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0653/31

October/November 2016

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 **23** printed pages and **1** blank page.

- 1 Fig. 1.1 shows a solar-powered pump used to fill a water trough from a well on a farm. Animals in a field on the farm drink from the trough.

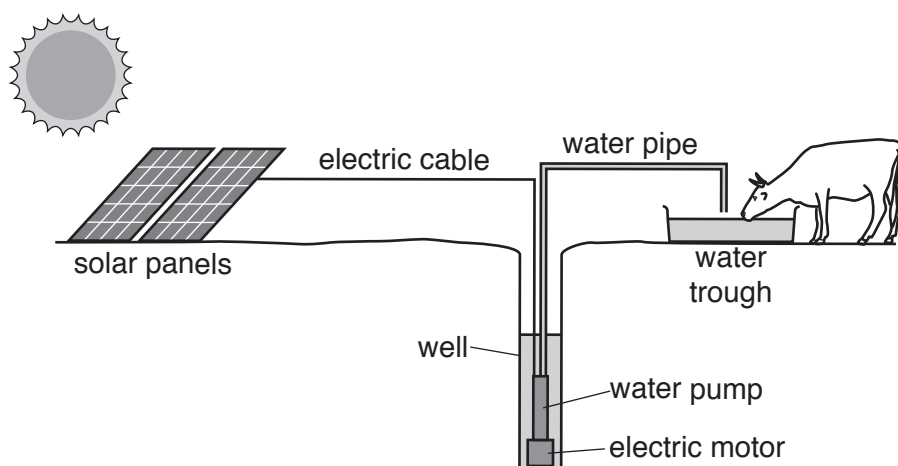


Fig. 1.1

The solar panels use sunlight to generate electricity.
 The motor uses the electricity to drive the pump.
 The pump moves water from the well to the water trough.

- (a) (i) Complete the sequence of energy transformations that takes place as the water pipe is filled when the pump is switched on.

from energy
 to **electrical** energy
 to energy
 to **potential** energy

[2]

- (ii) The pipe from the pump to the trough is 9 m long. When the pump starts, it takes 12 s for water to move from the well to the trough.

Calculate the average speed of the water through the pipe.

speed = ... m/s [1]

- (b) Fig. 1.2 shows a speed/time graph for one water molecule as it moves from the well through the pipe to the trough.

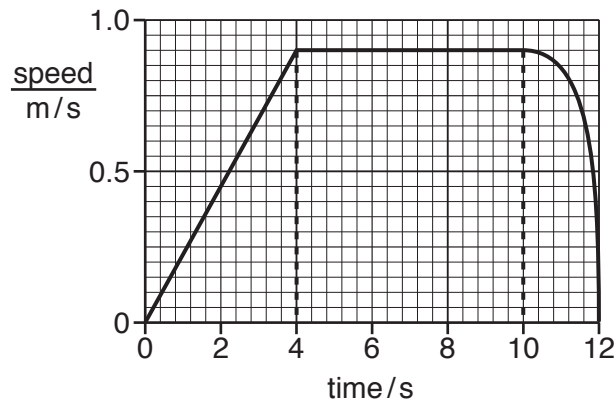


Fig. 1.2

- (i) State the maximum speed of the water molecule through the pipe.

speed = ... m/s [1]

- (ii) Use Fig. 1.2 to describe how the motion of the molecule between 0 s and 4 s differs from its motion between 10 s and 12 s.

.....

 [2]

- (c) The water level in the well is 6 m below the water in the trough.

- (i) Calculate the work done in raising 10 kg of water from the well to the trough.
 (gravitational field strength, $g = 10 \text{ N/kg}$)

State any formula you use and show your working.

formula

working

work done = ... J [2]

- (ii) When the pump is working steadily, it takes 2 minutes to pump 10 kg of water from the well into the trough.

Use your answer to (i) to calculate the output power of the pump.

State any formula you use and show your working.

formula

working

power = ... W [2]

Please turn over for Question 2.

- 2 An atom of sodium has the symbol shown.



- (a) Deduce the number of neutrons and the number of electrons in an atom of sodium.

neutrons

electrons

[2]

- (b) State the electronic structure of the sodium atom.

.....

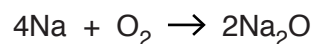
[1]

- (c) Describe the relationship between the electronic structure of the sodium atom and the number of its group in the Periodic Table.

.....

.....[1]

- (d) The equation for the reaction between sodium and oxygen is



- (i) Describe, in terms of electrons, the formation of a sodium ion from a sodium atom.

.....[1]

- (ii) Use the Periodic Table on page 24 to identify the element which has atoms with the same electronic structure as a sodium ion.

.....[1]

- (e) All of the Group I metals are solid at 20 °C.

Table 2.1 shows the melting points of some of the Group I metals.

Table 2.1

metal	melting point/°C
Li	
Na	98
K	64
Rb	39
Cs	

Complete Table 2.1 by suggesting the melting points of lithium, Li, and caesium, Cs. [2]

- (f) Solid sodium chloride, NaCl, contains sodium ions, Na⁺, and chloride ions, Cl⁻.

observations

1. Sodium ions cannot be separated from chloride ions in solid sodium chloride by any simple separation method.
2. An aqueous solution of sodium chloride can be separated into sodium chloride and water by the process of evaporation.

Explain these observations.

observation 1

.....

.....

observation 2

.....

.....[2]

- 3 Some cress seeds are placed on damp cotton wool in a dish. They are left to germinate in a light-proof box for a few days.

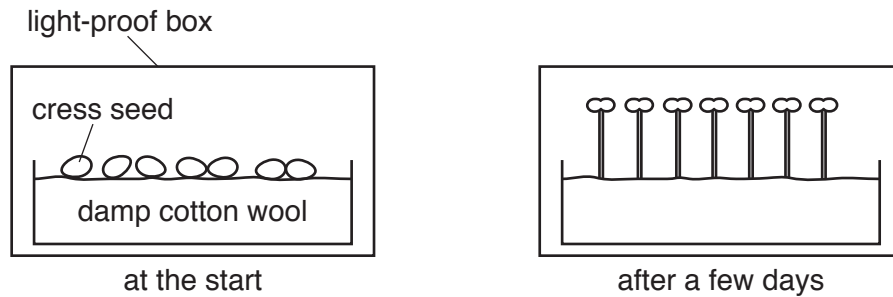


Fig. 3.1

- (a) Fig. 3.1 shows that the seedlings grow directly upwards.

Name this response.

.....[1]

- (b) The dish of seedlings is removed from the box and lit from one side.

Fig. 3.2 shows what happens.

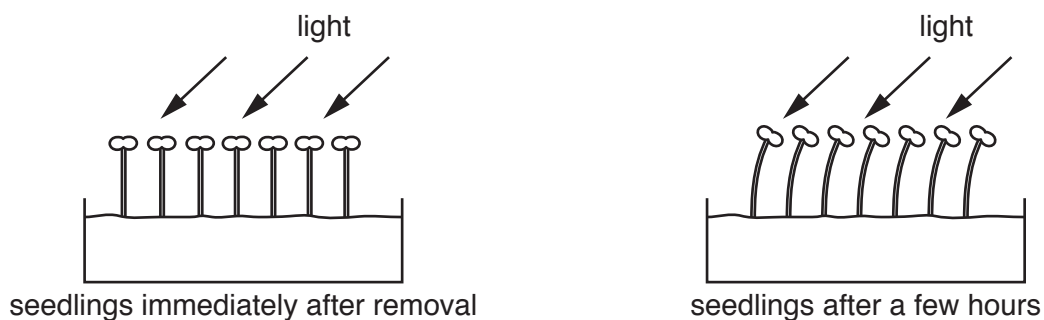


Fig. 3.2

Explain in detail how hormones in the seedlings cause the response shown in Fig. 3.2. You may use a diagram to illustrate your answer.

.....

.....

.....

.....

.....[3]

- (c) A student thinks that the germination of seeds might be affected by acid rain.

The student has five dishes each containing 20 seeds. He waters them with solutions that have a range of pH values.

Table 3.1 shows the results after a few days.

Table 3.1

pH of solution	number of seeds that germinate
3	1
4	3
5	3
6	14
7	16

- (i) Describe the effect of pH on the germination of the seeds.

.....

.....

.....

.....

.....[2]

- (ii) Explain why the germination of seeds is affected by pH.

.....

.....

.....[1]

- (iii) The pH of acid rain is usually between pH 4 and 5.

Calculate the percentage germination in this pH range.

answer = ... % [1]

- (d) (i) Describe how the activities of humans cause acid rain.

.....

.....

.....

.....

.....[2]

- (ii) Suggest how acid rain affects the productivity of farms which grow crops.

Explain your answer.

.....

.....[1]

Please turn over for Question 4.

- 4 There is a water trough in a field for animals to drink from. On a hot day, the level of the water in the trough drops even when there are no animals drinking from it.

- (a) (i) Explain in terms of the energy and movement of water molecules why the level of water goes down in the trough on a hot day.

.....

.....

.....

.....

.....

.....[3]

- (ii) The thermal energy causing the process in (i) is provided by the Sun.

Suggest one way in which the loss of water from the trough could be reduced without placing a lid on the trough.

.....

.....[1]

- (b) Fig. 4.1 shows the farmer looking at a stick lying in the water trough.

