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0653/31

October/November 2015

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

A copy of the Periodic Table is printed on page 24.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **22** printed pages and **2** blank pages.

- 1 (a) Fig. 1.1 shows some features of the human gas exchange system. Use lines to connect each feature with its benefit to the system. One line is drawn for you.

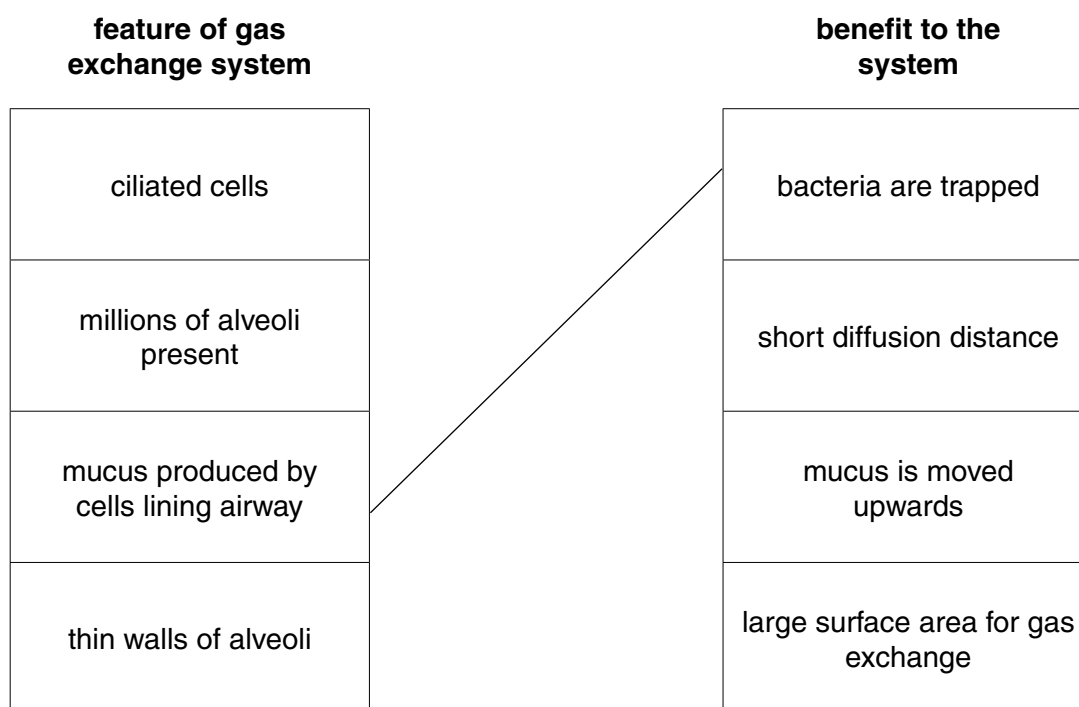


Fig. 1.1

[2]

- (b) (i) Describe how each of these features is affected by cigarette smoking.

mucus production

.....

ciliated cells

.....
[2]

- (ii) Explain how the effects you described in (b)(i) make lung infections more likely.

.....

[1]

- (c) One of the products of smoking is the gas carbon monoxide. This gas reduces the ability of the blood to carry oxygen. Oxygen is needed by all cells to carry out aerobic respiration.

(i) Write the balanced symbol equation for aerobic respiration.

.....[2]

(ii) Describe how the blood transports oxygen around the body.

.....

.....[1]

- (d) Smoking a cigarette causes the level of carbon monoxide in the blood to increase. This level gradually falls if no more cigarettes are smoked.

A group of people were trying to give up smoking. The level of carbon monoxide in their blood was tested four times during the day and the results compared with those of a non-smoker.

The results are shown in Table 1.1.

Table 1.1

person	units of carbon monoxide in the blood			
	08.00 hours	11.00 hours	14.00 hours	17.00 hours
A	1.9	1.5	1.3	1.0
B	3.4	2.2	4.8	3.6
C	3.7	2.6	2.0	1.6
D (non-smoker)	0.6	0.5	0.5	0.5

Use the information in Table 1.1 to

- (i) suggest which person had most recently smoked **before** any readings were taken. Explain your answer.

person

explanation

.....[1]

- (ii) state which person may have smoked a cigarette **during** the day and explain your answer.

.....

.....

.....[2]

- 2 (a) Fig. 2.1 shows samples of elements in Group VII of the Periodic Table. The elements are shown at room temperature.

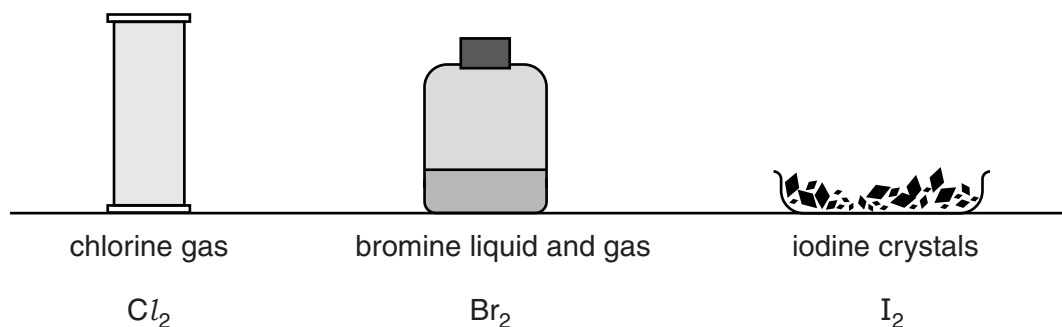


Fig. 2.1

Describe the trend in melting point down Group VII.

.....
[1]

- (b) Fig. 2.2 shows what happens when a student adds colourless chlorine solution to a colourless solution of sodium bromide, NaBr.

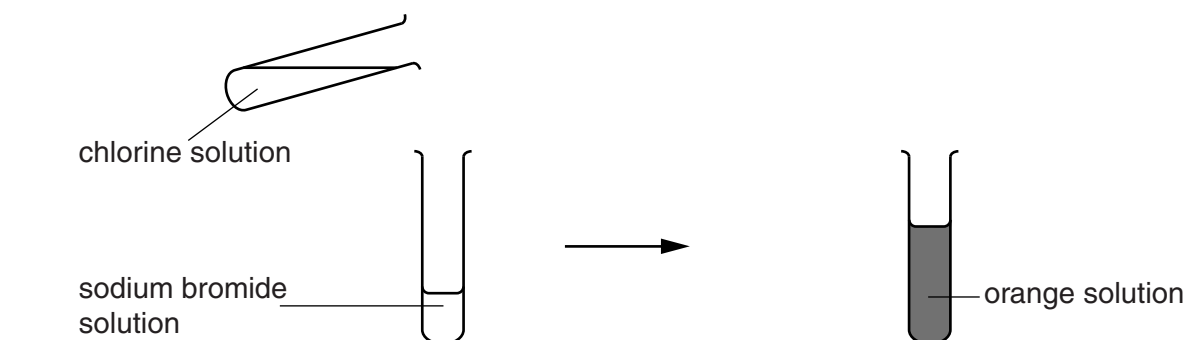


Fig. 2.2

The resulting mixture is orange.

- (i) State the name of the substance formed which gives the final mixture this colour.

.....[1]

- (ii) Write a balanced chemical equation for the reaction that occurs.

.....[2]

- (iii) Write in order of reactivity the halogens bromine, chlorine and iodine.

most reactive

.....

least reactive

[1]

- (iv) Use this trend in reactivity to explain why fluorine **cannot** be displaced from sodium fluoride by another halogen.

.....

[2]

- (c) Fluorine gas is extracted by electrolysis.

Fig. 2.3 shows the electrolysis cell that is used.

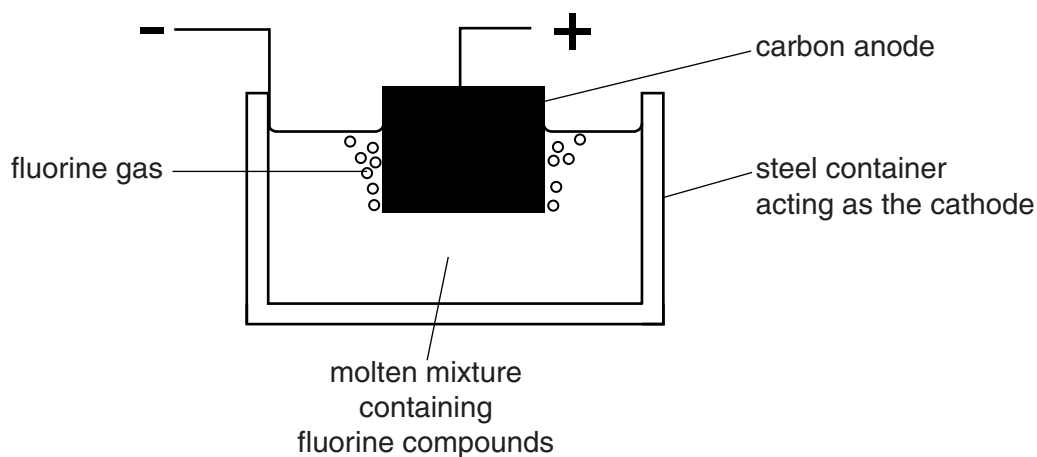


Fig. 2.3

The fluorine compounds which are used contain fluoride ions, F^- .

Describe how fluoride ions become fluorine atoms at the anode of the cell.

.....

[2]

- 3 Fig. 3.1 shows a man bungee jumping. He is attached to a long elastic rope as he jumps off a bridge.

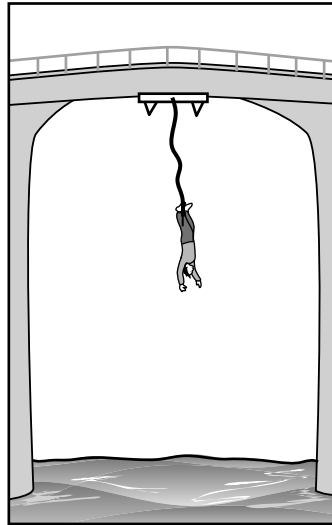


Fig. 3.1

Fig. 3.2 shows the jump at several stages from the time the man jumps off the bridge.

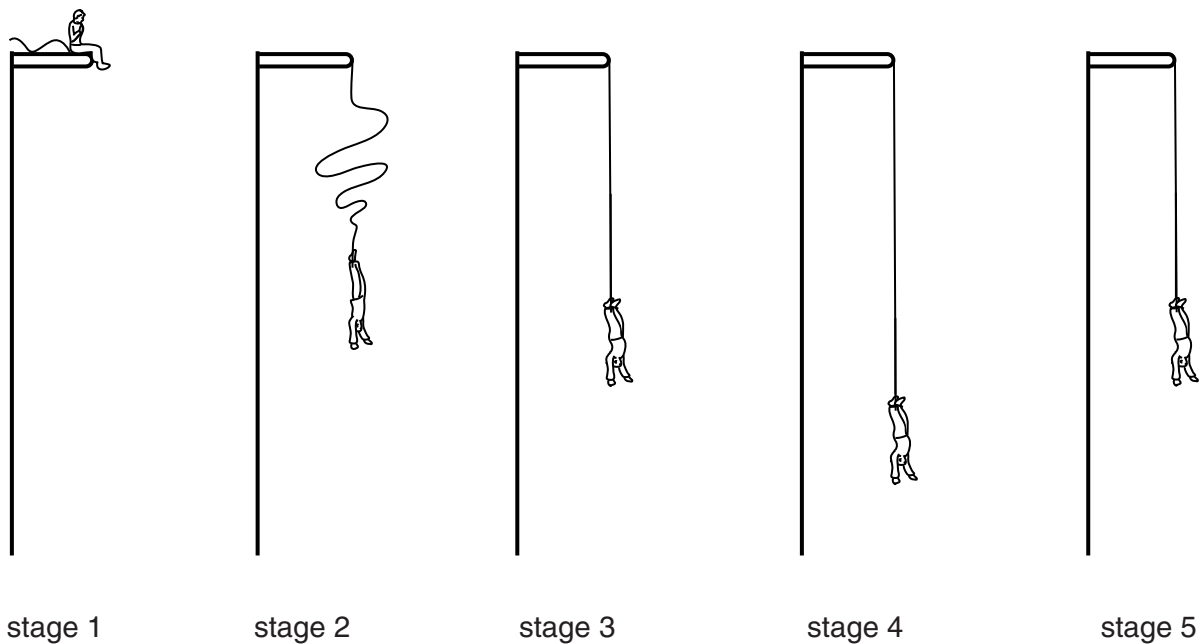


Fig. 3.2

- (a) (i) Identify the main force acting on the man just after he jumps off the bridge.

.....[1]

- (ii) As the man falls, another force, air resistance, acts on him to reduce his acceleration.

On Fig. 3.3, draw an arrow to show the direction in which air resistance is acting on the man.



Fig. 3.3

[1]

- (b) (i) Tick the box or boxes beside the correct statement or statements in the list below.

When the man reaches his lowest point

the speed of the man becomes zero,

☐

the acceleration of the man becomes zero,

☐

the tension in the rope becomes zero.

☐

[1]

- (ii) As the man falls, the rope begins to stretch.

On the axes below, sketch a speed/time graph to show how his speed changes as the rope stretches until he reaches the lowest point.



[2]

- (c) (i) Identify the energy transformations occurring from the time the man jumps until he reaches his lowest point.

from gravitational potential energy

to energy

to energy.

[1]

- (ii) At the lowest point, the length of the rope is 40m. The man has a mass of 80 kg.

