Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

PHYSICAL SCIENCE **0652/41**

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

1 hour 15 minutes

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 80.
- 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/FC) 337859/4

[Turn over

1 **(a)** Fig. 1.1 shows the structures of some substances, **A**–**F**.

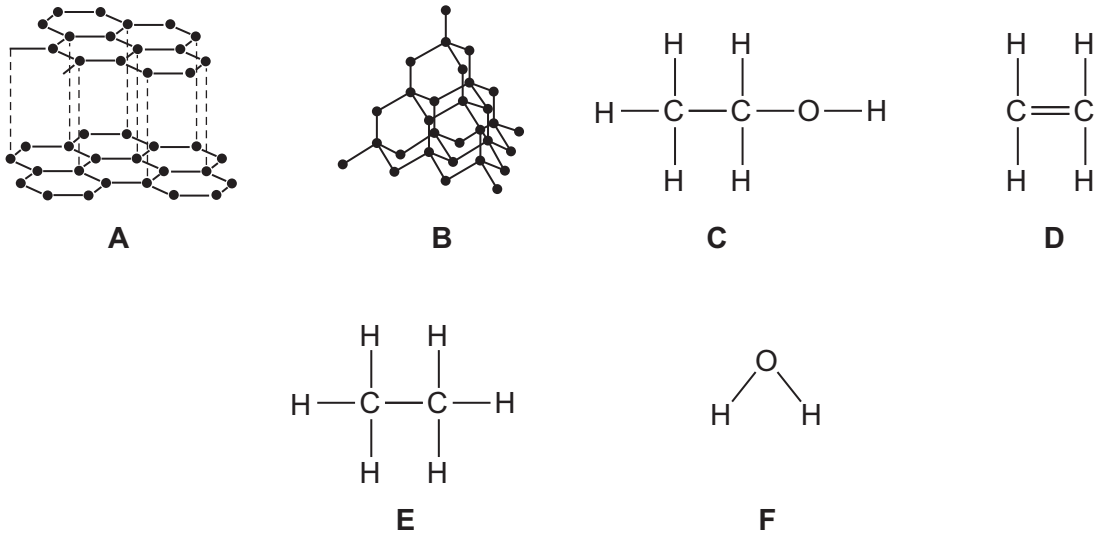

Fig. 1.1

Use the letters **A**–**F** to answer the questions that follow.

Each letter may be used once, more than once or not at all.

State which substance:

(i) has the molecular formula C_2H_6

..... [1]

(ii) reacts with bromine in an addition reaction

..... [1]

(iii) is an alkane

..... [1]

(iv) is formed by fermentation

..... [1]

(v) is a product of the complete combustion of methane

..... [1]

(vi) has a giant structure and is used as a lubricant.

..... [1]

(b) Carbon dioxide, CO_2, is a covalent compound.

Complete Fig. 1.2 to show the dot-and-cross diagram for a molecule of CO_2.

Show outer shell electrons only.

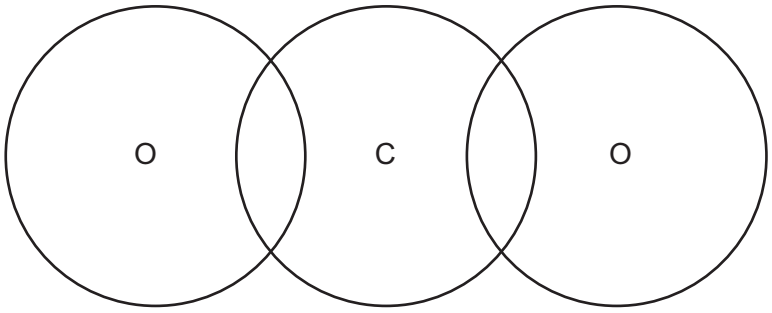

Fig. 1.2

[2]

[Total: 8]

2 **(a)** A long thin wire is attached to the ceiling, as shown in Fig. 2.1.

Different loads are suspended from the wire.

The extension for the different loads is measured.

