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COMBINED SCIENCE **0653/43**

Paper 4 Theory (Extended) **May/June 2022**

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 **24** pages. Any blank pages are indicated.

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1 **(a)** Fig. 1.1 is a diagram of the alimentary canal and associated organs in humans.

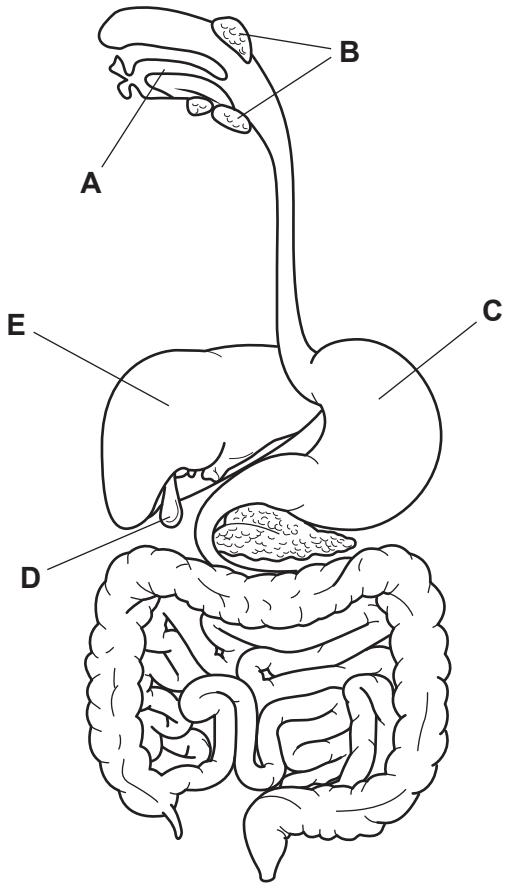

Fig. 1.1

(i) Table 1.1 shows some of the parts labelled in Fig. 1.1 and their function.

Complete Table 1.1.

Table 1.1

letter	function
.....	digests food and uses hydrochloric acid to kill bacteria
.....	ingestion
B	secretes the enzyme .....

[3]

(ii) Draw a label line and the letter **L** to identify the position of the large intestine on Fig. 1.1.
[1]

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(b) Describe the function of protease in the alimentary canal.

.....

.....

..... [2]

(c) Digested food is absorbed into the blood and transported through arteries and veins.

Describe **two** ways the structure of an artery is different to the structure of a vein.

1 .....

.....

2 .....

.....

[2]

(d) Complete these sentences about coronary heart disease.

Coronary heart disease is caused by a ..... in the coronary artery.

Possible risk factors of coronary heart disease include poor diet, smoking and

..... predisposition.

[2]

[Total: 10]

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2 Sodium, potassium and rubidium are elements in Group I of the Periodic Table.

Table 2.1 shows some information about these elements.

Table 2.1

element	melting point / °C	reaction with water
sodium	98	reacts very quickly to produce hydrogen and an alkaline solution
potassium		reacts violently to produce hydrogen and an alkaline solution
rubidium	39	reacts explosively to produce hydrogen and an alkaline solution

(a) Predict a value for the melting point of potassium.

..... °C [1]

(b) Lithium is another element in Group I.

Predict the reaction of lithium with water.

.....

..... [1]

(c) A piece of sodium is added to water that contains universal indicator.

(i) Predict the colour change of the universal indicator during the reaction.

from ..... to ..... [1]

(ii) State the name of the product of the reaction between sodium and water that causes this colour change.

..... [1]

(d) **(i)** Explain why sodium, potassium and rubidium are all in Group I of the Periodic Table.

Use ideas about the arrangement of electrons in your answer.

.....

..... [1]

(ii) Explain why potassium is below sodium in Group I.

Use ideas about the arrangement of electrons in your answer.

.....

..... [1]

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(e) Iron is a transition element.

(i) Use the word **higher** or **lower** to complete each sentence about the properties of iron and sodium.

The melting point of iron is ..... than that of sodium.

The density of iron is ..... than that of sodium.

The reactivity of iron is ..... than that of sodium.

[1]

(ii) Barrier methods are used to prevent iron from rusting.

State **one** barrier method and explain how it prevents rusting.

method .....

explanation .....

.....

