Cambridge Assessment International Education

# Cambridge IGCSE™ (9–1)

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |



**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.

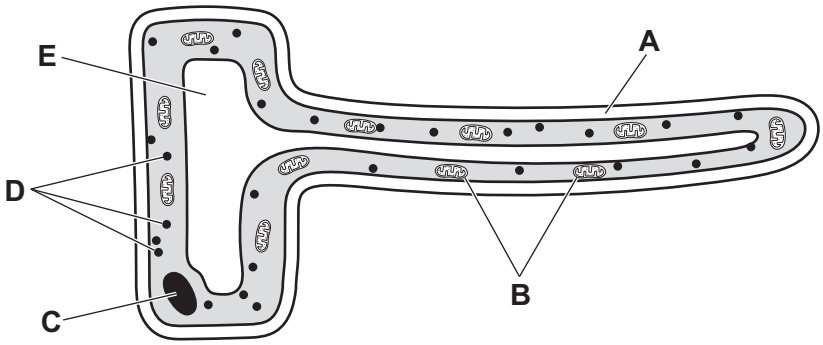



**Fig. 1.1**

**(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.

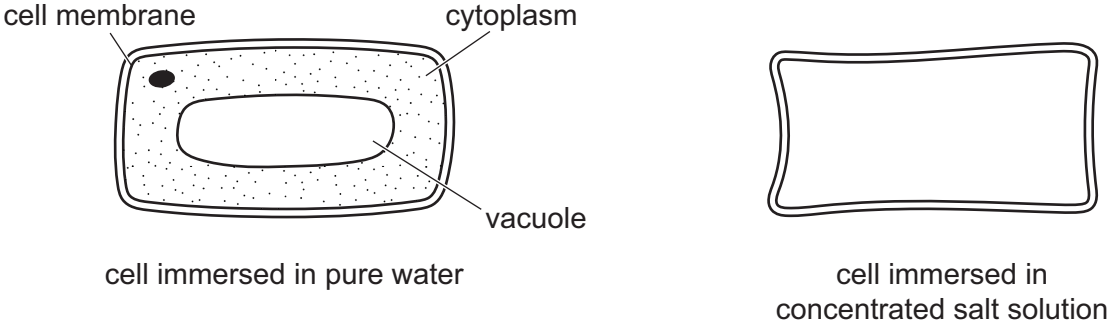



**Fig. 1.2**

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.

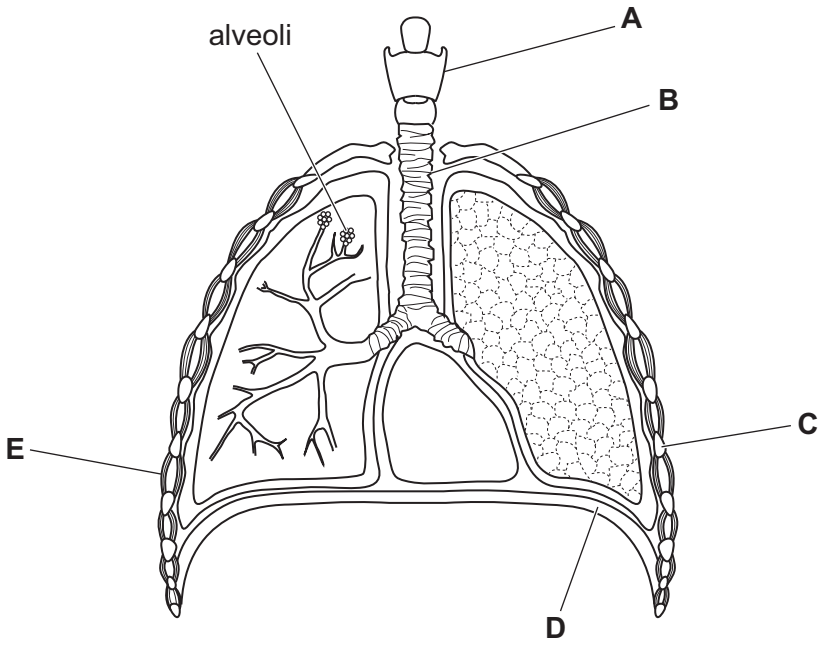



**Fig. 2.1**

**(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.

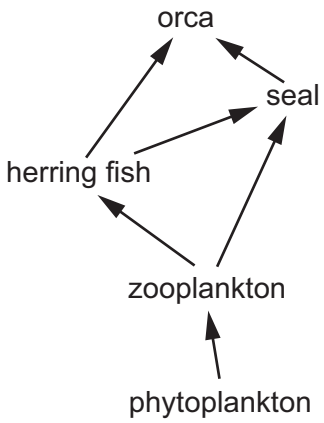



**Fig. 4.1**

**(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.

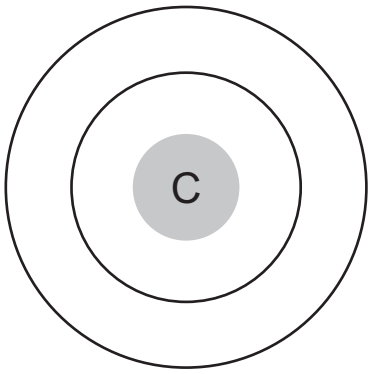



**Fig. 5.1**

[1]

**(b)** A carbon atom has 6 neutrons.

State the mass number of this carbon atom.

