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0653/41

October/November 2017

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 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 24.

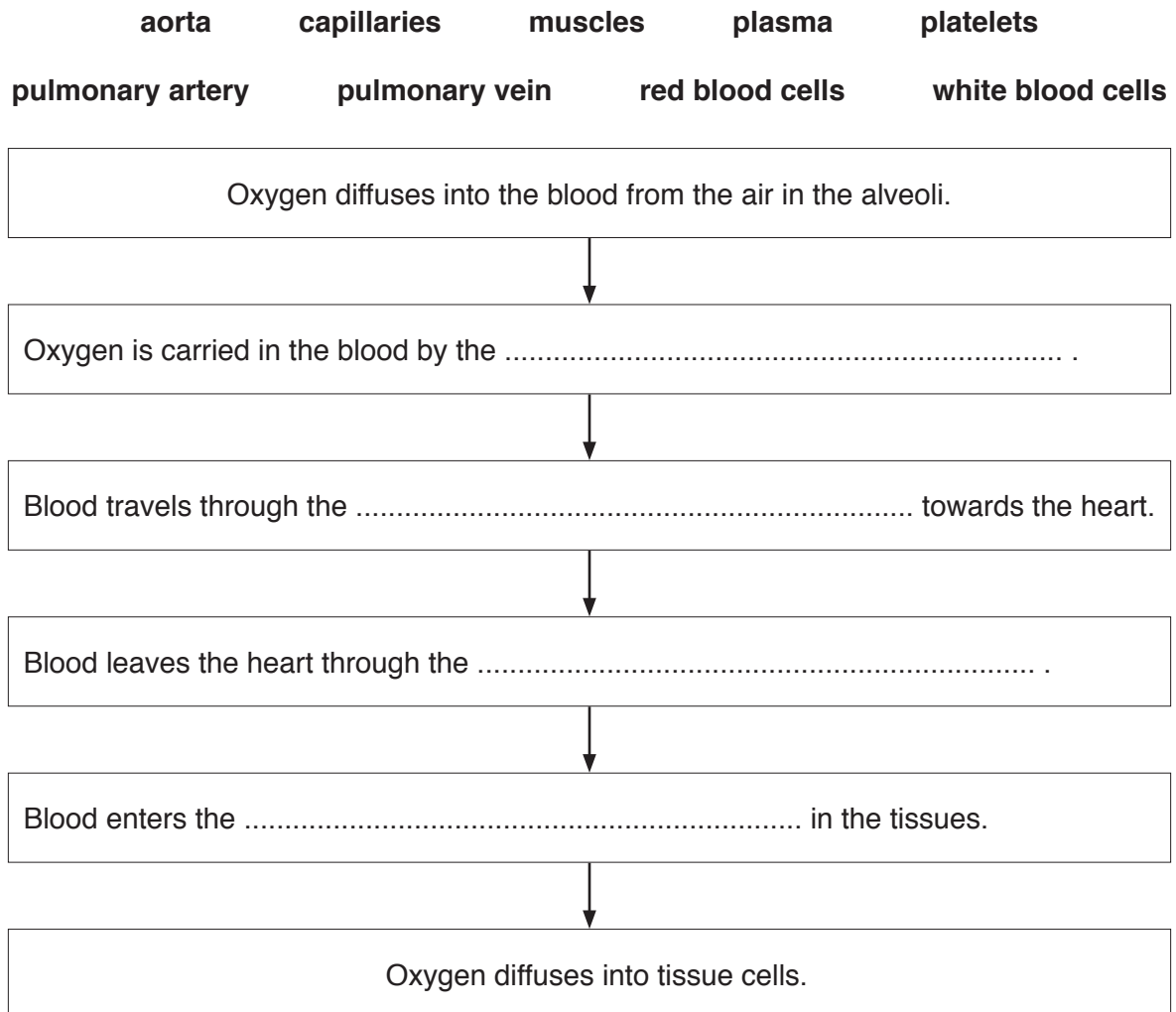
At the end of the examination, fasten all your work securely together.

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

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

- 1 (a) Use the following words or phrases to complete the flow chart about the transport of oxygen to the tissues of the body.

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



[4]

- (b) Fig. 1.1 shows a cross-sectional diagram of an artery which carries blood away from the heart.

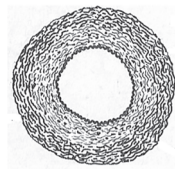


Fig. 1.1

Describe **one** way in which the structure of the wall of the artery helps it to carry out its function.

.....

.....

.....[2]

(c) Fig. 1.2 shows the human gas exchange system.

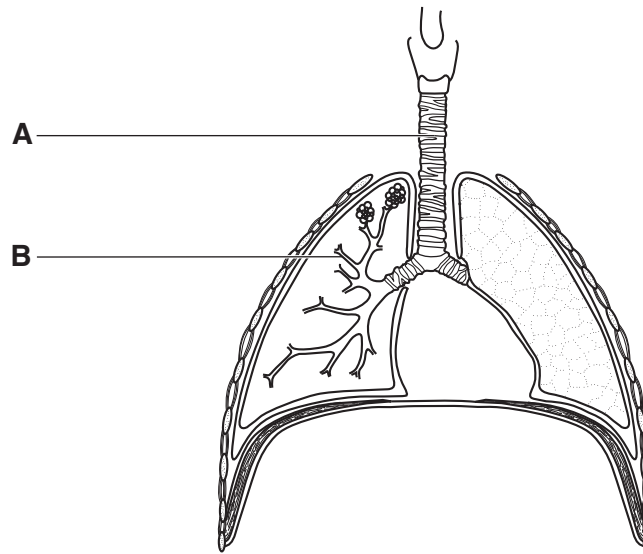


Fig. 1.2

Name the structures **A** and **B** shown in Fig. 1.2.

A

B

[2]

(d) Tobacco smoke can have harmful effects on the gas exchange system and the body.

Describe the harmful effects of the following components of tobacco smoke.

nicotine

.....

.....

tar

.....

.....

[2]

- 2 (a) Electrolysis is used to break up some compounds into simpler substances.

Fig. 2.1 shows the electrolysis of molten potassium bromide using inert electrodes.

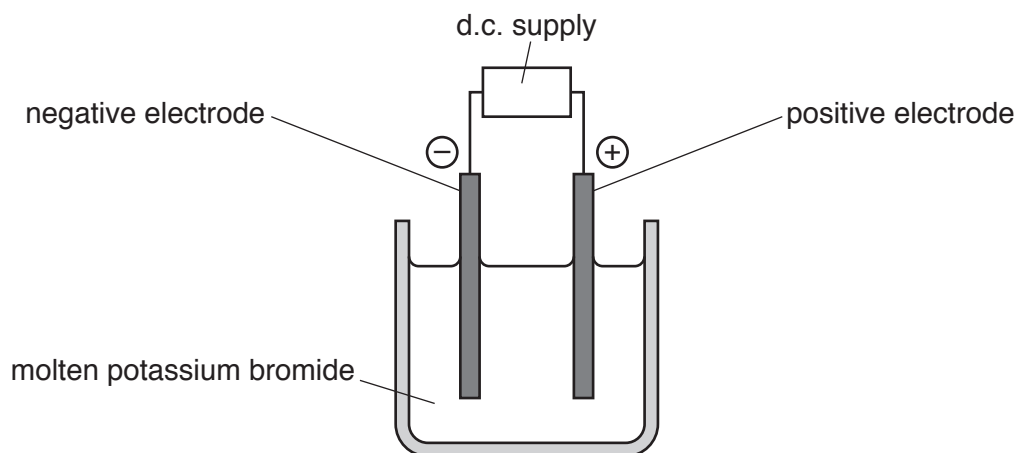


Fig. 2.1

- (i) State the names of the negative electrode and of the positive electrode.

negative electrode

positive electrode [1]

- (ii) Identify the substances formed at the negative electrode and at the positive electrode.

at negative electrode

at positive electrode [2]

- (iii) Explain, in terms of the ions present, why potassium bromide must be molten during this electrolysis.

.....

.....

..... [1]

- (b) The salt potassium chloride is made when excess solid potassium carbonate reacts with an acid.

A gas is made during this reaction.

- (i) Complete the balanced symbolic equation, with state symbols, for this reaction.



- (ii) Describe a test to show that a solution contains chloride ions.

test

observation

[2]

- (iii) A mixture is formed in the reaction between excess solid potassium carbonate and the acid.

Suggest how pure, dry crystals of potassium chloride can be obtained from this mixture.

You may draw a diagram as part of your answer.

.....

.....

.....[2]

3 Fig. 3.1 shows a guitar.



Fig. 3.1

(a) The guitar produces sounds with frequencies between 80 Hz and 5000 Hz.

(i) State what is meant by a frequency of 80 Hz.

.....[1]

(ii) A guitarist plays a note of frequency 250 Hz twice on his guitar.

The first time he plays the note with a large amplitude.

The second time he plays the note with a small amplitude.

Describe the difference the listener will hear between these two notes.

.....
[1]

(iii) State whether a person with normal hearing can hear all the frequencies produced by this guitar. Give a reason for your answer.

.....

[1]

- (b) At a concert the sound of the guitar is broadcast on a radio programme using radio waves.

A boy in the audience is 100m from the stage. He listens to the guitar on his radio, but he can also hear the sound of the guitar coming directly from the stage.

The boy hears the sound from his radio **before** the same sound comes from the stage.

Explain why the sound coming directly from the stage arrives later than the sound from his radio.

.....

[1]

- (c) Fig. 3.2 shows a girl using a mirror to see the guitarist over the heads of people.



Fig. 3.2

On Fig. 3.2 draw accurately one light ray from the guitarist to show how the girl is able to see the guitarist. [2]

- (d) The guitarist investigates the extension of a guitar string made of steel when different tension forces are used to stretch it.

Fig. 3.3 shows the graph of some results obtained from this experiment.

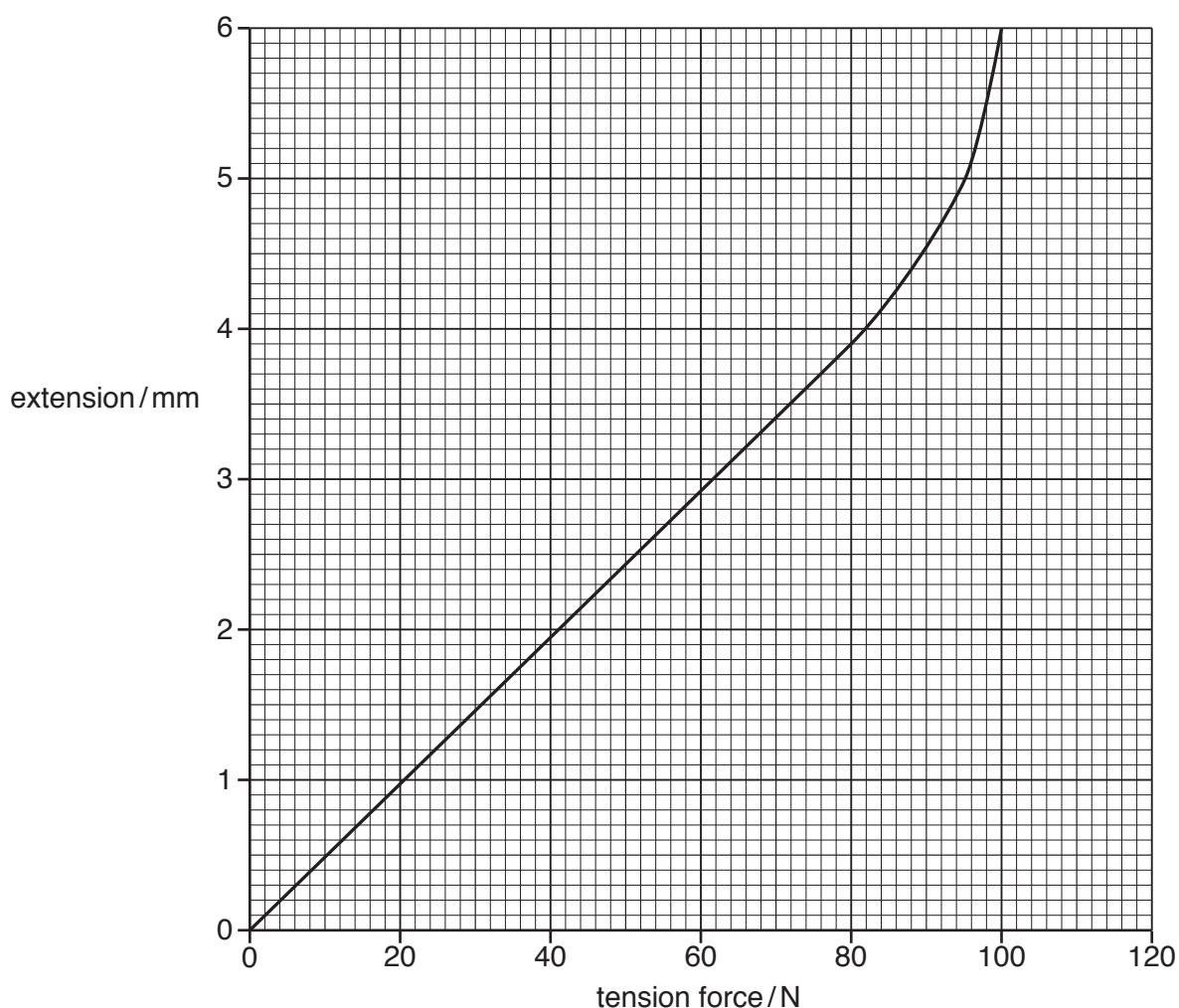


Fig. 3.3

The guitarist adjusts the note played by a guitar string by adjusting the tension force in the string. The more the tension force, the higher the note.

