the stick of sealing-wax as quickly as he could upon the sleeve of his coat.

Alfred laughed and did as his father had desired.

"I do so because you desire me to do so, papa," said he, "and because I always like to do what you desire me to do, but what reason you can possibly have for wishing me to rub this sealing-wax upon the sleeve of my coat, I cannot imagine."

"Now hold it towards these little bits of paper which are spread out on the table," said Mr. A., without noticing his remark.

Alfred did so, and the pieces of paper were, to the astonishment of the children, immediately drawn towards it, raised on an end, and otherwise put in motion.

"I never saw pieces of paper jump before, papa," said little Fanny, laughing at the novelty of such an appearance.

"*Jump!*" said Alfred, laughing still more, "you would not say they *jumped*, would you, papa? though, to tell the truth, I can scarcely say what word should be used in its place."

"They are *attracted*," said his father—"attracted towards the sealing wax."

"But what can possibly have produced this effect? Perhaps the sealing-wax was not quite cold, for you

know I had just been sealing Fanny's letter with it; and this might make it attract the paper."

"But the paper does not stick to it, as it would do if the wax had been warmed in the candle," said his father, "you may easily shake it off, if you please. There, warm it again in the flame of the taper, and try the effect."

Alfred did so, and the little bits of paper of course stuck firmly to it, so firmly, that he could not take them off.

"Now rub the other end of the sealing-wax once more upon your coat, and convince yourself that the effects produced by friction and by the heat of the candle are different, very different," said his father.

Alfred complied with his father's desire, and the little bits of paper

were affected just in the same manner as they had been at first.

"Here is an empty glass bottle," said Mr. A. "rub it on the sleeve of your coat in the same manner, and then hold it over the bits of paper."

The effect produced was similar to that produced by the sealing-wax; the bits of paper were attracted towards the glass, and Mr. A. said that if the experiment had been made in the dark, the *glass* and the *wax* would have exhibited faint signs of *light*.

It now remained to seek the cause of so curious an effect. Alfred appealed, as usual, to his father.

"The power thus excited," said Mr. A. "is called *electric*, and the little *light* which I have just told you might be perceived emanating from the wax had the experiment been

made in the dark, is called the *electrical fire*, or *fluid*. I have often told you that we must cultivate the habits of observation and reflection, in order to aid us in the acquisition of knowledge. Mr. Boyle was the first who had a glimpse of the electric fluid; as he remarked, after rubbing some diamonds that they afforded light in the dark. This observation led to reflection, and the various electric properties of bodies became an object of curiosity.

This electrical fire or fluid is one of the most wonderful in nature, and the earth, and almost all bodies with which we are acquainted, are supposed to contain a certain quantity of it, though it seems to lie dormant until put in action by rubbing or friction, and then, as I have already

said, it appears like fire. The bodies over which it passes freely are all metals, and most animal and vegetable substances, all of which are called *conductors of electricity*, as air and water are conductors of sound. But this peculiar fluid will not pass over glass, sulphur, charcoal, silk, baked woods, or dry woollen substances; all these bodies, therefore, are called *non-conductors*.

"Is sealing-wax a conductor, father?"

"No, my dear, I was going to tell you that heat, produced by friction and moisture, renders all substances conductors, and that it was in consequence of the heat produced by the friction on the woollen cloth, of which your coat is made, that the sealing-wax became one. Here is a

piece of amber," continued he, opening a little drawer in his escritoire, "this contains the same properties as sealing-wax; I mean, that on being rubbed, it acquires electric powers. The ancients were well acquainted with them, and the name electricity is derived from a Greek word, *electron*, signifying amber."

"Well, papa, and, after all, what grand discovery has been made in electricity?"

"I led your attention to the subject," said Mr. A., "in consequence of having heard you express a wish to become acquainted with the cause of thunder and lightning: thunder and lightning are the effect of electricity in the clouds. A flash of lightning is simply a stream of the electric power passing from the

clouds to the earth, from the earth to the clouds, or from one cloud to another cloud; and thunder is the report and the echoes of the report between the clouds and the earth.

"Oh, papa, how can you prove this? how can you prove that lightning is nothing more than a stream of electric fluid?"

"Flashes of lightning are generally seen crooked, and waving in the air," said Mr. A.; "this is also the case with the electric spark, when it is drawn from an irregular body at some distance. Lightning strikes the highest and most pointed objects in its way, the church spire, last summer, for instance; in the same manner all pointed conductors receive or throw off the electric fluid more readily than such as are termi-

nated by flat surfaces. Lightning takes the readiest and best conductor, so does the electrical fluid; lightning burns, so does electricity; lightning sometimes dissolves metals, so does electricity; lightning has been frequently known to strike people blind; pigeons and other small birds have lost their sight by electricity; lightning sometimes destroys animal life, animals have also been killed by electricity. But what proves, in the clearest manner possible, the perfect similarity, or rather identity, of lightning and electricity, is, that Dr. Franklin, who is justly celebrated for his many discoveries, particularly in this branch of natural philosophy, astonishing as it may appear to you, actually contrived to bring lightning down from the heavens by means of

a kite, which he raised when a storm of thunder was coming on."

"How could he possibly manage this, papa?—I wonder what gave him the idea in the first place, that lightning and electricity were one and the same thing."

"Observation, my little friend. What is there that observation, aided by reflection, will not accomplish? He was first led to the discovery by comparing, as we have done, the effects of lightning with those of electricity, and by considering that if two gun barrels electrified will strike at two inches, and make a loud report, what must be the effect of ten thousand acres of electrified cloud? He, however, was of too ardent a disposition to rest satisfied with mere speculation; he therefore constructed a kite—"

"A paper kite?—a common paper kite, like mine, papa?"

"Not quite like yours, my love, because it was composed of silk, silk being better adapted than paper to bear the wet and wind of a thunder gust, without tearing. He first made a small cross of two light strips of cedar, the arms of which were so long as to reach to the four corners of a large thin silk handkerchief when extended; he then tied the corners of the handkerchief to the extremity of the cross, and fixed a very sharp pointed wire, rising a foot or more above the wood, to the top of the upright stick of the cross; the kite was of course provided with a tail, loop, and string, like yours, and thus completed, the ingenious philosopher contrived to send it up into an electrical cloud during a

thunder-storm. The wire in the kite, being a conductor, attracted the lightning or electric fire from the cloud, and it descended down the hempen string, and was received by a key fastened to the extremity of it; that part of the string which he held in his hand being of silk, that the electric virtue might stop when it came to the key."

"Why should it stop there?—If I had been in Dr. Franklin's place, I should have been afraid that the flash of lightning drawn down from the clouds would have produced some dangerous consequence."

"Prudent foresight induced him to use the precaution of placing a long piece of silk between himself and the key," said Mr. A. "Cannot you tell why he did so?"

"Oh, I know now," said Alfred, after a moment's reflection, "I need not have asked the question. I recollect you said that silk is a non-conductor: that was a clever contrivance of the Doctor's! Well, what did he do with his electrified key?"

