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

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

5860193233

PHYSICAL SCIENCE **8780/03**

Paper 3 Structured Questions **October/November 2013**

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 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, highlighters, 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.

This document consists of **20** printed pages.

Answer **all** the questions in the spaces provided.

Relevant Data, Formulae and the Periodic Table are provided in the Data Booklet.

1 Strontium, Sr, is a Group II element. It is found in the Earth's crust as the carbonate and as the sulfate. The chemistry of strontium is very similar to that of barium.

Fig. 1.1 shows some reactions of strontium and its compounds.

On reaction with oxygen, strontium can form two different oxides, SrO and compound **E**.

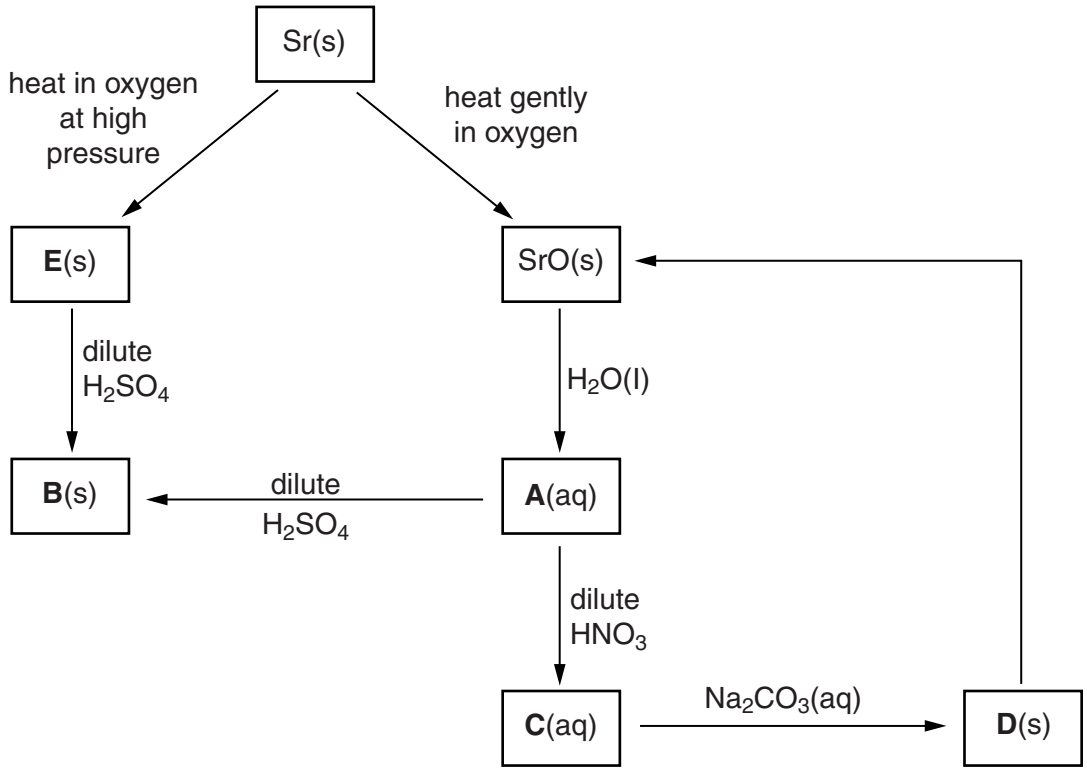

Fig. 1.1

(a) Identify compounds **A**, **B** and **C**.

A is.....

B is .....

C is..... [2]

(b) Compound **D** can be converted directly into SrO.

(i) State the main condition needed for this reaction to occur.

..... [1]

(ii) Write a balanced equation for this reaction.

..... [1]

(c) The strontium oxide, compound **E** contains 26.76% by mass of oxygen.
Compound **E** reacts with dilute sulfuric acid in a 1:1 ratio to form compound **B** plus other product, **X**.

