English in Physical Science

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7 The Electric Bell

1 READING AND COMPREHENSION

PASSAGE A The components of the bell
An electric bell operates by means of an electromagnet. This consists of two cylinders of soft iron fixed one above the other to a soft iron bar. Around these cylinders is wound a length of copper wire, the direction of winding being reversed as the wire passes from one cylinder to the other. One end of it passes from the free end of the upper cylinder and is connected to a battery terminal. The other end passes down from the top of the lower cylinder and is connected to the fixed end of a steel spring which is situated below and to the left of the electromagnet. To the right side of this spring is attached a metal rod, the head of which acts as a hammer, or striker. The spring passes up the left side of the striker rod and then bends outwards to touch a screw, or key, which is connected to the other terminal of the battery by means of copper wire. On the other side of the striker rod, just opposite the free ends of the soft iron cylinders, is fixed a piece of soft iron which is called the armature. Above the electromagnet, and close to the head of the striker rod, is a gong.

EXERCISE A Composition of a diagram based on a description
Make a diagram of an electric bell, as described in the passage by putting together the parts illustrated below. Use a different coloured pen or pencil to draw in the copper wire.

Label the diagram you have drawn with the following terms:
SOFT IRON CYLINDERS / SOFT IRON BAR / BATTERY / KEY / GONG /
STEEL SPRING / STRIKER ROD / ARMATURE
Indicate with arrows how the wire is wound on the two cylinders.

EXERCISE B Statements about diagrams
1. Make statements about the position of A relative to B in the following diagrams by using the given expressions.

Examples
Diagram (a) – A is attached (or fixed) to the top of B.
Diagram (b) – A is opposite and to the left of B.

2. Make statements about the way in which A is connected to B in the following diagrams by using the given expressions. The line between the boxes represents a piece (or length) of copper wire.

EXAMPLE
Diagram (a) – A piece (or length) of copper wire passes from the top of A to the bottom of B.

or The top of A is connected to the bottom of B by means of a length of copper wire.

PASSAGE B The operation of the bell
To operate the bell, the key, or screw, is connected to the positive terminal of the battery, and the copper wire coming from the electromagnet is connected to the negative terminal. When the current is switched on, it flows through the key into the spring, passing from there round the coils of the electromagnet and then back to the battery. As the current passes through the coils of copper wire, the soft iron cylinders around which it is wound become magnetized. Consequently, they attract the armature, causing the head of the striker rod to hit the gong. As the striker hits the gong, the spring to which it is fixed loses contact with the screw, breaking the circuit. The current ceasing to flow, the electromagnet loses its magnetism and the armature, being no longer attracted, is pulled back by the spring. When this happens, the spring makes contact with the screw once more, allowing the electric current to pass, again magnetizing the cylinders. These then attract the armature, once more pulling the spring away from the screw and breaking the circuit. The whole process is repeated over and over again, causing the head of the striker to vibrate rapidly against the gong, thus producing the familiar sound of an electric bell.

EXERCISE A Illustrating the reading passage with diagrams
Illustrate the above text by drawing two diagrams: one showing the positions of the parts of the bell when the circuit is complete, and one showing their positions when the circuit is broken.
Label the diagrams which you have drawn and shade in the parts of the bell which move.

EXERCISE B Description of a sequence of events
(i) Put the expressions after, before, when in the blank spaces so as to make statements which are correct according to the passage.
1. The current passes into the spring . . . it passes through the key.
2. The current passes into the battery . . . it passes through the coils of copper wire.
3. The soft iron cylinders are magnetized . . . the current passes through the coils of copper wire.
4. The spring makes contact with the key . . . the electromagnet loses its magnetism.
5. The spring is pulled away from the key . . . the head of the striker hits the gong.
6. The armature is pulled back by the spring . . . the spring makes contact with the screw.
7. The striker hits the gong . . . the electromagnet loses its magnetism.
8. The electromagnet loses its magnetism . . . the striker hits the gong.

(ii) Refer to Grammar Exercise A in Unit 6. Change the statements you have made above by using sentences of the following form.
First [A] then [B]  After/Before/When [A] [B]

EXAMPLE
First the current passes through the key (and) then (it passes) into the spring.

or:
The current first passes through the key (and) then (it passes) into the spring.

The soft iron cylinders are magnetized when the current passes through the coils of copper wire.

or:
The current passes through the coils of copper wire when the soft iron cylinders are magnetized.

(iii) Refer to Grammar Exercise B in Unit 6 to guide you. Change the statements you have just made by using short-form time clauses where possible.

EXAMPLE
After passing through the key, the current passes into the spring.

