Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

5473212718

PHYSICAL SCIENCE **0652/31**

Paper 3 Theory (Core) **October/November 2023**

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.

1 A person hits a golf ball with a golf club.

Fig. 1.1 shows the golf ball moving towards the hole, where it falls in.

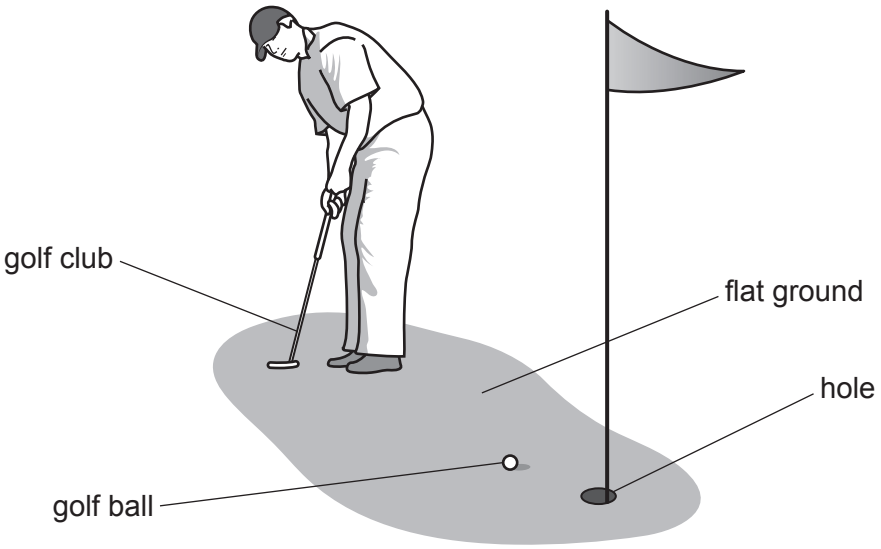

Fig. 1.1

(a) Fig. 1.2 shows the distance time graph for the ball as it moves towards the hole.

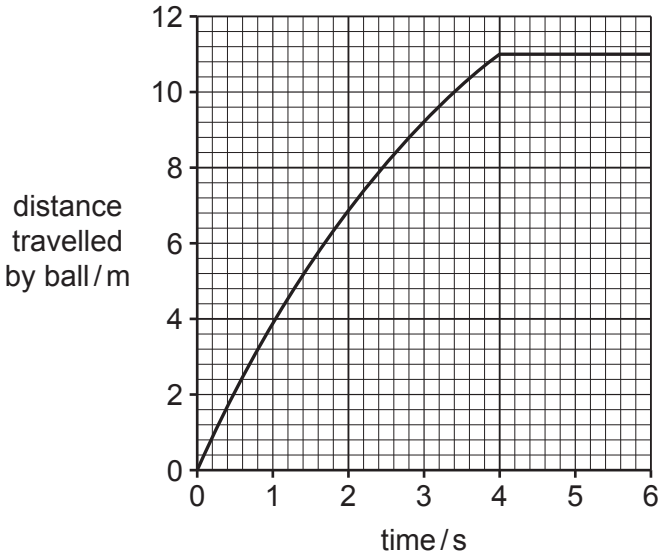

Fig. 1.2

(i) Use Fig. 1.2 to determine the distance the ball moves to the hole.

..... m [1]

(ii) Describe the motion of the ball shown in Fig. 1.2.

.....

..... [2]

(iii) The ball takes 4.0 s to reach the hole.

Calculate the average speed of the ball when it is moving.

..... m/s [1]

(b) Complete the following sentences using words or phrases from the box.

You may use each word or phrase once, more than once or not at all.

work	**kinetic energy**	**strain energy**	**gravity**	**friction**
power	**the surroundings**	**gravitational energy**		

The force of ..... causes the ball to lose kinetic energy.

As the ball moves, energy is transferred from the ball to ..... .