Calculate the gravitational potential energy loss that occurs during the fall to the lowest point.

State the formula used and show your working.

$$(g = 10 \text{ N/kg})$$

formula

working

gravitational potential energy loss = ... J [2]

Please turn over for Question 4.

- 4 (a) Fig. 4.1 shows two plant cells as seen under the light microscope. They are not drawn to scale.

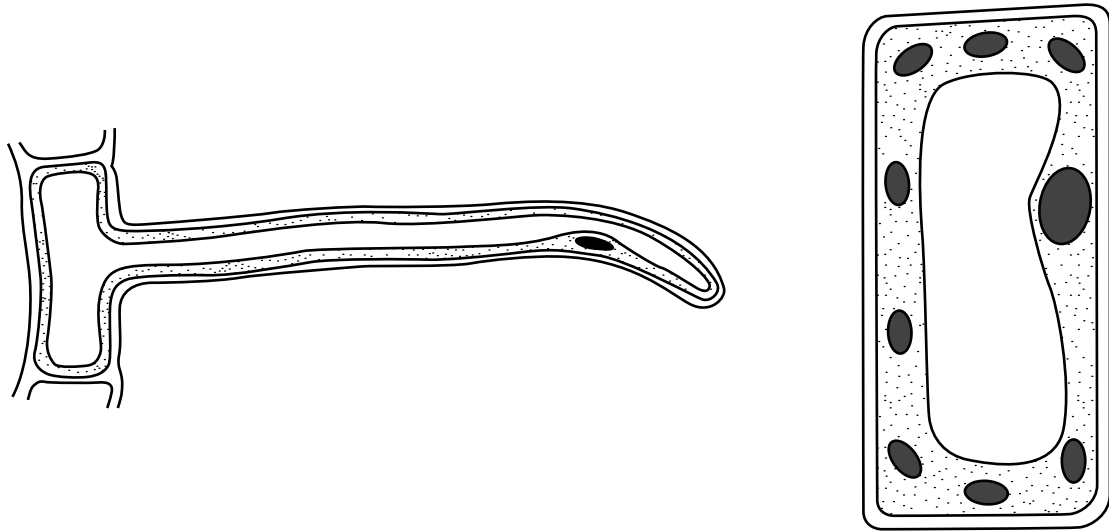


Fig. 4.1

- (i) On one of the plant cells in Fig. 4.1 label **two** cell parts that are present in **both** of these plant cells but are absent from animal cells. Use label lines and the correct names for your answer. [2]

- (ii) Describe the functions of the two cell parts you have labelled in (a)(i).

cell part

function

.....

cell part

function

.....[2]

- (b) Fig. 4.2 shows two leaves of approximately the same length. They were both taken from different regions of the same oak tree.

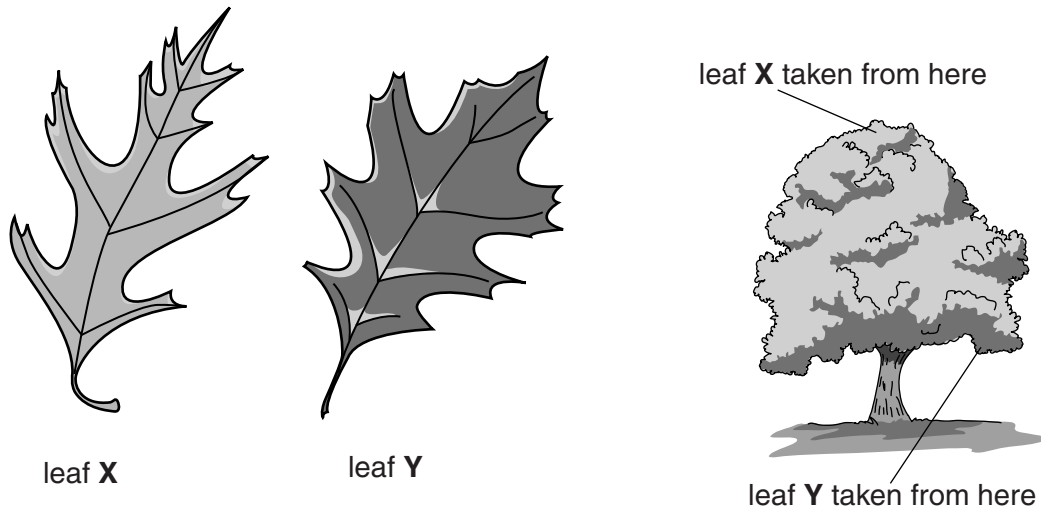


Fig. 4.2

Leaf X gets full sun. Leaf Y is in a shaded location.

- (i) Describe one difference in structure between leaf X and leaf Y.

.....
[1]

- (ii) Suggest one advantage to the tree of having leaves of shape X at the top of the tree.

.....

[2]

- (iii) Suggest one advantage to the tree of having leaves of shape Y at the bottom of the tree.

.....

[2]

5 Methane is a hydrocarbon which is used as a fuel.

(a) State one source of methane.

.....

[1]

(b) Fig. 5.1 shows a demonstration of an explosion caused when methane burns.

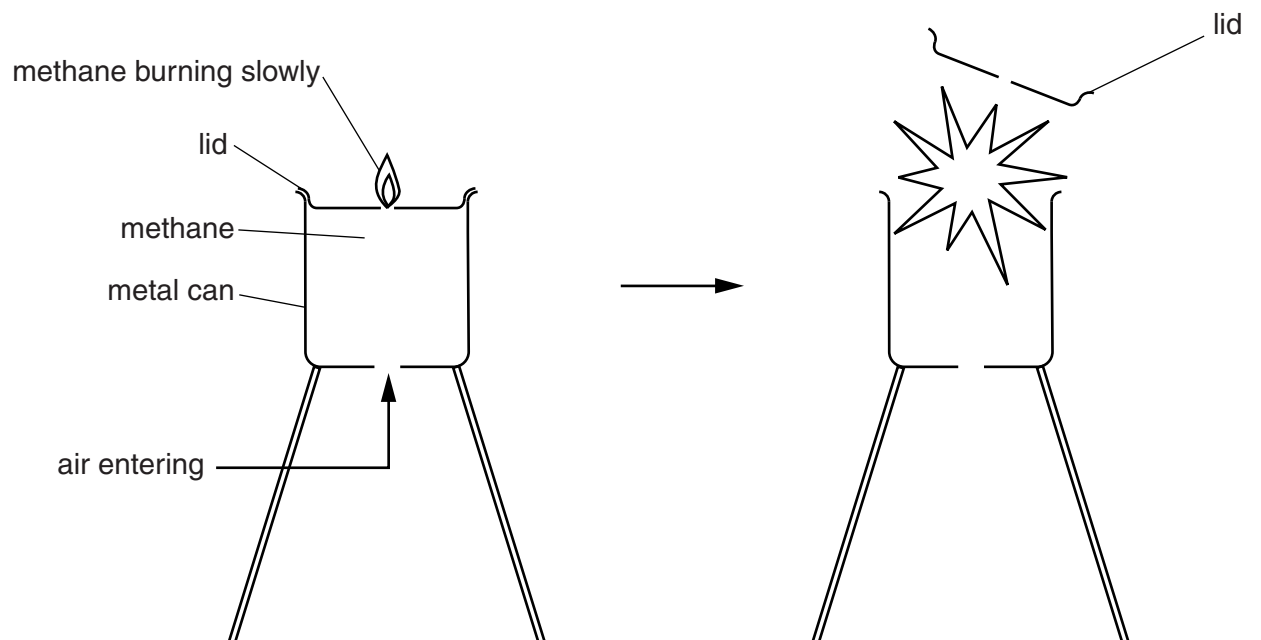


Fig. 5.1

- At first, methane escapes through the hole in the lid and burns slowly.
- As methane leaves the can, air enters through the hole in the base.
- When enough air has entered, an explosion occurs.

(i) Table 5.1 compares the three main gases in the can just before and just after the explosion.

Table 5.1

gases present just before the explosion	→	gases present just after the explosion
methane		
oxygen		

Complete Table 5.1 to show the main gases present just before and just after the explosion.

[2]

- (ii) The explosion occurs when the rate of combustion of methane suddenly increases. This causes a rapid increase in temperature of the gases in the can.

Describe an energy transformation which occurs during this reaction.

.....
.....[1]

- (iii) State the term used to describe a chemical reaction which causes an increase in temperature.

..... [1]

- (c) Methane reacts with oxygen when it burns.

- (i) Use the Periodic Table on page 24 to deduce and explain

the number of electron shells in an oxygen atom,

number

explanation

.....

the number of electrons in the outer shell of an oxygen atom.

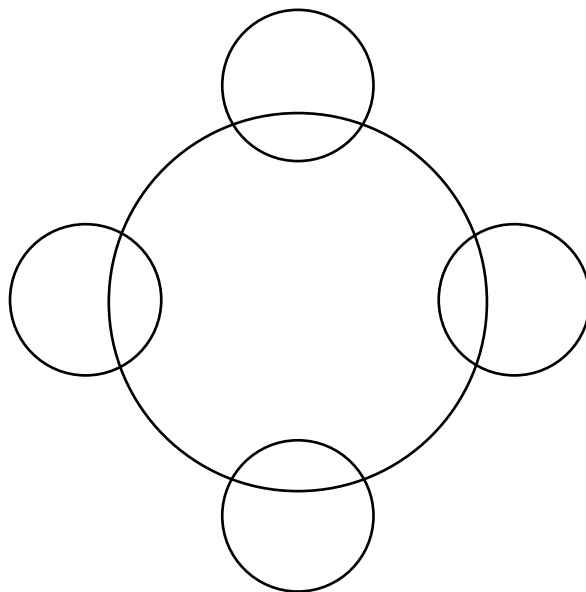
number

explanation

.....[2]

(ii) Complete the covalent bonding diagram of one molecule of methane to show

- the chemical symbols of each atom,
- how the outer electrons of each atom are arranged.



[2]

(d) (i) State the group in the Periodic Table that contains **only** unreactive gaseous elements.

.....

[1]

(ii) Explain why these elements are unreactive.

.....

.....[1]

- 6 (a) (i) Fig. 6.1 shows a glass block and a ray of light entering a glass block.

On Fig. 6.1 complete the path of the ray of light as it enters and passes through the block, and out into the air on the other side.

On your diagram, indicate clearly the angle of incidence i and the angle of refraction r as the ray passes into the block.

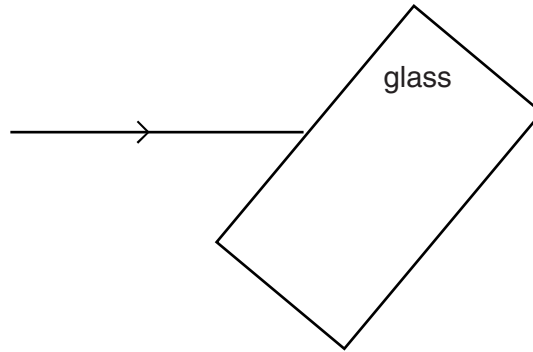


Fig. 6.1

[3]

- (ii) The Sun is visible to a person at point **X**, as shown in Fig. 6.2. The dotted line shows the outer limit of the Earth's atmosphere.

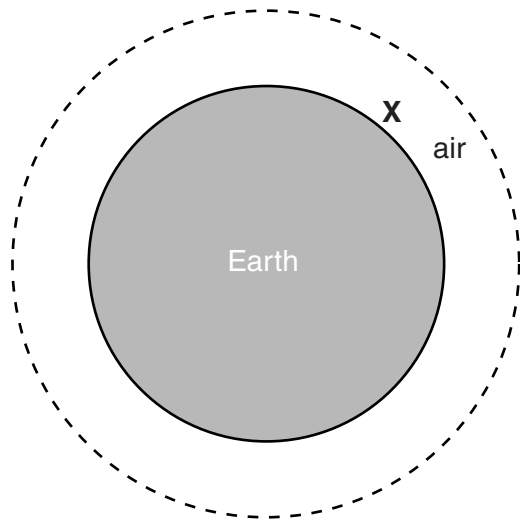
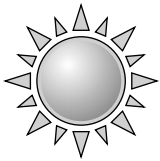


Fig. 6.2

The Earth is between the person at **X** and the Sun.

On Fig. 6.2 draw the path of a ray from the Sun that reaches point **X** to show how the person at **X** can still see the Sun.

Explain why the person at **X** can still see the Sun.

.....

.....

.....[2]

(b) Electromagnetic radiation from the Sun warms the Earth.

- (i) State the form of electromagnetic radiation mainly responsible for this energy transfer from the Sun.

.....[1]

- (ii) Suggest why, on a sunny day, the temperature of the sand on a beach next to the sea is higher than the temperature of the sea-water.

.....

.....[1]

- (c) When electromagnetic waves move from a vacuum to the atmosphere, they slow down, but their frequency remains the same.

Explain why the wavelength of light changes as light from the Sun enters the Earth's atmosphere.

.....

.....

.....

.....[2]

- 7 The tree shown in Fig. 7.1 was blown over during a storm. Shortly afterwards, fungi began to grow on the tree trunk.



Fig. 7.1

- (a) The fungi are decomposers.

Define the term *decomposers*.

.....

.....

.....

.....[2]

- (b) The fungi secrete their digestive enzymes into the wood of the tree trunk.

- (i) Suggest why the fungi secrete these enzymes into the tree trunk.

.....

.....

.....

.....[2]

- (ii) The rate of digestion of the wood by the fungi is affected by the pH of the wood.

Suggest how the rate of digestion of the wood by the fungi is changed if acid rain has been falling on the tree trunk for some time.