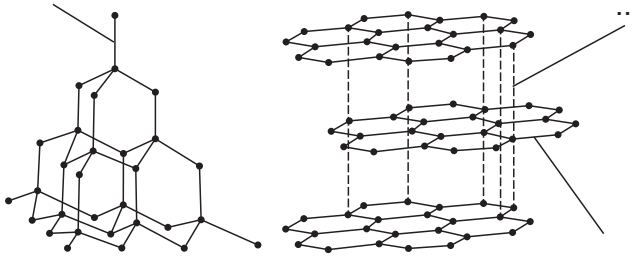
mass number = ..... [1]

**(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.

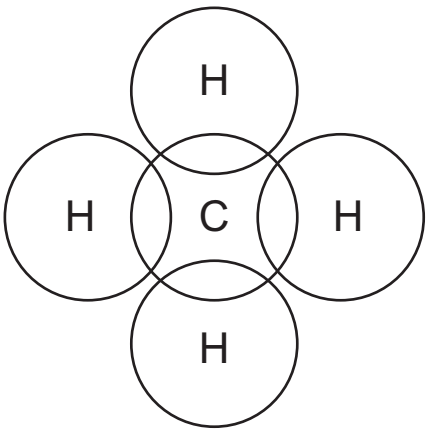



**Fig. 5.3**

[2]

[Total: 10]

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

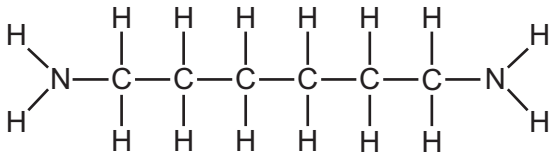


**Fig. 6.1**

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

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

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

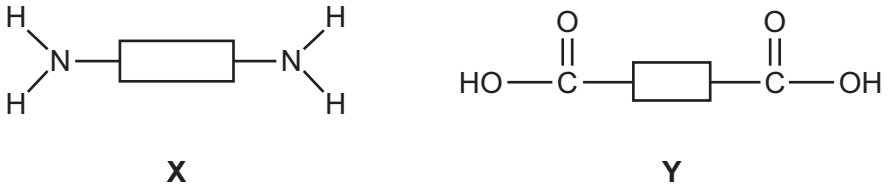
.....

..... [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.

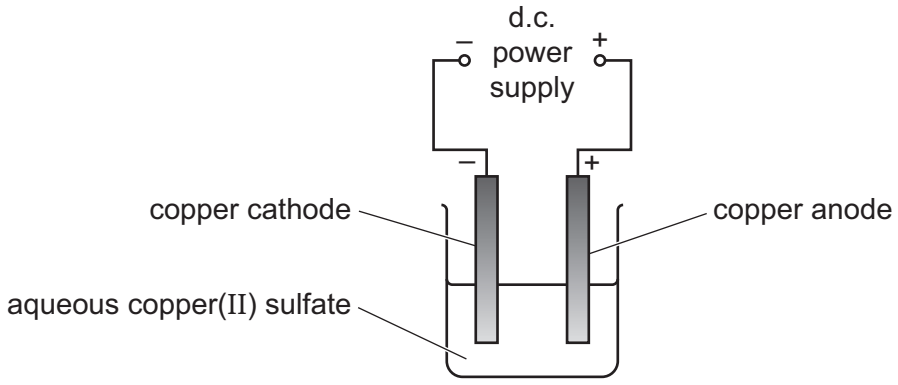



**Fig. 7.1**

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

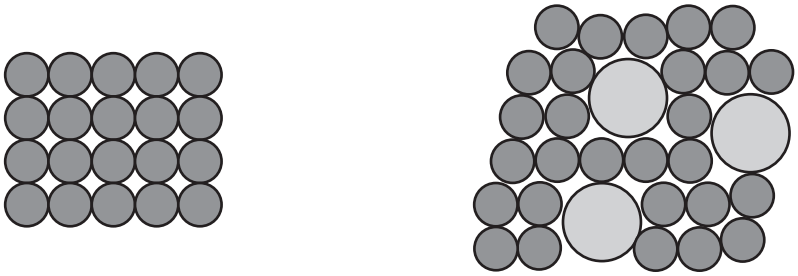
[2]