As the ball falls in the hole, gravitational energy is transferred to ..... .

As the ball falls in the hole, the force on it does ..... .

[4]

[Total: 8]

[Turn over

2 **(a)** The symbols for some elements are shown.

Al **Be** **Cl** **Cu**

He **Na** **P** **S**

Use the symbols of the elements to answer the questions that follow.

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

State which element:

(i) is a soft, reactive metal

..... [1]

(ii) forms an oxide that contributes to acid rain

..... [1]

(iii) exists as a diatomic gas at room temperature

..... [1]

(iv) has a full outer shell of electrons

..... [1]

(v) has 11 protons in each atom

..... [1]

(vi) forms an ion with a 3+ charge.

..... [1]

(b) Iron is a metal. Iron rusts.

(i) State the conditions needed for iron to rust.

.....

..... [2]

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

..... [1]

[Total: 9]

3 A student applies a force **F** to a beaker as shown in Fig. 3.1.

The beaker falls over as shown in Fig. 3.2.

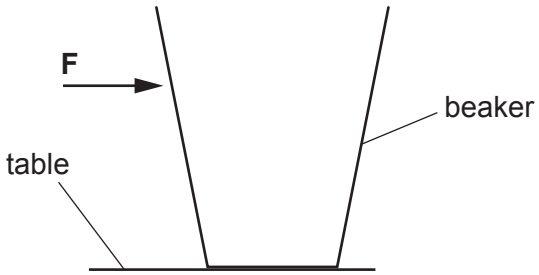

Fig. 3.1

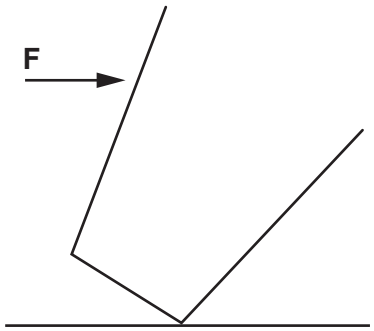

Fig. 3.2

(a) On Fig. 3.2, label the position of the pivot with a **P**. [1]

(b) State the name of the turning effect of a force about a pivot.

..... [1]

(c) State **two** changes to force **F** that will reduce the turning effect on the beaker.

1 .....

2 .....
[2]

(d) Describe how the position of the centre of mass affects the stability of the beaker.

.....

..... [1]

(e) The student cuts a piece of card in the shape of a glass. There are two holes in the shape, labelled **A** and **B**.

The student hangs the shape using a pin in hole **A**. The glass shape swings freely and then stops as shown in Fig. 3.3.

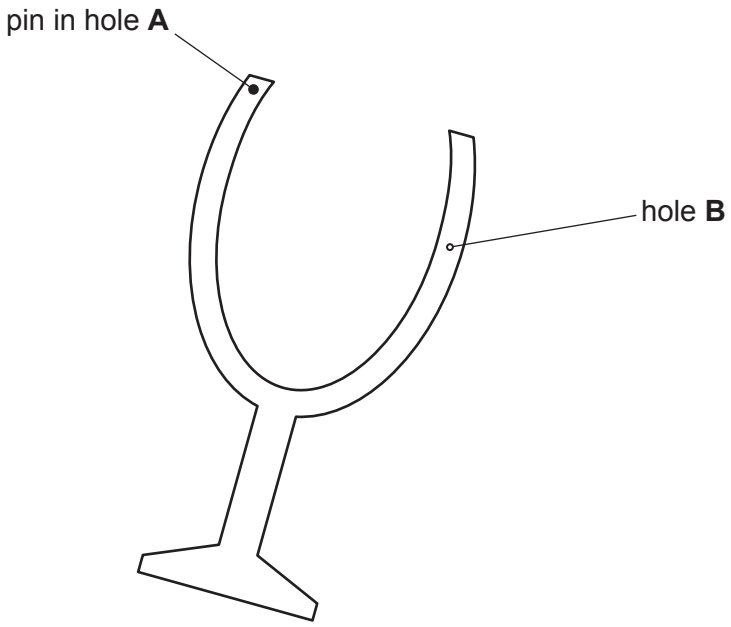

Fig. 3.3

(i) The student draws a line on the shape in Fig. 3.3 to help find the centre of mass.

