Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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CO-ORDINATED SCIENCES **0973/42**

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 **28** pages. Any blank pages are indicated.

[Turn over

1 Fig. 1.1 is a diagram of a root hair cell.

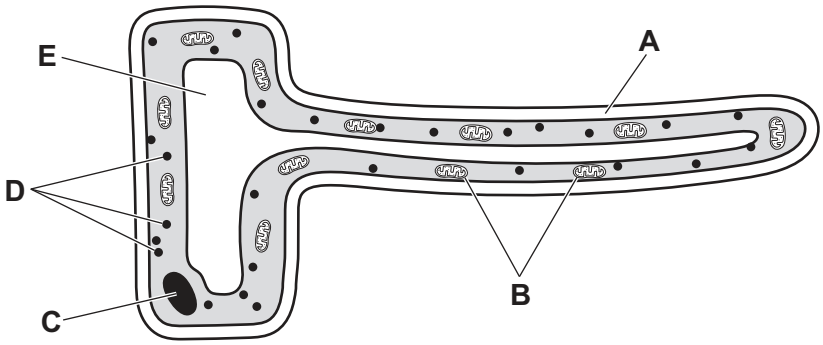


Fig. 1.1

(a) Using letters **A** – **E** in Fig. 1.1, identify the part of the cell:

where protein synthesis takes place .....

made from cellulose. .....

[2]

(b) Amino acids are used in protein synthesis.

State the name of the process used to transport amino acids from sources to sinks in plants.

..... [1]

(c) Root hair cells are specialised for absorption.

Complete Table 1.1 about substances absorbed by root hair cells.

Table 1.1

substance	method of absorption	one use of substance in plant
water	.....	.....
nitrate ions	.....	.....

[2]

(d) Fig. 1.2 shows two of the same plant cells, one immersed in pure water (water with no chemical impurities) and the other immersed in concentrated salt solution.

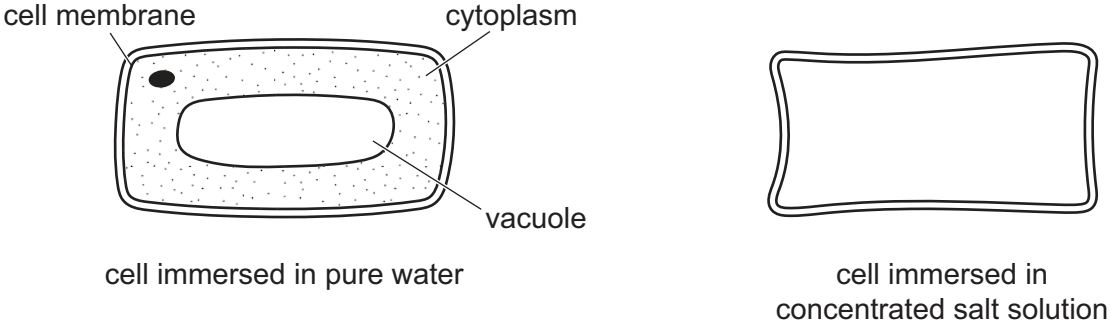


Fig. 1.2

Complete Fig. 1.2 to show the contents of the plant cell immersed in the concentrated salt solution. [2]

(e) Explain the effects of high winds on transpiration rate in plants.

.....

.....

.....

.....

..... [3]

[Total: 10]