"He charged phials with it, and from the electric fire thus obtained, kindled spirits, and performed a great number of other experiments; but above all completely demonstrated the identity of lightning with that of electricity. Soon after this discovery he constructed an insulated rod to draw the lightning from the atmosphere into his house, in order to enable him to make experiments upon it; he also connected with it two bells, which gave him notice by their ringing when the rod was elec-

trified. This was the origin of the metallic conductors now in general use.

"To know that lightning and electric matter are the same, is a great step in natural philosophy, though we still remain ignorant of the causes of many of the appearances which accompany thunder-storms.

"Now, my dear Alfred, try to explain the manner in which the claps of thunder that usually accompany the flashes of lightning are occasioned."

"The air rushes together in a moment to fill the space made by the passage of the electric matter, I suppose, papa," said Alfred.

"Yes;—and thunder is the report and the echoes of the report between the clouds and the earth.

"A number of entertaining and

useful experiments may be made by means of a machine constructed for the purpose, and called an electrical machine," said Mr. A.; "but I think we have said almost enough upon the subject at present.

"From what a variety of sources may we derive improvement. A simple stick of sealing-wax may prove the origin of many ingenious inquiries, and of much novel information. Seize every opportunity, my love, of adding to your store of useful knowledge; let nothing pass unnoticed; let no opportunity be neglected. Lord Bacon has justly told us, that "Knowledge is Power."

"Fanny has written *her* letter; now let me write *mine*."

"Presently, papa, presently: my curiosity is not half satisfied. I want

to know a great, great deal more about this curious electric fluid. In the first place, I do not quite understand what you mean by *metallic conductors.*"

"The use of metallic conductors is to secure buildings from the dreadful effects which lightning sometimes produces," said Mr. A. "This is done by fixing a pointed iron rod higher than any parts of the building, and joining to the lower end of it a wire which must communicate with the earth, or rather the nearest water: this rod the lightning will seize upon sooner than any part of the building; it will therefore descend along it, and then along the annexed wire, until it reaches the earth or water, when it will be dispersed without doing any harm."

"I am glad, very glad, that I understand the cause of the wonderful phenomenon of thunder and lightning, papa: you have the art of explaining—of making every thing appear plain and easy. I think there are few things more awful and wonderful than thunder and lightning."

"Few," said Mr. A. "more calculated to raise serious reflections; when we hear the thunder's tremendous clap, and see the lightning's vivid flash, we are naturally filled with wonder and awe; but instead of shrinking with terror when "gathering tempests cloud the vaulted skies," we should rely with full confidence upon that Almighty Power, by whose fiat their course is directed. The elements are in His hand:

" His word the raging tempest can control,
And bid the awful thunder cease to roll;
Can stay the raging of the boisterous main,
And make its billows sleep in peace again;
His hand can quench the liquid fiery flames
That flash across the vast aërial plains;
Can make the sun's enlivening beams arise,
And dissipate the darkness of the skies."

Caroline's Magnetic Swan.

WINTER was come, the toils of the harvest were ended, the ground was covered with one vast sheet of ice, and the leafless branches of the trees and shrubs hung down in consequence of the weight of snow that covered them. Icicles were suspended from the roof of every cot, the birds had ceased their warbling, and Nature, lately gay and smiling, was clad in a mantle of snowy white.

Every season, however, has its peculiar pleasures: when we can no longer wander abroad amidst the fields and woods, we can seek for enjoyments at home, and this may surely be found by the cheerful fireside of domestic happiness—by the fireside of a delightful home, where "polished friends and dear relations mingle into bliss."

Alfred had been absent some days on a visit to his father's friend at Widcomb. He returned home one evening when it was growing late, and "twilight gray had in her sober livery all things clad," and entered the drawing-room at that beloved retreat just as the curtains were drawn and the candles lighted. The moment the door was opened, he beheld an animated group of

merry children kneeling upon their chairs round a large table, and intently engaged in watching the movements of a little artificial swan, which was gliding about with apparent ease, in a large basin of water. Their voices assumed a still more joyful tone when Alfred's name was announced, and the little circle instantaneously, and with one accord, opened to receive him; his amiable disposition had endeared him to his sisters and all his young companions, and he was presently appealed to as the oracle of the party, called upon, in fact, to account for the movements of this extraordinary swan. But even the intelligent Alfred was at a loss to explain by what means a little artificial swan should be enabled to follow

the bit of bread, which, being placed at the end of a small stick, Caroline held towards it, and he begged to know where it came from : the children replied, that this swan had been sent as a present to Caroline during his absence and that they had been all the preceding evening amusing themselves with it, and endeavouring to find out the reason of its curious motions; for, if the crumb of bread were held on one side of the basin, it immediately advanced towards it; if it were placed on the other side of the basin, it was instantly there; if Caroline drew it in circles round and round the basin the little swan, unwearied in the chace, still pursued it.

All this was a mystery; no one could solve the problem. The pretty

little white swan continued to glide about as gracefully as ever, and the curiosity of the young group, who were still gazing upon it with fixed attention, became more lively than heretofore. At length, Mr. A., whose attention was arrested by the repeated bursts of laughter that proceeded from the side of the room where the children were stationed, put down the book he was reading, and advanced towards the table. "Oh, here comes papa! here is papa!" exclaimed Caroline; "we will appeal to him, for papa knows every thing."

"Profoundly skilled in deep and learned lore!" said he, laughing, "what is it you wish to know?"

"We wish to have mysteries unravelled, papa" continued Caroline;

" we wish to know how a little artificial swan, composed of nothing more than plaster of Paris, can have the power of following this little stick in whatever direction I please to move it. You see there is nothing but water in the basin. There, look, papa! the poor little thing tries in vain to catch my crumb of bread. Pray, papa, account for this wonderful phenomenon."

" Who can tell me how nature is divided?" said Mr. A. " Either of you can answer that simple question."

"Into three kingdoms—animal, vegetable, and mineral, papa," said Alfred.

" All minerals, that is, all earths, soils, stones, and metals, belong to the latter," said Mr. A.; " but of all the

wonderful and varied productions of the mineral kingdom, there is not one more astonishing than that called the loadstone or magnet, which is a hard body of a dark brown, or almost black colour, and when examined is found to be an ore of iron. It is met with in various countries, generally in iron mines, and of all sizes and forms. This ore possesses the peculiar property of attracting iron; that is, when a piece of iron is held near it, it will attract or draw it towards itself: you, Alfred, are acquainted with the meaning of attraction; it is a general term to denote the principle by which any bodies mutually tend towards each other. The natural loadstone has the power of communicating its properties to iron and steel; and when pieces of steel, properly prepared, are

touched, as it is called, by the loadstone, they are called *artificial magnets.*

"The movements of Caroline's swan, whichhave hitherto appeared so extraordinary, may now be easily explained. Its body is made of a composition, but its bill is formed of a little bit of steel; the end of the little stick, upon which the crumb of bread is placed, has a small artificial magnet inserted in it; and, as I have just told you, as all magnets attract iron (steel, you know, is only iron prepared in a peculiar manner), the swan is of course attracted or drawn towards it, and astonishes those who are ignorant of the cause, by appearing as though it were in quest of the bread, which is, in fact, only placed upon the stick to aid the deception." The children

were delighted with this explanation of the curious phenomenon which had excited their curiosity, and continued to amuse themselves with it ; for novelty was still attached to the employ ; and, to the ardent mind of youth, novelty presents charms as endless as itself.

