Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

PHYSICAL SCIENCE **0652/42**

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.

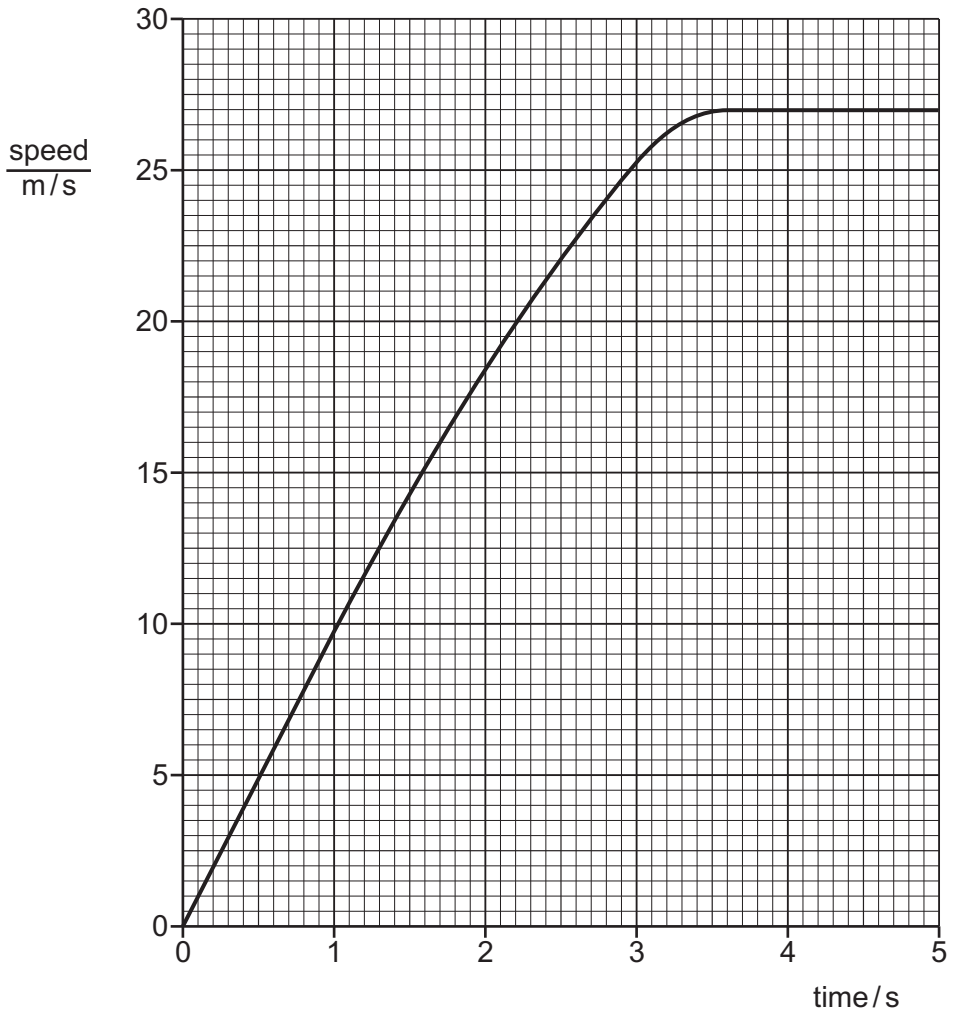


Fig. 1.1

(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.

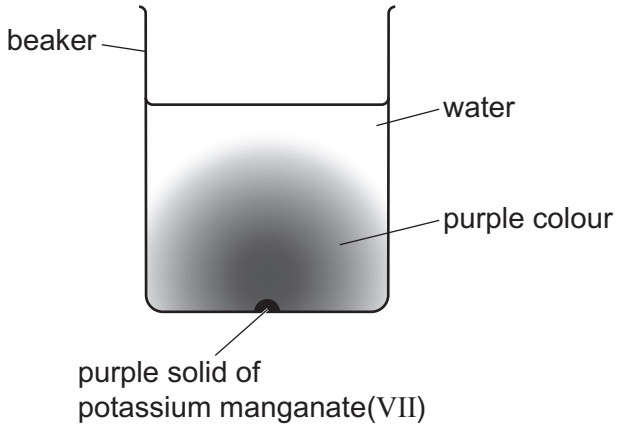


Fig. 2.1

(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.