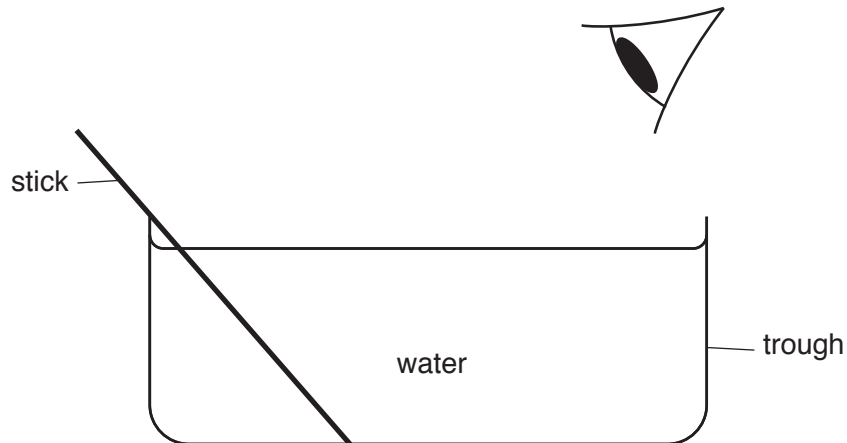


Fig. 4.1

The farmer says that the stick looks bent where it goes into the water.

- (i) Name the property of light that causes the stick to look bent.

.....[1]

- (ii) On Fig. 4.1, draw a ray diagram using two rays from the bottom of the stick to show why the stick appears bent when the farmer looks at it from the side. [3]

- (c) The farmer speaks to someone on his cell phone (mobile phone).

Identify and describe the two different types of wave that enable two people to speak to each other using cell phones.

.....

.....

.....

.....

.....

.....[3]

- 5 (a) Iron is extracted in the blast furnace, as shown in Fig. 5.1.

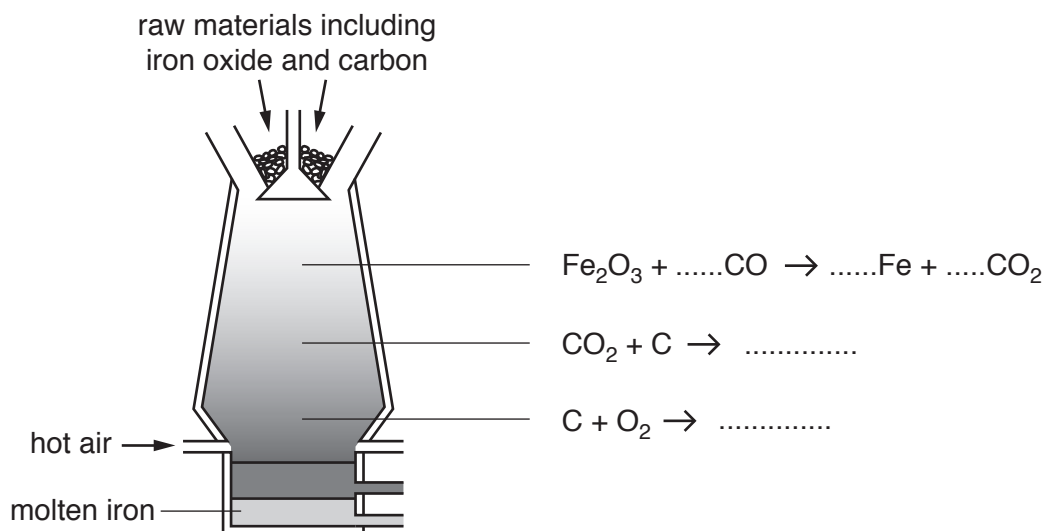


Fig. 5.1

- (i) Complete and balance the equations in Fig. 5.1. [3]
- (ii) The three equations in Fig. 5.1 represent redox reactions.

Identify **one** substance in these equations which is reduced.
Explain your answer briefly.

substance

explanation

.....[2]

- (b) Aluminium is extracted from aluminium oxide, Al_2O_3 , by the process of electrolysis, as shown in Fig. 5.2.

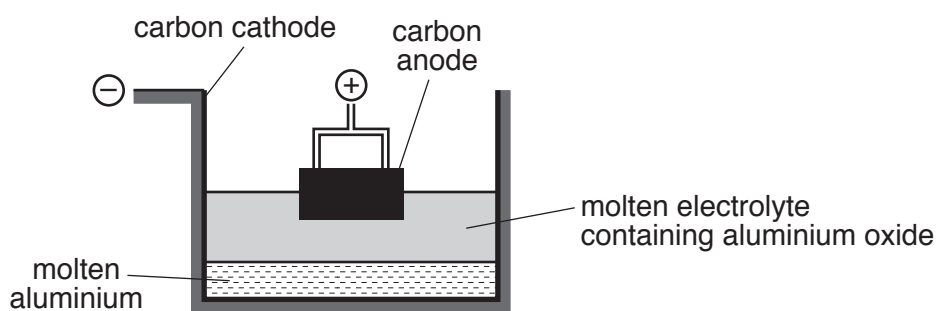


Fig. 5.2

- (i) Suggest why aluminium cannot be extracted from aluminium oxide by heating with carbon in a blast furnace.

.....

.....[1]

- (ii) The electrolysis of aluminium oxide does not occur if it is solid.

Explain, in terms of the ions present, why the electrolyte must be molten.

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

- (iii) Describe briefly, in terms of electrons, what happens to the aluminium ions, Al^{3+} , and the oxide ions, O^{2-} , when aluminium and oxygen are formed during electrolysis.

aluminium ions
.....
oxide ions
.....[1]

- (c) (i) Suggest why aluminium alloys, rather than iron alloys, are used in aircraft construction.

.....[1]

- (ii) Suggest why aluminium alloys, rather than pure aluminium, are used in aircraft construction.

.....[1]

- 6 (a) Microorganisms are added to milk to make yoghurt. They use the nutrients in the milk to make lactic acid. The lactic acid causes the milk to thicken.

Fig. 6.1 shows how the lactic acid production of a microorganism varies with temperature.

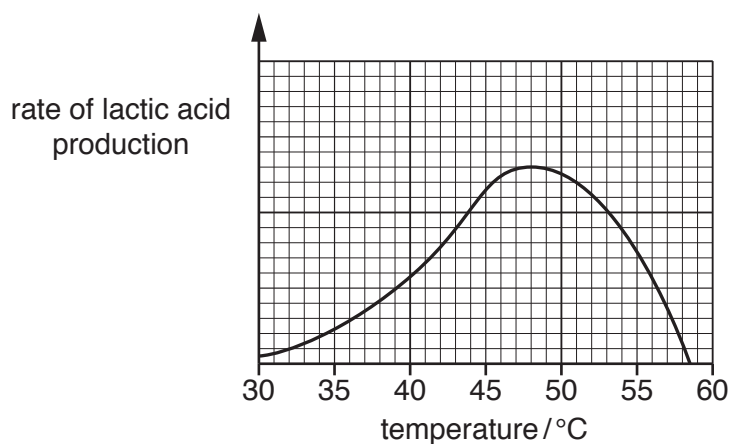


Fig. 6.1

- (i) State the optimum temperature for lactic acid production by this microorganism.

.....[1]

- (ii) Describe evidence from Fig. 6.1 that shows that lactic acid production depends on enzyme action in the microorganism.

.....

[1]

- (b) Yoghurt can be made from different types of milk.

Table 6.1 shows some of the substances found in two different types of milk.

Table 6.1

substance	milk A /g per 100 cm ³	milk B /g per 100 cm ³
protein	3.4	7.2
fat	3.6	0.1
carbohydrate	4.7	4.9
calcium (mineral salt)	0.1	0.1
fibre	none	none

- (i) Milk **B** contains more protein than milk **A**.

State why the body needs protein.

.....
[1]

- (ii) A balanced diet contains five nutrient groups, as well as fibre and water.

Name the nutrient group, present in milk, which is **not** listed in Table 6.1.

.....
 Describe the importance of including this nutrient group in a balanced diet.

[2]

- (iii) Suggest which type of milk, **A** or **B**, would be a healthy choice for someone who does not wish to develop coronary heart disease.

Explain your answer.

type of milk
 explanation

[1]

- (c) Sometimes fresh fruit is added to yoghurt in the final stages of manufacture. This improves the yoghurt by adding fibre.

Explain the importance of fibre in the diet.

.....
[1]

- 7 Fig. 7.1 shows a circuit diagram for a solar-powered electric motor.

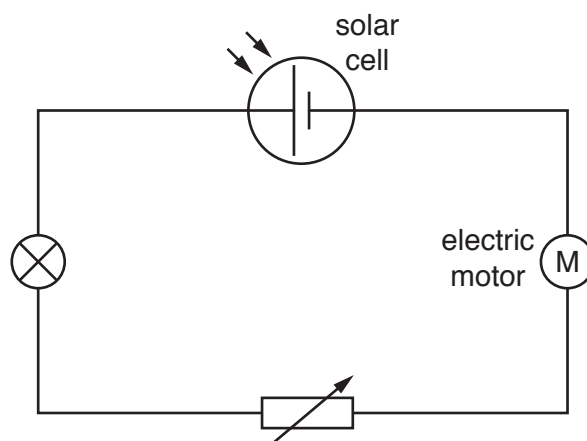


Fig. 7.1

- (a) When the motor is turning, the potential difference (p.d.) across the motor is 1.5 V, across the lamp is 0.5 V, and across the variable resistor is 0.6 V.

