Cambridge IGCSE

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

PHYSICAL SCIENCE 0652/04

Paper 4 Theory (Extended) **For Examination from 2019**

SPECIMEN PAPER

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 22.

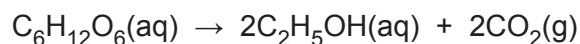At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **22** printed pages.

CAMBRIDGE
International Examinations

[Turn over

1 Ethanol can be made by fermentation.

Yeast is added to aqueous glucose.

$$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

Carbon dioxide is given off and the mixture becomes warm.

(a) The rate of reaction can be calculated by measuring the quantity of product formed at regular intervals.

Suggest the measurements you need to make to calculate the rate of this reaction.

....

....

.... [2]

(b) The graph in Fig. 1.1 shows how the rate of reaction changes with time.
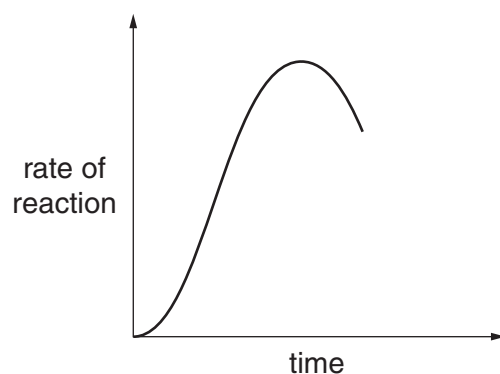
Fig. 1.1

Suggest why the rate of reaction is initially increasing.

....

.... [1]

[Total: 3]

2 A solar panel is mounted on the roof of a house. Fig. 2.1 shows a section through part of the solar panel.
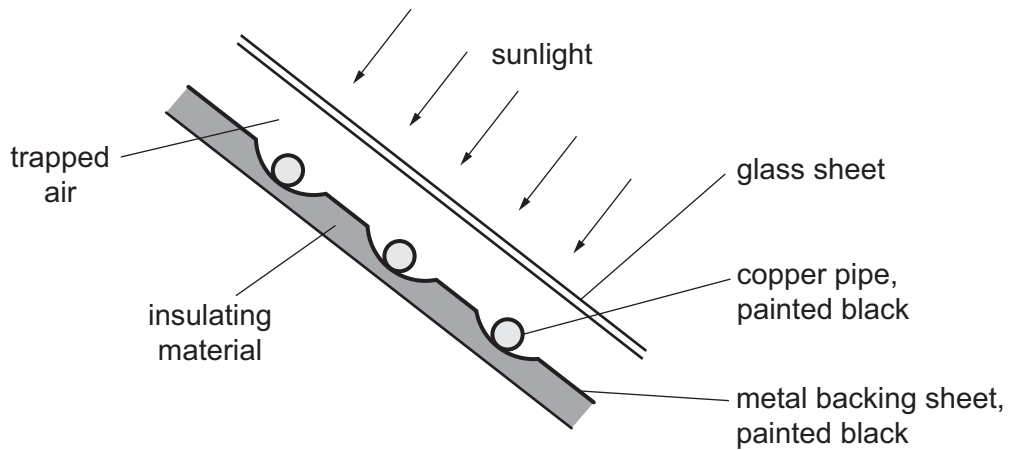
Fig. 2.1

Water is pumped through the copper pipes. The water is heated as it flows through the solar panel.

Explain **three** features of this solar panel that increase the final temperature of the water.

Feature 1. ....

Explanation ....

   ....

Feature 2. ....

Explanation ....

   ....

Feature 3. ....

Explanation ....

   ....
[4]

[Total: 4]

3 **(a)** The equation shows the reaction for the combustion of methane.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

   (i) This reaction releases energy.

   State the term used to describe a chemical reaction that releases energy.

   .... [1]

   (ii) Use ideas about bond breaking and bond forming to explain why energy is released in this reaction.

   ....

   ....

   ....

   .... [3]

(b) Name the fossil fuel that consists mainly of methane.

.... [1]

[Total: 5]

4 (a) A sulfur atom has 16 protons and 16 electrons.

A sulfur ion has a 2$^-$ charge.