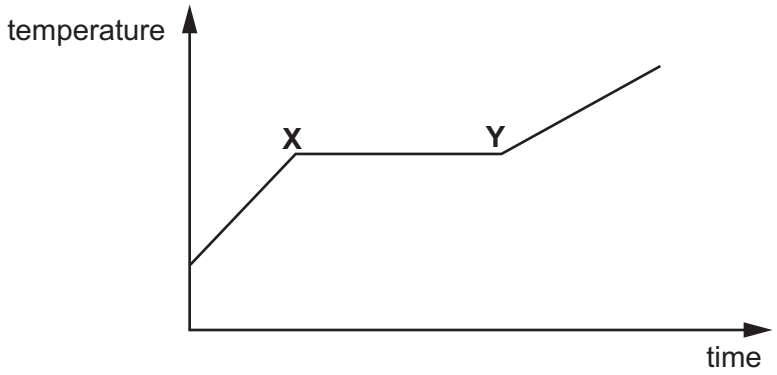


Fig. 3.1

(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 .....

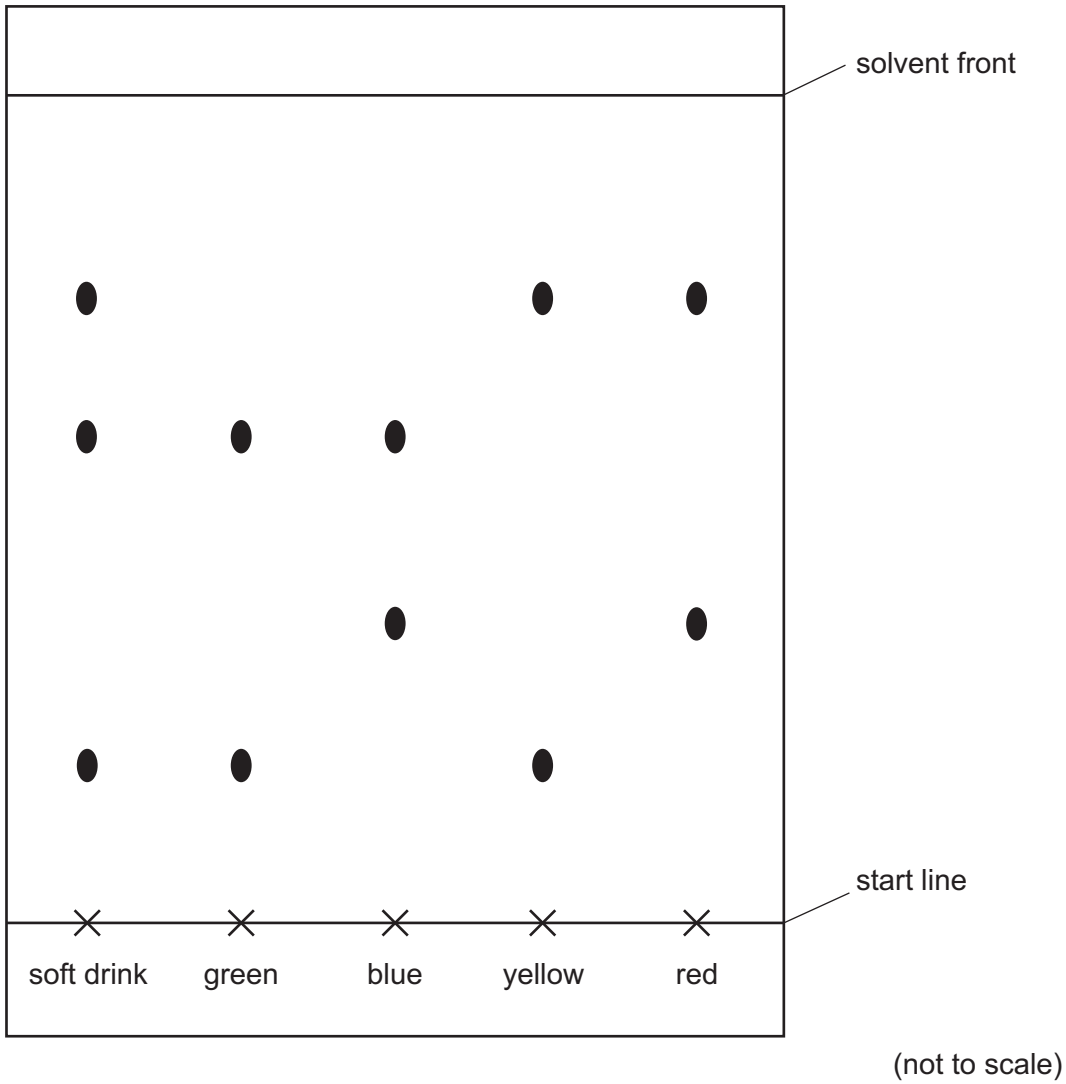
..... [1]

[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.



(not to scale)

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.