On Fig. 3.3, draw the student's line. Label it **L**. [1]

(ii) Next, the student hangs the card from hole **B** and draws another line.

Describe how the experiment indicates the position of the centre of mass.

.....

..... [1]

[Total: 7]

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4 **(a)** Fig. 4.1 shows the apparatus needed for the electrolysis of dilute sulfuric acid.

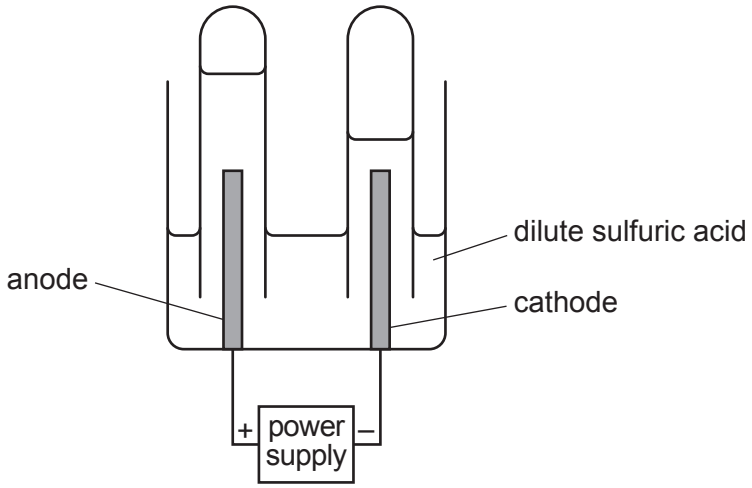

Fig. 4.1

(i) State the products formed at the:

- negative electrode (cathode)

.....

- positive electrode (anode).

..... and .....
[3]

(ii) The anode and cathode are described as inert electrodes.

State why the electrodes must be inert.

.....

..... [1]

(b) Sulfuric acid reacts with magnesium to form magnesium sulfate and one other product.

(i) Write the word equation for this reaction.

..... [2]

(ii) Suggest a pH value for sulfuric acid.

pH = ... [1]

(c) Some oxides are acidic and some are basic.

Complete the sentences to describe the characteristic that is used to classify oxides as acidic or basic.

Acidic oxides are formed from ..... .

Basic oxides are formed from ..... .

[1]

(d) The acidity of soil can be controlled.

(i) Describe how to reduce the acidity of soil.

.....

..... [1]

(ii) Explain why it is important that the acidity of soil is controlled.

.....

..... [1]

[Total: 10]

5 A fire starts on the floor of a hotel room.

Fig. 5.1 shows a sprinkler in the ceiling of the room.

Water from the sprinkler puts out the fire.

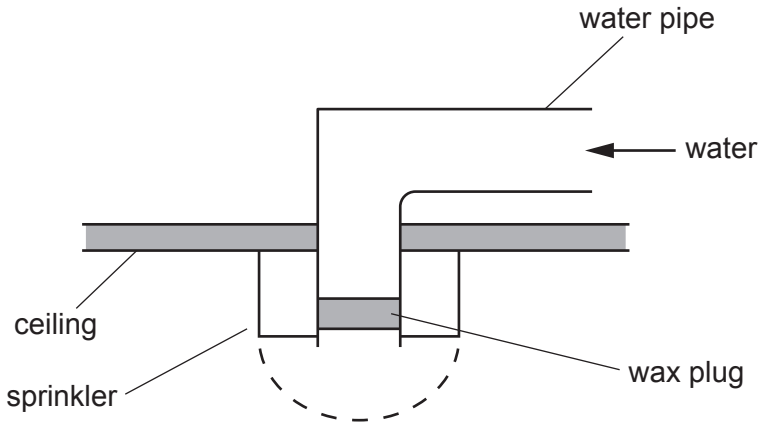

Fig. 5.1

(a) The water pipe is blocked by a wax plug.

