Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

2776264594

CO-ORDINATED SCIENCES **0654/43**

Paper 4 Theory (Extended) **May/June 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 **28** pages. Any blank pages are indicated.

DC (SL/CB) 331169/3

1 **(a)** Fig. 1.1 is a diagram of the structure of the human eye.

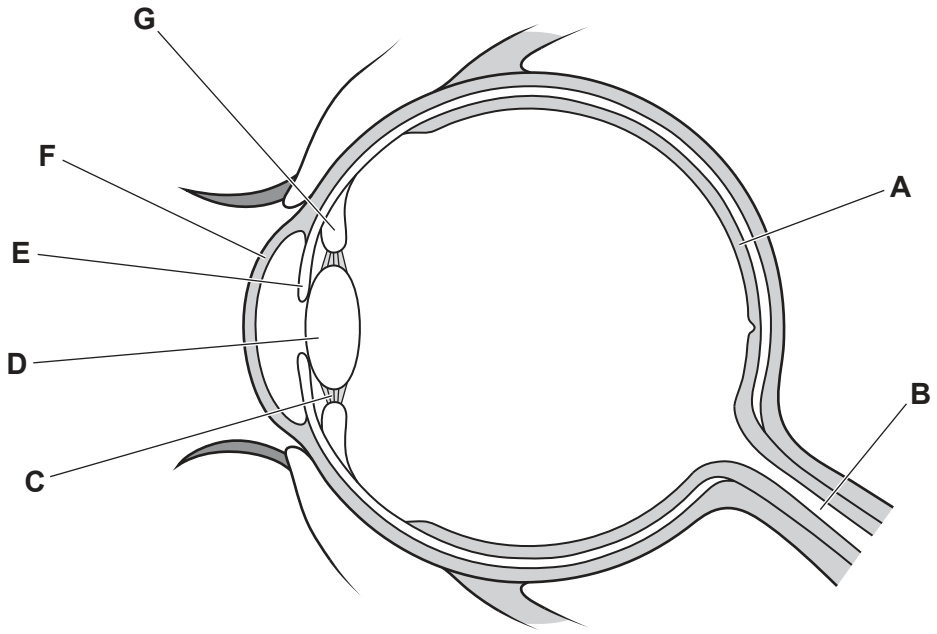


Fig. 1.1

Table 1.1 shows the names and functions of some of the parts labelled **A**–**G** in Fig. 1.1.

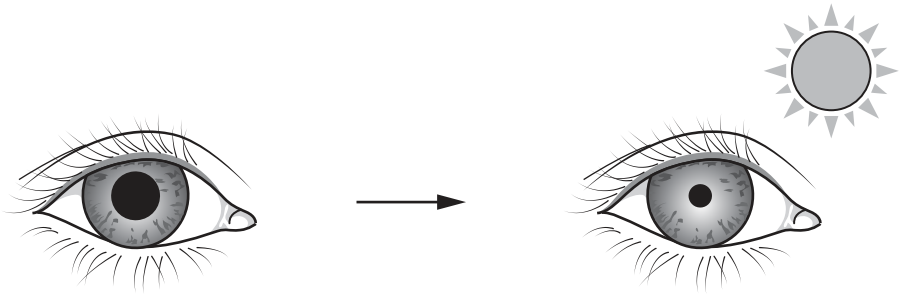
Complete Table 1.1.

Table 1.1

name of part	letter in Fig. 1.1	function
lens		
		contains light receptors
optic nerve		

[3]

(b) Fig. 1.2 shows the response of the eye to a stimulus.



in normal light in bright sunshine

Fig. 1.2

(i) State the name of the response shown in Fig. 1.2.

..... [1]

(ii) State the stimulus and the effector that cause the response shown in Fig. 1.2.

stimulus .....

effector .....

[2]

(c) The response shown in Fig. 1.2 is an involuntary action.

Tick (✓) the boxes to show **two** other involuntary actions.

drinking	
heart beating	
running	
sneezing	
talking	

[2]

[Total: 8]

2 Petroleum is a mixture of hydrocarbons.

(a) State what is meant by a hydrocarbon.

.....

..... [2]

(b) Petroleum can be separated into useful fractions by fractional distillation.

Fig. 2.1 shows a fractionating column.