2 Fig. 2.1 is a diagram of the human breathing system.

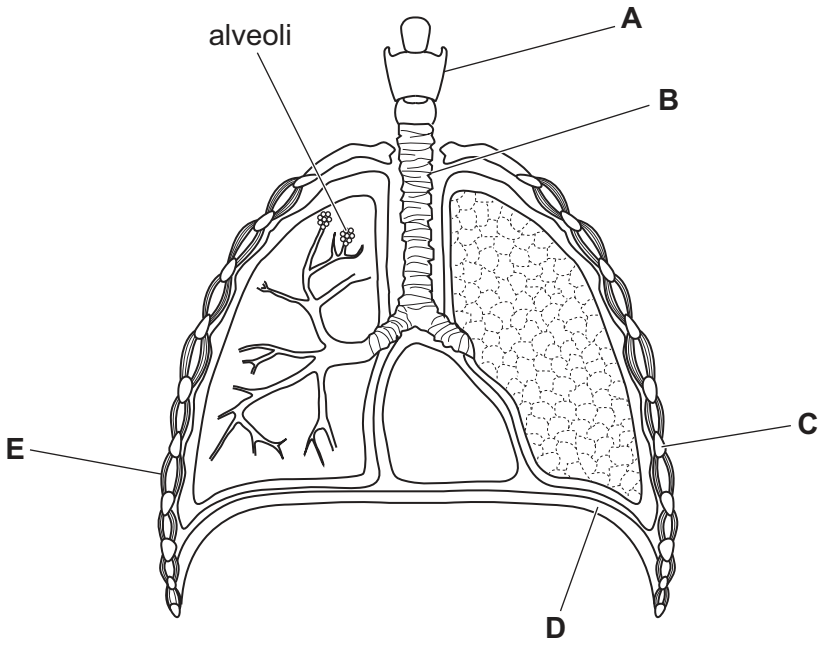


Fig. 2.1

(a) Using letters **A** – **E** in Fig. 2.1, identify the:

trachea .....

diaphragm. .....

[2]

(b) Alveoli are the gas exchange surface in humans.

Describe **two** features of an efficient gas exchange surface.

1 .....

.....

2 .....

.....

[2]

(c) Table 2.1 shows the composition of inspired and expired air.

Table 2.1

	composition / %		
gas	inspired air	expired air	difference
oxygen	21.00	16.00	–5.00
carbon dioxide	0.04	4.00	.....
water vapour	low	high	increased

(i) Calculate the difference in composition of the carbon dioxide in Table 2.1.

Write your answer in Table 2.1. [1]

(ii) Explain the differences in composition between inspired and expired air.

.....

.....

.....

.....

.....

..... [3]

(d) A student runs very fast for 20 minutes.

The rate and depth of breathing increases during exercise and stays high after the student has finished running.

Explain why the rate and depth of breathing **stays high** after the student has finished running.

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 12]

3 **(a)** Table 3.1 shows the diameter of a flu virus and different types of cells.

Table 3.1

	diameter / μm
flu virus	0.1
bacterial cell	1.0
red blood cell	7.0
lymphocyte	15.0
plant cell	50.0
human egg cell	120.0

(i) Calculate the difference in size between the largest and smallest **animal** cells in Table 3.1.

..... μm [2]

(ii) State the name of the cell in Table 3.1 that contains haemoglobin.

..... [1]

(b) Complete the sentences about an immune response to a flu virus infection.

Use words from the list.

active **antibodies** **enzymes**

lymphocytes **passive** **pathogens** **phagocytes**

The flu virus has antigens on its surface. Proteins with a specific shape bind to antigens.

These proteins are called ..... .

This causes the virus to be destroyed or marked for engulfing by

..... .

After the infection, a human has ..... immunity to the flu virus.

[3]

(c) Flu vaccinations are used each year to protect people from flu virus infection.

Outline how this vaccine gives protection.

.....

.....

.....

.....

..... [3]

(d) The flu virus reproduces quickly and often mutates.

Suggest why a new vaccine is developed every year.

.....

.....

.....

..... [2]

[Total: 11]

4 Orcas are large mammals that live in the sea.

(a) Orcas reproduce using egg cells and sperm cells like humans.

Describe **two** adaptive features of egg cells.

1 .....

.....

2 .....

.....

[2]

(b) Fig. 4.1 shows part of a marine food web for an orca.

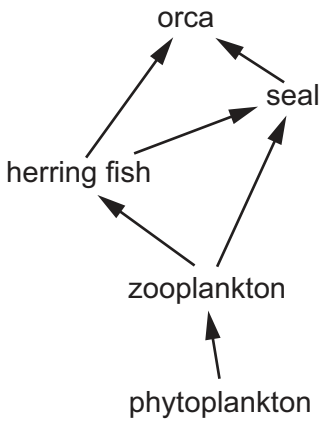


Fig. 4.1

(i) Orcas feed at more than one trophic level.

State the name of the lowest trophic level orcas feed at as shown in Fig. 4.1.

..... [1]

(ii) Humans also eat herring fish.

Draw an arrow and label for humans on Fig. 4.1. [1]

(c) An orca tangled in a fishing net is found dead on a beach.

The orca has a high level of PCB in its body.

PCB is a pollutant that stops orcas reproducing.

Suggest how human activity is causing the population of orcas to decrease.

.....

.....

.....

.....

.....

..... [3]

[Total: 7]

5 **(a)** The element carbon has a proton (atomic) number of 6.

Complete Fig. 5.1 to show the electronic configuration of a carbon atom.