- (i) Calculate the p.d. across the solar cell.

p.d. across cell = ... V [1]

- (ii) The current in the circuit is 0.3 A.

Calculate the resistance of the lamp in the circuit.

State the formula you use and show your working.

formula

working

resistance = ... Ω [2]

- (iii) Calculate the power output of the solar cell.

State any formula you use and show your working.

formula

working

power = ... W [2]

- (b) The purpose of the lamp in the circuit in Fig. 7.1 is to indicate that the motor is working.

Explain why the lamp is connected in series and not in parallel with the motor.

.....

.....[1]

- 8 Fig. 8.1 shows fractional distillation and catalytic cracking at an oil refinery.

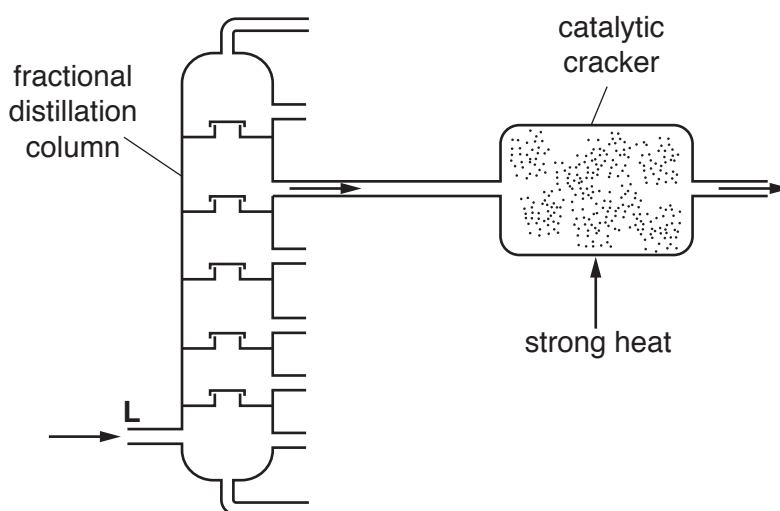
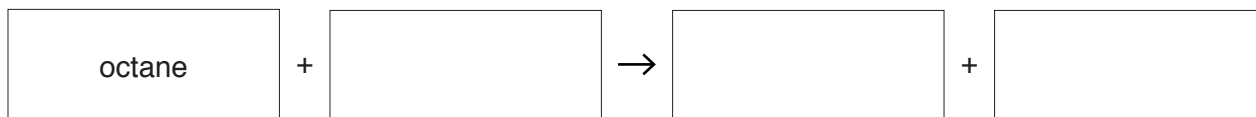


Fig. 8.1

- (a) (i) Name the raw material that enters the fractional distillation column at L.
[1]
- (ii) State the physical property which enables the different molecules to be separated during fractional distillation.
[1]
- (b) Cracking molecules of the hydrocarbon $C_{20}H_{42}$ produces a mixture of compounds, as shown below.
- $$C_{20}H_{42} \rightarrow 3C_2H_4 + 2X + C_8H_{18}$$
- (i) Deduce the formula of compound X.
[1]
- (ii) Name the compound with the formula C_2H_4 .
[1]
- (iii) Describe a simple chemical test that can distinguish octane, C_8H_{18} , from C_2H_4 .
 Give the results for both compounds.
- test

 C_8H_{18} result.....
 C_2H_4 result[2]

(c) Give the word equation for the complete combustion of octane.



[1]

Please turn over for Question 9.

9 Fig. 9.1 shows a fetus shortly before it is born.

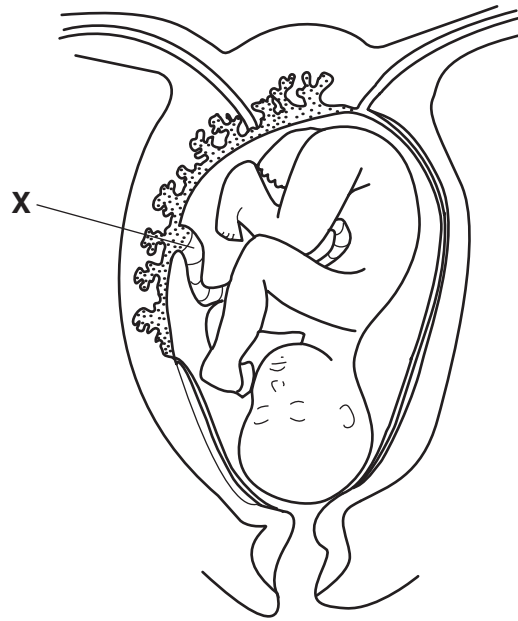


Fig. 9.1

(a) Complete the sentences below using the words or phrases provided.

You may use each word or phrase once, more than once or not at all.

amnion an artery a vein carbon dioxide
oxygen placenta umbilical cord

Structure X is the It contains
..... which carries blood to the
..... to collect for the
growing fetus.

[4]

(b) (i) Describe **two** ways in which HIV can be transmitted.

1.
2.[2]

(ii) Describe how the immune system is affected by HIV/AIDS.

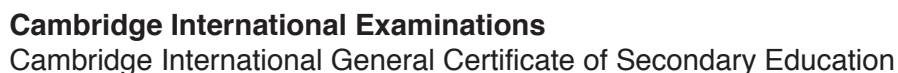
.....
.....
.....[2]

The Periodic Table of Elements

Group																		
I	II											III	IV	V	VI	VII	VIII	
		Key										1 H hydrogen 1						
		atomic number atomic symbol name relative atomic mass																
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	VIII	
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	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	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	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	Rn radon	
87 Fr francium	88 Ra radium	89–103 actinoids	104 Rf rutherfordium	105 Db dubium	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			

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			
actinoids					
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 dm^3 at room temperature and pressure (r.t.p.)



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0653/32

October/November 2016

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 20.

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

This document consists of **20** printed pages.

- 1 Fig. 1.1 shows a wireless doorbell to alert people inside a building that someone has come to visit.

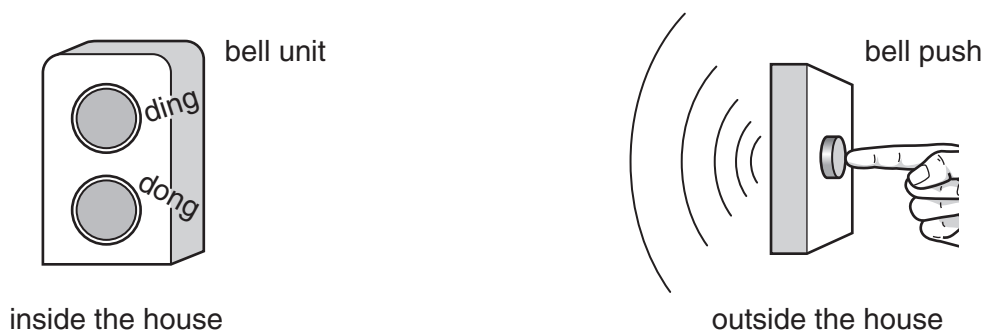


Fig. 1.1

When the button in the bell push is pressed, a radio signal is sent to the bell unit, and the bell sounds.

- (a) Table 1.1 shows part of the electromagnetic spectrum.

Table 1.1

	X-rays	ultraviolet		infra-red		
--	--------	-------------	--	-----------	--	--

highest frequency ←————→ lowest frequency

- (i) Three forms of electromagnetic radiation are shown in Table 1.1.

State which of these forms of electromagnetic radiation has the shortest wavelength.

Give a reason for your answer.

Electromagnetic radiation having the shortest wavelength is

Reason

.....[1]

- (ii) In Table 1.1, write the name of the electromagnetic waves used for radio signals in the correct position in the electromagnetic spectrum. [1]

(b) The radio signal travels at a speed of $3 \times 10^8 \text{ m/s}$.

(i) Suggest the speed of visible light. Give a reason for your answer.

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

(ii) The radio signal has a frequency of 200 MHz ($200 \times 10^6 \text{ Hz}$).

Calculate the wavelength of the radio signal.

State the formula that you use and show your working.

formula

working

wavelength = ...m [2]

- (c) The bell unit also contains an electrical circuit.

Fig. 1.2 shows two different bells, **A** and **B**, inside the bell unit. When the wireless signal is received, an arm moves and hits the two bells.

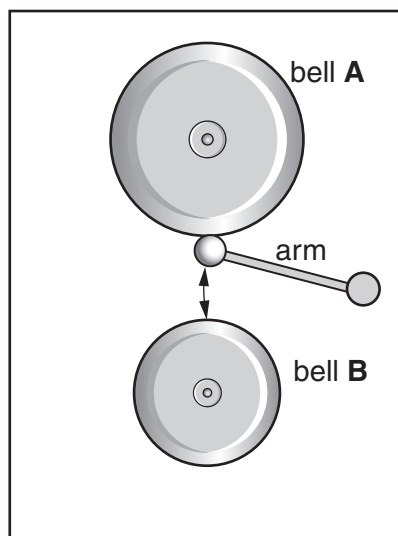


Fig. 1.2

- (i) Complete the sequence of useful energy transfers when someone hears the bells.

from electrical energy
 to energy
 to energy.