The guitarist must only increase the tension force within the limits where Hooke's Law applies.

- (i) State Hooke's Law.

.....
[1]

- (ii) Use the graph to identify the limit of proportionality for this guitar string.

.....[1]

- 4 (a) Fig. 4.1 shows some bacterial cells as seen using an electron microscope. They are an example of the microorganisms used in the manufacture of yoghurt.

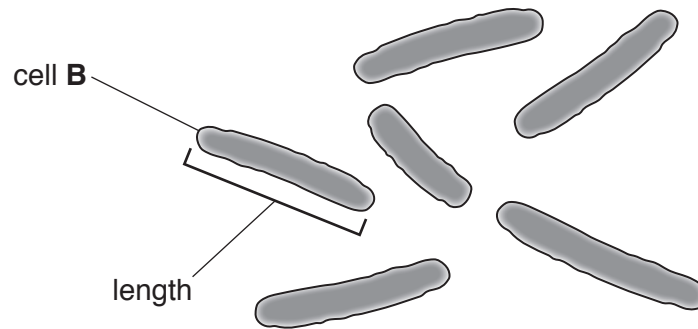


Fig. 4.1

The actual length of cell **B** is 0.001 mm.

Calculate the magnification of cell **B**.

magnification = ... [2]

- (b) The microorganisms break down the sugar in milk. They produce an acid as a waste product. The acid affects the activity of the enzymes in the microorganisms.

- (i) Suggest the effect of the acid on the rate of sugar breakdown. Explain your answer.

.....

[1]

- (ii) Yoghurt can be made at a range of temperatures. However the reaction is usually carried out at 44 °C.

Suggest why the temperature of 44 °C is used, and not a higher temperature.

.....

[2]

(c) Microorganisms have the role of decomposers in the carbon cycle.

(i) Define the term *decomposer*.

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

(ii) Explain **two** reasons why decomposers are essential in the carbon cycle.

1.
.....
2.
.....
[2]

- 5 Petroleum is separated into useful products by process **W** shown in Fig. 5.1.

Process **X** changes some molecules into shorter molecules.

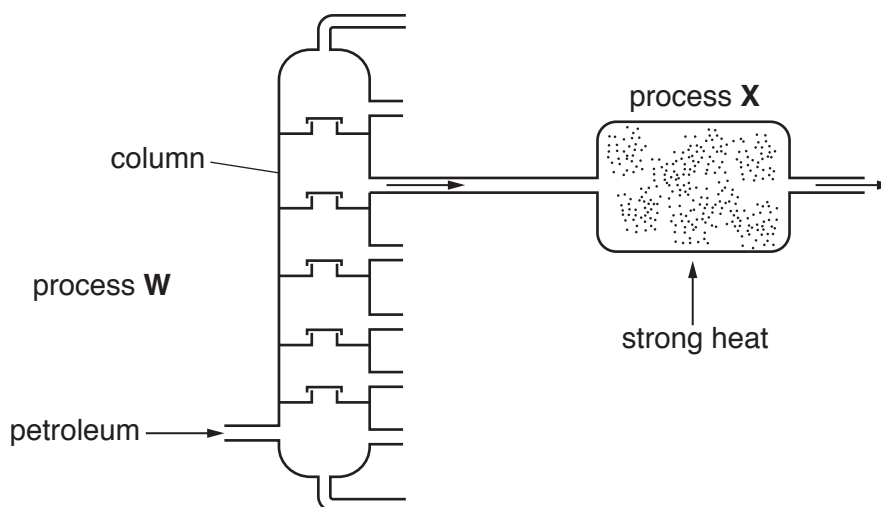


Fig. 5.1

- (a) (i) Name process **W** shown in Fig. 5.1.

.....[1]

- (ii) Use words from the list to complete the sentences about process **W**.

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

higher	greater	lower
smaller	stronger	weaker

Products with molecular sizes collect at the bottom of the column.

Products with boiling points collect at the top of the column.

Molecules with higher boiling points have intermolecular attractive forces.

[1]

- (b) Process **X** produces short hydrocarbon molecules.

Name process **X**.

.....[1]

- (c) Two hydrocarbon molecules, **A** and **B**, are shown in Fig. 5.2.

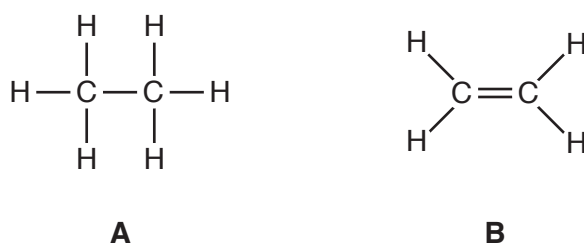


Fig. 5.2

- (i) Describe the chemical test that is used to distinguish between these two hydrocarbon molecules.

test

observation with **A**

observation with **B**

[2]

- (ii) Name hydrocarbon **B**.

.....[1]

- (d) Combustion of hydrocarbons produces carbon dioxide.

- (i) Explain why the proportion of carbon dioxide in air is increasing.

.....

.....[1]

- (ii) Explain why people are concerned that the proportion of carbon dioxide in air is increasing.

.....

.....[1]

- 6 Fig. 6.1 shows a fan heater used to heat a room in cold weather.

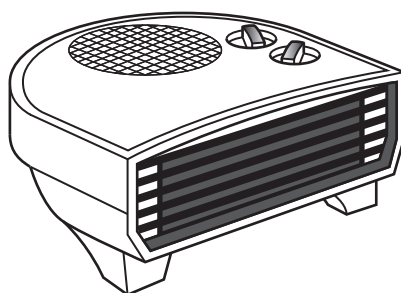


Fig. 6.1

The fan heater is connected to the mains electricity supply.

Fig. 6.2 shows the circuit diagram for the fan heater.

The fan heater has two heating elements, heater 1 and heater 2, and a motor to drive the fan, connected to a 240 V mains electricity supply.

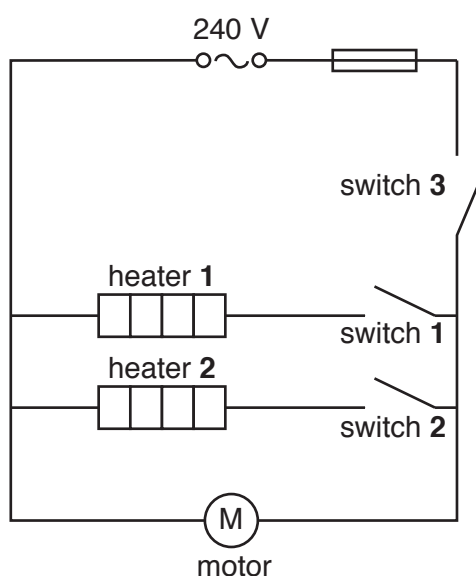


Fig. 6.2

- (a) Deduce which switch or switches must be closed (on) for heater 1 and the motor to work without heater 2.

.....[1]

- (b) (i) Each heating element has a power consumption of 1100 W.

Calculate the current through one heating element when switched on.

State the formula that you use and show your working.

formula

working

current = ... A [2]

- (ii) The fan motor is rated at 50 W.

The fuse in the circuit is rated at 10 A.

Explain whether this fuse provides good protection if an overload happens.

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

- (c) An electrician wants to measure the current through the fan motor.

Complete the circuit diagram in Fig. 6.3 to show how the electrician should connect a meter to do this.

You should use the correct symbol for the meter to be used, and complete all missing circuit connections.

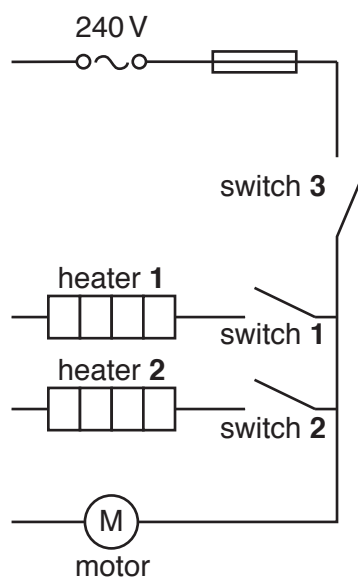


Fig. 6.3

[2]

- 7 Fig. 7.1 shows a sealed glass jar containing soil and plants. An oxygen sensor is used to find out how the concentration of oxygen in the glass jar changes during the day.

The plants can live in the glass jar for several weeks without opening the jar.

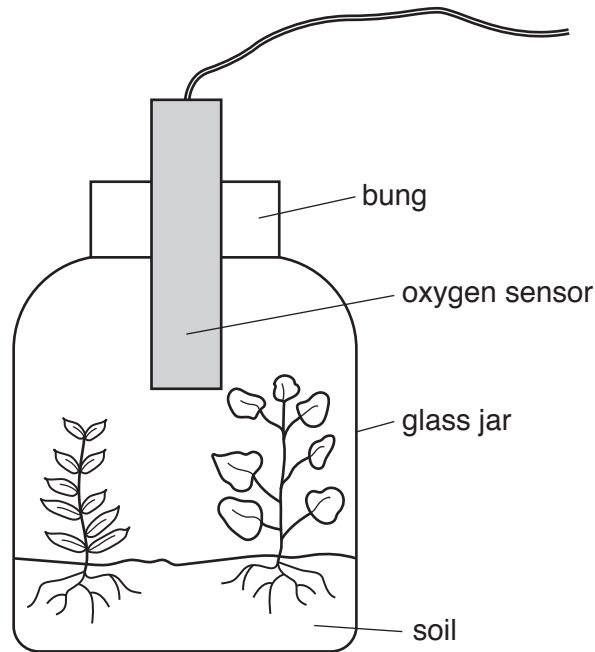


Fig. 7.1

- (a) The plants in Fig. 7.1 use carbon dioxide for photosynthesis.

Explain why they do not run out of carbon dioxide in the sealed jar.

.....

.....

.....[2]

- (b) The water needed for photosynthesis enters the root hair cells of the plants.

Describe how the structure of a root hair cell adapts it for water uptake.

.....

.....

.....

.....[2]

- (c) Fig. 7.2 shows a graph of the oxygen concentration in the glass jar shown in Fig. 7.1 over a 12-hour period on a sunny day.

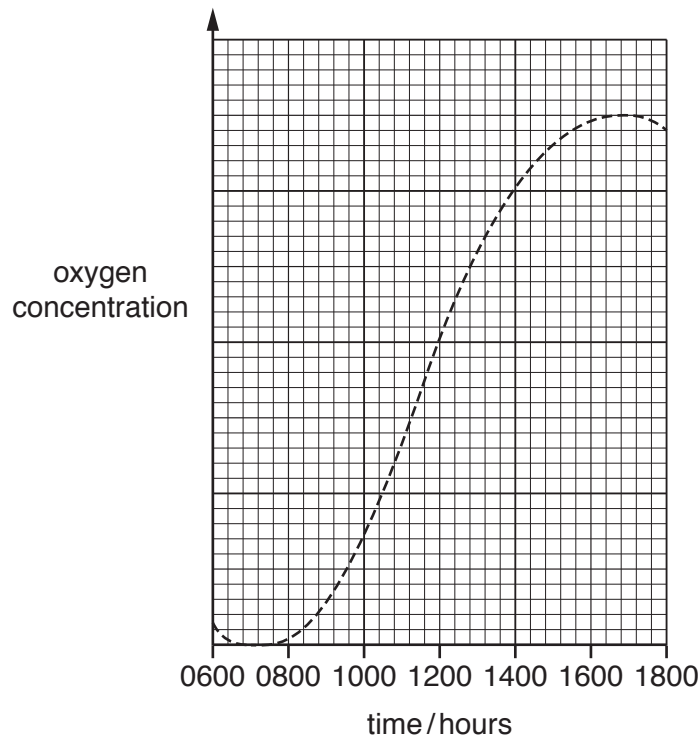


Fig. 7.2

Oxygen is produced by photosynthesis taking place in the plant.

