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COMBINED SCIENCE

0653/41

Paper 4 Theory (Extended)

October/November 2020

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Blank pages are indicated.

- 1 (a) Gas exchange takes place at the gas exchange surfaces of organisms.

Fig. 1.1 shows where gas exchange takes place in the lungs.

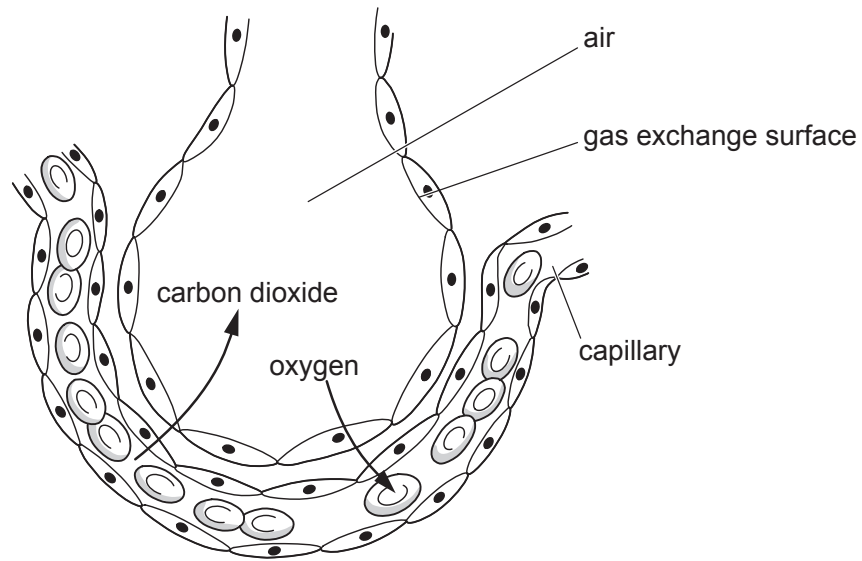


Fig. 1.1

- (i) Use Fig. 1.1 to describe what happens at a *gas exchange surface*.

.....

 [2]

- (ii) Name the gas exchange surface in the lungs.

..... [1]

- (iii) List **two** features of gas exchange surfaces.

1
 2
 [2]

(b) Fig. 1.2 shows a fetus inside a uterus.

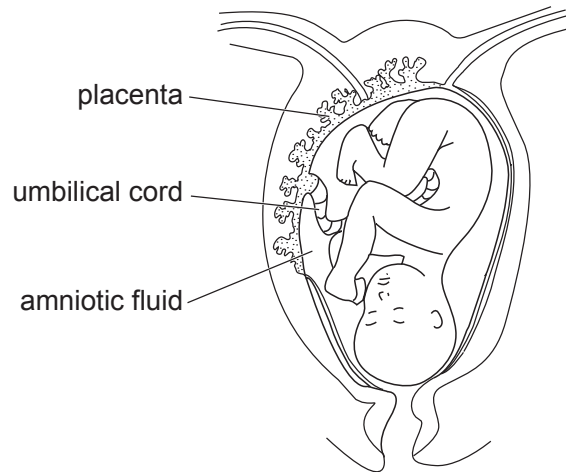


Fig. 1.2

(i) State the function of the umbilical cord.

.....
 [1]

(ii) State the function of the amniotic fluid.

.....
 [1]

(iii) Small molecules that are useful for the fetus diffuse across the placenta from the mother to the fetus.

Circle **two** small molecules which diffuse **from** the mother **to** the fetus.

amino acids

carbon dioxide

fats

glucose

glycogen

starch

[2]

[Total: 9]

- 2 Fig. 2.1 is a simplified diagram of the fractional distillation of petroleum.

The formulae of three compounds contained in different fractions are shown.

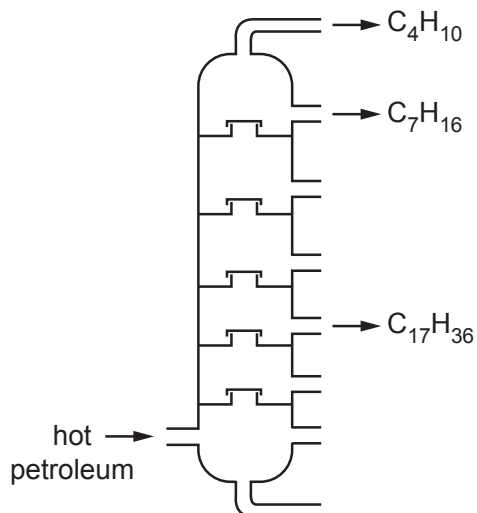


Fig. 2.1

- (a) Describe the trend in the boiling points of the compounds C_4H_{10} , C_7H_{16} and $C_{17}H_{36}$.

Use ideas about the sizes of the molecules and the forces between the molecules to explain your answer.

trend

.....

explanation

.....

.....

..... [3]

- (b) C_4H_{10} and C_7H_{16} are members of the homologous series of alkanes.

- (i) Describe what is meant by a *homologous series*.

.....

.....

..... [2]

- (ii) Draw a dot-and-cross diagram to show the bonding in a molecule of carbon dioxide, CO_2 . Show only the outer shell electrons.

[2]

- (iii) Carbon dioxide is one of the products of the complete combustion of heptane, C_7H_{16} .

Complete and balance the symbol equation for the complete combustion of heptane, C_7H_{16} .

State symbols are **not** required.



[2]

- (c) Carbon dioxide is a greenhouse gas.

State **one** effect of an increase in the concentration of carbon dioxide in the atmosphere.

.....

 [1]

[Total: 10]

3 Fig. 3.1 shows a woman travelling on an escalator (a moving staircase).

The escalator moves the woman through a vertical distance of 9.0 m, from a lower level to a higher level.

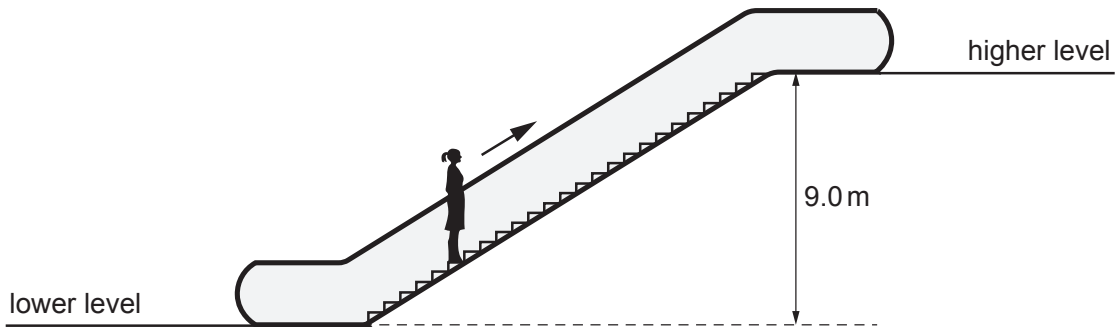


Fig. 3.1

(a) Fig. 3.2 shows a speed–time graph for the woman as:

- she walks on the lower level at a constant speed for 5.0 seconds
- she travels on the escalator at a constant speed for 20 seconds
- she steps off the escalator and walks away on the higher level.