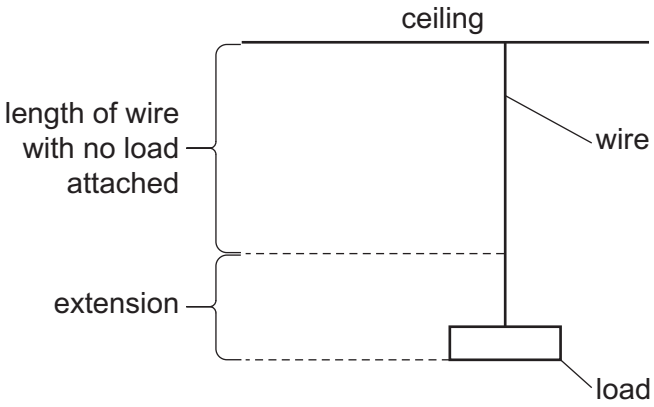

Fig. 2.1

Fig. 2.2 shows a graph of the results.

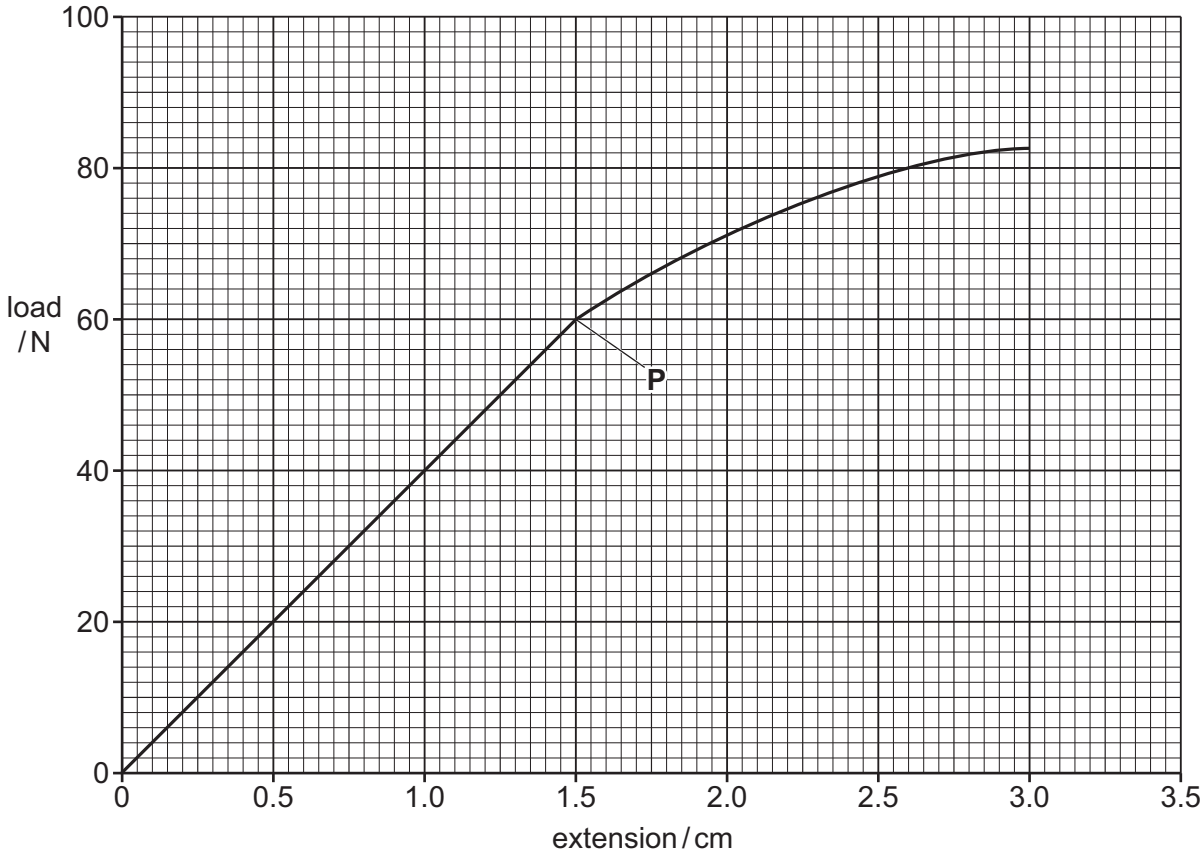

Fig. 2.2

(i) Calculate the spring constant for the wire.

Give a suitable unit.

spring constant = ... unit ..... [3]

(ii) Name point **P** shown in Fig. 2.2.

..... [1]

(b) As the wire is stretched it becomes thinner.

Name an instrument suitable for measuring the diameter of a thin wire.

..... [1]

(c) Describe how changing the length and changing the cross-sectional area of a wire affects the electrical resistance.

length .....

.....

cross-sectional area .....

.....

[2]

[Total: 7]

3 **(a)** Sodium chloride, NaCl, is an ionic compound.

