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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5706058917

PHYSICAL SCIENCE **0652/31**

Paper 3 (Extended) **October/November 2012**

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 soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
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.

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1	
2	
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10	
Total	

This document consists of **18** printed pages and **2** blank pages.

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1 Fig. 1.1 shows an uncalibrated liquid in glass thermometer and a ruler. The upper and lower fixed points are marked on the thermometer.

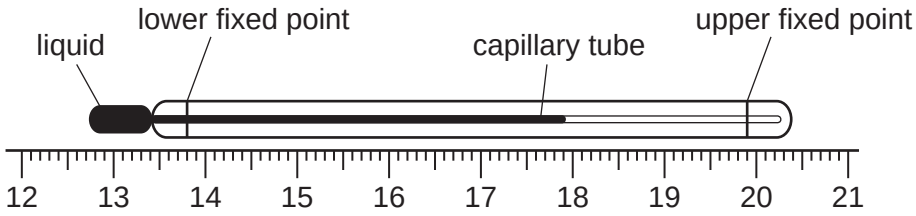

Fig. 1.1

(a) (i) State the physical property of the liquid on which the operation of the thermometer depends.

.....[1]

(ii) What are the values of the fixed points on the Celsius temperature scale?

upper fixed point .....

lower fixed point .....[1]

(iii) Take measurements from Fig. 1.1 and use them to calculate the temperature indicated by this thermometer.

temperature = ... °C [4]

(b) (i) Explain what is meant by the *sensitivity* of the thermometer.

.....

.....[1]

(ii) Suggest a design change to increase the sensitivity of the thermometer in Fig. 1.1.

.....

.....[1]

(c) Other physical properties can be used to measure temperature.

Name **one** of these properties.

.....[1]

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2 **(a)** Table 2.1 shows information about three elements in Group II of the Periodic Table.

Table 2.1

element	atomic number	relative atomic mass	electron arrangement	density in g / cm^3	melting point in °C
beryllium	4	9	2,2	1.85	1278
magnesium	12	24	2,8,2	1.74	649
calcium	20	40	2,8,8,2	1.54	839

(i) What information in Table 2.1 shows that these elements are metals?

.....

..... [1]

(ii) Explain how the information in Table 2.1 shows that these are Group II elements and are successive in Group II.

.....

.....

.....

..... [2]

(iii) The elements in Group II show a trend in physical properties.

Use information from Table 2.1 to describe this trend.

.....

.....

..... [2]

(b) Magnesium reacts with chlorine to form magnesium chloride. This compound contains the ions Mg^{2+} and Cl^-.

Deduce the formula of magnesium chloride. ..... [1]

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(c) Magnesium is malleable.

Describe metallic bonding and use this to explain why magnesium is malleable.

.....

.....

.....

.....

..... [3]

For Examiner's Use

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3 Fig. 3.1 shows a non-uniform beam of length 2.4 m and mass 0.80 kg. The beam is pivoted at its centre. Point **C** marks the centre of mass of the beam.

A weight of 4.5 N is hung on the beam. The distance *x* of the weight from the pivot is adjusted until the beam balances.

[g = 10 N / kg]

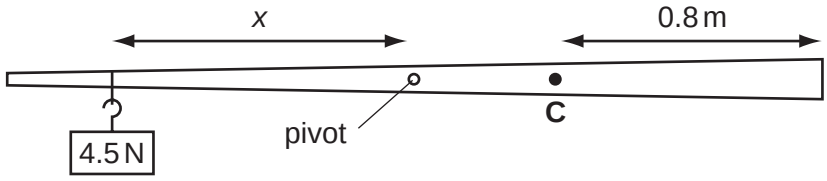

Fig. 3.1

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

.....

.....

..... [2]

(b) (i) Calculate the weight of the beam.

..... N [1]

(ii) Calculate the distance of the centre of mass from the pivot.

distance = ... m

Now calculate the moment produced by the weight of the beam about the pivot.

moment = ... Nm [2]

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(iii) State the moment that the 4.5 N weight produces about the pivot.

moment = ... [1]

(iv) Calculate the distance *x*.

x = ... m [2]

For Examiner's Use

4 Calcium sulfate is a salt that is insoluble in water.

It can be made in the laboratory from solid calcium nitrate, $Ca(NO_3)_2$, and solid sodium sulfate, Na_2SO_4. Both of these solids are soluble in water.

