Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

7422413471

CO-ORDINATED SCIENCES **0973/41**

Paper 4 Theory (Extended) **May/June 2025**

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.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m / s^2).

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 **32** pages. Any blank pages are indicated.

DC (IP) 367252/1

[Turn over

1 **(a)** Carbon dioxide is taken in for the process of photosynthesis.

State the balanced symbol equation for photosynthesis.

..... [2]

(b) Fig. 1.1 shows the net uptake and the net release of carbon dioxide by a plant between midnight and midday.

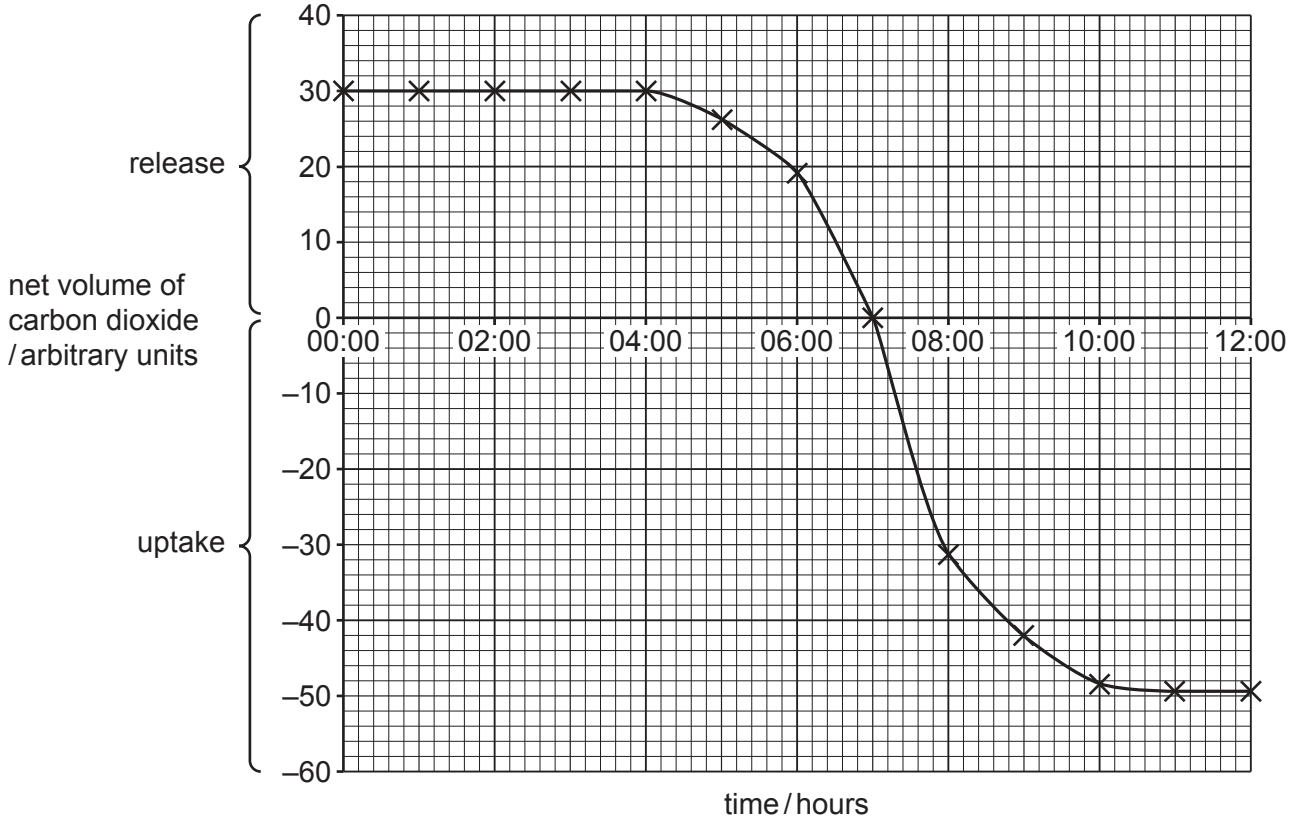

Fig. 1.1

Complete the sentences to explain the shape of the graph shown in Fig. 1.1.