Alfred, however, was of a more inquiring disposition than the rest of the group, and he was determined to make a little swan for himself, to *prove*, as he said, that it contained nothing more than a little bit of steel. Having formed his project, he left the party in the drawing-room and hastened to the nursery, where he found his little sister Emma busily engaged amongst her dolls : by displaying before her a box of sweetmeats, which he had brought from

Widcomb, she was prevailed upon to part with a little wax-doll, the arm of which being broken off, had, as Alfred said, entirely lost its beauty. He then proceeded to his mother's dressing-room, and reached a large needle from her work-box, which he broke in two ; he then softened the wax, of which the doll was composed, before the fire, and moulded it in his fingers until it was sufficiently pliable to be formed into some shape. At last, with a good deal of ingenuity, a swan, or at least something resembling a swan, was constructed ; the broken needle formed its bill ; and Alfred, in triumph, returned to the drawing-room before the children were become tired of their amusement.

" Clever, clever Alfred ! " ex-

claimed Fanny, as her brother placed his swan upon the water. Caroline held the stick towards it, and the children shouted and clapped their hands with joy when they saw how well it glided across the basin after the bread.

Many little experiments succeeded the trial of the new swan : a steel topped thimble was lifted up by the artificial magnet ; some emery being scattered over a sheet of writing paper, on the approach of the magnet, arranged itself into various regular forms ; several needles were placed on the table, which, on the magnet being held towards them, were immediately raised on an end, and otherwise put in motion.

" Oh, papa," said Fanny, " the needles jump about, and fasten themselves to the magnet just as the little

bits of paper did to the sealing-wax the other day."

"Is there any difference, papa," inquired Alfred, "between the attraction of magnetism and the attraction of electricity?"

"The latter differs from the former in its operation, being confined to a particular state of the bodies, that is, when excited by friction. There are, in nature, several different kinds of attraction; and whether the same principle acts in each of them, or whether each of their effects depends upon a distinct cause, human sagacity has not yet been able to discover.

"The ancients were, I believe, acquainted with the attractive property of loadstone, but we have reason to suppose they were ignorant of its peculiar property of always turning

towards the north; accident, however, about five hundred years ago, led an Italian to discover, that if the loadstone were suspended on a point, and allowed to turn in any direction, one end would invariably turn towards the north, and of course the other end towards the south. In consequence of this remarkable circumstance, the mariner's compass was invented, an instrument which enables us to conduct ships across seas many thousand miles wide, and in which we must often sail for weeks together without seeing any land: by this means commerce is carried on; the produce and manufactures of one country are exchanged for those of another, and colonies are formed for this purpose in various parts of the world: nor is this the only use to

which the directive property of the loadstone may be applied; it guides the miners in their subterranean excavations, and conducts travellers through the vast sandy deserts of Arabia, which would otherwise be almost impassible."

"What an unaccountable and wonderful property!" exclaimed Alfred. "But if the compass be so essentially necessary to the sailors, papa, how did they manage before this loadstone was discovered?—how did they contrive to guide their vessels across the immense ocean?"

"This little instrument," replied his father, "gives us infinite advantages over the ancients; for till within the last four hundred years no ship ever ventured out of sight of land; at least, if they lost sight of land,

they gave themselves up to despair, and it was by mere accident if they ever gained it again ; they were, consequently, ignorant of the incalculable advantages we possess in the commerce so extensively carried on with other nations."

"Were the English the people who first employed the mariner's compass for this purpose, papa?"

"No: I believe the instrument itself was invented by the Dutch, and the Dutch and the Portuguese have, during the two last centuries, divided the trade of the world with the English. Within the last twenty years, however, England is become the undisputed mistress of the seas, which are every where covered with her ships ; her wealth, the extent of her commerce, and the value of her manu-

factures, are quite unequalled; and these, combined with the industry, intelligence, and energy of her inhabitants, have contributed to place her upon the standard of fame, and to render her an object of admiration to all other nations.

"Her present flourishing condition may, in some degree, be ascribed to the peculiar property of a little piece of iron ore! You need no stronger proof of the good resulting from the habit of *observation*, without which it would probably have ever remained unnoticed and undiscovered."

"But, papa," said Alfred, "are you sure, quite sure, that the loadstone, or pieces of iron rubbed with loadstone, always point north?"

"Can you doubt it, after the proofs I have given you of such being the

fact," said Mr. A.—" a fact proved by the experience of ages?

" I have a compass in my little drawer in the library; you shall see it.

" Here it is," said he, when he returned. " You see it is merely a magnetic needle, suspended on a centre, and placed on a frame, covered with glass. Beneath it, in the frame, are marked the thirty-two points of the compass, that is to say, the whole circle of the heavens are there divided into thirty-two parts. The principal of these are the cardinal points—north, south, east, and west; they are called cardinal from the Latin word *cardo*, signifying *chief*. By means of this small and simple instrument, the mariner is enabled to direct the course of his voyage in the wide and pathless ocean; for by

merely pointing northward, it proves a certain guide-post, and enables him to ascertain his exact position, and to shape his future course accordingly."

"All this is very wonderful and very astonishing!" said Alfred. "But now, papa, tell me *why* the useful loadstone always points towards the north."

"Ah, my little friend," said Mr. A. "that question would baffle the investigations of the most ingenious philosophers: it is yet unaccounted for.

"You see," continued he, with a significant glance at Caroline,—"you see that even *papa does not know every thing!*"

A Breakfast Conversation.

ALFRED entered the breakfast parlour one morning before the rest of the party; for it was winter, and on a cold frosty winter morning we often feel disposed to indulge ourselves by remaining too long on our warm downy pillows. It was Caroline's usual office to make breakfast, and the hissing urn already stood on the table waiting her *entrée*. Alfred stationed himself before the fire, and watched the steam, as it ascended in volumes from the lid of the urn, and he began to try to account for the cause of steam. Ever ingenious in making little experiments to prove the truth of any thing that suggested itself to

him, he took one of the plates off the table, and held it upside down about a foot above the urn. in order to see whether the ascent of the steam would be interrupted by it; he found that the side of the plate next to the urn was almost instantaneously covered with moisture, and that the particles of moisture were presently condensed, or formed into drops of water, upon the plate. His father came into the room while he was trying his experiments.

"I am endeavouring to prove that *steam* is merely water in a state of evaporation, papa," said he. "I once heard Fanny call the steam, that she saw rising from the urn, smoke; but smoke it cannot be! for, look, the inside of this plate is covered with water, with drops of water. The

steam from the urn is merely water, which, being converted into vapour, ascends like smoke."

"How is it converted into vapour?" said Mr. A.

