UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

9888112762

PHYSICAL SCIENCE **0652/31**

Paper 3 (Extended) **October/November 2013**

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 a 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 20.

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 **20** printed pages.

UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

1 A metre rule is clamped to a ramp. Fig. 1.1 shows the experimental set up.

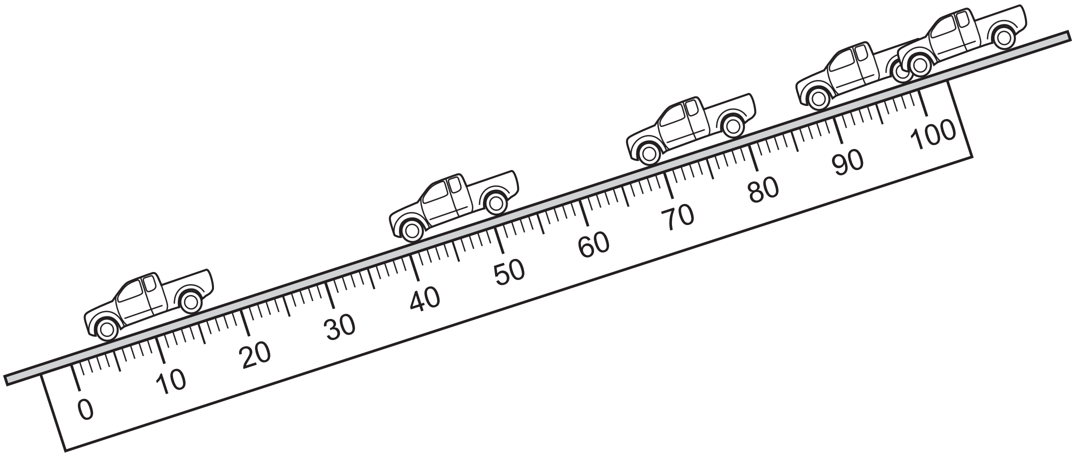


Fig. 1.1

- The ramp is tilted and a toy car is held at the top of the ramp.
- The car is given a gentle push and it moves down the ramp.
- The positions of the car after successive time intervals of 0.20 s are shown.

(a) **(i)** Read off the positions of the front of the car after each time interval.

Record the values, to the nearest centimetre, in Table 1.1.

Calculate the total distance travelled after each time interval and complete the table.

Table 1.1

time / s	0.0	0.20	0.40	0.60	0.80
position / cm	99				
total distance travelled / cm	0				

[2]

(ii) On the grid in Fig. 1.2, draw a distance / time graph for the car's journey.