Explain your answer.

.....

.....

.....

.....[2]

- 8 A student investigates the speed of reaction between metals and dilute hydrochloric acid. He knows that adding dilute hydrochloric acid to iron wire will produce hydrogen gas. Fig. 8.1 shows the apparatus he uses.

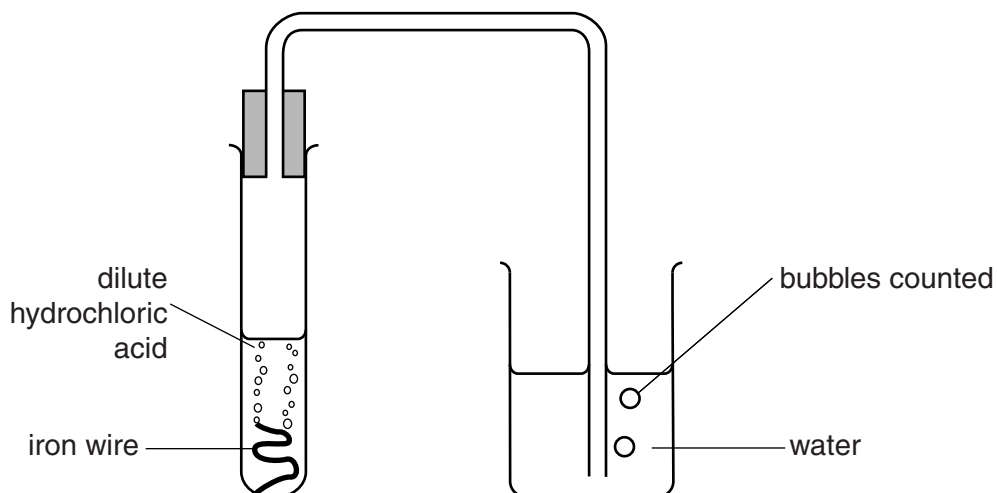


Fig. 8.1

He measures the speed of the reaction by counting the number of bubbles of hydrogen produced each minute for 10 minutes.

Some wire is left when the reaction stops.

Fig. 8.2 shows his results as a graph of number of bubbles per minute against time.

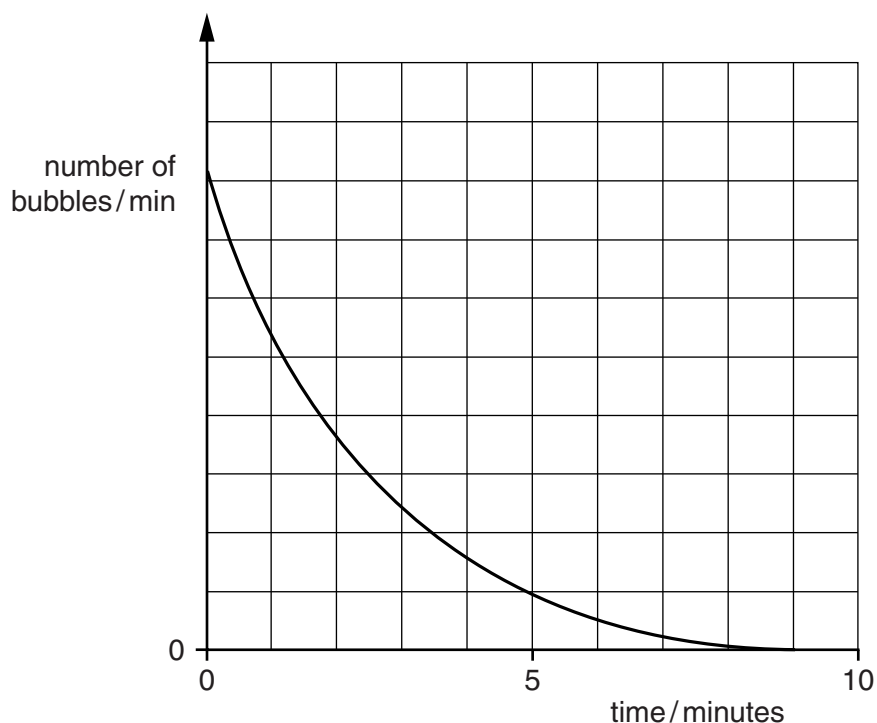


Fig. 8.2

- (a) (i) Explain, in terms of acid concentration, why the number of bubbles per minute decreases with time.

.....
.....
.....[1]

- (ii) On Fig. 8. 2, mark with an **X** the time when the reaction stops. [1]

- (iii) Explain why the reaction stops.

.....
.....[1]

- (b) He repeats the experiment using an identical piece of iron wire and the same volume of acid, but at a **higher** temperature.

- (i) Sketch the graph for his new results on Fig. 8.2. [2]

- (ii) The initial rate of reaction is different at a higher temperature.

Explain this difference in terms of the collision of particles.

.....
.....
.....
.....[2]

- 9 Fig. 9.1 shows a circuit being used to investigate the resistance of pieces of wire. The pieces of resistance wire are connected to the circuit between **X** and **Y**.

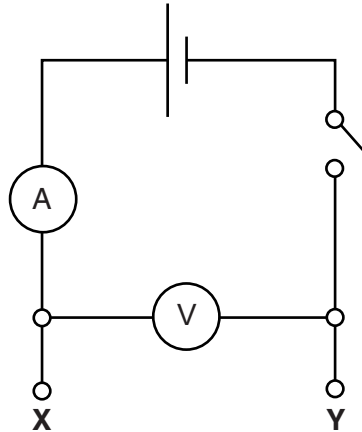


Fig. 9.1

A piece of resistance wire of length 100 cm is connected between **X** and **Y**.

The ammeter reading is 0.5 A.

The voltmeter reading is 1.2 V.

- (a) (i)** Calculate the resistance of the piece of wire.

State the formula used and show your working.

formula

working

resistance = ... Ω [2]

- (ii)** The piece of wire is cut into two shorter pieces of length 50 cm.

Predict the resistance of one of the shorter pieces of wire.

..... Ω [1]

(b) The energy stored in the cell in the circuit is used to drive the current round the circuit.

(i) State the equation for finding electrical power in a circuit.

.....[1]

(ii) Name the unit of power and give its symbol.

name

symbol [1]

(iii) The circuit is left switched on for 2 minutes. The current during this time is 0.5 A, and the voltage remains at 1.2V.

Calculate the energy output from the cell in this time.

State the formula used and show your working.

formula

working

energy = ... J [2]

(c) Most of the stored chemical energy taken from the cell is changed to thermal energy in the wire.

(i) Some of this thermal energy is then transferred to the air in contact with the wire before being transferred to the surroundings.

Name the method of thermal energy transfer by the heated air to the surroundings.

.....[1]

(ii) The rest of the thermal energy is transferred from the resistance wire to the connecting wires in the circuit.

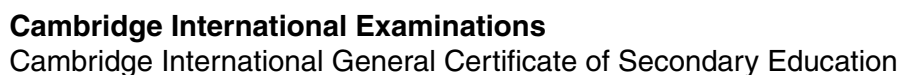
Describe how this transfer happens in terms of molecular motion.

.....

[2]

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

PAPA CAMBRIDGE



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0653/32

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This document consists of **24** printed pages.

- 1 Fig. 1.1 shows a van being driven along a flat road at a constant speed. The arrows on the diagram represent the four main forces acting on the van.

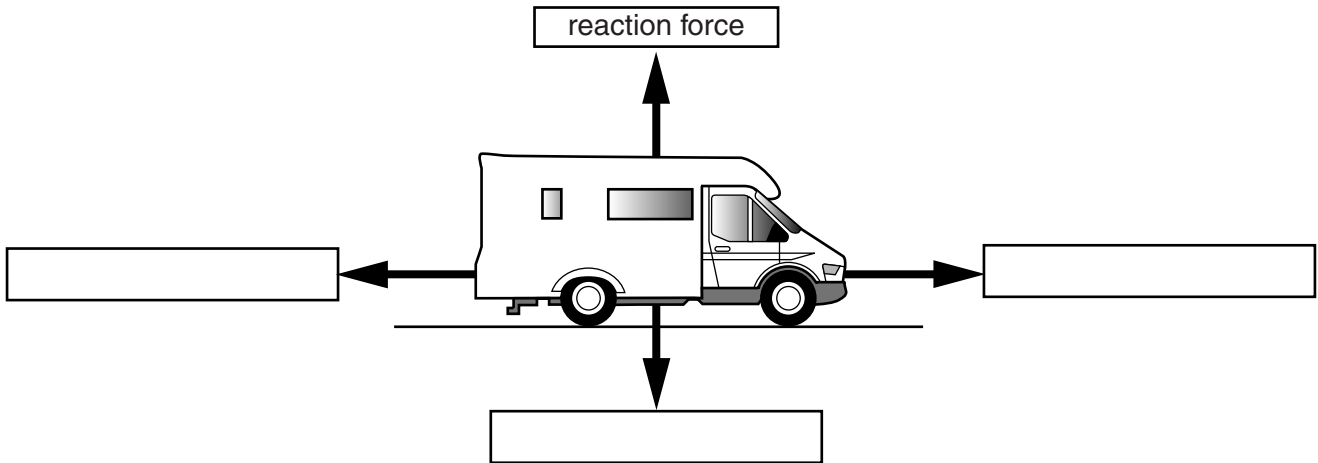


Fig. 1.1

- (a) (i) On Fig. 1.1, use words from the list to complete the boxes next to the arrows to label the three missing forces.

Each word from the list can be used once, more than once or not all.

driving	friction	gravity
mass	pressure	weight

[2]

- (ii) The reaction force is 30 000 N.

State the value of the downward force. Give a reason for your answer.

downward force = ... N

reason

.....[2]

- (iii) Explain where the downward force in (a)(ii) comes from.

.....

.....[1]

(b) Fig. 1.2 shows a speed/time graph for the van for a short journey.

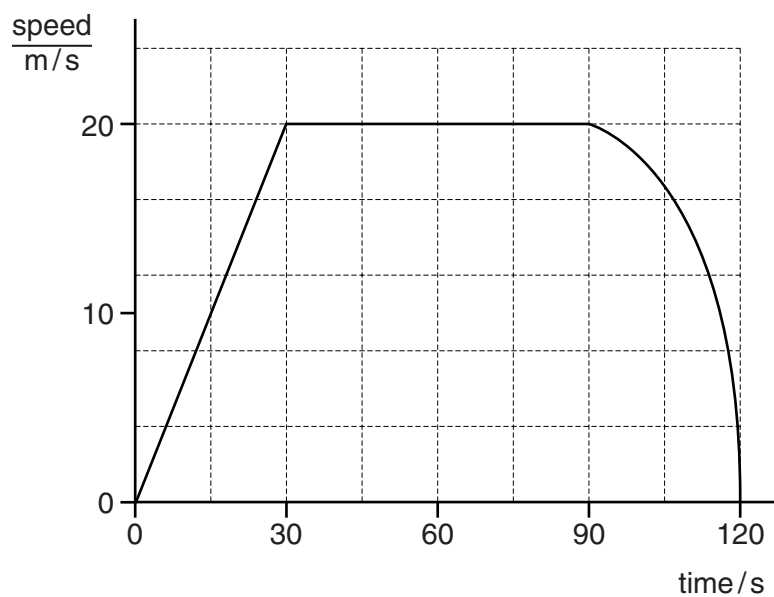


Fig. 1.2

- (i) Describe the motion of the van between 30 s and 120 s

.....

[2]

- (ii) Use the speed/time graph in Fig.1.2 to calculate the distance travelled in kilometres in the first 90 s of the journey.

Show your working.

distance travelled = ... km [3]

2 (a) Yoghurt is made by adding bacteria to milk.

- The milk is heated to 85 °C, then allowed to cool before adding the bacteria.
- The bacteria use the nutrients in the milk as their food source.
- Lactic acid is a waste product which lowers the pH of the milk.
- This causes the yoghurt to be made.

Explain why

(i) the milk used to make yoghurt is heated to 85 °C before it is used,

.....
[1]

(ii) the milk is then cooled before adding the bacteria.

.....
[1]

(b) Many manufacturers use two types of bacteria to make yoghurt instead of just one. Both types produce lactic acid. They also produce other chemicals which are helpful in the process of making yoghurt as shown in Fig. 2.1.

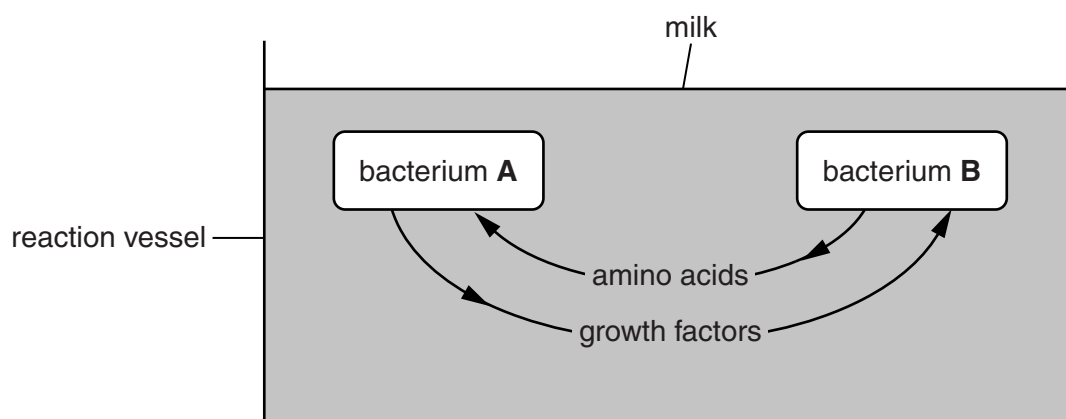


Fig. 2.1

Bacterium **B** produces amino acids by breaking down much larger molecules that are present in the milk.

