Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

3613463103

PHYSICAL SCIENCE **0652/41**

Paper 4 Theory (Extended) **October/November 2020**

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. Blank pages are indicated.

DC (RW/CB) 192666/5

[Turn over

1 **(a)** Fig. 1.1 shows a go-kart travelling at constant speed along a straight horizontal road.

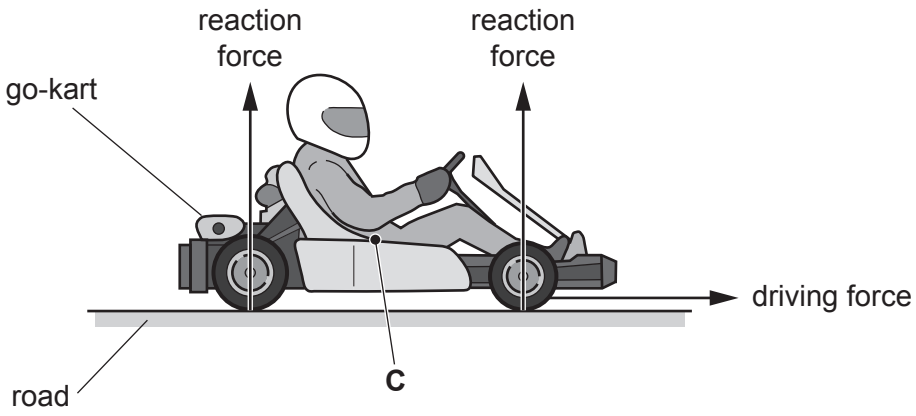

Fig. 1.1

(i) Point **C** is the centre of mass of the go-kart.

Explain what is meant by the term *centre of mass*.

.....

.....

..... [2]

(ii) State why it is an advantage to have the centre of mass of the go-kart as low as possible.

.....

..... [1]

(iii) The driving force and the reaction forces acting on the go-kart are shown on Fig. 1.1.

On Fig. 1.1, draw and label **two** more arrows to show two different forces acting on the go-kart. [2]

(iv) Deduce the resultant force on the go-kart travelling at constant speed.

resultant force = ... [1]

(b) The go-kart and driver have a total mass of 850 kg and travel at a speed of 24 m / s.

Calculate the total kinetic energy of the go-kart and driver.

Give the unit.

kinetic energy = ... unit ..... [3]

[Total: 9]

2 Three states of matter are solid, liquid and gas.

(a) Complete Table 2.1 to compare the structure of a solid and a liquid in terms of particle separation, particle arrangement and particle motion.

Table 2.1

	solid	liquid
particle separation	....	....
particle arrangement	regularly arranged	....
particle motion	....	....

[4]

(b) Fig. 2.1 shows how the temperature of a substance varies when it is heated steadily for a period of time.