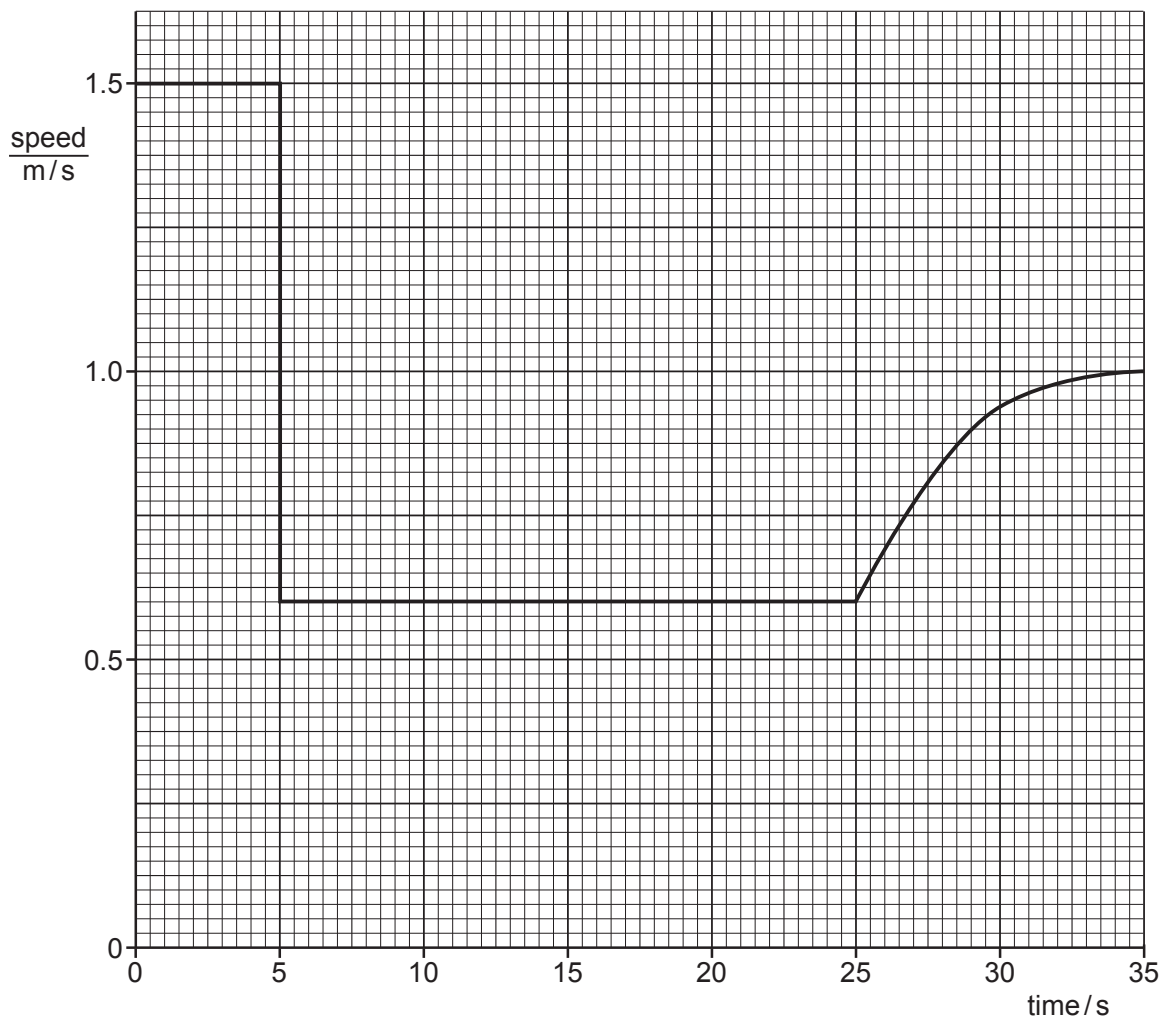


Fig. 3.2

- (i) Use Fig. 3.2 to calculate the distance the woman walks on the lower level.

distance = ... m [3]

- (ii) Use Fig. 3.2 to state the time at which the woman steps off the escalator.

time = ... s [1]

- (iii) On Fig. 3.2, draw an **X** on the graph to show when the woman is moving with acceleration that is **not** constant. [1]

- (b) The woman has a weight of 600 N.

- (i) Calculate the change in gravitational potential energy ($\Delta G.P.E.$) of the woman in moving through the vertical distance of 9.0 m.

$\Delta G.P.E.$ = ... J [2]

- (ii) The electric motor for the escalator has a power of 48 kW.

Calculate the energy supplied by the electric motor in the 20 seconds the woman travels on the escalator.

energy supplied = ... J [3]

- (iii) Suggest **two** reasons why the answer to (b)(ii) is much greater than the answer to (b)(i).

1

2 [2]

[Total: 12]

4 Fig. 4.1 shows an external view of the heart.

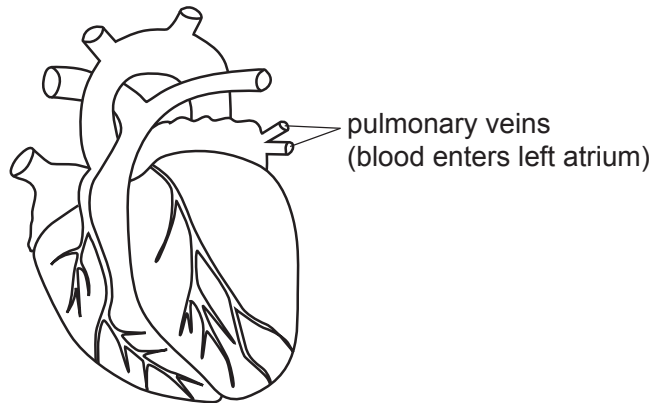


Fig. 4.1

(a) On Fig. 4.1, use a label line and the letter **C** to identify a coronary artery. [1]

(b) Name the substance in red blood cells that carries oxygen.

..... [1]

(c) The heart rate increases during exercise causing the blood to flow more quickly.

Explain why the heart rate increases during exercise.

.....

 [3]

(d) (i) Hormones are transported in blood plasma.

Define a *hormone*.

.....

 [2]

(ii) Name the hormone that causes an increase in heart rate.

..... [1]

[Total: 8]

5 (a) Sodium reacts with water to form aqueous sodium hydroxide, NaOH, and hydrogen gas.

(i) This reaction is exothermic.

Fig. 5.1 is an energy level diagram for the reaction.

On Fig. 5.1, label the energy level diagram to show the *reactants*, the *products* and the *activation energy*.

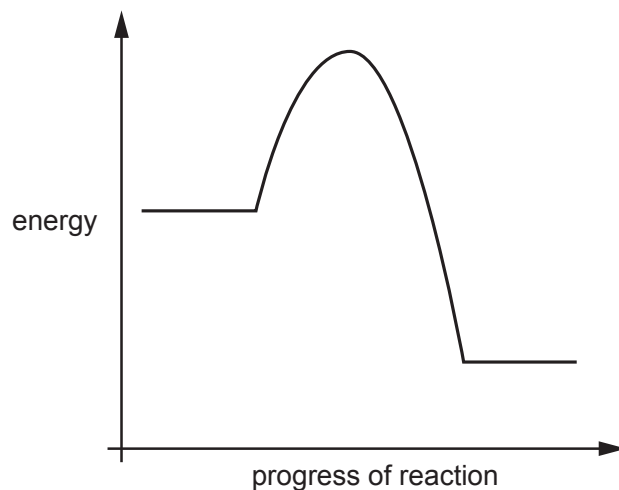


Fig. 5.1

[2]

(ii) During the reaction, the sodium melts.

Describe, in terms of particle bonds and energy, what happens when sodium melts.

.....

 [2]

(iii) Suggest the pH of the aqueous sodium hydroxide.

Give a reason for your answer.

pH
 reason
 [1]

(iv) State the formulae of the two ions present in sodium hydroxide.

..... and [1]

- (b) Explain why sodium must **not** be added to dilute hydrochloric acid.

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

- (c) Sodium is extracted from molten sodium chloride by electrolysis.

Sodium is formed at the cathode.

Name the product formed at the anode.

..... [1]

- (d) Sodium is an element in Period 3 of the Periodic Table.

Describe the relationship between the number of outer shell electrons and the metallic character of elements across a period.

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

[Total: 9]

- 6 Fig. 6.1 shows a girl using a bicycle pump to 'pump up' (add air to) a bicycle tyre.

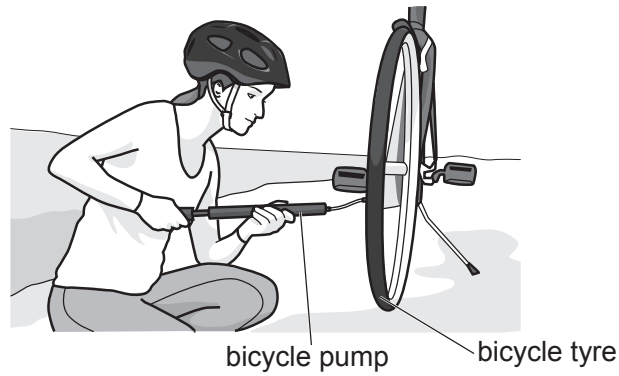


Fig. 6.1

- (a) After pumping up the tyre, the pressure of the air inside the tyre is greater than the pressure of the air outside the tyre.

Describe how the distances between the molecules in the air are different inside the tyre and outside the tyre.

.....
 [1]

- (b) The pressure of the air inside the bicycle tyre is $3.0 \times 10^5 \text{ N/m}^2$.

The total surface area of the inside wall of the bicycle tyre is 0.25 m^2 .

Calculate the total force exerted by the air inside the bicycle tyre on the inside wall of the tyre.

force = ... N [2]

(c) Fig. 6.2 shows the structure of the girl's bicycle helmet.

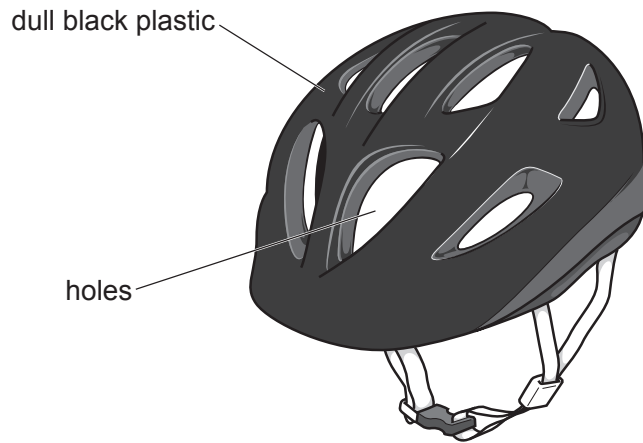


Fig. 6.2

(i) When the girl is cycling, her head gets hot. The skin on her head sweats.

Suggest how the structure of the helmet helps the sweat on her head to evaporate.

.....

.....

..... [2]

(ii) Suggest a change to the appearance of the helmet that would reduce the amount of radiation absorbed by the helmet.

Give a reason for your answer.

.....

.....

..... [2]

(d) Fig. 6.3 shows a bell on the handlebars of the bicycle.

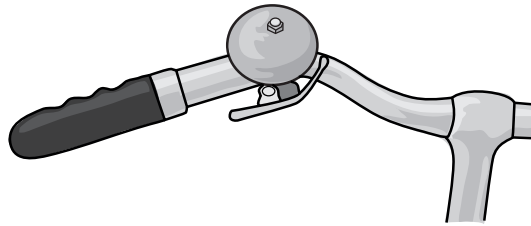


Fig. 6.3

When the girl rings the bell, it emits sound waves of frequency 1320 Hz.