(i) Name these larger molecules.

.....[1]

(ii) Suggest how bacterium **B** breaks down these larger molecules into amino acids.

.....
[1]

- (iii) Use the information in Fig. 2.1 to explain why manufacturers prefer to use two types of bacteria instead of one.

.....

.....

.....

.....[2]

- (c) Some of the nutrients in two types of yoghurt are illustrated in Table 2.1.

Table 2.1

nutrient	amount in 100g	
	yoghurt C	yoghurt D
protein/g	3.6	4.7
carbohydrate/g	10.6	8.8
fat/g	4.2	0.2
calcium/mg	124	202

Suggest and explain which type of yoghurt would be the better choice

- (i) for avoiding coronary heart disease,

.....

.....[1]

- (ii) for building strong bones.

.....

.....[1]

3 Petroleum (crude oil) is a mixture of compounds.

Some of these compounds are used as fuels.

(a) (i) Name the process used to separate the petroleum mixture into useful fractions.

.....[1]

(ii) State and explain whether this process involves a physical or a chemical change.

.....

.....[1]

(b) Fig. 3.1 shows how petroleum fractions can be separated in the laboratory.

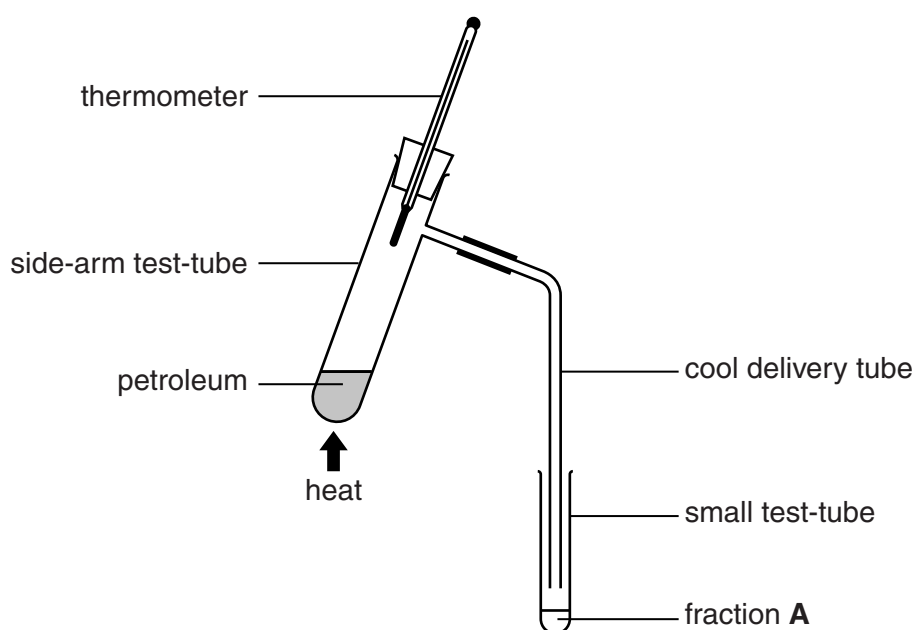


Fig. 3.1

The petroleum is heated and petroleum vapour is formed.

When the thermometer shows a temperature of 100 °C, fraction **A** collects in the small test-tube.

The small test-tube used to collect the fraction is replaced with a fresh test-tube. Heating is continued, and three further fractions, **B**, **C**, and **D**, are collected. All four fractions are shown in Fig. 3.2.

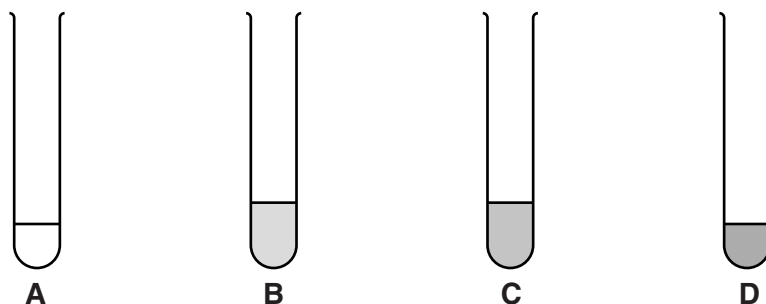


Fig. 3.2

The fractions become darker from **A** to **D**.

The fractions are collected over the temperature ranges shown in Table 3.1.

Table 3.1

fraction	temperature range/°C
A	room temperature to 100
B	100 to 150
C	150 to 200
D	200 to 250

- (i) Use the information in Table 3.1 to state **one** trend in a physical property of the fractions **A** to **D** apart from colour.

.....
[1]

- (ii) Suggest how the average size of the molecules in the fractions changes from **A** to **D**.

Explain your answer.

.....

[2]

- (c) Ethane is one of the compounds found in petroleum.

Complete the drawing of the structure of a molecule of ethane.



[2]

- (d) The cracking of petroleum produces compounds which react readily with bromine.

State the **type** of compound produced by cracking that reacts with bromine.

.....[1]

Please turn over for Question 4.

4 Fig. 4.1 shows an electric fan heater used to keep people warm.

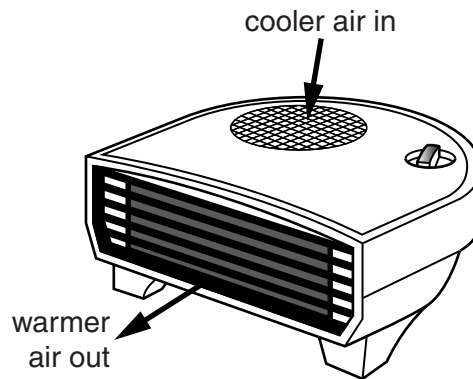


Fig. 4.1

(a) The fan heater contains

- a switch to control the mains electricity supply,
- an electric heater to warm the air,
- an electric motor to drive the fan,
- a fuse to protect the circuit.

The fan must continue to work, even when the heater is not working.

Fig. 4.2 shows the circuit symbols for a heater, an electric motor and a fuse.

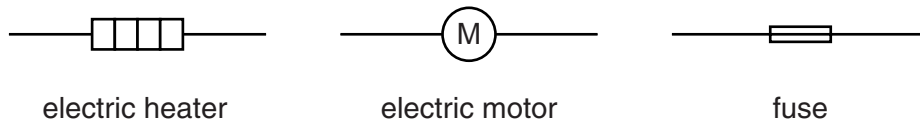


Fig. 4.2

On Fig. 4.3 complete the circuit diagram for the fan heater connected to the mains electricity supply, using the correct circuit symbols for the components listed above.

The mains electricity supply has been drawn for you.

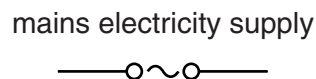


Fig. 4.3

[3]

- (b) Another type of switch is also needed in the circuit as a safety device to cut off the heater if the temperature rises too much. This is called a thermal cut-out.

The thermal cut-out must switch off the heater but not the fan. The fan must continue to operate to reduce the temperature.

Fig. 4.4 shows the structure of this switch.

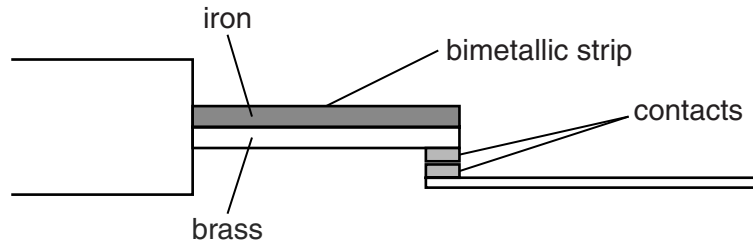


Fig. 4.4

- (i) On Fig. 4.3 in (a), mark with an **X** a point in your completed circuit where this switch could be put into the circuit to switch off the heater but not the fan. [1]
- (ii) As the temperature rises, the bimetallic strip bends upwards, so breaking the contact and switching off the heater.

Explain in terms of the particles in the brass and iron why the strip bends in this way.

.....

[2]

- (iii) Suggest a suitable position inside the fan heater to place the thermal cut-out so that, when the temperature of the room is warm enough, the heater is switched off.

Give a reason for your answer.

.....

[2]

- 5 (a) Fig. 5.1 shows a male and a female gamete. They are **not** drawn to scale.

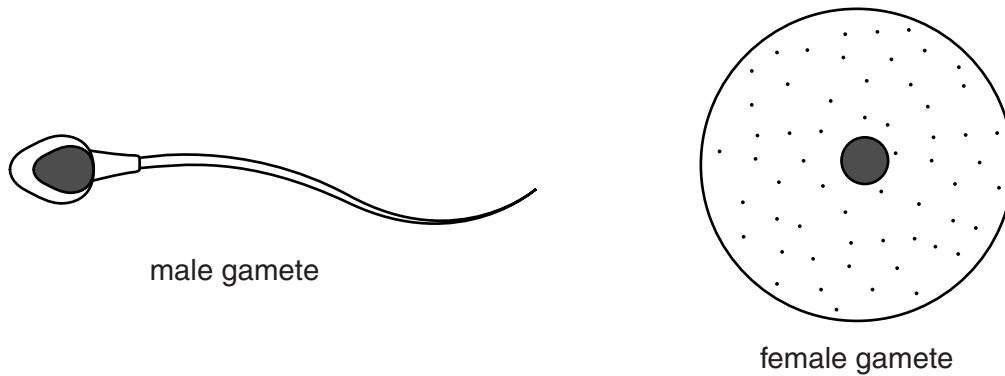


Fig. 5.1

- (i) The actual diameter of the female gamete is 100 micrometres.
 Estimate a value for the length of the male gamete.
 micrometres [1]
- (ii) Estimate how many gametes are produced during the lifetime of the average human
 male, ...
 female.[2]
- (iii) State how the nucleus of the male gamete differs from the nucleus of a zygote.

[1]

(b) Fig. 5.2 shows a fetus developing in the uterus of a pregnant woman.

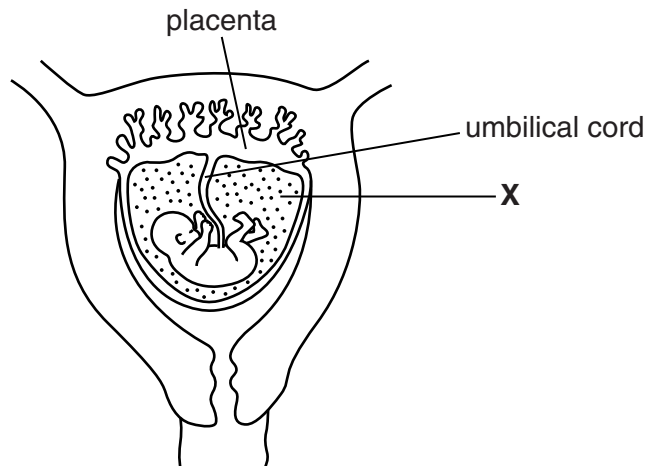


Fig. 5.2

Name part **X** and describe its function.

name

function
[2]

(c) During pregnancy a possible complication is narrowing of the blood vessels in the umbilical cord.

(i) Explain why this affects the amount of blood flowing to and from the placenta.

.....
[1]

(ii) Describe how this will affect the fetus.

.....

[2]

- 6 Table 6.1 shows some elements placed in order of reactivity.

Table 6.1

potassium
sodium
calcium
magnesium
zinc
iron
hydrogen
copper

- (a) Table 6.2 shows the reactions of some of the elements when added to dilute hydrochloric acid.

Table 6.2

element added to acid	observation
calcium	bubbles vigorously
copper	no reaction
zinc	

- (i) Complete Table 6.2 by adding the observation you would expect when zinc is added to the acid. [1]
- (ii) Explain your answer to (a)(i) by referring to the reactivity series.

.....

.....

.....[2]

(b) Fig. 6.1 shows what happens when a student places a zinc rod in copper sulfate solution.

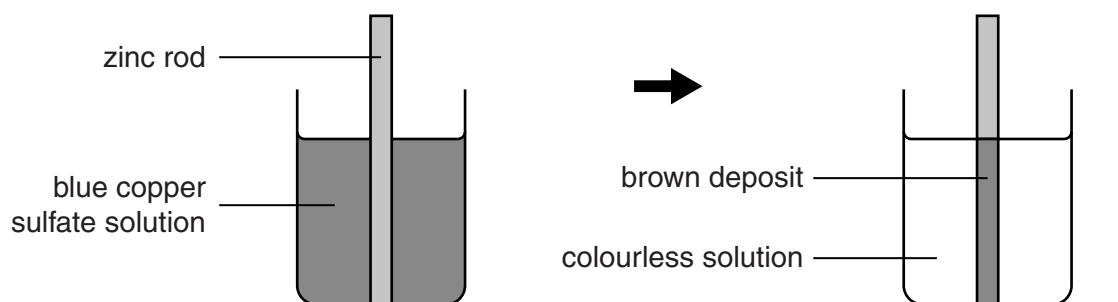


Fig. 6.1

The rod becomes coated in a brown deposit and the solution slowly changes from blue to colourless.

The zinc rod consists of zinc atoms.

Copper sulfate solution contains aqueous copper ions, Cu^{2+} , which are coloured blue.

(i) State the type of particles which form the brown coating on the zinc rod.

..... [1]

(ii) Suggest why the colour of the solution changes during the reaction.

.....
 [1]

(iii) Use the reactivity series in Table 6.1 to explain why this reaction occurs.