The shape of the graph is linked to two processes: photosynthesis and process **X**.

At midnight (00:00 hours), the net volume of carbon dioxide is due to process **X**. Process **X** is

..... .

There is no photosynthesis at midnight because there is no .....

energy available at night.

Between 05:00 – 10:00 hours, the rate of photosynthesis ..... as

energy becomes available during the day.

The rate of photosynthesis equals the rate of process **X** at ..... hours.
[4]

(c) The uptake and release of carbon dioxide by the same plant is measured on a different day. On this day, the temperature is lower than the previous day.

This time, the net volume of carbon dioxide uptake levels out at –40 arbitrary units.

Enzymes are required for photosynthesis.

Explain this difference in net volume of carbon dioxide uptake.

.....

.....

.....

.....

..... [3]

[Total: 9]

2 Fig. 2.1 is a diagram of the human heart and the blood vessels that connect with it.

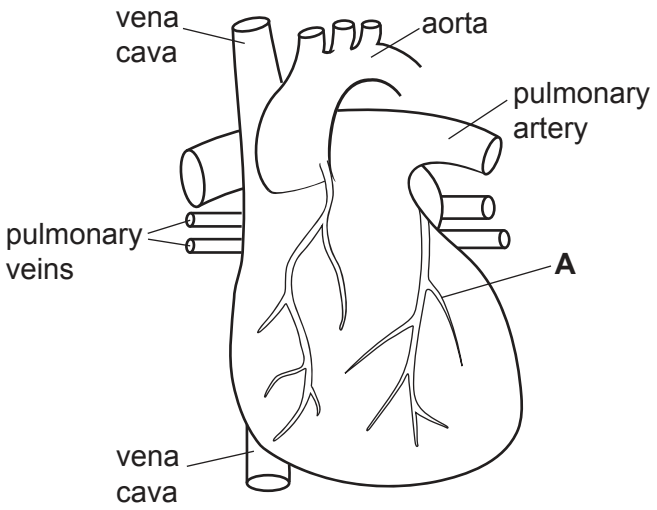

Fig. 2.1

(a) Describe **two** differences between the pulmonary artery and the vena cava.

1 .....

.....

2 .....

.....

[2]

(b) Describe how blood is moved through the heart from the pulmonary veins to the aorta.

Include the names of the chambers.

.....

.....

.....

.....

.....

.....

..... [4]

(c) A patient has a problem with his heart.

(i) The doctor takes the patient's pulse rate.

State **one** other way doctors monitor the activity of the heart.

..... [1]

(ii) The doctor thinks the blood vessel labelled **A** in Fig. 2.1 is blocked.

Explain why this causes a problem with the function of the heart.

Include the name of blood vessel **A** in your answer.

.....

.....

.....

.....

..... [3]

[Total: 10]

3 Fig. 3.1 is a magnified image of a plant root tip viewed using a light microscope.

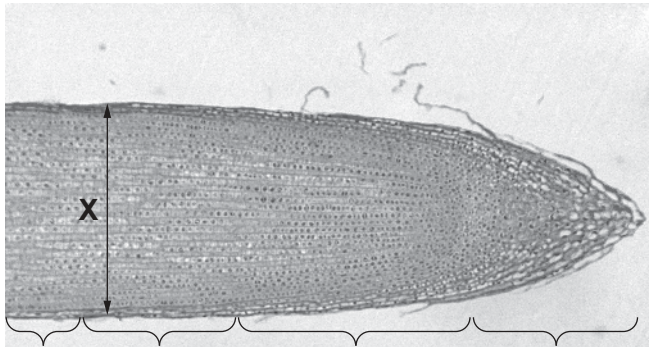

Fig. 3.1

(a) At **X** in Fig. 3.1, there are 37 cells across the width of the root tip.