[1]

[Total: 8]

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3 **(a)** Fig. 3.1 shows a man standing still and holding a bucket filled with water.

The weight of the bucket of water is 75.0 N.

Fig. 3.1

(i) Calculate the mass of the bucket of water.

The gravitational force on unit mass is 10 N / kg.

mass = ... kg [2]

(ii) The man lowers the bucket of water to the ground from a height of 1.2 m.

Calculate the loss in gravitational potential energy of the bucket of water.

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

(iii) The area of the base of the bucket is 400 cm^2.

Calculate the pressure in pascals (Pa) of the bucket on the ground.

pressure = ... Pa [3]

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(b) Fig. 3.2 shows two buckets, **A** and **B**, of identical size and shape.

Bucket **A** is made of shiny metal. Bucket **B** is made of dull black plastic.

Each bucket is filled with hot water and covered by a lid.

The buckets are placed on the ground to cool.

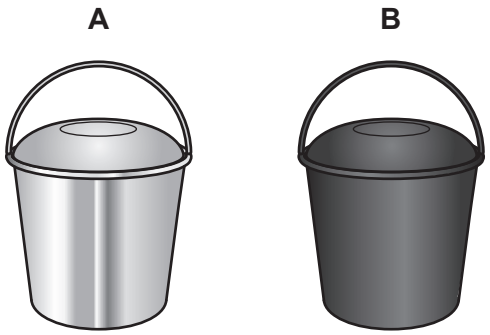

Fig. 3.2

Thermal energy leaves the buckets by **conduction** and **radiation**.

Suggest, with a reason, which one of these processes:

will cool bucket **A** more effectively .....

reason .....

.....

will cool bucket **B** more effectively. .....

reason .....

.....

[2]

[Total: 9]

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4 **(a)** Fig. 4.1 is a diagram of the gas exchange system in humans.