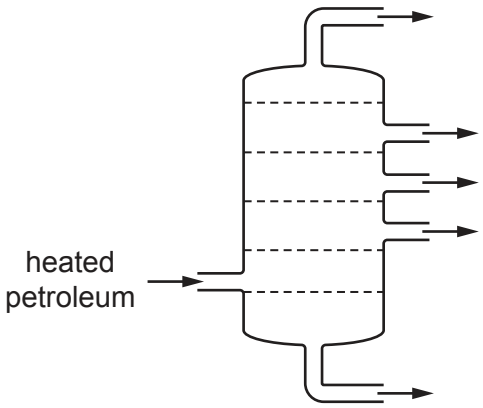


Fig. 2.1

(i) On Fig. 2.1, write the letter **X** in the **coolest** part of the fractionating column. [1]

(ii) Fractional distillation separates petroleum into fractions containing substances with similar properties.

State the names of **two** of these properties.

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

(c) Methane, CH_4, is obtained from fractional distillation of petroleum.

In the complete combustion of methane, methane reacts with oxygen, O_2.

Carbon dioxide and water are made.

Construct the balanced symbol equation for the complete combustion of methane.

..... [2]

(d) The reaction between methane and oxygen is exothermic.

State what is meant by the term exothermic.

..... [1]

[Total: 8]

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3 **(a)** Fig. 3.1 shows a speed–time graph for a journey made by a car.

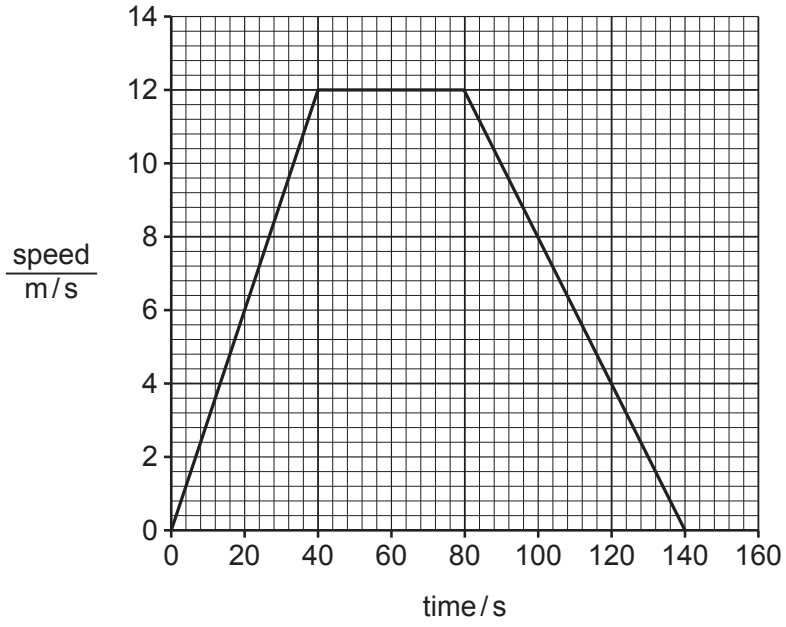


Fig. 3.1

(i) Use Fig. 3.1 to determine the distance travelled by the car during the first 40 seconds of this journey.

distance = ... m [2]

(ii) During the first 40 seconds of the journey, the car accelerates.

Define the term acceleration.

.....

..... [1]

(iii) The maximum store of kinetic energy of the car during this journey is 108 000 J.

Use information from Fig. 3.1 to calculate the mass of the car.

mass = ... kg [2]

(b) The car's headlamps emit light with a frequency of 5.6×10^{14} Hz.

Calculate the wavelength of this light in air.

wavelength = ... m [3]

[Total: 8]

4 **(a)** Fig. 4.1 shows a cross-section of a leaf.