(i) Define the term *empirical formula*.

.....

..... [1]

(ii) Calculate the empirical formula of compound **E**.

empirical formula of compound **E** = ... [2]

(iii) Suggest a formula for the soluble product, **X**.

..... [1]

[Total: 8]

2 Frictionless motion can be demonstrated using an air track, as shown in Fig. 2.1.

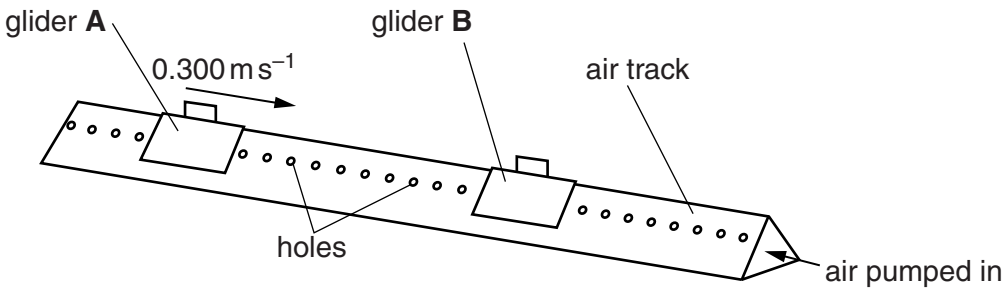

Fig. 2.1

The gliders float on a cushion of air emerging from the holes in the track.

Glider **A** has a mass of 0.120 kg and a velocity of 0.300 m s^{-1} towards **B**.

Glider **B** has a mass of 0.450 kg and is stationary.

The gliders collide. After the collision glider **A** has a velocity of –0.160 m s^{-1}.

(a) The value of the velocity of **A** after the collision has a negative sign. Explain what this means.

.....

..... [1]

(b) Calculate the velocity of glider **B** after the collision.

velocity = ... m s^{-1} [2]

(c) Show whether or not the collision is elastic.

[3]

[Total: 6]

3 The label on a bottle of liquid plant food states that the aqueous solution in the bottle co... both potassium oxide, K_2O, and phosphorus pentoxide, P_4O_{10}. A chemist realises that th... two oxides cannot exist in water.

Explain what the bottle does contain, assuming that these two oxides are added to water to make the plant food.

Use your understanding of the trends across Period 3 and support your explanation with appropriate equations.

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.....

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.....

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..... [5]

[Total: 5]

4 Fig. 4.1 shows a uniform beam hinged at one end. The beam is held in position by a s... the other end.

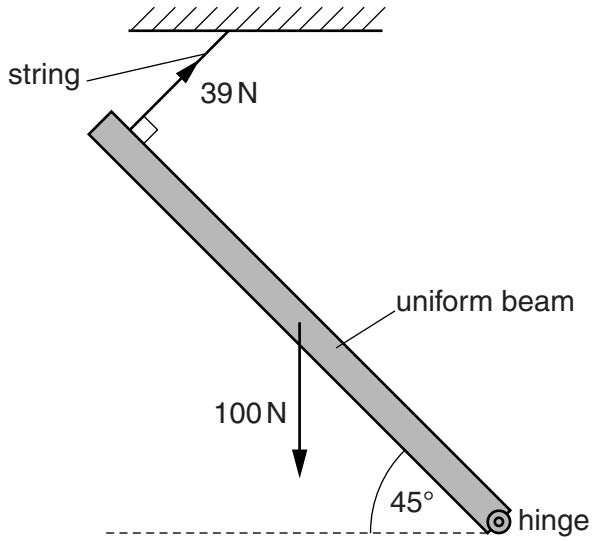

Fig. 4.1

(a) State the **two** conditions required for the beam to be in equilibrium.

1. .....

.....

2. .....

.....

[2]

(b) The beam weighs 100 N and is at an angle of 45° to the horizontal.

The string is at 90° to the beam. The tension in the string is 39 N.