The wax has a melting point of 80 °C.

State what is meant by melting point.

.....

..... [1]

(b) Suggest how the sprinkler automatically starts spraying water a short time after a fire starts.

.....

..... [1]

(c) State the main method of thermal energy transfer from the fire to the sprinkler.

..... [1]

[Total: 3]

6 **(a)** A student makes a circuit using two cells, two switches **S1** and **S2**, and two lamps **L1** and **L2** as shown in Fig 6.1.

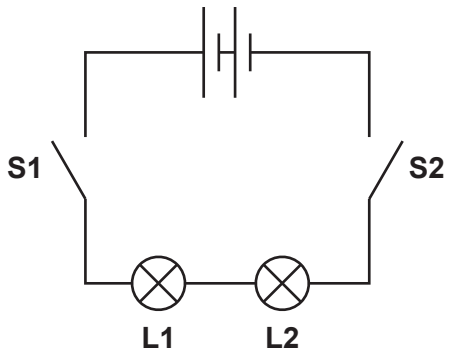

Fig. 6.1

(i) Complete the sentence to describe how the lamps are connected in the circuit in Fig. 6.1.

The lamps are connected in ..... . [1]

(ii) The student opens and closes **S1** and **S2** and observes the brightness of **L1** and **L2**.

The observations are recorded in Table 6.1.

Table 6.1

switch position		brightness of lamp	
S1	**S2**	**L1**	**L2**
open	open	.....	off
open	closed	.....	.....
closed	closed	bright	.....

Complete Table 6.1 using the words ‘off’ or ‘bright’. [1]

(iii) The current in **L1** is 0.15A.

The resistance of **L1** is 10 Ω.

Calculate the potential difference across **L1**.

potential difference = ... V [2]

(b) The student removes one cell and rearranges the other components to make the circuit shown in Fig. 6.2.

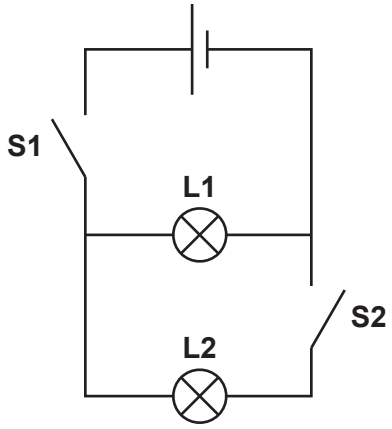

Fig. 6.2

(i) The student opens and closes **S1** and **S2** again.

The observations of the brightness of **L1** and **L2** in the new circuit are recorded in Table 6.2.

Table 6.2

switch position		brightness of lamp	
S1	**S2**	**L1**	**L2**
open	open	.....	off
open	closed	.....	.....
closed	open	.....	.....
closed	closed	bright	.....

Complete Table 6.2 using the words ‘off’ and ‘bright’. [2]

(ii) Circle the option in the sentence to state how the current in **S1** compares with the current in **S2** when both switches are closed.

The current in **S1** is **larger than** / **smaller than** / **the same as** the current in **S2**. [1]

[Total: 7]

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7 A student measures the rate of the reaction between pieces of calcium carbonate and excess dilute hydrochloric acid.

Carbon dioxide gas is produced in the reaction.

The student measures the volume of carbon dioxide gas produced every 30 s to investigate the rate of the reaction.

Fig. 7.1 shows the apparatus the student uses.