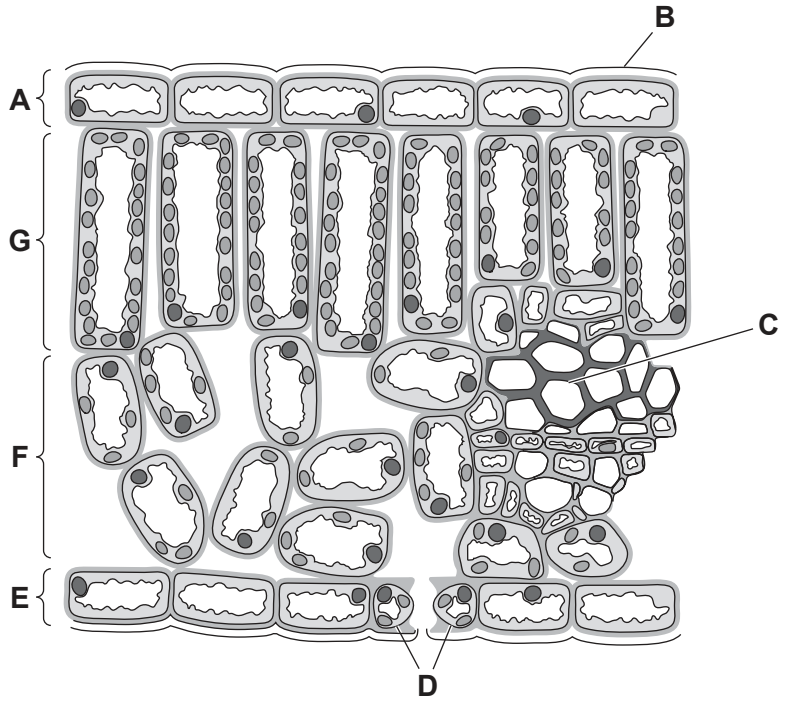


Fig. 4.1

(i) State the letter in Fig. 4.1 that identifies the cells that control loss of water vapour from a leaf.

..... [1]

(ii) State the names of the parts labelled **A** and **B** in Fig. 4.1.

A .....

B .....
[2]

(iii) Describe **two** ways in which the part labelled **G** in Fig. 4.1 is adapted for photosynthesis.

1 .....

.....

2 .....

.....
[2]

(b) Carbohydrates produced by photosynthesis are transported to areas of the plant described as sinks.

(i) Describe how the carbohydrates are transported to the sinks.

.....

.....

.....

.....

..... [3]

(ii) State **two** uses of carbohydrates in sinks.

1 .....

2 .....
[2]

(c) Carbon dioxide diffuses into a leaf during gas exchange.

State **two** factors which **increase** the rate of diffusion during gas exchange.

1 .....

2 .....
[2]

[Total: 12]

5 Table 5.1 gives some information about the Group VII elements.

Table 5.1

element	colour	state at room temperature	melting point / °C	boiling point / °C
fluorine	pale yellow	gas	……	–188
chlorine	pale green	……	–101	–35
bromine	……	liquid	–7	59
iodine	dark grey	solid	114	184

(a) (i) Complete Table 5.1 to show the colour of bromine. [1]

(ii) Complete Table 5.1 to show the state of chlorine at room temperature. [1]

(iii) Complete Table 5.1 to predict the melting point of fluorine.

Use ideas about trends down a group to help you. [1]

(b) Fig. 5.1 shows a diagram of a sodium atom.

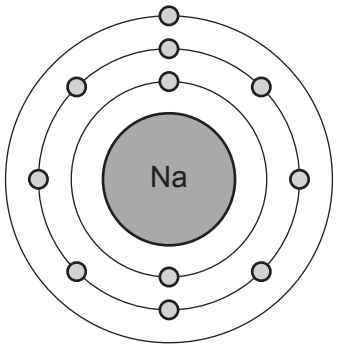


Fig. 5.1

(i) Sodium is in Period 3 of the Periodic Table.

Use Fig. 5.1 to explain why sodium is in Period 3.

..... [1]

(ii) A sodium atom is neutral.

Explain why.

Use ideas about the particles in an atom.

.....

.....

..... [2]

(c) Chlorine reacts with sodium to form the compound sodium chloride.

Sodium has the electronic structure 2.8.1.

Chlorine has the electronic structure 2.8.7.

Draw a dot-and-cross diagram to show the ions in sodium chloride. Show outer-shell electrons only.

Include the charges on the ions.

[2]

(d) Solid sodium chloride has a lattice structure.

Put a tick (✓) next to the statement that describes this lattice structure.

giant structure of atoms with strong bonds between the atoms ☐

irregular arrangement of random positive and negative ions ☐

regular arrangement of alternating positive and negative ions ☐

simple molecules with weak forces between the molecules ☐

[1]

[Total: 9]