"Oh, papa, I have not forgotten your explanation of the cause of rain and dew," said Alfred. "Heat is the cause of evaporation; the particles of water upon this plate were evaporated from the urn, in consequence of the heat that is in the urn—in consequence of the *heater* that is in it, I mean—and are now condensed into drops by the cold plate, just as the particles of water are evaporated by the heat of the sun from seas, lakes, and rivers, and condensed into drops of rain by the cold air in the sky."

"I will light this little wax-candle," said Mr. A., "and you may hold

another plate over the smoke of the candle in order to see the different effects of smoke and steam."

Alfred held the plate a foot or two above the flame of the candle; and and it was presently covered with black soot.

"Exhalation is a dispersion of dry particles from a body," said Mr. A.; "hence soot is an exhalation of smoke.

"Evaporation is a dispersion of wet particles from a fluid; hence steam is an evaporation of water."

"I suppose the cause of the vapour rising so rapidly from the urn is, that the water within it is so very hot," said Alfred.

"It is," said his father; "and the stronger the heat the greater is the evaporation.

Vapour or steam is water converted into an elastic fluid; you understand the subject so far. Now, attend to me. The process of passing from the state of a common fluid to that of vapour, is called boiling, and the degree of heat at which a fluid begins to boil, is called the boiling point. Do you know of any thing which is used to determine, to show and mark to us the different degrees of heat?"

"Yes, papa, a thermometer. There is a thermometer hanging up in your dressing-room."

"Yes," said Mr. A. "Thermometer comes from two Greek words, one of which signifies heat, and the other measure. *Meter* means measure. Thermo*meter*, a measurer of heat; hygro*meter*, a measurer of

moisture; baro*meter*, a measurer of the heat of the air; electro*meter*, a measurer of electricity; anemo*meter*, a measurer of the velocity of the wind. I dare say if you think a little about the thermometer, you will recollect having seen these words at a certain mark, *boiling heat*."

"Yes, papa, I do remember it; and I suppose the quicksilver in the thermometer would rise to that mark if it (I mean the thermometer) were immersed in water made boiling hot."

"Yes," said Mr. A. "Perhaps you would like to try the experiment. I will ring the bell and order a jug of boiling water to be brought in, and you, while your chocolate cools, may fetch the little thermometer from my dressing-room."

Away went Alfred, and soon returned, bringing with him the thermometer inclosed in its red-morocco case; it was, however, so contrived as to slip out of this case, and on being put into the hot water, the quicksilver, hitherto just at *temperate*, rose almost instantaneously to *boiling heat*.

"When water is boiling hot, that is, when it is as hot as the water in this jug," said his father, "it is as hot as it can be made, and consequently flies off or evaporates. The steam, or elastic fluid thus produced, admits of being compressed within a compass proportioned to the force which compresses it. Its force in resisting compression, when it is accumulated to a certain degree, is, however, greater than that of gunpowder, or of any

other power with which we are acquainted. Steam is therefore one of the most powerful, and at the same time most dangerous, agents in nature.

"The triumph of mechanics is the *steam-engine.* The inventor observed the excessive force of steam in lifting up the stiff lid of a tea-kettle as he sat at breakfast one morning, and he and others have applied this resistless power to produce a motion applicable to all kinds of machinery. You, yourself, may have noticed the same thing; you have probably observed that the lid of the urn is sometimes lifted up by the force of the steam evaporated from the boiling water within it."

"Yes," said Alfred; "but I never knew before that steam possessed so

much force as to be applied to any real use.

"How is the steam-engine constructed, papa?"

"I fear I cannot easily explain its construction to you, though extremely simple in itself," said Mr. A. "I will some day take you to see one, and describe its parts to you more minutely than I can do at present. Steam from a copper is thrown into a hollow iron cylinder, with a close lid or stopper, which rises as the steam rushes into the cylinder, and falls when the steam is condensed by cold water, thrown in for that purpose. So far you may understand me; the effect produced being somewhat similar to that occasionally produced by the steam in the urn. An upright iron rod is fixed to the lid of the cylinder, and to one end of a large beam, which

has an action communicated to it similar to that of a see-saw, and is lifted up and pulled down with astonishing force and precision. The mechanic seizes upon the regular and powerful motion thus produced, and readily applies it to all kinds of machinery. Some steam-engines perform the labour of thirty or fifty horses, and do the work of many hundred people. Flour-mills, cotton-mills, and silk-mills are turned by the steam-engine, and in various manufactures of iron, steel, and other metals, the labour of the workmen is diminished by this ingenious contrivance. A steam-engine, on a very improved principle, facilitates many of the operations carried on at Soho, near Birmingham, a place noted for the variety of its manufactures, and particularly that of coining, as the different processes are all performed

on the same spot : such as rolling the cakes of copper hot into sheets ; then fine-rolling the same cold in steel-polished rollers, and cutting out the blank pieces of coin ; which, with this assistance, is done with greater ease and rapidity by boys of your own age than could be effected by strong men without it. The steam-engine is also employed in the operations of finishing the coin, such as shaking the coin in bags, and working a number of coining machines with more expedition and exactness by a few boys, than could otherwise possibly be effected by a great number of men. With this machinery, between thirty and forty pieces may be coined in an hour, so superior is the advantage of mechanical power over that of mere manual labour! But of all the varied uses to which steam has been applied,

perhaps there is not one more wonderful than that of impelling vessels through the boisterous ocean. You look surprised; but it is a fact, that by the powerful effects of steam—the simple evaporation of water—a vessel may be impelled across the 'wide and trackless ocean, or along the wild and breaker-beaten shore,' without the aid of either wind or tide. Here are some lines for you to read; they are extracted from a poem entitled an 'Address to a Steam Vessel'—

'Thou hold'st thy course in independant pride;
No leave ask'st thou of either wind or tide.
To whate'er point the breeze, inconstant, veer,
Still doth thy careless helmsman onward steer,
As if the stroke of some magician's wand
Had lent thee power the ocean to command.
What is this power which thus within thee lurks,
And, all unseen, like a masked giant works?
E'en that which gentle dames, at morning's tea,
From silver urn ascending, daily see

With tressy wreathings playing in the air,
Like the loosed ringlets of a lady's hair;
Or rising from the enamelled cup beneath,
With the soft fragrance of an infant's breath:
That which within the peasant's humble cot
Comes from the uncovered mouth of sav'ry pot,
As his kind mate prepares his noon day fare,
Which cur and cat, and rosy urchins share:
That which, all silvered with the moon's pale beam,
Precedes the mighty Geyser's upcast stream,
What time, with bellowing din exploded forth,
It decks the midnight of the frozen north,
Whilst travellers from their skin-spread couches rise
To gaze upon the sight with wondering eyes."

Little Experiments.

"ALFRED is trying experiments, I suppose," said his mother, as the family were seated at tea one evening. "I have been waiting a long time for his cup, but in vain; I see he has not yet began to empty it."

"You gave me my tea without sugar, mamma," said Alfred.

"And is that the reason you do not drink it? Caroline, my love, hand the sugar basin to Alfred." "It is by him, mamma," said his sister, "and I have watched him put five lumps of sugar one after the other into his cup."