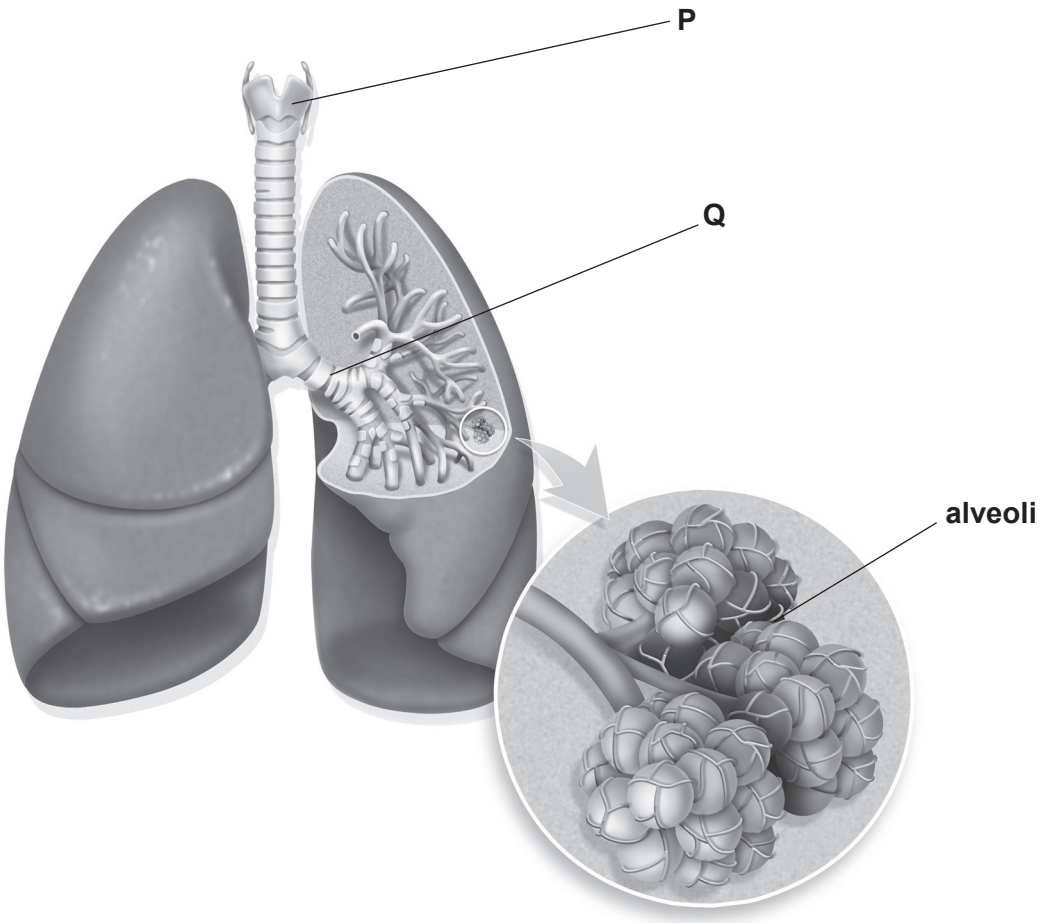

Fig. 4.1

(i) Name the parts labelled **P** and **Q** in Fig. 4.1.

P .....

Q .....

[2]

(ii) The alveoli are the gas exchange surface in humans.

List **two** features of a gas exchange surface.

1 .....

2 .....

[2]

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(b) Fig. 4.2 shows how the volume of oxygen taken in and used by an athlete changes during and after physical exercise.

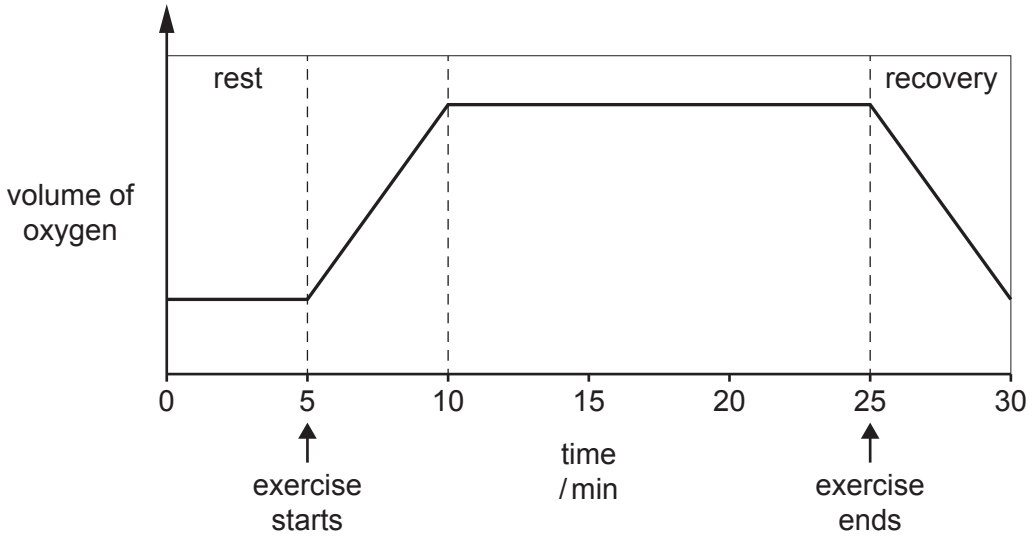

Fig. 4.2

(i) Explain the results between **5 and 10 minutes** in Fig. 4.2.

.....

.....

.....

.....

..... [3]

(ii) Describe **two** ways the athlete's breathing changes between **25 and 30 minutes** in Fig. 4.2.

1 .....

.....

2 .....

.....

[2]

(c) Tobacco smoke also affects breathing.

State the toxic component of tobacco smoke that causes addiction.

..... [1]

[Total: 10]

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5 The structure of a molecule of ethene is shown in Fig. 5.1.

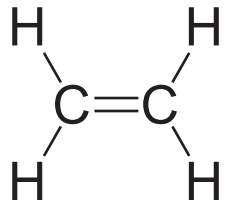

Fig. 5.1

(a) State how Fig. 5.1 shows that ethene is an alkene.

..... [1]

(b) Ethene is made from naphtha in an industrial process.

Name this process.

..... [1]

(c) Ethene undergoes a polymerisation reaction.

(i) State the name of the polymer formed.

..... [1]

(ii) State the type of polymerisation reaction that happens when ethene forms a polymer.

..... [1]

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(d) A student investigates the combustion of ethene.

A cold surface is held near burning ethene. Drops of colourless liquid collect on the cold surface, as shown in Fig. 5.2.