The speed of sound in air is 330 m/s.

Calculate the wavelength of the sound waves emitted.

wavelength = ... m [2]

[Total: 9]

7 During sexual reproduction in flowering plants, both pollination and fertilisation take place.

(a) Describe fertilisation in a flower.

.....

.....

..... [2]

(b) Fig. 7.1 shows a diagram of a wind-pollinated flower **X** and a diagram of an insect-pollinated flower **Y**.

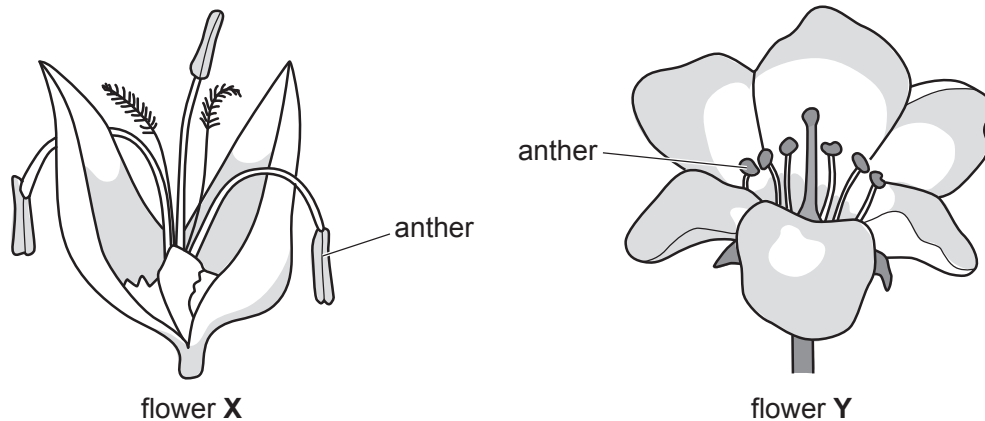


Fig. 7.1

(i) Describe how the anthers of **X** are adapted for wind pollination.

.....

.....

..... [2]

(ii) Give **two** pieces of evidence in Fig. 7.1 that show that **Y** is an insect-pollinated flower.

1

2 [2]

(c) Explain why flowering plants are called *producers*.

.....

.....

..... [2]

- (d) Producers are the first trophic level of every food chain.

Explain why food chains usually have fewer than five trophic levels.

.....

.....

..... [2]

[Total: 10]

8 Copper chloride is produced when dilute hydrochloric acid reacts with copper carbonate.

(a) State **one** other substance that reacts with dilute hydrochloric acid to produce copper chloride.

..... [1]

(b) Copper is a transition element. Potassium is a Group I element.

(i) State **one** property of copper that is also a property of potassium.

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

(ii) State **one** property of copper compounds that is **not** a property of potassium compounds.

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

(c) Copper is extracted by heating copper oxide with carbon.

A redox reaction occurs.

The equation for this reaction is shown.



Explain, in detail, why this reaction is a *redox reaction*.

.....
.....
.....
..... [3]

(d) Fig. 8.1 shows the arrangement of copper atoms and zinc atoms in a sample of brass.

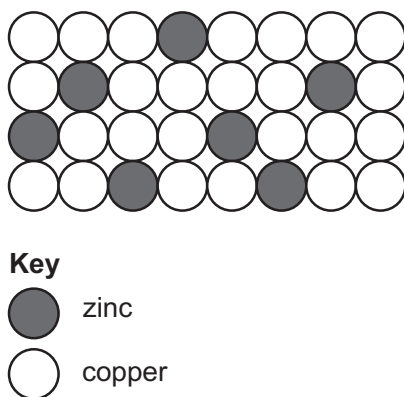


Fig. 8.1

Circle words from the list that can be used to describe brass.

alloy

compound

element

mixture

molecule

[1]

[Total: 7]

9 Fig. 9.1 shows an electric lawnmower that is used for cutting grass.



Fig. 9.1

The lawnmower operates from a 230 V mains electricity supply.

The circuit in the lawnmower contains:

- an electric motor
- a switch to switch the motor on and off
- a lamp to show when the motor is switched on
- a variable resistor to vary the current in the motor but not the current in the lamp
- a fuse to protect the circuit.

(a) On Fig. 9.2, complete the circuit diagram for the lawnmower.

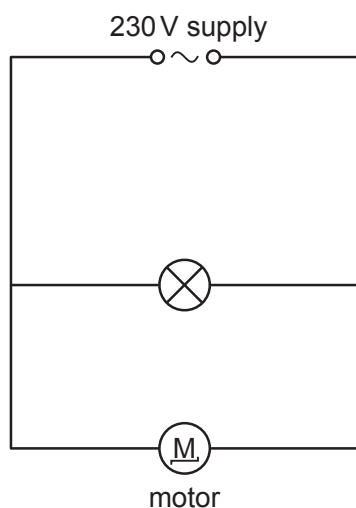


Fig. 9.2

[4]

- (b) The current in the lamp is 0.25 A.

The potential difference across the lamp is 230 V.

Calculate the resistance of the lamp.

resistance = ... Ω [2]

[Total: 6]

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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	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 —	115 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	euporium	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.).



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COMBINED SCIENCE

0653/42

Paper 4 Theory (Extended)

October/November 2020

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

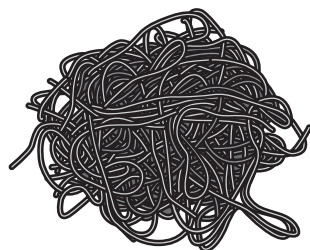
- Answer **all** questions.
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INFORMATION

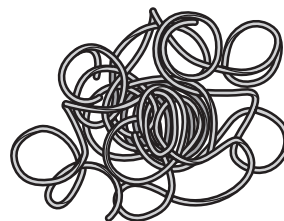
- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **24** pages. Blank pages are indicated.

1 Fig. 1.1 shows some pasta noodles and some vegetable noodles.



pasta noodles



vegetable noodles

Fig. 1.1

Table 1.1 compares the nutrients and energy listed on a packet of each type of noodles.

Table 1.1

nutrient	typical value in 100 g of pasta noodles	typical value in 100 g of vegetable noodles
carbohydrate (fibre)	31 g (1.3 g)	6.2 g (2 g)
protein	5.8 g	2.4 g
fat	0.9 g	0.6 g
calcium	7 mg	32 mg
vitamin C	0 mg	36 mg
iron	1.3 mg	0.7 mg
energy content	664 kJ	143 kJ

(a) Use the information in Table 1.1 to suggest why the vegetable noodles may be better than the pasta noodles at preventing scurvy.

.....
 [1]

(b) A doctor advises an obese person to eat vegetable noodles rather than pasta noodles.

Use the information in Table 1.1 to explain why the doctor gives this advice.

.....

 [2]

- (c) State **one** nutrient shown in Table 1.1 that must be broken down by chemical digestion before it can be used in the body.

..... [1]

- (d) Describe the importance of fibre in the diet.

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

- (e) The word equation for aerobic respiration is shown.



- (i) Describe how oxygen is transported by the blood.

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

- (ii) Explain the effect of exercise on the pattern of breathing.

Refer to concentration of carbon dioxide in the blood in your answer.

.....
.....
.....
.....
..... [3]

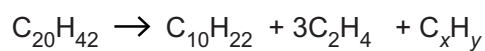
[Total: 10]

- 2 (a) Cracking breaks down large saturated hydrocarbon molecules into smaller hydrocarbon molecules.

(i) State what is meant when a hydrocarbon is described as *saturated*.

.....
 [1]

(ii) The equation for a cracking reaction is shown.



Determine the values of x and y .

$x =$ $y =$ [2]

(b) One of the products of cracking hydrocarbons is ethene, C_2H_4 .

(i) Draw a dot-and-cross diagram to show the bonding in a molecule of ethene.

Show only the outer shell electrons.

[2]

(ii) State the colour change seen when ethene is added to aqueous bromine.

from to [1]

(c) The complete combustion of ethene is an exothermic reaction.

(i) Identify the **two** compounds that are produced in this reaction.

1

2

[2]

(ii) State whether bond breaking and bond forming are endothermic or exothermic processes.

Use your answer to explain why the combustion of ethene is an exothermic reaction.

bond breaking is

bond forming is

explanation

..... [2]

[Total: 10]

- 3 (a) Fig. 3.1 shows the forces acting on a truck full of sand as it is pulled along level ground at constant speed.

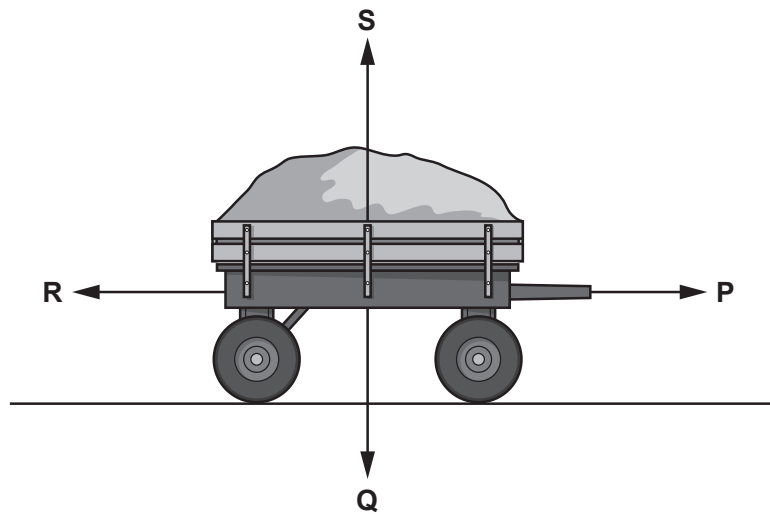


Fig. 3.1

- (i) State the letter of the force, **P**, **Q**, **R** or **S**, due to the effect of the Earth's gravitational field.

