



Cambridge IGCSE™

CANDIDATE
NAME

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--



PHYSICAL SCIENCE

0652/41

Paper 4 Theory (Extended)

October/November 2022

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 **20** pages.

1 A ball of mass 84 g is dropped from the top of a high building.

The graph in Fig. 1.1 shows the speed of the ball as it falls.

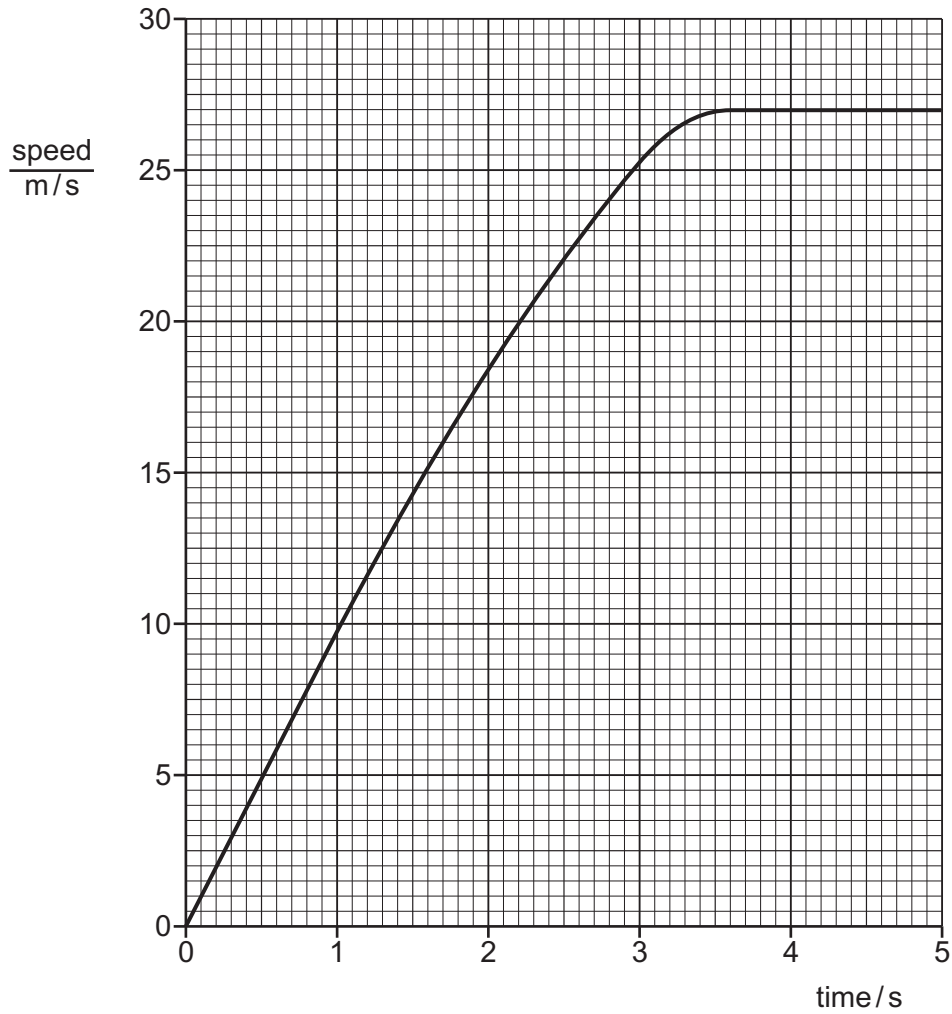


Fig. 1.1

(a) (i) Use the graph to determine the maximum speed of the ball.

maximum speed = m/s [1]

(ii) State the resultant force on the ball when it is falling at its maximum speed.

force = N [1]

(b) (i) Calculate the kinetic energy of the ball when it is falling at its maximum speed.

Show your working.

kinetic energy = J [3]

(ii) The ball hits the ground and bounces.

The speed of the ball just after it hits the ground is less than its speed just before it hits the ground.

Suggest what happens to the kinetic energy that is lost.

.....
..... [1]

[Total: 6]

- 2 (a) Potassium manganate(VII), KMnO_4 , is a purple coloured solid.

It dissolves in water and the purple colour slowly spreads out, as shown in Fig. 2.1.