II PROBLEMS
DIAGRAMS AND DESCRIPTIONS OF DEVICES

A. Illustrate the following descriptions with diagrams according to the instructions given in each case.

(i) The mercury thermometer
Thermometers are instruments which are used to measure temperature. The most common thermometer consists of a tube with a very narrow bore, known as a capillary tube, which is sealed at one end. At the other end of the tube there is a bulb containing mercury. When the thermometer is made, the
air between the sealed end of the tube and the level of mercury in the bulb is removed, creating a vacuum. The tube is marked with a measuring scale by reference to two fixed points; the lower fixed point, which is the temperature at which ice melts, and the upper fixed point, which is the temperature at which pure water boils under normal atmospheric pressure. The space between the two points may be marked out on two different scales: the Celsius scale, on which the fixed points are 0°C and 100°C, or the Fahrenheit scale, on which the fixed points are 32°F and 212°F.

Draw a diagram of a thermometer and label it with the following terms:

- capillary tube
- bulb
- vacuum
- mercury
- lower fixed point
- upper fixed point
- measuring scale

Mark in the degrees of the fixed points on the Celsius scale on one side of the tube, and the degrees of the fixed points on the Fahrenheit scale on the other.

(ii) The aneroid barometer

Barometers are instruments which are used for measuring atmospheric pressure. The aneroid barometer consists of a thin metal box in the shape of a concertina containing a partial vacuum. The box is prevented from collapsing by means of a steel spring fixed at the side of it. This spring is bent over the top of the box, exerting pressure upon it by means of a metal shaft, one end of which is attached to the spring. The other end is attached to a flat piece of metal which presses down on the top of the box. The spring extends sideways from the top of the metal shaft and then bends downwards to connect up with a short horizontal lever which is connected to a long vertical lever by means of a pivot. The longer lever extends upwards and is connected to a thread which passes sideways and winds on to the axle of a pointer fixed above a dial. A small coiled spring is attached to this axle.

Make a diagram of an aneroid barometer as described in this text by putting together the parts illustrated below.

Label your diagram with the following terms:

- spring
- pivot
- coiled spring
- shaft
- metal box
- partial vacuum
- dial
- axle
- levers
- pointer
- thread
- coiled spring
- atmospheric pressure
- axle
- pointer
- dial
- vacuum
- mercury
- lower fixed point
- upper fixed point
- measuring scale
- pull (verb)
- push
- cause
- move
- attach
- turn
- upwards
- at
- over
- the top of
- to the right

B. Write descriptions of a water pump by referring to the diagrams provided. First describe the parts, or components, of the pump (see Passage A). Then describe the way it works, beginning

"On the upstroke, when the handle is pulled down, the piston valve closes. . . ." (see Passage B)

III GRAMMAR

EXERCISE A The use of the -ing form

An ing-clause can be used

(i) as a simple addition to a preceding statement:

We keep the solution hot and add further small quantities of the oxide, letting each dissolve before the next is added.
(ii) as an explanation:

The molten iron, having been in contact with coke in the lower part of the furnace, contains several percent of dissolved carbon.

(iii) to show a result or consequence:

Nitric acid will dissolve nearly all the common metals, forming their nitrates.

If the subject of the ing-clause is the same as the subject of the main clause it is omitted, as in the above examples. However, if the two subjects are different the subject of the ing-clause must be stated:

The atom and its sub-units are so small that an ordinary microscope is no longer of help, light itself not being a delicate enough probe.

Combine each pair of statements into a sentence containing an ing-clause. State whether the ing-clause is an addition, an explanation, or a result.

EXAMPLE

Earthworms tunnel through the soil. Earthworms cause excellent aeration.

= Earthworms tunnel through the soil causing excellent aeration. (result)

1. The zeolite is able to remove the ions from the water. The zeolite replaces them by the sodium ion.
2. The salt dissolves in water. The salt makes a solution which is in equilibrium with ice at a temperature below the freezing point of water.
3. At the end of the process a solution of ammonium chloride remains. The sodium hydrogen carbonate has been precipitated out.
4. In these reactions the hydrated ions of aluminium lose protons. The hydrated ions of aluminium form successive hydroxide complexes.
5. If an aircraft is standing on the ground the air pressure on all its different parts is the same. Air pressure is exerted equally in all directions.
6. A solute such as alcohol or glycerol added to the radiator water keeps the water from freezing. The freezing point of a solution is lower than that of the pure solvent.
7. Quite possibly larger amounts of carbon dioxide existed in the atmosphere during the Carboniferous Period than at the present time. Larger amounts of carbon dioxide permitted plant life to flourish and the great coal beds to be laid down.
8. Carbon is the first element of the fourth group of the periodic table. The others are silicon, germanium, tin and lead.
9. Sulphuric acid must be considered one of the most important of all chemicals. Sulphuric acid is used throughout the chemical industry and related industries.
10. White phosphorus ignites at about 35°C and oxidizes slowly at room temperature. The white phosphorus gives off a white light.
11. The metallic solutions slowly decompose, with evolution of hydrogen. The metallic solutions form amides, such as sodamide, NaNH₂.
12. Stable molecules and complex ions usually have structures such that each atom has the electronic structure of a noble-gas atom. The shared electrons of each covalent bond are counted for each of the two atoms connected by the covalent bond.