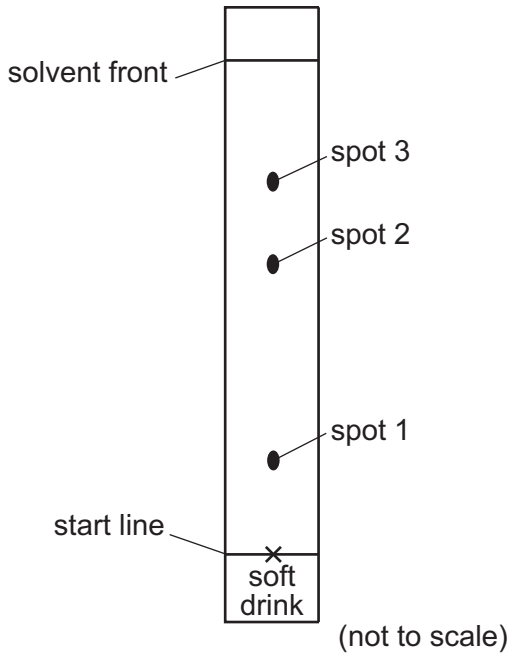


Fig. 4.2

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 = ... [2]

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

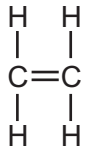
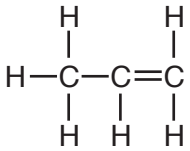
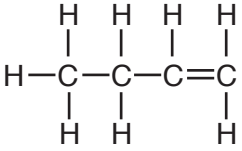
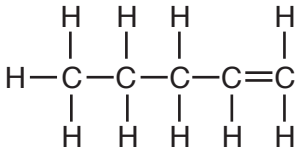
.....

..... [1]

[Total: 4]

5 Table 5.1 shows information about some compounds.

Table 5.1

compound	molecular formula	structure
ethene	C_2H_4	
propene	C_3H_6	
butene	C_4H_8	
pentene	C_5H_{10}	

(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]

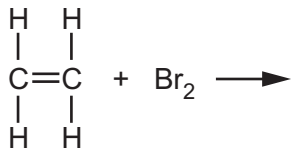
(iii) Explain how the information in Table 5.1 shows that these compounds are unsaturated.

.....

..... [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.

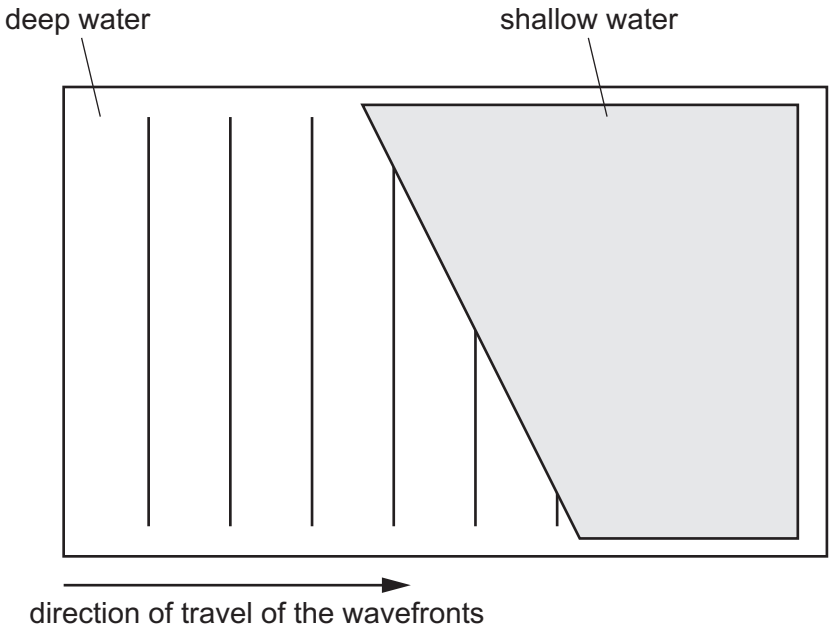


Fig. 6.1

(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 = ... [2]

[Total: 8]

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

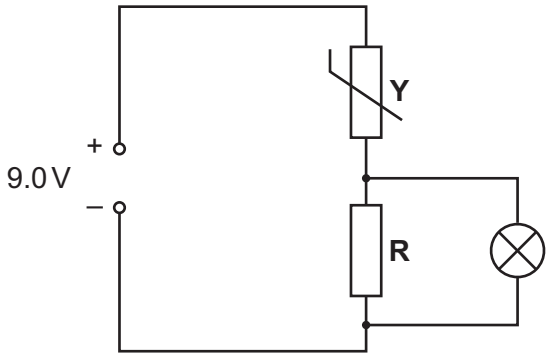


Fig. 7.1

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

(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.

$$2\,PbS(s) + 3\,O_2(g) \rightarrow 2\,PbO(s) + 2\,SO_2(g)$$

(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.

$$2\,PbO(s) + C(s) \rightarrow 2\,Pb(l) + CO_2(g)$$

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 $^{14}_{6}C$ 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 $^{14}_{6}C$.

number of neutrons .....

number of protons .....
[1]

(b) $^{14}_{6}C$ decays by the emission of a β-particle.