"Then it must be sweet enough, now, surely," said Mrs. A.

"Yes, too sweet, mamma," said Alfred, "but my reason for putting so many lumps of sugar into my tea, was to watch them melt—to watch them dissolve. Is not sugar a solid, papa."

"Yes; and when a solid on being put into a fluid disappears, leaving the liquor clear, that liquor is called a *solution*."

"Then my five lumps of sugar are in a state of solution, for they are all

melted—dissolved I should say; they gradually disappeared one after the other as I threw them in, and now I can taste them in every single drop of my tea; but the tea is as clear as before. I think this is a very curious circumstance, papa. Would all solids do the same?"

"Do what, my dear?"

"Dissolve in fluids, papa?"

"Think a little—consider for yourself."

Alfred thought, and at last he said that salt would do the same,—it would dissolve in water.

"True," said Mr. A. "salt is a *soluble* substance."

"Papa, I wish you would let me try some little experiments."

"Certainly, my dear, if you wish it; but, as your mamma is still waiting

for you, would it not be more polite to take your tea now, and to try these experiments afterwards."

Alfred instantly complied with his father's suggestion, and did not resume the conversation till tea was quite over, and the urn and tea things taken away.

Evening was come, and the long winter evenings were, to Alfred, seasons of peculiar delight. Happy boy! always doing something useful or agreeable—always endeavouring to gain knowledge, or to improve himself in some way or other. He was, however, highly gratified whenever he could prevail upon his beloved preceptor to devote an hour or two exclusively to him, and, when the sofa was wheeled round to the fire, and the rest of the children had seated themselves to their several employ-

ments, Mr. A. inquired what experiments Alfred wished to make. He asked his father if he might have three or four glasses full of water. Mr. A. rung the bell, in compliance with his wishes, and, when the glasses of water were brought in Alfred put a lump of sugar into one, which presently dissolved ; the water tasted sweet, but nothing of the sugar could be seen. He then put a lump of salt into another, which likewise presently dissolved ; the water had a *saline* or salt taste, but nothing of the salt could be seen. He then, at the request of his father, put a lump of alum into another; it, also, quickly dissolved.

" Now," said Alfred, " I have salt, sugar, and alum in a state of solution.

Papa can you give me a little lump of chalk?"

Mr. A. could not recollect that he had any chalk in the house, and, on being applied to, Caroline produced a *morceau* from her box of crayons.

Alfred put it into another glass of water.

"You see, papa," said he, after looking at it for a short time, "you see that, although chalk is a solid, it does not dissolve as the sugar and salt and alum did; it remains in a lump at the bottom of the glass."

"Thus," said Mr. A. "you have answered your own question, and proved that all solids will *not* undergo solution."

"When I stir the water, in the glass containing the chalk, it becomes white

and thick, papa:—what do you call that?"

"It has the same effect upon water, as cream has upon tea," said Mr. A. "it mixes with the water, and makes it lose its transparency; this is called a *diffusion*."

"And now, father, I wish to know whether the salt, or the sugar, or the alum, could be recovered again into their former state and quantity—formed into solids again."

"By what means might this be effected, and what gave you the idea that such a thing could be done, my dear?"

"I will tell you, papa. You know that the clouds are raised by evaporation from the sea, and, being condensed in the cold regions of the air, fall down in rain; now I know very

well, that all sea-water is extremely salt, but that the rain that comes down from the clouds is not salt, so I fancy that the salt that is in sea-water does not rise with the vapour, and consequently, that the salt must remain in the sea. Now if this be the case, and I suppose you will say that it is, I think that if the water were evaporated from the glass containing either the sugar, the salt, or the alum, we should perhaps find it, I mean the sugar, the salt, or the alum, remaining in the glass in its original state."

"Well, my little philosopher, I am highly pleased with the ingenuity of your conjecture; for this would undoubtedly be the case, were there a sufficient quantity of each of those ingredients, in proportion to the

quantity of water to be evaporated. When solids are dissolved in fluids they may assuredly be recovered again by evaporation, and it is by this operation that common salt is obtained from sea-water and salt springs, both artificially, and, in hot countries, by the heat of the sun. If the water in each of your glasses were no more than just sufficient to dissolve the salt, the alum, or the sugar, the water in each glass would be termed a *saturated solution,* and on evaporating the water, the particles of which those ingredients are composed would gradually unite together again, and arrange themselves into little regular masses called crystals.

This process would be called *crys tallization.*"

"Then sugar-candy is sugar crystallized, papa?" said Alfred.

"Yes: and that pretty substance called artificial spar, which you admired so much the other day, is nothing more than alum crystallized."

"What, papa! is it really possible that those beautiful specimens we saw at Dr. B's. last week, and which I thought were specimens of real Derbyshire spar, were nothing more than crystallized alum?—I wish—oh, how I wish you would allow me to make some artificial spar:—it would be such a pretty, and at the same time such a simple, experiment."

"You shall, my love," said Mr. A. "by and by, when we have finished our conversation; you shall make some specimens to ornament the

mantel-piece in your mamma's dressing-room."

"Thank you, dear and kind papa! Now will you tell me something more?"

"You are convinced by your own reflections," said Mr. A., "that the vapour evaporated from sea-water is not salt, and you proved, by holding the plate over the urn yesterday morning, that vapour is condensed or turned into water, when stopped in its way by any cold body. This is an important operation in chemistry. It is called *distillation*. For many years people at sea suffered exceedingly from the want of fresh water; this inconvenience is, however, remedied in a great degree, by the simple process of distilling sea-water."

"That may easily be done, I should think, papa," said Alfred; "you know

the steam, as it ascended from the urn the other morning, was condensed into drops of water upon my plate in a few moments. I wonder sailors did not think of the plan before; they might so easily have boiled a little salt water, and then have collected the steam by holding a plate over it as I did."

"Consider, my dear boy, the amazing time that it would take to collect, in this manner, a sufficient quantity to be of any avail to a ship's crew," said Mr. A. "It would be impossible, quite impossible, to procure a sufficient supply for so many persons; in fact it would employ the whole time of a single man to procure even a scanty portion for himself." "I spoke without thought," said Alfred, "but will you have the goodness to tell me how

they manage to collect and condense the vapour."

"In order to have a clear idea of the method employed for accomplishing this desirable purpose," said Mr. A. "suppose to yourself a tea kettle, a very large tea kettle, made without a spout, and with a hole in the lid in the place of a knob; then suppose that this kettle is filled with sea water; the fresh vapour that arises from the sea-water as it boils will issue through the hole in the lid; the mouth of a long tube is therefore fixed in that hole and the vapour of fresh water passing through this tube may be collected by fitting a proper vessel to receive it at the other end of the tube, which will serve as a reservoir, and which is, indeed, called the *receiver*. Thus fresh water may be

obtained though in a comparatively insignificant quantity; but even a single cup of fresh water is often received with more delight and gratitude by a poor man on board a ship than a bottle of the most highly-flavoured wine could be. True riches do not consist in an abundant supply of those luxuries, which are, in fact, as their name implies, unnecessary to our real comfort and happiness, so much as in a moderate sufficiency of those things which *are* essential to our life and health."