[2]

- (ii) Bell **A** emits a loud sound of frequency 500 Hz.

Bell **B** emits a quieter sound of frequency 250 Hz.

State which bell, **A** or **B**, produces the sound with the

1. higher pitch, ...
2. larger amplitude.

[1]

- (d) The sound of the bell is transmitted through the air as a succession of compressions and rarefactions.

Describe how the arrangement of molecules in the air in a compression is different from the arrangement in a rarefaction.

.....
[1]

2 The Periodic Table lists all of the elements in order.

(a) State, in terms of atomic structure, which number determines the order of the elements in the Periodic Table.

.....[1]

(b) Part of the Periodic Table is shown in Fig. 2.1. The letters in this table are **not** the symbols of the elements.

I		II												III	IV	V	VI	VII	VIII	
																				A
B												C					D			
E																				
F									G							H				

Fig. 2.1

(i) Choose from letters **A** to **H** to complete the sentences below.

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

The most reactive element in Group I is

The least reactive element in Group VII is

The **three** elements with the same number of outer shell electrons are

....., ... and [3]

(ii) Suggest **two** properties of the element labelled **G**.

1.

2.

[2]

(c) Aluminium, Al, is in Group III. Oxygen, O, is in Group VI.

Deduce the charges on the aluminium ion and on the oxygen ion.

aluminium ion charge

oxygen ion charge

[2]

(d) Magnesium ions have the formula Mg^{2+} .

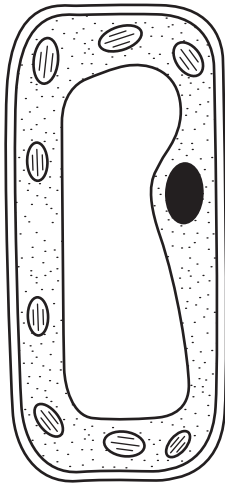
Nitride ions have the formula N^{3-} .

Deduce the formula of magnesium nitride.

.....[1]

- 3 (a) Fig. 3.1 shows a plant cell as seen under the microscope.

Draw lines to label the parts of the plant cell that carry out the functions shown.



controlling centre of the cell

controls what enters and leaves the cell

where respiration takes place

Fig. 3.1

[3]

- (b) (i) With reference to Fig. 3.1 describe how the contents of the cell enable it to carry out photosynthesis.

.....

.....

.....

.....

.....[2]

- (ii) Write the balanced symbol equation for photosynthesis.

.....[2]

- 4 Fig. 4.1 shows an electric iron for smoothing clothes. An electric heater inside the iron is connected to the mains electricity supply.

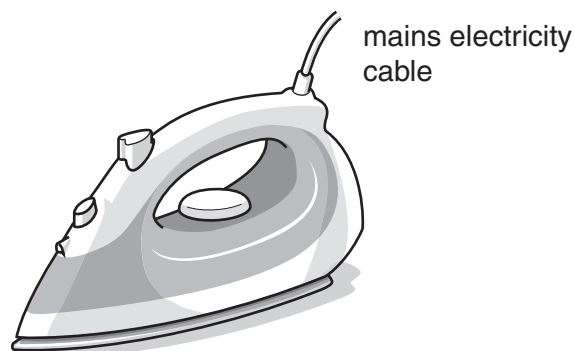


Fig. 4.1

- (a) The heating element inside the electric iron is made of two long thin wires that have equal resistance.

The two wires

- are made of the same material,
- are equal in diameter.

- (i) State another property that must be the same for the wires to have equal resistance.

.....[1]

- (ii) The wires are connected in parallel with each other, and connected to the mains a.c. power supply through a fuse and a switch.

Draw a circuit diagram for this arrangement.

Use the resistor symbol to represent each of the wires.

[4]

- (b) In an electric steam iron, the element heats water inside the iron. When the water boils, the steam comes out through holes in the bottom of the iron.

Explain, in terms of the distances between water molecules, why the steam is forced out from the holes in the bottom of the iron.

.....

.....

.....

.....[2]

- (c) Fig. 4.2a and Fig. 4.2b show another switch included inside the iron to control the temperature.

This type of switch uses a bimetallic strip, made of two different metals, brass and steel, joined together.

Fig. 4.2a shows the switch when the iron is cold.

Fig. 4.2b shows the switch when the iron has reached the correct temperature for ironing.

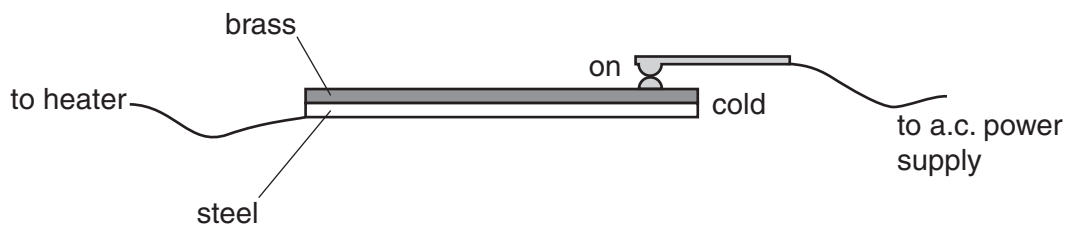


Fig. 4.2a

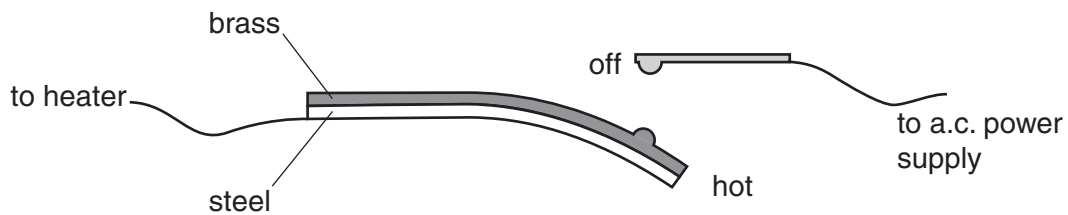


Fig. 4.2b

Explain why this bimetallic strip switches off the heating element when the temperature increases.

.....

.....

.....

.....[2]

- 5 A student investigates the speed of the reaction between excess dilute hydrochloric acid and powdered calcium carbonate.

The equation for the reaction is shown below.



Fig. 5.1 shows some of the apparatus she uses.

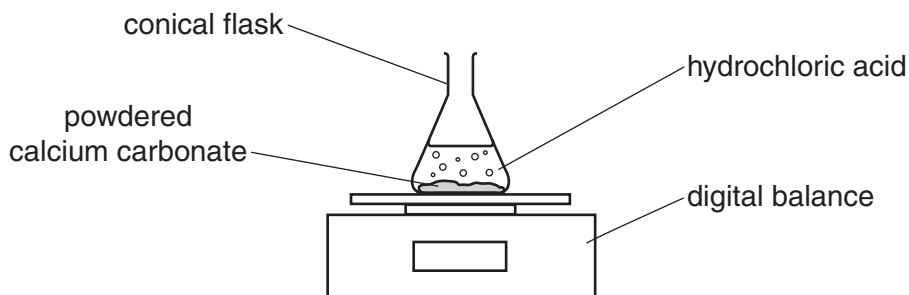


Fig. 5.1

- (a) Name one other piece of apparatus that is needed to investigate the speed of this reaction.

.....[1]

- (b) The student plots the mass of the conical flask and its contents, as shown in Fig. 5.2.

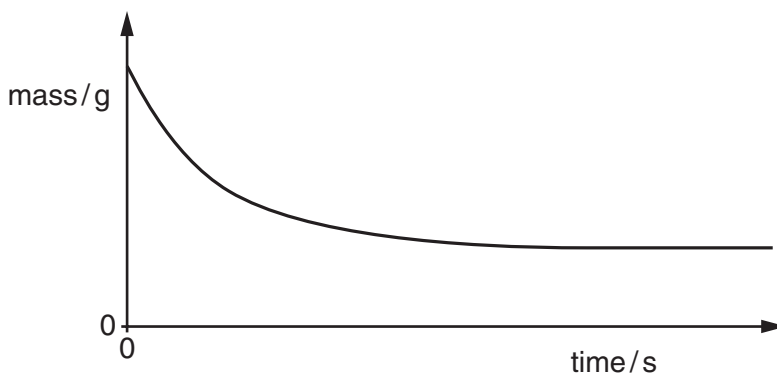


Fig. 5.2

- (i) Explain why

the mass decreases,

.....

the mass becomes constant.

.....

[2]

(ii) On Fig. 5.2, draw a line to show the results obtained when the experiment is repeated at a higher temperature. [2]

(iii) State and explain, in terms of particle collisions, the effect of increasing the concentration of the acid on the speed of the reaction.

effect

explanation

.....

.....[2]

(c) The student repeats the experiment using **excess** powdered calcium carbonate.

Suggest **two** further processes that are used to obtain calcium chloride crystals from the mixture formed in this reaction.

first process

second process

[2]

(d) Pure calcium chloride is an ionic substance that can be melted and electrolysed.

Predict the substances that form at the electrodes during this electrolysis.

at the anode

at the cathode

[2]

- 6 (a) Fig. 6.1 is a diagram of an alveolus in the lungs.