(a) Describe how you would make a pure dry sample of calcium sulfate starting from these solid materials.

.....

.....

.....

.....

..... [4]

(b) Write a balanced equation for the reaction between calcium nitrate and sodium sulfate.

Include state symbols in your equation.

..... [3]

(c) Calcium sulfate can also be made by reacting calcium chloride with sodium sulfate.

$$CaCl_2 + Na_2SO_4 \longrightarrow CaSO_4 + 2NaCl$$

What is the maximum mass of calcium sulfate that could be made from 5.0 g calcium chloride?

[Relative atomic masses: A_r: Ca,40; Na,23; Cl,35.5; O,16; S,32.]

Show your working in the box.

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

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5 Fig. 5.1 shows blue light entering a triangular prism. The prism is made of a transparent plastic.

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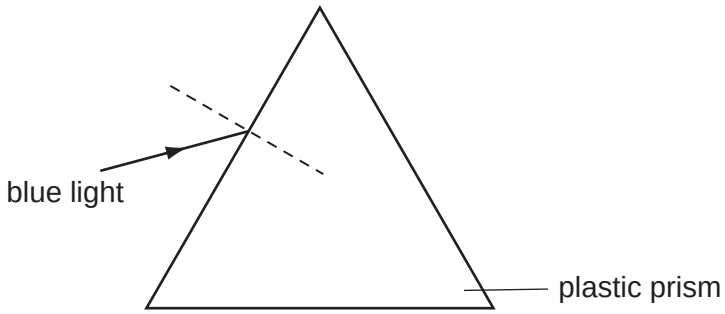

Fig. 5.1

The blue light enters at an angle of incidence 45°. The light is refracted so that the angle of refraction is 30°.

(a) (i) On Fig. 5.1, draw the path of the blue light inside the plastic prism. [1]

(ii) Calculate the refractive index *n* of the plastic for blue light.

n = ... [3]

(iii) On Fig. 5.1, complete the path of the light after it leaves the prism. Label this line **blue**. [1]

(b) The refractive index of the plastic for red light is slightly less than for blue light.

Red light is shone along the same incident path as the blue light.

On Fig. 5.1, draw the path of the red light as it passes through and out of the prism.

Label this line **red**. [2]

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6 A student investigates the reaction of four metal powders with 100 cm^3 dilute hydrochloric acid using the apparatus in Fig. 6.1.

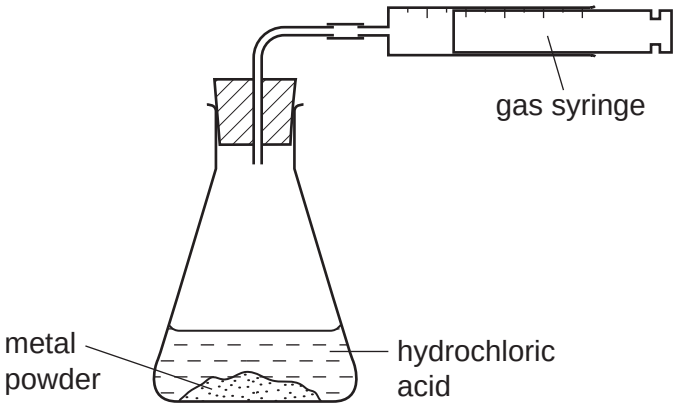

Fig. 6.1

The student measures the time taken to collect 100 cm^3 of hydrogen for each metal. Results of this investigation are shown in Fig. 6.2.