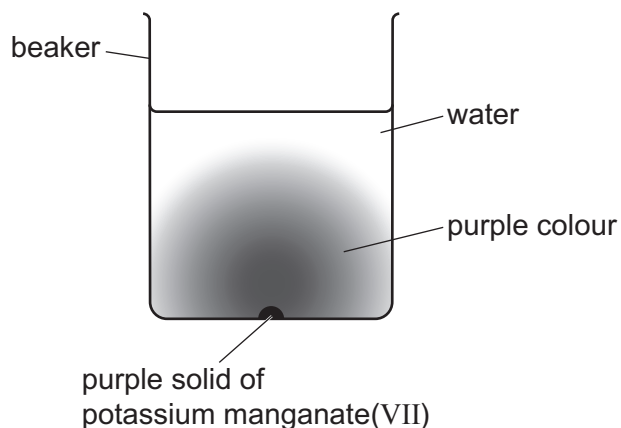


Fig. 2.1

- (i) State the name of the process by which particles spread out.

..... [1]

- (ii) Explain why the process of particles spreading out occurs more slowly in liquids than in gases.

.....

..... [1]

- (b) Determine the relative molecular mass of KMnO_4 .

[A_r : O, 16; K, 39; Mn, 55]

molecular mass = [1]

[Total: 3]

3 A beaker containing a crushed solid substance is heated at a steady rate.

Fig. 3.1 shows how the temperature changes as the substance is heated.

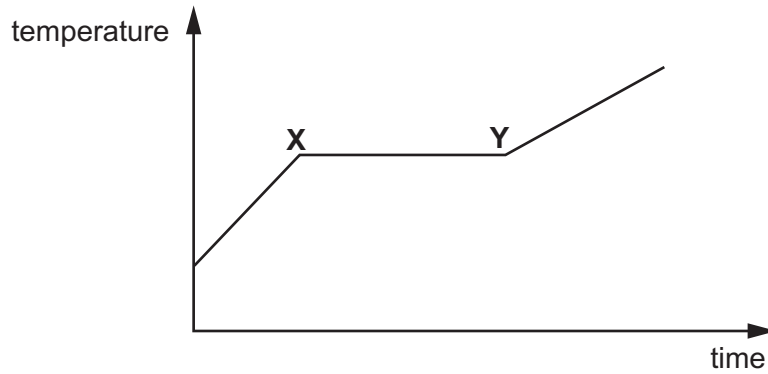


Fig. 3.1

(a) The temperature of the substance remains constant between X and Y.

Suggest a reason.

.....
 [1]

(b) The substance is heated for a further period of time. It evaporates and then starts to boil.

State **one** similarity and **two** differences between evaporation and boiling.

similarity

.....

difference 1

.....

difference 2

.....

[3]

(c) The thermometer in this experiment has a large range but a low sensitivity.

Explain what is meant by each of the terms:

(i) range

..... [1]

(ii) sensitivity

..... [1]

[Total: 6]

- 4 Food colours are coloured compounds added to food or drinks to improve their appearance. A student uses chromatography to find out the types of food colours that are in a soft drink.

(a) Fig. 4.1 shows the chromatogram of the student's results.