The actual width of the root tip at **X** is 1.2 mm.

Calculate the average size of the cells in the root tip in **μm**.

..... μm [2]

(b) Fig. 3.1 shows a zone in the root tip where cells become specialised.

Tick (✓) **one** box to identify a type of specialised cell made in the root.

ciliated cells ☐

guard cells ☐

palisade mesophyll cells ☐

phloem cells ☐

[1]

(c) Fig. 3.1 shows a zone in the root tip where cells divide so the root can grow.

(i) State the type of cell division needed for growth.

..... [1]

(ii) During this type of cell division, the number of chromosomes is maintained in each daughter cell.

Describe **two** processes in cell division that ensure that the chromosome number is maintained.

1 .....

.....

2 .....

.....
[2]

(d) A different type of cell division takes place in the ovary and anther of flowers to make gametes.

(i) Fig. 3.2 is a diagram of a wind-pollinated flower.

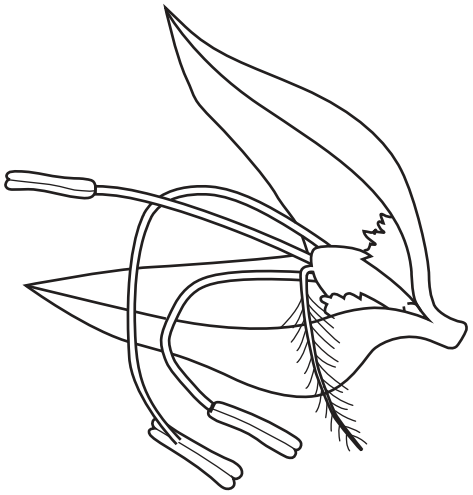

Fig. 3.2

On Fig. 3.2, draw a label line and the letter **A** to identify **one** anther. [1]

(ii) The anthers produce male gametes.

Complete the sentences about male gametes in plants.

Male gametes in plants are called ..... grains.

During production of male gametes, the chromosome number is halved from ..... to haploid.

Male gametes produced are all genetically ..... .

A nucleus of a male gamete will fuse with the nucleus of an ovule. This process is called ..... .

[4]

(iii) Describe **one** advantage of sexual reproduction to a population of plants in the wild.

.....

..... [1]

[Total: 12]

4 Tropical forests are some of the most important ecosystems in the world.

(a) Fig. 4.1 is a food chain from a tropical forest.

organism:	banana tree →	grasshopper →	frog →	python
position in food chain:	producer	.....	.....	.....

Fig. 4.1

Complete Fig. 4.1 to show the position of each organism in this food chain. [2]

(b) Fig. 4.2 shows another food chain that includes the python.

banana tree → monkey → python

Fig. 4.2

Explain why it is more efficient for the python to eat a monkey and **not** a frog.

Include trophic levels in your answer.

.....

.....

.....

.....

..... [3]

(c) The Amazon rainforest is a large tropical forest.

In 1970, the Amazon rainforest covered an area of 4.1 million km^2.

By 2022, the area covered was estimated to be 3.3 million km^2.

One effect of this deforestation is a loss in biodiversity.

Explain **other** negative effects that deforestation has on the environment.

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 9]

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5 Water exists in the solid, liquid or gas state.

The particles are arranged differently in each physical state.

(a) Name the state where the water particles are furthest apart.

..... [1]

(b) Describe what happens to the **movement** of water particles during melting.

.....

.....

..... [2]

(c) A student takes some ice out of the freezer and leaves it in a beaker in a warm room.

Fig. 5.1 shows how the temperature in the beaker changes.

