Cambridge International **AS Level**

Cambridge International Examinations
Cambridge International Advanced Subsidiary Level

CANDIDATE NAME

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7705810267

PHYSICAL SCIENCE **8780/03**

Paper 3 Structured Questions **October/November 2017**

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 in the spaces at the top of the page.
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 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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Total	

This document consists of **17** printed pages and **3** blank pages.

CAMBRIDGE International Examinations

1 A racing car travels along a straight horizontal track.
At one point, the car decelerates uniformly from a speed of $60\,m\,s^{-1}$ to $12\,m\,s^{-1}$.

Table 1.1 shows the data from the race and the uncertainties in the measurements.

Table 1.1

total mass m of car and driver / kg	initial speed v_1 / $m\,s^{-1}$	final speed v_2 / $m\,s^{-1}$	time t for deceleration / s
650 ± 10	60 ± 1	12 ± 1	1.50 ± 0.05

The braking force F can be calculated from the formula shown.

$$F = \frac{m(v_2 - v_1)}{t} = 20\,800\,N$$

(a) (i) Calculate the actual uncertainty in the change of speed of the car.

actual uncertainty = ± ..... $m\,s^{-1}$ [1]

(ii) Calculate the percentage uncertainty in the change of speed of the car.

percentage uncertainty = ± .....% [1]

(b) The percentage uncertainty in m is ± 1.5 %.

The percentage uncertainty in t is ± 3.3 %.

Calculate the actual uncertainty in the calculation of the braking force F.

actual uncertainty = ± ..... N [2]

[Total: 4]

2 There are trends in the physical and in the chemical properties of the halogens fluorine to iodine.

(a) Explain, in terms of intermolecular forces, why chlorine has a lower boiling point than iodine.

.....

.....

.....

.....[2]

(b) Explain the decrease in first ionisation energy from fluorine to iodine.

.....

.....

.....

.....[2]

(c) Describe an experiment that could be carried out to show that chlorine is a stronger oxidising agent than iodine.

In your answer you should:

- identify the reagents to be used,
- write an equation for the reaction,
- describe one observation that would show that a reaction had occurred.

.....

.....

.....

.....

.....

.....[3]

[Total: 7]

3 **(a)** State what is meant by the term *work done*.

.....

.....[1]

(b) An astronaut on the Moon drops a metal sphere from rest on to the Moon's surface from a height of 1.25 m.

The mass of the sphere is 1.40 kg.
The acceleration of free fall near the Moon's surface is 1.62 m s^{-2}.

(i) Calculate the work done on the sphere by the Moon's gravitational field.

work done = ...J [1]

(ii) State the loss in gravitational potential energy of the sphere.

loss in energy = ...J [1]

(c) The astronaut uses a solar-powered vehicle to move around on the Moon's surface. On one journey the vehicle moves at a constant speed of 4.0 m s^{-1}, on horizontal ground, against a constant frictional force of 150 N.

(i) Calculate the power supplied by the vehicle's motor.
State the unit.

power = ... unit = ... [2]

(ii) The solar panels on the vehicle convert 10% of sunlight incident on them into electric potential energy. The motor has an efficiency of 24%.

The intensity of the Sun's radiation on the panels is 1400 W m^{-2}. Intensity is the power incident per unit area.

Calculate the minimum area of solar panel required to power the vehicle on this journey.

area = ... m^2 [3]

[Total: 8]

4 **(a)** Compound **Y** can be prepared by exposing a gaseous mixture of compound **X** and bromine to ultraviolet light. The structural formulae of **X** and **Y** are shown.

$(CH_3)_3CH$	$(CH_3)_3CBr$
X	**Y**

(i) Name compound **Y**.

.....[1]

(ii) Write an equation to show the initiation stage of the mechanism for this reaction.

.....[1]

(iii) Compound **Y** is formed in the propagation stage of this mechanism.

Write equations for the **two** steps in this propagation stage.

.....

.....[2]

(iv) An isomer of **Y** is also formed in this reaction.

Draw the displayed formula of this isomer.

[1]

(v) Very small quantities of a compound with molecular formula C_8H_{18} may be formed in this reaction.

Write an equation for a termination stage in this mechanism in which C_8H_{18} is formed.

.....[1]

(b) Compound **Q**, $C_4H_{11}N$, is formed when **Y** is reacted with the reagent **P**.

Identify reagent **P**, by name or formula, and draw the structural formula of **Q**.

P is .....

structural formula of **Q**

.....

[2]

[Total: 8]

5 **(a)** State what is meant by the term *momentum*.

.....

.....[1]

(b) Fig. 5.1 shows two gliders, **A** and **B**, on an air track. Glider **A** has a mass of 0.50 kg and glider **B** has a mass of 0.75 kg.