- (i) State a time at which the rate of photosynthesis is highest.

Explain your answer.

time

explanation

.....

.....

[2]

- (ii) On a different day the graph follows a similar pattern as Fig. 7.2 until 10.00 hours.

After 10.00 hours the weather changes and it becomes darker.

On Fig. 7.2 draw a line to show how the oxygen production changes after this time.

Explain your answer.

.....

.....

.....

[2]

- 8 (a) An atom of phosphorus is represented as shown.



- (i) State the number of protons and neutrons in this atom of phosphorus.

number of protons

number of neutrons

[2]

- (ii) Deduce the electronic structure of an atom of phosphorus.

.....

[1]

- (b) Nitrogen, N, is in the same group of the Periodic Table as phosphorus.

Nitrogen forms molecules, N₂.

- (i) State the type of chemical bonding in a molecule of nitrogen.

.....[1]

- (ii) Complete the dot-and-cross diagram to show the multiple bonds in a molecule of nitrogen.



[1]

- (c) The noble gases, in Group VIII of the Periodic Table, are unreactive and do not bond with other elements.

State **one** use for helium.

.....[1]

- (d) Lithium, sodium and potassium are Group I metals.

Explain why these metals **cannot** be extracted from their ores by heating the ores with carbon.

.....

.....[1]

- (e) The melting points and physical states at room temperature of the first four elements in Group VII are shown in Table 8.1.

Table 8.1

element	physical state	melting point/°C
fluorine	gas	–220
chlorine	gas	–101
bromine	liquid	–7
iodine	solid	114
astatine		

Complete Table 8.1 by predicting the physical state and melting point of astatine, the fifth element in Group VII.

[1]

- 9 Fig. 9.1 shows the horizontal and vertical forces which act on a car on a level road.

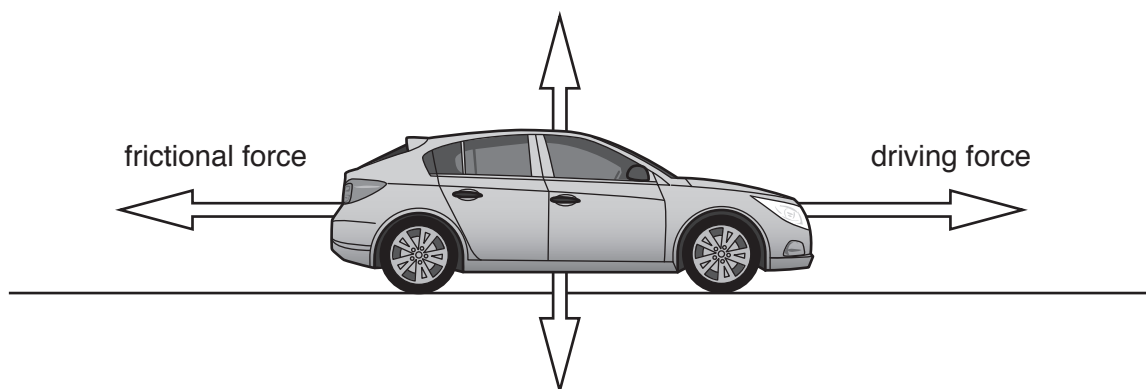
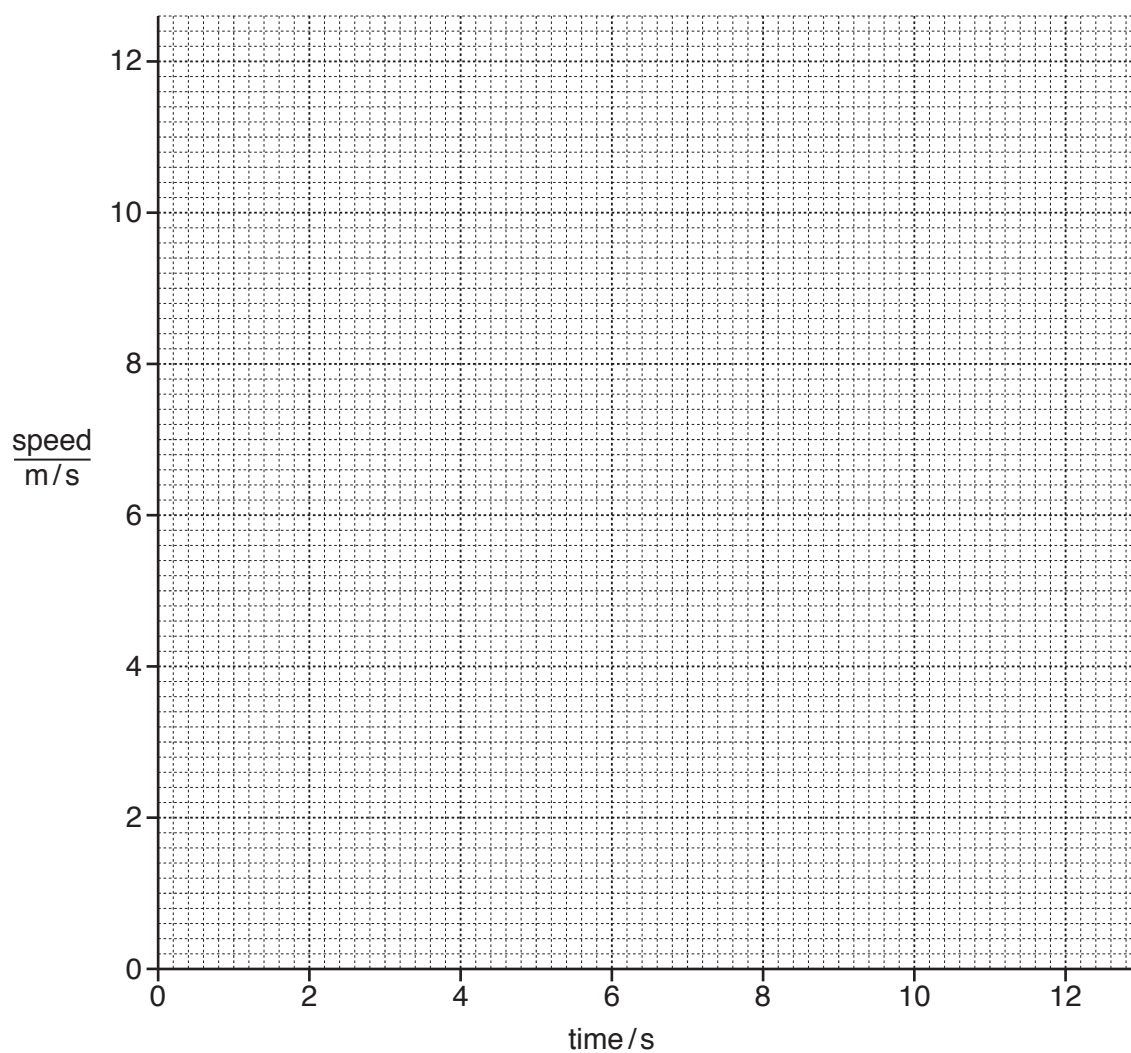


Fig. 9.1

- (a) (i) Name the force represented by the arrow pointing downwards.
[1]
- (ii) After the car starts to move, the driving force is constant, but the frictional force increases. The car reaches a speed of 10 m/s after 12 seconds.

On the grid below sketch a speed-time graph for this part of the journey.



- (b) The car is powered by batteries that can be recharged from solar cells when the batteries run down.

- (i) 40 000 000 J of electrical energy are needed to charge the batteries from the solar cells.

The solar cells have an efficiency of 20%.

Calculate the energy input from the Sun to the solar cells required to charge the batteries.

State the formula that you use and show your working.

formula

working

energy input = ... J [2]

- (ii) Electric cars are intended to replace cars that use fossil fuels. The electricity is usually generated by power stations, many of which use non-renewable resources such as fossil fuels.

Solar panels are a renewable energy resource.

State two other renewable energy resources that can be used to generate electricity.

..... and [2]

- (c) Fig. 9.2 shows the car crossing a bridge.

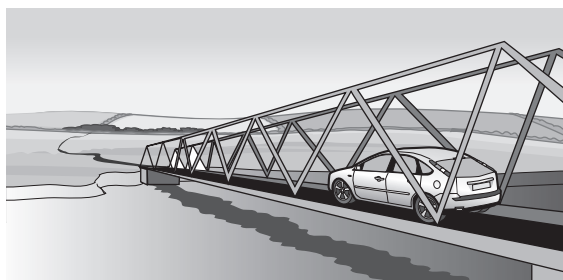


Fig. 9.2

Fig. 9.3 shows a gap in the road surface on the bridge.

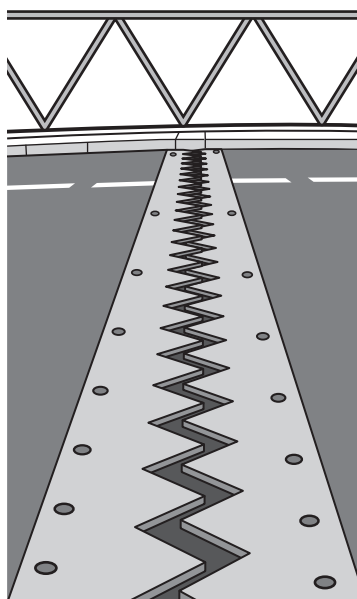


Fig. 9.3

- (i) On a hot sunny day the temperature of the bridge rises and the gap shown closes.

Explain why this happens.

.....
[1]

- (ii) Suggest what might happen to the bridge on a hot sunny day if this gap was not provided.

.....
[1]

- (iii) Use words from the list below to complete the blanks in the sentence that follows.

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

boils evaporates faster larger melts slower smaller

After rain, the road surface is wet with water which slowly

as the molecules escape from the water surface. [2]

- (iv) On a cold winter's day, the temperature is -5°C .

Water vapour in the air freezes onto the road surface as ice.

On Fig. 9.4 draw a line to link the correct arrangement of molecules in water vapour to the correct arrangement of molecules in ice.

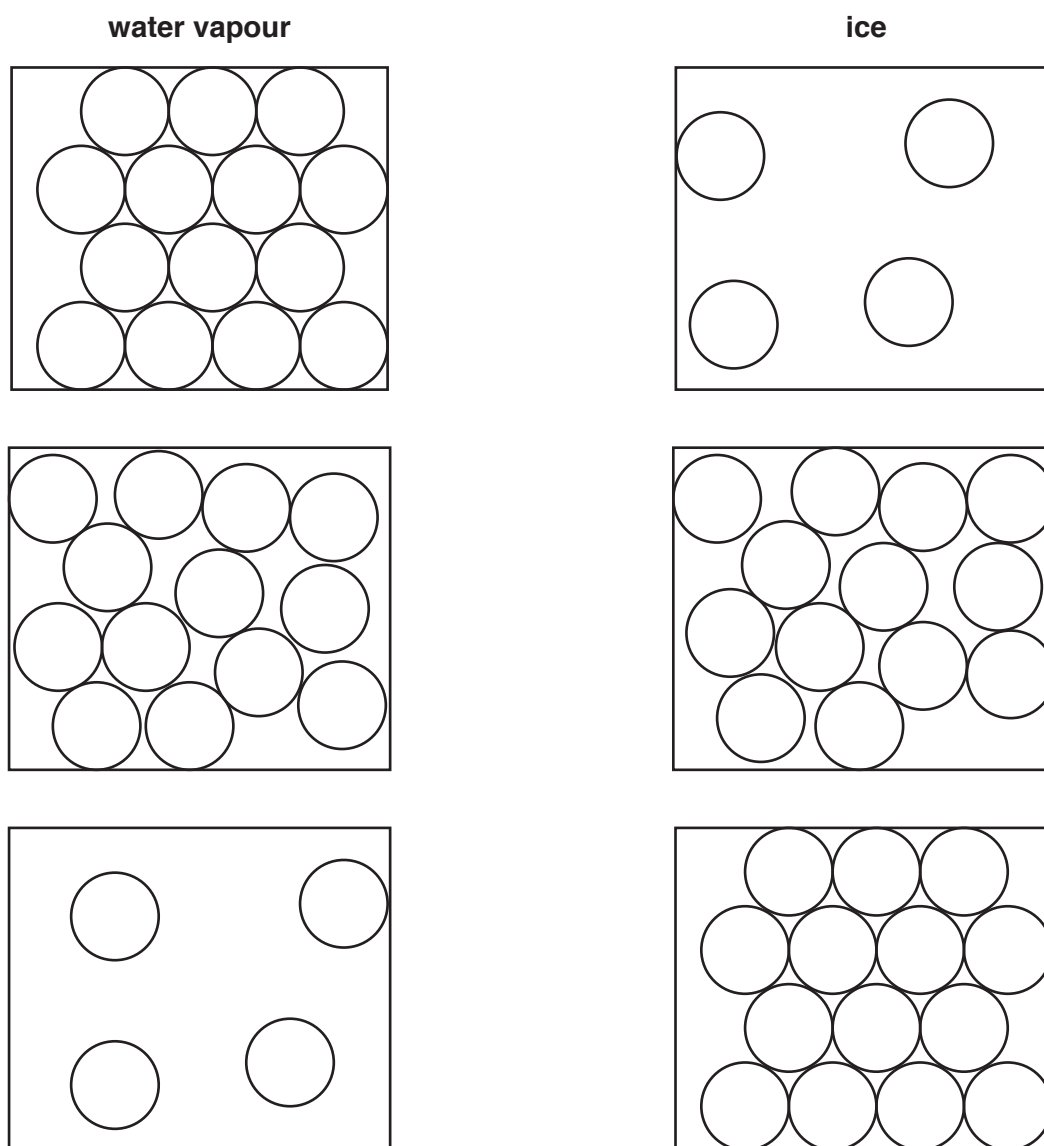


Fig. 9.4

[1]