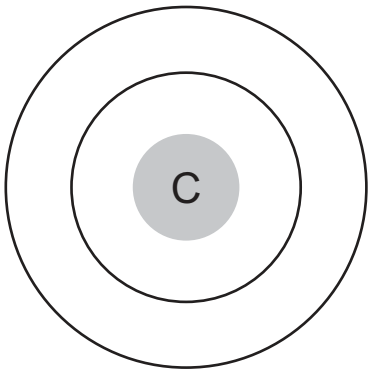


Fig. 5.1

[1]

(b) A carbon atom has 6 neutrons.

State the mass number of this carbon atom.

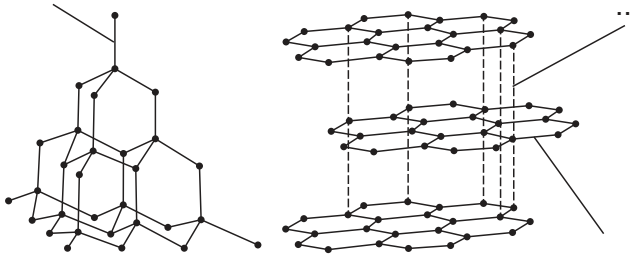
mass number = ... [1]

(c) State the number of atoms in 1 mole of carbon.

number of atoms = ... [1]

(d) Fig. 5.2 shows **two** different forms of the element carbon.

.....



.....

.....

Fig. 5.2

(i) Complete the labels on Fig. 5.2.

Use phrases from the list.

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

weak forces

ionic bond

metallic bond

covalent bond

[3]

(ii) One of the forms of carbon in Fig. 5.2 is diamond.

Explain why diamond is used in cutting tools.

.....

.....

..... [2]

(e) Carbon reacts with hydrogen to form methane, CH_4.

Complete the dot-and-cross diagram in Fig. 5.3 to show the bonding in methane.

Only show the outer-shell electrons.

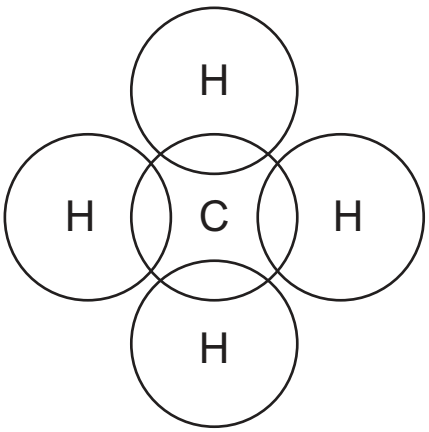


Fig. 5.3

[2]

[Total: 10]

6 **(a)** Fig. 6.1 shows the structural formula of a molecule, **X**.

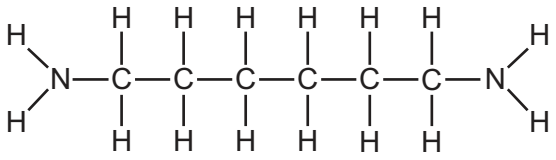


Fig. 6.1

(i) Deduce the molecular formula of molecule **X**.

molecular formula of **X** = ... [1]

(ii) Explain why molecule **X** is **not** a hydrocarbon.

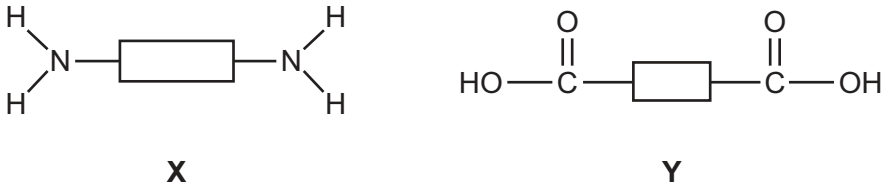
.....

..... [1]

(b) Molecule **X** can be drawn using a box to represent the carbon chain.

This is shown in Fig. 6.2.

Fig. 6.2 also shows another molecule, **Y**.



X **Y**

Fig. 6.2

Molecules of **X** react with molecules of **Y** to make the polymer nylon.

Draw the structure of the polymer nylon.

[2]

(c) The formation of nylon is an example of condensation polymerisation.

Describe **two** differences between condensation polymerisation and addition polymerisation.

1 .....

.....

2 .....

.....

[2]

(d) Molecule **Y** reacts with sodium carbonate.

Carbon dioxide is made in the reaction.

State the test for carbon dioxide.