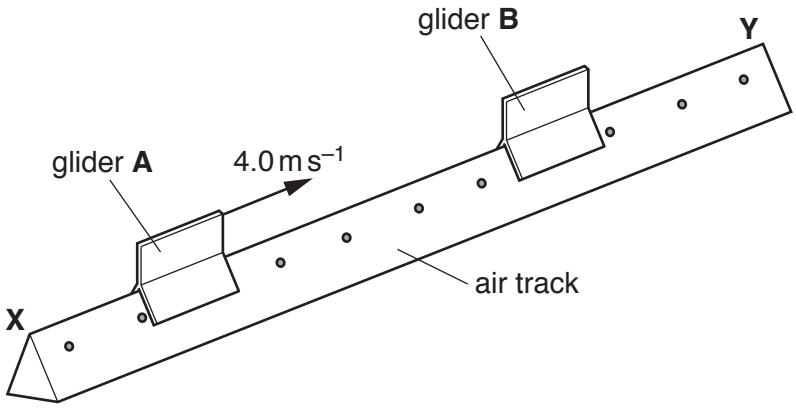

Fig. 5.1

Glider **B** is stationary. Glider **A** moves from **X** towards **Y** and collides with **B** at a velocity of $4.0\,m\,s^{-1}$.

After the collision, glider **B** moves in the direction **XY** at a speed of $3.2\,m\,s^{-1}$.

Calculate the velocity of glider **A** after the collision.
Assume there is no friction between the gliders and the air track.

velocity = ... $m\,s^{-1}$ [3]

(c) Show whether this collision is elastic or inelastic.

[2]

[Total: 6]

6 Ammonia is manufactured in the Haber process. The equation and enthalpy change of formation, ΔH_f, for this reaction are shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H_f = -45.9\,kJ\,mol^{-1}$$

In this process, a temperature of about 450 °C, a pressure of about 20 MPa (200 atm) and an iron catalyst are used.

(a) (i) State and explain the effect of using a much higher temperature than 450 °C on the rate and on the yield of this reaction.

effect on rate .....

explanation .....

.....

.....

.....

effect on yield .....

explanation .....

.....

.....

.....

[4]

(ii) The temperature of 450 °C is known as a compromise temperature.

Explain why a much higher or a much lower temperature than the compromise temperature is **not** used in the Haber process.

.....

.....

.....[1]

(b) Ammonia is also produced when a mixture of solid ammonium chloride and solid calcium hydroxide is heated strongly. The equation for this reaction is shown.

$$2NH_4Cl(s) + Ca(OH)_2(s) \rightarrow CaCl_2(s) + 2H_2O(l) + 2NH_3(g)$$

Table 6.1 gives the enthalpy change of formation, ΔH_f, data for these compounds.

Table 6.1

compound	$NH_4Cl(s)$	$Ca(OH)_2(s)$	$CaCl_2(s)$	$H_2O(l)$	$NH_3(g)$
ΔH_f / kJ mol^{-1}	–314.6	–986.1	–795.8	–285.8	–45.9

Use the data in Table 6.1 to calculate the molar enthalpy change, ΔH_R, for this reaction.

ΔH_R = ... kJ mol^{-1} [2]

(c) Ammonia is very soluble in water due to the type of intermolecular force present between ammonia molecules and water molecules.

(i) Name the strongest type of intermolecular force present between ammonia and water molecules.

.....[1]

(ii) Explain why ammonia and water molecules are able to produce this type of intermolecular force.

.....

.....

.....[1]

[Total: 9]

7 Fig. 7.1 shows an experiment used to demonstrate interference of visible light.

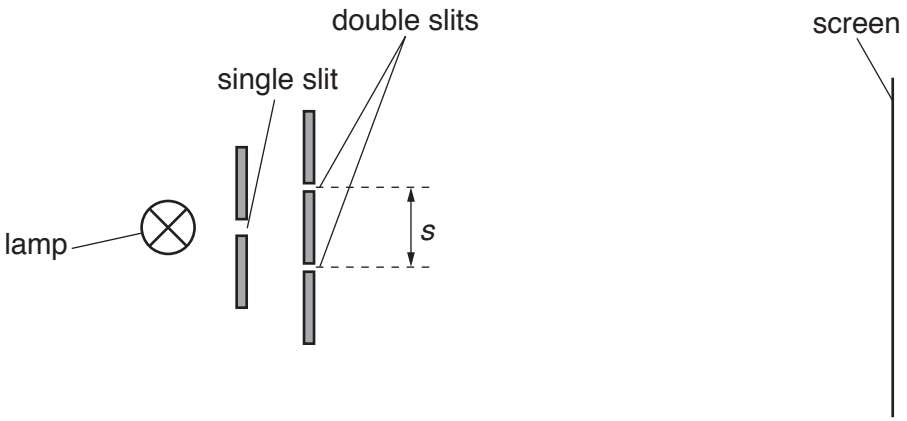

Fig. 7.1

The lamp emits monochromatic light from the red end of the spectrum. The double slits act as two coherent sources.