EXERCISE B Patterns expressing result

A number of patterns can be used to express result:

- The electric field is turned on, so that the plates are charged.
- The electric field is turned on, with the result that the plates are charged.
- The electric field is turned on. As a result the plates are charged.

Combine each pair of statements, using one of the above patterns.

1. The electrodes are then put into the solution. The sodium ions are attracted towards the cathode, and the chloride ions are attracted towards the anode.
2. The mixture of aluminium powder and iron (III) oxide, Fe₂O₃, is ignited. The reaction 2Al + Fe₂O₃ = 2Fe + Al₂O₃ takes place.
3. Sulphur dioxide destroys fungi and bacteria. It can be used as a preservative in the preparation of dried fruits.
4. The rate of the reaction is very slow at low temperatures. The direct combination of the substances is unsuitable as a commercial process.
5. Sulphuric acid has a high boiling point. It can be used with salts of more volatile acids in the preparation of these acids.
6. The arrangement of the framework of tetrahedra in the glass is irregular. A very small region may resemble quartz and an adjacent region may resemble cristobalite.
7. Manganese steel is extraordinarily hard. It can be used to make crushing and grinding machines and safes.
8. Iron becomes passive when it is dipped in very concentrated nitric acid. It no longer displaces hydrogen from dilute acids.
9. The silver halogenides are sensitive to light. They undergo photochemical decomposition.
10. Atoms are not hard spheres. By increased force they may be pushed more closely together.

IV PARAGRAPH WRITING

STAGE 1 Sentence building

Join each of the thirteen groups of words below into one sentence, using the additional material at the beginning of each group. Omit words in italics. Number your sentences and begin each one with a capital letter.
1 ARE SAID/TO BE, WHILE/AND PIECES OF IRON OR GLASS, WHICH/
THEMSELVES, ARE SAID/TO BE
we say that such bodies are luminous
bodies such as bricks do not produce light
we say that these bodies are non-luminous

2 THREADED/THAT/ THEY
thread a length of cotton through the holes
this will demonstrate this
the holes are in a straight line

3 THAT/, A/WHICH/MEDANS OF/THE FOLLOWING
these observations suggest this
light travels in straight lines
this fact can be verified by an experiment

4 SUCH AS CLEAR GLASS AND WATER/WHICH/SO THAT/ CAN BE/SEEN/
ARE SAID/TO BE
some substances allow light to pass through them
we can see objects on the other side clearly
we say that these substances are transparent

5 AND/SMALL/THE MIDDLE OF/OF THEM
take three pieces of cardboard
make a hole in each piece

6 MOST/WHICH/, FOR/, GLOWING/AN ELECTRIC/, OR
some bodies emit light
some bodies also emit heat
one example is the sun
another example is the filament of a light bulb
another example is a fire

7 FROM A POCKET TORCH, A SEARCHLIGHT OR CAR HEADLAMPS/
, AND/UNLESS/DO SO/THE HELP OF/OR SOME OTHER REFLECTING
DEVICE
a beam of light appears to have straight edges
a beam of light will not bend round corners
a beam of light is made to bend with mirrors

8 ALL/LIGHT/AND/THAT
these bodies emit energy
they can be seen by the light
they give out light

9 WHICH/WITHOUT/BEING/ ARE SAID/TO BE/, WHILE/WHICH/THE
PASSAGE OF/ ARE SAID/TO BE
some substances allow light to pass through them
objects on the other side are not clearly seen

we say that these substances are translucent
some substances do not permit light to pass
we say that these substances are opaque

10 IF IS MOVED/ SO THAT/ NO LONGER/, move one of the pieces of cardboard slightly
the holes are not in a straight line
the light will be cut off

11 /LIKE/, AND/THERE IS/THE TWO
light is a form of energy
heat is a form of energy
a close connection exists between light and heat