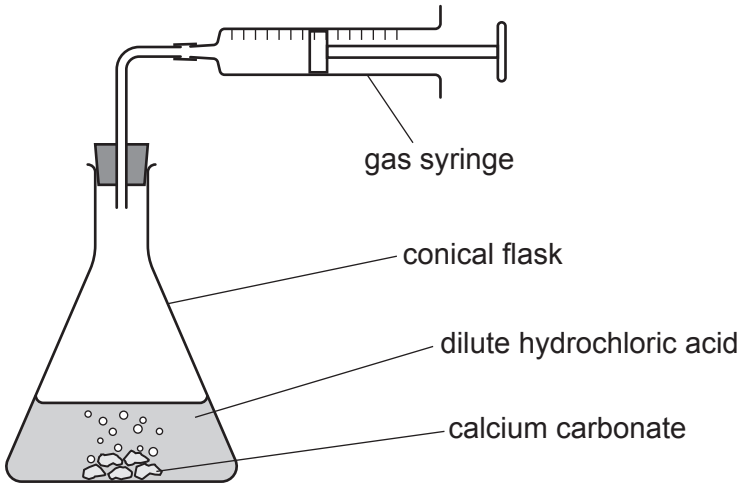

Fig. 7.1

Fig. 7.2 shows a sketch graph of the results.

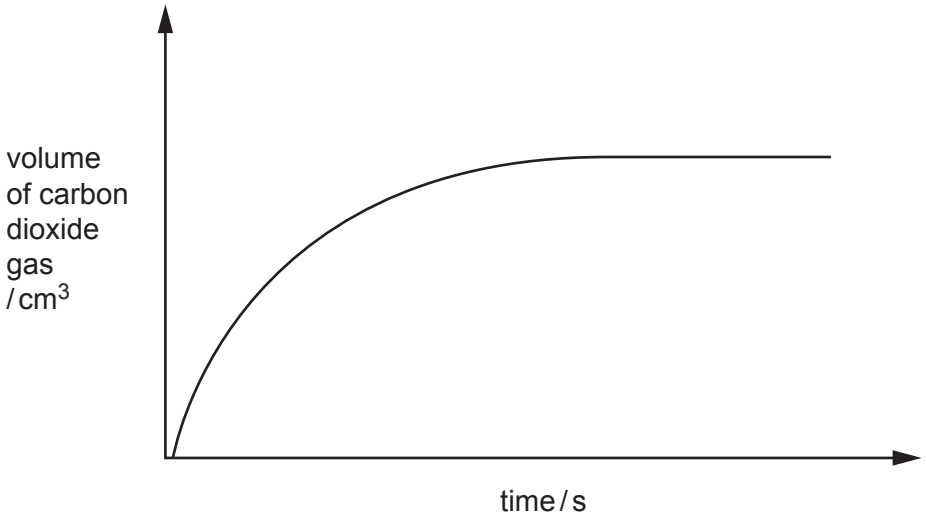

Fig. 7.2

(a) (i) Explain why the curve of the graph flattens and becomes horizontal.

.....

..... [1]

(ii) The student repeats the experiment with hydrochloric acid of a higher concentration.

All other conditions are kept the same.

State what happens to the rate of reaction when the concentration of hydrochloric acid is increased.

.....

..... [1]

(iii) State one **other** method to measure the rate of this reaction.

.....

..... [1]

(b) Describe a test to confirm the gas produced is carbon dioxide. State the observation for a positive result.

test .....

observation .....
[2]

(c) State how the student determines that the reaction between calcium carbonate and hydrochloric acid is exothermic.

.....

..... [1]

(d) Explain why fine powders in flour mills can cause explosions.

.....

..... [1]

(e) Calcium carbonate, $CaCO_3$, is heated to produce calcium oxide, CaO, and carbon dioxide, CO_2, as the only products.

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

..... [1]

(ii) Write the symbol equation for this reaction.

..... [1]

(f) State why an increase in the concentration of carbon dioxide gas in the atmosphere is a global concern.

..... [1]

[Total: 10]

[Turn over

8 ^{228}Th and ^{230}Th are isotopes of thorium.