(i) Complete Fig. 4.1 to show the electron arrangement in a sulfur ion, S^{2-}.
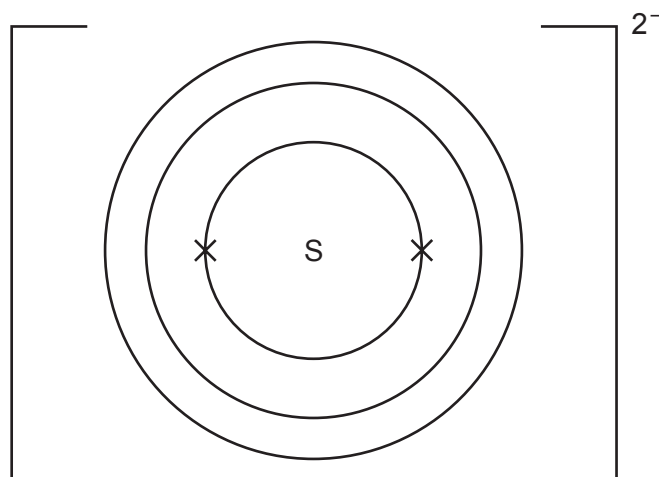

Fig. 4.1

[2]

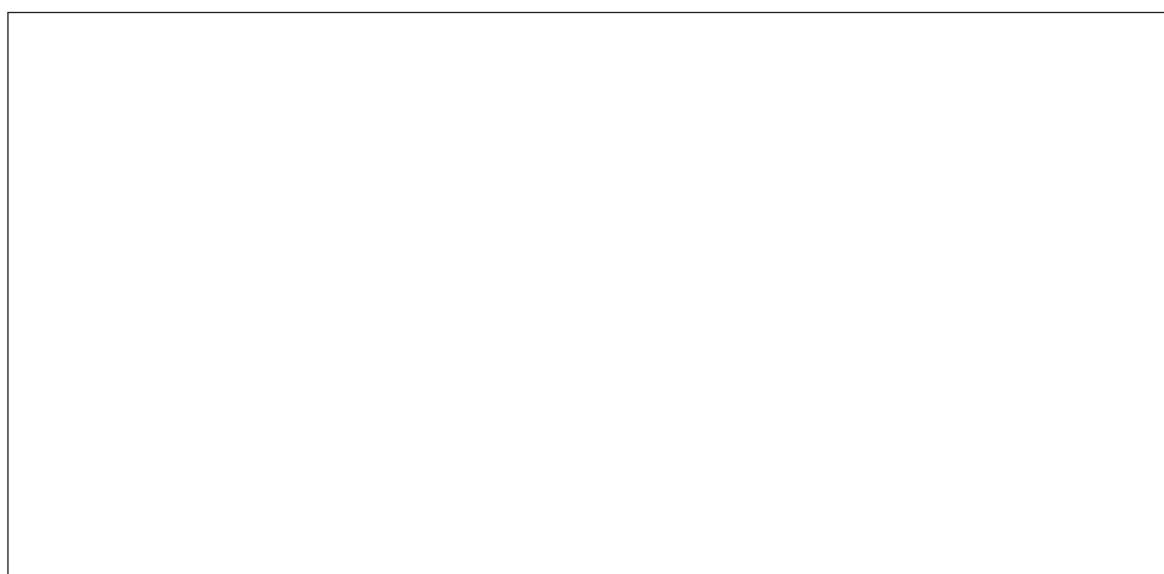**(ii)** Sulfur forms the ionic compound sodium sulfide.

Predict the formula of sodium sulfide.

.... [1]

(b) Methanol, CH$_3$OH, is a covalent compound.