..... [1]

- (ii) Force **S** is called the reaction force.

Describe the relationship between force **S** and force **Q**.

.....
 [1]

- (b) Fig. 3.2 shows a man pulling the truck full of sand along the ground, up a slope and onto a platform.

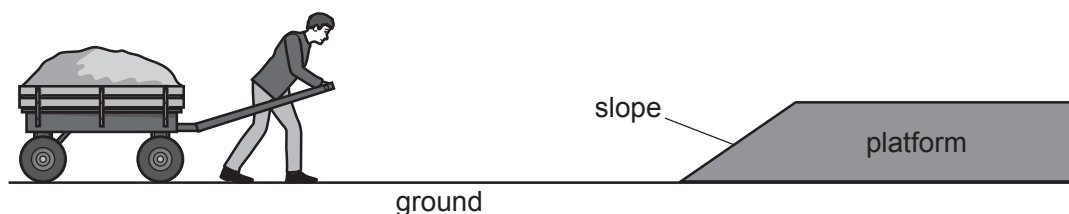


Fig. 3.2

Fig. 3.3 shows a speed–time graph of the motion of the man and truck.

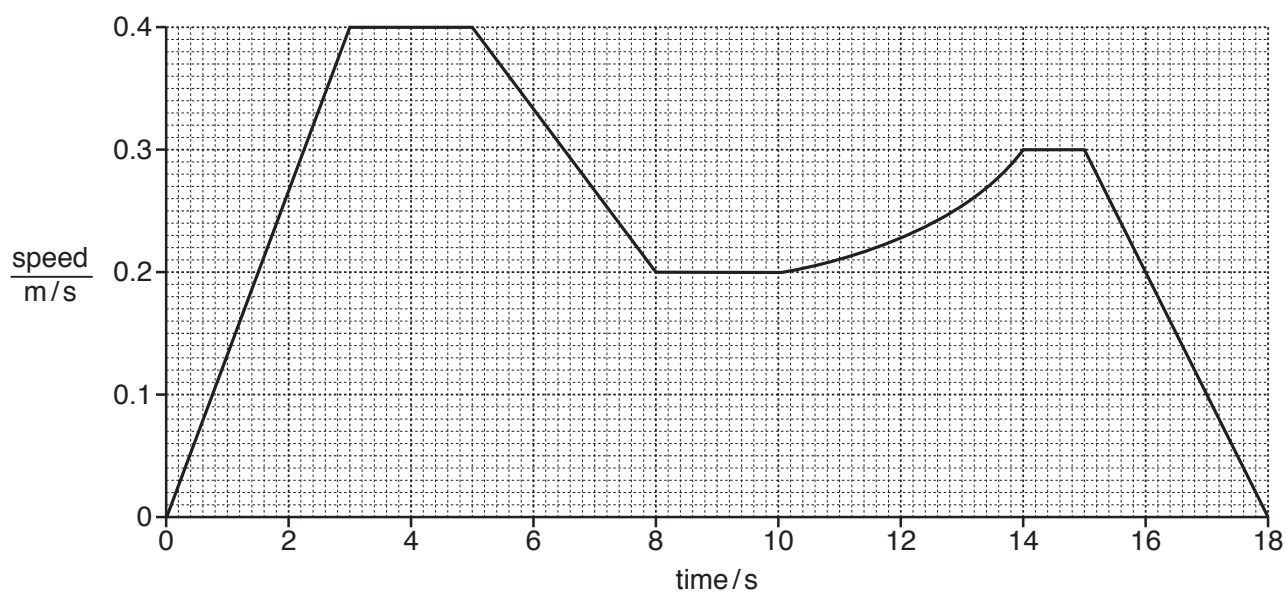


Fig. 3.3

- On Fig. 3.3, draw an **X** on the graph to show when the man and truck have the greatest acceleration. [1]
- On Fig. 3.3, draw a **Y** on the graph to show when the man and truck are moving with non-constant acceleration. [1]
- Use Fig. 3.3 to calculate the acceleration of the truck between 5.0 s and 8.0 s.

Give the units of your answer.

acceleration = ... units [3]

- (c) (i) The height of the platform in Fig. 3.2 is 1.2m.

The mass of the truck full of sand is 200 kg.

The gravitational field strength g is 10 N/kg.

Show that the increase in gravitational potential energy of the truck full of sand due to moving from the ground to the platform is 2.4 kJ.

[2]

- (ii) The man does 5.0 kJ of work to pull the truck full of sand up the slope and onto the platform.

This work done is much greater than the increase in gravitational potential energy from (c)(i).

Suggest reasons for this difference.

.....

.....

.....

..... [2]

[Total: 11]

4 Fig. 4.1 is a cross-sectional diagram of a leaf.

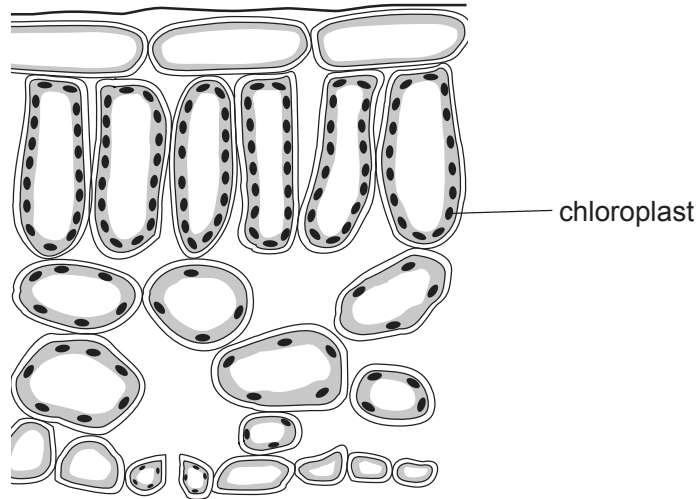


Fig. 4.1

- (a) (i) On Fig. 4.1, use a label line and the letter **P** to show a cell in the **lower epidermis** where photosynthesis takes place. [1]

- (ii) Explain your answer to (i).

.....
 [1]

- (b) Explain why the rate of transpiration increases when the temperature of the environment increases.

.....

 [3]

(c) In a garden, snails feed on the leaves of trees. Thrushes feed on the snails, and hawks eat the thrushes.

(i) Construct the food chain for these organisms.

[2]

(ii) Identify the primary consumer in this food chain.

Give a reason for your answer.

name of primary consumer

reason

[2]

(iii) State **two** ways that energy is lost between the trophic levels in the food chain.

1

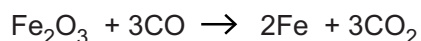
2

[2]

[Total: 11]

- 5 (a) Iron is extracted from iron oxide in a blast furnace.

One of the reactions occurring in the blast furnace is shown.



Name the oxidising agent in this reaction.

..... [1]

- (b) Iron is a transition element. Aluminium is **not** a transition element.

Describe **one** property of iron that is **not** a property of aluminium.

.....
 [1]

- (c) Aluminium is obtained by the electrolysis of molten aluminium oxide.

- (i) Explain why aluminium oxide must be molten during electrolysis.

.....
 [1]

- (ii) Aluminium oxide contains aluminium ions, Al^{3+} , and oxide ions, O^{2-} .

Deduce the formula of aluminium oxide.

formula [1]

- (iii) The melting point of aluminium oxide is 2072°C . The melting point of methane is -182°C .

Explain the difference in these melting points.

Use ideas about types of bonds and attractive forces in your answer.

.....

 [3]

(d) Aluminium is an element in Period 3 of the Periodic Table.

Describe the relationship between the number of outer shell electrons and the metallic character of the elements across a period.

.....

..... [1]

[Total: 8]

- 6 Fig. 6.1 shows a device called a 'solar still'. A solar still is used to produce fresh water from sea water.