(a) (i) State what is meant by *monochromatic light*.

.....

.....[1]

(ii) State what is meant by *coherent sources*.

.....

.....[1]

(b) The lamp in Fig. 7.1 is replaced by a lamp that emits monochromatic light from the violet end of the spectrum. The interference pattern is different from the pattern produced by the light from the red end of the spectrum.

(i) Describe this difference.

.....[1]

(ii) Explain why this difference occurs.

.....

.....[2]

(c) A student is investigating the pattern of fringes formed by the double slits using red light.

Describe **two** ways in which the apparatus can be altered so that the red fringes formed on the screen are further apart.

1. .....

.....

2. .....

.....

[2]

[Total: 7]

8 **(a)** Magnesium nitrate, $Mg(NO_3)_2$, can be prepared by the reaction of magnesium hydroxide, $Mg(OH)_2$, with nitric acid. The equation for this reaction is shown.

$$Mg(OH)_2(s) + 2HNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + 2H_2O(l)$$

An excess of magnesium hydroxide is added to 175 cm^3 of 1.50 mol dm^{-3} nitric acid.

Calculate the maximum mass of magnesium nitrate which could be obtained from this reaction.

maximum mass of magnesium nitrate = ...g [3]

(b) When heated, magnesium nitrate decomposes as shown in the equation.

$$2Mg(NO_3)_2(s) \rightarrow 2MgO(s) + 4NO_2(g) + O_2(g)$$

A sample of magnesium nitrate was heated until decomposition was complete.

(i) Describe **one** observation you could make that would show that decomposition was taking place.

.....

..... [1]

(ii) Calculate the total amount of gas, in moles, formed when 3.47 g of magnesium nitrate decomposes completely on heating.

total amount of gas formed = ...mol [2]

(iii) A student performs this experiment, using a different mass of magnesium nitrate, and obtains a total of 0.211 mol of gas.

Use the ideal gas equation, $pV = nRT$, to calculate the volume, in m^3, that 0.211 mol of gas occupies at a temperature of 298 K and a pressure of 100 kPa.

volume = ... m^3 [2]

[Total: 8]

9 **(a)** A student investigates the I-V characteristic of different electrical components.

Fig. 9.1 shows a graph of the current I in a metal wire against the potential difference V across it.

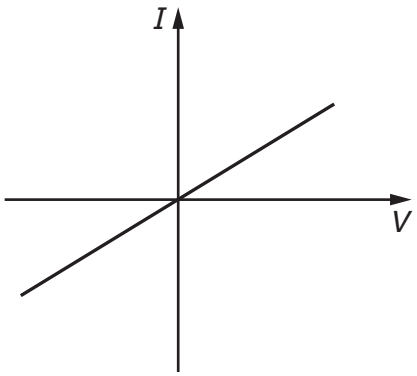

Fig. 9.1

Use Fig. 9.1 to deduce the relationship between the current and the potential difference.

.....[1]

(b) Fig. 9.2 shows a graph of the current I through a filament lamp as the potential difference V across it changes.

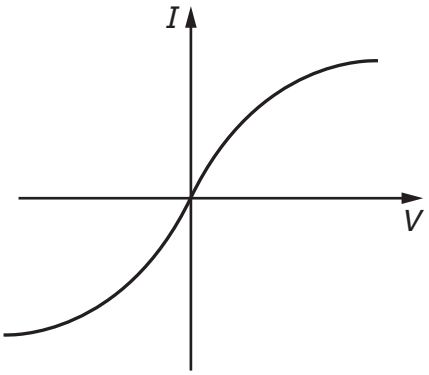

Fig. 9.2

Explain why the I-V characteristic of the lamp is different from that of the metal wire **and** explain why the current in the lamp changes in this way.

.....

.....

.....[2]

(c) Fig. 9.3 shows the I-V characteristic of another component, **Z**.

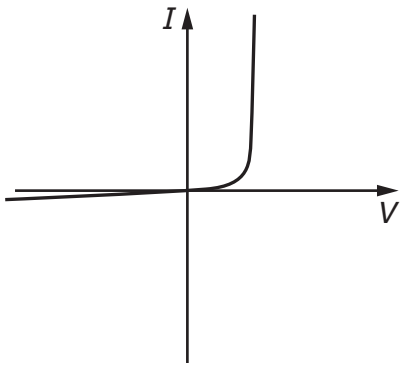

Fig. 9.3

(i) Use Fig. 9.3 to identify component **Z** and give a reason for your answer.

component .....

reason .....

.....