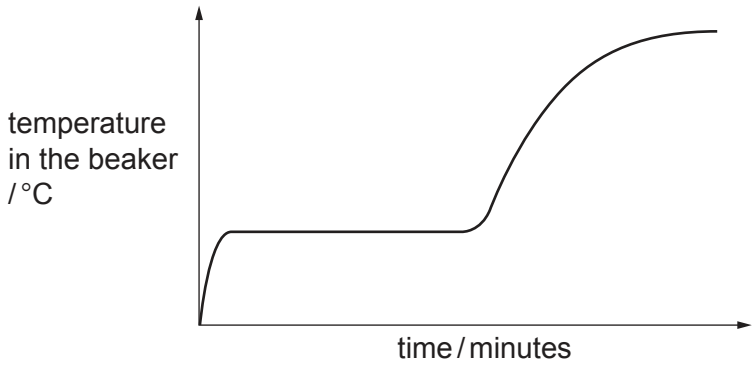

Fig. 5.1

(i) Label the part of the graph where the ice is melting with the letter **X**. [1]

(ii) Describe how Fig. 5.1 shows that the ice is pure rather than a mixture.

.....

..... [1]

(d) Domestic water is treated so that it is pure enough to drink.

Draw **one** line from each **treatment** to show **why it is used**.

treatment	**why it is used**
chlorination	to remove solids
sedimentation and filtration	to remove tastes and odours
use of carbon	to kill microbes

[2]

(e) Water, H_2O, is a simple covalent molecule.

(i) Complete the dot-and-cross diagram in Fig. 5.2 to show the bonding in water.

Only show the outer-shell electrons.

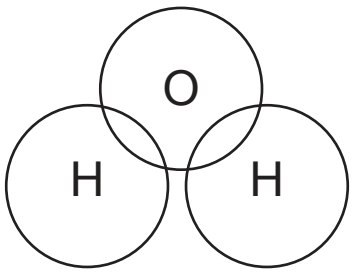

Fig. 5.2

[2]

(ii) Explain why pure water is a poor conductor of electricity.

.....

..... [1]

[Total: 10]

6 **(a)** A sodium atom is represented with numbers next to its chemical symbol, as shown in Fig. 6.1.

$$^{23}_{11}\mathrm{Na}$$

Fig. 6.1

Complete Table 6.1 to show the structure of a sodium atom.

Table 6.1

atomic number	mass number	number of		
		protons	neutrons	electrons
.....	23	.....	.....	11

[2]

(b) Fig. 6.2 shows an outline of the Periodic Table.

The letter **E** shows the position of an element in the Periodic Table.

The letter **E** is **not** the chemical symbol of the element.

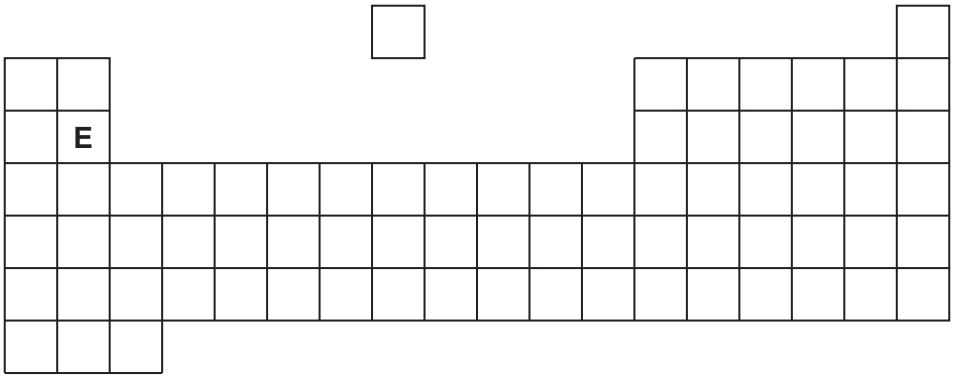

Fig. 6.2

Predict the electronic configuration of element **E**.

Tick (✓) **one** box.

2.2 ☐

2.8.2 ☐

2.3 ☐

2.8.3 ☐

[1]

(c) Carbon-12 and carbon-13 are two isotopes of the element carbon.