(a) State **one** similarity and **one** difference in the nuclei of these two isotopes of thorium.

similarity .....

difference .....

[2]

(b) Fig. 8.1 shows a decay curve for a sample of ^{228}Th.

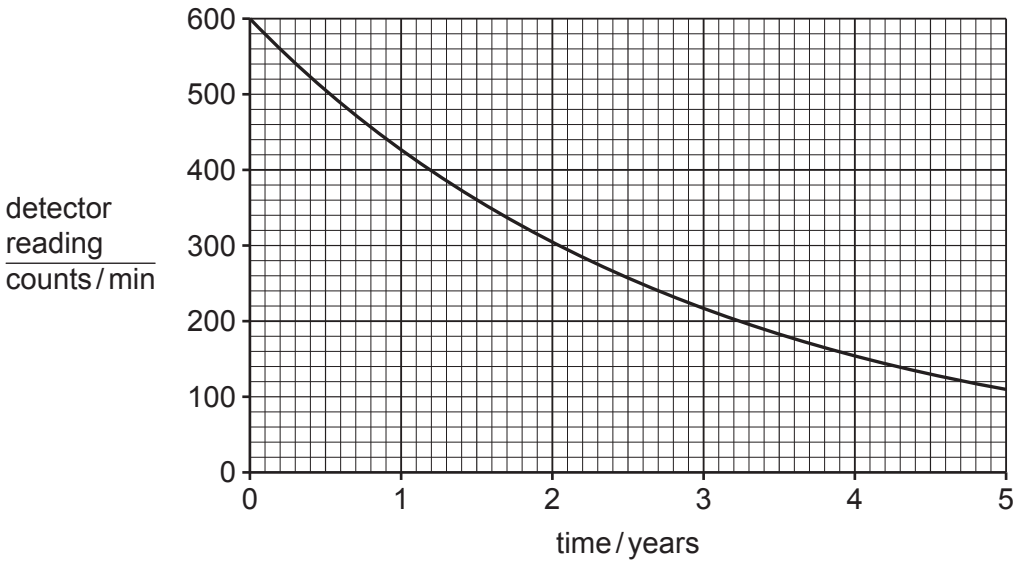

Fig. 8.1

Use Fig. 8.1 to estimate the half-life of ^{228}Th.

half-life = ... years [1]

(c) Fig. 8.2 shows a simple design for a smoke alarm placed on a ceiling.

It contains a sample of ^{228}Th and a radiation detector.

Initially, the count rate on the detector is 600 counts / min.

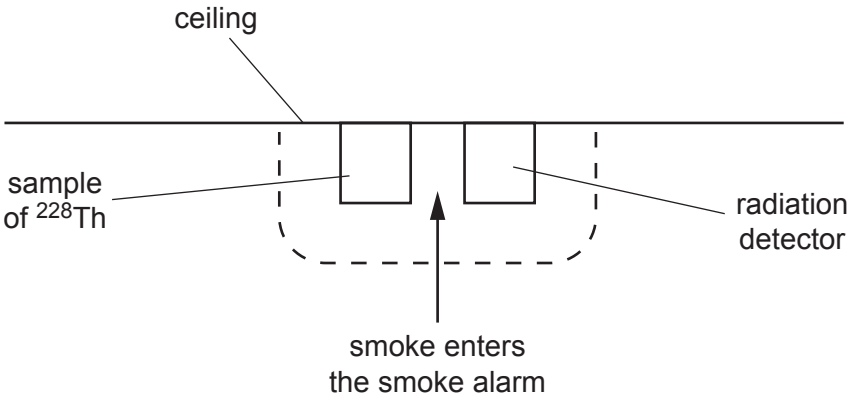

Fig. 8.2

When a small amount of smoke enters the smoke alarm, the radiation is absorbed by the smoke and the count rate on the detector decreases.

The alarm sounds when the count rate decreases to 400 counts / min.