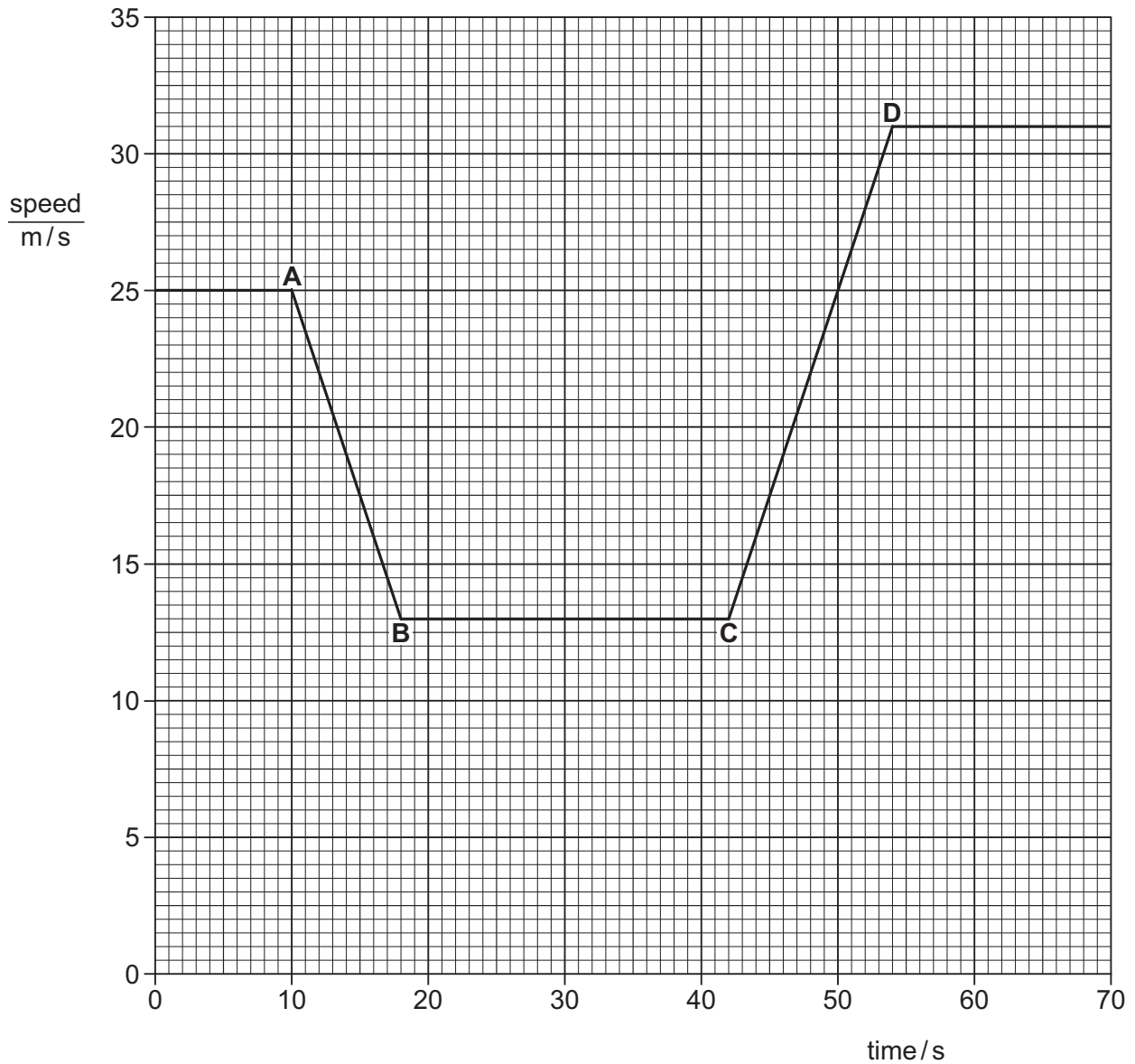Draw a dot-and-cross diagram to represent the bonding in a molecule of methanol.

You only need to show the outer electrons of each atom.

[3]

[Total: 6]

 [Turn over

5 Fig. 5.1 shows the speed-time graph for a car travelling along a straight road. The car enters a small town at point **B** and leaves at point **C**.

Fig. 5.1

Calculate the distance the car travels between the start of the town (point **B**) and the end of the town (point **C**).

Show your working.

distance = ... m [3]

(b) Calculate the acceleration of the car between points **C** and **D**.