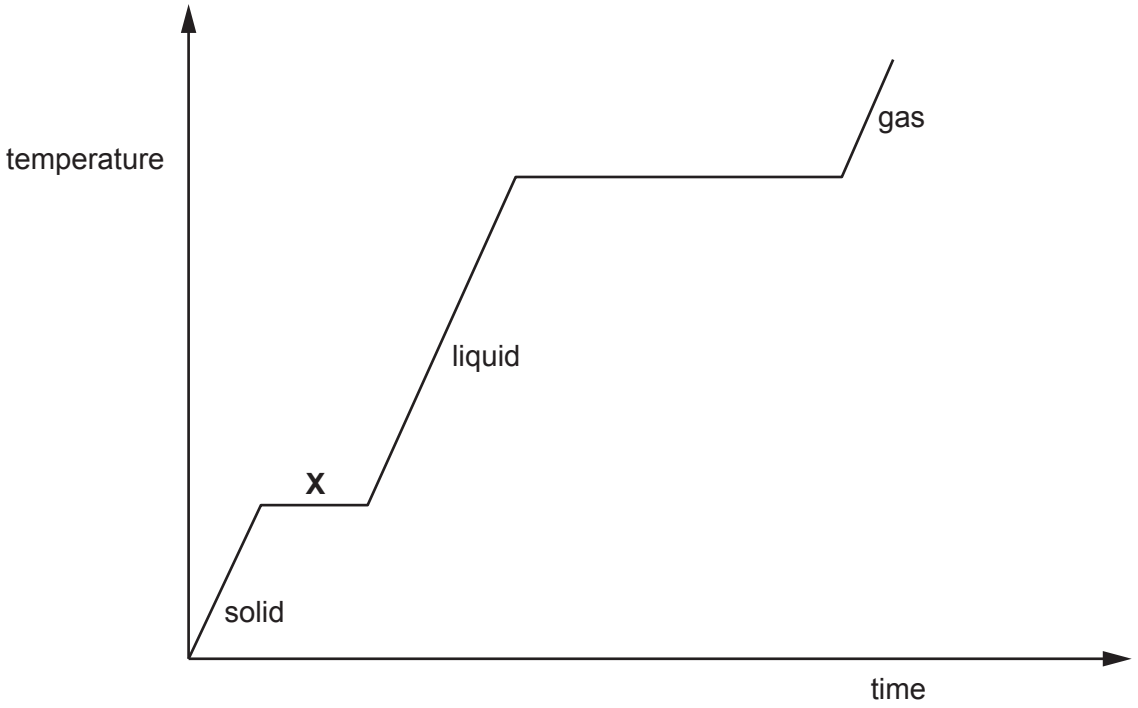

Fig. 2.1

Explain why the temperature stays constant for some time at **X**.

.....

.....

.....

.....

.....

..... [3]

[Total: 7]

3 Fig. 3.1 shows a refrigerator.

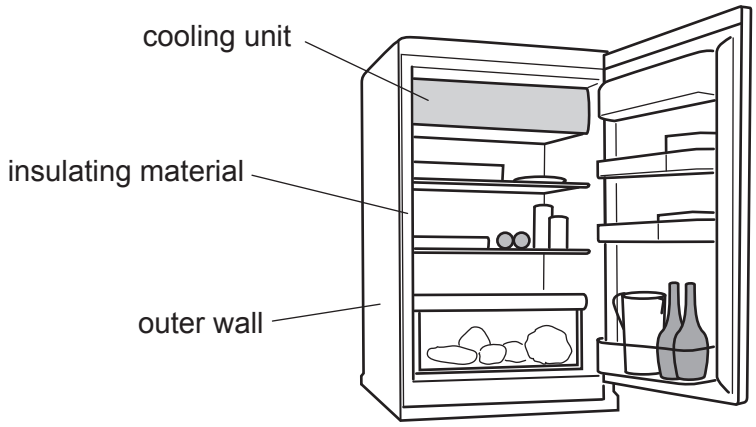

Fig. 3.1

(a) The cooling unit is placed at the top of the refrigerator.

Explain why this causes convection currents in the refrigerator.

.....

.....

.....

..... [3]

(b) **(i)** Explain why the insulating material is required.

.....

..... [1]

(ii) The outer wall is made from metal.

Explain why metals are good thermal conductors.

.....

.....

..... [2]

(c) The metal outer wall is usually painted shiny white.

Explain the effect this has when bright sunlight falls on the refrigerator.

.....

.....

..... [2]

[Total: 8]

4 Sound is transmitted by longitudinal waves. Water waves are mainly transverse waves.

(a) Explain the difference between *longitudinal* and *transverse* waves.

.....

.....

.....

..... [2]

(b) A sound wave consists of a series of compressions and rarefactions.

Explain what is meant by a *rarefaction*.

.....

.....

..... [2]

(c) A musical note has a frequency of 256 Hz.

The speed of sound in air is 320 m / s.

Calculate the wavelength of the musical note.

wavelength = ... m [2]

(d) A sound wave enters a person's ear.

State how the sound wave affects the person's ear to cause them to detect the sound.

.....

..... [1]

[Total: 7]

5 A student investigates the melting point of a sample of a medicinal drug.

The result is shown in Table 5.1.