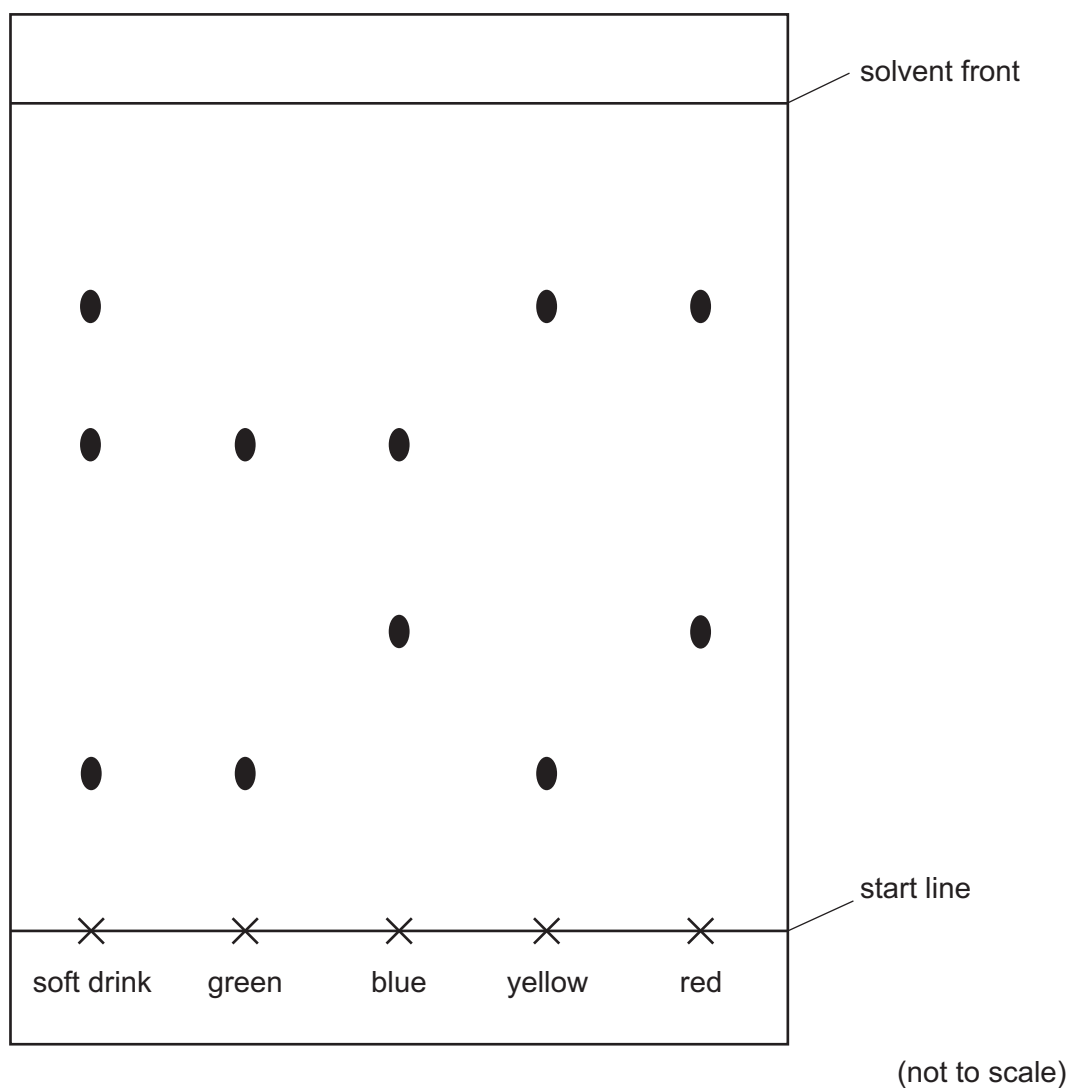


Fig. 4.1

Circle **all** the food colours that are in the soft drink.

green

blue

yellow

red

[1]

(b) The chromatogram for the soft drink is shown in Fig. 4.2.

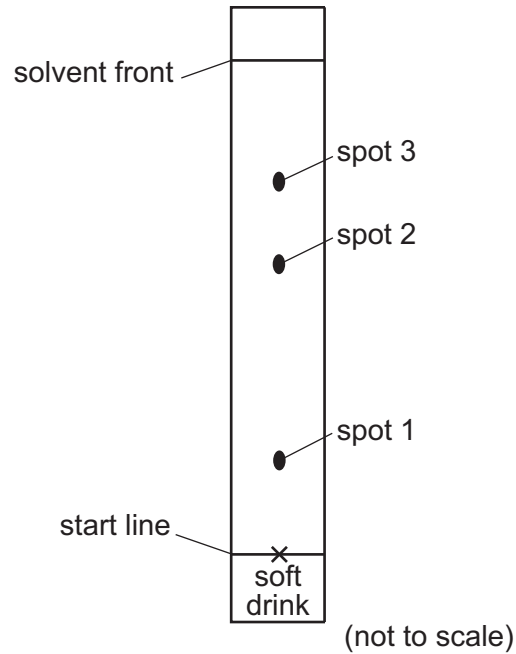


Fig. 4.2

The student labels the spots and measures the distance from the start line to the centre of each spot.

Table 4.1 shows these results.

Table 4.1

distance from start line / cm				
spot 1	spot 2	spot 3	solvent front	top edge of paper
3.5	6.4	8.3	12.0	15.0

Calculate the R_f value for spot 2 using the information in Table 4.1.

Show your working.

$$R_f = \dots\dots\dots [2]$$

(c) Explain why crystallisation is **not** a suitable method for separating the different coloured compounds in the soft drink.