Show your working.

acceleration .... m/s² [3]

(c) State how the graph shows that the deceleration of the car (points **A** to **B**) and the acceleration of the car are the same size (points **C** to **D**).
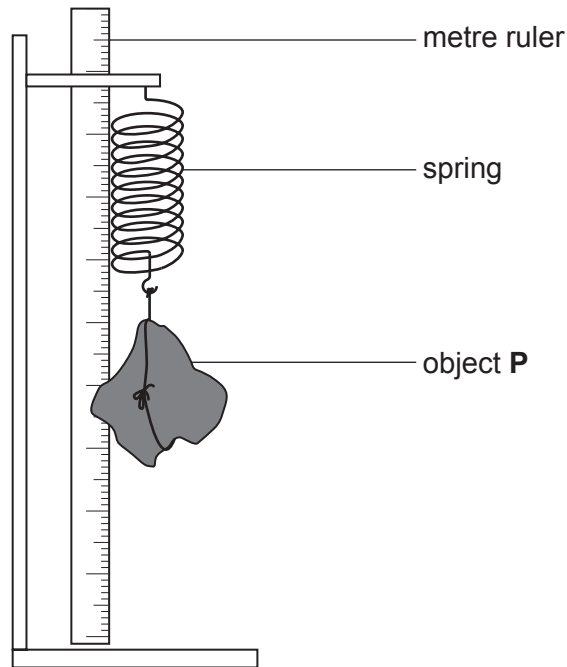
....

.... [1]

[Total: 7]

6   A student wants to find the density of an irregular object **P**.

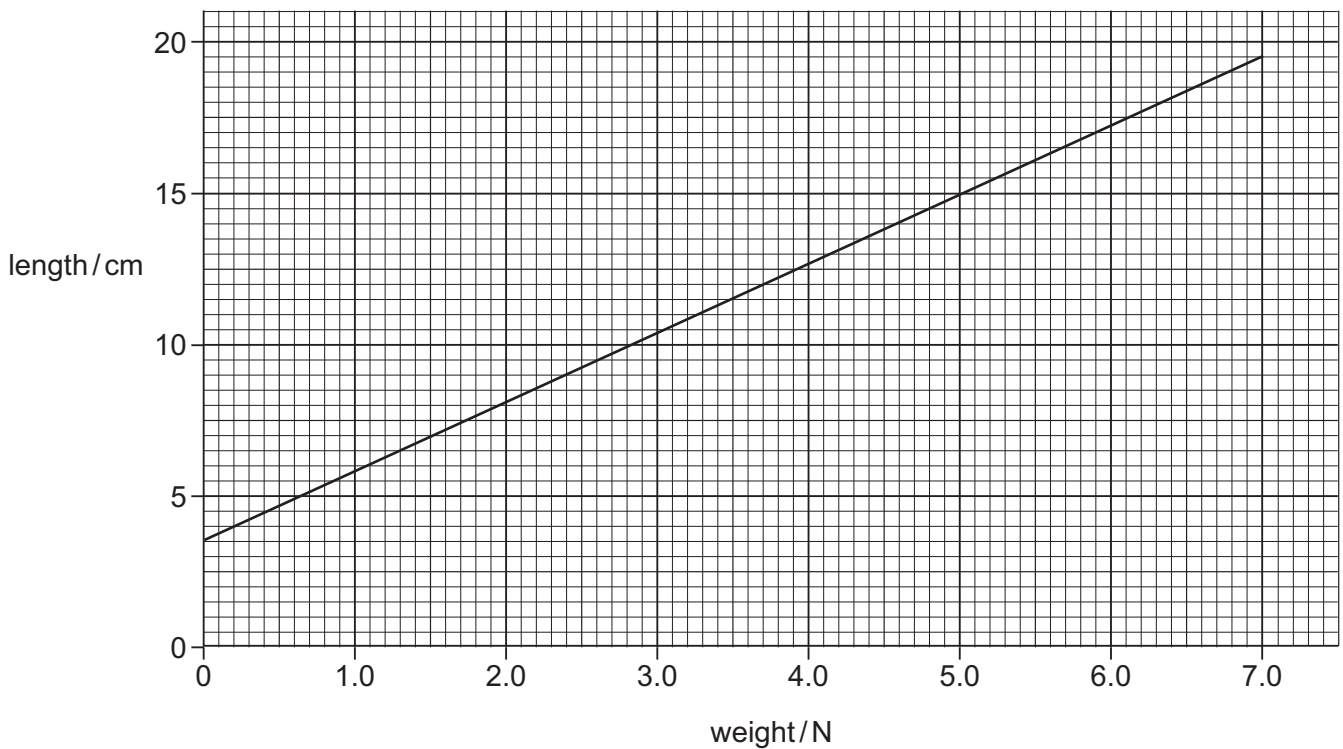To find the mass of **P**, he suspends a spring and a metre ruler from a stand and clamp.