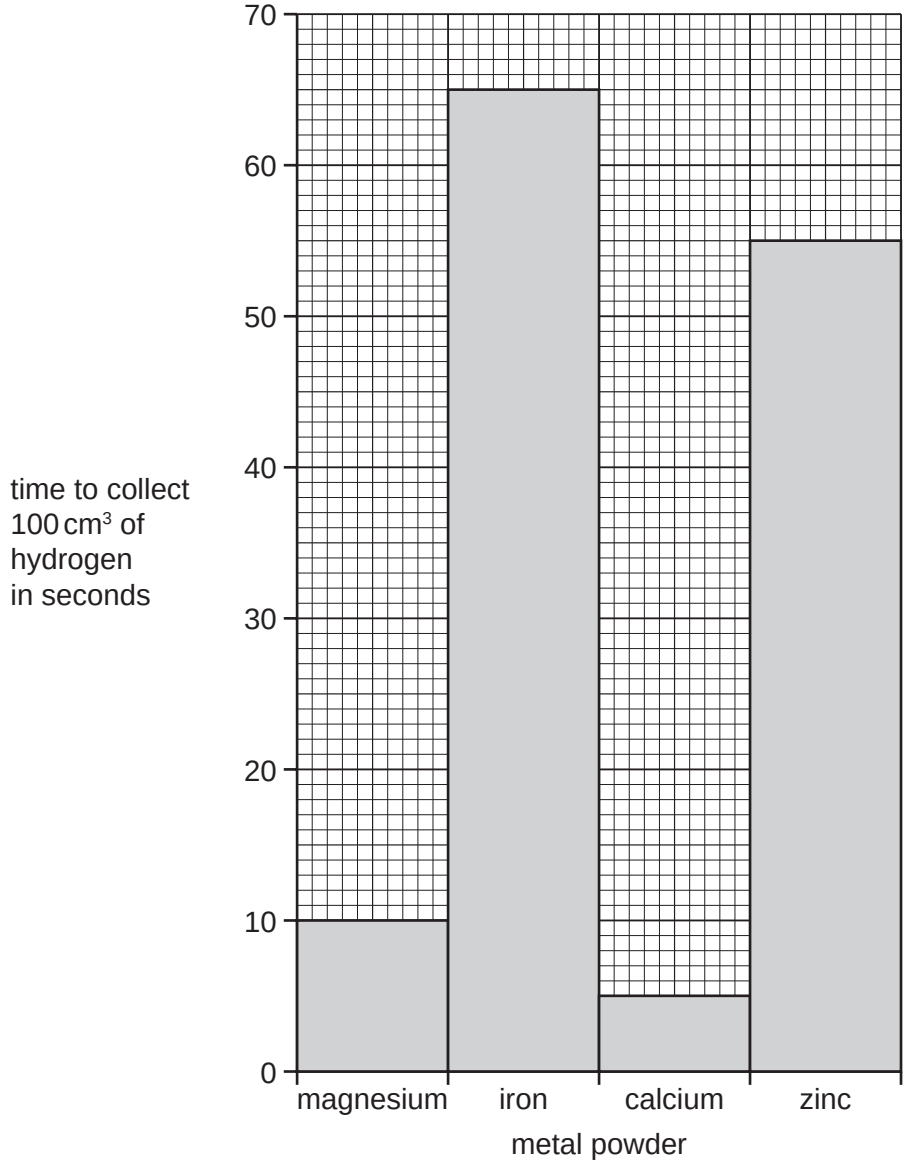

Fig. 6.2

For Examiner's Use

(a) (i) Place the four metals in order of reactivity, from most reactive to least reactive.

1 ..... most reactive

2 .....

3 .....

4 ..... least reactive [1]

(ii) The student repeats the experiment using copper powder.

Predict what the student will observe.

..... [1]

(iii) The student then does the experiment with magnesium ribbon instead of magnesium powder. The same mass of magnesium is used.

Predict what the student will observe.

..... [1]

(b) The student repeats the experiment with zinc. This time it is allowed to continue until it stops. When the reaction stops some of the zinc powder is left unreacted.

The total volume of hydrogen given off, measured at room temperature and pressure, is 180 cm^3. The reaction takes place according to this equation.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

(i) Calculate the mass of hydrogen chloride in the hydrochloric acid used in the reaction. [Relative atomic masses: A_r: H,1; Cl,35.5; Zn,65.]

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 hydrogen chloride = ... g [3]

(ii) Work out the concentration of the 100 cm^3 hydrochloric acid in mol / dm^3.

Show your working in the box.

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concentration of hydrochloric acid = ... mol / dm^3 [2]

For Examiner's Use

7 Fig. 7.1 shows a battery for a mobile telephone.

Fig. 7.1

The battery has an e.m.f. of 3.7 V. When fully charged the battery can provide a steady current of 0.020 A for 51 hours.

(a) Explain what is meant by the term *e.m.f.*

.....

..... [1]

(b) (i) Calculate the power of the battery when it supplies a current of 0.020 A.

power = ... [2]

(ii) Calculate the charge which will flow through the circuit if there is a steady current of 0.020 A for 51 hours.

charge = ... [2]

(iii) Calculate the energy the battery will supply in this time.

energy = ... [2]

(c) Mobile telephones send signals by use of microwaves.