(i) State the type of radiation that is absorbed by the smoke.

..... [1]

(ii) The sample of ^{228}Th decays with time as shown in Fig. 8.1.

The count rate on the detector eventually reaches 400 counts / min due to the source decaying. When this happens, the alarm sounds without any smoke.

Use the graph in Fig. 8.1 to determine how long it takes for the alarm to begin to sound when there is no smoke.

time = ... years [1]

[Total: 5]

9 **(a)** Fig. 9.1 shows two organic molecules, methane and ethene.

methane ethene

Fig. 9.1

(i) State why both the molecules in Fig. 9.1 are described as hydrocarbons.

.....

..... [2]

(ii) State the products of complete combustion of these hydrocarbons.

..... and ..... [2]

(iii) Methane is the main constituent of natural gas. Natural gas is a fossil fuel.

Name one **other** fossil fuel.

..... [1]

(iv) Explain why ethene is described as unsaturated.

.....

..... [1]

(v) Describe the observation when aqueous bromine is added to:

- methane .....

.....

- ethene. .....

.....
[2]

(b) Ethene reacts with steam to produce ethanol.

(i) Complete the symbol equation for this reaction.

$$C_2H_4 + \text{.....} \rightarrow C_2H_5OH$$ [1]

(ii) Name one **other** type of reaction that produces ethanol.

..... [1]

(iii) Ethanol is used in the drinks industry.

State one **other** use for ethanol.

..... [1]

[Total: 11]

10 **(a)** Fig. 10.1 shows a graph of a wave on a rope at a point in time.

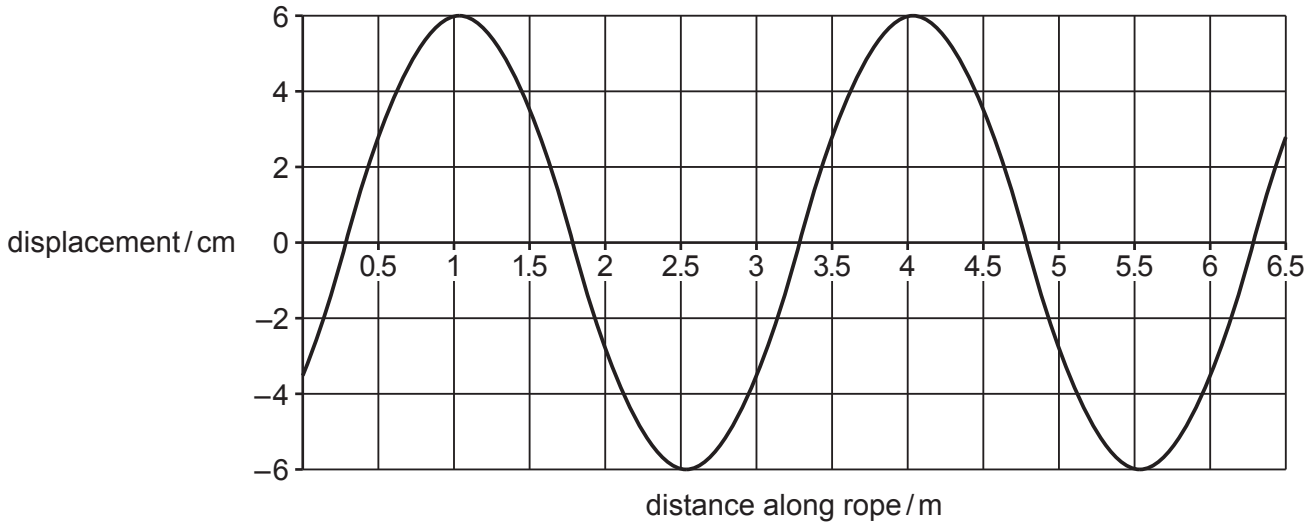

Fig. 10.1

(i) Use the information in Fig. 10.1 to determine the wavelength and amplitude of the wave.

wavelength = ... m

amplitude = ... cm
[2]

(ii) Determine the frequency of the wave if one vibration of the wave takes 0.2 s.

frequency = ... Hz [1]

(iii) State what the wave transfers.