(i) Complete Fig. 3.1 to show the arrangement of the electrons in the ions in NaCl.

Show the charges on the two ions.

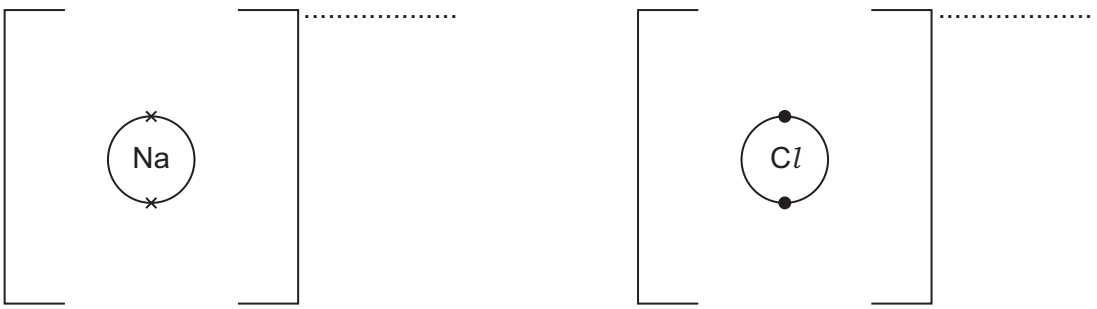

Fig. 3.1

[3]

(ii) Complete the sentences which describe the ionic structure of NaCl.

NaCl is a ..... structure.

The ions are in a ..... arrangement.

[2]

(b) Chlorine is an element in Period 3 of the Periodic Table.

Explain how the electronic structure of chlorine shows this information.

.....

..... [1]

(c) Chlorine reacts with iron to form iron(III) chloride, $FeCl_3$.

Write the symbol equation for this reaction.

..... [2]

(d) Chlorine, bromine and astatine are in Group VII of the Periodic Table.

Chlorine is a pale yellow-green gas at room temperature and pressure.

Bromine is a red-brown liquid at room temperature and pressure.

Predict the colour and state of astatine at room temperature and pressure.

colour .....

state .....

[2]

(e) Explain why neon will **not** react with chlorine.

.....

.....[1]

[Total: 11]

4 **(a)** A radioactive source emits three different types of radiation.

Name the **three** types of radiation.

1 .....

2 .....

3 .....

[3]

(b) Fig. 4.1 shows the deflection of the three types of radiation, **A**, **B** and **C**, in the electric field between two metal plates.

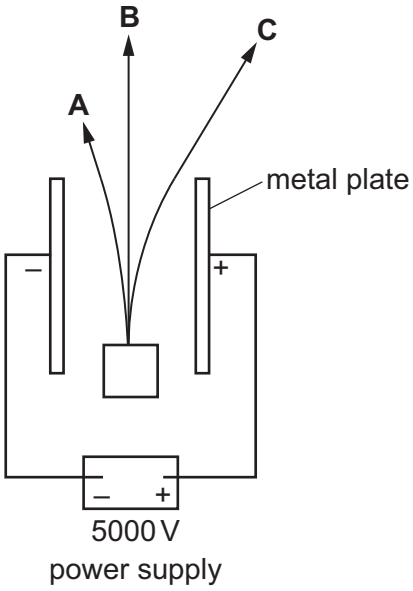

Fig. 4.1

(i) Explain why **C** deflects more than **A**.

.....

..... [1]

(ii) Explain why **B** is **not** deflected.

.....

..... [1]

(c) Fig. 4.2 shows a ball suspended between two metal plates.

The ball is suspended using an insulating thread.

The ball is light and is covered with thin metal foil.

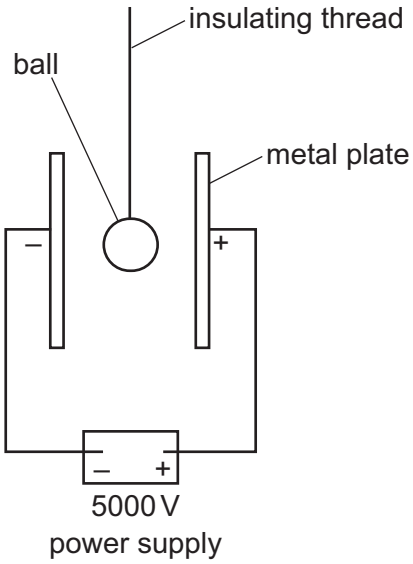

Fig. 4.2

The ball is given a positive charge and released.

