UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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PHYSICAL SCIENCE **8780/03**

Paper 3 Structured Questions **For Examination from 2011**

SPECIMEN PAPER

1 hour 30 minutes

Candidates answer on the Question Paper.

Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on 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, highlighters, glue or correction fluid.

Answer **all** questions.
You may lose marks if you do not show your working or if you do not use appropriate units.

A Data Booklet is provided.

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.

For Examiner's Use	
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11	
Total	

This document consists of **14** printed pages and **2** blank pages.

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Answer **all** the questions in the spaces provided.
Relevant Data, Formulae and the Periodic Table are provided in the Data Booklet.

1 The mass of a cube of aluminium is found to be 580 g with an uncertainty in the measurement of 10 g.

(a) Determine the percentage uncertainty in this measurement.

uncertainty = ... % [1]

(b) Each side of the cube has a length of (6.0 ± 0.1) cm.
Calculate the density of aluminium with its uncertainty. Express your answer to an appropriate number of significant figures.

density = ... ± ..... g cm^{-3} [4]

[Total: 5]

2 A ball **B** of mass 1.2 kg travelling at constant velocity collides head-on with a stationa
S of mass 3.6 kg, as shown in Fig. 2.1.

Fig. 2.1

Frictional forces are negligible.

The variation with time *t* of the velocity *v* of ball **B** before, during and after colliding with ball **S** is shown in Fig. 2.2.

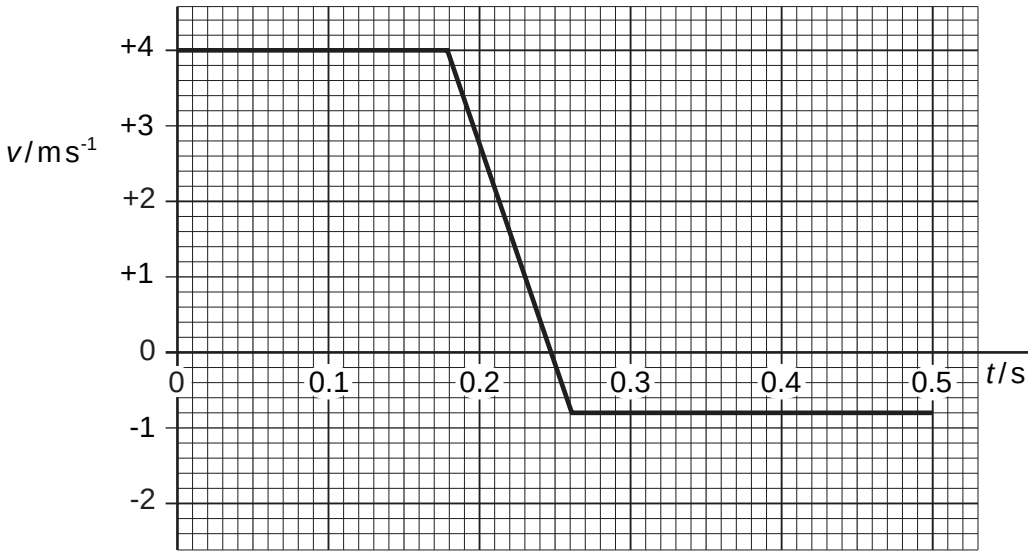

Fig. 2.2

(a) State the significance of positive and negative values for *v* in Fig. 2.2.

.....

..... [1]

(b) Use Fig. 2.2 to determine, for ball **B** during the collision with ball **S**,

(i) the change in momentum of ball **B**,

change in momentum = ... N s [3]

(ii) the magnitude of the force acting on ball **B**.

force = ... N [3]

(c) Calculate the speed of ball **S** after the collision.

speed = ... $m\,s^{-1}$ [2]

(d) The collision is inelastic. Explain what is meant by *inelastic*.

.....

..... [1]

[Total: 10]

3 **(a)** Describe and explain the trend observed in the thermal stability of the carbon
the Group II elements.

.....

.....

.....

..... [3]

(b) Malachite is an ore of copper. It contains the following percentages by mass.

copper 57.7%
oxygen 36.2%
carbon 5.4%
hydrogen 0.9%

Malachite reacts with dilute H_2SO_4 producing a gas **B**, that turns limewater milky, and a blue solution **C**.

When heated in the absence of air, malachite produces gas **B** and steam, and leaves a black solid **D**. **D** reacts with dilute H_2SO_4 to produce the same blue solution **C**.

Adding iron filings to **C** produces a pink solid **E** and a pale green solution **F**.

(i) Calculate the empirical formula of malachite.

empirical formula = ... [2]

(ii) Suggest the formula of the ion responsible for the blue colour of solution **C**.

..... [1]

(iii) Suggest an identity for the black solid **D** and calculate the mass of **D** that could be obtained by heating 10 g of malachite.

.....

.....

.....