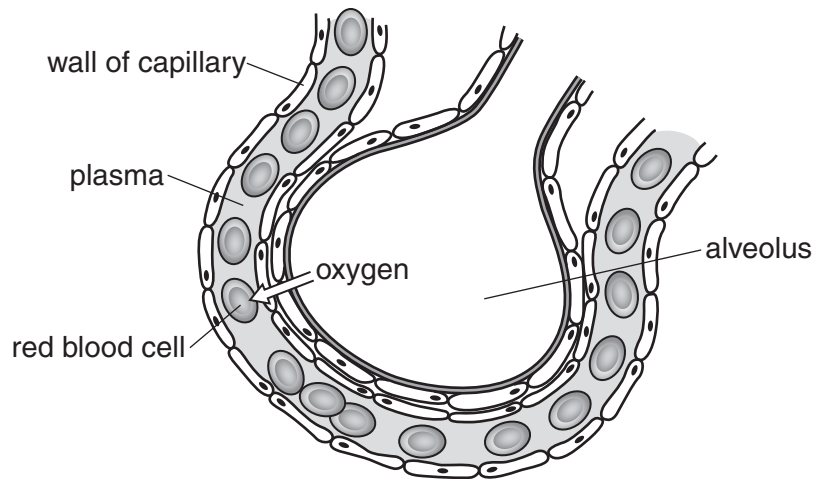


Fig. 6.1

- (i) An arrow in Fig. 6.1 shows the diffusion of oxygen.

Draw another arrow to show the diffusion of carbon dioxide.

[1]

- (ii) Describe **two** ways in which the structure of the alveolus is adapted for efficient gas exchange.

1.
-
2.
-

[2]

- (b) A student uses a machine to measure the volume of air breathed in and out of his lungs. The machine produces a graph showing the results.

Fig. 6.2 shows how the volume of his lungs changes as he breathes in and out while resting.

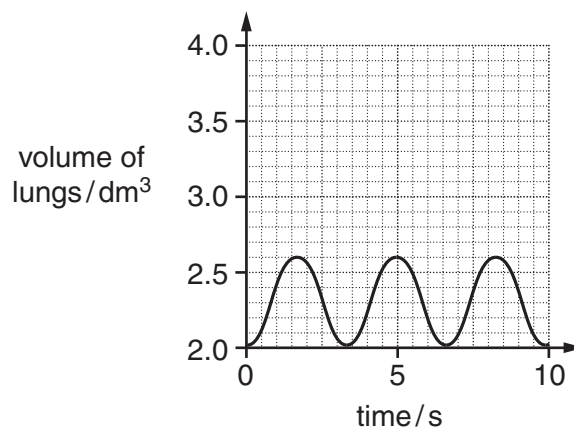


Fig. 6.2

- (i) State the volume of air he breathes in with each breath.

volume = ... dm^3 [1]

- (ii) Calculate the total volume that he breathes in during ten seconds.
Show your working.

total volume = ... dm^3 [1]

- (c) The student then does a running exercise. His breathing pattern changes.

Fig. 6.3 shows the graph of his breathing while exercising.

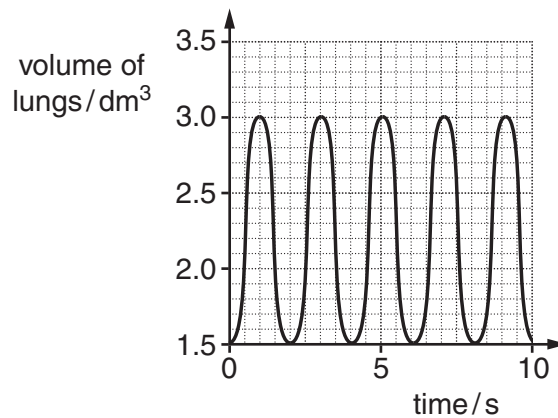


Fig. 6.3

- (i) Describe **two** ways in which the student's breathing changes when he starts to exercise.

1.

2.

[2]

- (ii) Explain in detail why the student's breathing needs to change during exercise.

.....

.....

.....

.....

.....

.....[3]

- 7 A boy uses a catapult to launch a ball vertically upwards, as shown in Fig. 7.1.

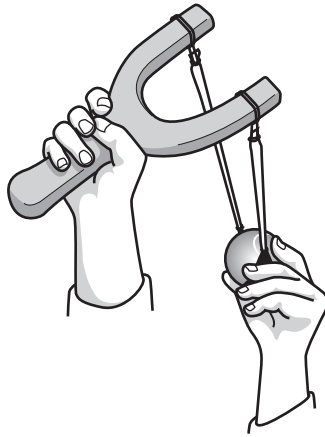


Fig. 7.1

The boy places a ball of mass 0.055 kg in the catapult.

He applies a force to stretch the elastic cords before the ball is launched. This is shown in Fig. 7.2.

When the elastic cords are fully stretched, the boy holds the ball at rest in the catapult.

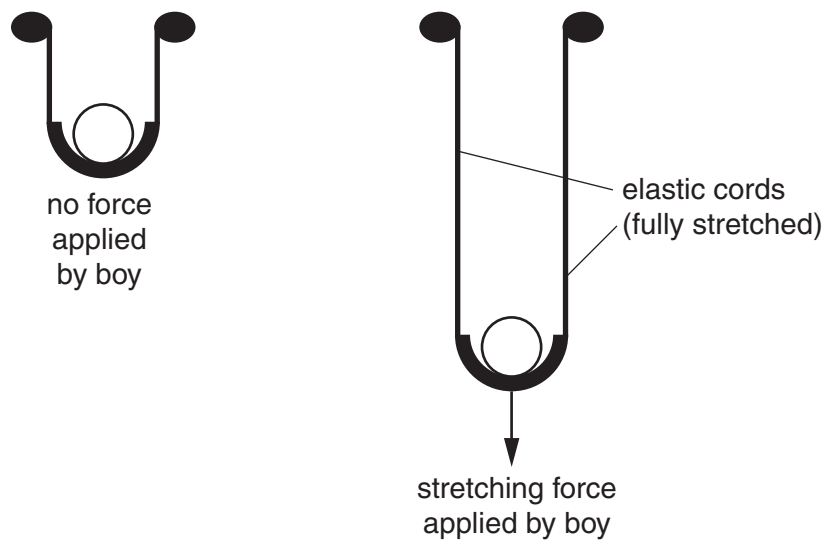


Fig. 7.2

- (a) Explain why, before the boy stretches the catapult, there is a small force stretching the elastic cords.

.....

.....

.....[2]

- (b) (i) Describe how the forces in the elastic cords change as the cords stretch.

.....
[1]

- (ii) When the cords are fully stretched by a total force of 100 N, the boy holds the ball without moving the catapult.

State the total upward force when the elastic cords are fully stretched.
 Give a reason for your answer.

total upward force = ... N

reason
[2]

- (c) The boy releases the stretched catapult and launches the ball.

The ball, mass 0.055 kg, moves vertically upwards at a speed of 20 m/s.

- (i) Calculate the kinetic energy of the ball as it leaves the catapult.

State the formula that you use and show your working.

formula

working

kinetic energy = ... J [2]

- (ii) Use your answer to (c)(i) to calculate the maximum height above the catapult reached by the ball. Assume there is no loss of energy to the air as the ball rises.

State any formula that you use and show your working.

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

formula

working

height = ...m [2]

- 8 (a) Some fuels are listed below.

coal

natural gas

petroleum

wood

State which of these four fuels is **not** a fossil fuel.

.....[1]

- (b) Petroleum is a mixture of hydrocarbons. It is separated by fractional distillation, as shown in Fig. 8.1. Another process, **X**, is also shown.

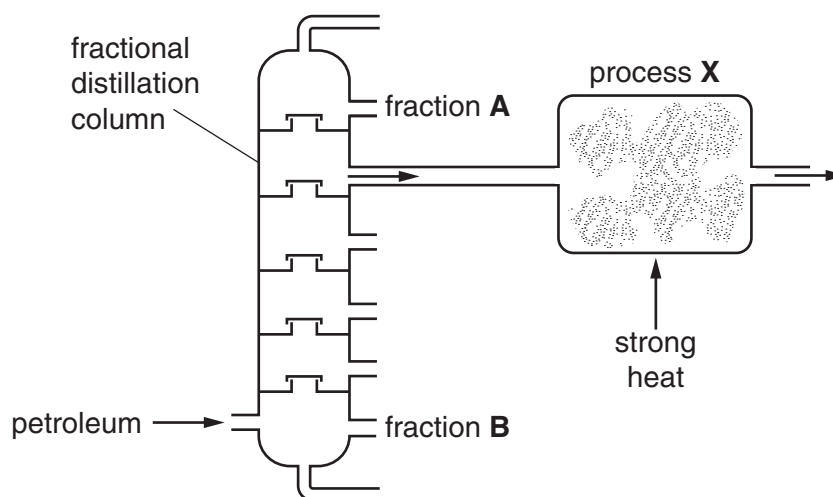


Fig. 8.1

- (i) A hydrocarbon in fraction **A** has a different boiling point from a hydrocarbon in fraction **B**.

Explain why these hydrocarbons have different boiling points.

Use ideas about molecules in your answer.

.....

.....

.....

.....

.....[2]

- (ii) One of the fractions obtained contains octane. Fig. 8.2 shows a molecule of octane.