The ball swings to the left and touches the negative plate.

(i) Explain in terms of transfer of particles what happens when the ball touches the negative plate.

.....

..... [2]

(ii) The ball swings backwards and forwards hitting the plates on either side.
After touching the positive plate, the ball becomes positively charged.

State why the ball then moves towards the negative plate.

.....

..... [1]

[Total: 8]

5 Calcium carbonate is heated strongly. Calcium oxide and carbon dioxide are produced. The reaction is endothermic.

The equation for the reaction is shown.

$$CaCO_3 \rightarrow CaO + CO_2$$

(a) State the type of reaction that takes place.

..... [1]

(b) Calculate the mass of CaO produced from 15.3 g of $CaCO_3$.
[A_r: Ca, 40; C, 12; O, 16]

Use the following steps.

- Determine the relative molecular mass, M_r, of $CaCO_3$.

M_r = ...

- Use the equation for the reaction to determine the stoichiometric ratio of $CaCO_3$: CaO.

ratio = ... : .....

- Calculate the mass of CaO produced from 15.3 g of $CaCO_3$.

mass of CaO = ... g
[3]

(c) Explain why **one** of the products of this reaction is an atmospheric pollutant.

.....

..... [1]

(d) Explain why it is important to treat some soils with calcium carbonate.

.....

.....

.....

..... [2]

(e) Circle the term that classifies calcium oxide.

acidic **amphoteric** **basic** **neutral**

[1]

[Total: 8]

6 Fig. 6.1 shows a type of simple d.c. electric motor which consists of a metal wheel, liquid metal mercury and two magnets.

A current passes through the metal wheel and through the mercury.

The wheel rotates in the direction shown.

Key

◄— direction of current

direction of rotation of wheel

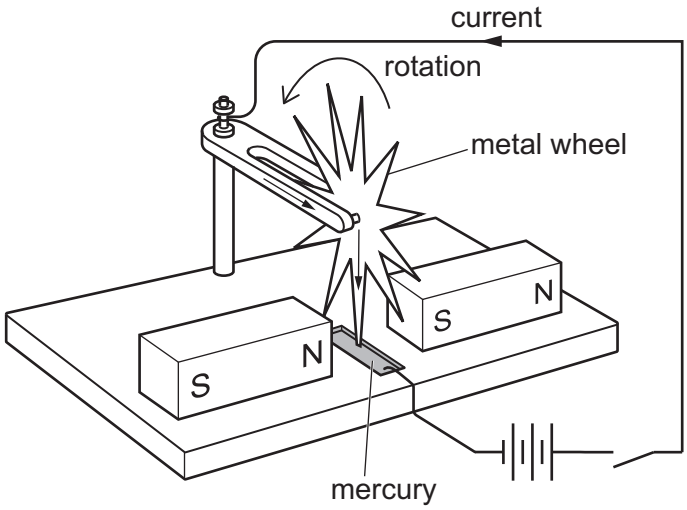

Fig. 6.1

(a) The moment of the force on the wheel is 0.72 N cm.

The distance from the centre of the wheel to the surface of the mercury is 6 cm.

Calculate the force on the wheel.

force = ... N [2]

(b) A student suggests four changes, **A**–**D**, to the motor in Fig. 6.1.

A Increase the current.

B Reverse the direction of the current.

C Reverse the poles of **one** magnet.

D Reverse the poles of **both** magnets.

(i) Circle the **two** changes which each cause the wheel to rotate in the opposite direction.

A **B** **C** **D**

[2]

(ii) Circle the change which stops the wheel rotating.

A **B** **C** **D**

[1]

(c) The battery is replaced by an ammeter as shown in Fig. 6.2.