.....

 [2]

- (c) A student investigates the position of tin in the reactivity series. Her experiments are shown in Fig. 6.2.

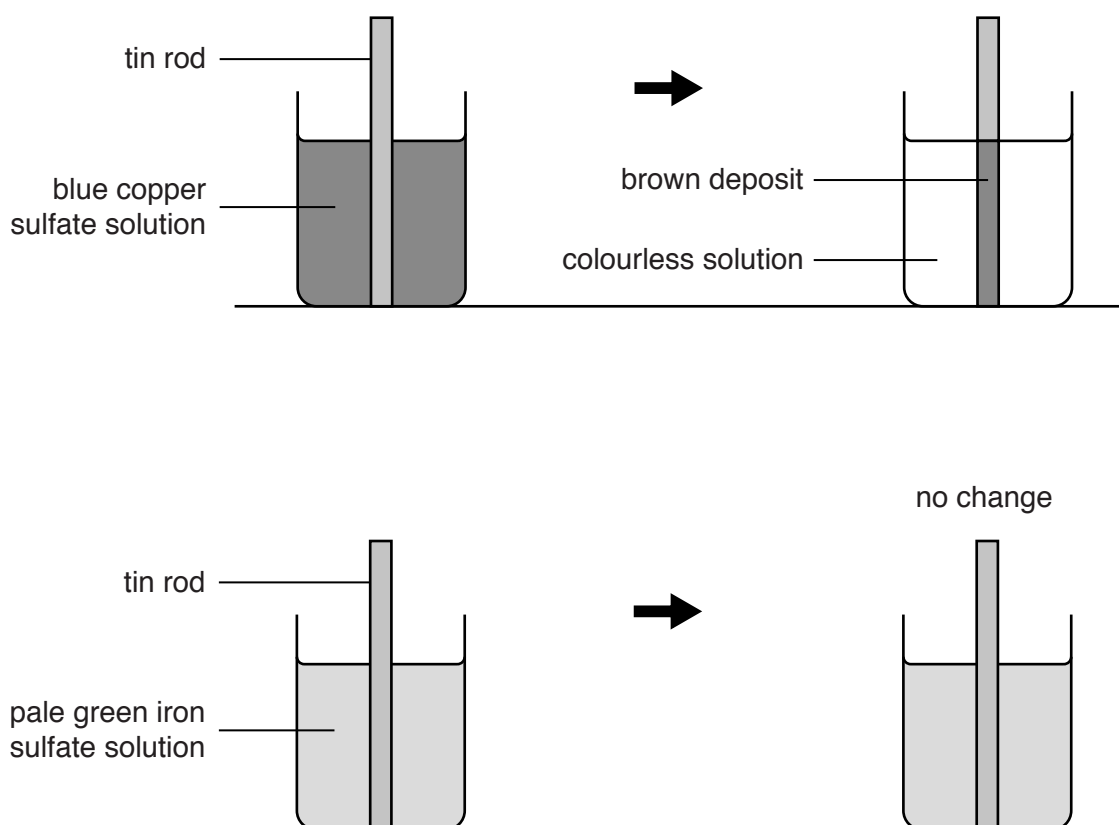


Fig. 6.2

- (i) Add tin to the section of the reactivity series in Table 6.3.

Table 6.3

zinc
iron
copper

[1]

(ii) By referring to Fig. 6.2, explain your answer to (c)(i).

.....

.....

.....

.....[2]

- 7 (a) A motorcyclist needs to see other vehicles and pedestrians.

Fig. 7.1 shows a motorcyclist from above and a car some distance behind him.

The motorcyclist looks in his rear view mirror to see the car.



Fig. 7.1

On Fig. 7.2 construct an accurate ray diagram for the reflection in the motorcycle's rear view mirror. Use arrowheads to show the direction of the ray



Fig. 7.2

[2]

- (b) The motorcyclist follows directions to his destination using his satellite navigation system (Satnav). The Satnav picks up signals from satellites orbiting the Earth to show the position of the motorcycle on a map displayed on the Satnav screen in front of him.

State the type of electromagnetic wave used by satellites sending signals to Earth.

.....[1]

- (c) The motorcyclist travels along a street at night.

The street is lit by lamps which emit yellow light with a wavelength of 589 nanometres (nm) or $589 \times 10^{-9} \text{ m}$.

- (i) State the formula that relates the speed, frequency and wavelength of a wave motion.

.....[1]

- (ii) Calculate the frequency of the electromagnetic waves of yellow light from the street lights.

Speed of light = $3 \times 10^8 \text{ m/s}$.

Show your working and state the unit of your answer.

frequency = ... unit = ... [2]

- (d) The motorcycle has two headlamps and a rear lamp, powered by a 6V battery.

The headlamps are identical, and are rated at 6V 36W.

The rear lamp is rated at 6V 6W and takes a current of 1A.

- (i) Calculate the current taken by one headlamp when lit.

State the formula used and show your working.

formula

working

current = ... A [2]

- (ii) The lamps are all connected in parallel.

Calculate the total current drawn from the battery by the three lamps when all are lit.

total current = ... A [1]

- 8 (a) Fig. 8. 1 shows part of a simple food chain in a field of wheat.

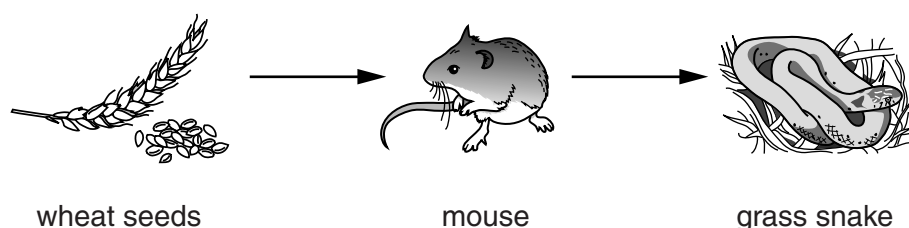


Fig. 8.1

- (i) There are three trophic levels in the food chain shown in Fig. 8.1.

Define the term *trophic level*.

.....
[1]

- (ii) Explain why food chains usually have fewer than five trophic levels.

.....

[2]

- (iii) A badger also lives in the habitat. The badger eats **all** of the organisms in the food chain. These organisms and the badger form a food web.

Complete Fig. 8.2 to show the food web.



Fig. 8.2

[2]

- (b) All food chains must have decomposers, though they are not always included in diagrams.

Explain the importance of decomposers in the habitat.

.....

[2]

- (c) The wheat is harvested. Suggest **two** possible ways in which the mice respond to the removal of their food supply.

1

.....

2

.....[2]

9 A copy of the Periodic Table is printed on page 24.

(a) (i) State how the position of chlorine in the Periodic Table shows that it is a non-metal.

.....
[1]

(ii) State how the Periodic Table is used to predict the number of outer shell electrons in a fluorine atom.

.....
[1]

(iii) State how the number of outer shell electrons in an atom of an element can be used to predict whether the element is likely to be a metal or a non-metal.

.....
[1]

(b) Hydrogen and chlorine react to form hydrogen chloride gas.

(i) Write a balanced chemical equation for the reaction between hydrogen and chlorine.

.....[2]

(ii) Fig. 9.1 shows the outer shell electrons in a hydrogen atom and in a chlorine atom.

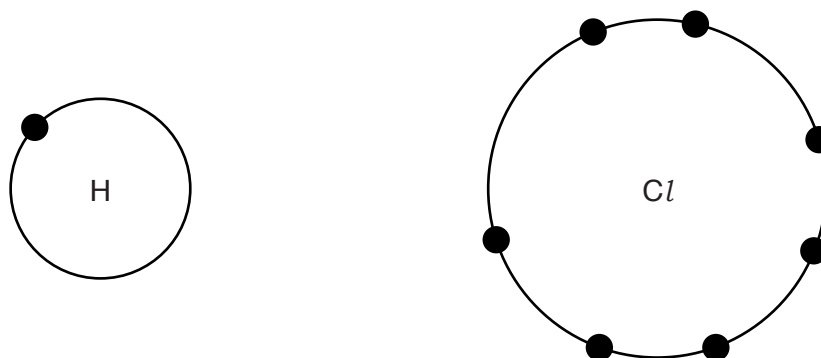


Fig. 9.1

Draw a diagram to show how these atoms form a hydrogen chloride molecule.

[2]

- (c) Fig. 9.2 shows apparatus used to dissolve hydrogen chloride gas in water to form hydrochloric acid.

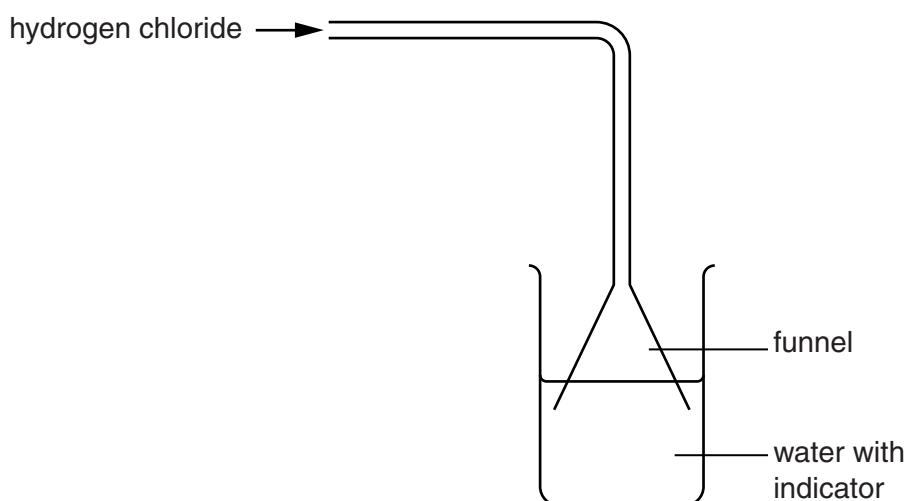


Fig. 9.2

The water contains full-range indicator (Universal Indicator) added before the hydrogen chloride dissolves.

- (i) State the colour of the indicator in pure water.

.....[1]

- (ii) The indicator turns red. Suggest the change in pH.

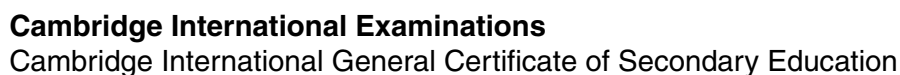
from pH to pH

[1]

DATA SHEET
The Periodic Table of the Elements

Group																		
I	II											III	IV	V	VI	VII	0	
		1 H Hydrogen 1																
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10	
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18	
39 K Potassium 19	40 Ca Calcium 20	48 Ti Titanium 22	45 Sc Scandium 21	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	84 Kr Krypton 36		
85 Rb Rubidium 37	88 Sr Strontium 38	91 Zr Zirconium 40	89 Y Yttrium 39	93 Nb Niobium 41	96 Mo Molybdenum 42	101 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	131 Xe Xenon 54		
133 Cs Cesium 55	137 Ba Barium 56	178 Hf Hafnium 72	139 La Lanthanum 57	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	209 Po Polonium 84	222 Rn Radon 86		
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89																
* 58–71 Lanthanoid series																		
† 90–103 Actinoid series																		
a X b a = relative atomic mass X = atomic symbol b = atomic (proton) number																		
				140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71	
		232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103	280 Lu Lutetium 71		

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).



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0653/33

October/November 2015

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

A copy of the Periodic Table is printed on page 28.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **28** printed pages.

- 1 (a) Use words from the list to complete the sentences about the human gas exchange system.

Each word can be used once, more than once, or not at all.

arteries capillaries into large long
out of small veins

The alveoli have a surface area for the diffusion of oxygen
..... the blood. There is a good supply of blood flowing in
..... close to the alveoli which provides a short diffusion pathway for
gases. [3]

- (b) Some people suffer from asthma which affects the bronchioles of the gas exchange system.

Fig. 1.1 shows a cross section of a healthy bronchiole, and a bronchiole of a person with asthma.

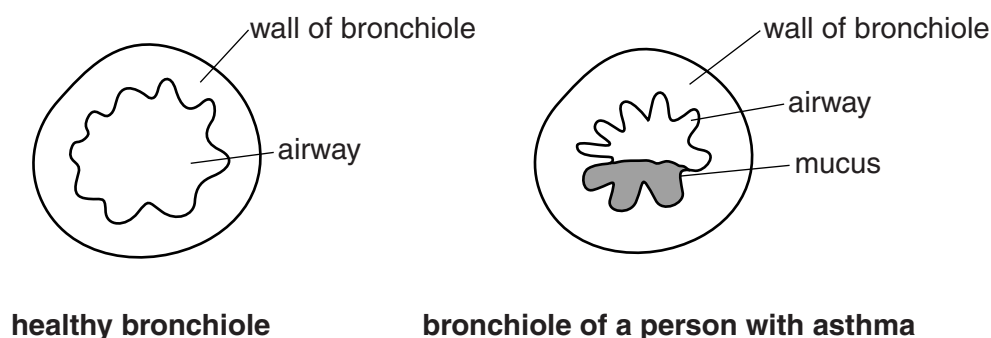


Fig. 1.1

The airflow towards the alveoli is reduced if a person has asthma.

Describe **two** features visible in Fig. 1.1 which could reduce the airflow to the alveoli.

1

2 [2]

- (c) A study is carried out to compare the breathing of people with asthma with the breathing of healthy people.

The volumes of air inhaled in one minute are measured and an average is calculated.

Both groups of people are tested while resting.