.....
 [1]

[Total: 4]

5 Table 5.1 shows information about some compounds.

Table 5.1

compound	molecular formula	structure
ethene	C_2H_4	<pre> H H C=C H H </pre>
propene	C_3H_6	<pre> H H H-C-C=C H H H </pre>
butene	C_4H_8	<pre> H H H H H-C-C-C=C H H H </pre>
pentene	C_5H_{10}	<pre> H H H H H-C-C-C-C=C H H H H H </pre>

(a) (i) Nonene, C_9H_{18} , is in the same family of compounds as the compounds in Table 5.1.

State **two** ways in which C_9H_{18} will be similar to the other compounds in Table 5.1.

1

.....

2

.....

[2]

(ii) State the family of compounds to which the compounds in Table 5.1 belong.

..... [1]

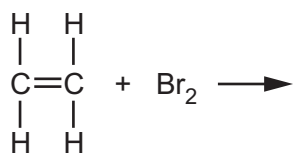
(iii) Explain how the information in Table 5.1 shows that these compounds are unsaturated.

.....

..... [1]

(b) Ethene reacts with bromine.

(i) Draw the structure of the product of the reaction of ethene with bromine in the box.



[2]

(ii) State the name of this type of reaction.

..... [1]

[Total: 7]

6 Fig. 6.1 shows wavefronts in a tank of water.

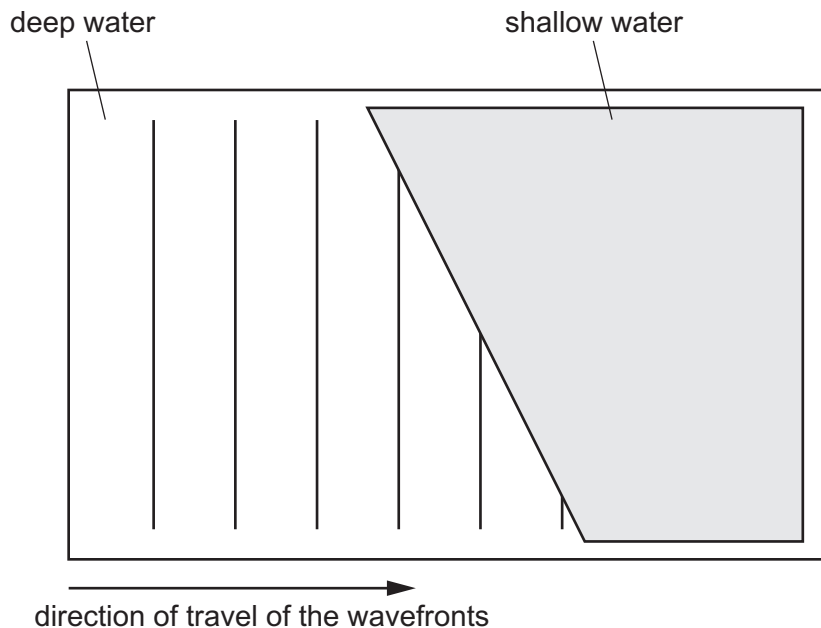


Fig. 6.1

- (a) Complete Fig. 6.1, to show **three** wavefronts as the wave travels through the shallow water. [3]
- (b) The speed of the wave in the deep water is 24 cm/s. The distance between successive wavefronts is 5.0 cm.

Calculate the frequency of the wave.

Show your working and give the unit.

frequency = unit [3]

- (c) The speed of the wave in the shallow water is 18 cm/s.

By comparing the speeds of the wave in shallow and deep water, calculate the refractive index, n , at the boundary between the deep and shallow water.

$n = \dots\dots\dots$ [2]

[Total: 8]

7 Fig. 7.1 shows a circuit diagram. The power supply has an e.m.f. of 9.0V.

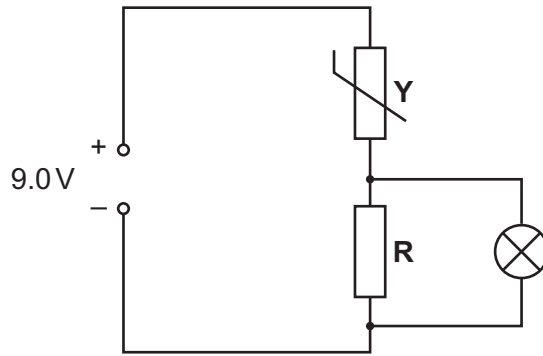


Fig. 7.1

The potential difference across the lamp is 0.50V and the power is 0.45W.