"Mamma has a little bottle of lavender water, in her closet," said Alfred, "and I recollect seeing the words, 'double-distilled lavender water' printed upon the label that is pasted round the bottle. Is lavender water procured by distillation, papa?

"Yes, my love: all aromatic or sweet-scented liquors are drawn from fragrant vegetables by means of water or spirits. The fragrant part being light and *volatile*, rises with the steam of the water or spirit and remains united with it after it is condensed. Rose-water and lavender-water are liquors of this kind—liquors procured by *distillation*.

"But I must leave you now; the evening is far advanced, and we must delay our little chemical discourse till another time."

"What, papa! is this chemistry—real chemistry?" "Yes, my dear: it is real chemistry. You look astonished."

"I thought chemistry was a very abstruse and difficult science, but I have had no difficulty in comprehen-

ding any thing that you have told me to night." "Chemistry requires observation, attention, and reflection, certainly," said Mr. A. "Perseverance and patience are also requisite towards the success of various experiments, for it is the object of chemistry to ascertain the simple substances or *first principles* of which bodies are composed, to discover their several properties, and to observe their action on each other.

"Chemistry comprehends almost every change in natural objects with which we are more immediately connected, and in which we have the greatest interest; it is useful in many of the various arts of life, and in the different manufactures which are carried on in England and in every other civilized nation. Dying,

bleaching, tanning, glass-making, the working and composition of metals, the common domestic operations of making butter and cheese, baking, brewing, &c. are all chemical processes. Chemistry is employed in agriculture, for it is used in investigating the nature of soils; it explains the phenomena of the growth and nourishment of vegetables, as in the case of the white water crowfoot. It is in short connected with all the phenomena of nature—"

"Yes, papa," interrupted Alfred, "such as rain, snow, hail and dew."

"Likewise wind, earthquakes and volcanic eruptions," continued Mr. A. "and its great importance in medicine has been long and universally acknowledged. Chemistry, therefore,

is highly worthy of our attention, because, beyond every other branch of study, it increases our knowledge, and, by extending the number of our resources, is calculated to heighten our enjoyments and to increase our power of doing good to our fellow creatures—you have not forgotten Lord Bacon's motto—"*Knowledge is Power.*"

Besides, no science can give us more exalted ideas of the Wisdom and Goodness of God than this, which displays the most astonishing effects often produced by the most simple means, and exhibits to our view the admirable care with which the comfort and happiness of all living creatures have every where been secured.

On this as on other occasions, the lines of our favorite Cowper occur to my recollection,

> "Nature is but the name for an effect
> Whose Cause is God."

The same subject continued.

A FEW weeks after the preceding conversation had taken place, Mr. A., desirous of proving the retention of Alfred's memory, and of convincing himself that he remembered what he heard, requested him to give him, in a few words, the substance of their late chemical lecture, as he termed it, and to tell him what he could recollect respecting it.

"I recollect all that you told me,

I believe, papa," said Alfred, "but I will tell you part of it.

"Chemistry is the science that enables us to ascertain the *first principles* of which bodies are composed. When salt is dissolved in water it forms a *solution*. If so much salt is dissolved that the water will not dissolve a particle more, it (the water) is *saturated*. If we wish to extract or recover the salt—that is, to form it again into a solid body— we *evaporate* the water by heat; when the water is thus evaporated we find that the salt remaining in the vessel has formed itself into little regular masses, called crystals, and this is called *crystallization*. If we wish to obtain that part of the water which was turned into vapour by the heat we *condense* the evaporated fluid, that is,

turn it into drops again by placing a cold vessel over it, and this process is called *distillation*. There, papa, I have told you what I know."

"You have made your statement very correctly, and with much regularity and order, my dear," said Mr. A. "To reward your attention I am going to show you how to make some artificial spar. If you look under the slab in the hall you will see a basket of clinkers, or coals which have been burnt to cinders in a blacksmith's furnace until perfectly calcined and hard — bring it to me."

"Here are your clinkers, papa! but what can you be going to do with such black dirty looking things as these?"

"They are not dirty now," said Mr.

A. "though they look black; they have been well washed and cleaned."

"But clean or dirty, what can they be for, papa?"

"You shall see," said Mr. A., and he ordered a servant to bring a saucepan of water into the room. He put a quantity of alum into this water, and then placed the saucepan over the fire, and whilst the water was boiling he placed each of the cinders, called clinkers, into separate earthenware vessels that stood on the floor.

"I boil the alum," said he, "in order that it may dissolve more quickly than it otherwise would do."

When the water had boiled, and when the alum was perfectly dissolved, Mr. A. poured some of the solution into each of the basins con-

taining a clinker, and then told Alfred that he must leave the room, and not look at them again till the next day, as the slightest motion of the vessels would disturb the particles of alum, and of course destroy the regular form of the crystals, which it was intended should attach themselves to the clinkers. Alfred promised not to enter the room again till his father should give him leave to do so, and he always kept his promise.

The next morning his father called him, and told him that he imagined the spar was ready to be taken out of the vessels, and that he might, if he pleased, accompany him to the room where it was. "You have now a very pretty example of the crystallization of a saline mineral,"

said Mr. A. as he drew out a clinker from one of the vessels, perfectly incrusted with beautiful transparent sparry crystals. "You see that the particles of which alum is composed unite again after having been dissolved, and form themselves into regular crystals. Part of the water, in which it was dissolved yesterday, evaporated in the air, and part of it is left in the vessels, and called the *solvent;* the liquor in which any solid substance is dissolved is known by the name of *solvent.* The same substance always produces crystals of the same shape; those of the alum, for instance, all consist of two four-sided pyramids called octohedrons; common salt crystallizes into a cubic form; salt-petre into that of oblong pillars with six sides; camphor

into crystals shaped like stars, similar to those little stars of ice which you have sometimes observed upon the window on a cold frosty morning; *they*, however, are the effect of freezing or *congelation*, which signifies the fixing a fluid body into a firm or solid mass by the action of cold. The word crystal is derived from *cryos* frost and *stello* to contract; it was at first confined to a clear stone resembling ice, and was probably afterwards extended to all bodies which were transparent and had their particles disposed in a regular manner, particularly the different species of salts."

"But it is, at present, expressive of that regular order or disposition, in which the particles of bodies arrange themselves on passing from

a fluid to a solid state, papa," said Alfred.

"Yes: and you are now I believe, perfectly acquainted with one method by which a solid may be separated from the fluid in which it has been dissolved."

"Yes."

"Well, then, you shall try a little experiment to prove that there is *another* method of separating a solid from a fluid.

"Here is a glass of spirit of wine, and here is some camphor; you may dissolve the camphor in the spirit of wine, till the spirit is saturated."

Alfred broke the camphor into pieces and threw lump after lump into the glass containing the spirit of wine, until no more could be dissolved, and then he told his father

that he believed the liquor was *saturated.*

"It is so," said Mr. A. "and how shall we manage to separate them again— I mean to separate the camphor from the spirit of wine."

Alfred was at a loss.