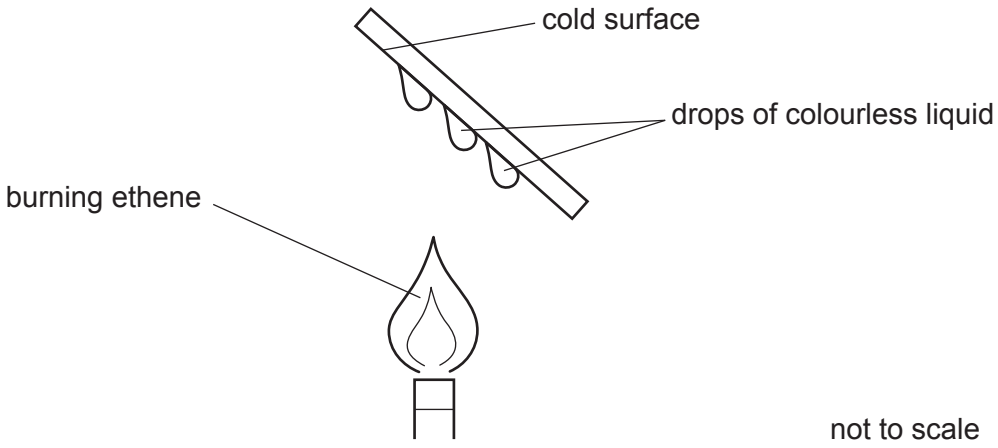

Fig. 5.2

(i) The student does a test which shows that the colourless liquid contains water.

Describe a chemical test for water.

State the colour change observed.

test .....

colour change

from ..... to .....
[2]

(ii) During combustion, water forms as a gas.

State the change that occurs when the gas collects as a liquid on the cold surface in Fig. 5.2.

.....

..... [1]

(iii) State the name of the **other** product formed during the complete combustion of ethene.

..... [1]

[Total: 8]

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6 A glacier is a very large area of ice that moves slowly down a slope or valley.

Fig. 6.1 shows a glacier as it flows into a lake.

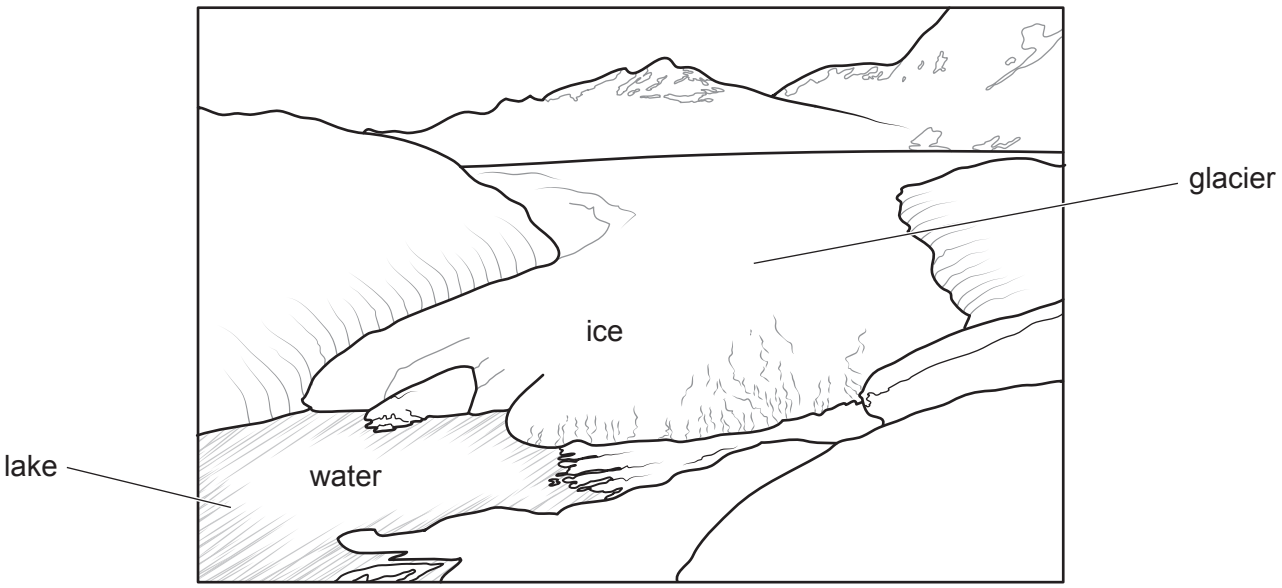

Fig. 6.1

(a) At the end of the glacier, the ice in contact with water is melting.