..... [4]

(iv) Suggest an identity for the pink solid **E** and the solution **F**. Write an equat
the reaction producing them.

.....

.....

..... [2]

(v) What type of reaction is the reaction that produces **E** and **F**?

..... [1]

[Total: 13]

4 Two sources $\mathbf{S}_1$ and $\mathbf{S}_2$ of sound are situated 80 cm apart in air, as shown in Fig. 4.1.

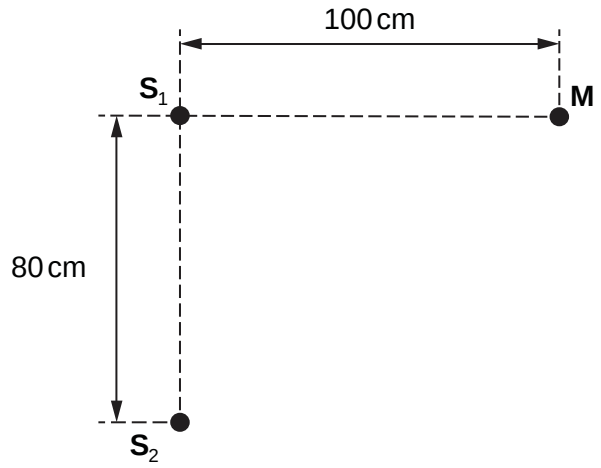

Fig. 4.1

The frequency of vibration can be varied. The two sources always vibrate in phase but have different amplitudes of vibration.

A microphone **M** is situated a distance 100 cm from $\mathbf{S}_1$ along a line that is normal to $\mathbf{S}_1\mathbf{S}_2$.

As the frequency of $\mathbf{S}_1$ and $\mathbf{S}_2$ is gradually increased, the microphone **M** detects maxima and minima of intensity of sound.

(a) State the two conditions that must be satisfied for the intensity of sound at **M** to be zero.

1. .....

.....

2. .....

..... [2]

(b) The speed of sound in air is 330 m s^{-1}.

The frequency of the sound from $\mathbf{S}_1$ and $\mathbf{S}_2$ is increased. Determine the number of minima that will be detected at M as the frequency is increased from 1.0 kHz to 4.0 kHz.

number = ...[4]

[Total: 6]

5 **(a)** The viscosity of engine oil can be improved by the addition of certain medium length polymers. A portion of the chain of one such polymer is shown below.

$$–CH_2CH(CH_2CH_2CH_3)CH_2CH(CH_2CH_2CH_3)CH_2–$$

On average, the molecules of the medium-chain polymer contain 40 carbon atoms.

(i) Suggest the structure of the monomer.

.....

[1]

(ii) How many monomer units are incorporated into the average molecule of the polymer?

.....

[1]

(b) Used car engine oil can be recycled for use as a fuel by the processes of distillation and cracking.

(i) Assuming a typical molecule of engine oil has the formula $C_{40}H_{82}$, suggest an equation for a cracking reaction that could produce diesel fuel with the formula $C_{16}H_{34}$ and other hydrocarbons only.

.....

[1]

(ii) What conditions are needed for this cracking reaction?

.....

[1]

(iii) Considering only the bonds broken and the bonds formed during the reaction, use the *Data Booklet* to calculate the enthalpy change for the reaction you wrote in **(b)(i)**.

enthalpy change = ... [1]

(iv) Comment on how the conditions you described in **(b)(ii)** relate to the enthalpy change you calculated in **(b)(iii)**.

.....

.....

.....

[1]

[Total: 6]

6 In the Haber Process, ammonia is synthesised from its elements.

(a) Write an equation for the Haber process and state whether it is endo- or exo-thermic.

.....

..... [2]

(b) What are the **three** usual operating conditions of the Haber Process?

.....

.....

..... [2]

(c) Explain the considerations which lead to the temperature you have stated in **(b)** being used.

.....

.....

.....

..... [2]

(d) One of the uses of ammonia is to form nitrates which are used as efficient inorganic fertilisers. The uncontrolled use of these fertilisers has led to environmental problems. Briefly describe and explain these problems.

.....

.....

.....

.....

..... [3]

[Total: 9]

7 An electron travelling horizontally in a vacuum enters the region between two hor
metal plates, as shown in Fig. 7.1.

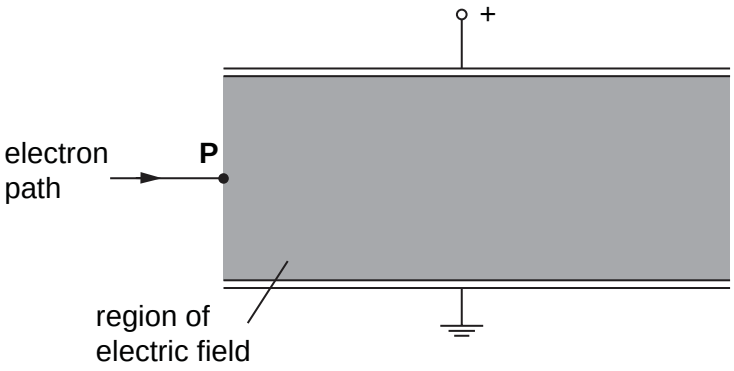

Fig. 7.1

The lower plate is earthed and the upper plate is at a positive potential. The electric field between the plates may be assumed to be uniform and outside the plates to be zero.