(a) (i) Calculate the current through the lamp.

current = A [2]

(ii) Calculate the charge passing through the lamp in 5 minutes.

charge = C [2]

(iii) Identify the component labelled Y.

..... [1]

(iv) Determine the potential difference across component Y.

potential difference = V [1]

(b) When the temperature of the surroundings increases, the lamp shines more brightly.

Explain why this happens.

.....

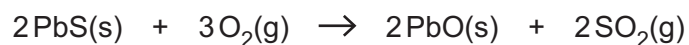
 [3]

[Total: 9]

8 The equation for the extraction of lead, Pb, from its ore, PbS, takes place in two stages.

(a) **Stage one** of the extraction of Pb uses oxygen.

The equation for stage one is shown.



(i) Calculate the mass of PbO that is produced from 7.0 tonnes of PbS.

1 tonne = 1000 kg

[A_r : Pb, 207; S, 32; O, 16]

Show your working in the box.

mass of PbO tonnes

[3]

(ii) Sulfur dioxide, SO_2 , is a pollutant gas, which is released into the atmosphere during the combustion of fossil fuels.

State **one** adverse effect of sulfur dioxide gas on the environment.

.....
 [1]

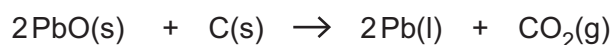
(iii) Describe how emissions of sulfur dioxide from fossil fuels can be reduced.

.....

 [2]

(b) **Stage two** of the extraction of Pb uses carbon.

The equation for stage two is shown.



State which substance is reduced during this reaction.

..... [1]

(c) Lead is sometimes alloyed with other metals.

State why alloys are sometimes used instead of pure metals.

.....
 [1]

(d) Iron is a metal that rusts.

(i) Describe how sacrificial protection helps prevent rusting of iron.

.....

 [3]

(ii) State **one** other method of rust prevention.

..... [1]

[Total: 12]

9 (a) The isotope $^{14}_6\text{C}$ is formed in the upper atmosphere.

(i) Explain what is meant by isotope.

.....

 [2]

(ii) State the number of neutrons and protons in a nucleus of $^{14}_6\text{C}$.

number of neutrons

number of protons [1]

(b) $^{14}_6\text{C}$ decays by the emission of a β -particle.

Complete the equation to show this decay.



[2]

[Total: 5]

- 10 (a) A student investigates the electrolysis of molten calcium chloride, CaCl_2 .

Fig. 10.1 shows the apparatus used by the student.

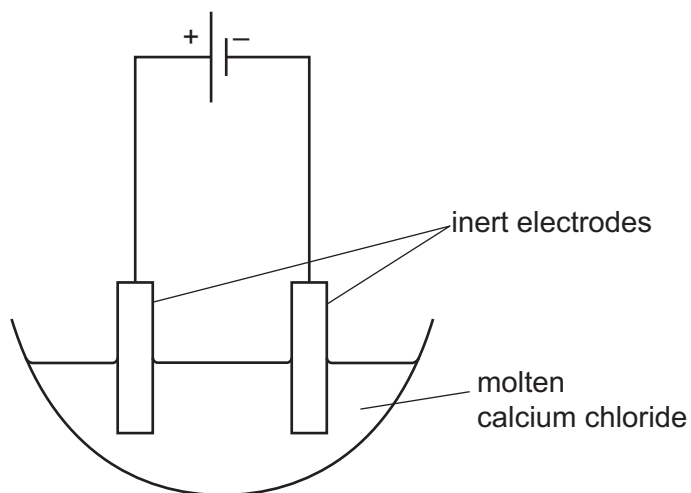


Fig. 10.1

- (i) The student uses inert electrodes.

Explain why the electrodes should be inert.

.....
 [1]

- (ii) Predict the products formed at each electrode during the electrolysis of molten calcium chloride, CaCl_2 .