These isotopes of carbon have the same chemical properties.

Explain why.

.....

..... [1]

(d) State the type of oxide formed when carbon, a non-metal, reacts with oxygen to produce carbon dioxide, CO_2.

..... [1]

(e) Carbon dioxide is a greenhouse gas and causes global warming.

Complete the sentences to describe how carbon dioxide causes global warming.

Use words from the list.

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

absorbed
reflected
refracted
stored

Energy from the Sun reaches the Earth's surface. Some energy is

..... back into space. Most of the energy is

..... by the Earth's surface, causing an increase in

temperature. The warm Earth emits energy. Some of this emitted energy is then

..... by greenhouse gases. When this energy is re-emitted, it

can be transferred back to the Earth's surface.

[3]

(f) Some coal burns to make 11 000 g of carbon dioxide gas.

Calculate the volume occupied by 11 000 g of carbon dioxide gas.

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

[A_r: C, 12; O, 16]

volume of carbon dioxide gas = ... dm^3 [3]

[Total: 11]

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7 The metal iron is extracted from hematite in a blast furnace.

The extraction happens in several stages.

(a) In the first stage, carbon (coke) is burnt to provide heat and produce carbon dioxide.

State the type of reaction that transfers thermal (heat) energy to the surroundings.

..... [1]

(b) In the second stage, carbon reacts with carbon dioxide to make carbon monoxide.

$$C + CO_2 \rightarrow 2CO$$

State what happens to the carbon dioxide in this reaction.

Choose from the list.

combustion

oxidation

reduction

thermal decomposition

..... [1]

(c) In the third stage, iron(III) oxide, Fe_2O_3, reacts with carbon monoxide.

Iron and carbon dioxide are made.

Construct the balanced symbol equation for this reaction.

..... [2]

(d) Calcium carbonate (limestone) is added to the blast furnace to remove impurities from the hematite.

The calcium carbonate thermally decomposes to make calcium oxide and carbon dioxide.

$$CaCO_3 \rightarrow CaO + CO_2$$

Calculate the mass of calcium carbonate needed to make 7 tonnes of calcium oxide.

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

mass of calcium carbonate = ... tonnes [2]

(e) Iron is protected from rusting by coating the iron with a layer of zinc.

This is called sacrificial protection.

Explain how sacrificial protection protects iron.

Use ideas about the reactivity series and loss of electrons.

.....

.....

..... [2]

(f) Fig. 7.1 shows the metallic bonding in zinc.

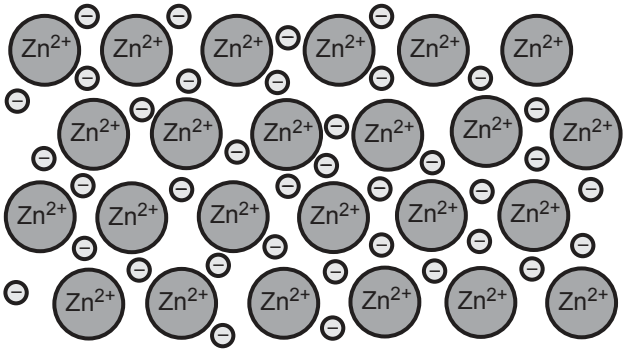

Fig. 7.1

Use Fig. 7.1 to describe the metallic bonding in zinc.

.....

.....

..... [2]

[Total: 10]

8 Petroleum is separated into useful fractions by fractional distillation.

Fig. 8.1 shows the fractions obtained.