The Periodic Table of Elements

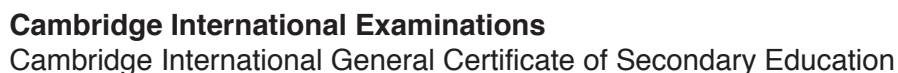
Group																								
I	II											III	IV	V	VI	VII	VIII							
		Key atomic number atomic symbol name relative atomic mass										1 H hydrogen 1												2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20							
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40							
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84							
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131							
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids		72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —						
87 Fr francium —	88 Ra radium —	89–103 actinoids		104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —												

lanthanoids

actinoids

57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

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



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0653/42

October/November 2017

1 hour 15 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

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

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) A fetus is the name given to a developing baby in the later stages of pregnancy.

Use the following words or phrases to complete the flow chart about the supply of oxygen to a growing fetus.

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

amniotic fluid

diaphragm

placenta

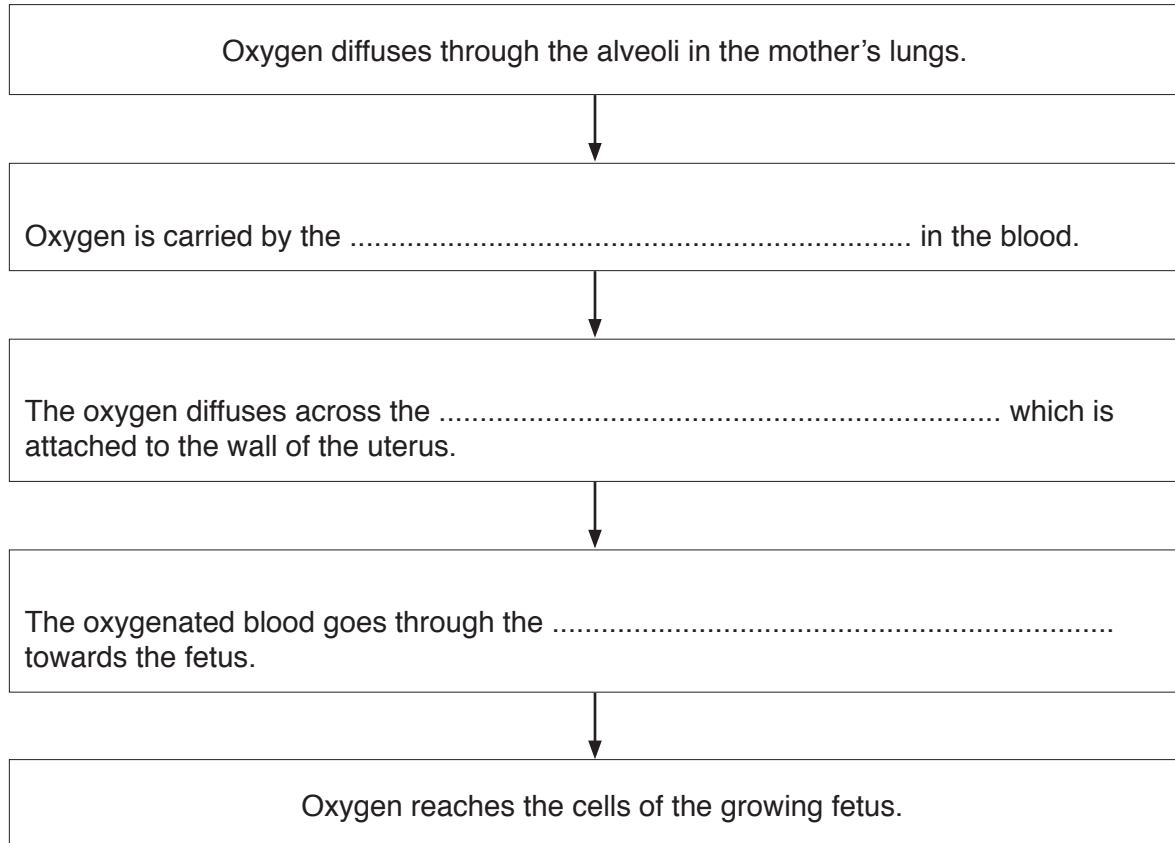
plasma

red blood cells

trachea

umbilical cord

white blood cells



[3]

(b) Fig. 1.1 shows flow charts of how identical and non-identical twins occur.

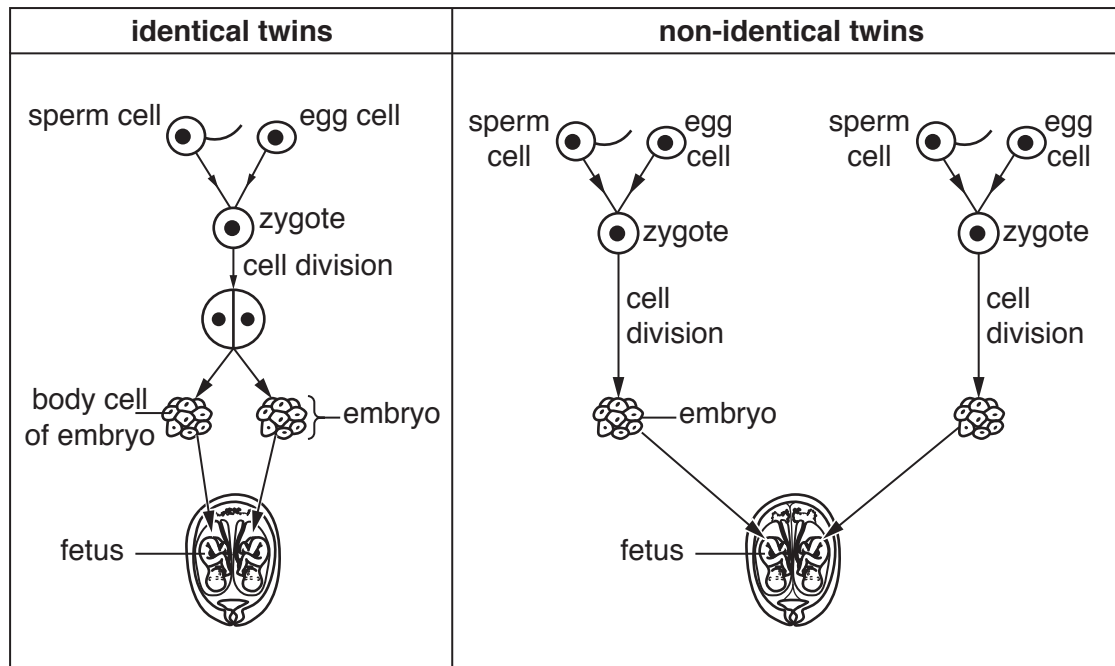


Fig. 1.1

Use Fig. 1.1 to name

1. a haploid cell, ...

2. a diploid cell.

[2]

(c) Fig. 1.1 shows how the genetic material in the nuclei of the cells is passed from the egg and sperm to the fetus.

Taking each pair of twins in turn, predict whether the genetic material in their body cells is similar or different from each other.

Explain your answers.

identical twins

.....

.....

non-identical twins

.....

.....

[3]

(d) Fig. 1.2 shows one of the cells from a growing fetus.

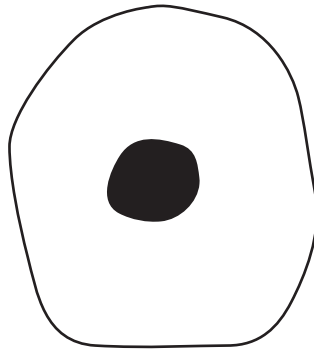


Fig. 1.2

(i) Identify the cell parts on Fig. 1.2 using label lines and the letters **C** and **R**.

Use **C** to show the part which controls what enters and leaves the cell.

Use **R** to show where chemical reactions, such as respiration, take place. [2]

(ii) Complete the balanced symbolic equation for aerobic respiration.

..... + ...O₂ → CO₂ + ... [2]

- 2 (a) A student places identical sized pieces of four metals, **A**, **B**, **C** and **D**, into separate beakers containing dilute hydrochloric acid, HCl , of the same concentration, volume and temperature.

The gas made during the reactions with the acid is collected, as shown in Fig. 2.1.

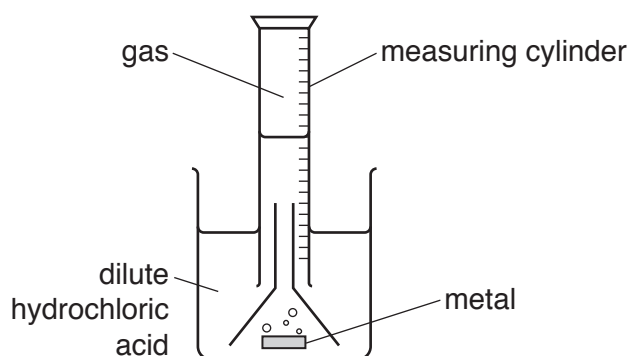


Fig. 2.1

The total volume of the gas that is collected is measured every two minutes.

Table 2.1 shows the volumes of the gas that the student records.

Table 2.1

metal	total volume of gas collected / cm^3			
	2 minutes	4 minutes	6 minutes	8 minutes
A	7	13	17	20
B	1	2	3	4
C	3	5	6	7
D	10	15	18	20

- (i) Using the information in Table 2.1, deduce the order of reactivity of the four metals, from most to least reactive.

..... most reactive

 least reactive

[1]

- (ii) State which of these four metals forms positive ions

most readily, ...

least readily.

[1]

- (iii) Using the information in Table 2.1, state when the rate of the reaction between metal **D** and dilute hydrochloric acid is the greatest.

.....[1]

- (iv) Describe and explain, in terms of particle collisions, the effect of increasing the temperature on the rate of reaction.

effect

explanation

.....

.....

[2]

- (b) When iron reacts with dilute hydrochloric acid, a solution of an iron salt is made.

The student thinks that this salt contains iron(II) ions.

Another student thinks that the salt contains iron(III) ions.

They add dilute sodium hydroxide solution to a sample of the iron salt solution.

Describe the observations that are expected for iron(II) ions and for iron(III) ions.

iron(II) ions

iron(III) ions

[2]

- (c) The arrangements of particles in four substances are shown in Fig. 2.2.

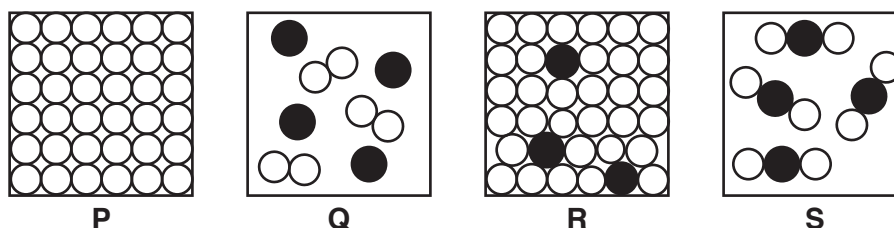


Fig. 2.2

- (i) State which arrangement, **P**, **Q**, **R** or **S**, represents the structure of an alloy.

.....[1]

- (ii) Explain why iron is used in the form of alloys, rather than as pure iron, for kitchen knives.

.....

.....