Results

average volume inhaled by a healthy person = $5.8 \text{ dm}^3/\text{minute}$

average volume inhaled by a person with asthma = $12.5 \text{ dm}^3/\text{minute}$

- (i) Calculate the average percentage of **extra** air the person with asthma inhales per minute compared with a healthy person.

Show your working.

answer = ...% [2]

- (ii) The person with asthma needs to breathe a greater volume of air per minute by breathing more quickly and more deeply. The same changes occur to the breathing of all people when they exercise.

Explain why these breathing changes are needed during exercise.

.....

[2]

- (d) The tar in tobacco smoke affects the gas exchange system.
 Two of these effects are listed below.

cilia become paralysed
 more mucus is produced

Choose **one** of the effects above and explain why it is **especially** harmful for a person with asthma to smoke. State which change you are choosing.

change
 explanation

[2]

- 2 Fig. 2.1 shows the apparatus used to investigate the temperature changes which occur during some chemical processes.

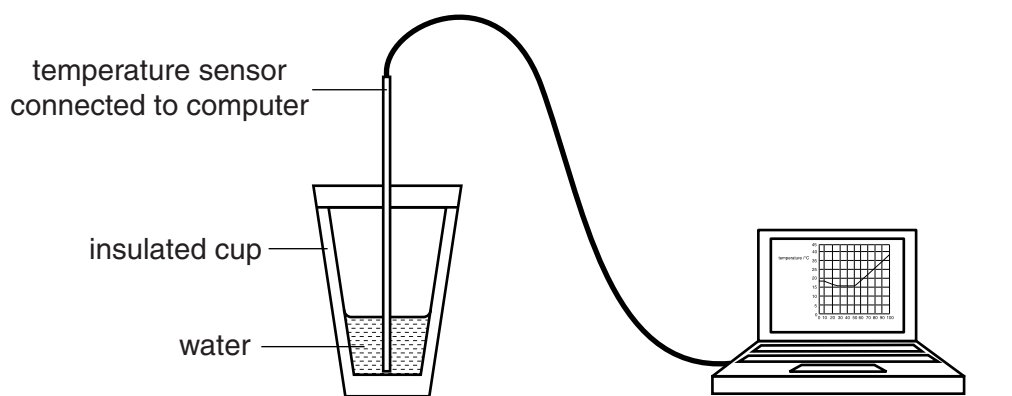


Fig. 2.1

The temperature sensor is placed in the water and the computer starts to log data. After 10 seconds some solid silver nitrate is added to the water in the cup. The mixture is stirred until the solid dissolves.

After another 40 seconds a length of copper wire is placed in the solution.

Fig. 2.2 shows the computer display of temperature change for the first 100 seconds.

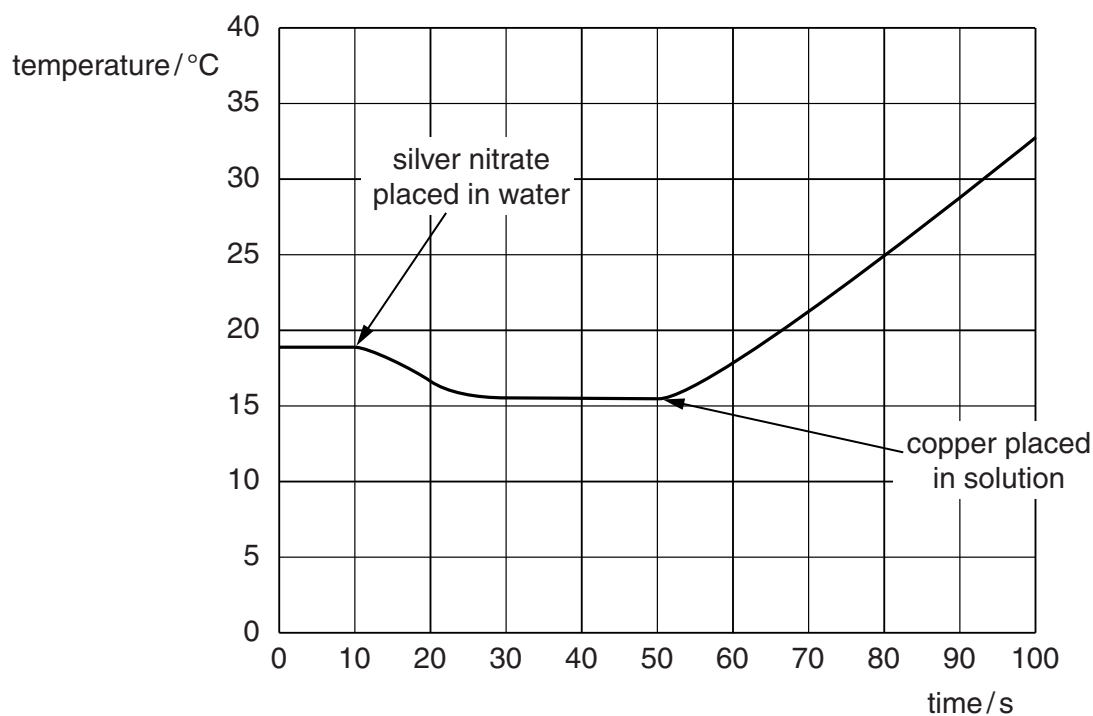


Fig. 2.2

- (a) Describe the **energy change** taking place as the silver nitrate dissolves.

.....[1]

(b) The experiment shown in Fig. 2.2 is **experiment 1**.

The procedure is repeated, using twice the mass of silver nitrate in the same volume of pure water. This is **experiment 2**.

The same length of copper wire is added at 50 seconds.

Fig. 2.3 shows part of the computer display with the results of both experiments.

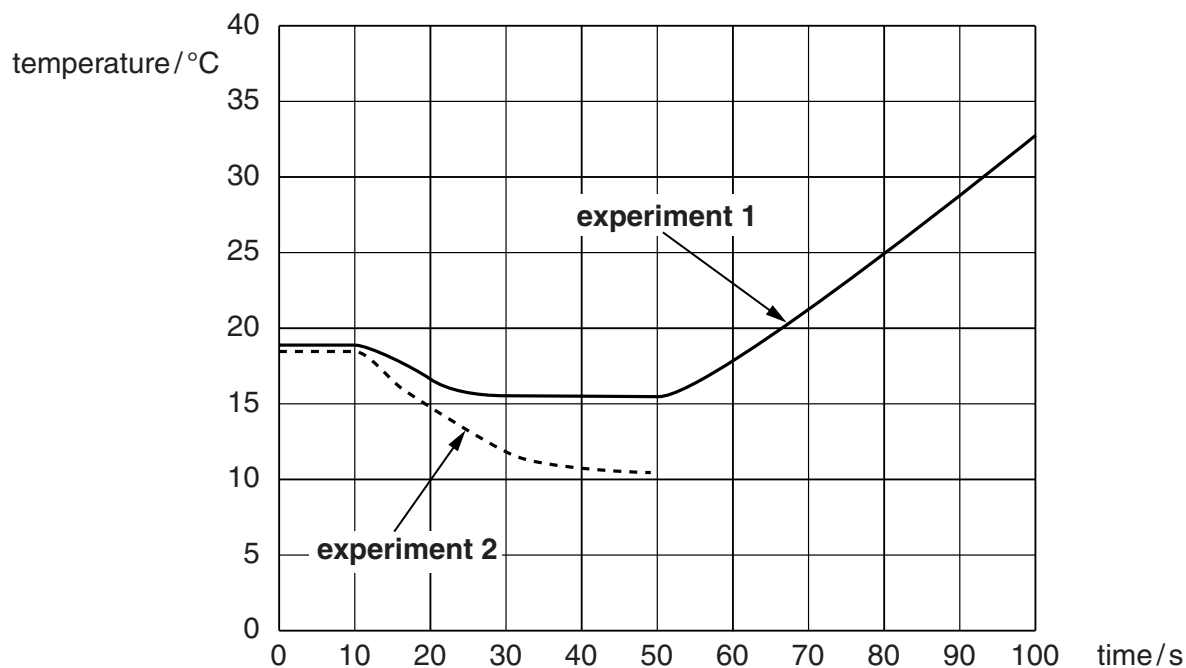


Fig. 2.3

- (i) Complete the graph for **experiment 2** on Fig. 2.3 to show the change in temperature as copper reacts. [1]
- (ii) Explain, in terms of the collision of particles, how increasing concentration affects the rate of reaction.

.....

.....

.....[2]

- (c) Fig. 2.4 shows the appearance of the contents of the cup at the end of the experiment.

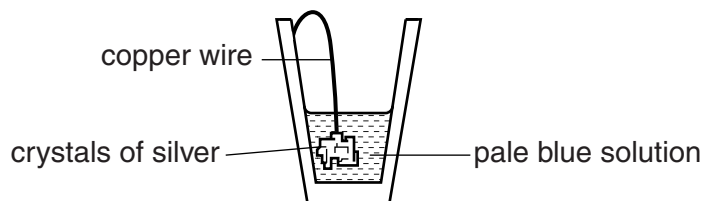


Fig. 2.4

Crystals of metallic silver coat the copper wire and the liquid is now a pale blue solution.

- (i) Use the words **atoms** and **ions** to complete the sentences which explain what happens during the reaction. Each word may be used once or more than once.

Copper in the wire become copper in the solution.

Silver in the solution become silver in the crystals.
[1]

- (ii) Table 2.1 shows a list of metals in order of reactivity.

Table 2.1

potassium
sodium
calcium
magnesium
zinc
iron
copper

Write silver in its correct position in the list in Table 2.1.

[1]

- (iii) Suggest how the reactivity of a metal depends on how easily its atoms change into ions in a chemical reaction.

.....

[1]

Please turn over for Question 3.

3 Fig. 3.1 shows a girl on a skateboard track which ends in a shallow pool of water.

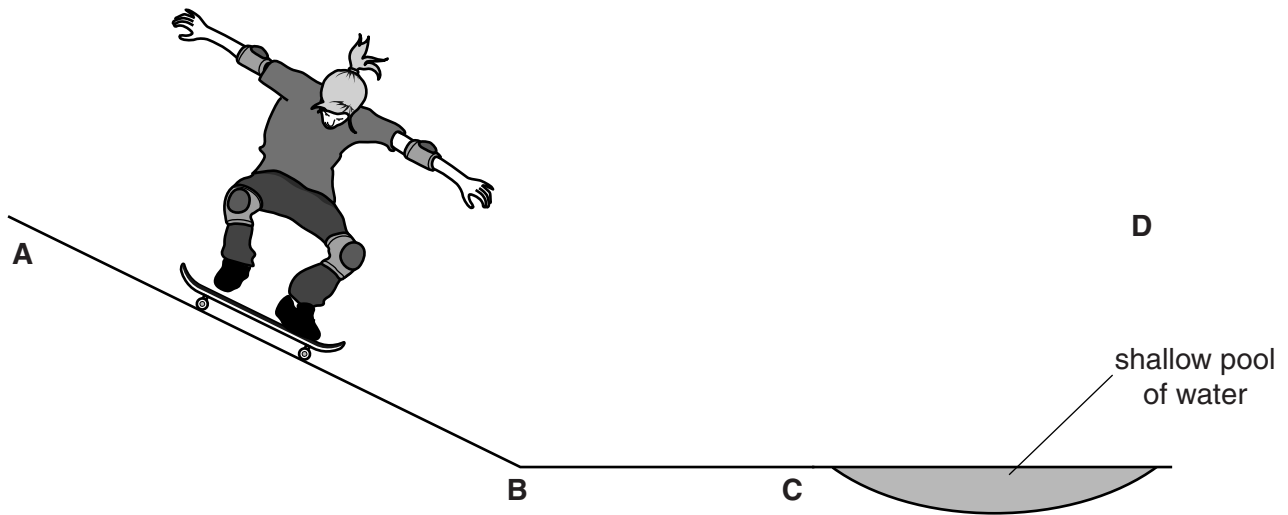


Fig. 3.1

(a) Name the force that causes the girl to move down the skateboard track from **A** to **B**.

.....[1]

(b) State the main energy transfer as the girl travels from **A** to **B**.

from energy

to energy

[1]

(c) Fig. 3.2 shows a speed/time graph of the girl as she travels.