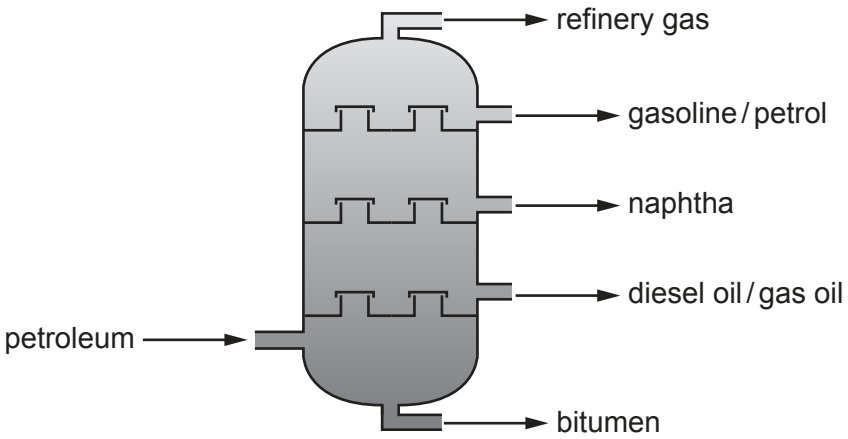

Fig. 8.1

(a) Describe how the chain length and the boiling points of the fractions change from the bottom to the top of the fractionating column.

chain length .....

boiling points .....

[2]

(b) **(i)** Describe how large alkane molecules produced by fractional distillation are changed into smaller alkene molecules.

.....

.....

..... [2]

(ii) The large alkane $C_{22}H_{46}$ is changed into butane and an alkene.

Complete the balanced symbol equation for this reaction.

$$C_{22}H_{46} \rightarrow \underset{\text{butane}}{\text{.....}} + \underset{\text{alkene}}{\text{.....}}$$

[2]

(c) A mixture containing 5.6 g of ethene, C_2H_4, is allowed to react with 5.4 g of steam.

Ethanol, C_2H_5OH, is made.

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

Determine the limiting reactant in this reaction.

Show your working.

[A_r: C, 12; H, 1; O, 16]

[3]

[Total: 9]

9 **(a)** The Sun is the star in our Solar System.

(i) State the **two** most common elements found in the Sun.

1 .....

2 .....
[2]

(ii) Describe how the following change, if at all, when the distance from the Sun increases:

the strength of the Sun's gravitational field

.....

the orbital speed of the planets.

.....
[2]

(b) The Earth is 1.5×10^{11} m from the Sun.

The Earth takes one year to complete an orbit of the Sun.

Calculate the orbital speed of the Earth around the Sun.

orbital speed = ... m/s [3]

(c) State, in order, the stages in the life cycle of a very large mass star after it leaves the stable main sequence stage.

1 .....

2 .....

3 .....
[3]

(d) Describe the difference between the processes of nuclear fusion and nuclear fission.

.....

.....

..... [2]

[Total: 12]

10 (a) A rocket travels vertically upwards.

Fig. 10.1 shows the speed–time graph for the rocket.