.....[1]

3 Fig. 3.1 shows a helicopter hovering above the ground.

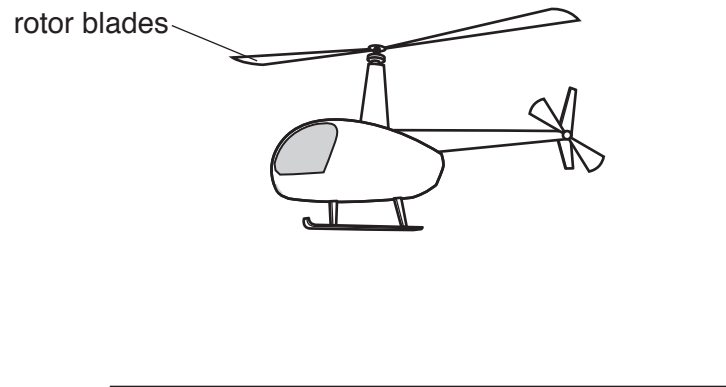


Fig. 3.1

- (a) The helicopter stays in one place as it hovers. The turning rotor blades provide the uplift force to keep it in the air.

On Fig. 3.1 draw two force arrows to show the vertical forces acting on the helicopter.

Label each arrow with the name of the force acting on the helicopter.

[3]

- (b) The helicopter uses fuel to power its engines which turn the rotor blades. The pilot increases the speed of the rotor blades and the helicopter climbs vertically to a height of 1000 m. It then hovers again at this height.

Complete the sequence of energy transfers for the helicopter below.

..... energy in the fuel

→ **kinetic** energy of the rotor blades

→ **kinetic** energy of the climbing helicopter

→ energy of the helicopter at 1000 m.

[2]

(c) Fig. 3.2 shows the speed-time graph for a helicopter journey.

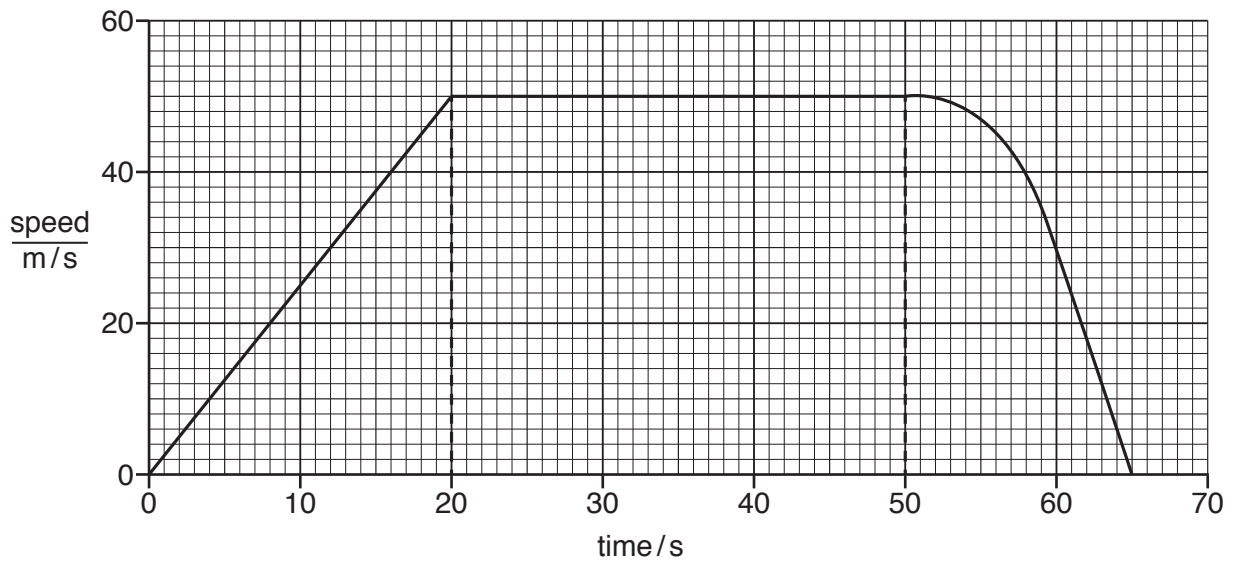


Fig. 3.2

- (i) Use Fig. 3.2 to calculate the initial acceleration of the helicopter from rest to constant speed.

Show your working and give the units of your answer.

acceleration = ... unit [2]

- (ii) Use Fig. 3.2 to calculate the distance moved by the helicopter in the first 50 seconds of this journey.

Show your working on the graph or below.

distance = ... m [2]

- (iii) Describe the motion of the helicopter between 50 s and 65 s.

.....
[1]

- 4 (a) A student does an experiment to investigate the germination of barley seeds. The treatment of the seeds before the experiment is shown in Table 4.1.

Table 4.1

seed	treatment of seeds before the experiment	pH of soaking solution
A	boiled in water for 10 minutes	7
B	soaked at room temperature for a few hours	3
C	soaked at room temperature for a few hours	7

- After treatment, a piece of each seed is placed on an agar plate containing starch.
- After two days an iodine solution is added to the plate which shows the area of starch remaining on the plate.

The results are shown in Fig. 4.1.

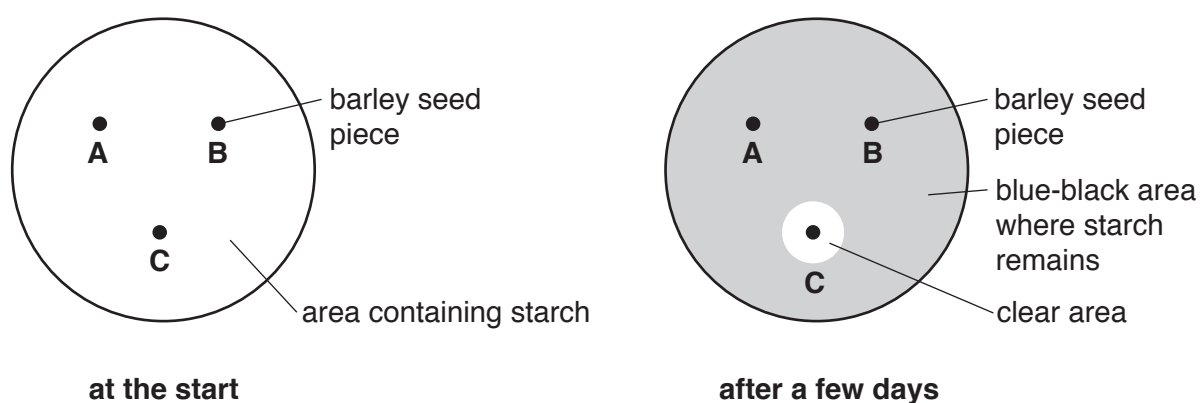


Fig. 4.1

The student thinks that an enzyme is produced by the barley seed which causes the starch to be broken down in the clear area.

Explain in detail how the results for seed **A** and seed **B**, shown in Fig. 4.1, support this idea.

seed **A**

.....

.....

seed **B**

.....

.....

[3]

- (b) Germinating seeds use their store of energy until the young seedlings have chlorophyll in their leaves. Chlorophyll is needed for photosynthesis.

Describe the role of chlorophyll in photosynthesis.

.....

.....

.....[2]

- 5 (a) Explain why the proportion of carbon dioxide in the air is increasing.

Suggest why some people are concerned about this increase.

.....

.....

.....[2]

- (b) The structure of ethanol is shown in Fig. 5.1.

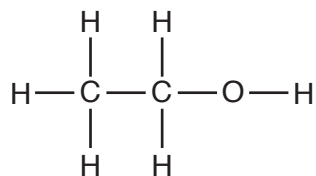


Fig. 5.1

Deduce the formula of ethanol.

.....[1]

- (c) Octane, C_8H_{18} , and methane are obtained from petroleum by fractional distillation.

- (i) State and explain the difference in the boiling points of octane and methane.

Use ideas about molecular size and intermolecular attractive forces in your answer.

.....

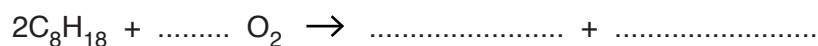
.....

.....

.....

.....[2]

- (ii) Complete the balanced symbolic equation for the complete combustion of octane.



[2]

(d) Ethene is manufactured by breaking down larger hydrocarbon molecules obtained from the fractional distillation of petroleum.

(i) Name this process.

.....[1]

(ii) Ethene and ethane are two different types of hydrocarbon.

Name these two different types of hydrocarbon.

ethene

ethane

[1]

- 6 Fig. 6.1 shows a radiator which uses hot water to provide heating for people sitting in a room watching television.

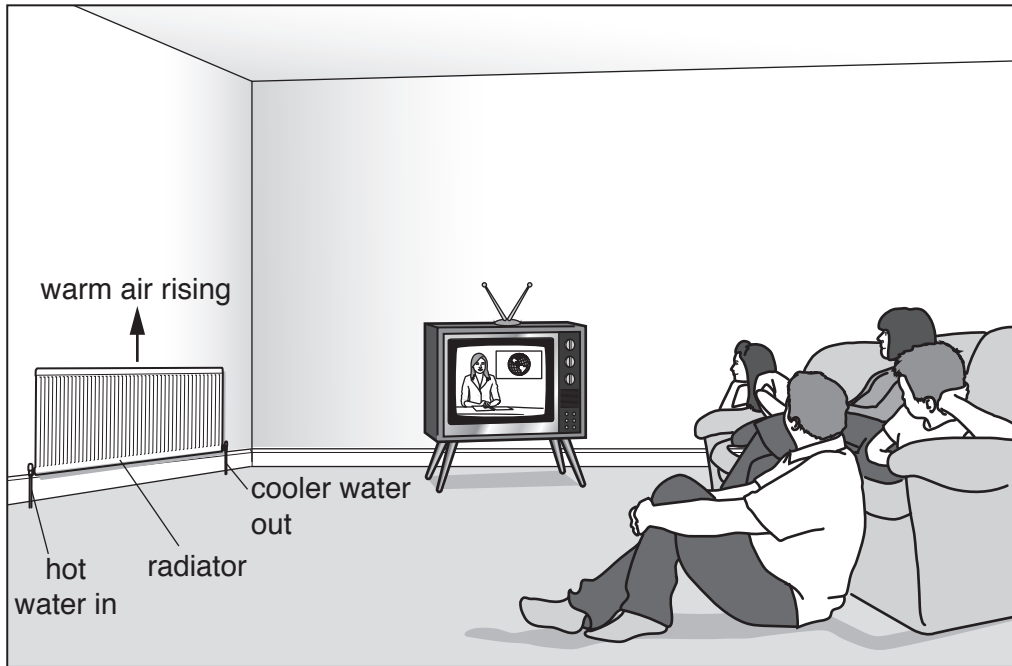


Fig. 6.1

- (a) Describe, in terms of the motion of the atoms and molecules, how thermal energy is conducted from the hot water inside the radiator through the solid radiator.

.....

.....

.....

.....[2]

- (b) (i) On Fig. 6.1 complete a sequence of **five** arrows to show how the warm air from the radiator is able to transfer thermal energy to the people sitting in the room and return as cool air to the radiator. [2]

- (ii) Explain why the air moves around the room in this way.

.....

.....

.....

.....[2]

- (c) Television signals use electromagnetic waves.

Fig. 6.2 shows the electromagnetic spectrum.

gamma	X-rays	ultraviolet	visible	infra-red	microwaves	radio
-------	--------	-------------	---------	-----------	------------	-------

Fig. 6.2

The aerial on the television set receives a signal from a television transmitter on a nearby hill.

State the type of electromagnetic waves received by the television set.

.....[1]

- (d) The people in the room are watching a game of football on the television. The game is being played in a stadium two kilometres away.

A goal is scored and the crowd shouts very loudly. The people in the room hear the sound on the television, and a few seconds later they hear the sound directly from the stadium coming through the window.

Explain why they hear the sound of the crowd at different times.

.....

[2]

- 7 (a) Fig. 7.1 shows a longitudinal section of a capillary next to some tissue cells.

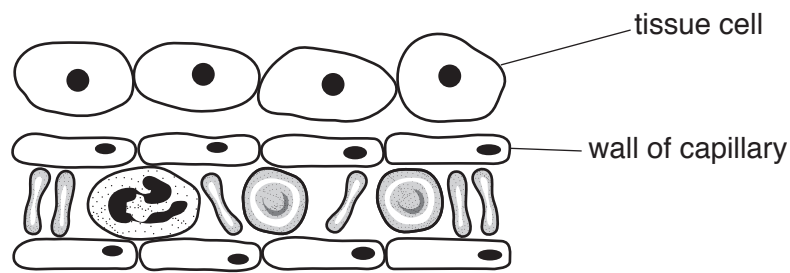


Fig. 7.1

- (i) On Fig. 7.1 draw an arrow to show the direction of the net movement of oxygen molecules by diffusion. [1]
- (ii) Explain your answer to (i).

.....