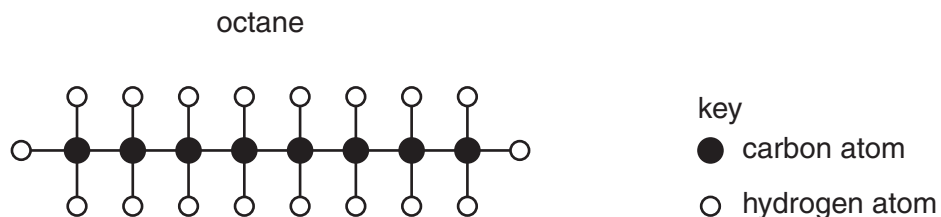


Fig. 8.2

State the formula of octane.

.....

[1]

- (iii) Process **X** converts large hydrocarbon molecules into many shorter molecules.

Name process **X**.

.....[1]

- (iv) The structure of propene is shown in Fig. 8.3.

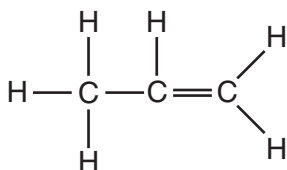


Fig. 8.3

Describe a chemical test that distinguishes propene from octane.

Give the results for both compounds.

test

propene result

octane result

[2]

9 Fig. 9.1 shows a food web in a lake.

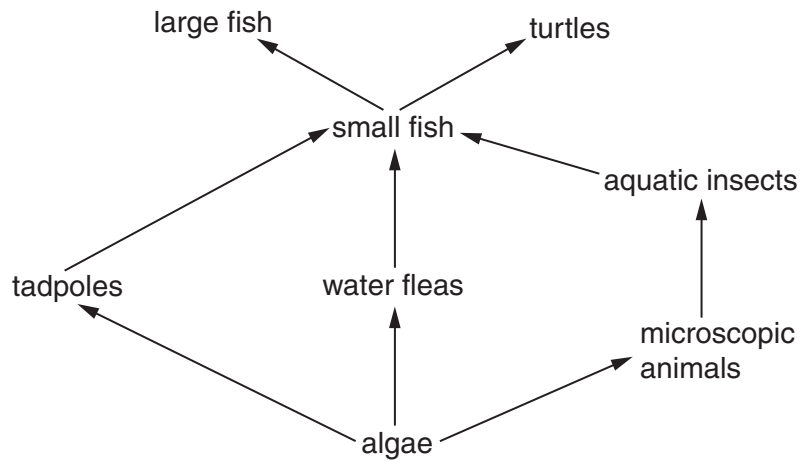


Fig. 9.1

(a) Use the words or phrases in the list below to complete the following sentences.

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

algae	consumer	decomposers	environment	food chain
	nests	Sun	turtle	water flea

The source of energy for this food web is the

The lake is the ecosystem because it contains all the organisms interacting with their

..... In this food web one example of a herbivore is a

..... and one example of a carnivore is a

.....

[4]

- (b) A food web is a network of interconnected food chains.

Use this idea to explain why the small fish in the food web in Fig. 9.1 cannot be placed in just one trophic level.

Include **two** different food chains from Fig. 9.1 in your answer.

.....

.....

.....

.....[3]

- (c) The actions of humans can affect the environment.

A farmer uses fertiliser near to the lake.

Explain what could happen if some of the fertiliser gets washed into the lake.

.....

.....

.....

.....

.....[2]

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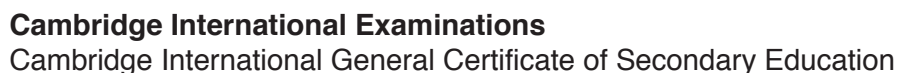
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The Periodic Table of Elements

Group																			
I	II											III	IV	V	VI	VII	VIII		
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										1 H hydrogen 1							2 He helium 4
11 Na sodium 23	12 Mg magnesium 24											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20		
												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 —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —	

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 —

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 2016

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 **23** printed pages and **1** blank page.

- 1 Fig. 1.1 shows a man using a longbow to fire arrows at a target.

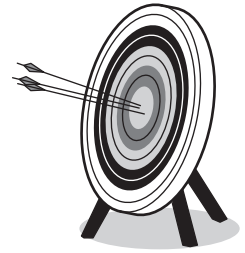
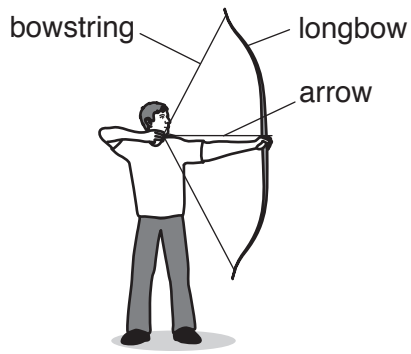


Fig. 1.1

- (a) The man uses a force of 300 N to pull the arrow back through a distance of 40 cm.

- (i) Calculate the work done by the man when he draws the arrow back by 40 cm.

State the formula you use, show your working and include the unit of your answer.

formula

working

work done = ... unit [3]

- (ii) State how much elastic potential energy is stored in the longbow and bowstring before the arrow is released.

stored energy = ... J [1]

- (b) The arrow has a mass of 0.1 kg.

The speed of the arrow as it leaves the longbow is 30 m/s.

- (i) Calculate the kinetic energy of the arrow as it leaves the longbow.

State the formula that you use and show your working.

formula

working

kinetic energy = ... J [2]

- (ii) Use your answers to (a)(ii) and (b)(i) to calculate the efficiency of the energy transfer from the longbow to the arrow.

State the formula you use and show your working.

formula

working

efficiency = ... % [2]

- (iii) The speed of the arrow as it approaches the target is 25 m/s.

Suggest why the speed of the arrow is no longer 30 m/s.

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

- 2 (a) A student investigates the reaction between dilute hydrochloric acid and 0.1 g of different metals. The metal samples used are of identical size and shape.

The apparatus he uses is shown in Fig. 2.1.

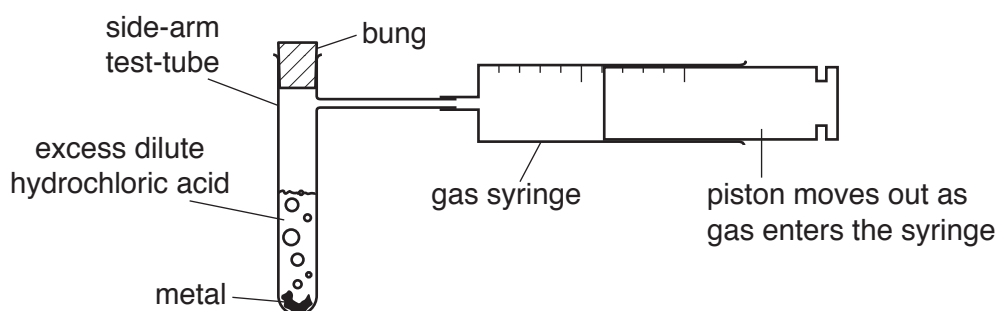


Fig. 2.1

He measures how long it takes to collect 25 cm^3 of gas made in each of the reactions.

- (i) Name one other piece of apparatus that is needed to investigate the speed of this reaction.

.....[1]

- (ii) The results the student obtains are shown in Table 2.1.

Table 2.1

metal	time to collect 25 cm^3 of gas / s
calcium	10
copper	more than 300
iron	more than 300
magnesium	20
zinc	45

State which metal reacts fastest.

.....[1]

- (b) The student repeats the experiment for copper and iron.

He uses hydrochloric acid with a greater concentration at a higher temperature.

The results the student obtains are shown in Table 2.2.

Table 2.2

metal	time to collect 25 cm ³ of gas / s
copper	more than 300
iron	30

State and explain the effects of changing the concentration and the temperature of the acid on the speed of the reaction with iron.

Use ideas about particles in your answer.

concentration

.....

.....

.....

temperature

.....

.....

.....[4]

- (c) Using the results shown in Table 2.1 and Table 2.2, deduce the order of reactivity of the five metals from most to least reactive.

.....

most reactive

.....

.....

.....

.....

least reactive

[1]

(d) The student places two other metals into test-tubes **A** and **B**, as shown in Fig. 2.2.

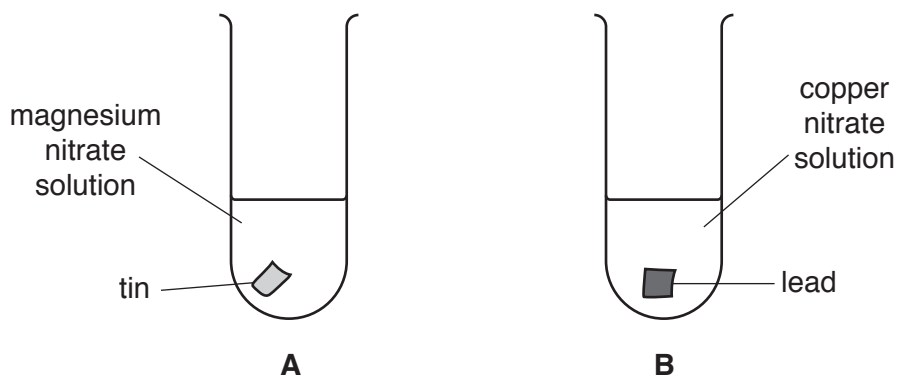


Fig. 2.2

There is no change in the contents of test-tube **A**, but in test-tube **B** the surface of the lead turns brown.