"You must separate them by pouring into the mixture a considerable quantity of water," said Mr. A.

"Alfred immediately fetched a decanter from the sideboard and poured some water into the glass.

"The liquor in the glass was transparent a few minutes ago, papa, but now it is thick, and muddy, and white," said he.

"Patience, my little chemist!" said Mr. A. "patience and perseverance are two essential requisites towards the success of any undertaking. This

muddy appearance is owing to the separation of the camphor from the spirit."

In a few minutes more the camphor had risen to the top of the glass in the form of a curd, in such a quantity that Mr. A. thought that if the camphor had been weighed both before and after its solution, the result would have been nearly the same. Alfred was highly delighted with the success of his experiment, and he requested his father to acquaint him with the technical term of this chemical operation.

"It is called *precipitation*:" said Mr. A. "the recovery or separation of a solid from its solvent (that is, you know, the fluid in which it has been dissolved) by the addition of a third substance, so that the solid may ap-

pear in its original state, however divided, is called *precipitation*. The substance thus recovered is called a *precipitate*, and the introduction of another body that occasions this precipitation is called a *precipitant*."

"Then, in this instance, the camphor is the precipitate, and the water the precipitant," said Alfred.

"Yes, my love. In the first instance the spirit of wine attracted the camphor and therefore dissolved it. When you poured water into the glass, the spirit of wine attracted the water more strongly than it did the camphor; the camphor, therefore, being let loose, rose to the surface of the mixture."

"And as the camphor is now separated from the spirit of wine," said Alfred, "I suppose that the spirit

might be separated from the water by distillation."

"It might, most certainly," said Mr. A.

"When the substance that rises, or that is separated from other bodies by heat is a solid, or may at least be condensed by cold into a solid form, the process is called *sublimation*, not distillation.

"Well, are you tired of trying experiments?"

"Tired! oh, no, no, papa! I was never so much delighted with doing any thing before. I always used to think that chemistry was something that I could not understand—something quite beyond my comprehension—but you have, as Caroline says, the art of explaining every thing, and making the most difficult subjects ap-

pear plain and simple. I like chemistry very much indeed, papa, and I wish you would have the goodness to tell me something more."

"Do you know what is meant by an acid?" said Mr. A.

"Yes, papa: any thing sour or sharp: the juice of barberries is an acid; the juice of the little wild crabs I gathered in the wood last autumn, is an acid; lemon-juice is an acid, and so is vinegar."

"Very well. Acids are by far the most important bodies in chemistry. It is the peculiar property of acids, to turn all vegetable *blues* into *reds*, and to give the flavour called *sour*.

"There is also another property in nature called *alkaline*, which is distinguished from the *acid* by a burning and pungent taste; and it is the

peculiar property of *alkalies* to convert vegetable *blues* into *greens*. *Alkali*, is a word of Arabian origin, and was introduced into chemistry after it had been applied to the plant which still retains the name of *kali*. When this plant is burnt, the ashes washed in water, and the water evaporated to dryness, a white substance remains, which is called *alkali*. This, however, may be obtained from various substances besides the kali, from the ashes of many other burnt vegetables, as the vine and fern, as well as from sea weeds.

"Now shut your eyes, and taste the substance in this spoon."

"Oh, papa! how very very disagreeable! Why did you ask me to taste it?"

"That you might have a distinct

notion of the difference between an alkali and an acid," said Mr. A., laughing at the curious faces which Alfred made. "This powder is soda; soda is an alkali. You have now, I imagine, a clear idea of the difference between an alkali and an acid."

"Yes, papa: and I shall never forget the disagreeable taste of the former, nor the sour taste of the latter."

"Very well: that is what I wish you to remember."

"Are alkalies capable of combining with acids, papa?"

"Yes: and when thus combined they have the property of simplifying or neutralizing each other; that is, the sour taste of the one, and the pungent taste of the other, are destroyed.

"Alkalies mixed with oils form soap; and melted with silex or flint, make glass.

"I told you just now that the blue colour of vegetables is converted into red by acids, and into green by alkalies. You shall try a little experiment to convince yourself that this is the case."

As Mr. A. spoke, company was announced; and Alfred's patience was again called into requisition. He thought he had better employ the time of his father's absence in visiting his own little garden, and thither he went. This garden was, as we have before observed, well stocked with trees and shrubs and vegetables; one little bed was at this time wholly devoted to some radishes, which Alfred had been raising under a hand glass; he had been paying peculiar attention to them, and watching their growth with unusual interest, in the hope that he should be able to present a dish

of radishes to his mother before any one else could do so, for he had heard her say that she was fond of early radishes.

He this day drew two or three, by way of experiment, just to see if they were large enough; and finding that they were of a sufficient size, he pulled a large handful and was returning, with them in his hand towards the house, when he was met by Mr. A.

"Look at my nice fine radishes papa!" exclaimed Alfred. "Did you ever see such!—they are for mamma. What a beautiful colour they are!—are they not?—Look papa!"

"What did I tell you this morning respecting the effect that acids and alkalies have upon the blue colour of vegetables?" said his father.

"That acids will turn the blue colours of vegetables into red and that alkalies will change blues into greens, papa.—Oh, I know what I will do! I will try a little experiment with one of these radishes. I will scrape some of the blue part off the radish and put it in water. I dare say it will discolour the water—turn the water blue—and if it does I can easily try the experiment of mixing an alkali or an acid with that water."

Alfred hastened to the house procured a knife and scraped off the outside or peel of the radish into a glass of water.

"I thought the water would turn blue, papa," said he "but you see it does not."

"Time and patience, my love, are,

as I have before told you, absolutely necessary in trying chemical experiments. Suppose you leave the water with the scraped radish peel in it just as it is till after dinner, and then see what effect it has had upon the water." Alfred thought it was a long time to wait till after dinner; however he said to himself, time passes quickly when we are employed, and he sat down to write an exercise which his father had desired him to write, resolving to think no more about the radish till the appointed time.

After dinner, as soon as the cloth was removed, Alfred went to the sideboard and brought the glass containing the radish peel to the table.

"I am convinced that your favourite patience is a very good thing,

papa," said he. "You see that the water is perfectly blue now."

"Divide the liquor, my dear," said Mr. A. "Pour half of it into this glass."

Alfred did so; and as soon as he had divided the liquor he squeezed a little lemon juice into one of the glasses, when, to his great delight, the liquor that that glass contained instantly became red. Thus he was convinced beyond all doubt, of the fact he had wished to establish, that acids will turn vegetable *blues* into *reds*.

"Now will you give me a little alkali, papa?"

Mr. A. dissolved a little soda in some water and gave it to his son.

Alfred poured this into the other glass and the blue water imme-

diately became green. Thus he was likewise convinced that alkali will convert vegetable *blues* into *greens*.

"Paper stained with the blue colour of vegetables is called *test* paper," said Mr. A. "this may be changed by the least powerful of the acids or alkalies, and I will therefore give you some that you may amuse yourself with making little experiments upon it.