..... [1]

(b) Fig. 10.2 shows the wavefronts on a wave travelling from deep water to shallow water.

The wave changes direction as it enters the shallow water.

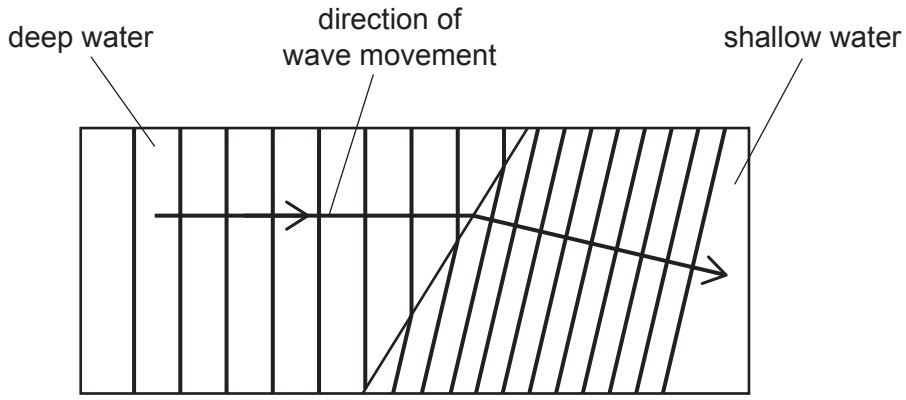

Fig. 10.2

(i) State the name given to the change of direction of a wave shown in Fig. 10.2.

..... [1]

(ii) State what causes the wave to change direction when it enters shallow water.

..... [1]

(c) Fig. 10.3 shows a candle standing on a table in front of a plane mirror.

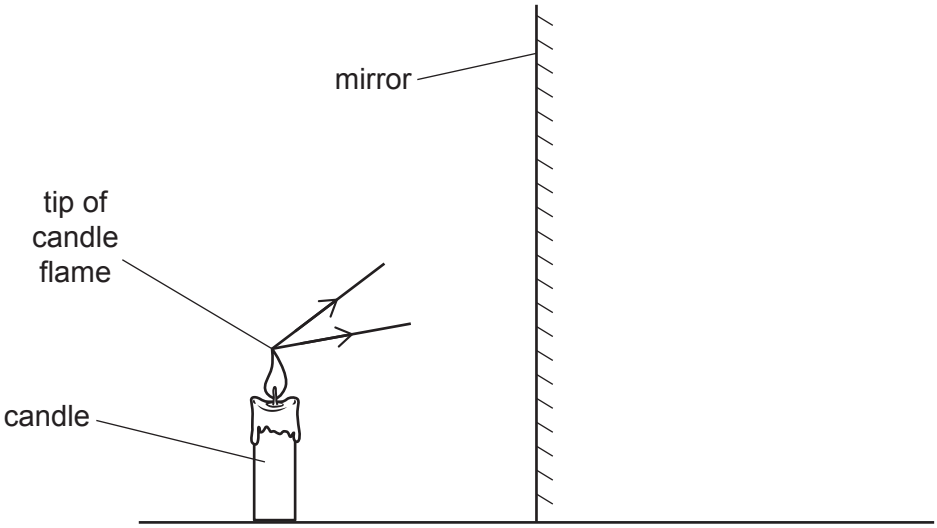

Fig. 10.3

(i) Complete the **two** rays to show them reflecting from the mirror.

Label the normal and the angles of incidence and reflection for **one** ray. [3]

(ii) Use the reflected rays you have drawn in **(c)(i)** to find the position of the image of the tip of the candle flame.

Mark this position with an **F**. [1]

[Total: 10]

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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.).