6 Fig. 6.1 shows a jellyfish.

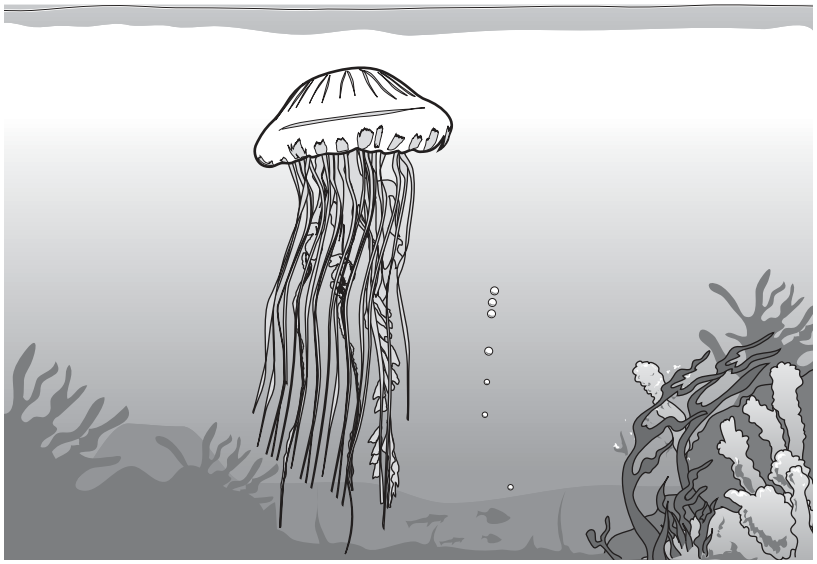


Fig. 6.1

(a) The jellyfish experiences an upwards force of 2.1 N from the water.

The mass of the jellyfish is 0.15 kg.

There are no horizontal forces acting on the jellyfish.

Describe and explain the motion of the jellyfish.

The gravitational field strength g = 10 N / kg.

.....

.....

.....

..... [3]

(b) Fig. 6.2 shows a scuba diver using a camera to photograph the jellyfish.

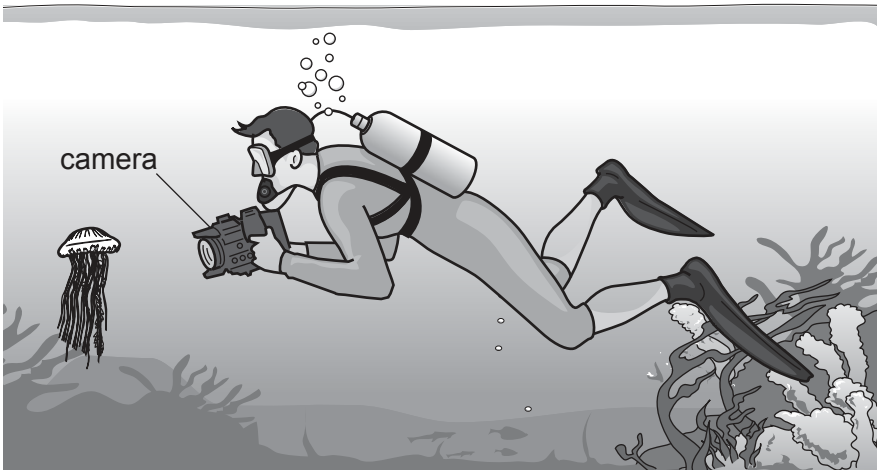


Fig. 6.2

(i) The pressure of the water on the lens of the camera is 180 kPa.

The circular lens has a radius of 0.035 m.

Calculate the force exerted by the water on the lens of the camera.

force = ... N [3]

(ii) The camera uses a thin converging lens to form an image.

Complete Fig. 6.3 to show how a thin converging lens forms an image.

Draw **two** rays to locate the image and draw an arrow to represent the image.

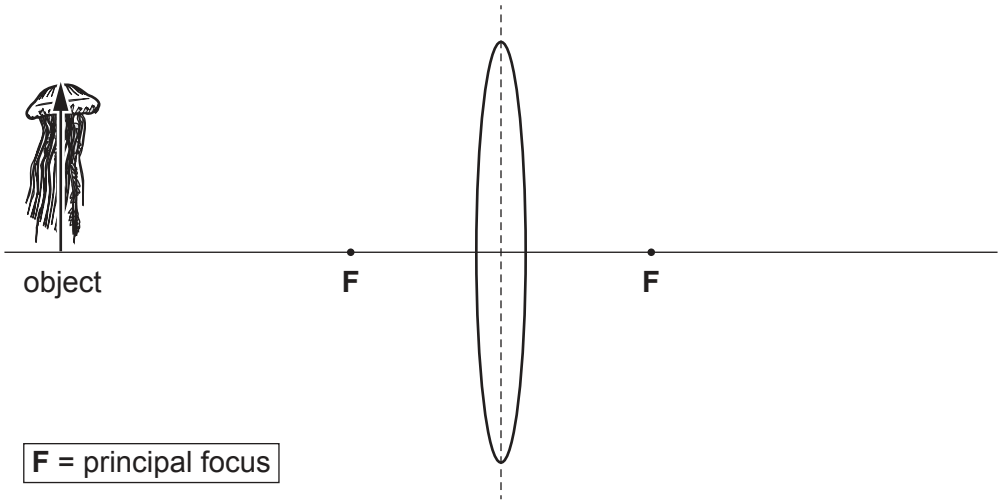


Fig. 6.3

[3]

[Total: 9]

7 Fig. 7.1 is a diagram of the alimentary canal and some of the associated organs in humans.

The pH values of some of the parts are shown in Fig. 7.1.

