Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CO-ORDINATED SCIENCES **0654/42**

Paper 4 Theory (Extended) **October/November 2024**

2 hours

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 120.
- 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.

DC (WW/CT) 337874/3

[Turn over

1 **(a)** The circulatory system in horses is similar to in humans.

Fig. 1.1 is a simplified diagram of the circulatory system in horses.

The arrows represent the direction of blood flow.

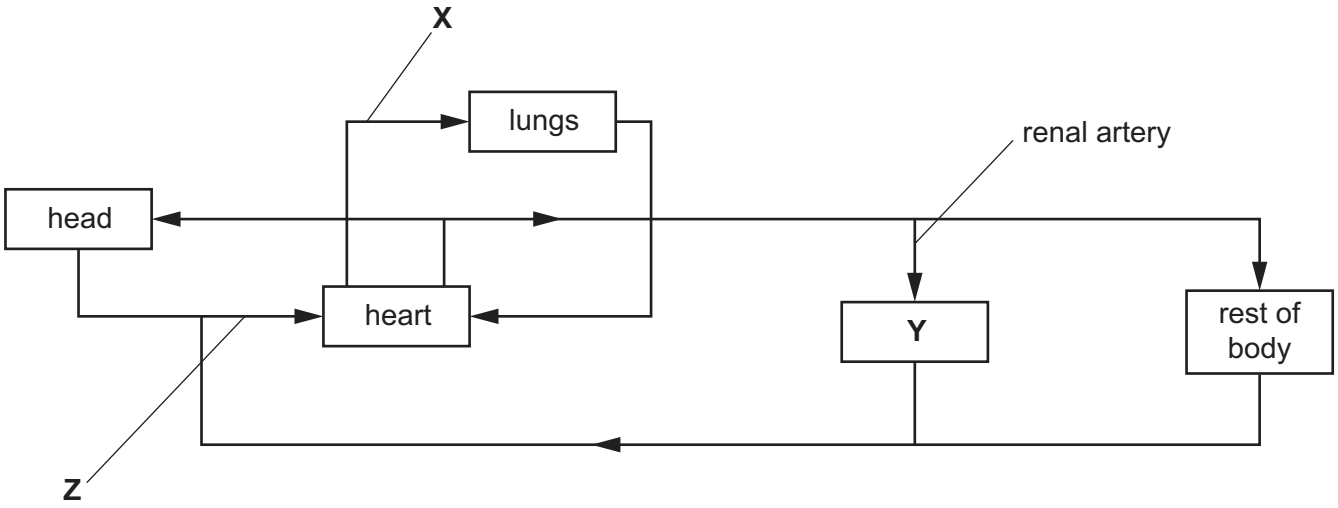

Fig. 1.1

(i) Identify from Fig. 1.1:

blood vessel **X** .....

organ **Y** .....

blood vessel **Z** .....

[3]

(ii) Describe evidence from Fig. 1.1 that horses have a double circulatory system.

.....

.....

.....

.....

..... [2]

(b) The circulatory system transports blood around the body.

(i) State **two** blood groups in humans.

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

(ii) White blood cells are one component of blood.

Tick (✓) **all** the boxes that show the correct functions of white blood cells.

antibody production	
blood clotting	
phagocytosis	
transport of hormones	
transport of oxygen	

[2]

(c) Table 1.1 shows the average thickness of wall for an artery and a capillary.

Table 1.1

blood vessel	thickness of wall / mm
artery	1.0000
capillary	0.0005

(i) Calculate how many times thicker an artery wall is than a capillary wall.

..... [1]

(ii) Explain the reasons for this difference in thickness shown in Table 1.1.

.....

.....

.....

.....

..... [2]

[Total: 12]

2 Carbon dioxide gas is made in many chemical reactions.

(a) Tick (✓) the **two** chemical reactions that make carbon dioxide.

reaction between an acid and a metal ☐

reaction between an alkali metal and water ☐

respiration ☐

thermal decomposition of calcium carbonate ☐

[2]

(b) Scientists are concerned about increased concentrations of carbon dioxide in the atmosphere.

Explain why.

.....

.....

.....

..... [2]

(c) Oxides, such as carbon dioxide, can be classified as acidic, basic, or amphoteric.

Classify carbon dioxide by putting a (ring) around the correct type of oxide.

acidic

amphoteric

basic

Explain your answer.