Table 5.1

melting point data / °C
70–75

The student thinks the sample is a drug called ibuprofen.

The melting point of ibuprofen is 76 °C.

(a) Explain how the data indicates that the sample is **not** pure.

.....

..... [1]

(b) The molecular formula for ibuprofen is $C_{13}H_{18}O_2$.

Determine the relative molecular mass, M_r, of ibuprofen.

[A_r: C, 12; H, 1; O, 16]

M_r of ibuprofen = ... [1]

(c) The structure of ibuprofen is shown in Fig. 5.1.

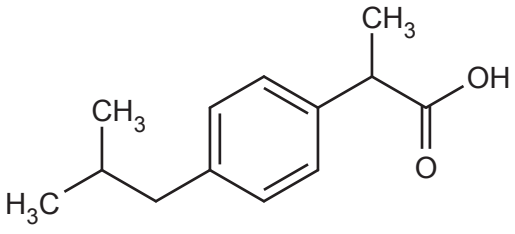

Fig. 5.1

Explain why ibuprofen is **not** a hydrocarbon.

.....

..... [1]

(d) Ibuprofen is a weak acid.

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

.....

..... [1]

(e) Ibuprofen reacts with sodium.

(i) Table 5.2 shows the charges on an ibuprofen ion and a sodium ion.

Table 5.2

name	formula of ion	charge of ion
ibuprofen ion	$C_{13}H_{17}O_2^-$	–1
sodium ion	Na^+	+1

Determine the formula of the ionic compound formed when the ibuprofen ion and sodium ion combine.

..... [1]

(ii) The other product formed is a gas that gives a pop sound when tested with a lighted splint.

State the name of the gas.

..... [1]

(f) Ibuprofen is soluble in ethanol.

Explain how a chemist can separate the ibuprofen from the ethanol.

.....

.....

.....

..... [2]

[Total: 8]

[Turn over

6 **(a)** Carbon and oxygen react to form carbon dioxide.

The equation for the reaction is shown.

$$C + O_2 \rightarrow CO_2$$

Calculate the mass of carbon dioxide produced when 4 g of carbon reacts with oxygen.

[A_r: C, 12; O, 16]

mass of CO_2 = ... g [3]

(b) State why incomplete combustion of carbon is a problem.

.....

..... [1]

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

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

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

[3]

(d) Table 6.1 gives the melting points of some compounds.

Table 6.1

compound	melting point / °C
V	0
W	801
Y	–210
Z	–57

Circle the letters of **all** the compounds that are covalent.

Give a reason for your choices.

V **W** **Y** **Z**

.....

.....

[2]

[Total: 9]

7 Fig. 7.1 shows a circuit with a battery of electromotive force (e.m.f.) 9.0 V, connected to two resistors in series.

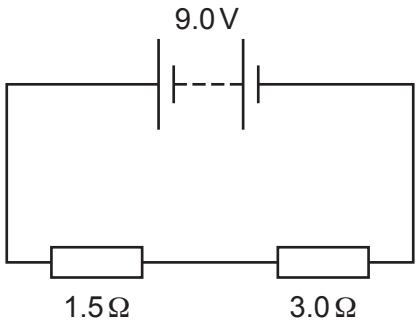

Fig. 7.1

(a) (i) Calculate the total resistance in the circuit.

resistance = ... Ω [1]

(ii) Calculate the current in the circuit.

current = ... A [2]

(iii) Calculate the power produced by the battery.

power = ... W [2]

(b) A student connects a 6.0 Ω resistor in parallel with the two resistors, as shown in Fig. 7.2.