Key

→ direction of current

↶ direction of rotation of wheel when turned by hand

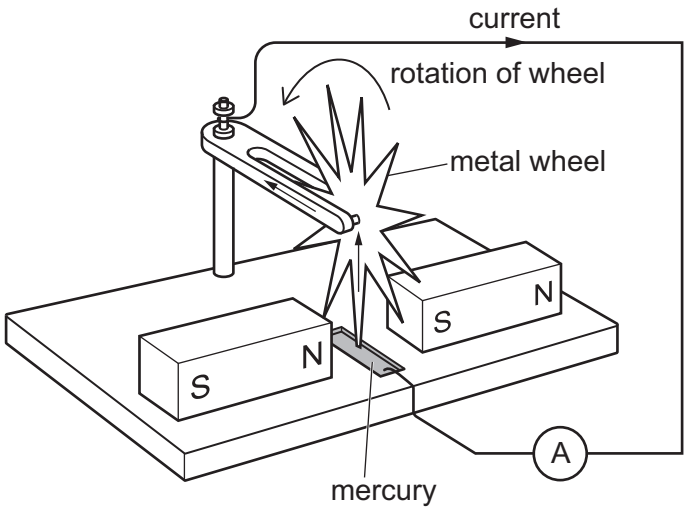

Fig. 6.2

The wheel is turned by hand in the same direction as in Fig. 6.1.
An electromotive force (e.m.f.) is induced.
The e.m.f. causes a current in the opposite direction to the current in Fig. 6.1.

Explain why this current must be in the opposite direction to Fig. 6.1.

.....

.....

..... [1]

[Total: 6]

7 Magnesium reacts with dilute hydrochloric acid.

(a) Suggest the pH of dilute hydrochloric acid.

pH = ... [1]

(b) Describe the difference between acids and bases in terms of transfer of protons.

.....

..... [1]

(c) The magnesium and dilute hydrochloric acid react together in a conical flask.

(i) Bubbles of gas are observed during the reaction.

Name the gas produced.

..... [1]

(ii) The reaction stops. Some magnesium is left in the conical flask.

Suggest a conclusion using this information.

.....

..... [1]

(d) No bubbles of gas are produced when aluminium is added to dilute hydrochloric acid.

Explain this observation.

.....

..... [1]

(e) State **two** properties of aluminium that explain why it is used in aircraft parts.

1 .....

2 .....

[2]

(f) Aluminium is used in the test for nitrate ions.

State the type of reaction that happens in this test.

..... [1]

[Total: 8]

8 **(a)** Fig. 8.1 shows transverse waves on a section of a long rubber cord.

The waves travel a distance of 2.7 m in 0.80 s.

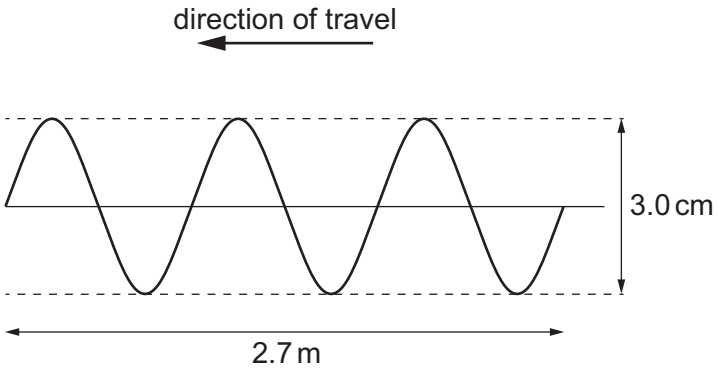

Fig. 8.1 (not to scale)

(i) On Fig. 8.1 draw an arrow (↔ or ↕) to indicate the amplitude of the waves. [1]

(ii) State the number of complete waves shown in Fig. 8.1.

number of complete waves = ... [1]

(iii) Determine the wavelength of the waves in Fig. 8.1.

wavelength = ... m [1]

(iv) Calculate the frequency of the waves in Fig. 8.1.

frequency = ... Hz [2]

(v) Calculate the speed of the waves in Fig. 8.1.

speed of waves = ... m/s [2]

(b) Describe what is meant by a transverse wave.

.....

.....

..... [2]

[Total: 9]

9 Fig. 9.1 shows a fractionating column used in the fractional distillation of petroleum.

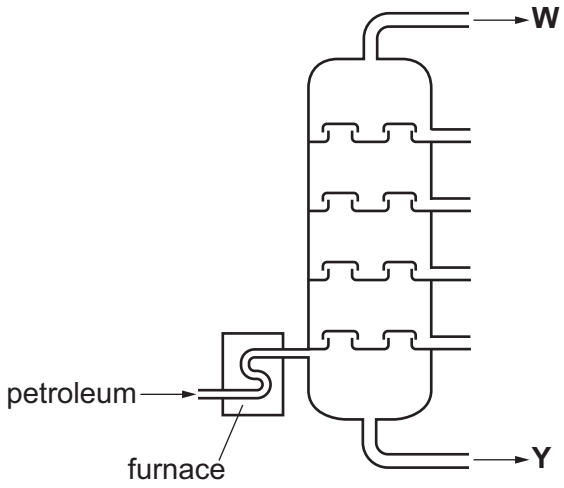

Fig. 9.1

(a) Write an **X** in the hottest part of the fractionating column. [1]

(b) Name the fraction produced at **Y**.