.....

..... [2]

(d) Carbon dioxide, CO_2, is a simple molecule.

(i) State the **type** of chemical bonding in a molecule of carbon dioxide.

..... [1]

(ii) Draw a dot-and-cross diagram to show the bonding in carbon dioxide.

You only need to draw the outer-shell electrons.

[2]

[Total: 9]

3 Fig. 3.1 shows a wind turbine used to generate electricity.

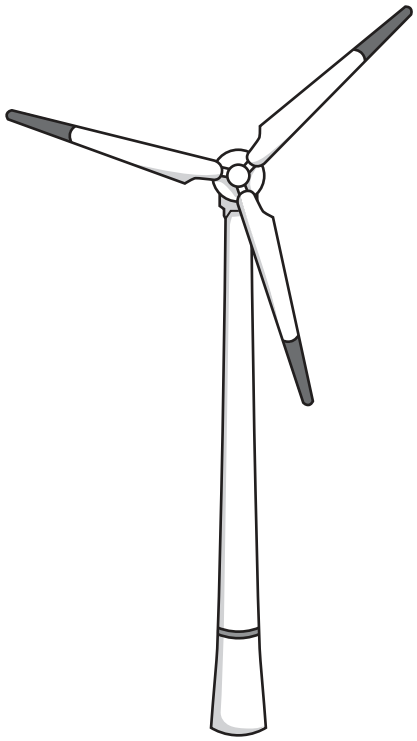

Fig. 3.1

(a) State **one** advantage of generating electricity using wind turbines.

.....

..... [1]

(b) The wind turbine contains an alternating current (a.c.) generator.

On Fig. 3.2, sketch a graph of output voltage against time for the a.c. generator when the wind turbine is turning at a constant speed.

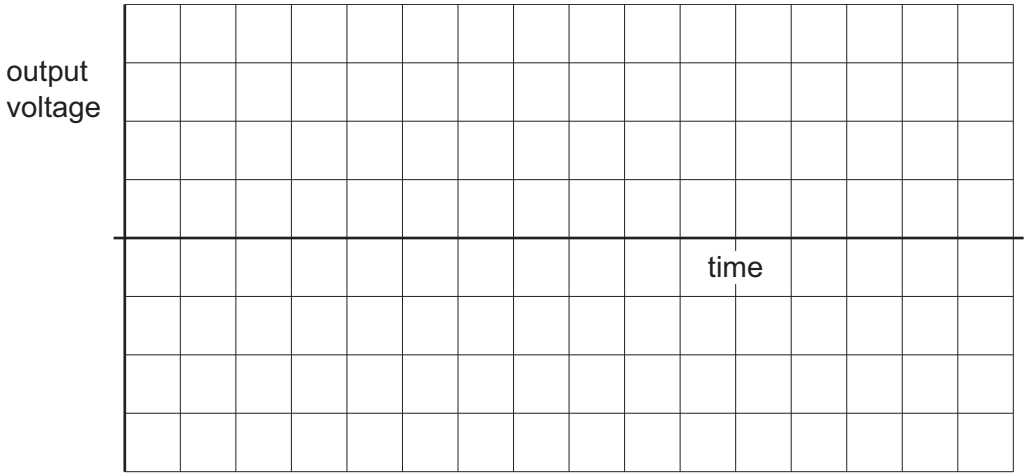

Fig. 3.2

[2]

(c) A step-up transformer is used to increase the voltage from the generator.

Describe the construction of a basic step-up transformer.

You may include a labelled diagram to aid your description.

.....

.....

.....

.....

..... [3]

(d) The wind exerts a pressure of 7200 Pa on each blade of the wind turbine.

Each blade has a surface area of 90 m^2.

Calculate the force exerted by the wind on each turbine blade.

force = ... N [2]

(e) The wind turbines produce a low-pitch sound when they turn.

(i) State the minimum frequency of sound which can be heard by a healthy human ear.

frequency = ... Hz [1]

(ii) Sound waves are longitudinal waves.

Describe, in terms of oscillations and energy transfer, what is meant by a longitudinal wave.

.....

.....

..... [1]

[Total: 10]

4 **(a)** State the balanced symbol equation for photosynthesis.

..... [2]

(b) Photosynthesis is an enzyme-controlled reaction.

Fig. 4.1 is a graph showing the effect of temperature on the rate of photosynthesis.