He hangs **P** from the spring as shown in Fig. 6.1.

Fig. 6.1

He records the length of the spring with **P** hanging from it.

He removes **P**. He records the length of the spring with different weights added to it. He uses these results to plot the graph in Fig. 6.2.

Fig. 6.2

The length of the spring with **P** hanging from it is 16.0 cm.

(a) **(i)** Determine the weight of **P**.

weight = ... N [1]

(ii) Calculate the mass of **P** and state the unit.

Gravitational field strength g = 10 N/kg

mass = ... unit = ... [2]

(b) In order to calculate the density of **P**, the student needs to find its volume.

Describe how the volume of **P** can be found.

....

....

....

.... [3]

(c) The volume of **P** is found to be 180 cm^3.

Calculate the density of **P** in g/cm^3.

density = ... g/cm^3 [2]

[Total: 8]

7 A teacher demonstrates the properties of waves using a shallow container of water.

A barrier with a small gap is placed in the container.
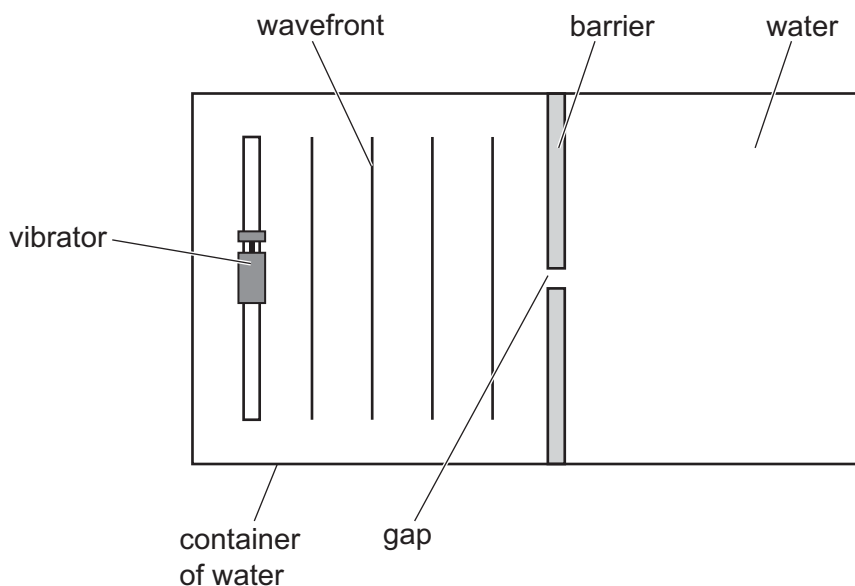
Fig. 7.1 shows a view of the container from above.

Fig. 7.1

The vibrator produces a series of waves of constant frequency. These waves move towards the barrier and pass through the gap.

(a) State what is meant by the term *frequency*.

....

....

.... [1]

(b) (i) On Fig. 7.1, draw **three** wavefronts after they pass through the gap. [3]

(ii) Name the wave property demonstrated by the waves that have passed through the gap.

.... [1]

(c) The barrier is replaced by a similar barrier with a much wider gap.

Compare the waves after they have passed through the original gap with the waves that have passed through the wider gap. Describe **one** similarity and **one** difference.

similarity ....

....

difference ....

....

[2]

[Total: 7]

8 **(a)** The elements in Group III of the Periodic Table show similarities in their atomic structures.

(i) State the number of outer shell electrons in atoms of elements in Group III.

.... [1]

(ii) State the relationship between group number and outer shell electrons.