.....[1]

- (b) Fig. 7.2 shows a diagram of a root hair cell. It absorbs water by diffusion.

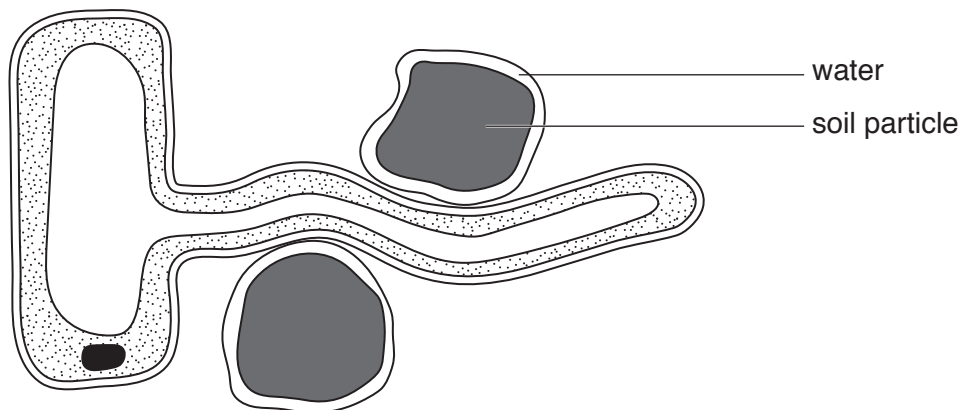


Fig. 7.2

- (i) Describe how the structure of the root hair cell is adapted for its function.

.....

.....

.....[2]

- (ii) A large amount of salt is added to the soil. The salt dissolves in the water in the soil.

Suggest what happens to the rate of diffusion of water into the root hair cell.

Explain your answer.

.....

.....

.....[2]

- (c) Some fertiliser is washed by rain into a pond.

The fertiliser causes the algae on the surface of the pond to reproduce rapidly and cover the surface of the pond. Many algae and plants beneath the surface die due to lack of light.

Describe the changes that follow in the pond which can cause fish in the pond to die.

.....

.....

.....

.....[3]

- 8 (a) A student tries to produce chlorine gas and copper by electrolysis.

He uses solid copper chloride, as shown in Fig. 8.1.

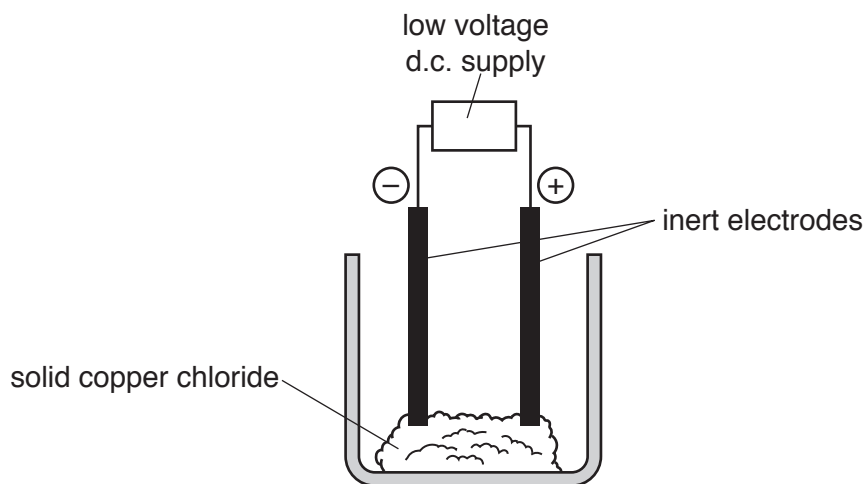


Fig. 8.1

- (i) Describe **one** change that the student must make to produce chlorine gas and copper.

Explain, in terms of the ions present, why the student must do this.

change

explanation

[2]

- (ii) The atomic number of chlorine is 17.

Complete Fig. 8.2 to show the electronic structure of a chlorine atom.

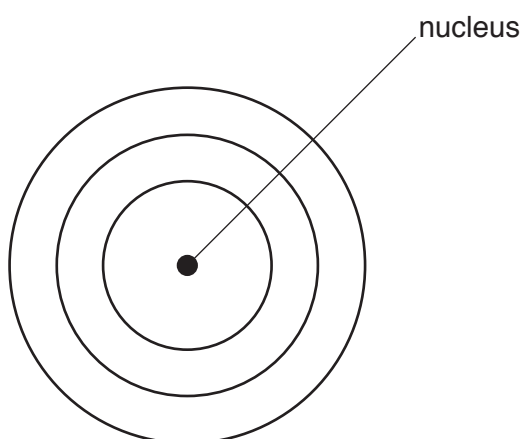


Fig. 8.2

[1]

- (iii) Complete the dot-and-cross diagram of a molecule of chlorine, Cl_2 , in Fig. 8.3.

Show all of the outer shell electrons only.



Fig. 8.3

[2]

- (b) Copper can be produced by heating copper oxide with carbon.

- (i) The reaction between carbon and copper oxide is endothermic.

State the energy change that occurs in an endothermic reaction.

..... energy $\rightarrow$ energy [1]

- (ii) In the reaction between carbon and copper oxide, oxygen is removed from copper.

State the type of reaction that involves the loss of oxygen.

.....[1]

- (iii) Copper can be extracted from its ore by reaction with carbon and by electrolysis.

Group I metals are only extracted by electrolysis.

Relate the method of extraction of a metal from its ore to its position in the reactivity series.

.....

.....

.....

.....[2]

- 9 In a theatre, spotlights are used to shine a beam of light on one person on the stage.

Fig. 9.1 shows a spotlight shining a parallel beam of light on a singer.



Fig. 9.1

- (a) Fig. 9.2 shows a powerful lamp shining through a narrow hole in front of a lens inside the spotlight.

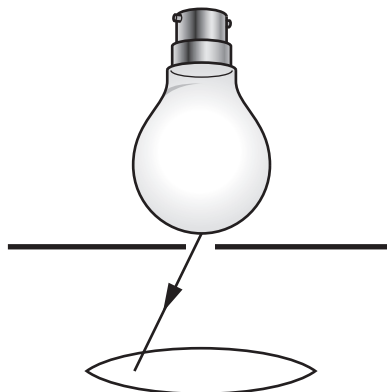


Fig. 9.2

On Fig. 9.2 use a ruler to draw three rays that come through the narrow hole, pass through the lens and emerge parallel to each other to form a narrow beam of light.

One ray has been started for you.

[2]

- (b) Fig. 9.3a shows the way the lamps in two identical spotlights are connected to the electricity supply. The circuit contains a dimmer control so that the brightness of the lights can be changed.

Fig. 9.3b shows part of the circuit diagram for this.

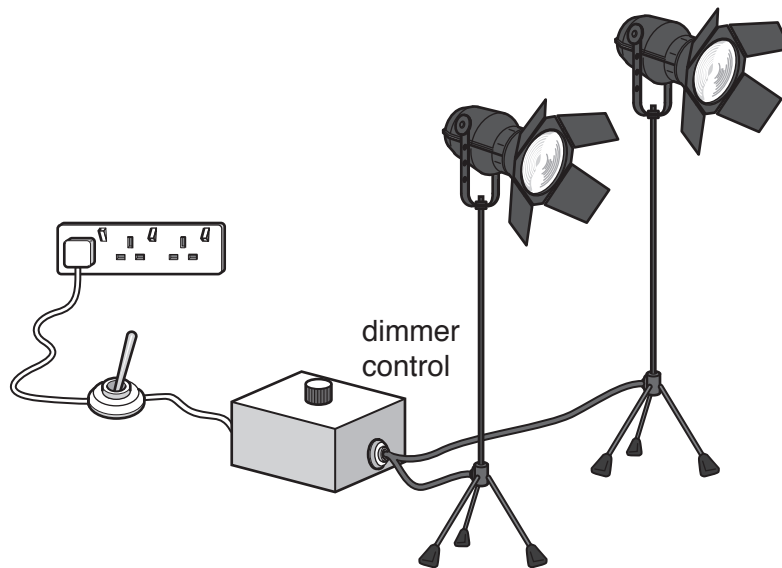


Fig. 9.3a

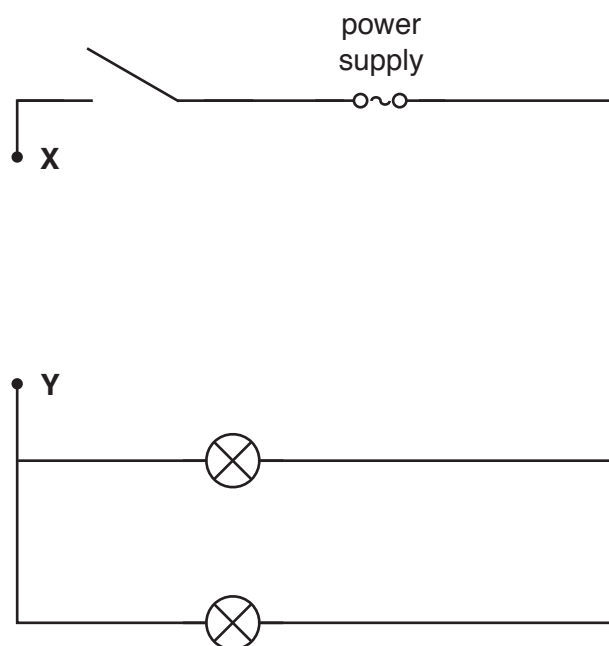


Fig. 9.3b

- (i) The dimmer control contains a variable resistor.

On Fig. 9.3b complete the circuit diagram by connecting the variable resistor into the circuit between **X** and **Y** using the correct circuit symbol. [1]

- (ii) The dimmer control is set so that the current through one of the lamps is 10A.

State the current in the main circuit. Explain your answer.

current = ... A

explanation

[2]

- (iii) The filament of one of the lamps breaks.

State what will happen to the other lamp. Give a reason for your answer.

.....

.....

.....[1]

- (c) One lamp has a label as shown in Fig. 9.4.

Voltage = 240 V Maximum power = 3000 W
--

Fig. 9.4

- (i) Use the formula $P = IV$ to calculate the maximum current through the lamp.

Show your working.

current = ... A [1]

- (ii) Describe how to set the variable resistor in the dimmer control to provide maximum power in the lamp.

.....

.....[1]

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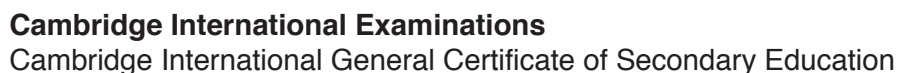
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The Periodic Table of Elements

Group																							
I	II											III	IV	V	VI	VII	VIII						
		Key atomic number atomic symbol name relative atomic mass										1 H hydrogen 1											
3 Li lithium 7	4 Be beryllium 9																					5 B boron 11	6 C carbon 12
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40						
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84						
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131						
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids		72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —					
87 Fr francium —	88 Ra radium —	89–103 actinoids		104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	114 Fl flerovium —		116 Lv livermorium —								



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0653/43

October/November 2017

1 hour 15 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

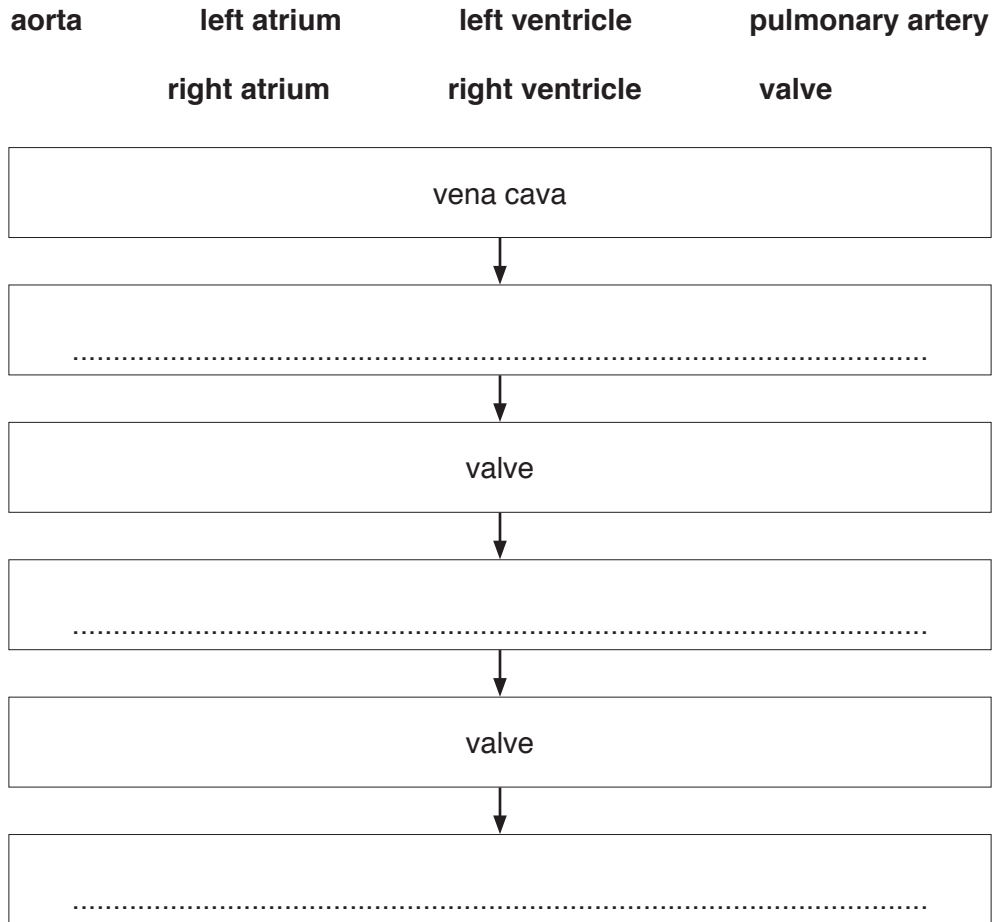
A copy of the Periodic Table is printed on page 24.