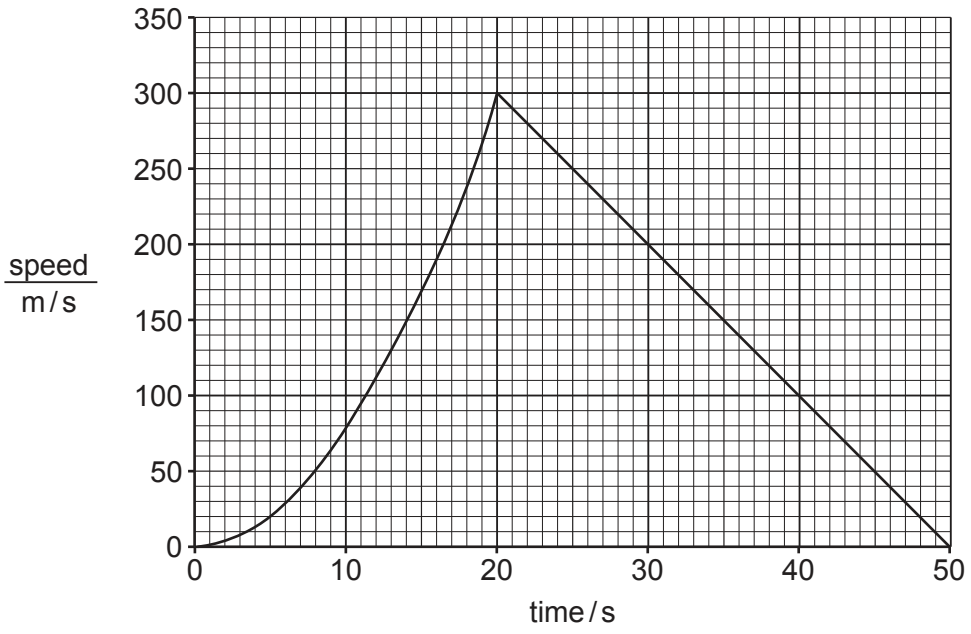

Fig. 10.1

(i) Describe the motion of the rocket in the first 20 seconds.

..... [1]

(ii) Calculate the deceleration of the rocket between time = 20 s and time = 50 s.

State the unit of your answer.

deceleration = ... unit ..... [3]

(iii) Calculate the distance travelled by the rocket between time = 30 s and time = 50 s.

distance = ... m [2]

(iv) State the time at which the rocket reaches its maximum height above the ground.

time = ... s [1]

(b) A car travels at constant speed on a horizontal road.

State and describe the horizontal forces acting on the car.

.....

.....

..... [2]

[Total: 9]

11 (a) (i) Describe **one** similarity and **two** differences between boiling and evaporation.

similarity .....

.....

difference 1 .....

.....

difference 2 .....

.....

[3]

(ii) State **three** factors which increase the rate of evaporation.

1 .....

2 .....

3 .....

[3]

(b) Fig. 11.1 shows a beaker of water on a tripod and gauze.

The beaker of water is being heated.

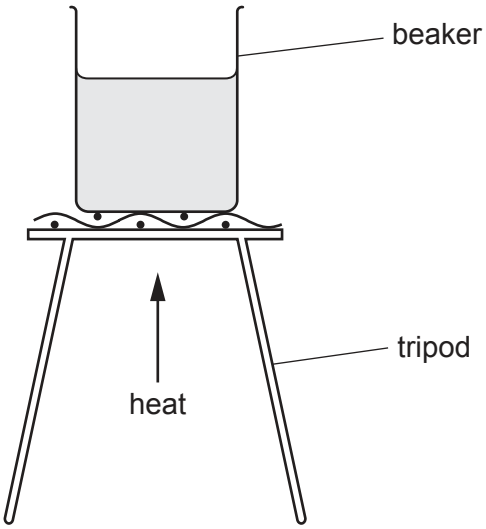

Fig. 11.1

Water at the bottom of the beaker is heated by conduction through the glass beaker.

Explain the process of **convection** which causes all the water in the beaker to increase in temperature.

.....

.....

.....

.....

..... [3]

[Total: 9]

12 **(a)** Fig. 12.1 shows a 10 Ω resistor and a resistor **R** of unknown resistance connected in parallel with a 1.8 V cell.

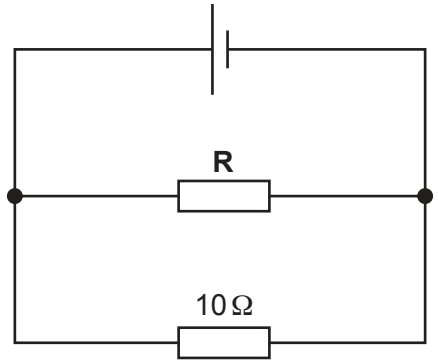

Fig. 12.1

The current in the cell is 0.32 A.

The current in the 10 Ω resistor is 0.18 A.

(i) Calculate the current in resistor **R**.

current = ... A [1]

(ii) State the potential difference across resistor **R**.

potential difference = ... V [1]

(b) A 40 Ω resistor and a 20 Ω resistor are connected in parallel.