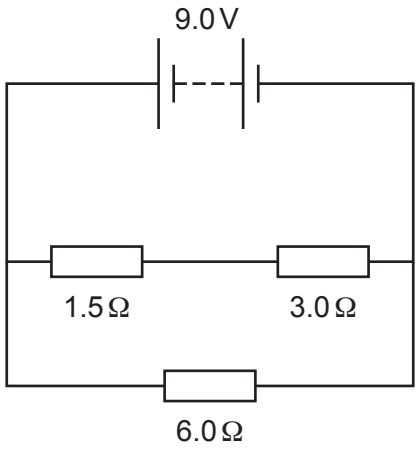

Fig. 7.2

Calculate the resistance of this combination of the three resistors.

resistance = ... Ω [2]

[Total: 7]

8 Fig. 8.1 shows the structure of an organic compound, 3-cyclopentene-1-ol.

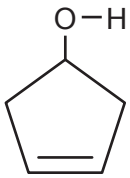

Fig. 8.1

- The *cyclo* part of the name of this compound is because there is a ring shape,  .
- The *pent* part is because there are five carbon atoms.
- The *-ol* part is because there is an OH group, which is present in all alcohols.

(a) Describe what the *-ene* part of the name refers to.

.....

..... [1]

(b) Ethanol is an alcohol. The equation shows the formation of ethanol, CH_3CH_2OH.

$$C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + 2CO_2$$

(i) State the name of the process this equation represents.

..... [1]

(ii) State **one** use for ethanol.

..... [1]

(c) A catalyst is involved during the formation of the organic compound shown in Fig. 8.1.

(i) Catalysts increase the rate of a reaction by affecting the activation energy of the reaction.

Explain what is meant by the term *activation energy*.

.....

..... [1]

(ii) Concentration of the reactants affects the rate of a reaction.

Describe and explain the effect of increasing the concentration of a reactant on the rate of a reaction.

.....

.....

.....

.....

.....

..... [3]

(d) Fig. 8.2 shows an energy level diagram for an exothermic reaction.

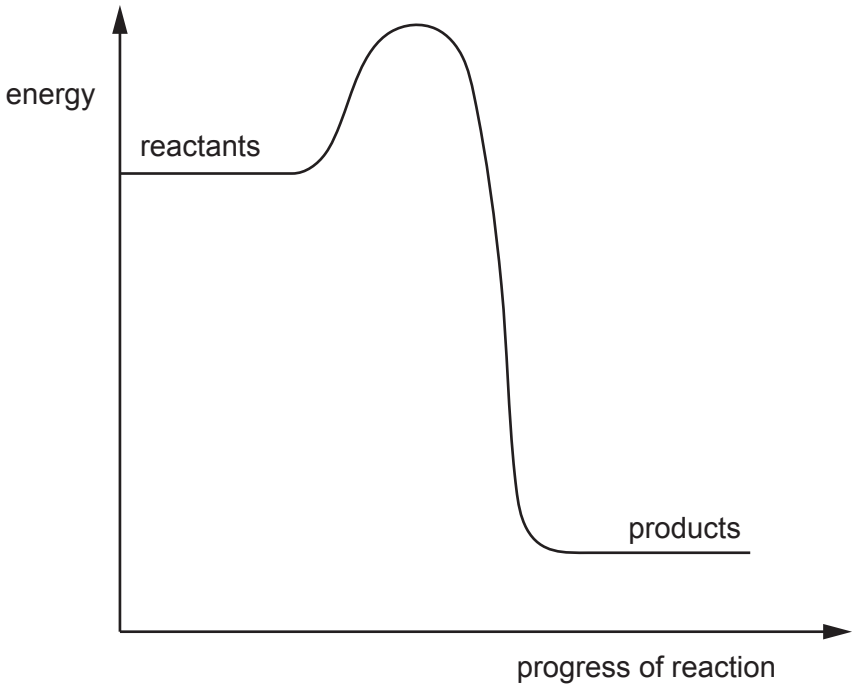

Fig. 8.2

On Fig. 8.2, use labelled arrows to show:

- the activation energy
- the overall change in energy.

[2]

[Total: 9]

[Turn over

9 Fig. 9.1 shows a conductor in the magnetic field formed by two electromagnets.

The conductor is connected to a sensitive voltmeter.