..... [1]

(c) Naphtha is a fraction produced from petroleum.

State **one** use for naphtha.

..... [1]

(d) Compare the properties of the fractions produced at **W** with the fractions produced at **Y**.

.....

.....

.....

..... [2]

[Total: 5]

Question 10 starts on page 18.

10 **(a)** Fig. 10.1 shows a ray of light travelling through air and entering a rectangular glass block.

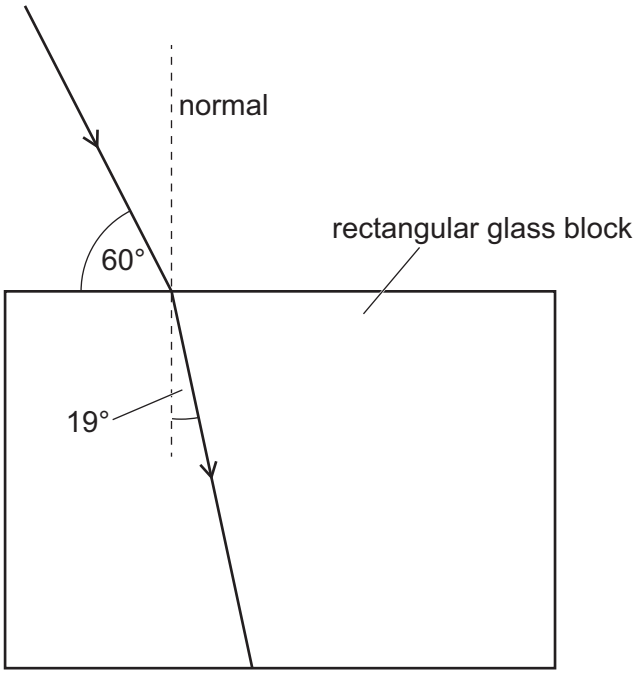

Fig. 10.1

State the angle of incidence and the angle of refraction for the ray as it enters the glass block.

angle of incidence = ...°

angle of refraction = ...°

[1]

(b) A different glass block has a refractive index of 1.6.

(i) Determine the speed of light in this glass block.

[speed of light in air = 3.0×10^8 m/s]

speed of light in glass = ... m/s [2]

(ii) A ray of light enters the glass block in **(b)(i)**.

The angle of incidence is 50°.

Calculate the angle of refraction.

angle of refraction = ...° [2]

(c) Fig. 10.2 shows a ray diagram of an object, a lens and the image formed by the lens.

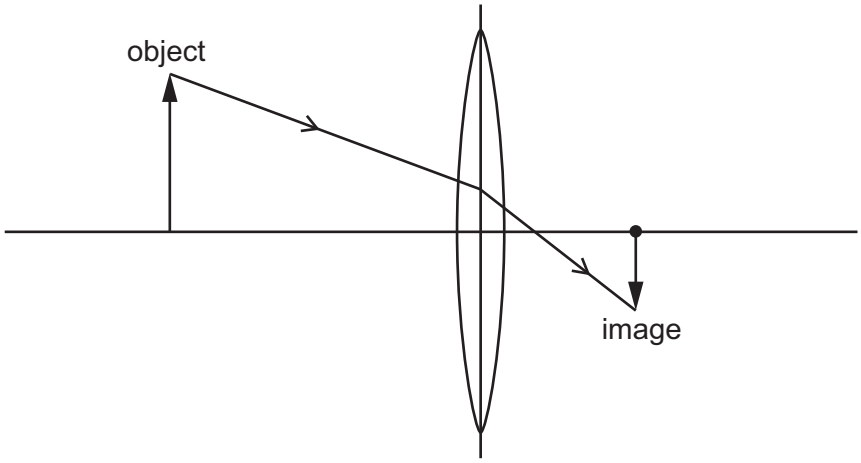

Fig. 10.2

(i) On Fig. 10.2, draw **one** ray from the top of the object to the image that passes through the focal point of the lens.

Label the focal point of the lens with **F**.

[2]

(ii) The image in Fig. 10.2 is diminished, inverted and real.

Describe the meaning of these terms.

diminished .....

inverted .....

real .....

[3]

[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.).