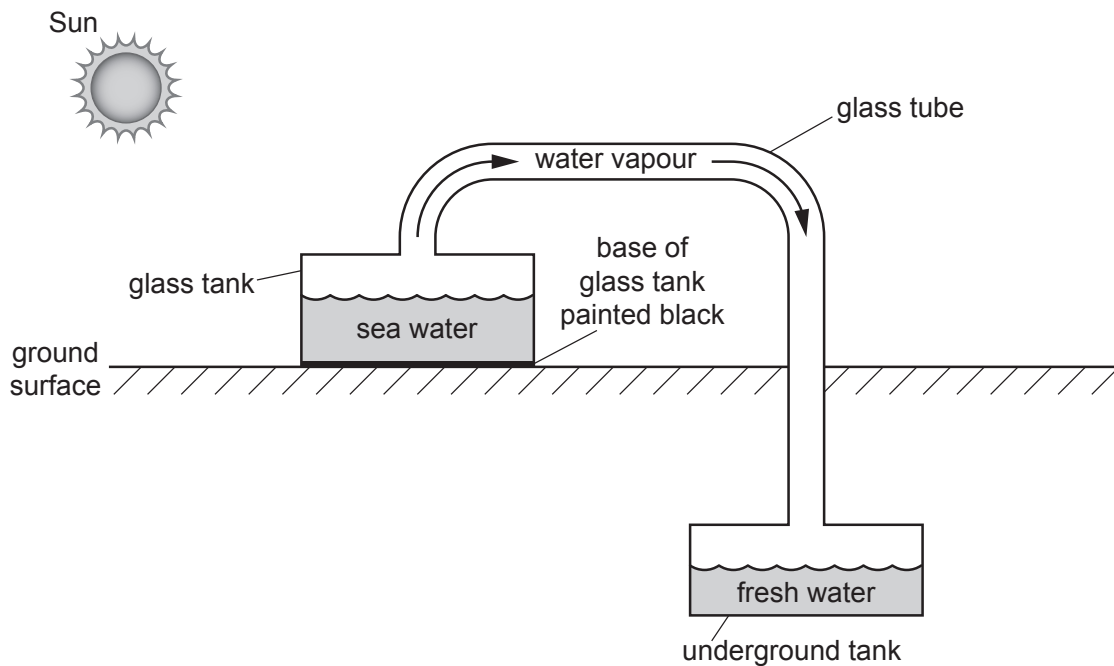


Fig. 6.1

Sea water is added to a glass tank. The glass tank is in full sunlight.

Water evaporates in the glass tank. The water vapour travels through a glass tube to an underground tank where it cools.

Fresh water condenses and collects in the underground tank.

(a) (i) Describe how the following change as liquid water evaporates into water vapour.

- the forces between the water molecules
- the distances between the water molecules
- the motion of the water molecules

.....

.....

.....

.....

.....

..... [3]

(ii) The bottom of the glass tank is painted black.

Describe how this helps to increase the rate of evaporation of the water in the glass tank.

.....

.....

.....

..... [2]

(iii) Explain why the temperature of the sea water remaining in the glass tank decreases as a result of the evaporation.

.....

.....

.....

..... [2]

(b) Energy from the Sun is used to heat the sea water.

State the method of energy transfer from the Sun to the Earth.

..... [1]

[Total: 8]

- 7 (a) Fig. 7.1 is a diagram of a cross-section through an artery.

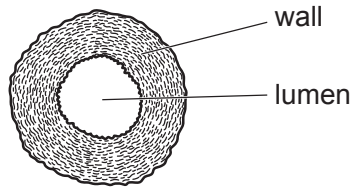


Fig. 7.1

Explain **two** ways the structure of the artery is adapted for its function.

- 1
-
- 2
-
- [2]

- (b) Describe how the structure of capillaries allows efficient exchange of materials.

-
- [1]

(c) Fig. 7.2 shows a diagram of the internal structure of the heart.

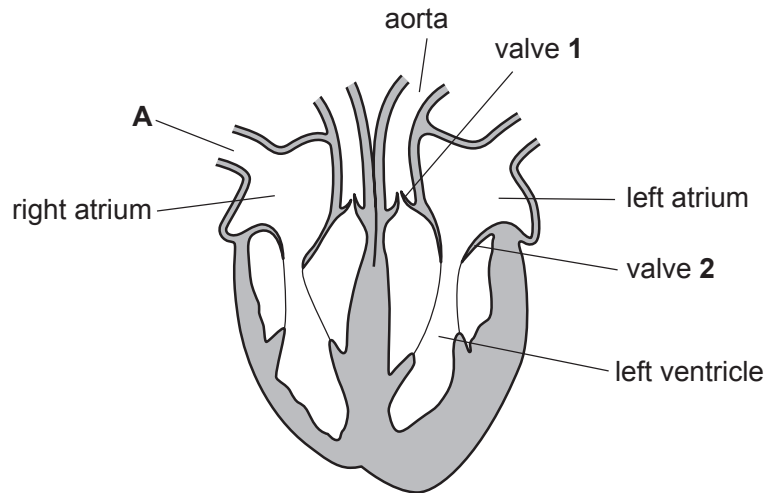


Fig. 7.2

- (i) Blood from the body enters the right atrium through blood vessel **A**.

State the name of blood vessel **A**.

..... [1]

- (ii) Blood is forced through the aorta by contraction of the muscle in the wall of the left ventricle.

Describe the action of valves **1** and **2** in Fig. 7.2 during this contraction.

valve **1**

valve **2** [1]

- (d) Describe the function of valves in veins.

.....
 [1]

[Total: 6]

- 8 When 1 g of copper carbonate **powder** is added to excess dilute hydrochloric acid, aqueous copper chloride and carbon dioxide gas are produced.

Fig. 8.1 shows a graph of the mass of the reaction mixture against time.

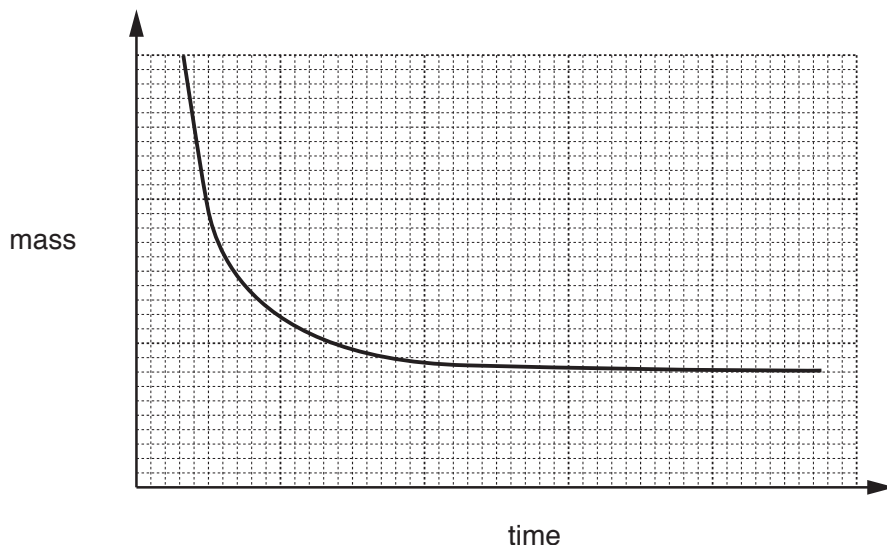


Fig. 8.1

- (a) The experiment is repeated using a 1 g **lump** of copper carbonate instead of powder.

On Fig. 8.1, sketch a line to show the graph of the mass of the reaction mixture against time for this experiment. [2]

- (b) The carbon dioxide produced is released into the atmosphere.

State why scientists are concerned about an increase in the concentration of carbon dioxide in the atmosphere.

.....
 [1]

- (c) Copper(II) ions, Cu^{2+} , in the aqueous copper chloride can be identified by chromatography.

The R_f value for copper(II) ions is 0.4.

Describe how a chromatogram can be used to show that a solution contains copper(II) ions.

.....

 [3]

- (d) During the electrolysis of aqueous copper(II) chloride, copper forms at the cathode.

Describe how copper forms at the cathode. Use ideas about ions and electrons in your answer.

.....

.....

..... [2]

[Total: 8]

- 9 Fig. 9.1 shows a circuit containing a 6.0V battery, an electric bell, two identical switches **S1** and **S2**, and two identical lamps **L1** and **L2**. Both switches are open.

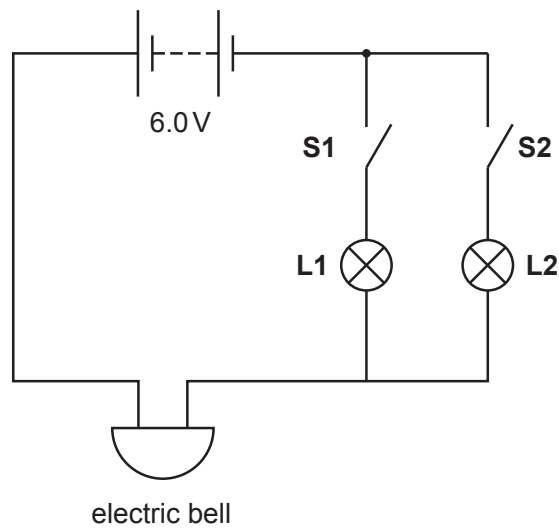


Fig. 9.1

- (a) The resistance of each lamp is 4.0Ω .
- (i) When switch **S1** is closed, lamp **L1** lights, and the bell rings.
- The current in the bell is 0.9 A .
- Show that the resistance of the bell is 2.7Ω .

[3]

- (ii) When both switches **S1** and **S2** are closed at the same time, both lamps **L1** and **L2** light, and the bell rings.

Calculate the current in the bell when both switches are closed.

current = ... A [3]

- (b) The lamps in Fig. 9.1 are connected in parallel.

State **two** advantages of connecting lamps in parallel in a circuit.

1

2

[2]

[Total: 8]

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The Periodic Table of Elements

Group																							
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII						
		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																	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 –	209	–	–	–					



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/43

October/November 2020

1 hour 15 minutes

No additional materials are needed.

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **24** pages. Blank pages are indicated.

- 1 (a) Fig. 1.1 shows red blood cells and white blood cells.