The temperature of the water is 4 °C.

(i) State the temperature of the melting ice.

temperature = ... °C [1]

(ii) Complete the sentences using words from the list.

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

chemical **electrical** **potential** **power**

pressure **resistance** **temperature** **thermal**

The ice melts because ..... energy is transferred from the water to the ice. This causes the ..... of the water to decrease. [2]

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(b) Ice is a solid. Water is a liquid.

Describe the differences between a solid and a liquid in terms of:

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

.....

.....

.....

..... [2]

(c) A scientist standing on the glacier sees a large rock fall onto the glacier 1900 m away.

The rock makes a loud sound as it hits the glacier.

(i) Show that the time for the sound to travel 1900 m through air to the scientist is 5.8 s.

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

[1]

(ii) Use data to explain why the scientist sees the rock fall onto the glacier before she hears the sound.

.....

.....

..... [2]

(iii) The scientist actually hears the sound of the rock falling onto the glacier just 0.49 s after seeing the rock fall.

Suggest why this time is less than the time in **(c)(i)**.

.....

.....

..... [2]

[Total: 10]

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7 Fig. 7.1 shows a food chain from a pond.

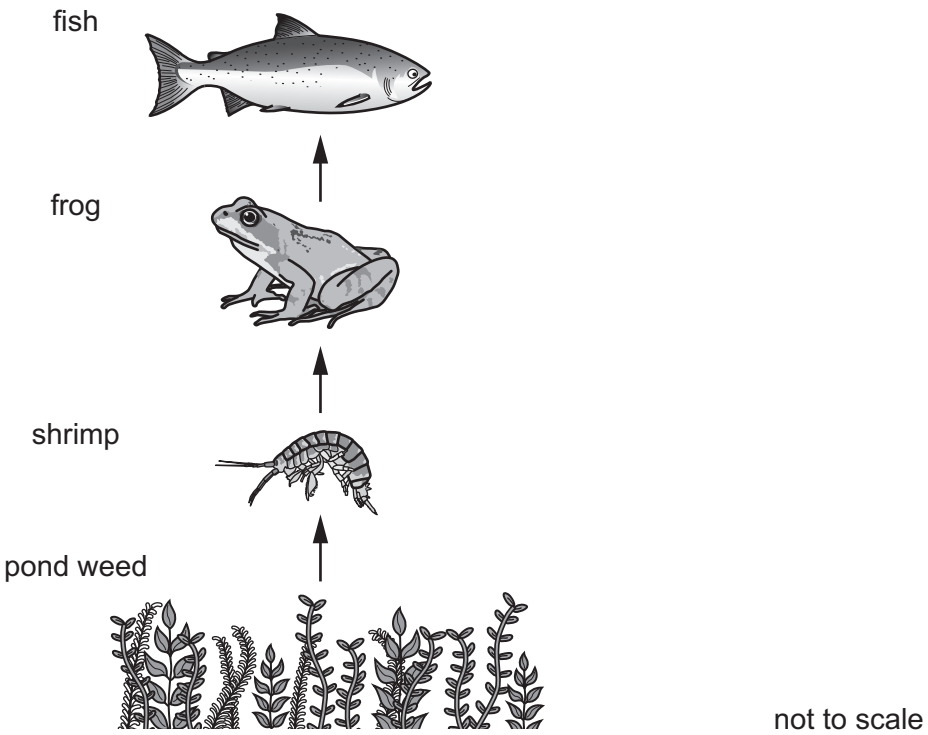

Fig. 7.1

(a) Identify the organism at the second trophic level in Fig. 7.1.

..... [1]

(b) Sewage containing high levels of nitrate gets into the pond.

Explain why a high concentration of nitrate in the pond may result in the death of animals in the food chain.

.....

.....

.....

.....

.....

..... [4]

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(c) Sewage damages the ecosystem.

Increasing carbon dioxide concentration in the atmosphere also damages ecosystems.

Explain why planting more trees reduces the carbon dioxide concentration in the atmosphere.

.....

.....

..... [2]

[Total: 7]

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8 Calcium carbonate reacts with dilute hydrochloric acid to produce a gas.