positive anode

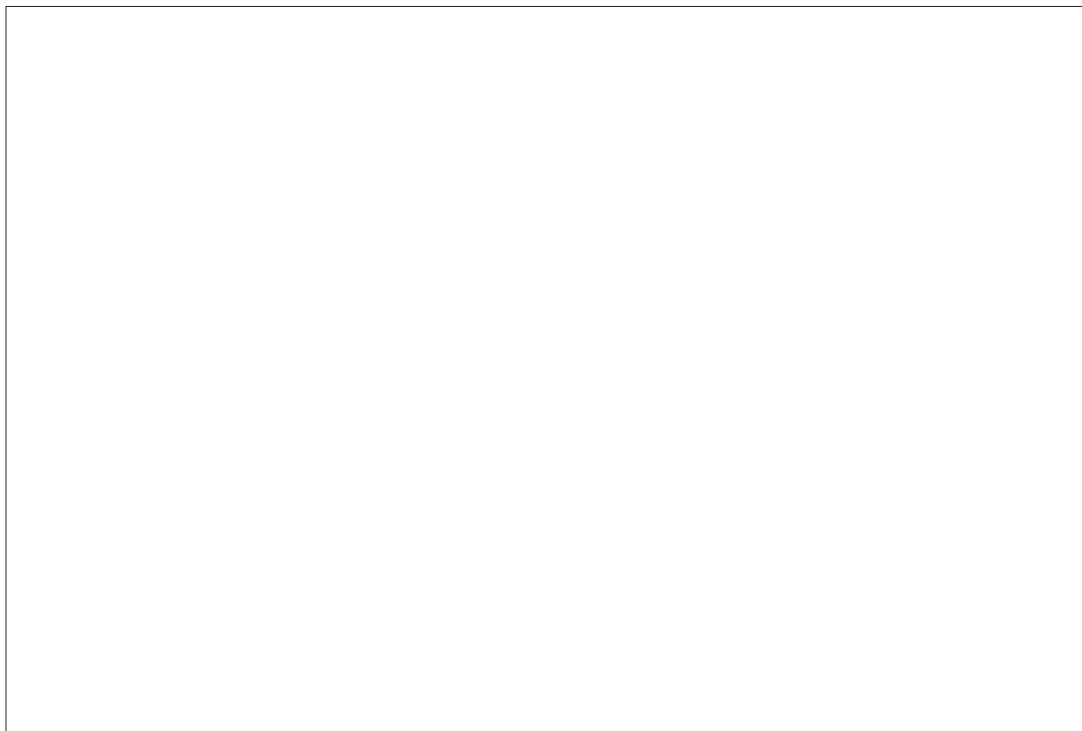
negative cathode

[2]

(b) Calcium chloride, CaCl_2 , is an ionic compound.

Draw the dot-and-cross diagram to represent the ionic bonding in calcium chloride.

You only need to show the outer electrons.



[3]

(c) Calcium is in Group II of the Periodic Table.

Fig. 10.2 shows the elements in Group II of the Periodic Table.

4 Be beryllium 9
12 Mg magnesium 24
20 Ca calcium 40
38 Sr strontium 88
56 Ba barium 137

Fig. 10.2

Calcium and barium both react quickly with cold water. Magnesium only reacts slowly with hot water.

Predict the reaction of beryllium, Be, with cold water.

Explain your answer.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 9]

11 Fig. 11.1 shows α -particles approaching an electric field.

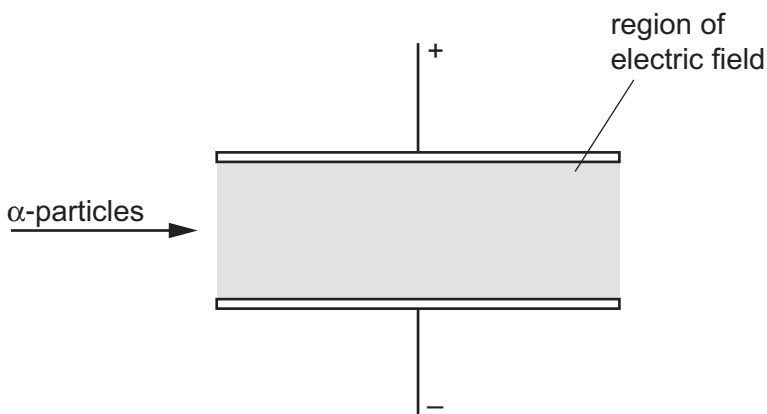


Fig. 11.1

(a) Explain what is meant by an electric field.

.....
 [1]

(b) The electric field is uniform.

(i) On Fig. 11.1, draw the path of an α -particle as it passes through the electric field. [1]

(ii) An electron with a similar speed to the α -particle passes through the same field.

State **two** ways in which the path of the electron is different from the path of the α -particle.

1
 2 [2]

(c) (i) State the name of **one** device that uses α -particles.

..... [1]

(ii) Describe how α -particles are used in this device.