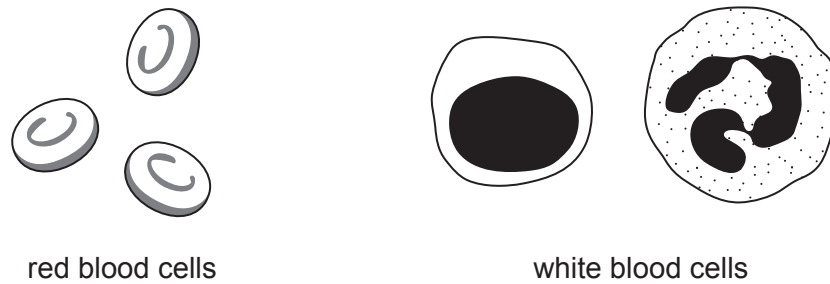


Fig. 1.1

- (i) Describe how the structure of a red blood cell is adapted for transporting oxygen.

.....
 [1]

- (ii) State **two** functions of white blood cells.

1
 2 [2]

- (b) Fig. 1.2 is a flowchart to show the circulation of blood in humans.

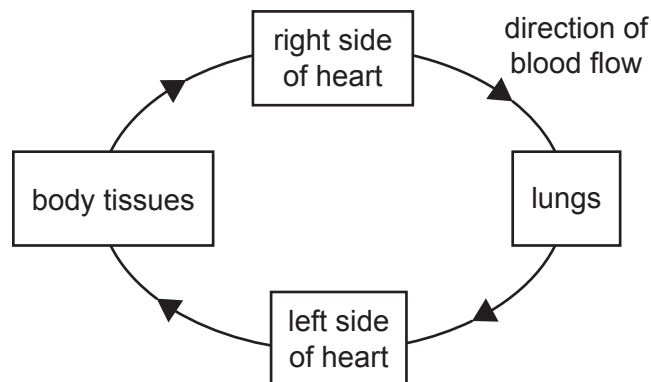


Fig. 1.2

- (i) Explain why the circulation in Fig. 1.2 is described as a *double circulation*.

.....
 [1]

- (ii) Describe **two** advantages of a double circulation.

1

 2
 [2]

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

Describe how these two increases cause an increase in the amount of oxygen reaching the exercising muscles.

increase in breathing rate

.....

.....

increase in heart rate

.....

.....

[2]

- (d) Smoking tobacco can cause cancer.

Name **two** other diseases caused by smoking tobacco.

1

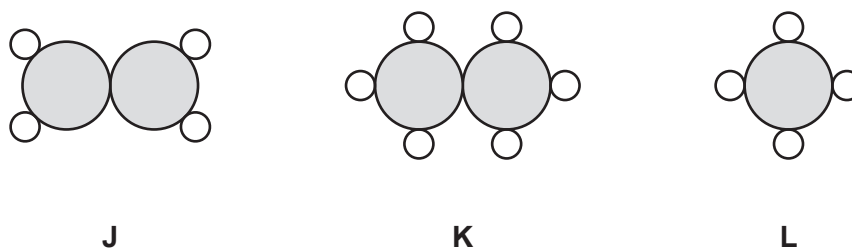
2

[2]

[Total: 10]

2 Compounds **J**, **K** and **L** are hydrocarbons.

The structures of one molecule of compounds **J**, **K** and **L** are shown in Fig. 2.1.



Key:

○ hydrogen

● carbon

Fig. 2.1

(a) State which compound, **J**, **K** or **L**, is ethene.

Explain your answer.

compound

explanation

.....

..... [1]

(b) Ethene is made by cracking gas oil.

(i) Describe what is meant by *cracking*.

.....

..... [1]

(ii) State **one** condition required for cracking.

..... [1]

- (c) Draw a dot-and-cross diagram of the molecule of compound **K**.

Show the outer shell electrons only.

[2]

- (d) In the presence of a catalyst, one molecule of compound **L** reacts with one molecule of steam to produce carbon monoxide and hydrogen.

Construct the balanced symbol equation for this reaction.

..... [2]

- (e) State **two** compounds that are produced during the complete combustion of compound **K**.

1

2

[2]

[Total: 9]

- 3 Fig. 3.1 shows a climber using a safety rope to climb a rock face.

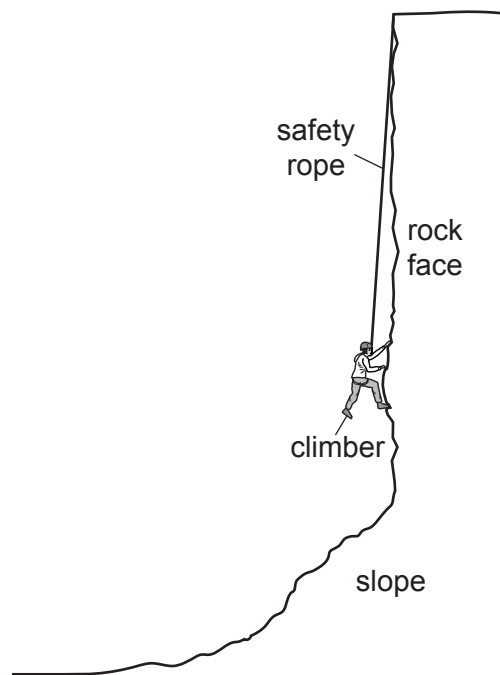


Fig. 3.1

- (a) The climber has a weight of 820 N.

The gravitational field strength g is 10 N/kg.

- (i) Calculate the mass of the climber.

mass = ... kg [1]

- (ii) The climber moves a vertical distance of 12 m up the rock face.

Calculate the change in gravitational potential energy (G.P.E.) of the climber.

change in G.P.E. = ... J [2]

- (b) A small piece of rock falls from the rock face, lands on the slope below and rolls to a stop.

Fig. 3.2 shows the speed–time graph for the piece of rock.

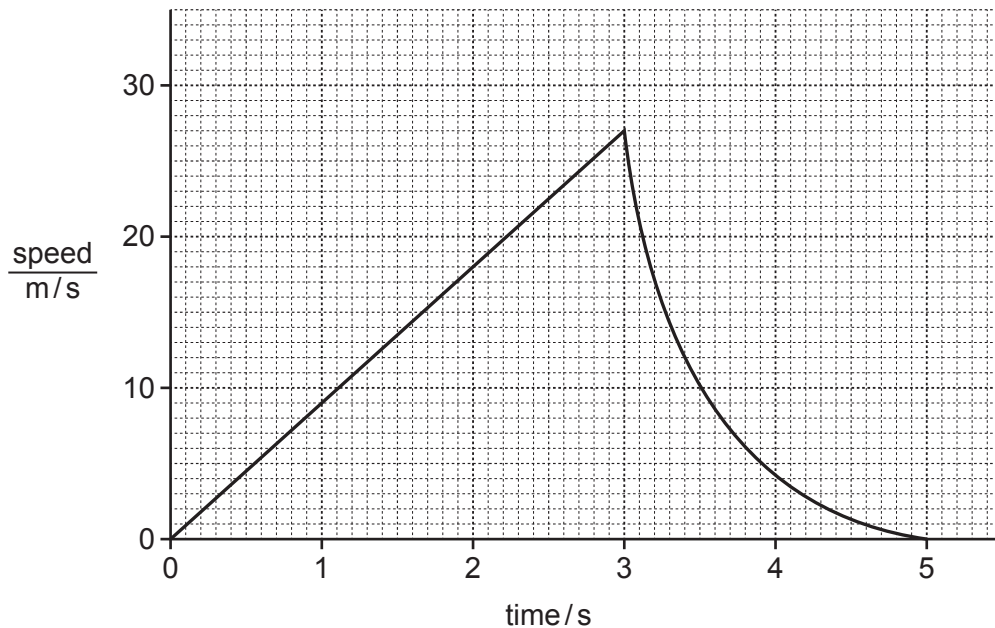


Fig. 3.2

- (i) Use Fig. 3.2 to calculate the initial acceleration of the piece of rock.

Give the units of your answer.

acceleration = ... units [3]

- (ii) On Fig. 3.2, draw an **X** on the graph to show when the piece of rock lands on the slope. [1]

- (iii) Describe the motion of the piece of rock between 3.0 s and 5.0 s.

.....
 [1]

- (c) A scientist investigates the extension of the safety rope.

The scientist tests the safety rope with a load of 820 N (Test 1) and with a load of 898 N (Test 2).

Fig. 3.3 shows the test results.

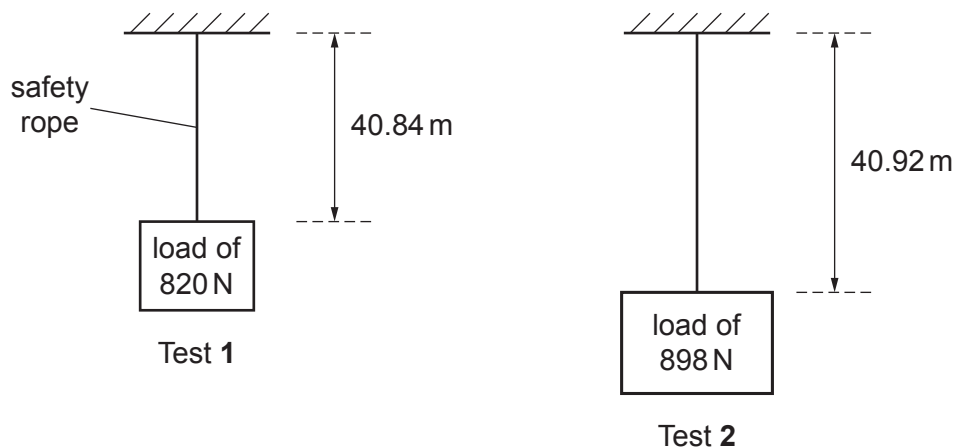


Fig. 3.3 (not to scale)

The scientist uses a safety rope with an original length of 40.00 m.