(a) Name the gas produced in this reaction.

..... [1]

(b) The reaction also produces calcium chloride.

Calcium chloride contains calcium ions, Ca^{2+}, and chloride ions, Cl^{-}.

Deduce the formula for calcium chloride.

..... [1]

(c) In an investigation, 5 g of calcium carbonate reacts with 20 cm^3 of dilute hydrochloric acid, as shown in Fig. 8.1.

The volume of gas collected during the first 10 s is measured.

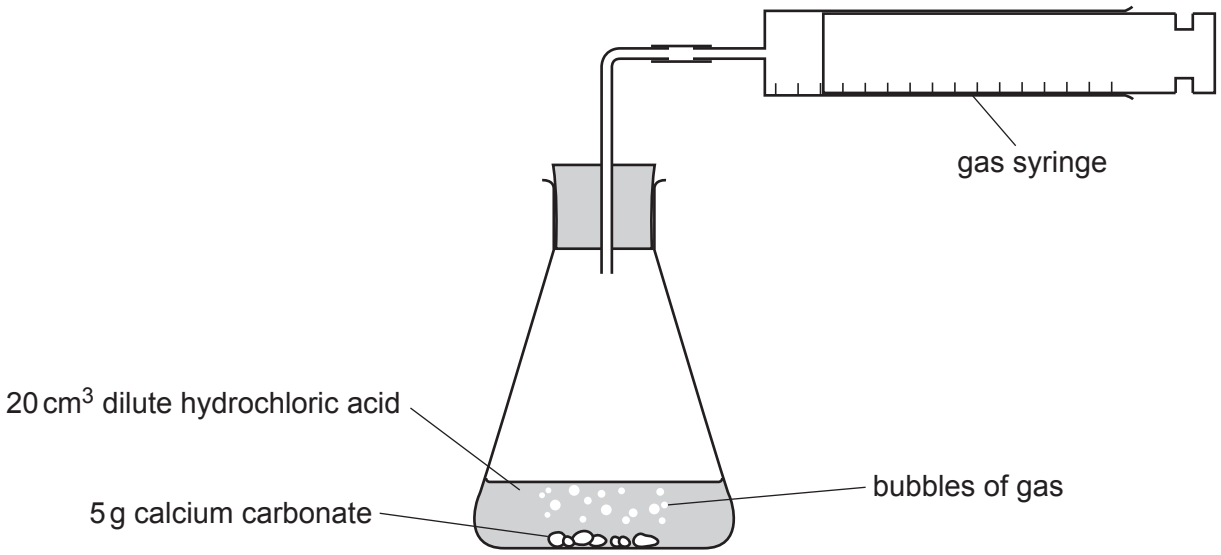

Fig. 8.1

The experiment is repeated using the same mass of calcium carbonate and the same volume of dilute acid.

Different concentrations of dilute acid and different temperatures are used.

The results are shown in Table 8.1.

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Table 8.1

experiment	concentration of dilute hydrochloric acid mol / dm^3	temperature / °C	volume of gas collected during the first 10 s / cm^3
1	1.0	20	25
2	2.0	20	43
3	0.5	10	9
4	0.5	20	14
5	1.0	30	37

(i) State the effect of increasing the temperature on the rate of a reaction.

.....

..... [1]

(ii) Identify **two** experiments from Table 8.1 that can be used to show the effect of increasing the temperature on the rate of the reaction.

Explain the reason for your choices.

experiment ..... and experiment .....

explanation .....

.....

[2]

(iii) Explain why the results for **experiment 1** and **experiment 4** are different.

Use ideas about collisions between reacting particles in your answer.

.....

.....

.....

..... [3]

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(d) The energy level diagram for the reaction between calcium carbonate and dilute hydrochloric acid is shown in Fig. 8.2.