Include the observation for a positive result.

test .....

observation .....

[2]

(e) Carbon dioxide is a simple molecular compound.

Tick (✓) **two** properties of simple molecular compounds.

good electrical conductivity when molten	☐
high boiling point	☐
low melting point	☐
malleable	☐
poor electrical conductivity when solid	☐

[2]

[Total: 10]

7 **(a)** The ionic compound sodium sulfate contains the ions Na^+ and SO_4^{2-}.

Determine the formula of sodium sulfate.

formula = ... [1]

(b) Copper sulfate is also an ionic compound.

A student investigates the electrolysis of aqueous copper(II) sulfate using copper electrodes.

Fig. 7.1 shows the student's experiment.

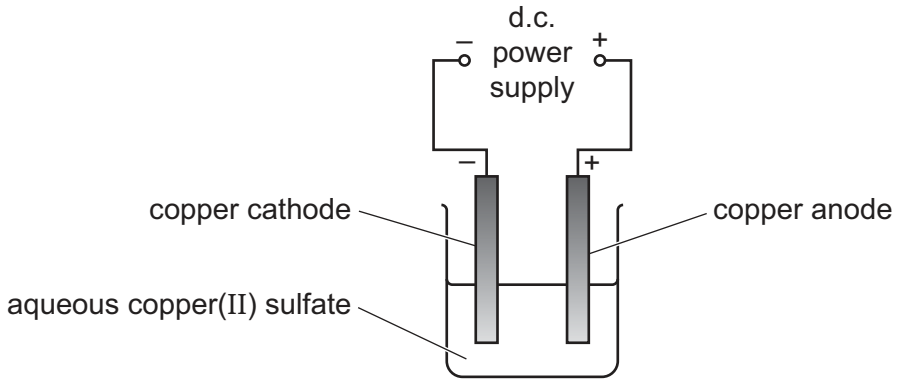


Fig. 7.1

Describe what the student observes at the anode.

.....

..... [1]

(c) **(i)** Copper is deposited at the cathode.

Write the ionic half-equation for the formation of copper, Cu, from copper ions, Cu^{2+}.

..... [2]

(ii) The ionic half-equation for the reaction at the anode is shown.

$$Cu \rightarrow Cu^{2+} + 2e^-$$

Explain if the reaction at the anode is oxidation or reduction.

.....

..... [1]

(d) A student investigates the displacement reactions of copper, magnesium, zinc and iron.

The student adds a piece of each metal to solutions of the metal sulfates.

Table 7.1 shows the student's results.

Table 7.1

	copper sulfate	magnesium sulfate	zinc sulfate	iron sulfate
copper		✘	✘	✘
magnesium	✓		✓	✓
zinc	✓	✘		✓
iron	✓	✘	✘	

✓ = reaction

✘ = no reaction

(i) Deduce the order of reactivity of the metals.

..... most reactive

.....

.....

..... least reactive

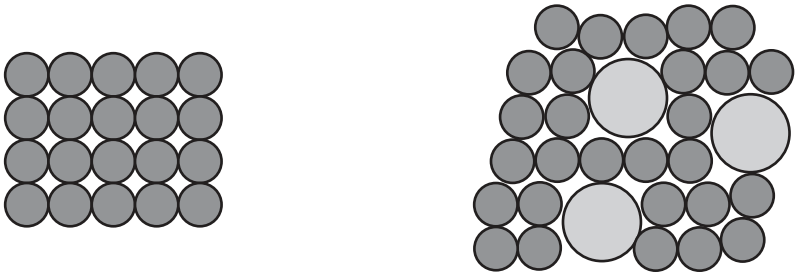
[2]

(ii) Construct the balanced symbol equation for the reaction of magnesium with zinc sulfate, $ZnSO_4$.

..... [2]

(e) Brass is an alloy of the metals copper and zinc.

Fig. 7.2 shows the structure of a pure metal and of an alloy.



pure metal alloy

Fig. 7.2

Explain why brass is harder and stronger than copper or zinc.

.....

.....

..... [2]

[Total: 11]

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

(a) The balanced symbol equation for the reaction is shown.

Complete the state symbols in the equation.

$$2HCl\,(.....) + CaCO_3\,(.....) \rightarrow CaCl_2\,(aq) + CO_2\,(.....) + H_2O\,(l)$$

[2]

(b) The student measures the total volume of carbon dioxide made every minute for 7 minutes.

Fig. 8.1 shows a graph of the student's results.