Complete the equation to show this decay.

$$^{14}_{6}C \longrightarrow \text{.....}^{\text{.....}}_{\text{.....}}N + \text{.....}^{\text{.....}}_{\text{.....}}\beta$$

[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.

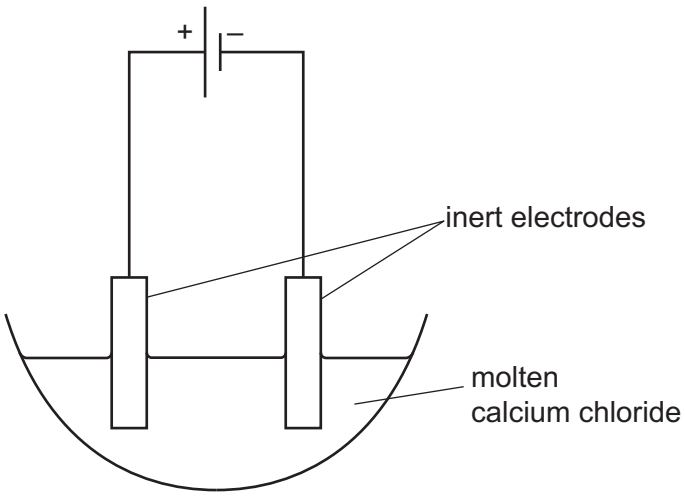


Fig. 10.1

(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.

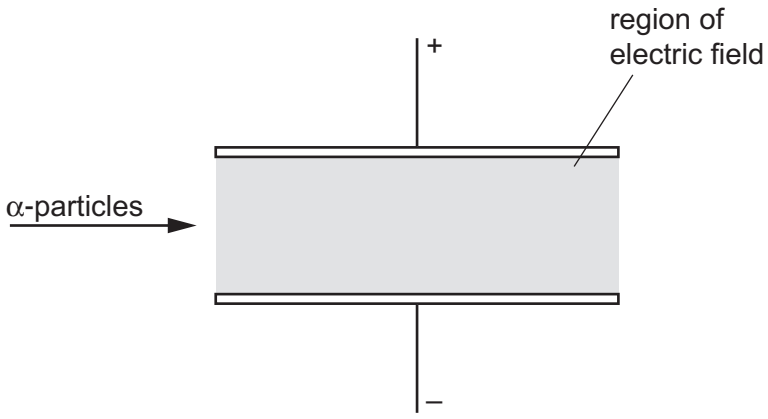


Fig. 11.1

(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.

calcium carbonate $\longrightarrow$ calcium oxide + carbon dioxide

(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.

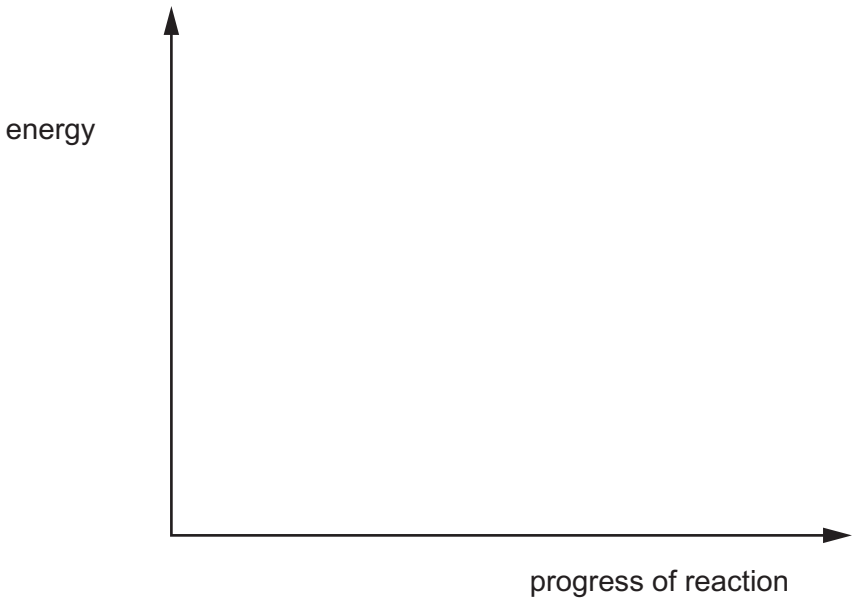


Fig. 12.1

[3]

[Total: 5]

The Periodic Table of Elements

Group																	
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 –		

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.).