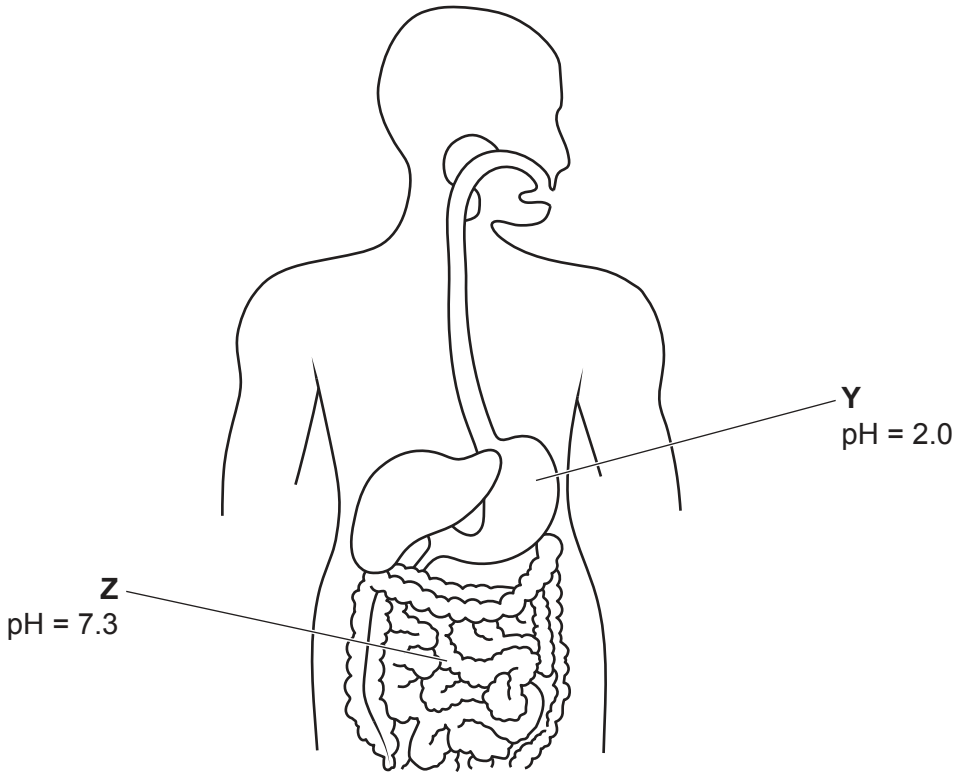


Fig. 7.1

(a) Explain the importance of the pH value for organ **Y** in Fig. 7.1.

.....

.....

.....

.....

..... [2]

(b) State the name of the substance that causes the increase in pH between organs **Y** and **Z** in Fig. 7.1.

..... [1]

(c) Mechanical digestion occurs in the mouth.

Define mechanical digestion.

.....

.....

.....

..... [2]

(d) The pH of the mouth can decrease after eating.

This decrease is caused by the production of acid.

(i) Describe how acid is produced in the mouth after eating.

.....

.....

.....

..... [2]

(ii) Describe the effect of acid on the teeth.

.....

.....

..... [1]

(e) Vitamins and minerals are two components of a balanced diet.

(i) State the names of **two** other components of a balanced diet.

1 .....

2 .....
[2]

(ii) State the name of the disease caused by vitamin C deficiency.

..... [1]

[Total: 11]

8 Fig. 8.1 shows a toy car that is powered by hydrogen gas.

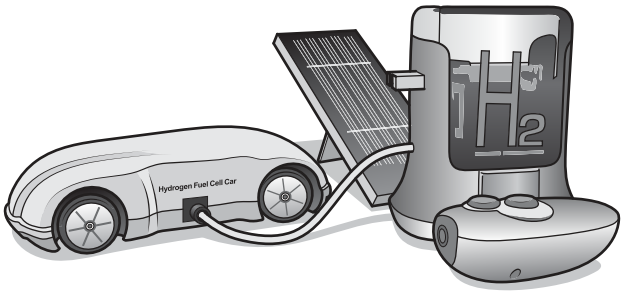


Fig. 8.1

(a) (i) The hydrogen gas is made by the electrolysis of water.