(a) On Fig. 7.1,

(i) draw an arrow at **P** to show the direction of the force on the electron due to the electric field between the plates,

(ii) sketch the path of the electron as it passes between the plates and beyond them.

[3]

(b) The electric field strength between the plates is $50 \times 10^4\,\text{N C}^{-1}$.

Calculate, for the electron between the plates, the magnitude of

(i) the force on the electron,

force = ... N

(ii) its acceleration.

acceleration = ... m s^{-2}

[4]

[Total: 7]

8 An electric heater consists of three similar heating elements **A**, **B** and **C**, connec... shown in Fig. 8.1.

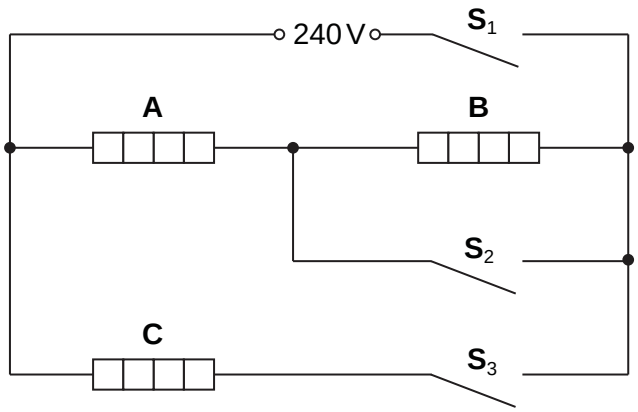

Fig. 8.1

Each heating element is rated as 1.5 kW, 240 V and may be assumed to have constant resistance.

The circuit is connected to a 240 V supply.

(a) Calculate the resistance of one heating element.

resistance = ... Ω [2]

(b) The switches S_1, S_2 and S_3 may be either open or closed.

Complete the table below to show the total power dissipation of the heater for the switches in the positions indicated.

S_1	S_2	S_3	total power / kW
open	closed	closed	.....
closed	closed	open	.....
closed	closed	closed	.....
closed	open	open	.....
closed	open	closed	.....

[5]

[Total: 7]

9 Compound, **A**, has the molecular formula C_4H_8O.

(a) **A** reacts with 2,4-dinitrophenylhydrazine but not with Fehling's or Tollens' reagents.

(i) State what you would see when **A** reacts with the 2,4-dinitrophenylhydrazine reagent.

.....

..... [1]

(ii) State what functional group is present in **A**.

..... [1]

(iii) Identify **A** either by name or by its structural formula.

..... [1]

(b) **A** can be reduced to compound **B**.

For this reaction

(i) state a suitable reducing agent,

..... [1]

(ii) name the functional group present in **B** (two words are required),

..... [1]

(iii) give the structural formula of **B**.

..... [1]

[Total: 6]

10 (a) (i) What is meant by the term *standard enthalpy change of formation* $\Delta H_f^{\ominus}$ of a compound?

.....

.....

..... [2]

(ii) Write an equation, with state symbols, for the $\Delta H_f^{\ominus}$ of water.

..... [1]

(b) When calcium is placed in water, aqueous calcium hydroxide is formed and hydrogen is given off.

(i) Write the equation for the reaction of calcium with water.

..... [1]

(ii) When 1.00 g of calcium is placed in 200 g of water, the temperature increases by 12.2 °C when the reaction is completed. The specific heat capacity of water, *c*, is $4.2\,J\,g^{-1}\,K^{-1}$.

Calculate the heat released in the experiment.

heat released = ... J [1]

(iii) Calculate the standard enthalpy change of reaction in $kJ\,mol^{-1}$ for your equation in **(b)(i)**.

standard enthalpy change of reaction = ... $kJ\,mol^{-1}$ [1]

(iv) Use the ideal gas equation to calculate the volume of hydrogen, in m^3, measured at 300 K and 1.00×10^5 Pa, liberated in the experiment described in **(b)(ii)**.

volume of hydrogen liberated = ... m^3 [2]

[Total: 8]

11 The spontaneous and random decay of a radioactive substance involves the emis
either α-radiation or β-radiation and/or γ-radiation.

(a) Explain what is meant by *spontaneous* decay.

.....

.....

..... [2]

(b) State the type of emission, one in each case, that

(i) is not affected by electric fields,

..... [1]

(ii) produces the greatest density of ionisation in a medium,

..... [1]

(iii) does not directly result in a change in the proton number of the nucleus.

..... [1]

[Total: 5]

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