Explain these observations in terms of the reactivity of metals.

test-tube **A**

.....

.....

test-tube **B**

.....

.....

[2]

Please turn over for Question 3.

- 3 (a) Fig. 3.1 shows a plan of the human circulatory system.

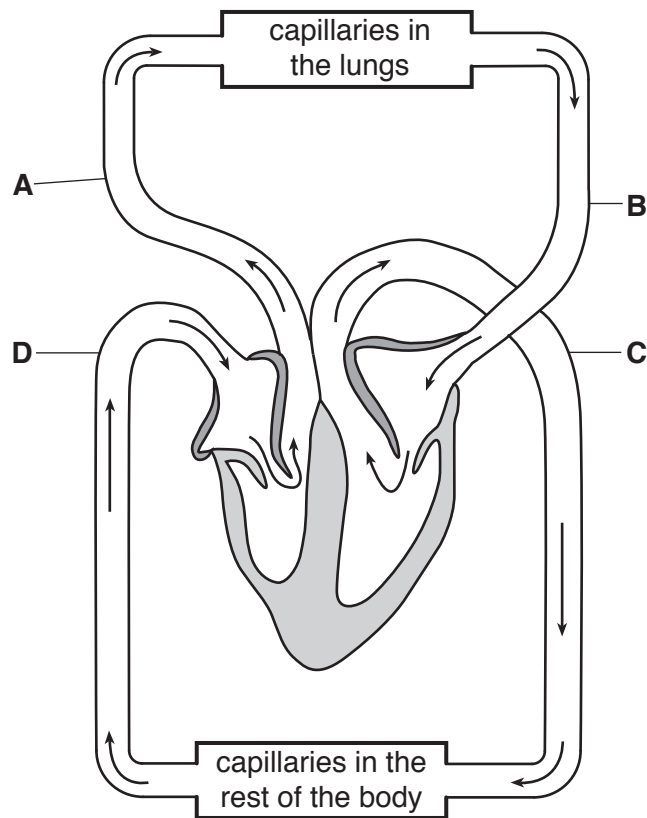


Fig. 3.1

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

.....

[1]

- (ii) State the letter and name of the blood vessel with the highest pressure in Fig. 3.1.

Explain your answer.

letter and name

explanation

.....

[2]

- (iii) Describe how each of the following features of veins enables them to return blood to the heart from parts of the body such as the feet.

valves

.....

.....

wide lumen

.....

.....

[2]

- (b) A student measures his pulse rate during the day. He takes a reading while sitting, and also as he does different activities. Some of his readings are shown in Table 3.1.

Table 3.1

activity	number of beats/min
sitting	68
running	164
Y	85

- (i) Explain in detail why the muscles of the student's legs need a greater supply of blood while he is running.

.....

.....

.....

.....

.....

.....[3]

- (ii) Suggest an activity for **Y**. Explain your answer.

activity

explanation

.....

[1]

- 4 Fig. 4.1 shows a simple solar heating system to provide hot water for a house.

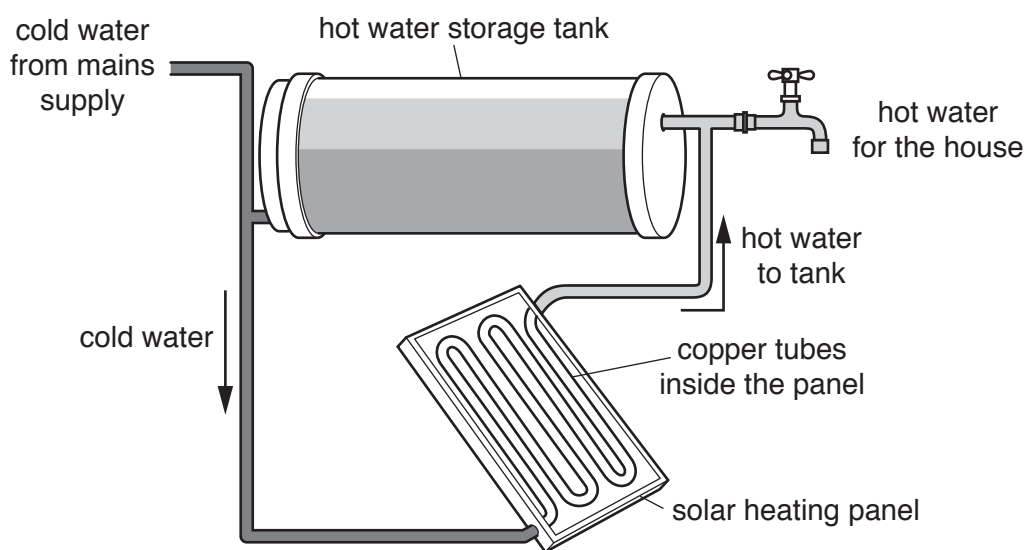


Fig. 4.1

- Cold water in copper tubes inside the panel is heated by energy from the Sun.
 - The hot water then flows to the hot water tank above.
 - Cold water from the tank flows back to the panel.
 - A supply of hot water for the house can be taken from the tank.
- (a) The Sun emits energy as electromagnetic radiation, some of which is absorbed by the solar panel.
- (i) On Table 4.1, in the correct box write the name of the main part of the electromagnetic spectrum which heats the solar panel.

Table 4.1

gamma radiation		ultraviolet				radio waves
-----------------	--	-------------	--	--	--	-------------

[2]

- (ii) The Sun also emits radio waves which take 8 minutes to reach the Earth.

A student says he thinks the radiation that heats the solar panel would take longer than 8 minutes to reach the Earth.

Explain why the student is wrong.

.....

.....[1]

(b) The solar panel contains copper tubes through which the water flows.

(i) The copper tubes are painted to improve the efficiency of energy absorption by the panel.

Suggest the colour of the paint that would give the best efficiency. Give a reason for your answer.

.....

.....

.....

.....[2]

(ii) State the method of thermal energy transfer

1. from the outside of the copper tubes to the water inside the tubes,

.....

2. from the hot water in the copper tubes to the hot water storage tank.

.....

[2]

(iii) Explain why the heated water in the copper tubes is able to travel up to the storage tank above the panel without pumping.

.....

.....

.....

.....

.....[2]

- 5 (a) (i) Name the main constituent of natural gas.

.....[1]

- (ii) Complete the sentences below using suitable words or phrases.

Coal, natural gas and petroleum are all fuels.

Petroleum is a mixture of different compounds and is separated by the process of

..... [2]

- (b) Cracking is used to break large molecules into smaller molecules.

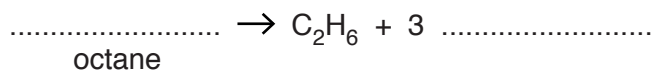
During cracking a molecule of octane forms one molecule of ethane, C_2H_6 , and three molecules of another compound.

The structure of octane is shown in Fig. 5.1.



Fig. 5.1

Deduce the formula of octane and complete the symbol equation for the cracking of octane.



[2]

- (c) Ethane is a hydrocarbon.

- (i) State what is meant by the term *hydrocarbon*.

.....

 [2]

- (ii) The formulae of two other hydrocarbons are C_6H_{12} and C_6H_{14} .

Deduce which is an alkene.
Explain your answer.

alkene

explanation

.....

.....

[1]

- (iii) Name a reagent that is used in a test to distinguish between alkanes and alkenes.
State the observation for each test.

reagent

alkanes

alkenes

[2]

- 6 (a) Describe how the following structures of a wind-pollinated flower differ from those of an insect-pollinated flower.

the stamen

.....

the stigma

.....

[2]

- (b) A student looks at some pollen from a wind-pollinated flower and an insect-pollinated flower under the microscope at the same magnification. Fig. 6.1 shows what she sees.

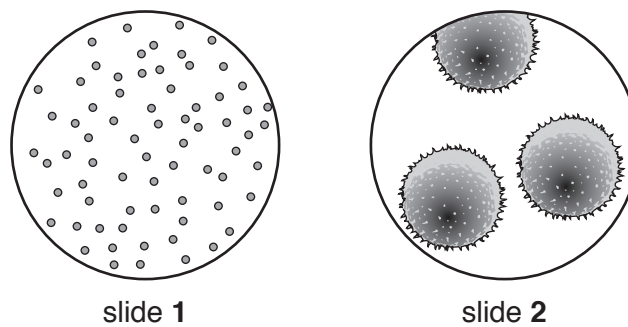


Fig. 6.1

State the slide showing pollen from a wind-pollinated flower.

.....

Explain how this pollen is adapted for wind pollination.

.....

.....

[1]

- (c) Another student investigates the rate of transpiration from a leafy twig under different conditions. Fig. 6.2 shows the apparatus he uses.