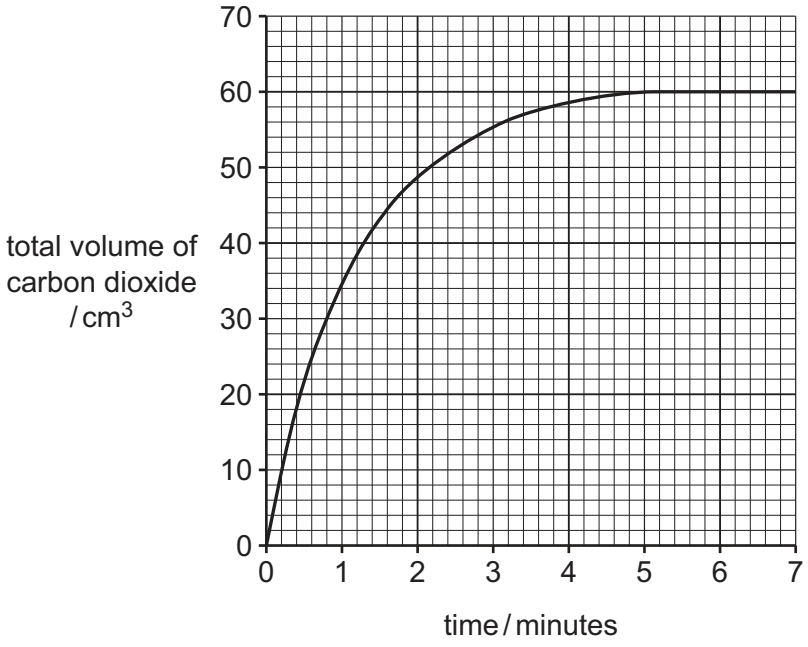

Fig. 8.1

(i) State when the reaction finished.

time = ... minutes [1]

(ii) The student repeats the experiment with **larger** pieces of calcium carbonate.

The student uses the same volume and concentration of hydrochloric acid and the same mass of calcium carbonate.

Draw on Fig. 8.1 the line for the student's results. [1]

(c) The student predicts the reaction will be faster with a higher concentration of hydrochloric acid.

Explain why the student is correct.

.....

.....

..... [2]

(d) Calculate the mass of calcium chloride, $CaCl_2$, made when 0.2 moles of hydrochloric acid react with excess calcium carbonate.

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

[A_r: Ca, 40; C*l*, 35.5; H, 1]

mass of calcium chloride = ... g [3]

[Total: 9]

9 **(a)** A torch (flashlight) consists of a battery, a switch and a lamp connected in series.

Fig. 9.1 shows a torch.

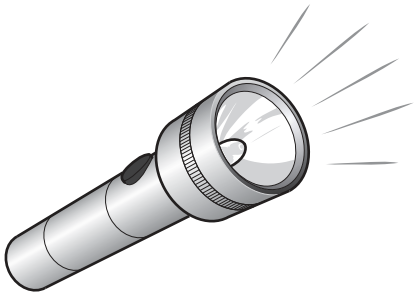

Fig. 9.1

(i) State the energy store which decreases when the battery powers the lamp.

..... [1]

(ii) State the energy transfer from the battery to the lamp.

..... [1]

(iii) State the energy transfer from the lamp to the surroundings.

..... [1]

(b) A diver with mass 70 kg stands 5.0 m above a swimming pool as shown in Fig. 9.2.

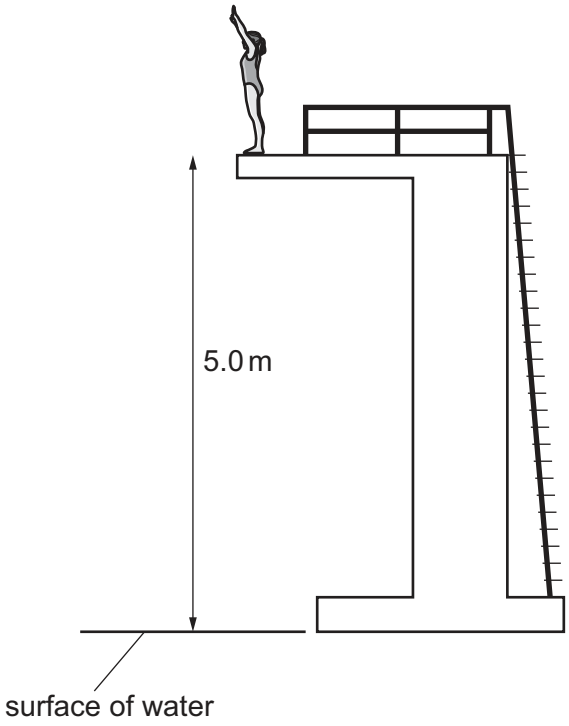

Fig. 9.2

(i) The diver falls 5.0 m.