(i) On Fig. 4.2, complete the vector triangle to determine the magnitude of the force *H* exerted on the beam by the hinge.

force *H* = ... N

(ii) On Fig. 4.2, use an arrow to mark the direction of force *H*.

[3]

Scale: 1 mm = 1 N

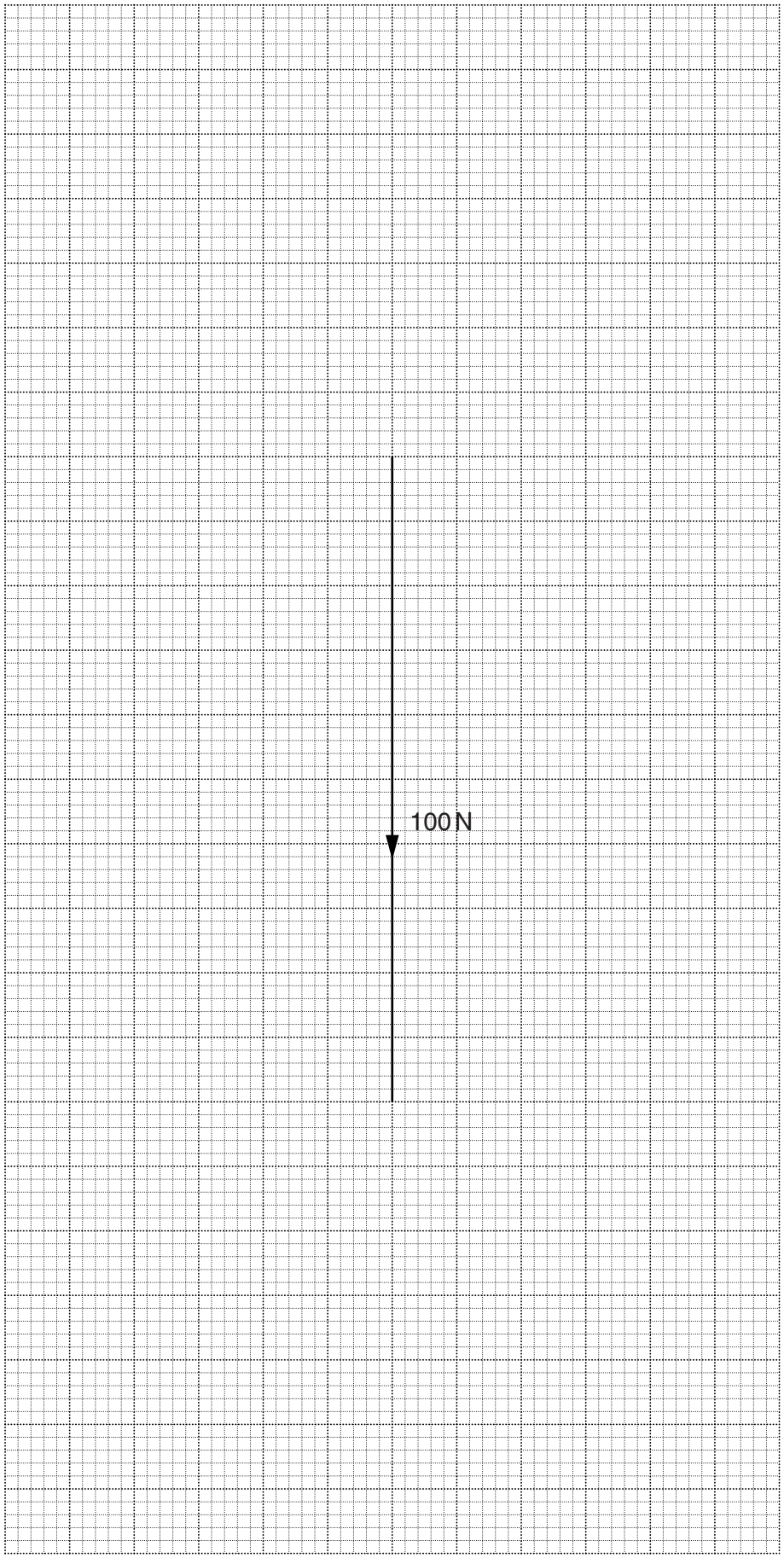

Fig. 4.2

[Total: 5]

5 **(a)** State the *principle of superposition*.