[2]

(ii) The student then connects component **Z** in series with the lamp as shown in Fig. 9.4.

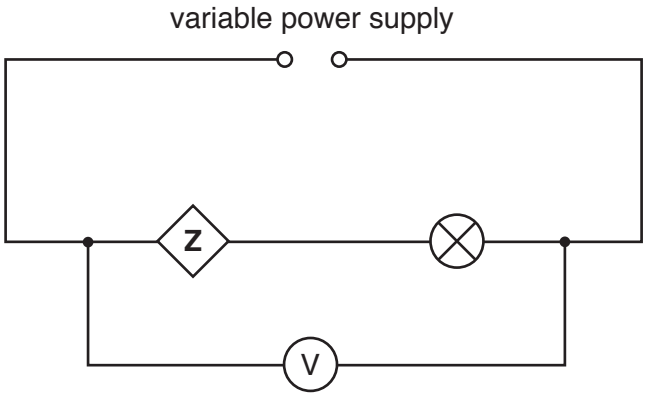

Fig. 9.4

On the axes in Fig. 9.5 sketch the I-V characteristic of the lamp and component in series.

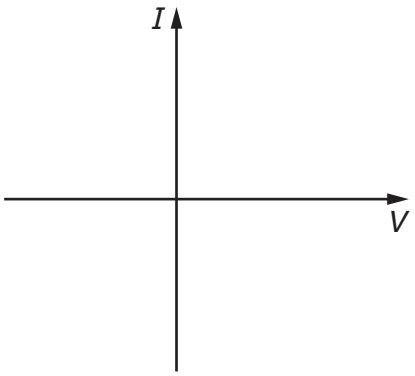

Fig. 9.5

[2]

[Total: 7]

10 Covellite is copper(II) sulfide, CuS, and occurs naturally as a mineral.

The extraction of copper from covellite involves the production of a dilute solution of copper(II) sulfate.

This is done by reacting covellite with nitric acid.

(a) The reaction between CuS and nitric acid is a redox reaction.

(i) Balance the equation for the reaction between covellite and nitric acid.

…….$CuS(s)$ + …….$HNO_3(aq)$ $\rightarrow$ $3CuSO_4(aq)$ + …….$NO(g)$ + …….$H_2O(l)$ [1]

(ii) Identify the element that is reduced in this reaction.

Explain your answer in terms of the oxidation numbers.

element reduced is .....

explanation .....

.....

.....

[2]

(b) Copper of high purity can be extracted from a solution of copper(II) sulfate.

(i) Complete the electron arrangements for a Cu atom and a Cu^{2+} ion.

Cu = $1s^2$.....

Cu^{2+} = $1s^2$.....

[2]

(ii) Write an equation to show how copper is formed in this extraction process.

..... [1]

(iii) Describe, with the aid of a labelled diagram, the structure and bonding present in elemental copper.

diagram

description .....

.....

.....

[2]

[Total: 8]

11 Fig. 11.1 shows a potential divider circuit.

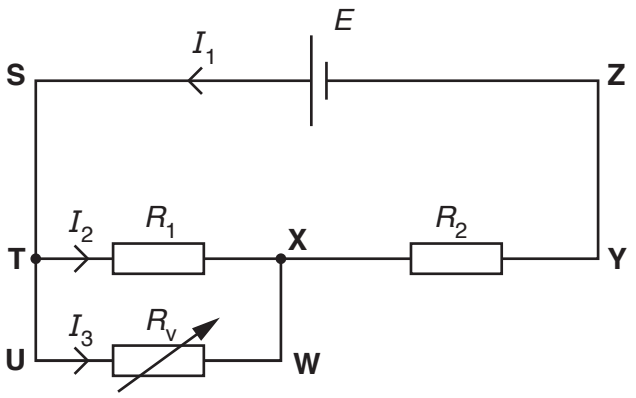

Fig. 11.1

(a) (i) Use Kirchhoff's first law to deduce a relationship between I_1, I_2 and I_3.

.....[1]

(ii) Use Kirchhoff's second law for the loop **STUWXYZ** to obtain the relationship between I_1, I_3, R_v, R_2 and E.

.....[1]

(iii) Use Kirchhoff's second law for the loop **TUWX** to obtain the relationship between I_2, I_3, R_v and R_1.

.....[1]

(b) A voltmeter is connected between **U** and **W** in Fig. 11.1. The voltmeter has a very high resistance and takes negligible current.

State and explain what would happen to the reading on the voltmeter when the value of R_v is decreased.

.....

.....

.....

.....[2]

[Total: 5]

12 The Bohr model of the atom was developed from the Rutherford model.

Identify **one** way that the model was unchanged and **two** ways in which the model was developed.

unchanged .....

.....

.....

developed .....

.....

.....

.....

.....

.....

[3]

[Total: 3]

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