**(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.

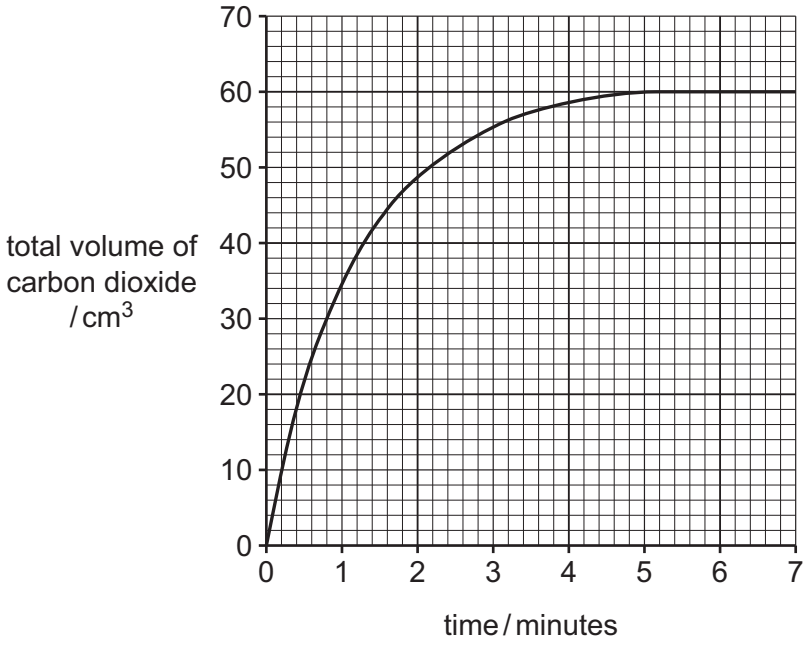


**Fig. 8.1**

**(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.

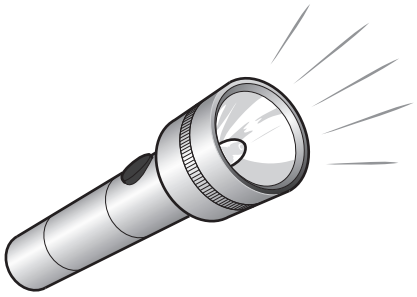

**Fig. 9.1**

**(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.

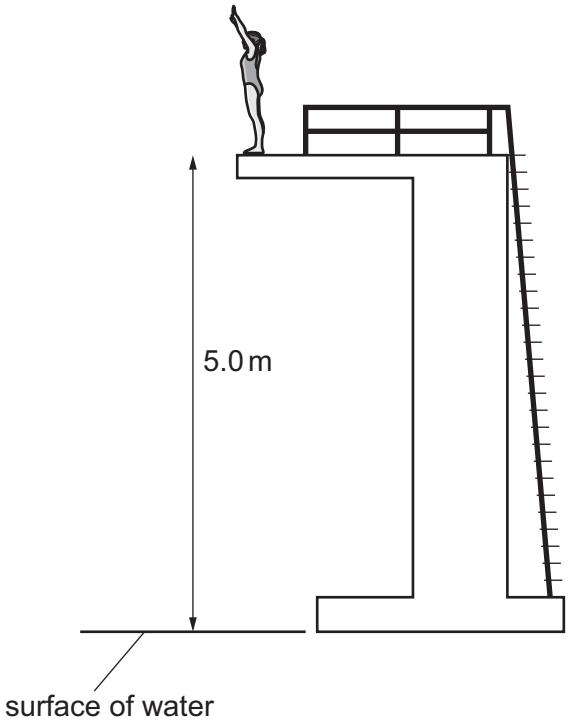


**Fig. 9.2**

**(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**.

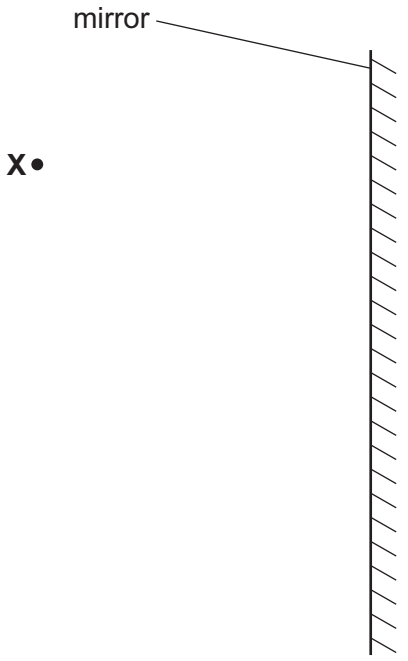


**Fig. 10.1**

[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 $6.6 \times 10^{14}$ Hz.

The speed of light is $3.0 \times 10^{8}$ 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.).