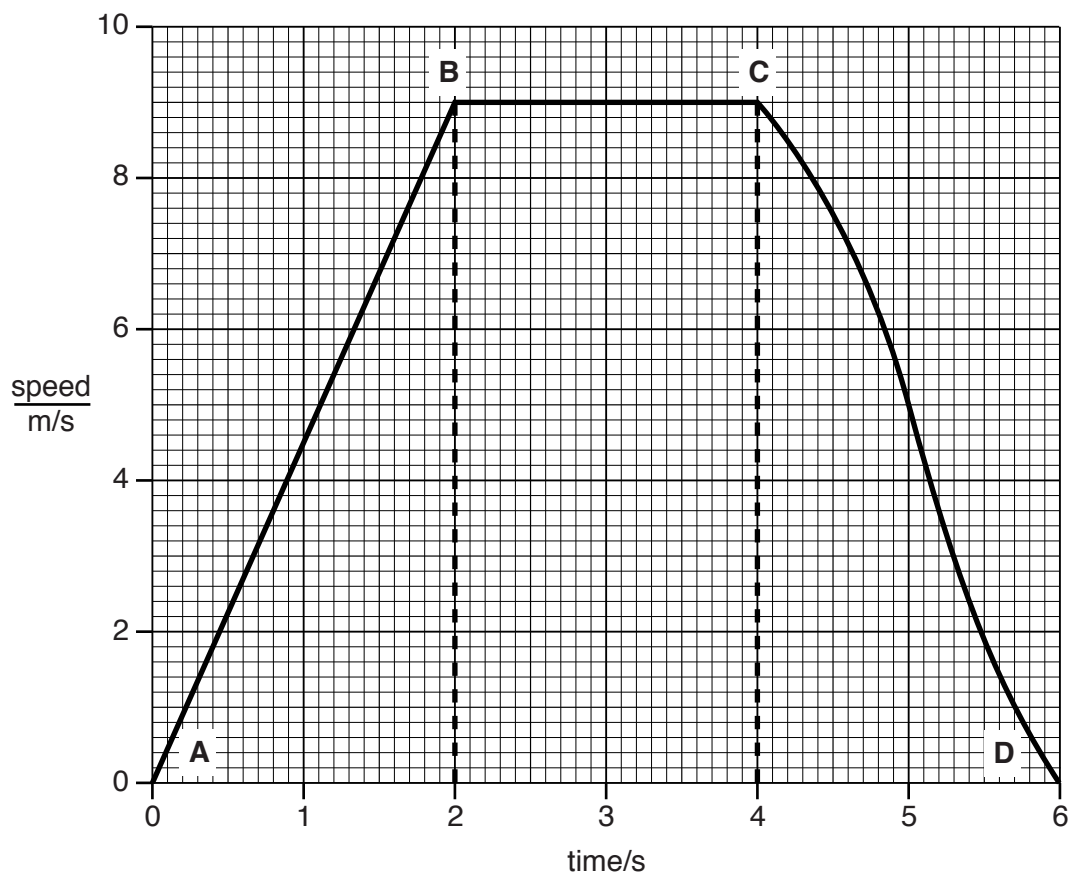


Fig. 3.2

(i) Describe the motion of the girl between points

A and **B**, ...

B and **C**.[2]

(ii) Use Fig. 3.2 to calculate the distance travelled by the girl between points **A** and **C**.

Show your working.

distance = ... m [2]

- (d) The girl crouches low on the skateboard to minimise air resistance. When she enters the shallow pool of water, the water resistance stops her quickly.

Explain, in terms of the particle theory of matter, why water resistance is more effective than air resistance at stopping the skateboarder.

You may wish to draw diagrams to help your explanation.

.....

.....

.....

.....

.....

.....[3]

Please turn over for Question 4.

- 4 (a) Vitamins are needed in small quantities as part of a balanced diet. One vitamin is vitamin C.

(i) State what is meant by the term *balanced diet*.

.....

.....

.....[1]

(ii) State why we need vitamin C in our diet.

.....

.....[1]

- (b) A student does an experiment to find if temperature affects the vitamin C content of a citrus fruit juice.

The fruit juice is freshly made and then 10 cm³ samples of the juice are stored for four days at the temperatures shown in the table.

At the start, a 10 cm³ volume of fruit juice contains 5 mg of vitamin C.

Table 4.1 shows the average mass of vitamin C in each 10 cm³ sample of juice at the end of the four days.

Table 4.1

temperature/°C	mass of vitamin C/mg in 10 cm ³ of juice
4 (in refrigerator)	4.9
20	3.8
30	3.5
40	2.8
50	1.4

(i) Describe the effect of increasing temperature on the vitamin C content of the juice.

.....

.....[1]

(ii) Suggest an explanation for the effect you described in (b)(i).

.....

.....[1]

- (iii) When the experiment was repeated in different parts of the world, the initial masses of vitamin C in the 10 cm^3 samples were found to be very different.

Suggest and explain a reason for this observation.

.....

.....

.....

.....[2]

- (c) Many new mothers feed their babies on formula milk which is made up with warm water and given to the baby from a bottle.

Using the information in Table 4.1 suggest why boiling water should not be used to make up formula milk.

.....

.....

.....[1]

- (d) A new mother was deciding whether to bottle-feed her baby.

Explain one advantage and one disadvantage of bottle feeding.

advantage

.....

disadvantage

.....[2]

- 5 (a) Fig. 5.1 shows Period 3 of the Periodic Table.

A								
23 Na Sodium 11	24 Mg Magnesium 12		27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
B								

Fig. 5.1

Draw an arrow in box **A** to show the direction of increasing metallic character of the elements across the period.

Draw an arrow in box **B** to show the direction of increasing number of outer shell electrons in atoms of the elements across the period. [1]

- (b) (i) Table 5.1 shows some observations made after a piece of sodium is dropped into water containing some full-range indicator (Universal Indicator).

Complete Table 5.1 to explain each observation.

Table 5.1

observation	explanation
bubbles of gas	
indicator changes from green to purple	

[2]

(ii) Fig. 5.2 shows part of Group I of the Periodic Table.

Group I	
7	Li Lithium 3
23	Na Sodium 11
39	K Potassium 19
85	Rb Rubidium 37

Fig. 5.2

Predict **one** way in which the reaction between rubidium and water differs from the reaction between sodium and water.

Explain your answer.

difference

explanation

.....

.....[2]

- (iii) Fig. 5.3 shows the outer electron shell in a sodium atom.

Complete the diagram of the outer shell of a rubidium atom to suggest how many electrons there are in the outer shell of a rubidium atom.

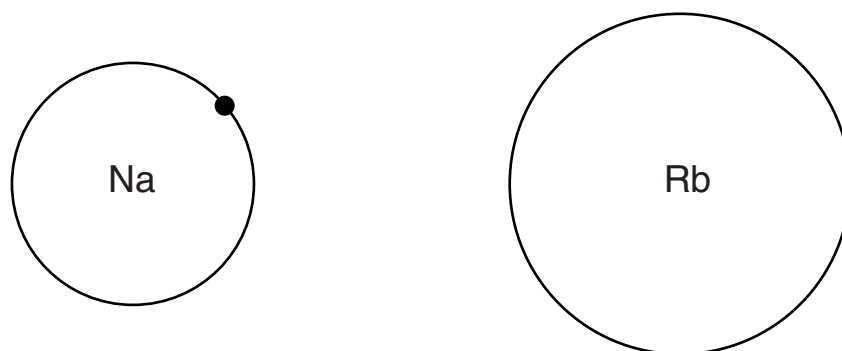


Fig. 5.3

Describe how you used the Periodic Table to make this suggestion.

.....

.....

.....[2]

Please turn over for Question 6.

- 6 Electric power can be generated using the energy of waves on the sea. Fig. 6.1 shows a group of small wave energy converters which are anchored to the sea floor below.

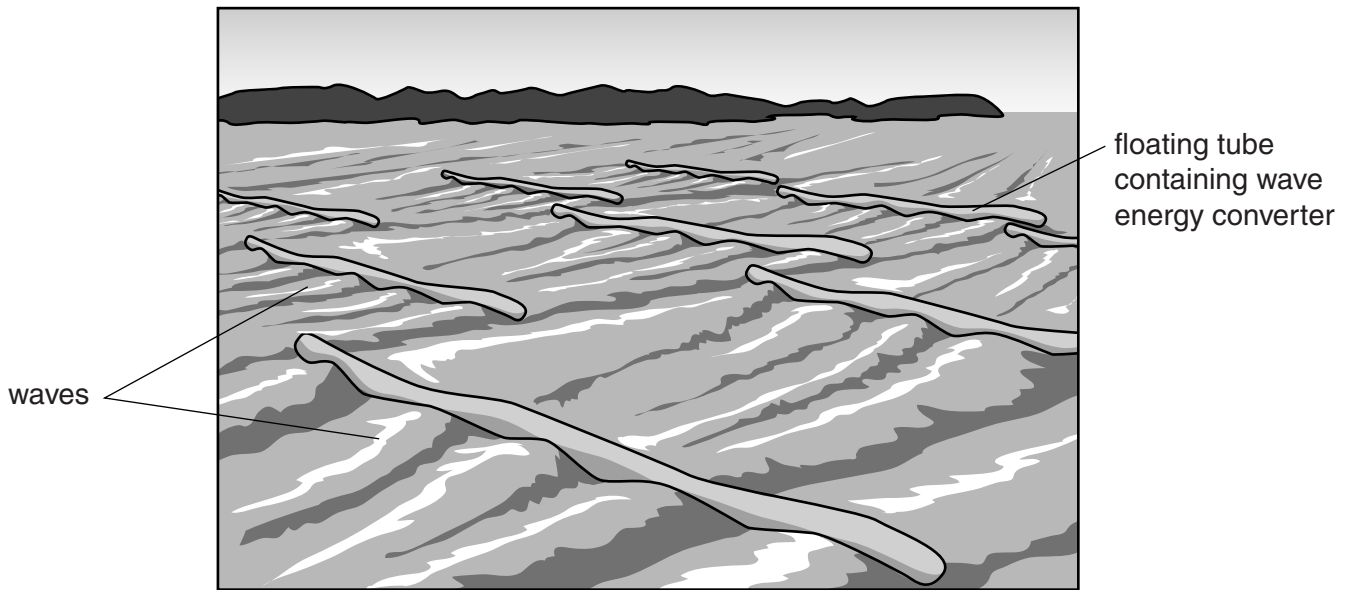


Fig. 6.1

Inside each floating tube there are several generators that convert the wave movement energy into electrical energy.

- (a) (i) A total of 10 waves passed one end of a container in 20 seconds.

Calculate the frequency of the waves. Show your working and state the unit of your answer.

frequency = ... unit [2]

- (ii) Each floating container is 30 m long. In Fig. 6.1 each sea wave takes 10 seconds to pass along each floating container from end to end.

Calculate the speed of the waves across the sea.

speed = ... m/s [1]

- (iii) Use your answers to (a)(i) and (ii) to calculate the wavelength of the waves.

State the formula that you use and show your working.

formula

working

wavelength = ... m [2]

- (b) The amplitude of the waves on one day was 0.5 m.

State the vertical distance that each container will move through as a wave passes.

distance = ... m [1]

- (c) The generators are controlled by radio signals. A radio signal is sent from a control centre 100 km away.

Fig. 6.2 shows an incomplete diagram of the electromagnetic spectrum.

gamma radiation			visible light			
-----------------	--	--	---------------	--	--	--

Fig. 6.2

Write an **R** in the box for the part of the spectrum where radio waves are found. [1]

- (d) Fig. 6.3 shows a tidal energy turbine, which is placed on the sea-bed. The flow of the tide turns the turbine.

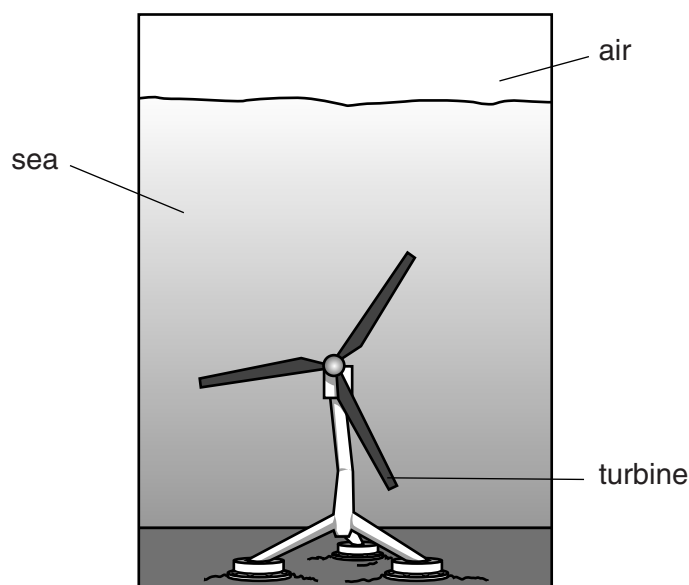


Fig. 6.3

Engineers believe wave generators and tidal generators will be important for supplying electrical energy in the future.

- (i) Give **one** advantage, other than cost, that tidal generators have over wave generators for the supply of electrical energy.

.....
[1]

- (ii) The water flow through a tidal generator delivers energy at 500kW. The electrical output from this turbine is 150kW.

Calculate the efficiency of the tidal turbine.

State the formula that you use and show your working.

formula

working

efficiency = ... % [1]

7 Fig. 7.1 shows what happens to most of the solar radiation reaching the Earth.

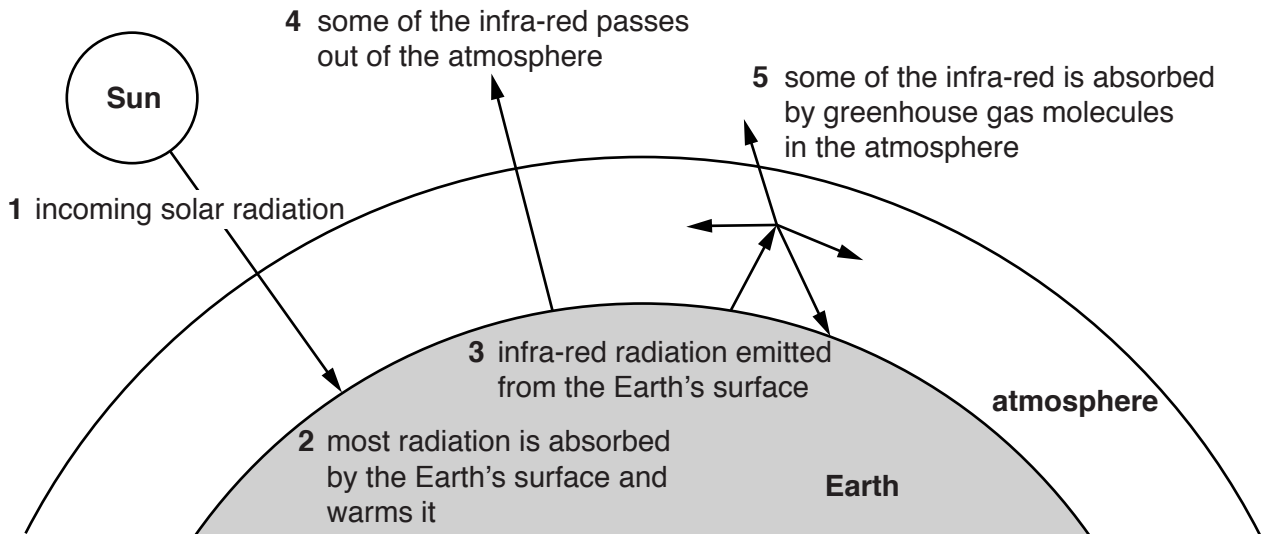


Fig. 7.1

Use Fig. 7.1 to

(a) Describe the role of the atmosphere in keeping the Earth warm.