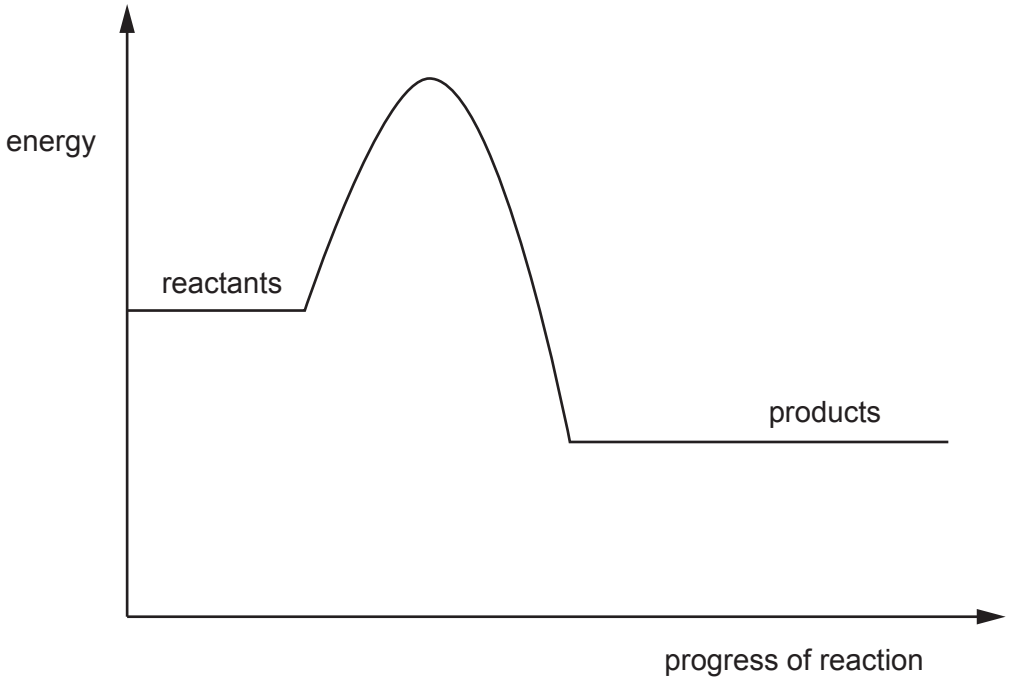

Fig. 8.2

(i) Draw an arrow on Fig. 8.2 to show the activation energy for the reaction.

Label this arrow **A**. [1]

(ii) Draw an arrow on Fig. 8.2 to show the energy change of this reaction.

Label this arrow **B**. [1]

[Total: 10]

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9 Fig. 9.1 shows a traffic light.

The traffic light has three different-coloured lamps, red, yellow and green.

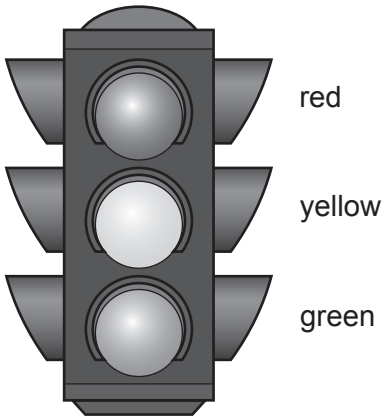

Fig. 9.1

(a) (i) Red, yellow and green are all types of visible light.

Fig. 9.2 shows an incomplete electromagnetic spectrum.

On Fig. 9.2, write visible light in the correct position.

← increasing frequency						
gamma radiation					microwaves	radio waves

Fig. 9.2 [1]

(ii) The frequency of the visible red light is 4.58×10^{14} Hz.

Calculate the wavelength of the visible red light.

wavelength = ... m [2]

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(b) Fig. 9.3 shows the circuit diagram for the traffic light.

The voltage of the a.c. power supply is 110 V.

Each lamp has a power rating of 60 W.

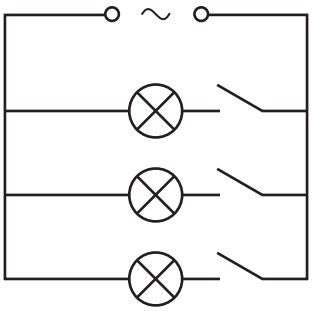

Fig. 9.3

(i) The red lamp is switched on.

Calculate the current in the red lamp.

current = ... A [2]

(ii) The red lamp and the yellow lamp are switched on at the same time. The green lamp is still switched off.

Calculate the current from the a.c. power supply at this time.

current = ... A [1]

(iii) One advantage of connecting the three lamps in parallel is that each lamp gets the full supply voltage across it.

Suggest **two** other advantages of connecting the three lamps in parallel.

1 .....

.....

2 .....

.....

[2]

[Total: 8]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

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.).