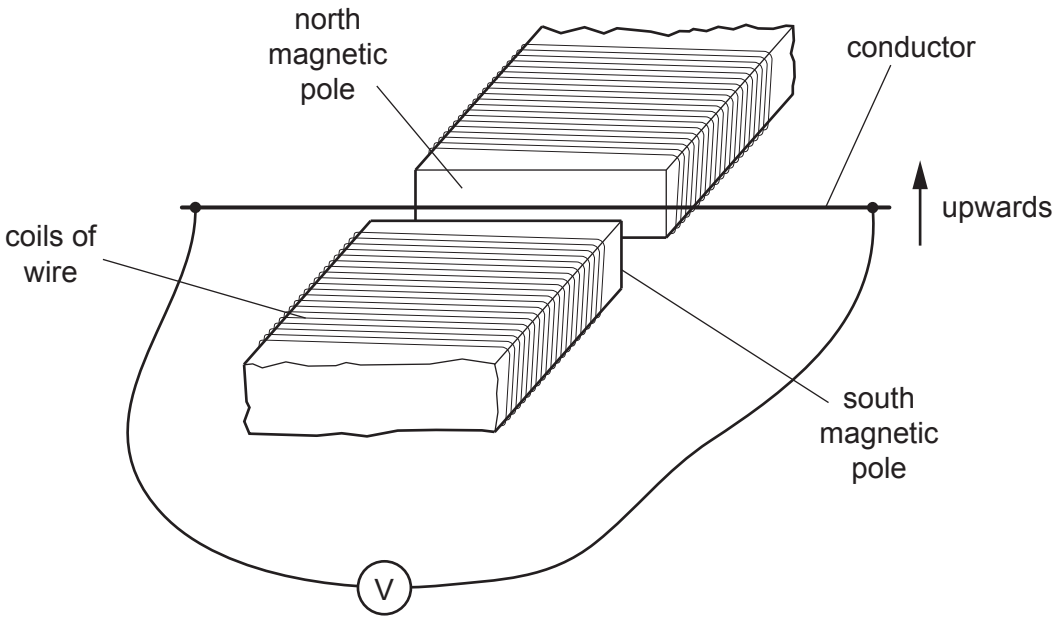

Fig. 9.1

State what is observed on the voltmeter when:

- the conductor is moved vertically upwards out of the magnetic field .....

  .....

- the conductor is then moved back to its original position in the magnetic field .....

  .....

- the current in the coils of the electromagnet is then switched off. .....

  .....

[4]

10 The halogens are in Group VII of the Periodic Table.

(a) Chlorine is an oxidising agent.

(i) Explain the meaning of the term *oxidising agent*.

.....

..... [1]

(ii) Predict whether iodine is a more or less powerful oxidising agent than chlorine. Give a reason for your answer.

.....

.....

..... [1]

(b) Complete the word equation for the reaction of bromine with aqueous sodium iodide.

bromine + sodium iodide → [ ] + [ ]

[1]

(c) Data about Group VII elements are shown in Table 10.1.

Table 10.1

element	symbol	melting point / °C	boiling point / °C	state at room temperature	colour
fluorine	F	–219	–188	gas	pale yellow
chlorine	.....	–101	–34	gas	yellow-green
bromine	Br	.....	59	liquid	red-brown
iodine	I	114	184	.....	purple
astatine	At	300	350	solid	.....

Complete the table. [4]

[Total: 7]

11 **(a)** The isotope thallium-208 ($^{208}_{81}Tl$) decays into a stable isotope of lead by emission of a β-particle.

Complete the equation showing this decay.

$$^{208}_{81}Tl \rightarrow {}^{\ldots\ldots}_{\ldots\ldots}Pb + {}^{\ldots\ldots}_{\ldots\ldots}\beta$$ [2]

(b) The half-life of the isotope thallium-208 ($^{208}_{81}Tl$) is investigated.

Fig. 11.1 shows a graph of the counter reading against time.

The background count is 8 counts per minute.