For Examiner's Use

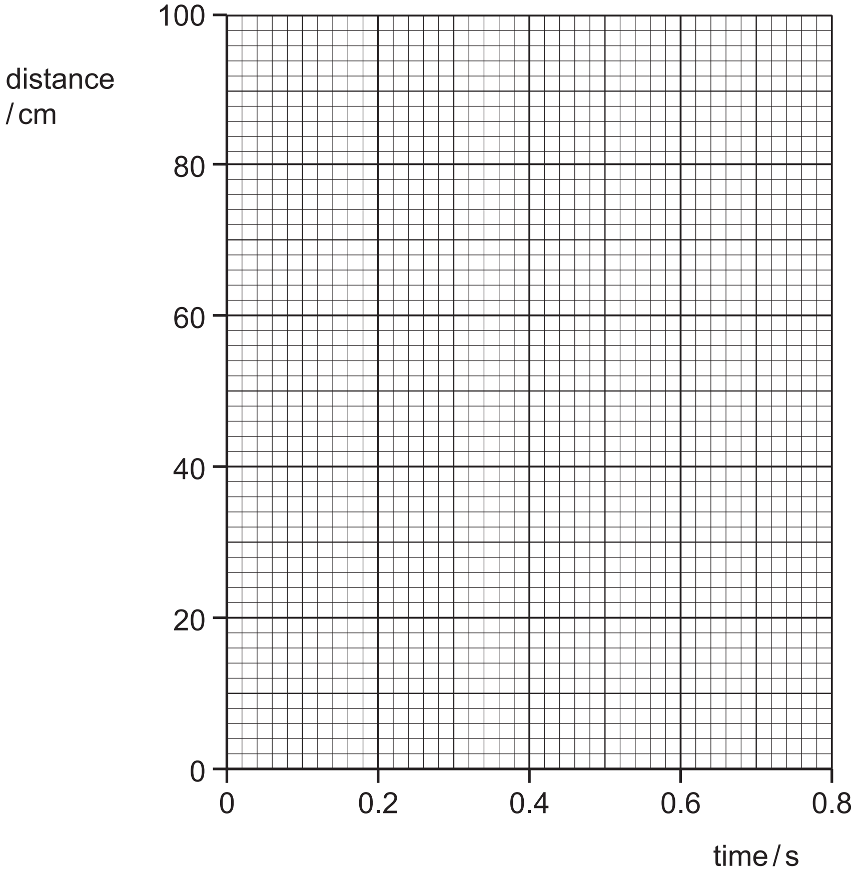


Fig. 1.2

[2]

For Examiner's Use

(b) The graph in Fig. 1.3 shows a speed / time graph for the car on a similar journey.

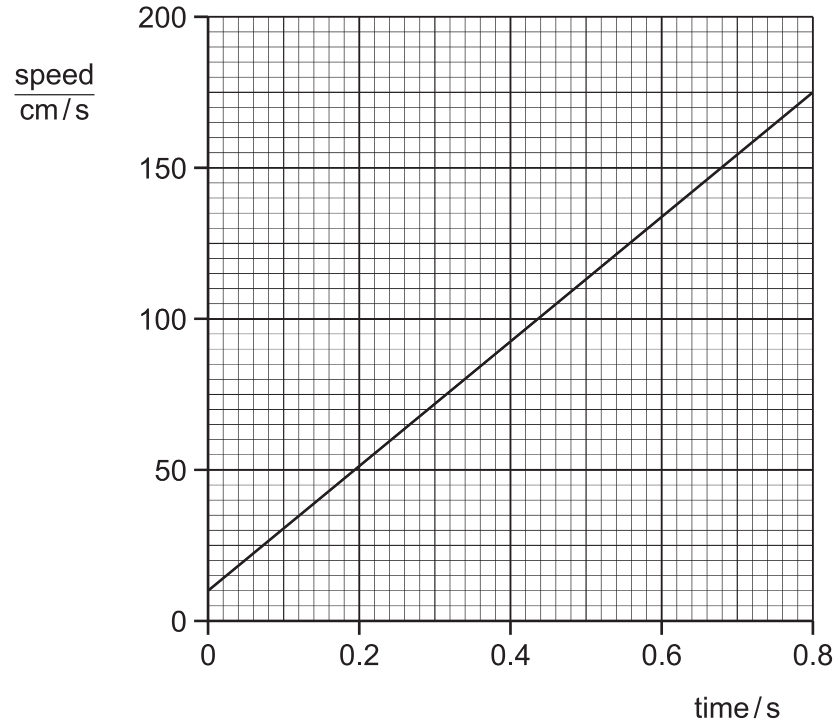


Fig. 1.3

Use the graph to determine the acceleration of the car.

Do your working in the box.

acceleration = ... unit .... [3]

2 **(a)** Table 2.1 shows the number of sub-atomic particles in several different atoms and ions.

For Examiner's Use

Complete Table 2.1 by writing in the symbol of each atom or ion. Include the charge on each ion. The first one has been completed for you.

Table 2.1

number of protons	number of electrons	number of neutrons	symbol
3	3	4	Li
9	10	10	
11	10	12	
15	15	16	

[2]

(b) The symbol for an iron(III) ion is Fe^{3+}.

The symbol for an oxide ion is O^{2-}.

Deduce the formula for the compound iron(III) oxide.

.... [1]

3 Table 3.1 gives information about four elements in Group 0 (noble gases) of the Periodic Table.

Table 3.1

element	electron arrangement	density of gas in kg/m^3	melting point / °C	boiling point / °C
helium	2	0.17	−272	−269
neon	2.8	0.84	−248	−246
argon	2.8.8	1.67		−186
krypton	2.8.18.8	3.50	−157	−152

(a) Describe the trend in boiling point down Table 3.1, from helium to krypton.