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

This document consists of **21** printed pages and **3** blank pages.

- 1 (a) Use the following words or phrases to complete the flow chart about the structures the blood passes through on **one side of the heart** during the cardiac cycle.

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



[3]

- (b) (i) Explain why the human circulation system is described as a *double circulation*.

.....
[1]

- (ii) Explain why the blood leaving the left side of the heart has a higher pressure than blood leaving the right side of the heart.

Higher pressure is needed in the blood on the left side of the heart because

.....

Lower pressure is needed in the blood on the right side of the heart because

.....

[2]

(c) During exercise the heart rate and breathing rate both increase.

(i) Explain why the heart rate increases during exercise.

.....

[2]

(ii) Explain why the breathing rate increases during exercise.

.....
[1]

(d) Smoking tobacco can have harmful effects on the gas exchange system and the body.

Choose **two** of the following components of tobacco smoke and describe **one** harmful effect of each component.

	carbon monoxide	nicotine	tar
component			
effect			
.....			
component			
effect			
.....			

[2]

- 2 (a) The arrangements of particles in four substances are shown in Fig. 2.1.

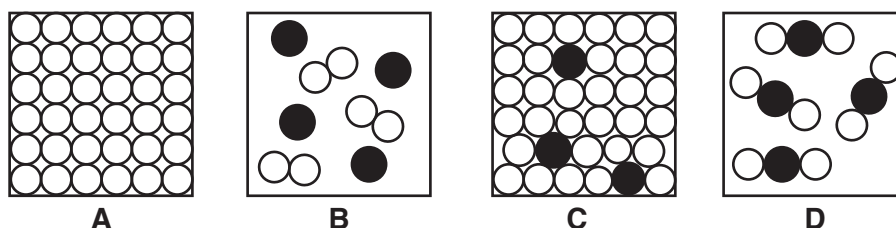


Fig. 2.1

Use letters **A**, **B**, **C** and **D** to identify

a pure substance, ...

a mixture, ...

an alloy, ...

a compound.

[2]

- (b) A student adds pieces of calcium to dilute hydrochloric acid. A vigorous reaction is observed.

- (i) Complete the balanced equation to show this reaction.

Include state symbols in the equation.



[2]

- (ii) The student repeats the reaction using a solution of hydrochloric acid that has a lower concentration.

State the effect of this change on the rate of the reaction.

Explain this effect using ideas about colliding particles in your answer.

effect on rate

explanation

.....

.....

[2]

- (iii) State a simple chemical test that shows the presence of chloride ions in dilute hydrochloric acid.

test

result

[2]

- (c) A salt contains iron(III) ions, Fe^{3+} , and sulfide ions, S^{2-} .

Determine the formula of this salt.

formula

[1]

3 Fig. 3.1 shows a toy car powered by batteries.

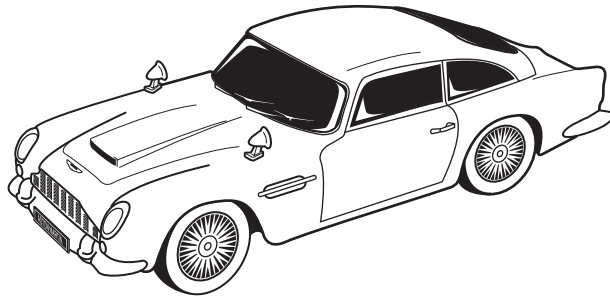


Fig. 3.1

Fig. 3.2 shows part of the circuit diagram for a circuit in the toy car, including the two headlamps which can be switched on when needed.

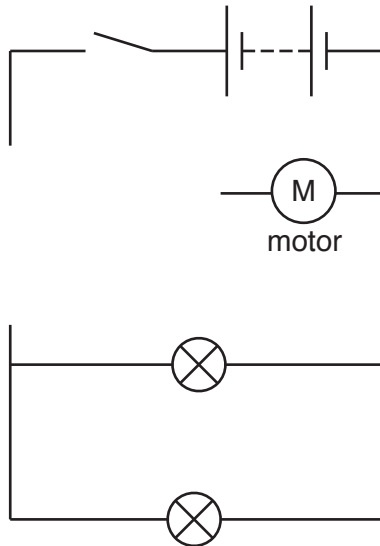


Fig. 3.2

- (a) The car is driven by an electric motor which must be able to operate whenever the switch shown in Fig. 3.2 is on.

The speed of the electric motor is controlled by a variable resistor.

The two headlamps are only switched on when needed, so a separate switch controls both headlamps.

On Fig. 3.2, using the correct symbols, complete the circuit diagram by adding

- a variable resistor that controls the electric motor.
- the switch that controls both headlamps.
- any wires needed to complete the circuit connections.

[2]

- (b) The resistance of the variable resistor is decreased in order to speed up the motor.

Suggest why decreasing the resistance will speed up the motor.

.....
[1]

- (c) Complete the sentences below by writing the correct phrase in each space.

Each phrase may be used once, more than once or not at all.

by an ammeter

by an insulator

in parallel

in series

less than

more than

the same as

The electric motor and the headlamps are connected

When the car is travelling by day, the headlamps are switched off. The current through the motor is then the current through the battery.

When the car is travelling at night, the headlamps are switched on. The combined resistance of the motor and headlamps is the resistance of the motor before the headlamps are switched on. [3]

- (d) The toy car travels at 5.0 km/h for 10 min before the battery runs out.

Calculate the distance travelled by the car during this 10 minute period.

Show your working.

distance = ... km [2]

- 4 Fig. 4.1 shows a diagram of the alimentary canal. The main areas where digestion takes place are labelled.

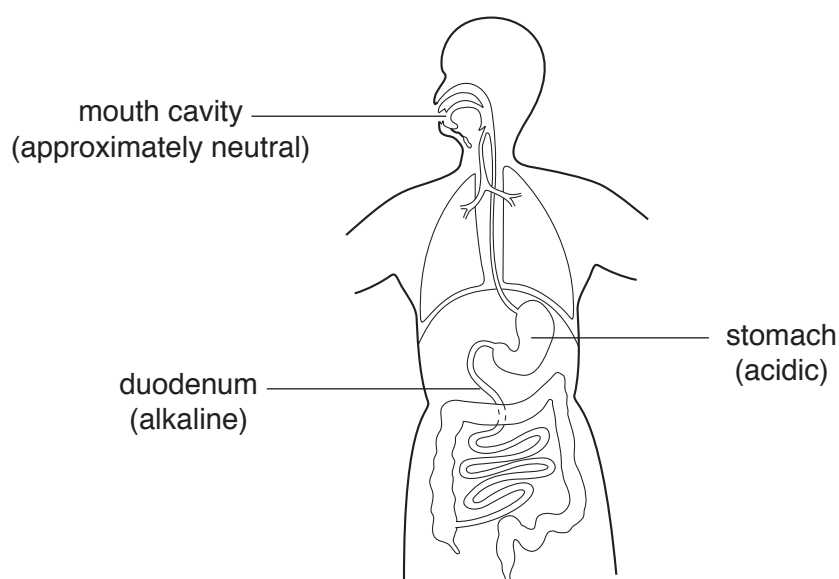


Fig. 4.1

- (a) On Fig. 4.1 use a label line and the letter **A** to show where absorption of digested food occurs. [1]

- (b) A student is investigating human digestive enzymes.

He has three test-tubes, **1**, **2** and **3**, containing protein solution at different pH values. He then adds the same enzyme to all three test-tubes and keeps them at 35 °C.

The protein solution is cloudy at the start of the experiment. If the protein in the solution is broken down the solution becomes clear and colourless.

The results are shown in Fig. 4.2.

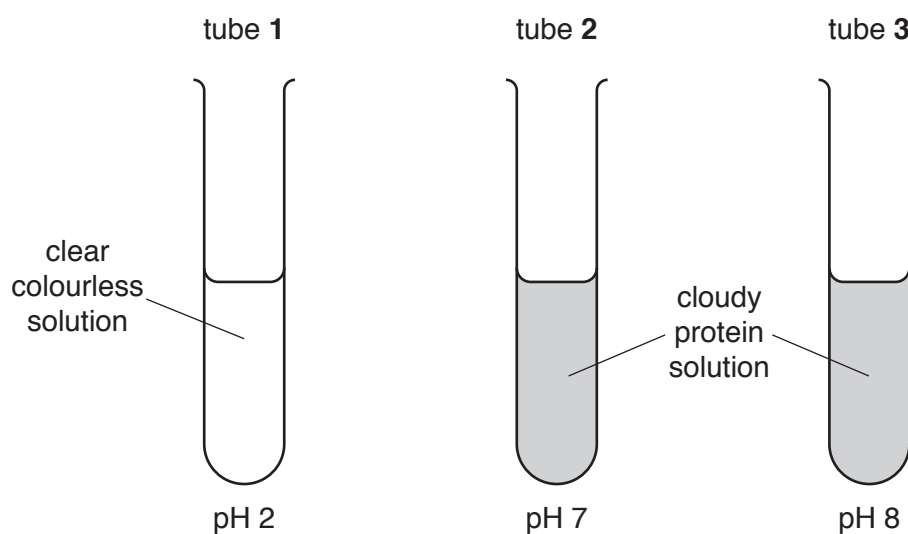


Fig. 4.2

- (i) Use the information in Fig. 4.1 to identify the likely source of the digestive enzyme that produces the result in tube **1** in Fig. 4.2.

Explain your answer.

source of enzyme

explanation

.....

.....

.....

[3]

- (ii) Explain why a temperature of 60 °C is **not** suitable for this experiment.

.....

.....

.....[2]

- (iii) Explain why the change that takes place in tube **1** is an example of chemical digestion.

.....

.....

.....[2]

- 5 Fractional distillation of petroleum produces fractions containing different compounds.

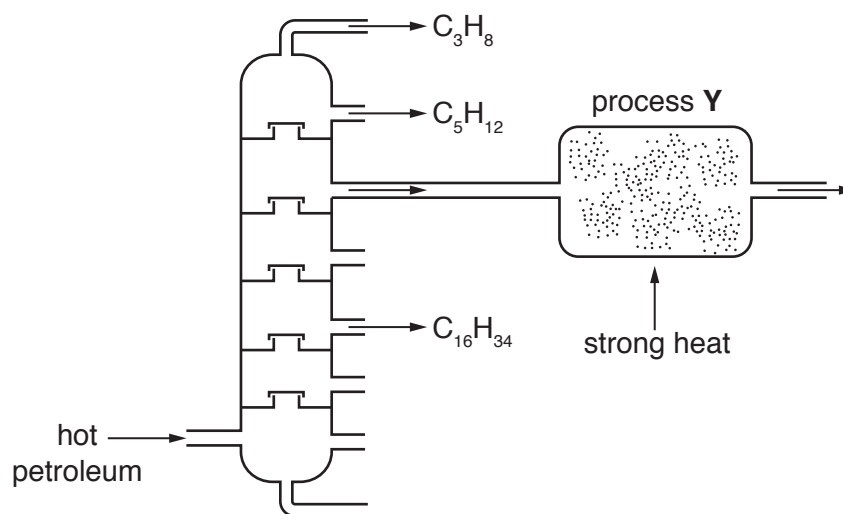


Fig. 5.1

- (a) The formulae of three compounds contained in three fractions are shown in Fig. 5.1.

Describe the trend in the boiling points of these three compounds, from C_3H_8 to $C_{16}H_{34}$.

Explain this trend in terms of the sizes of the molecules and the forces between the molecules.

trend

explanation

.....