....

.... [1]

Table 8.1 shows information about elements in Group III of the Periodic Table.

Table 8.1

element	symbol	melting point/°C	boiling point/°C	density/g per cm³	electrical conductivity
boron	B	2300	3659	2.3	poor
aluminium	Al	661	2467	2.7	good
gallium	Ga	30	2400	5.9	fair
indium	In	156	2080	7.3	good
thallium	Tl	304	1457	11.9	fair

(b) Describe two general trends in properties of the Group III elements shown in Table 8.1.

1. ....

....

2. ....

....
[2]

(c) Aluminium is a metal.

(i) Describe the bonding in metals.

....

....

.... [2]

(ii) Use ideas about the bonding in metals to explain how they conduct electricity.

....

....

....

[2]

[Total: 8]

9 The graph in Fig. 9.1 shows the variation of current with potential difference across a lamp **X**.
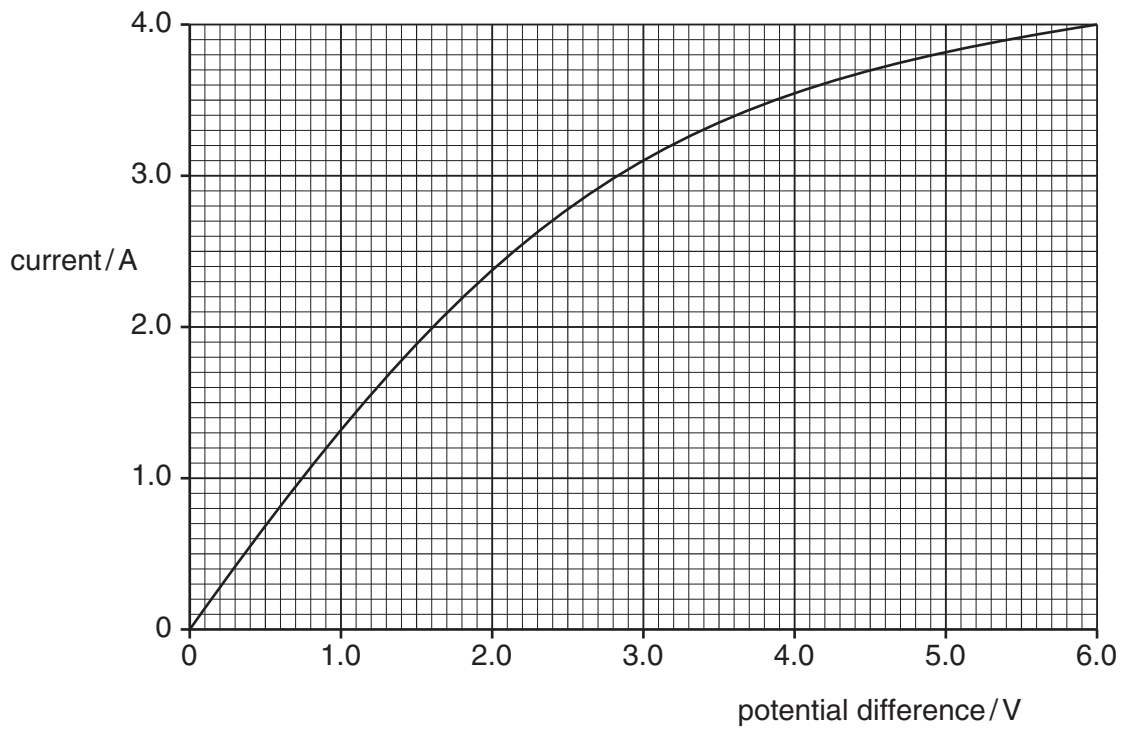
Fig. 9.1

(a) Use the graph to explain how the resistance changes as the current in the lamp is increased.

....

....

.... [2]

(b) The circuit in Fig. 9.2 contains lamp **X** and another lamp **Y**.