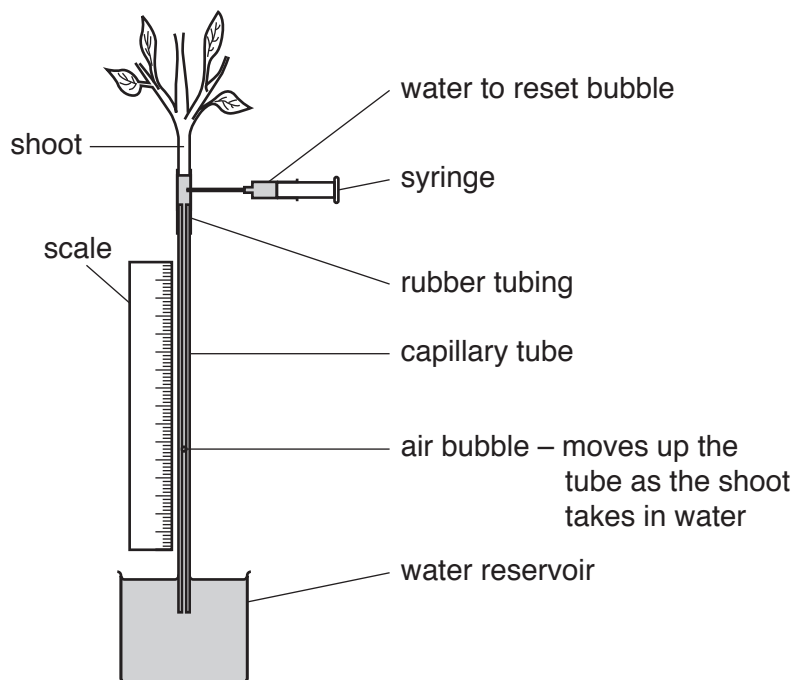


Fig. 6.2

- He measures how far the air bubble moves upwards in one minute.
- He uses the syringe of water to reset the apparatus.
- The student repeats the experiment under different environmental conditions.
- His readings are shown in Table 6.1.

Table 6.1

conditions	distance moved by bubble in one minute / cm
dry air at 22 °C	1.1
dry air at 27 °C	6.8
humid air at 22 °C	

- (i) Explain why the distance the bubble moved increases when the temperature rises to 27 °C.

.....

.....

.....

.....[2]

- (ii) Suggest a possible reading for humid air at 22 °C. Explain your answer.

reading

explanation

.....[1]

- (d) In the ground the plant takes in water at the roots.

Fig. 6.3 shows the distribution of the tissues in the cross-sections of two similar roots of the same size.

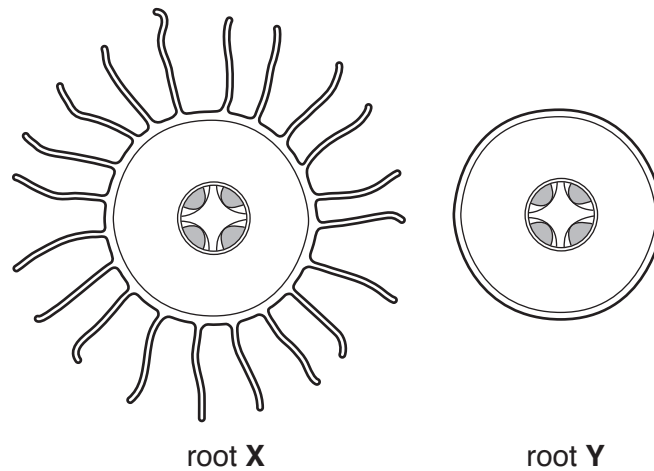


Fig. 6.3

Suggest which root would take in water more quickly.

root

Describe and explain why this root takes in water more quickly.

.....

[2]

- (e) These roots do not carry out photosynthesis because they are found underground and do not have chlorophyll.

Describe the role of chlorophyll in photosynthesis.

.....

[2]

- 7 (a) Fig. 7.1 shows a wave generated in a string. One end of the string is fixed to a stand and clamp, while the other end is attached to a vibrator driven by an electric motor.

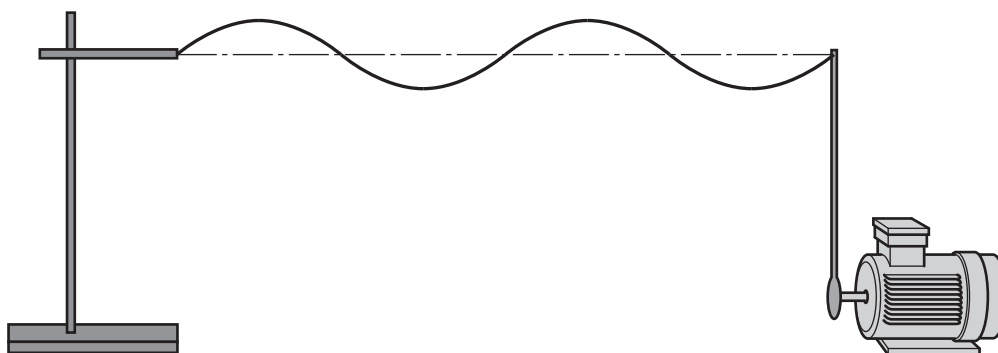


Fig. 7.1

- (i) The length of the string is 100 cm.

State the wavelength of the wave motion shown in Fig. 7.1.

..... cm [1]

- (ii) State what is meant by the *amplitude* of the wave.

.....

.....[1]

(b) Fig. 7.2 shows part of the circuit diagram for the circuit used to drive the vibrator.

The frequency of the vibrator depends on the speed of the motor. The speed of the motor depends on the current through the motor.

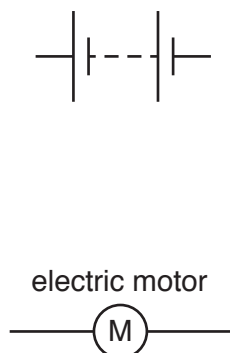


Fig. 7.2

Complete the circuit diagram by using the symbols for suitable circuit components in the correct places in the circuit to

1. control the current through the motor,
2. measure the current through the motor. [3]

(c) A voltmeter connected across the motor reads 3.0 V. The current through the motor is 2.0 A.

- (i) Calculate the resistance of the motor.

State the formula you use and show your working.

formula

working

resistance = ... Ω [2]

- (ii) Calculate the power input to the motor.

State the formula you use and show your working.

formula

working

power = ... W [2]

- 8 During the electrolysis of aluminium oxide, Al_2O_3 , aluminium is produced. This process is shown in Fig. 8.1.

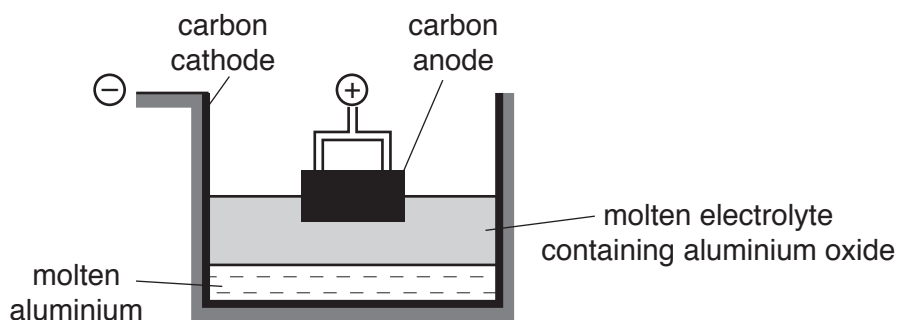


Fig. 8.1

- (a) Explain why the electrolysis of aluminium oxide does not take place at room temperature. Use ideas about particles in your answer.

.....

[2]

- (b) Describe what happens to the oxide ions, O^{2-} , during the electrolysis of aluminium oxide.

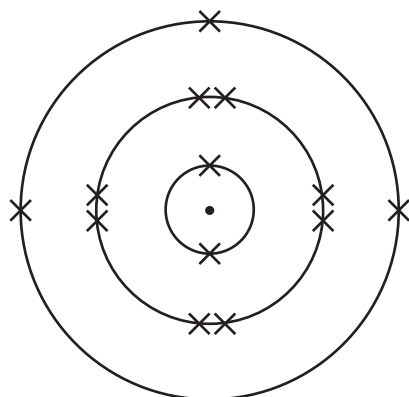
.....

[2]

- (c) State and explain whether aluminium is oxidised or reduced during electrolysis.

.....
[1]

- (d) The electronic structure of an aluminium atom is shown in Fig. 8.2a.



Al atom

Fig. 8.2a

Al ion

Fig. 8.2b

Draw the electronic structure of an aluminium ion in Fig. 8.2b.

[1]

- (e) Predict the type of bonding in a compound formed between rubidium, a Group I element, and fluorine, a Group VII element.

Explain your answer.

bonding

explanation

.....

.....

[2]

- 9 (a) Many human activities can affect the environment.

Draw **one** line from each human activity to its effect. One line is drawn for you.

human activity	effect
adding fertiliser to rivers	adds sulfur dioxide to the air
adding mercury to water	can cause extinction of land-living animals
burning coal and oil	protects endangered species
large scale deforestation	can cause eutrophication
	can poison animals in the food chain

[3]

- (b) Human activities can cause an increase in the concentration of carbon dioxide in the atmosphere.

- (i) State one large-scale human activity that increases the concentration of carbon dioxide in the atmosphere.

.....[1]

- (ii) Explain why an increase in the concentration of carbon dioxide in the atmosphere is undesirable.

.....

.....

.....

.....

.....

.....[3]

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The Periodic Table of Elements

Group																			
I	II											III	IV	V	VI	VII	VIII		
		1 H hydrogen 1																	
		Key atomic number atomic symbol name relative atomic mass																	
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 —	114 Fl flerovium —	116 Lv 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