....

.... [1]

(b) Predict the melting point of argon. .... °C [1]

(c) A balloon is filled with one of the noble gases.

The material of the balloon increases the average density of the filled balloon by $0.45\,kg/m^3$.

The density of air at 25 °C is $1.18\,kg/m^3$.

In order for the balloon to rise in air, its average density must be less than that of air.

State which of the noble gases could be used to fill this balloon so that it will rise in air at 25 °C and explain your answer.

noble gas ....

explanation ....

....

.... [2]

4 Fig. 4.1 shows the structure of a thermocouple thermometer.

For Examiner's Use

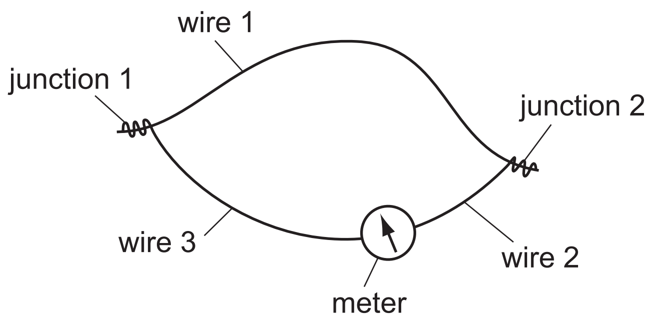


Fig. 4.1

(a) Wires 2 and 3 are made from the same material.

Suggest suitable materials from which the three wires could be made.

wire 1 ....

wires 2 and 3 .... [2]

(b) Junction 1 is placed in a cup of warm water and junction 2 is placed in melting ice.

Describe and explain what is observed.

....

....

....

.... [3]

(c) An engineer uses a thermocouple to investigate the temperature at one point in a jet engine. He takes measurements from the time that the engine is first switched on until it reaches a steady temperature.

Give **two** reasons why a thermocouple is a suitable thermometer to use.

Give an explanation for **one** of your reasons.

reason 1 ....

....

reason 2 ....

....

explanation ....

.... [3]

For Examiner's Use

5 Fig. 5.1 shows the arrangement of atoms in two forms of carbon, diamond and graphite.

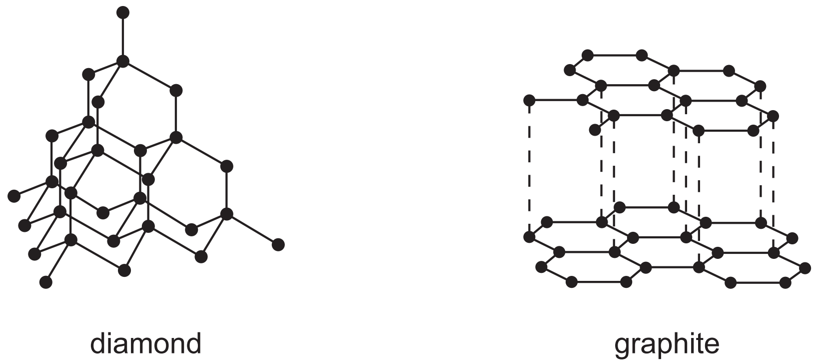


Fig. 5.1

Table 5.1 gives information about some of the properties of diamond and graphite.

Table 5.1

	diamond	graphite
hardness	10	2
melting point / °C	4227	3927
electrical conductivity	low	high

(a) Use ideas about the structure of diamond and graphite to explain the

(i) difference in hardness,

....

....

.... [2]

(ii) difference in electrical conductivity,

....

....

.... [2]

(iii) high melting points.

....

....

.... [2]

For Examiner's Use

(b) Carbon compounds are the basis of organic chemistry. An example is the compound methane, CH_4.

Methane has covalent bonding. At room temperature, methane is a gas.

Explain why methane has a very low boiling point.

....

....

.... [2]

(c) Plants make carbon compounds by the process of photosynthesis.

In this process plants react carbon dioxide with water to make glucose, $C_6H_{12}O_6$, and oxygen, O_2.

(i) Write a balanced equation for photosynthesis.

.... [2]

(ii) Photosynthesis is an endothermic process.