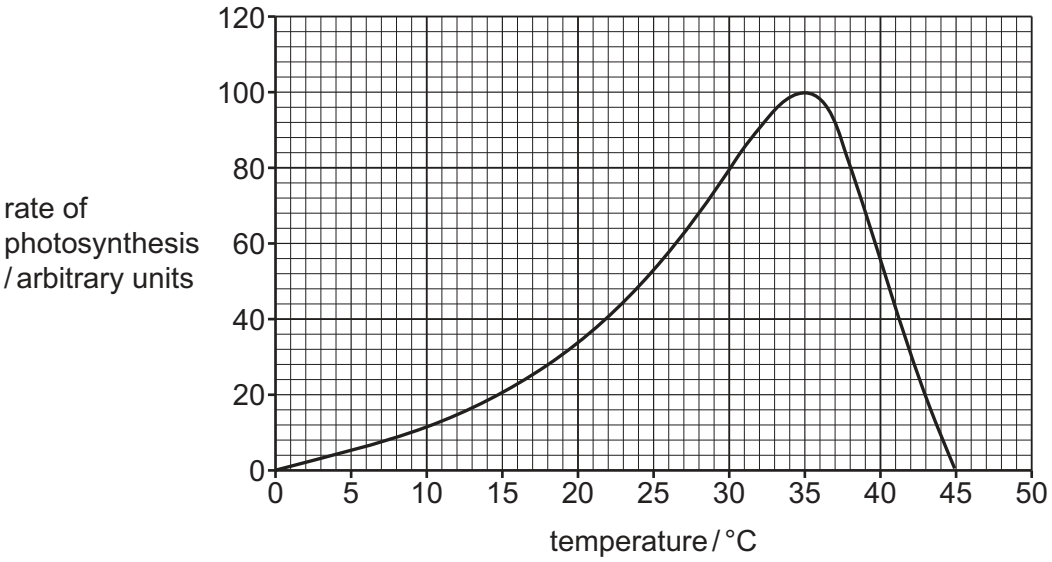

Fig. 4.1

Complete the sentences to describe **and** explain the graph in Fig. 4.1.

As the temperature increases, the rate of photosynthesis increases until it reaches the optimum temperature of ..... °C.

The rate increases because the particles gain more ..... energy causing more ..... collisions.

At 45 °C the enzymes are ..... .

Photosynthesis stops because the ..... of the enzyme has changed shape so the substrate can no longer fit.

[5]

(c) Complete the sentence to describe the transfer of energy during photosynthesis.

During photosynthesis chlorophyll transfers ..... energy into ..... energy.

[2]

(d) Carbohydrates are produced during photosynthesis.

State the name of the carbohydrate in plants that is used for:

storage .....

transport. .....

[2]

(e) Plants cells are adapted for their function.

State the name of the cells:

in the leaf that are adapted for efficient photosynthesis

.....

that are adapted for absorption of water from the soil.

.....

[2]

[Total: 13]

5 Fig. 5.1 shows the structures of four carbon compounds.

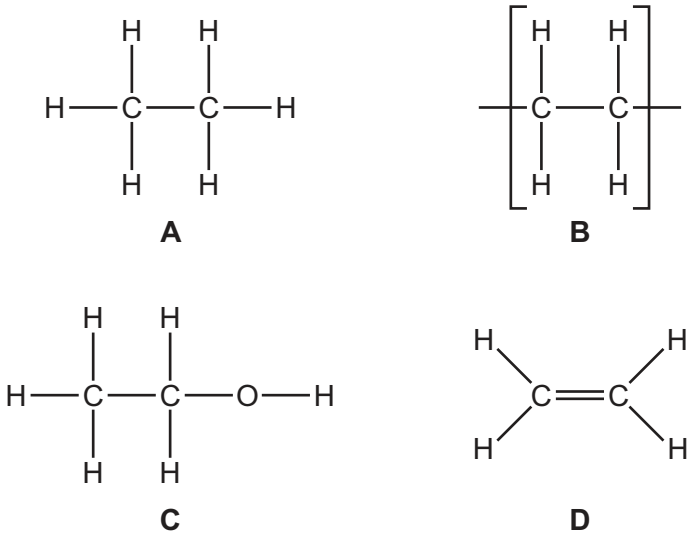

Fig. 5.1

(a) (i) State which compound is ethene.