Lamp **Y** is rated 3.0 V, 12.0 W.
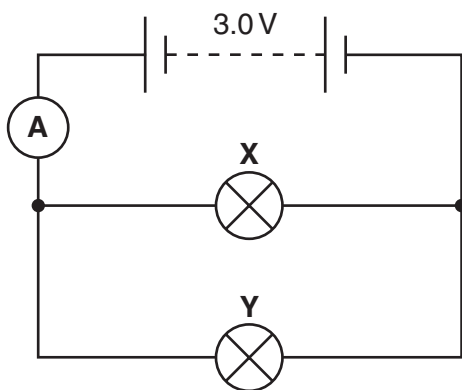
Fig. 9.2

(i) Use the graph in Fig. 9.1 to determine the current in lamp **X** when the potential difference is 3.0 V.

current = ... A [1]

(ii) Calculate the current in lamp **Y**.

Show your working.

current = ... A [2]

(iii) Calculate the total current in the circuit measured by the ammeter.

current = ... A [1]

(iv) Calculate the total charge that passes through the ammeter in 300 s.

Show your working.

charge = ... C [2]

[Total: 8]

10 Petroleum (crude oil) is separated into fractions by fractional distillation.

The bar chart in Fig. 10.1 shows the supply (the amount made) and the demand (the amount required) for each fraction from petroleum.

The fractions increase in molecular size from gases (smallest) to fuel oil (largest).
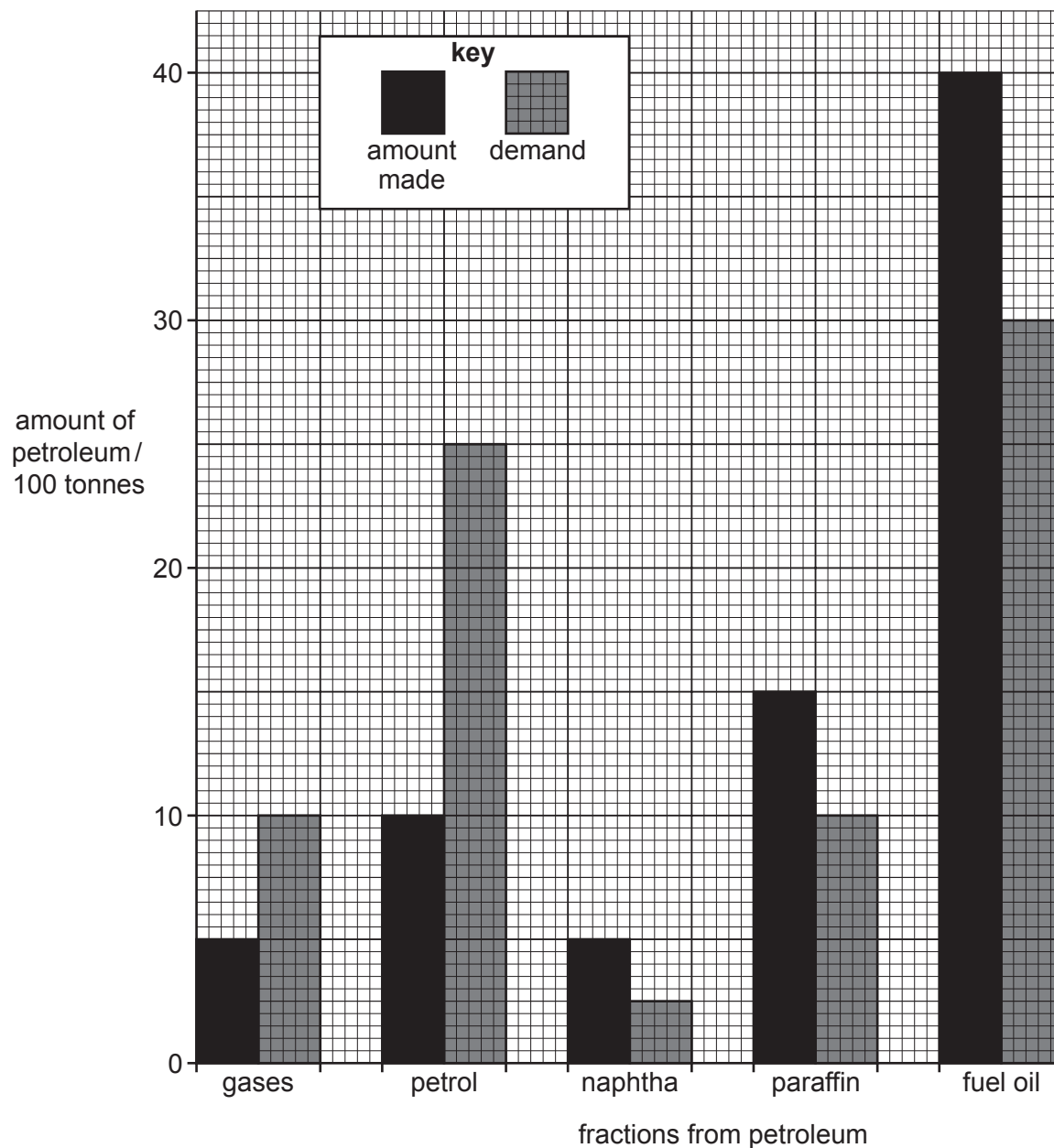
Fig. 10.1