Explain how plants obtain the energy for photosynthesis.

....

....

.... [2]

6 Air traffic control uses radar ranging to track an aircraft. A radar transmitter sends out a pulse of microwaves. The waves reflect back from an aeroplane and are detected by the radar station.

For Examiner's Use

Fig. 6.1 shows how the system works.

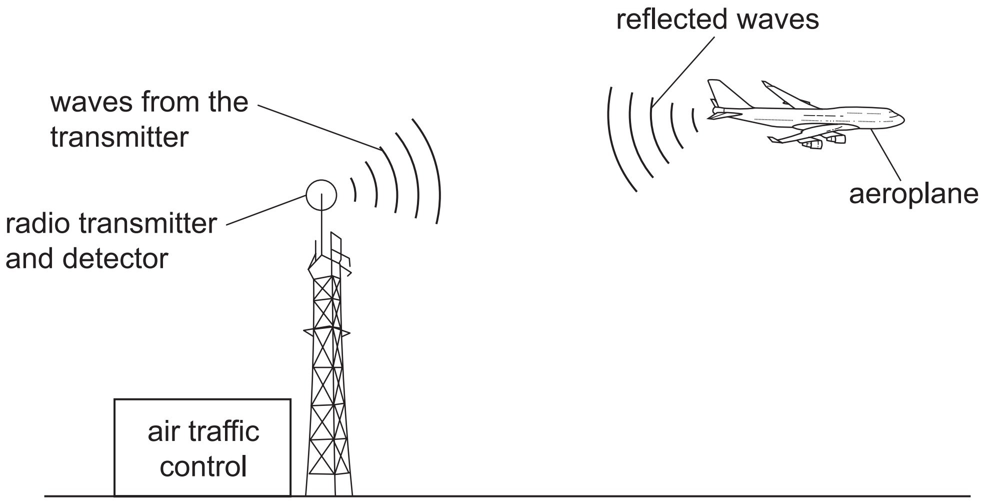


Fig. 6.1

(a) Fig. 6.2 shows the screen of a cathode ray oscilloscope (c.r.o.) at air traffic control.

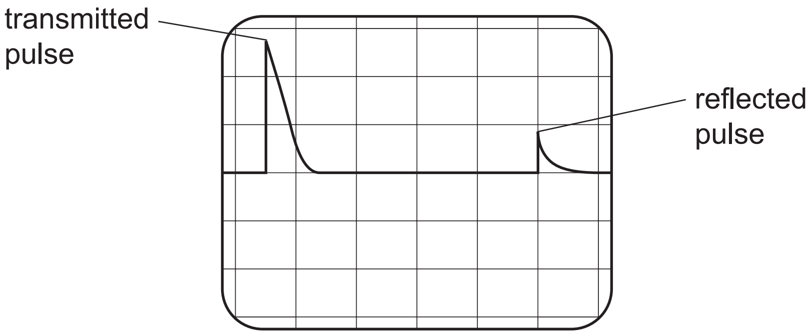


Fig. 6.2

The time–base of the c.r.o. is set at 0.05 ms / division.

(i) Suggest why the reflected pulse has a smaller amplitude than the transmitted pulse.

....

.... [1]

(ii) Calculate the time between the emission and detection of the pulse.

time = ... s [1]

For Examiner's Use

(iii) Calculate the distance of the aeroplane from the transmitter.
(speed of microwaves = 3×10^8 m/s)

distance = ... unit .... [2]

(b) (i) The microwaves used have a wavelength of 7.5 mm.

Calculate the frequency of the microwaves.

frequency = ... unit .... [2]

(ii) State **one** other use of microwaves.

.... [1]

7 Marble chips are made of calcium carbonate. They react with hydrochloric acid.

For Examiner's Use

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

A student uses the apparatus in Fig. 7.1 to measure the carbon dioxide given off in this reaction.