.....

[3]

- (b) Process **Y**, shown in Fig. 5.1, changes the molecules in one fraction.

The molecular structure of a hydrocarbon produced in process **Y** is shown in Fig. 5.2.

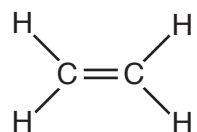


Fig. 5.2

- (i) Name process **Y**.

.....[1]

- (ii) Name the hydrocarbon shown in Fig. 5.2.

.....[1]

- (iii) Name this **type** of hydrocarbon.

.....[1]

- (iv) State the colour change that is seen when this hydrocarbon is added to bromine water.

from to [1]

- (c) The combustion of a fossil fuel is an exothermic reaction.

Explain why this is an exothermic reaction.

Use ideas about temperature change and energy transformation in your answer.

.....

[2]

- 6 Fig. 6.1a shows an insulated bag used to carry frozen food from the shop to home.

Fig. 6.1b shows the structure of the walls of the bag.



Fig. 6.1a

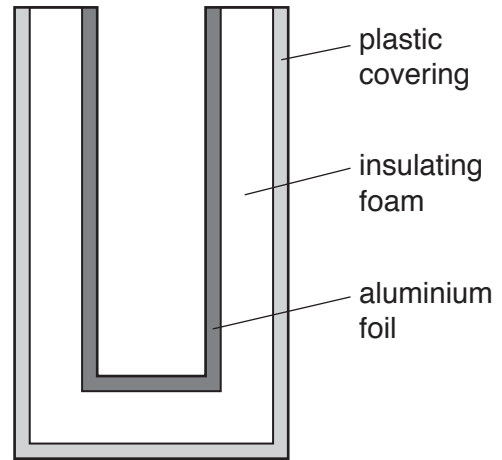


Fig. 6.1b (not to scale)

- (a) The insulating foam is designed to reduce thermal energy transfer through the bag. It has many small pockets of trapped gas which reduce conduction of thermal energy.

- (i) Describe how thermal energy is transferred through solids by conduction.

.....

[1]

- (ii) Suggest why the trapped gas is less able to transfer thermal energy by conduction.

.....
[1]

- (b) The aluminium foil also helps to reduce thermal energy transfer.

Name the method of thermal energy transfer reduced by the use of aluminium foil.

.....[1]

- (c) The food is transferred from the insulated bag into a refrigerator.

The refrigerator has an electric motor with a power input of 80 W when connected to a 240 V mains supply.

- (i) Calculate the current through the electric motor.

State the formula you use and show your working.

formula

working

current = ... A [2]

- (ii) Calculate the energy used by the refrigerator when the motor runs for one hour.

State the formula you use and show your working.

formula

working

energy = ... J [2]

7 Fig. 7.1 shows some processes occurring in a forest.

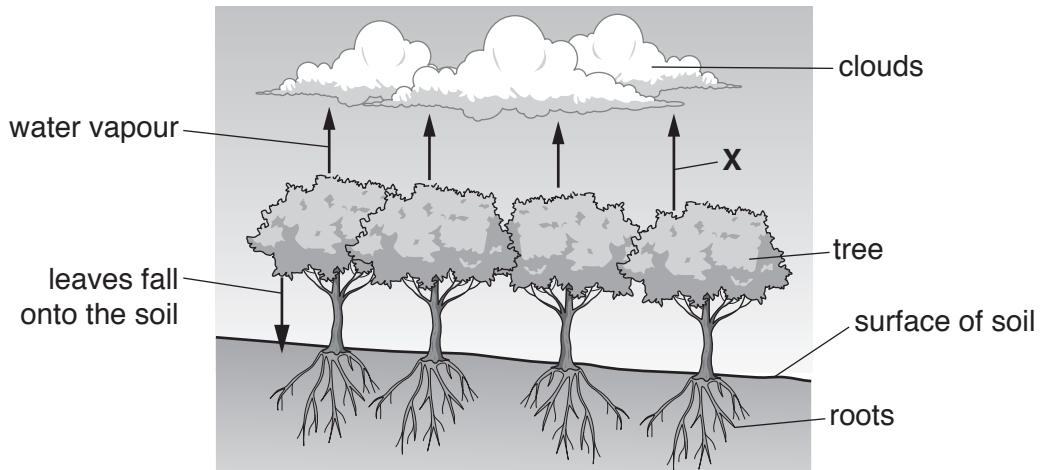


Fig. 7.1

(a) Name the process labelled **X**.

.....[1]

(b) The leaves of the trees contain nutrients in the form of minerals. When the leaves die they fall onto the soil. Organisms in the soil can make the minerals available to the trees again.

Name the type of organisms that make the minerals available. Explain your answer.

type of organism

explanation

.....

.....

[2]

(c) The trees in the forest shown in Fig. 7.1 are cut down.

Predict and explain the effect of clearing the trees on the amount of rain falling on the forest.

.....

.....[1]

- (d) A storm occurs higher up the hill and water comes flowing down the hill.

Suggest how the soil in the cleared area will be affected by water from heavy rainfall flowing down the hill.

Explain your answer.

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

- (e) The concentration of gases in the atmosphere changes immediately after the trees are cleared.

Describe and explain how the concentrations of the following gases change.

carbon dioxide
.....
oxygen
.....[2]

- 8 (a) (i) The atomic number of oxygen is 8.

Complete Fig. 8.1 to show the electronic structure of an oxygen atom.

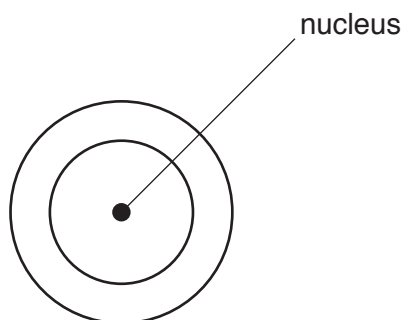


Fig. 8.1

[1]

- (ii) Complete the dot-and-cross diagram of a molecule of water.

Show all the outer shell electrons.



[2]

- (b) Element **Z** has two electrons in its outer shell.

Z is not the symbol for this element.

- (i) Predict the group number of element **Z** in the Periodic Table.

.....

[1]

- (ii) An atom of element **Z** forms an ion.

State the charge of this ion.

Explain how this ion forms.

charge

explanation

.....

.....

[2]

(c) Potassium, copper and iron are extracted by different methods.

Complete Table 8.1 to show the order of reactivity of these three metals.

State the method of extraction of each metal from its ore.

Table 8.1

order of reactivity	metal	method of extraction
most reactive ↓ least reactive		

[3]

- 9 Fig. 9.1 shows four forces, **P**, **Q**, **R** and **S**, acting on a submarine travelling underwater. The submarine is moving to the right at constant speed.

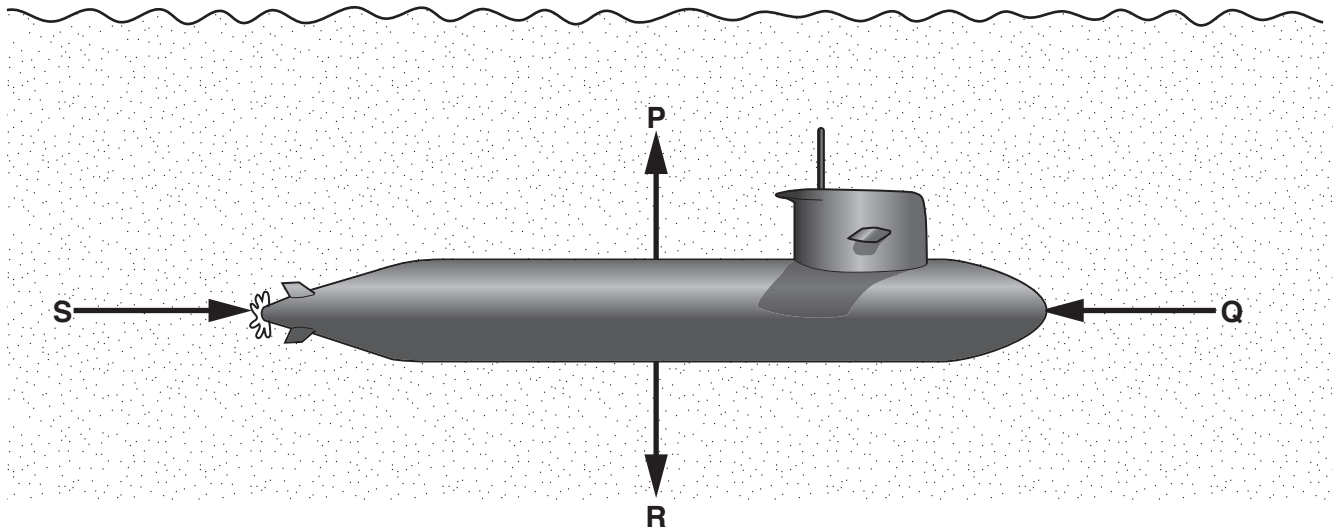


Fig. 9.1

The submarine has a mass of 3 000 000 kg.

- (a) (i) Name force **Q**.

.....[1]

- (ii) The submarine is travelling at constant speed at a constant depth.

State how the magnitude of force **Q** compares to the magnitude of force **S**.

.....[1]

- (iii) Calculate the value of force **R**.

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

State the formula you use and show your working.

formula

working

force **R** = ... N [2]

- (b) The captain orders the crew to bring the submarine to the sea surface from a depth of 50 m.

The crew change force **P** so that there is a net upward force of 100 000 N.

Calculate the work done by this upward force to bring the submarine to the surface.

State the formula you use and show your working.

formula

working

work done = ... J [2]

- (c) (i) On the surface of the sea the captain is able to use a radio to send a message to his base.

The radio sends a signal at a frequency of 120 MHz.

Calculate the wavelength of the radio waves used.

Speed of electromagnetic waves = 3×10^8 m/s.

State the formula you use and show your working.

formula

working

wavelength = ... m [2]

- (ii) Fig. 9.2 shows an incomplete electromagnetic spectrum. On Fig. 9.2 add radio waves in their correct place.

gamma rays			visible light		microwaves	
------------	--	--	---------------	--	------------	--

Fig. 9.2

[1]

- (iii) Radio waves do not travel through sea water. But when submerged, submarines can receive sound signals from sound sources placed on the sea floor.

Sound is transmitted through water in the same way that it is transmitted through air.

Suggest how sound waves are transmitted through water. You should say how water molecules are involved, and you may wish to draw a diagram as part of your answer.

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

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The Periodic Table of Elements

Group																		
I	II											III	IV	V	VI	VII	VIII	
1Hhydrogen1 Key atomic number atomic symbol name relative atomic mass																		
3Li lithium 7	4Be beryllium 9											5B boron 11	6C carbon 12	7N nitrogen 14	8O oxygen 16	9F fluorine 19	10Ne neon 20	2He helium 4
11Na sodium 23	12Mg magnesium 24											13Al aluminium 27	14Si silicon 28	15P phosphorus 31	16S sulfur 32	17Cl chlorine 35.5	18Ar argon 40	
19K potassium 39	20Ca calcium 40	21Sc scandium 45	22Ti titanium 48	23V vanadium 51	24Cr chromium 52	25Mn manganese 55	26Fe iron 56	27Co cobalt 59	28Ni nickel 59	29Cu copper 64	30Zn zinc 65	31Ga gallium 70	32Ge germanium 73	33As arsenic 75	34Se selenium 79	35Br bromine 80	36Kr krypton 84	
37Rb rubidium 85	38Sr strontium 88	39Y yttrium 89	40Zr zirconium 91	41Nb niobium 93	42Mo molybdenum 96	43Tc technetium —	44Ru ruthenium 101	45Rh rhodium 103	46Pd palladium 106	47Ag silver 108	48Cd cadmium 112	49In indium 115	50Sn tin 119	51Sb antimony 122	52Te tellurium 128	53I iodine 127	54Xe xenon 131	
55Cs caesium 133	56Ba barium 137	57–71 lanthanoids		72Hf hafnium 178	73Ta tantalum 181	74W tungsten 184	75Re rhenium 186	76Os osmium 190	77Ir iridium 192	78Pt platinum 195	79Au gold 197	80Hg mercury 201	81Tl thallium 204	82Pb lead 207	83Bi bismuth 209	84Po polonium —	85At astatine —	86Rn radon —
87Fr francium —	88Ra radium —	89–103 actinoids		104Rf rutherfordium —	105Db dubnium —	106Sg seaborgium —	107Bh bohrium —	108Hs hassium —	109Mt meitnerium —	110Ds darmstadtium —	111Rg roentgenium —	112Cn copernicium —	Flerovium Fl —		114Lv livermorium —			

lanthanoids

57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

actinoids

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