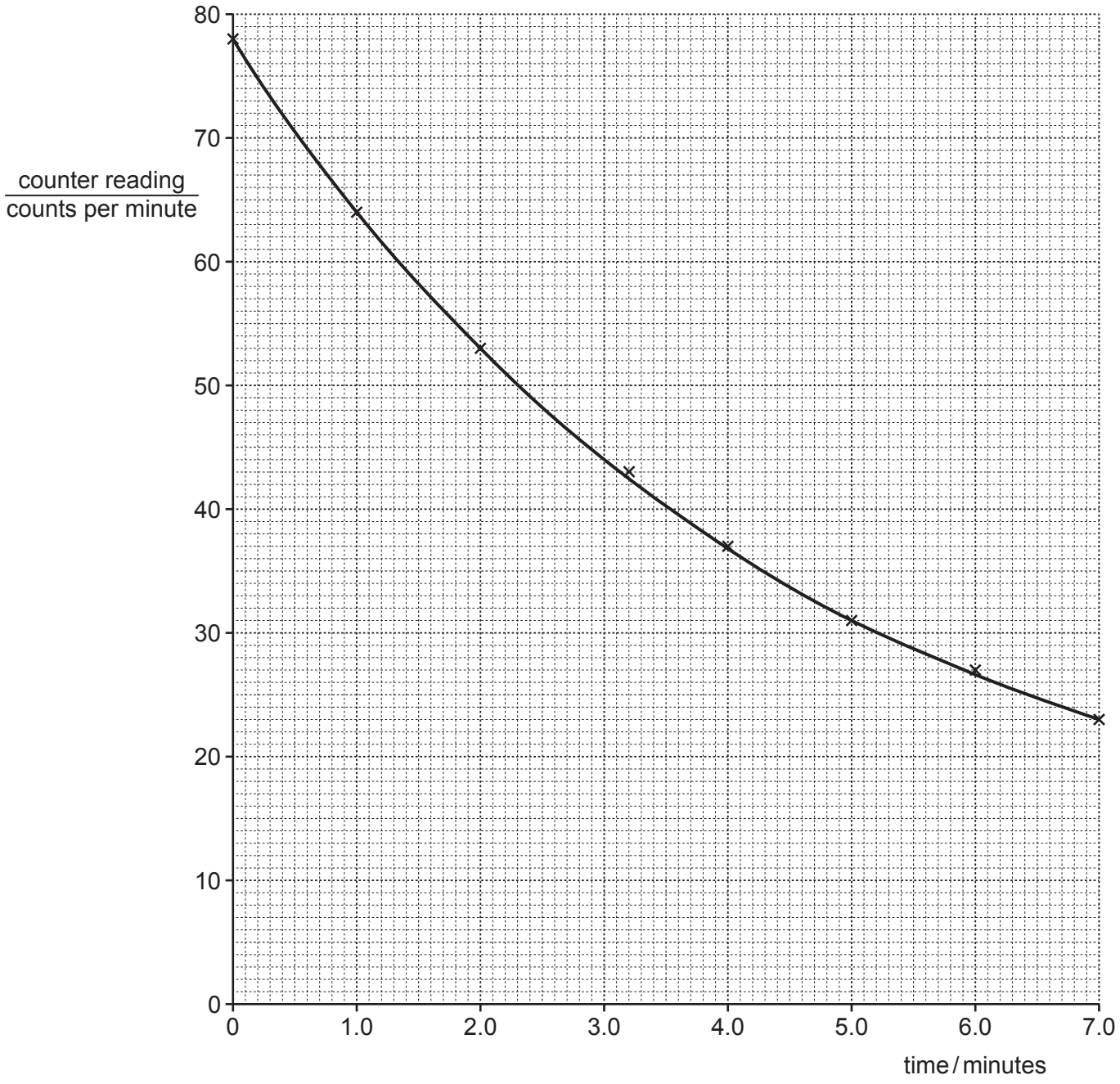

Fig. 11.1

Use the graph in Fig. 11.1 to determine the half-life of the isotope, thallium-208.

You must clearly show how you used the graph in Fig. 11.1.

half-life = ... minutes [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.).