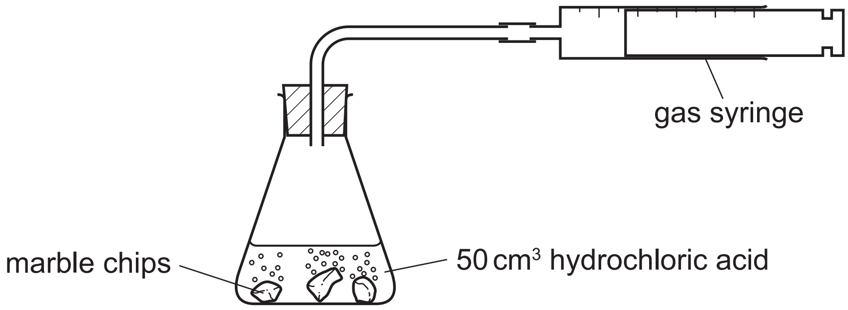


Fig. 7.1

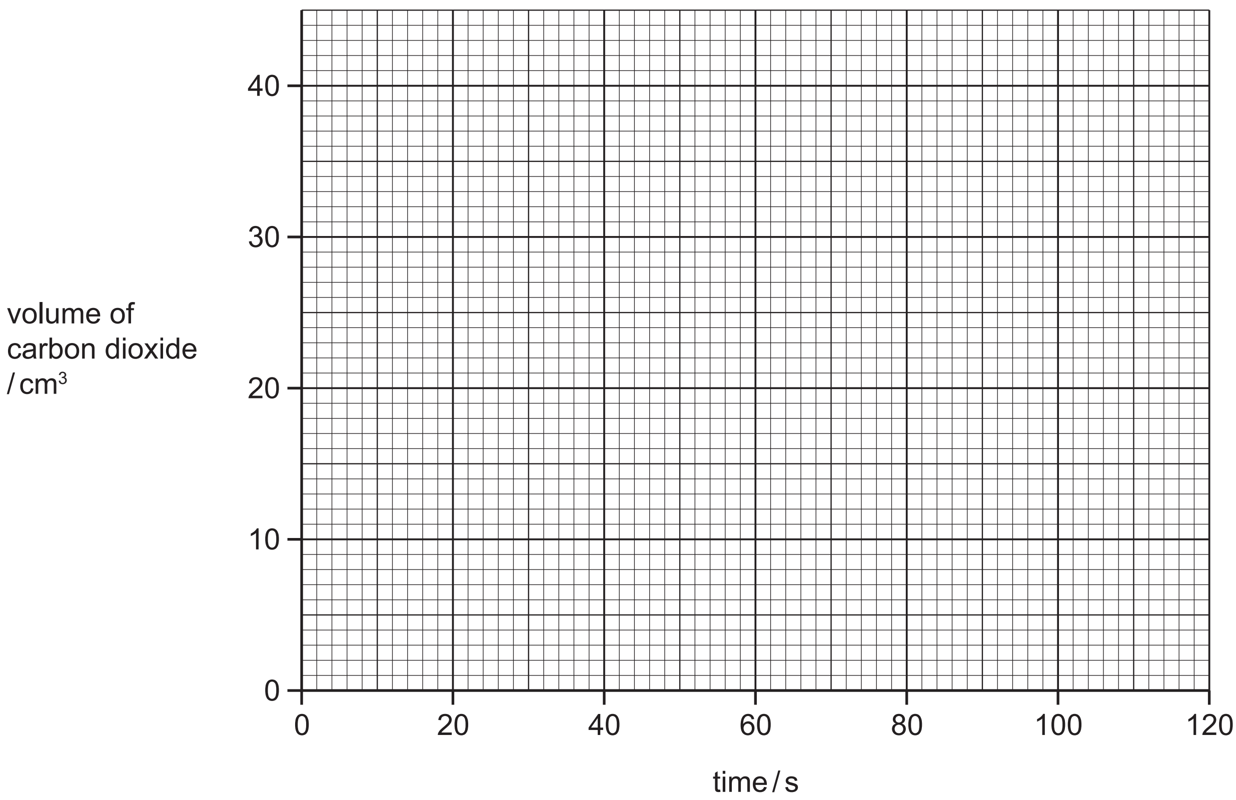
The results of this investigation are shown in Table 7.1.