.....

.....

..... [1]

(b) Fig. 5.1 shows an experiment to demonstrate interference.

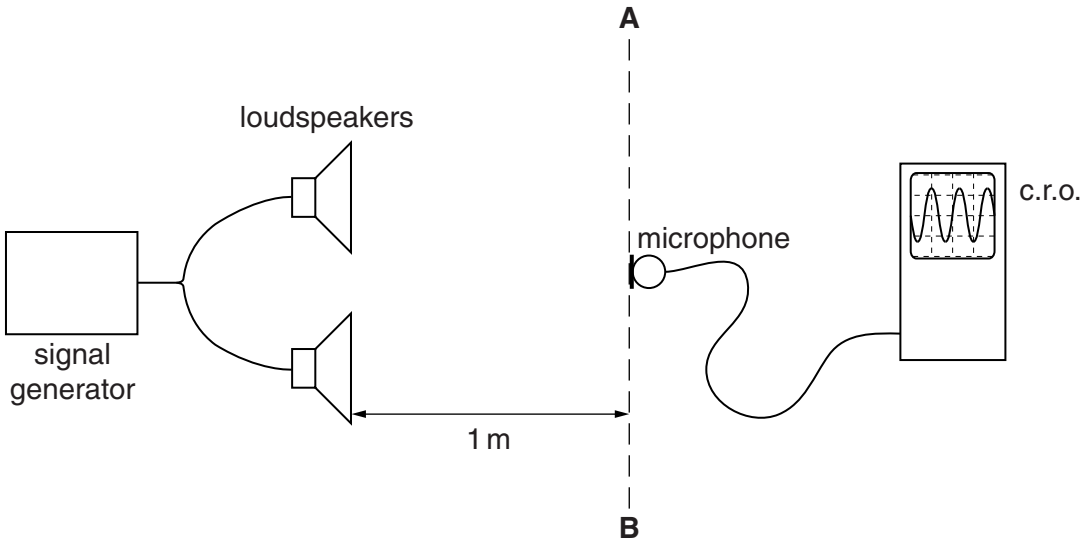

Fig. 5.1

The two loudspeakers are attached to the same signal generator. The loudspeakers both produce sound waves of wavelength 20 cm.

(i) Without performing any calculations, state what you would expect to observe on the c.r.o. as the microphone is moved from **A** to **B**.

.....

.....

..... [1]

(ii) Describe how the observations compare when

1. the frequency of the sound is increased,

.....

.....

2. the loudness of the sound is increased.

.....

.....
[2]

(c) Two radio transmitters in nearby towns are broadcasting the same programme.

Suggest why they transmit at different frequencies.

.....

.....

..... [2]

[Total: 6]

6 Copper is a transition metal with a wide range of uses. It is obtained from its ores by reduction. The copper extracted this way is impure.

(a) The impure copper is purified by the process of electrolysis.

(i) In the space below, draw a fully labelled diagram of this process.

[3]

(ii) Write equations to represent the electrode processes.

.....

..... [1]

(iii) A waste product of the electrolysis process contains valuable elements such as silver, gold and selenium.

Name this waste product.

..... [1]

(b) When dissolved in water, Cu^{2+} ions are joined to water molecules. The resulting aq ion may be represented as $[Cu(H_2O)_6]^{2+}$. A solution of these ions is blue in colour.