.....

[2]

(b) Name **two** greenhouse gases.

.....and.....[1]

(c) Describe **two** ways in which human activities cause the concentrations of these greenhouse gases to increase.

1

 2
[2]

(d) State one measure that can be taken to reduce the levels of greenhouse gases in the atmosphere.

.....
[1]

- 8 A student extracts some copper from a sample of green copper carbonate, CuCO_3 .
- (a) He adds dilute hydrochloric acid to the copper carbonate until it is all dissolved.
- A blue solution of copper chloride, CuCl_2 , is formed.

Fig. 8.1 shows that bubbles of gas appear.

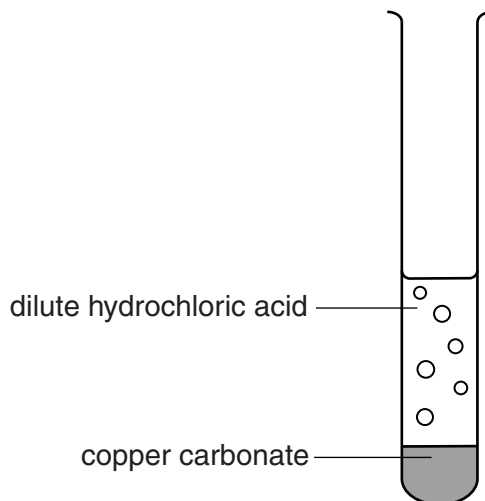
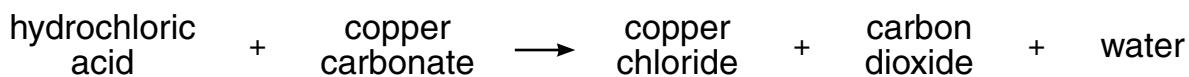


Fig. 8.1

- (i) The word equation for the reaction is:



Write the balanced chemical equation for this reaction.

.....[2]

- (ii) The student checks that the gas is carbon dioxide.

When the reaction is complete, he collects some of the gas in a pipette.

Fig. 8.2 shows how he collects the gas and then passes it through a solution **X**.

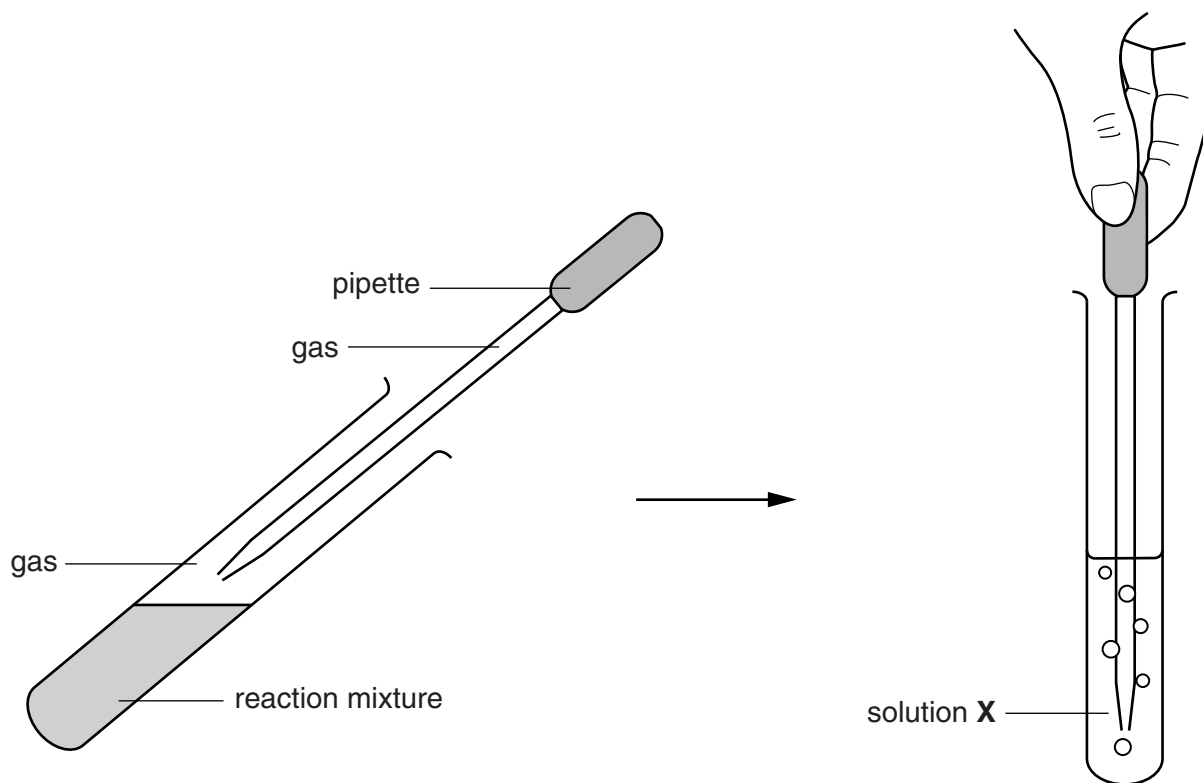


Fig. 8.2

State the name of solution **X** and describe the effect of carbon dioxide on its appearance.

name

effect

.....[2]

- (b) The student places the copper chloride solution that he has made into the electrolysis cell shown in Fig. 8.3.

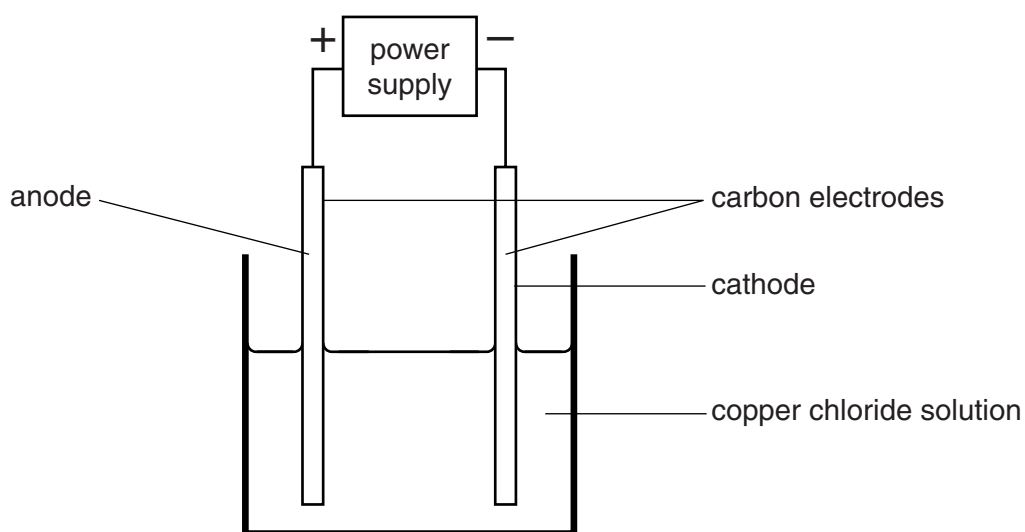


Fig. 8.3

- (i) Complete Fig. 8.3 by labelling each electrode to show the product formed. [2]
- (ii) The electrolyte contains copper ions and chloride ions. Describe the direction of movement of these particles when the switch in the circuit is closed.

copper ions (Cu^{2+})

.....

chloride ions (Cl^-)

.....[2]

- (c) Another compound of copper and chlorine exists, with a different formula.

It contains copper ions which have only one positive charge, Cu^+ .

- (i) Deduce the formula of the copper chloride compound containing the ion Cu^+ .

Explain your answer.

formula

explanation

.....

.....[2]

- (ii) Copper is a transition metal.

The ability to form more than one compound with another element is typical of transition metals.

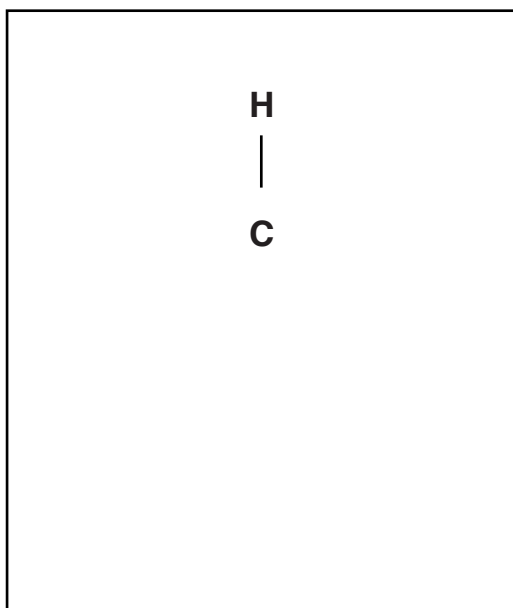
State another property which is typical of transition metals but **not** of other metals.

.....[1]

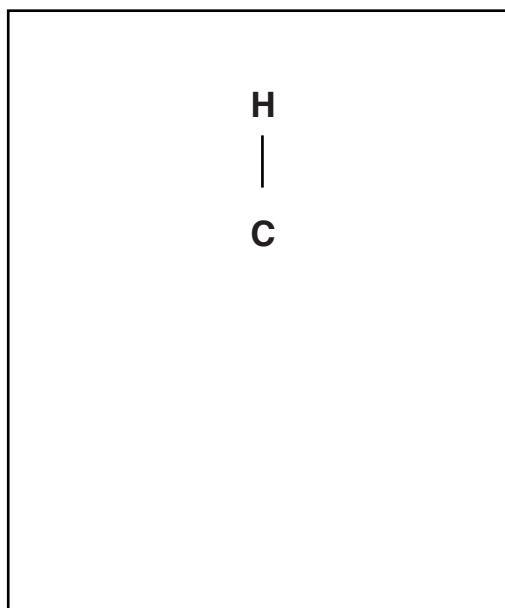
- (d) Carbon is an element that forms different compounds with the element hydrogen.

Draw the structures of molecules of the carbon compounds methane and ethene in the boxes.

methane



ethene



[2]

- 9 (a) Fig. 9.1 shows two oppositely charged metal plates.

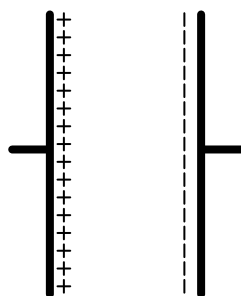


Fig. 9.1

The two oppositely charged plates are free to move.

State what will happen. Give a reason for your answer.

.....

.....

.....[2]

- (b) (i) Complete the following sentence:

An electric field is a region in which an electric charge experiences a [1]

- (ii) Fig. 9.2 shows an electron entering the electric field between two oppositely charged plates.

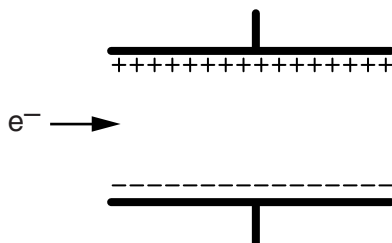


Fig. 9.2

An electron carries a negative charge.

On Fig. 9.2 draw a line to show the path the electron might take after it enters the electric field. [1]

- (c) Fig. 9.3 shows a circuit diagram for an electric heater, supplied with 12V from a car battery.

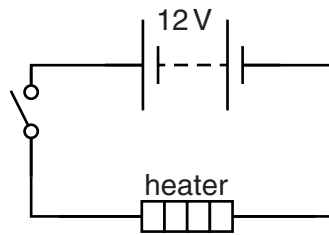
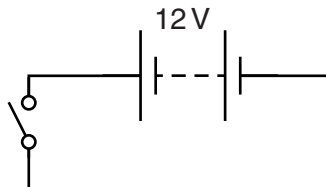


Fig. 9.3

- (i) The heater circuit is changed to include a second identical heater and a lamp to show when the heaters are switched on. The heaters must be connected in parallel to work.

Complete the circuit diagram below to include both heaters and the lamp connected so that the circuit works when the switch is closed.



[3]

- (ii) The heater transfers thermal energy to some water. This causes convection in the water.

Explain why the thermal energy causes convection in the water.

.....

[2]

DATA SHEET
The Periodic Table of the Elements

Group																																
I	II											III	IV	V	VI	VII	0															
		1 H Hydrogen 1																4 He Helium 2														
7 Li Lithium 3	9 Be Beryllium 4																															
23 Na Sodium 11	24 Mg Magnesium 12																	20 Ne Neon 10														
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36															
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54															
133 Cs Cesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86															
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89																														
* 58–71 Lanthanoid series † 90–103 Actinoid series																																
a X b a = relative atomic mass X = atomic symbol b = atomic (proton) number																		140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71	260 Lr Lawrencium 103
Key																																

* 58–71 Lanthanoid series
† 90–103 Actinoid series

a	X	a = relative atomic mass
b	X	X = atomic symbol
		b = atomic (proton) number

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).