Table 7.1

time / s	0	20	40	60	80	100	120
volume of carbon dioxide / cm^3	0	15	27	35	39	40	40

(a) (i) Plot the results on the grid. [2]

(ii) Draw a best-fit curve. [1]



For Examiner's Use

(b) State how the student could test the gas to show that it is carbon dioxide.

test ....

result .... [2]

(c) **(i)** After 100 seconds, no more carbon dioxide was given off. Some of the marble chips remained.

Explain why no more carbon dioxide was given off.

....

.... [1]

(ii) The volume of carbon dioxide was measured at room temperature and pressure.

Calculate the mass of calcium carbonate that reacted with the hydrochloric acid.
[relative atomic masses, A_r : C, 12; O, 16; Ca, 40]

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure.

Show your working in the box.

mass of calcium carbonate = ... g [3]

(d) The student repeated the experiment using the same mass of powdered calcium carbonate instead of marble chips.

Sketch on the grid in **(a)** the results you would expect from this second experiment. [2]

8 Fig. 8.1 shows the use of transformers in the transmission of electrical energy.

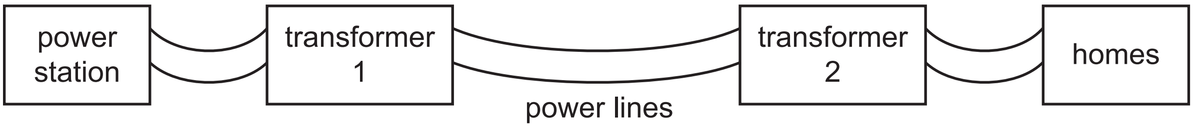


Fig. 8.1

(a) (i) State the function of each of the two transformers.

transformer 1 ....

....

transformer 2 ....

.... [2]

(ii) Explain why electrical energy is transmitted at very high voltages.

....

....

.... [2]

For Examiner's Use

For Examiner's Use

(b) Power lines can be made from several strands of copper, with a strand of steel, as shown in Fig. 8.2.

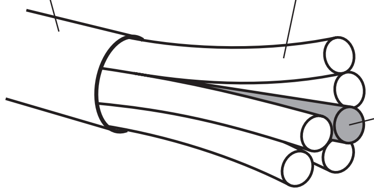


Fig. 8.2

(i) Describe the metallic structure of copper and explain how it makes copper a suitable material for the transmission of electricity.

....

....

....

....

.... [4]

(ii) Suggest why a steel strand is included in the power-line.

....

.... [1]

For Examiner's Use

9 Ethene is a hydrocarbon with the formula C_2H_4.

(a) Draw a dot and cross diagram to show the bonding in a molecule of ethene. Include only the outer shell electrons of carbon and hydrogen.

[2]

(b) Ethene can be made from long chain alkanes obtained from crude oil.

(i) State the name given to the process used to produce ethene from long chain alkanes.

.... [1]

(ii) State the **two** conditions needed for the process.

1 ....

2 .... [2]

(c) Ethene is reacted with steam to produce ethanol.

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

For Examiner's Use

(i) Calculate the mass of ethanol that can be made from each kg of ethene.
[relative atomic masses, A_r : H, 1; C, 12; O, 16]

Show your working in the box.

mass of ethanol = ... kg [2]

(ii) Name and describe another process that can be used to make ethanol.

....

....

....

.... [3]

10 Nuclear fusion takes place in the sun.

(a) **(i)** Explain what is meant by *nuclear fusion*.

....

....

.... [2]

(ii) Energy released as radiation from the sun reaches the earth.

Name **two** types of this radiation.

1 ....

2 .... [2]

(b) In a fusion reaction between two deuterium nuclei ($^{2}_{1}H$), each of mass 3.3434×10^{-27} kg, the total mass of the products of this reaction is 6.6810×10^{-27} kg.

(i) Show that the mass lost during this reaction is 5.8×10^{-30} kg.

Do your working in this box.

[1]

(ii) Calculate the energy released in this reaction.

Do your working in this box.

energy released = ... J [2]

For Examiner's Use

(iii) The output from the sun is approximately 4×10^{26} W.

Estimate the number of fusion reactions which occur each second. You may assume that this is the only type of fusion reaction that occurs in the Sun.

Do your working in this box.

number of reactions per second = ... [2]

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															
				140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
				232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a over **X** over b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).