Solid sodium chloride is dissolved in this solution. The reaction shown below occurs, and the solution turns green.

$$[Cu(H_2O)_6]^{2+}(aq) + 4Cl^-(aq) \rightleftharpoons [Cu(Cl)_4]^{2-}(aq) + 6H_2O(l)$$

blue green

When this green solution is diluted with water, the colour of the solution turns back to blue.

When more solid sodium chloride is dissolved in the solution, a green colour is again seen.

In terms of Le Chatelier's Principle, suggest an explanation for these observations.

.....

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.....

.....

.....

.....

..... [4]

[Total: 9]

7 You will need to use the Data Booklet to answer this question.

A beam of electrons travelling at a constant velocity enters a uniform electric field. The electric field is parallel to the direction of the beam.

Fig. 7.1 shows the velocity of an electron as it moves into, through and out of the electric field.

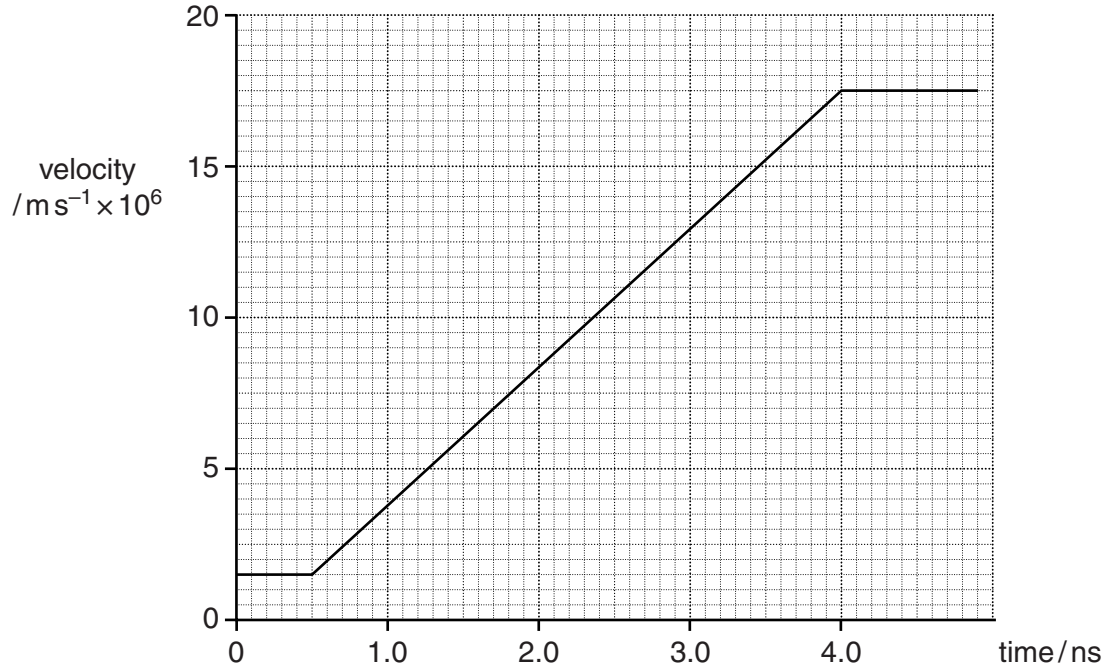


Fig. 7.1

(a) (i) Calculate the acceleration of an electron in the electric field.

acceleration = ... ms^{-2} [2]

(ii) Calculate the force on this electron in the electric field.

force = ... N [2]

(b) The electric field strength is increased.