Calculate the combined resistance of the two resistors.

resistance = ... Ω [2]

(c) **(i)** A computer projector has a power rating of 750 W.

Mains potential difference is 230 V.

Calculate the electric current in the projector.

current = ... A [2]

(ii) The computer projector uses a lens to form an image.

In another device, the object is placed between the principal focus and the lens.

On Fig. 12.2, draw rays to find the position of the image formed.

Use an arrow to represent the image.

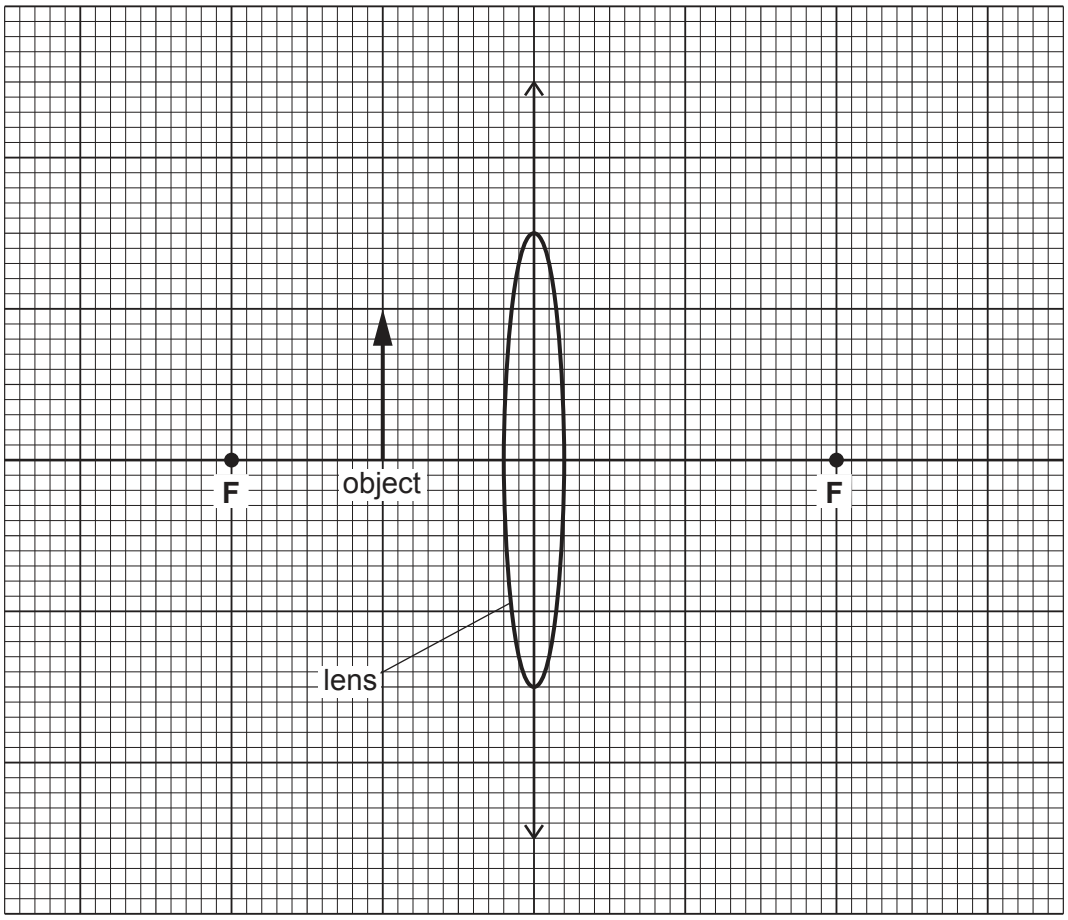

Fig. 12.2

[3]

(iii) State a use of the arrangement shown in Fig. 12.2.

..... [1]

[Total: 10]

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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.).