During the electrolysis, hydrogen ions, H^+, gain electrons.

Hydrogen gas, H_2, is made.

Construct the ionic half-equation for this reaction.

Use e^- to represent an electron.

..... [2]

(ii) Oxygen gas is also made during the electrolysis of water.

$$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$$

This is an example of oxidation.

Explain why.

.....

..... [1]

(b) The equation for the breakdown of water by electrolysis is shown.

$$2H_2O \rightarrow 2H_2 + O_2$$

45 g of water makes 40 g of oxygen gas.

Calculate the volume occupied by 40 g of oxygen gas at r.t.p.

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

[A_r: H, 1; O, 16]

volume of oxygen gas = ... dm^3 [3]

(c) Hydrogen, oxygen and water are all covalent molecules with low melting and boiling points.

Explain why these covalent molecules have low melting and boiling points.

.....

.....

..... [2]

(d) At very high temperatures, oxygen reacts with silicon to form silicon(IV) oxide (silicon dioxide), SiO_2.

Fig. 8.2 shows part of the structure of silicon dioxide.

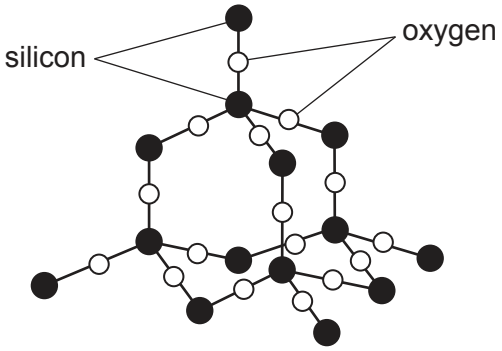


Fig. 8.2

Describe the structure of silicon dioxide.

.....

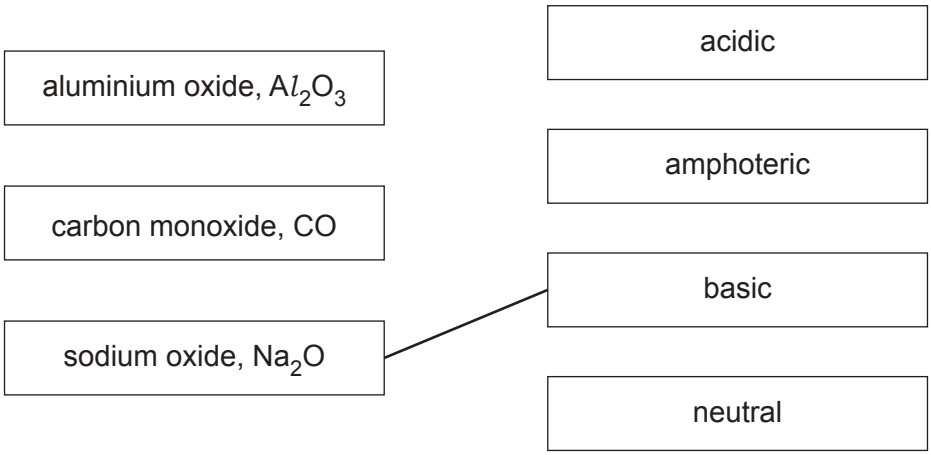
.....

..... [2]

(e) Oxides are classified as acidic, basic, amphoteric or neutral.

Silicon dioxide is an acidic oxide.

Draw a line to classify each of the oxides in the diagram. One has been done for you.



[2]

[Total: 12]

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9 A student is investigating resistance.

(a) Fig. 9.1 shows the circuit made by the student.

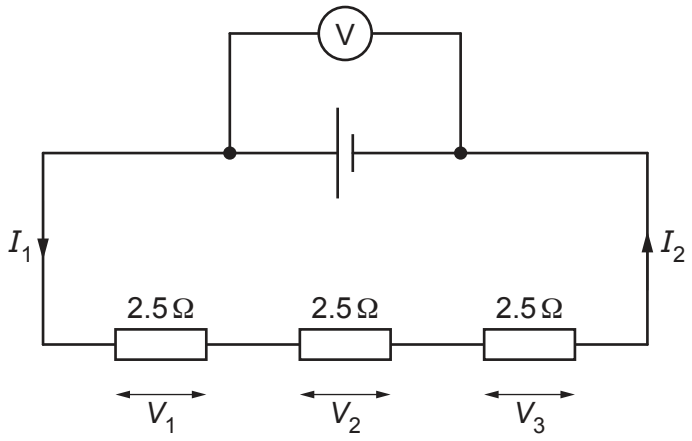

Fig. 9.1

(i) State how the currents labelled I_1 and I_2 compare with each other.