Choose from **A**, **B**, **C** or **D**.

..... [1]

(ii) State which compound is an unsaturated hydrocarbon.

Choose from **A**, **B**, **C** or **D**.

..... [1]

(iii) Compound **B** is made from compound **D**.

State what type of reaction takes place.

..... [1]

(iv) Describe how compound **C** is made from compound **D**.

.....

..... [2]

(v) Compound **A** is a member of a homologous series.

State **two** similarities between the members of a homologous series.

1 .....

2 .....

[2]

(b) Fig. 5.2 shows the structure of a carbon atom.

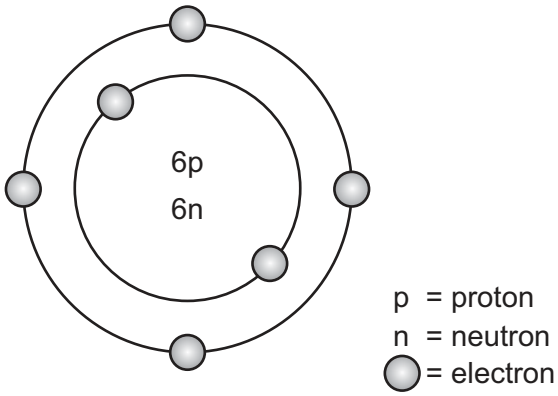

Fig. 5.2

(i) Carbon is in Group IV of the Periodic Table.

Describe how to deduce from Fig. 5.2 that carbon is in Group IV.

.....

..... [1]

(ii) Carbon exists as a mixture of **isotopes**.

Complete Fig. 5.3 to show a different isotope of carbon from that shown in Fig. 5.2.

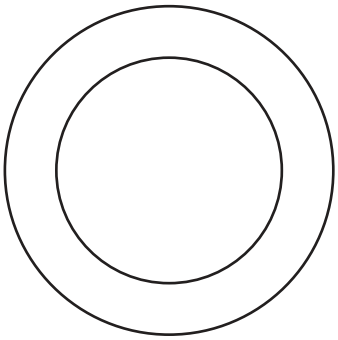

Fig. 5.3

[3]

[Total: 11]

6 Angler fish live in the sea at depths of up to 2000 m.

Fig. 6.1 shows an angler fish.

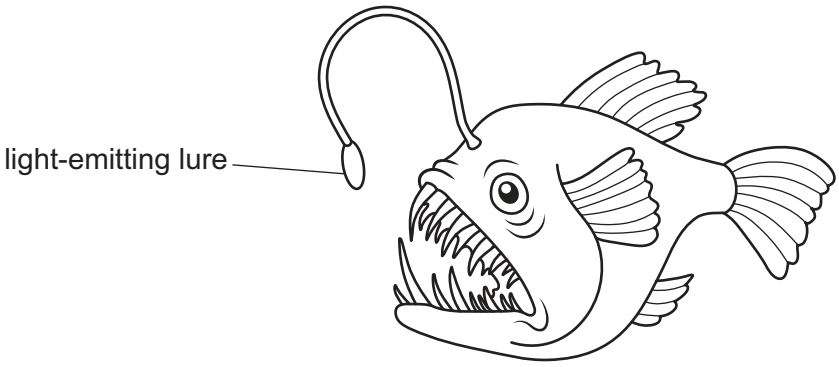

Fig. 6.1

(a) The angler fish has a light-emitting lure to attract smaller fish.

(i) The frequency of light emitted by the lure is 5.0×10^{14} Hz and the wavelength of the light is 4.5×10^{-7} m.

Calculate the speed of light in water.

speed = ... m/s [2]

(ii) Use your answer to **(a)(i)** to calculate the refractive index of water.

refractive index = ... [3]

(b) An angler fish of mass 28 kg moves at 0.11 m / s.

(i) Calculate the kinetic energy of the angler fish.

kinetic energy = ... J [2]

(ii) Fig. 6.2 shows the forces acting on the angler fish when it moves at a constant speed of 0.11 m / s.