- (i) Determine the extension of the safety rope in Test 1.

extension = ... m [1]

- (ii) Use Fig. 3.3 to show that the safety rope obeys Hooke's Law in Test 1 and Test 2.

.....

 [2]

[Total: 11]

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4 A balanced diet contains all the nutrients in the correct proportions to meet a person's need.

(a) Explain why a pregnant woman should increase her intake of vitamin D.

.....

.....

.....

..... [2]

(b) (i) State **one** symptom of a person who suffers from a deficiency of iron in the diet.

..... [1]

(ii) State **one** food that is a good source of iron.

..... [1]

(c) Fig. 4.1 shows the percentage of the adult population with obesity in different countries in 2000 and in 2016.

Key

■ 2000 ■ 2016

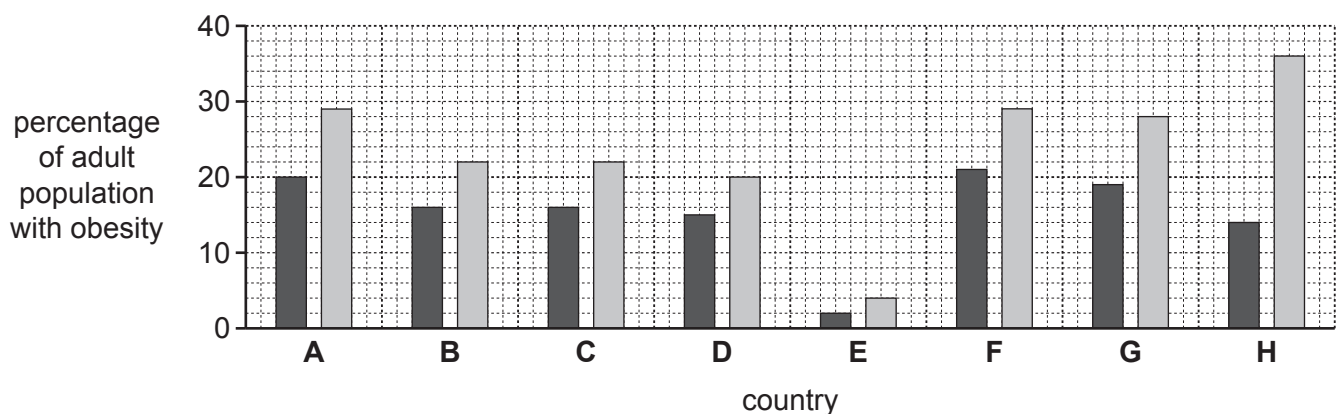


Fig. 4.1

(i) State how obesity is an example of **not** eating a balanced diet.

.....

..... [1]

(ii) State the letter of the country with the greatest increase in the percentage of adults with obesity from 2010 to 2016.

country = ... [1]

(d) Fig. 4.2 is a diagram of part of the alimentary canal.

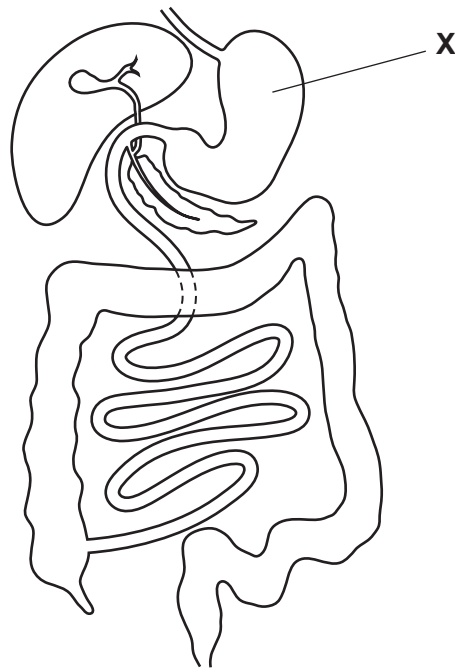


Fig. 4.2

(i) State the pH conditions inside organ X.

..... [1]

(ii) Describe how these conditions aid digestion.

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

[Total: 8]

- 5 (a) Magnesium is an element in Group II and Period 3 of the Periodic Table.

The Periodic Table is shown on p24.

The nucleon number of an atom of magnesium is 24.

- (i) Deduce the number of neutrons and the number of protons in the nucleus of a magnesium atom.

number of neutrons = ...

number of protons = ... [2]

- (ii) Describe the relationship between the number of outer shell electrons and the metallic character of elements across a period.

.....
 [1]

- (b) Magnesium chloride contains magnesium ions, Mg^{2+} , and chloride ions, Cl^- .

Deduce the formula of magnesium chloride.

formula = ... [1]

- (c) Magnesium is produced by the electrolysis of molten magnesium chloride.

- (i) Explain why magnesium chloride must be molten and not solid for electrolysis.

.....

 [2]

- (ii) Describe what happens to a magnesium ion, Mg^{2+} , at the cathode during electrolysis.

Use ideas about electrons in your answer.

.....

 [2]

- (d) Magnesium chloride is made in the reaction between magnesium and dilute hydrochloric acid. The temperature of the reaction mixture increases.

This reaction is exothermic because it releases thermal energy.

Explain why this reaction releases thermal energy.

Use ideas about bond breaking and bond forming in your answer.

.....

.....

..... [2]

[Total: 10]

- 6 Fig. 6.1 shows a space telescope for detecting gamma radiation from distant stars.

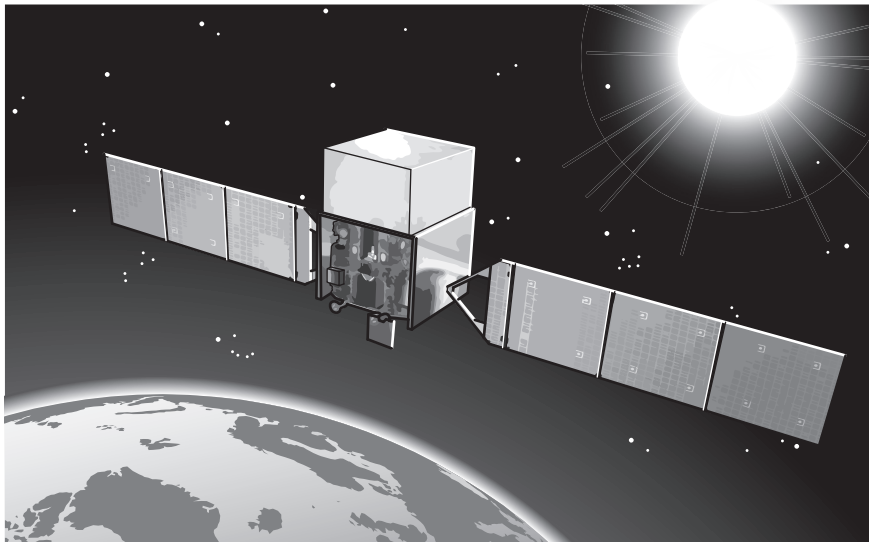


Fig. 6.1

- (a) Fig 6.2 shows the position of gamma radiation in the electromagnetic spectrum.

On Fig 6.2, write

- a tick (✓) underneath the radiation with the lowest frequency
- a cross (X) underneath the radiation that causes sunburn.

gamma radiation	X-rays	ultraviolet	visible light	infra-red	microwaves	radio waves

Fig. 6.2

[2]

- (b) A star that emits gamma radiation is billions of kilometres away from Earth.

- (i) The gamma radiation received by the space telescope today gives astronomers information about the star as it was in the past.

Explain why it does **not** give astronomers information about the star as it is today.

.....
 [1]

- (ii) The astronomer measures the wavelength of the gamma radiation received.

The wavelength of the gamma radiation is $2.0 \times 10^{-14} \text{ m}$.

The speed of the gamma radiation is $3.0 \times 10^8 \text{ m/s}$.

Calculate the frequency of the gamma radiation.

frequency = ... Hz [2]

- (c) Fig. 6.3 shows three penguins on a clear, sunny day.

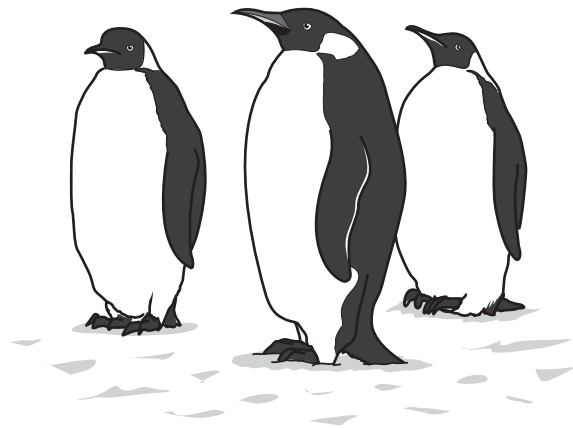


Fig. 6.3

Radiation from the Sun heats some parts of the penguins' bodies more than other parts.