"Besides the numerous acids obtained from vegetables," continued he, "there are three, much stronger than any we have hitherto mentioned, called, by way of distinction, fossil acids: they are, the vitriolic, the muriatic, and the nitric acids, the last of which will dissolve silver.

"When an acid is put upon potash, or lime, or chalk, or marle, you may

observe a bubbling and hear a noise, this is called *effervescence.*"

"Then I suppose soda water is the mixture of an acid and an alkali, papa."

"Yes it is;" said Mr. A. "and the effervescence of soda water arises from the escape of a considerable quantity of a particular sort of air, called fixed air, or carbonic acid gas.

"Many pretty little experiments may be made by dissolving various minerals in the fossil acids, but as they are very strong, great care, and order, and steadiness, are necessary when using them.

"Here is a little bit of a mineral of a dark gray colour, called *cobalt.* You may pound it, if you please, in your little black marble mortar."

Alfred glad to be employed in a manner he liked so well, fetched his little mortar, and pounded the *morceau* of cobalt.

"It is now in a state of *pulverization*," said Mr. A. "I am going to prove to you that a mineral may be dissolved in acid."

Mr. A. then poured a few drops of nitro-muriatic acid, diluted with water, upon the pounded cobalt, and it was presently dissolved.

"Now," continued he, going towards his portfolio, "I will show you a drawing representing a winter scene. You see the trees in this picture are destitute of leaves, and the fields are covered with one vast sheet of snow."

"Yes papa. It is an Indian ink drawing, which Caroline made for

you last summer. It is taken from a scene in Cowper's "Winter morning walk:"

"Forth goes the woodman, leaving unconcerned
The cheerful haunts of man; to wield the axe
And drive the wedge, in yonder forest drear,
From morn to eve his solitary task."

"Let us surprise your sister," said Mr. A. "I will put some leaves upon the trees with this solution that I have been making, and cover the fields and hedges with it."

"Why do you do so, papa?—I do not see any good in your washing the picture with that mixture.—The trees and the hedges look just as they did before, now that you have done them."

"Take the drawing into the library, and when Caroline has seen it in its present colourless state, hold

it before the fire and ask her if she recognizes it," said Mr. A.

Alfred did as his father had desired. No sooner had the picture approached the fire than the trees began to appear in all the verdure of spring, the fields became clothed in a robe of emerald green, and the wintry landscape was exchanged for a summer scene.

"How wonderful and how astonishing!—what a curious, what a singular effect!" exclaimed Caroline and Alfred in a breath. "A few moments ago there was not a single particle of colour to be seen in the picture, and now how beautiful it is!"

"Why, papa, I had no idea that the solution of a little bit of cobalt in some acid could produce such a change!" said the latter.

"I intended to surprise you," said

Mr. A. "What is there that *chemistry* will not effect! This interesting science is connected, as I have before remarked, with all the phenomena of nature. When the bright and brilliant hues of summer are succeeded by the long frosts and dreary snows of winter, and when the white mantle of the latter is exchanged for the flowery garb of spring, we may ascribe the transformation, in some degree, to a *chemical* operation."*

Conclusion.

"How much better it is to be employed than to be idle," said Alfred, one morning, after having been busily

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* The writer has again to acknowledge herself indebted to "Practical Education" for suggesting some of the little chemical experiments introduced in this chapter.

engaged for two hours in spreading some beautiful little sea-weeds upon paper and, with his mamma's assistance, arranging them in proper order. Mr. A. was seated by the fire with a book in his hand when Alfred spoke and he immediately read the following passage:

"Various pursuits, skilfully chosen and assiduously followed, can give proper activity to every faculty of the mind, inasmuch as they engage the judgment, the memory, and the imagination in an agreeable exercise, and are associated for one beneficial purpose—like the genial drops of rain, which descend from heaven, they unite in one common stream to strengthen and enlarge the current of knowledge."

"The constant desire of obtaining

useful knowledge," said he, turning to Alfred, "must lay a foundation for permanent happiness. You find from experience, my love, that employment is better than idleness; and it is to the habit of unceasing exertion you must acknowledge yourself indebted, if you ever acquire a large fund of information. The early forming of right habits on sound principles seems to be, as Mrs. More has justly observed, one of the grand secrets of virtue and happiness."

"Well, papa, I know that the habit of observation as well as that of unceasing exertion are great favourites of yours. What other habits would you particularly recommend to my notice?"

"It was to the habit of *unceasing exertion*, which is nearly synonymous

with that of *industry*," said Mr. A., "that the immortal Newton modestly ascribed his own vast attainments.

"It was to the habit of *observation* that Dr. Franklin acknowledged himself indebted for his grand discovery respecting the identity of lightning and electricity.

"It was to the habit of *reflection* that Galileo was, in a great degree, indebted for the invention of the telescope, an instrument which enables us to penetrate into the remotest regions of the starry heavens; he heard that some children of a Dutch spectacle-maker being at play with some spectacle glasses that lay upon their father's counter, made use of two of them together, the one convex and the other concave, in looking at the weather-cock of a distant spire,

and observed that it appeared much larger and nearer than it had ever done before. This little circumstance suggested to him the idea of applying such glasses to astronomical purposes, and with much ingenuity he contrived to construct a telescope, by fitting some glasses to the pipes of an organ: the habit of *reflection* enabled him to improve this telescope, and he, in the course of time, produced one that magnified more than thirty times.

"It was to the habit of unremitting *attention* that the celebrated Sicilian philosopher, Archimedes, was indebted for the success of his various scientific experiments.

"It was by the habit of *perseverance* that Linnæus, a native of Sweden, overcame all the difficulties that

poverty had laid in his way, and raised himself to the highest distinction as a most ingenious and indefatigable naturalist.

"Then there is the habit of *economy*; I mean such economy as may prove the 'source of charity;' and the habit of *punctuality*."——

"What do you mean by that, papa?"

"*Time* is saved by habits of *punctuality*," said Mr. A. "and a young person, anxious for the acquisition of knowledge, has not a moment to lose. By having one employment cleared away just as the next employment ought to be despatched, you acquire a habit of punctuality, and save many of those odd minutes, which people are so apt to lose from a want of regularity

in their several occupations, but which when multiplied together are found to form a considerable part of our time.

" Then there is the excellent habit of *early-rising*; a habit, which, if acquired in youth, will not easily be eradicated in future life. Rise early, and you begin the duties of the day with additional ardour and animation; for you possess the delightful consciousness of having devoted those hours, which would otherwise have been passed in useless slumber, to a better purpose. Youth, like the morning, is the proper season for every thing that requires time and pains. Youth, like the morning will soon be gone; health and sprightliness may be succeeded by age and infirmity, and the sunshine

which gilds your juvenile hours, may be overshadowed by the dark clouds of affliction and sorrow.

"Use the *present* time therefore, my dear boy, assured that in future life nothing will yield you more solid satisfaction than the reflection, that your youthful hours were profitably spent in the acquisition of useful knowledge, and in the cultivation of those sentiments and dispositions which can alone enable their possessor to bear with calmness all the little trials and troubles of life; and never forget that you are accountable for the application of knowledge as well as for the dedication of time."

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