.....
 [1]

[Total: 6]

- 12 When calcium carbonate is heated strongly it produces calcium oxide and carbon dioxide. This reaction is endothermic.

The word equation for this reaction is shown.



- (a) State the name of this type of endothermic reaction.

..... [1]

- (b) Calcium oxide is a base.

State what is meant by the term base, in terms of proton transfer.

.....
 [1]

- (c) On Fig. 12.1:

- draw the energy level diagram for this endothermic reaction
- label the reactants and label the products
- use an arrow to show the direction of energy change.

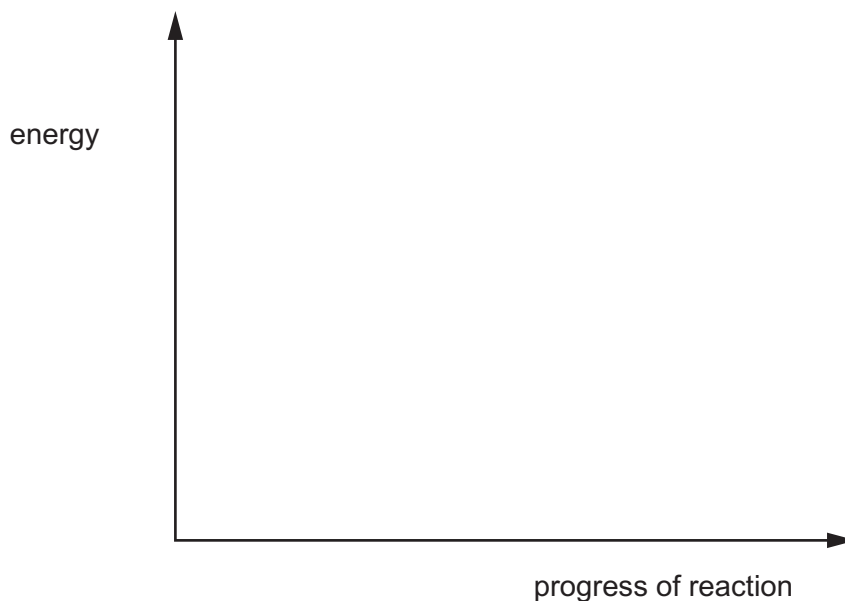


Fig. 12.1

[3]

[Total: 5]

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

The Periodic Table of Elements

Group																																																
I	II	III										IV	V	VI	VII	VIII																																
3 Li lithium 7	4 Be beryllium 9	<table border="1"> <thead> <tr> <th colspan="3">Key</th> </tr> <tr> <th>atomic number</th> <th>atomic symbol</th> <th>name</th> </tr> <tr> <th>relative atomic mass</th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>H</td> <td>hydrogen</td> </tr> <tr> <td>2</td> <td>He</td> <td>helium</td> </tr> <tr> <td>10</td> <td>Ne</td> <td>neon</td> </tr> <tr> <td>18</td> <td>Ar</td> <td>argon</td> </tr> <tr> <td>36</td> <td>Kr</td> <td>krypton</td> </tr> <tr> <td>54</td> <td>Xe</td> <td>xenon</td> </tr> <tr> <td>86</td> <td>Rn</td> <td>radon</td> </tr> </tbody> </table>																Key			atomic number	atomic symbol	name	relative atomic mass			1	H	hydrogen	2	He	helium	10	Ne	neon	18	Ar	argon	36	Kr	krypton	54	Xe	xenon	86	Rn	radon	2 He helium 4
Key																																																
atomic number	atomic symbol	name																																														
relative atomic mass																																																
1	H	hydrogen																																														
2	He	helium																																														
10	Ne	neon																																														
18	Ar	argon																																														
36	Kr	krypton																																														
54	Xe	xenon																																														
86	Rn	radon																																														
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	37 Rb rubidium 85	55 Cs caesium 133	87 Fr francium	56 Ba barium 137	88 Sr strontium 88	38 Sr strontium 88	89–103 actinoids	88 Ra radium																															
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	57–71 lanthanoids	56 Ba barium 137																															
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	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184																														
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	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium																														
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	118 Og oganeson	119 Uue unbinetium	120 Uuo unbinetium	121 Uuq unbinetium	122 Uub unbinetium	123 Uut unbinetium	124 Uuq unbinetium	125 Uuq unbinetium																														

lanthanoids

actinoids

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
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 dm³ at room temperature and pressure (r.t.p.).