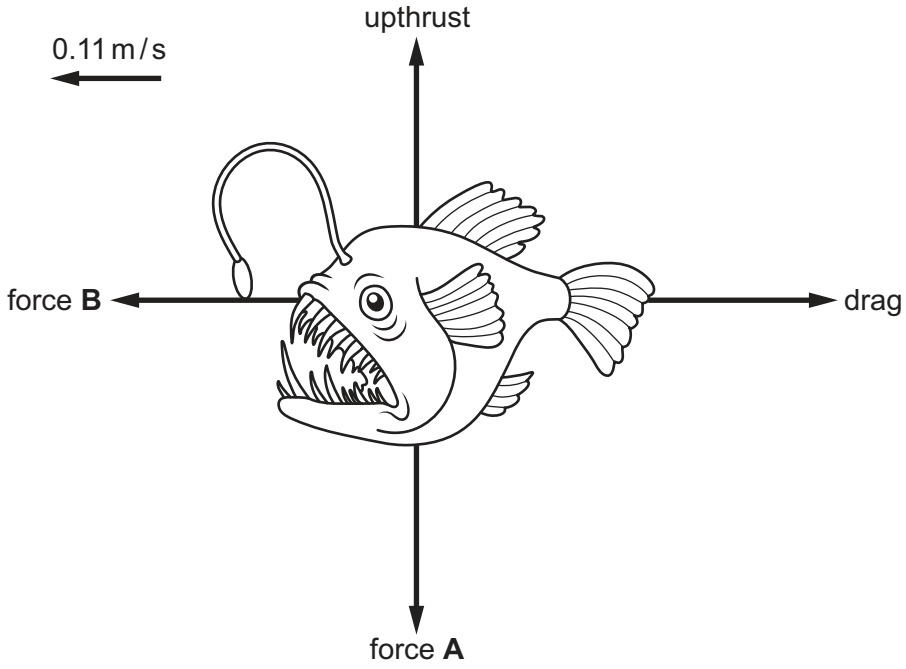

Fig. 6.2

Use Fig. 6.2 to complete the sentences to explain why the angler fish is moving at a constant speed.

Force **A** is called the ..... .

Force **A** has the same magnitude as the ..... , and

force **B** has the same magnitude as the ..... .

There is no resultant force acting on the angler fish. Therefore, there

is no ..... , so the angler fish moves at constant speed.

[3]

[Total: 10]

7 **(a)** Fig. 7.1 summarises mitosis and meiosis in an organism.

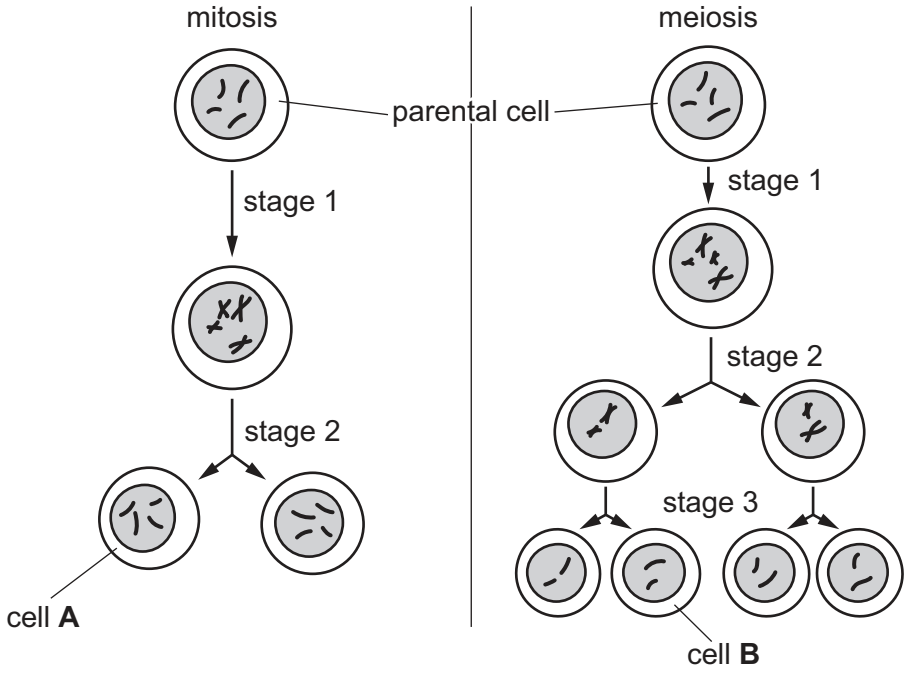

Fig. 7.1

(i) The parental cells in Fig. 7.1 have been drawn showing just four chromosomes. The actual number of chromosomes in each parental cell is 24.