..... [1]

(ii) Write an equation showing the relationship between the reading on the voltmeter, V, and the three potential difference values V_1, V_2 and V_3.

..... [1]

(iii) Calculate the total resistance of the circuit.

total resistance = ... Ω [1]

(iv) The reading on the voltmeter in Fig. 9.1 is 1.5 V.

Calculate the value of the current I_1.

State the unit for your answer.

current = ... unit ..... [3]

(b) The student replaces the three fixed resistors with one thermistor, moves the voltmeter and includes an ammeter.

Fig. 9.2 shows the new circuit made by the student.

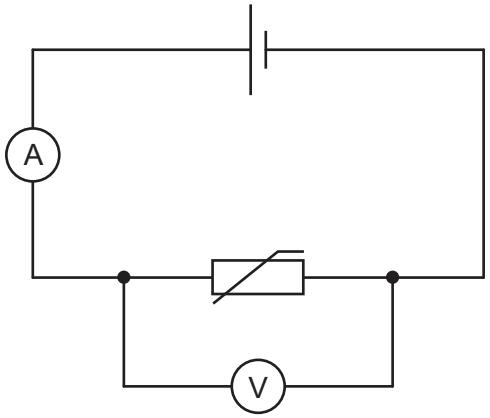

Fig. 9.2

(i) The student observes the readings on the ammeter and voltmeter as the thermistor is moved from a warm room into a beaker of ice.

State and explain what the student observes on the ammeter and voltmeter.

ammeter .....

.....

.....

voltmeter .....

.....

.....

[2]

(ii) While the student is conducting the experiment, the ice in the beaker melts into liquid water.

Compare the arrangement and motion of molecules in a solid to the arrangement and motion of molecules in a liquid.

arrangement .....

.....

motion .....

.....

[2]

[Total: 10]

10 **(a)** Fig. 10.1 shows part of a food web from a desert ecosystem.

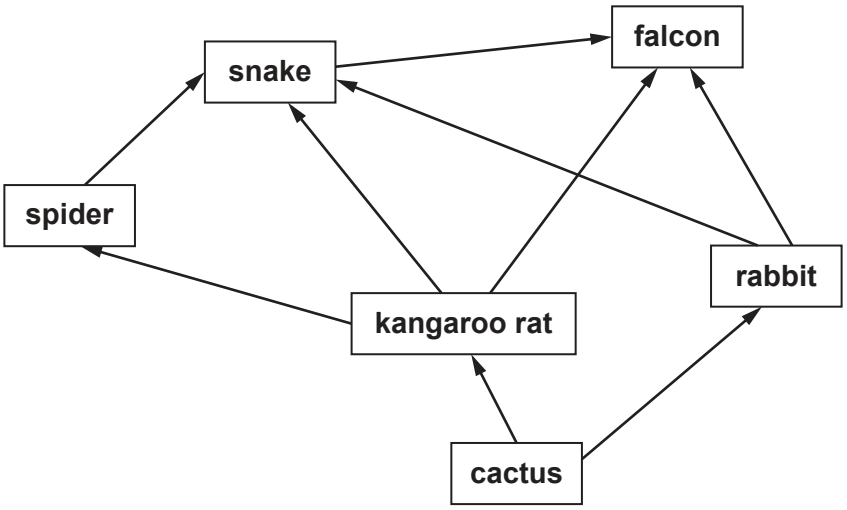

Fig. 10.1

(i) Use Fig. 10.1 to construct a food chain that contains a quaternary consumer.

..... [2]

(ii) State the maximum number of trophic levels in the food web in Fig. 10.1.

..... [1]

(iii) Identify an organism that occupies trophic level 1 in Fig. 10.1.

..... [1]

(b) Selective breeding of falcons for racing is done in some countries.

(i) Complete the sentences to describe selective breeding of falcons for racing.

Falcons are observed and selected for their ..... .

These falcons breed together.

This passes on their alleles to their ..... .

This process is ..... over many generations.

[3]

(ii) Explain why the changes to the population as a result of selective breeding are **not** an example of adaptation.

.....

.....

.....

.....

..... [2]

[Total: 9]

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

Calcium chloride, water and carbon dioxide are made.

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

The student collects and measures the volume of carbon dioxide made.