- (i) Name the electromagnetic radiation from the Sun that is mainly responsible for this heating effect.

..... [1]

- (ii) Suggest which parts of the penguins' bodies are heated more than other parts.

Give a reason for your answer.

.....

 [1]

[Total: 7]

- 7 Fig. 7.1 shows a mistletoe plant growing on a tree branch. The mistletoe plant is attached to the branch by structures that grow deep into the wood.

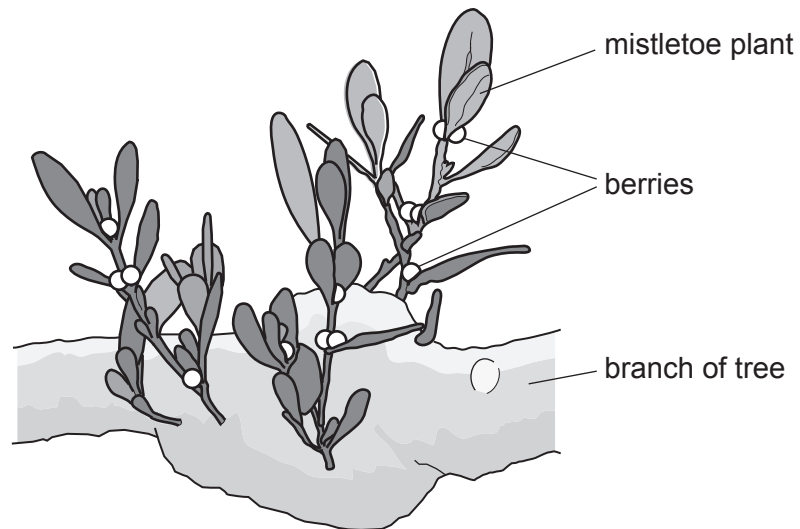


Fig. 7.1

- (a) (i) The mistletoe obtains water and mineral ions from inside the branch.

State the part of a flowering plant that has this function.

..... [1]

- (ii) Name the mineral ion that the mistletoe must absorb to make chlorophyll.

..... [1]

- (iii) Explain how a deficiency of the mineral needed to make chlorophyll affects the mistletoe plant.

.....

.....

.....

.....

.....

..... [3]

- (b) Small birds such as thrushes feed on the berries of the mistletoe plant.

Cats feed on thrushes. Hawks feed on cats and thrushes.

- (i) Construct **one** complete food chain using this information.

..... [2]

- (ii) Explain why the hawks can be described as secondary consumers **and** tertiary consumers.

.....

.....

.....

..... [2]

[Total: 9]

- 8 (a) Copper chloride is made when copper oxide reacts with dilute hydrochloric acid.

The equation for the reaction is shown.



Explain why warm hydrochloric acid reacts faster than cold hydrochloric acid.

Use ideas about particles and collisions in your answer.

.....

.....

.....

..... [2]

- (b) Copper is a transition element.

Describe **one** property of copper that is **not** a property of Group I metals.

.....

..... [1]

- (c) Chlorine gas is made by the electrolysis of aqueous copper chloride.

- (i) Damp litmus paper is used to test for chlorine.

State the positive result.

..... [1]

- (ii) Explain why chlorine is used in the treatment of water supplies.

.....

..... [1]

(d) Copper ions, Cu^{2+} , can be detected using chromatography.

Fig. 8.1 shows a chromatogram of a solution containing copper ions.

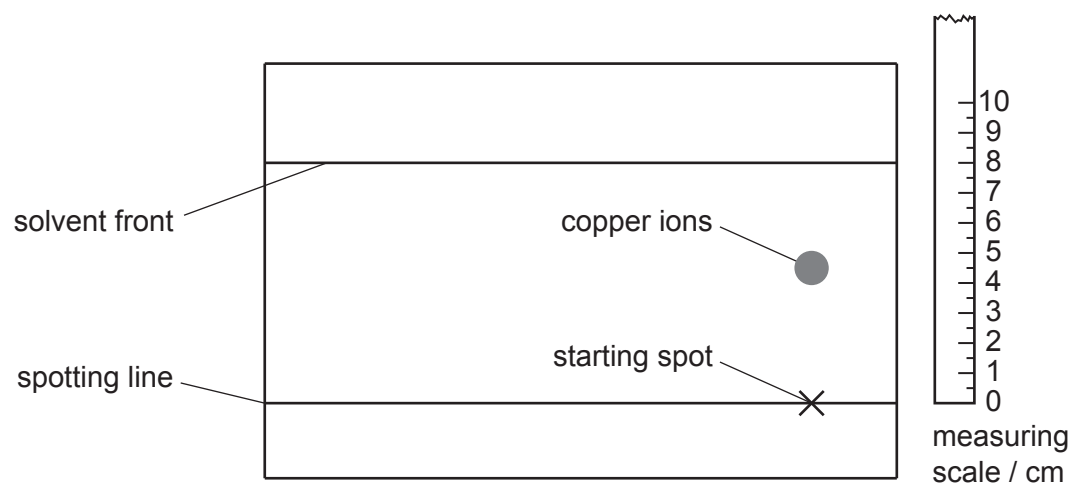


Fig. 8.1

Use the measuring scale in Fig. 8.1 to calculate the R_f value for the copper ions.

R_f value = ... [2]

[Total: 7]

- 9 Fig. 9.1 shows an extractor fan in the wall of a bathroom. The extractor fan is used to remove damp (wet) air from the bathroom.

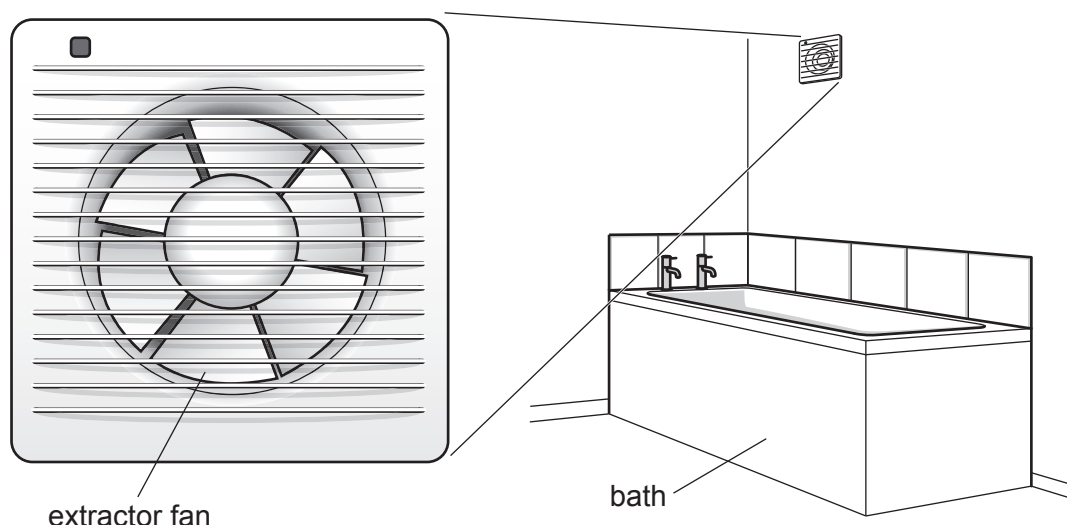


Fig. 9.1

(a) Compare a gas to a liquid in terms of:

- the distances between the molecules
- the forces between the molecules
- the motion of the molecules.

.....

.....

.....

.....

.....

..... [3]

(b) Hot water at the surface of the bath evaporates into water vapour. This makes the air in the bathroom damp.

Suggest how using the fan to extract damp air from the bathroom affects the evaporation of water from the bath.

Give a reason for your answer.

.....

.....

..... [2]

- (c) The bathroom light and the electric motor for the extractor fan are controlled by a single switch. A fuse protects the circuit.

Fig. 9.2 shows the circuit diagram.

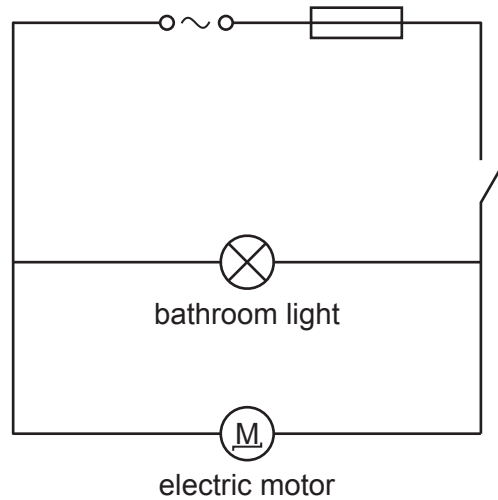


Fig. 9.2

The electric motor for the extractor fan has a power rating of 12 W. The current in the motor is 0.080 A.

- (i) Calculate the potential difference across the motor.

potential difference = ... V [2]

- (ii) The power rating of the bathroom light is 18 W.

The fuse in the circuit needs replacing.

Show that a fuse rated at 0.5 A is a suitable replacement.

.....
 [2]

[Total: 9]

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Group																	
I	II	1 H hydrogen 1					III	IV	V	VI	VII	VIII					
		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 —	117 Ts tennessine —	118 Og oganesson —	119 Uue ununennium —	120 Uuh ununium —

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	euporium	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
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	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	—