Identify the actual number of chromosomes in:

cell **A** .....

cell **B** .....

[2]

(ii) Identify the name of the type of cells represented by cell **B** in Fig. 7.1.

..... [1]

(iii) Describe the process occurring at stage **1** in Fig. 7.1.

.....

..... [1]

(iv) State the name of the type of nucleus in the parental cell in Fig. 7.1.

..... [1]

(v) Describe the arrangement of chromosomes in the parental cell in Fig. 7.1.

..... [1]

(b) State **two** uses of mitosis.

1 .....

2 .....

[2]

[Total: 8]

8 A student investigates the reaction between calcium carbonate and dilute hydrochloric acid.

The student does the experiment using three different sets of conditions, **A**, **B** and **C**.

All other variables are kept the same.

Fig. 8.1 shows the three sets of conditions.

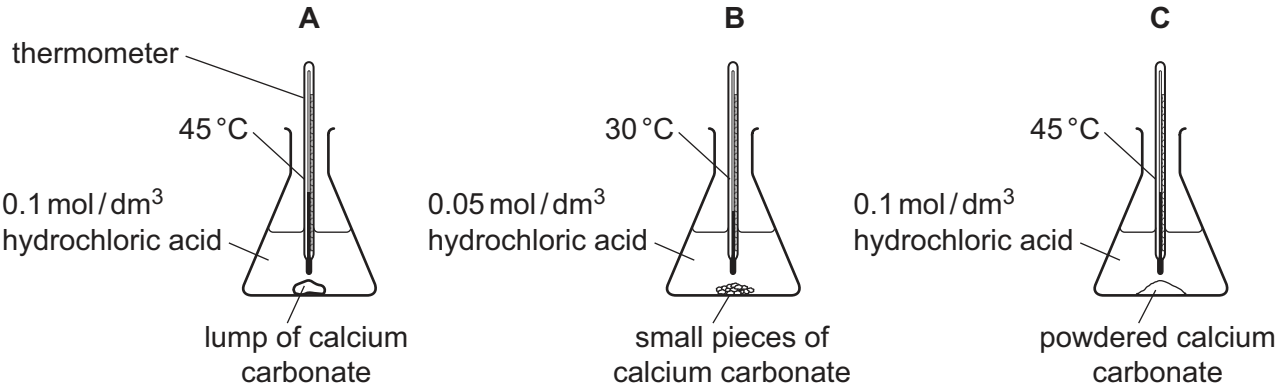

Fig. 8.1

(a) State which set of conditions, **A**, **B** or **C**, will give the fastest rate of reaction.

..... [1]

(b) The equation for the reaction in the student's experiment is shown.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Calculate the mass of 1.2 dm^3 of carbon dioxide gas measured at room temperature and pressure (r.t.p.).

The volume of one mole of any gas is 24 dm^3 at r.t.p.

Show your working.

[A_r: C, 12; O, 16]

mass of carbon dioxide gas = ... g [3]

(c) The reaction between calcium carbonate and dilute hydrochloric acid is exothermic.

State what is meant by an exothermic reaction.

.....

..... [1]

(d) A food company is making new self-heating cans of soup.

They investigate three different reactions.

Fig. 8.2 shows the reaction profiles for the three reactions, **X**, **Y** and **Z**.

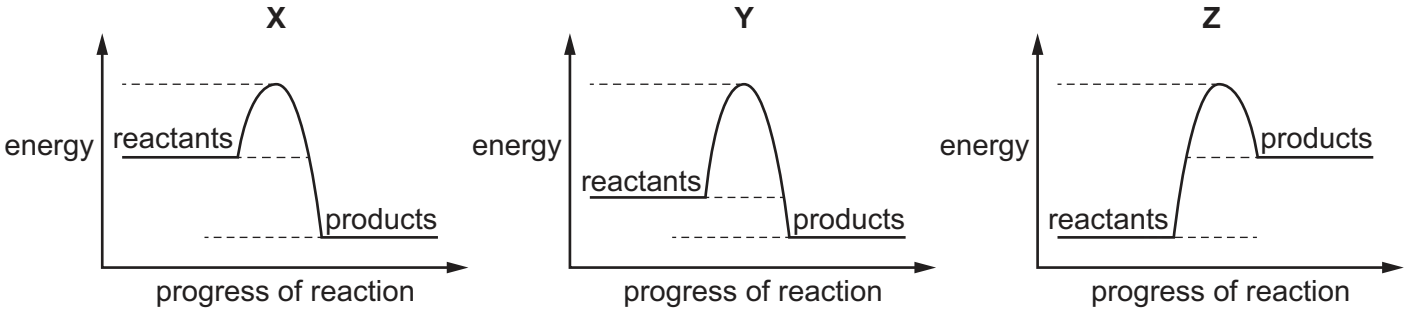

Fig. 8.2

The reaction profiles show:

- the energy change in the reaction
- the activation energy of the reaction.

(i) State what is meant by activation energy.

.....

.....

..... [2]

(ii) Suggest which reaction, **X**, **Y** or **Z**, would be most suitable to use in the self-heating cans.

Explain your answer.

reaction .....

explanation .....

.....

.....

[3]

[Total: 10]

9 A student investigates the use of cotton wool to insulate a beaker of hot water at 90 °C.

(a) The student uses a digital thermometer to measure the temperature of the water in the beaker as it cools.

The student repeats the experiment using different thicknesses of cotton wool.

Fig. 9.1 shows a graph of the results.

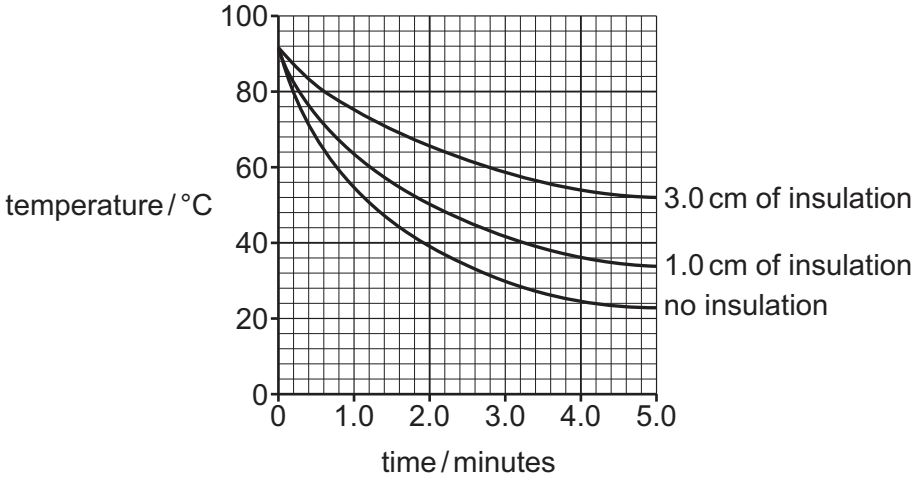

Fig. 9.1

(i) Predict the temperature after 5.0 minutes of a beaker of water which is insulated with 2.0 cm of insulation.

Use the results shown in Fig. 9.1 to explain your answer.

temperature ..... °C

explanation .....

.....

.....

[2]

(ii) Complete the sentences about the digital thermometer.

The digital thermometer contains two wires made of different metals.

The wires are joined together at each end to form two junctions.

This arrangement is known as a ..... . [1]

(b) The student uses an electric kettle to heat the water for the investigation.

The electric kettle has a power rating of 1800 W when a potential difference of 240 V is applied.

Calculate the resistance of the kettle.

resistance = ... Ω [4]

(c) Plastic is an electrical insulator.

Fig. 9.2 shows two lightweight, plastic sheets suspended by insulating threads.

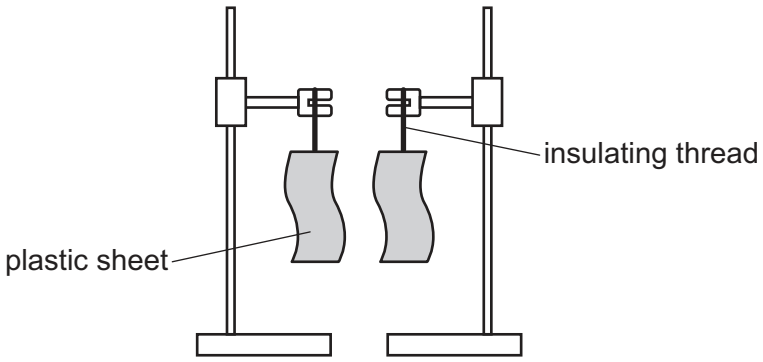

Fig. 9.2

Each plastic sheet is positively charged.