(a) Compare the trend in supply and demand shown in Fig. 10.1.

....

....

.... [2]

(b) The process of cracking is used on some of the fractions in Fig. 10.1.

(i) Explain what is meant by *cracking*.

....

....

....

.... [2]

(ii) Explain the effect of cracking on the supply of fractions shown in Fig. 10.1.

....

....

.... [2]

(c) Ethene can be made from petroleum.

Ethene belongs to the homologous series of alkenes.

(i) Explain what is meant by the term *homologous series*.

....

....

.... [2]

(ii) State how the structure of ethene shows that it is an alkene.

.... [1]

[Total: 9]

11 The isotope $^{231}_{91}$Pa is unstable and decays by emitting an α-particle to form nuclide X.

(a) (i) Complete this equation to describe the decay of $^{231}_{91}$Pa

$$^{231}_{91}\text{Pa} \rightarrow ^{....}_{....}\text{X} + ^{....}_{....}\alpha$$

[2]

(ii) Identify element X.

.... [1]

(b) The half-life of the isotope $^{231}_{91}$Pa is 3.4×3400 years.

(i) State what is meant by the term *half-life*.

....

....

.... [1]

(ii) Calculate the time it takes for the activity of a sample of $^{231}_{91}$Pa to fall to $\frac{1}{8}$ of its original value.

Show your working in the box.

time = ... years

[2]

[Total: 6]

Question 12 starts on page 20

 [Turn over

12 Cuprite, malachite and tenorite are ores that contain copper.

Each ore contains a different copper compound.

Each copper compound is heated with carbon to extract copper metal.

(a) Complete Table 12.1.

[Relative atomic masses: Ar: C, 12; Cu, 64; O, 16.]

Table 12.1

ore	formula of copper compound in ore	relative formula mass (RFM)	mass of copper in RFM	maximum mass of copper extracted from one tonne of copper compound / tonne
cuprite	Cu_2O	144	128	....
malachite	$CuCO_3$	124	....	0.52
tenorite	CuO	80	64	0.80

[2]

(b) The equation for the extraction of copper from copper carbonate (malachite) is shown.

$$2CuCO_3 + C \rightarrow 2Cu + 3CO_2$$
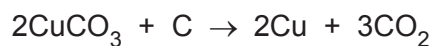
Calculate the mass of copper that is extracted from 5.0 tonnes of copper carbonate.
Show your working in the box.

mass of copper .... tonnes

[3]

(c) Cuprite, Cu_2O, is heated with carbon to extract copper.

Write the balanced symbol equation for the extraction of copper from cuprite.

.... [2]

(d) Carbon is also used in the extraction of iron in the blast furnace.

   (i) State the name of the iron ore used in the blast furnace.

   .... [1]

   (ii) The overall equation for the extraction of iron is shown.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$
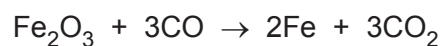
   State which chemical is reduced during this extraction process.

   .... [1]

[Total: 9]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII

Key

atomic number
atomic symbol
name
relative atomic mass

I	II											III	IV	V	VI	VII	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 –		114 Fl flerovium –		116 Lv livermorium –		

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.).