12 LIGHT/BUT/WHEN/FROM LUMINOUS BODIES/ AND/FROM THEIR
SURFACES
non-luminous bodies do not emit energy
they can be seen
light falls on them
light is reflected

13 PIECES OF/SO THAT/FROM A CANDLE FLAME/CAN BE SEEN/THREE/
AT THE SAME TIME
arrange the cardboard
we can see the light through all the holes

STAGE 2 Paragraph building
Rewrite the thirteen sentences in a logical order to make two paragraphs.
The first paragraph should contain a number of definitions, and the second
paragraph should deal with the fact that light travels in straight lines. Before
you write the paragraphs, add the following material:
write 'this is shown by the fact that' at the beginning of sentence 6.
When you have written your paragraphs, re-read them and make sure that
the sentences are presented in a logical order. Compare your paragraphs
with the relevant paragraphs in the Free Reading passage. Make any changes
that you think are necessary, but remember that sentences can often be
arranged in more than one way.

STAGE 3: Paragraph reconstruction
Read through the paragraphs again. Make sure you know all the words,
using a dictionary if necessary. Without referring to your previous work
rewrite the paragraphs. Here are some notes to help you.

paragraph 1
light – heat – forms of energy – close connection
emit heat and light: sun, light bulb, fire
these bodies emit light energy – can be seen by light given out
luminous, non-luminous bodies
non-luminous bodies - no light energy - can be seen - reflected light
transparent substances
translucent, opaque substances

**paragraph 2**
beam of light - straight edges - will not bend
light travels in straight lines - experiment
three pieces of cardboard - small hole
light from candle flame
length of cotton
move one piece of cardboard slightly

**V FREE READING**

Read the following passage in your own time. Try to find additional examples of the points you have studied in this and other Units.

Light, like heat, is a form of energy, and there is a close connection between the two. This is shown by the fact that most bodies which emit light also emit heat, for example the sun, the glowing filament of an electric light bulb, or a fire. All these bodies emit light energy and can be seen by the light that they give out. Such bodies are said to be luminous, while bodies such as bricks and pieces of iron or glass, which do not themselves produce light, are said to be non-luminous. Non-luminous bodies do not emit light energy but they can be seen when light from luminous bodies falls on them and is reflected from their surfaces. Substances such as clear glass and water which allow light to pass through them so that objects on the other side can be clearly seen are said to be transparent. Substances which allow light to pass through them without objects on the other side being clearly seen are said to be translucent, while substances which do not permit the passage of light are said to be opaque.

A beam of light from a pocket torch, a searchlight or car headlamps appears to have straight edges, and will not bend round corners unless made to do so with the help of mirrors or some other reflecting device. These observations suggest that light travels in straight lines, a fact which can be verified by means of the following experiment. Take three pieces of cardboard and make a small hole in the middle of each of them. Arrange the pieces of cardboard so that light from a candle flame can be seen through all three holes at the same time. A length of cotton threaded through the holes will demonstrate that they are in a straight line. If one of the pieces of cardboard is moved slightly so that the holes are no longer in a straight line, the light will be cut off.

The formation of shadows is a result of the fact that light travels in straight lines. If an opaque object is placed in front of a small source of light, such as a pocket torch, the light will throw a sharp shadow of the object on to a screen. The shadow will have the same shape as the object, but it will be larger than the object. Diagram 1 explains why this is so:

Light spreads out along straight lines in all directions around the small source, $S_1$, but that light which falls on the opaque object is stopped. The light which passes the edges of the object cannot bend round it, with the result that there is a clear-cut dark space behind the object. A shadow of the object will appear on a screen placed in position (a) since a section of the screen having the same shape as the object will receive no light. If the source is moved further from the object, to $S_2$, the shadow will become smaller, and if the screen is moved back to (b) the shadow will become larger.

Let us suppose now that we use a larger source of light. We will notice that the shadow obtained has a perfectly dark centre portion surrounded by a region that is only partly darkened. The formation of such shadows is illustrated in Diagram 2. A lamp is put inside a box which has a hole covered by tissue paper in one of its sides, and an opaque object is placed between the box and a screen. The area $xq$ will not receive light from any part of $ab$ and will therefore be perfectly dark. The area $px$ will receive light from the upper part of $ab$ but not from the lower part with the result that $px$ will be partly darkened. Similarly, the area $qy$ will receive light from the lower part of $ab$ but not from the upper part, so that $qy$ also will be partly darkened. All that area of the screen which falls outside $pq$ will be fully lighted by all parts of $ab$. The dark part of the shadow is called the umbra, and the partly darkened portion the penumbra.