Calculate the change in gravitational potential energy of the diver.

gravitational potential energy = ... J [2]

(ii) As the diver falls toward the water, there are no frictional forces acting on the diver.

State the kinetic energy of the diver just before entering the water.

kinetic energy = ... J [1]

(iii) Calculate the speed of the diver just before entering the water.

speed = ... m/s [2]

[Total: 8]

10 (a) (i) State the relationship between the direction of vibration and the direction of propagation of a transverse wave.

..... [1]

(ii) Circle **all** examples of transverse waves.

seismic P wave **sound** **ultraviolet**

visible light **water wave** [2]

(b) (i) On Fig. 10.1, draw the path of **two** rays of light from point **X** which reflect from the plane mirror.

Use the rays of light to locate the image of point **X** formed by the plane mirror.

Mark the position of the image with the letter **Y**.

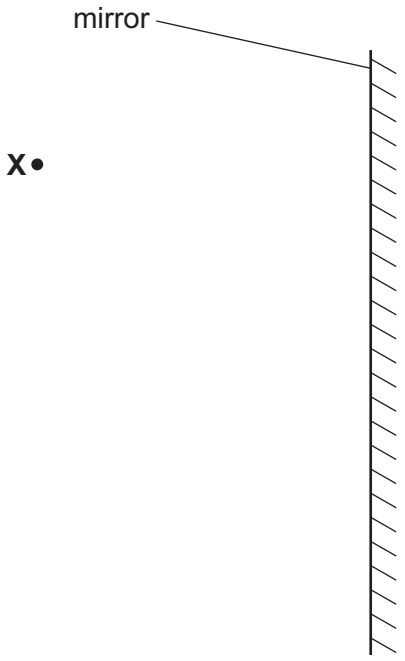

Fig. 10.1

[3]

(ii) Circle **all** the properties of the image formed by a plane mirror.

diminished **inverted (upside down)** **magnified**

real **upright** **virtual** [2]

(c) Blue light waves have a frequency of 6.6×10^{14} Hz.

The speed of light is 3.0×10^{8} m/s.

Calculate the wavelength of the blue light waves.

wavelength = ... m [2]

(d) When white light passes through a prism, it undergoes dispersion.

Describe dispersion in terms of wave frequency.

You may wish to draw a diagram to illustrate your answer.

.....

.....

..... [2]

[Total: 12]

11 **(a)** In a nuclear power station, the process of nuclear fission is used to generate electrical power.

Describe the process of nuclear fission.

.....

.....

..... [2]

(b) Uranium-235 has the nuclide notation $^{235}_{92}U$.

(i) State the number of protons in a nucleus of uranium-235.

..... [1]

(ii) Determine the number of neutrons in a nucleus of uranium-235.

..... [1]

(c) There is a step-up transformer in the nuclear power station.

(i) State the change made to the voltage by a step-up transformer.

..... [1]

(ii) Explain why a step-up transformer is used at the nuclear power station before transmission to homes.

.....

.....

.....

..... [3]

(d) A step-down transformer is used near homes.

The primary voltage is 30 000 V and the primary coil has 25 000 turns.

The secondary coil has 90 turns.

Calculate the secondary voltage.

secondary voltage = ... V [2]

[Total: 10]

12 **(a)** The explosion of a supernova forms a nebula.

State what may form from this nebula.

..... [1]

(b) **(i)** Describe how energy is released in a star such as the Sun.

.....

.....

.....

..... [3]

(ii) Energy is released in the core of the Sun.

Explain how thermal energy travels, by convection, through the outer gas layers of the surface of the Sun.

.....

.....

..... [2]

(iii) Energy from the Sun travels to Earth by radiation.

Satellites in orbit around the Earth can be in direct sunshine for long periods of time.

Suggest the colour and texture chosen for the outer surface of a satellite to limit the temperature of the satellite.

.....

..... [2]

(c) Complete the sentences to describe the Big Bang Theory.

The Universe initially expanded from a place of high ..... .

The Universe is still expanding.

The Universe is approximately ..... years old.

[2]

[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.).