Describe the nature of microwaves.

.....

.....

..... [2]

For Examiner's Use

8 **(a)** Aluminium is more reactive than iron.

Aluminium is used for food containers but steel is not unless it is first coated with a thin layer of tin.

Explain these facts.

.....

.....

.....

.....

..... [4]

(b) Duralumin is an aluminium alloy. It contains copper, manganese and magnesium. This alloy is widely used to make parts of aircraft.

(i) The main component of duralumin is aluminium.

What property of aluminium makes this aluminium alloy a good choice for aircraft parts?

..... [1]

(ii) Duralumin is used rather than pure aluminium because it is much stronger.

Explain why duralumin is stronger than pure aluminium.

.....

.....

.....

.....

..... [3]

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Please turn over for Question 9.

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9 Fig. 9.1 shows an a.c. generator.

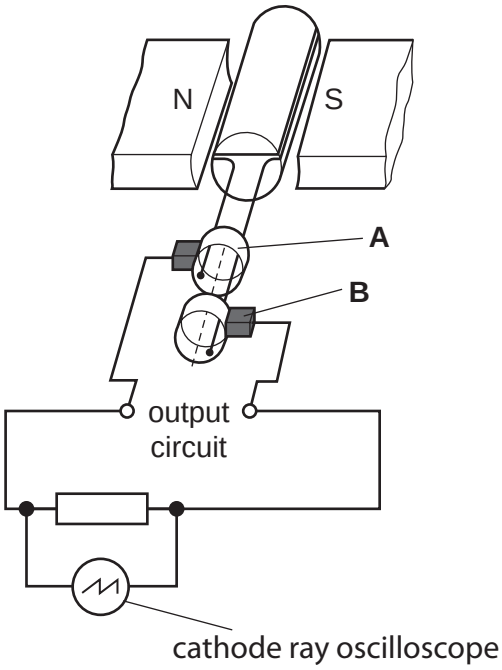

Fig. 9.1

The output from the generator is connected to a resistor and a cathode ray oscilloscope (c.r.o.).

(a) (i) Name part **A**. ..... [1]

(ii) Name part **B**. ..... [1]

(b) The generator works by electromagnetic induction.

Explain how this produces a current in the output circuit.

.....

.....

.....

.....

..... [3]

(c) Fig. 9.2 shows the trace on the c.r.o. shown in Fig. 9.1.

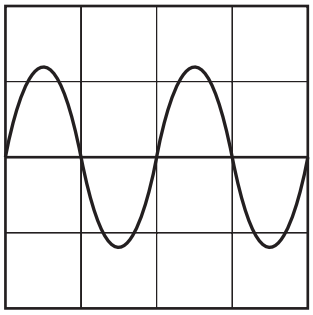

Fig. 9.2

Fig. 9.3a shows a similar circuit to the one shown in Fig. 9.1 but with a diode included.

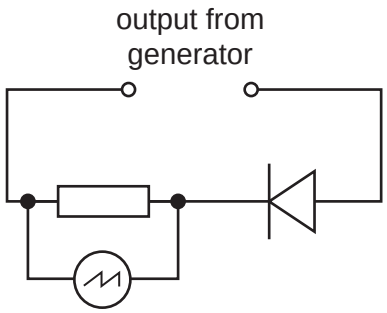

Fig. 9.3a

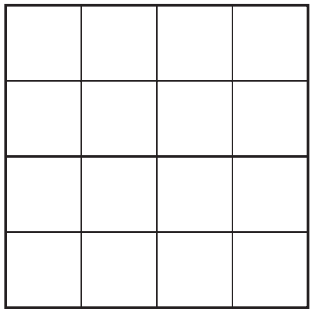

Fig. 9.3b

(i) Explain the purpose of the diode in this circuit.

.....

..... [1]

(ii) On Fig. 9.3b, draw the trace that is seen on the c.r.o. when the circuit of Fig. 9.3a is connected to the a.c. generator output of Fig. 9.1. [1]

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10 Ethanol is used as a fuel.

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It burns according to this equation.

$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$

(a) The burning of ethanol is an exothermic reaction.

Use ideas of energy, bond making and bond breaking to explain what this means.

.....

.....

.....

.....

..... [3]

(b) State how ethanol can be made on an industrial scale.

..... [1]

(c) State one use of ethanol, other than as a fuel.

..... [1]

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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 above **X** above 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.).

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