(a) Suggest the apparatus the student uses to collect and measure the volume of carbon dioxide.

..... [1]

(b) The rate of reaction between calcium carbonate and dilute hydrochloric acid is increased by increasing the temperature of the acid.

Explain why.

Use ideas about collisions between reacting particles.

.....

.....

.....

..... [3]

(c) Calculate the mass of calcium chloride made when 20 g of calcium carbonate reacts with excess dilute hydrochloric acid.

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

[A_r: C, 12; Ca, 40; Cl, 35.5; O, 16]

mass of calcium chloride = ... g [2]

(d) Iron is extracted from iron ore by heating the iron ore with carbon.

(i) Explain why iron can be extracted from iron ore by heating with carbon.

..... [1]

(ii) Put a tick (✓) next to the metal that **cannot** be extracted from its ore by heating with carbon.

aluminium ☐

copper ☐

zinc ☐

[1]

(iii) Iron is extracted from iron ore in a blast furnace.

Calcium carbonate (limestone) is added to the blast furnace to remove impurities in the iron ore.

Complete the symbol equations to show the reactions to remove the impurities.

$$CaCO_3 \rightarrow CaO + \text{.....}$$

$$CaO + \text{.....} \rightarrow CaSiO_3$$

[2]

(e) Iron can be coated with zinc to prevent rusting.

Explain, in terms of electrons, how zinc prevents iron from rusting.

.....

..... [1]

[Total: 11]

12 **(a)** Fig. 12.1 shows the path taken by an alpha particle as it passes through an electric field.

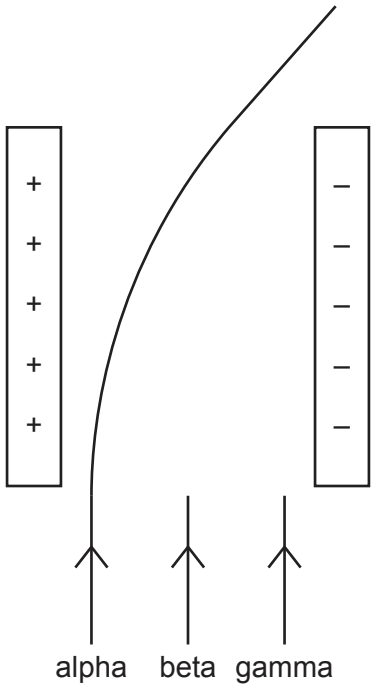

Fig. 12.1

(i) On Fig. 12.1, draw the paths taken by a beta particle and a gamma ray as they pass through the electric field. [2]

(ii) Draw **four** lines to give the nature, relative ionising ability and relative penetrating ability of an alpha particle.

an alpha particle	has no mass
	has a relative mass of 4
	has a relative mass of 1
	has no charge
	has a relative charge of +2
	has a relative charge of –1
	has a high ionising ability
	has a low ionising ability
	has a high penetrating ability
	has a low penetrating ability

[3]

(b) Nuclear power stations use nuclear fission to generate electricity.

(i) A nuclear power station generates 6.7×10^6 J of energy per day. The efficiency of the power station is 89%.

Calculate the useful energy output from the power station in one **year**.

useful energy output in one **year** = ... J [3]

(ii) State **one** advantage of generating electricity using nuclear fission compared to using fossil fuels.

.....

..... [1]

(iii) The nuclear power station uses a generator to produce electrical energy.

Fig. 12.2 shows a diagram of a simple a.c. generator.

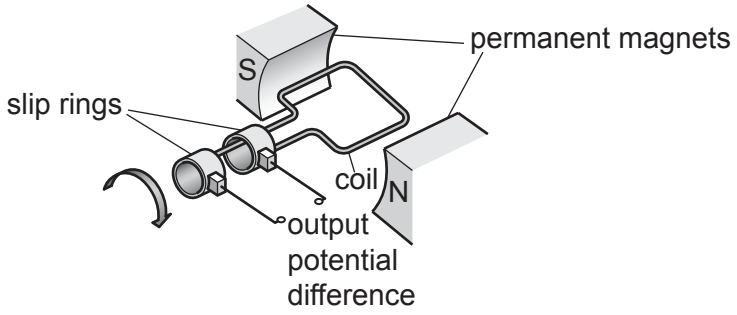

Fig. 12.2

Describe how a simple a.c. generator produces an output potential difference.

Include a description of the role of the slip rings in your answer.

.....

.....

.....

.....

.....

..... [4]

[Total: 13]

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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.).