(i) Explain what is observed when the two plastic sheets are moved close to each other.

.....

.....

..... [2]

(ii) Describe how a plastic sheet can become positively charged.

.....

.....

.....

..... [3]

[Total: 12]

10 **(a)** Fig. 10.1 shows a diagram of human skin.

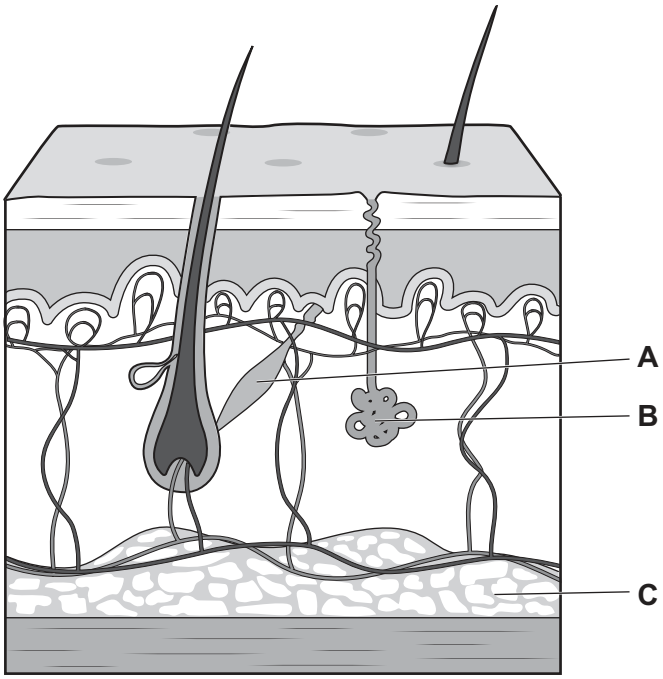

Fig. 10.1

Identify the parts labelled **A**, **B** and **C** in Fig. 10.1.

A .....

B .....

C .....

[3]

(b) Describe the role of the blood vessels in maintaining a constant internal body temperature when external temperature increases.

.....

.....

.....

.....

.....

.....

..... [3]

(c) State the name of the type of feedback used to maintain a constant internal body temperature.

..... [1]

[Total: 7]

11 **(a)** Complete the sentence about electrolysis.

Electrolysis is the breakdown of an ..... compound when

..... or in aqueous solution by the passage of electricity.

[2]

(b) The products of the electrolysis of any binary salt can be predicted.

The binary salt will always break down into its elements.

Complete the sentence about the electrolysis of a binary salt.

The ..... is formed at the cathode and the ..... is formed at the anode. [2]

(c) **(i)** Chlorine gas is made at the anode during the electrolysis of concentrated aqueous sodium chloride.

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

This is an example of oxidation.

Explain why.

.....

..... [1]

(ii) Construct the ionic half-equation for the formation of the product at the cathode.

..... [2]

(d) Sodium chloride has a melting point of 801 °C.

Chlorine has a melting point of –102 °C.

Explain the difference in the melting points.

Use ideas about:

- the bonding in sodium chloride and in chlorine
- attractive forces.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

12 Polonium is a highly radioactive metal with no stable isotopes.

(a) Polonium-210 ($^{210}_{84}$Po) decays to form lead-206 ($^{206}_{82}$Pb).

The decay of polonium-210 is a one-step process.

(i) State the type of ionising radiation emitted when polonium-210 decays to lead-206.

..... [1]

(ii) The half-life of polonium-210 is 140 days.

The activity of a sample of polonium-210 is measured as 680 counts per minute.

Calculate the time taken, in days, for the activity to decrease to 85 counts per minute.

time = ... days [2]

(b) Polonium is a solid at room temperature. The melting point of polonium is 254 °C.

(i) Explain, in terms of the motion and arrangement of atoms, why a fixed mass of solid polonium will occupy a smaller volume than the same mass of liquid polonium.

.....

.....

.....

.....

.....

..... [3]

(ii) The density of solid polonium is 9.4 g / cm^3.

Calculate the volume occupied by 235 g of solid polonium.

volume = ... cm^3 [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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).