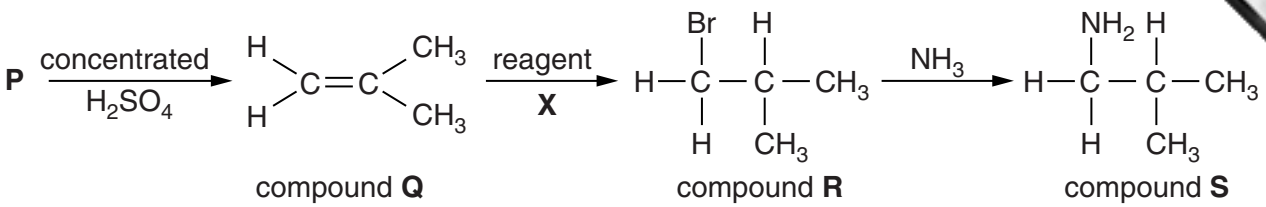
On Fig. 7.1, sketch a possible graph to show the velocity of an electron as it moves into, through, and out of this stronger electric field. [2]

(c) Calculate the electric field strength required to produce a force of 5.0×10^{-15} N on an electron.

electric field strength = ... NC^{-1} [2]

[Total: 8]

8 Consider the reaction scheme below.



(a) Compound **P** causes an acidified solution of potassium dichromate(VI) to turn from orange to green.

(i) Identify compound **P** by name or by structure.

..... [1]

(ii) Name the type of reaction involved in the conversion of **P** into **Q**.

..... [1]

(iii) Suggest a reagent, **X**, suitable for converting **Q** into **R**.

..... [1]

(b) Give the systematic name of compound **R**.

..... [1]

(c) Reaction of compound **R** with ammonia produces compound **S**.

(i) State the class of compounds to which compound **S** belongs.

..... [1]

(ii) Use drawings to show the S_N2 mechanism for this reaction.

In your mechanism, use curly arrows to show the movement of electrons.

[4]

[Total: 9]

9 **(a)** Define *potential difference*.

.....

..... [1]

(b) Fig. 9.1 shows a network of four resistors each of resistance *R*.

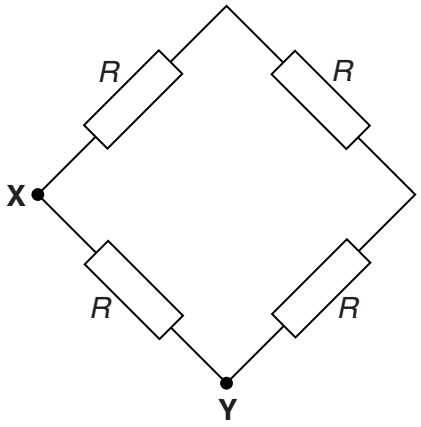


Fig. 9.1

Calculate the resistance between points **X** and **Y** if $R = 200\,\Omega$.

resistance = ... Ω [1]

(c) Fig. 9.2 shows a network of three resistors each of resistance 200 Ω and a ther connected in a circuit. The circuit can be used to measure temperature.

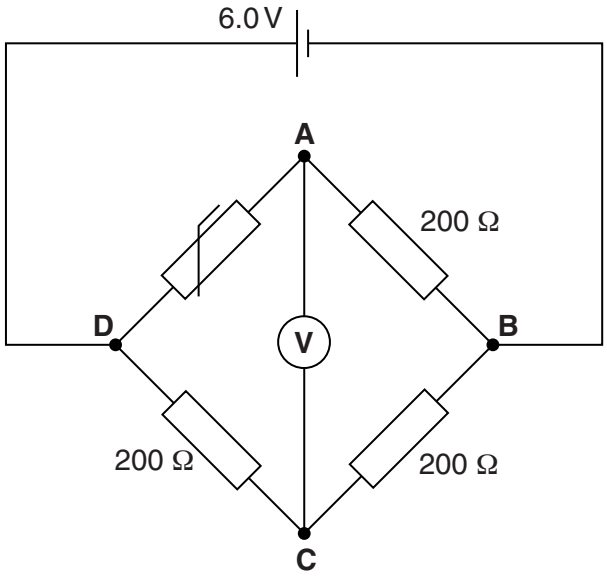


Fig. 9.2

The battery has an emf of 6.0 V and negligible internal resistance. A high resistance voltmeter is connected across AC.

Fig. 9.3 shows the variation of the resistance of the thermistor with temperature.

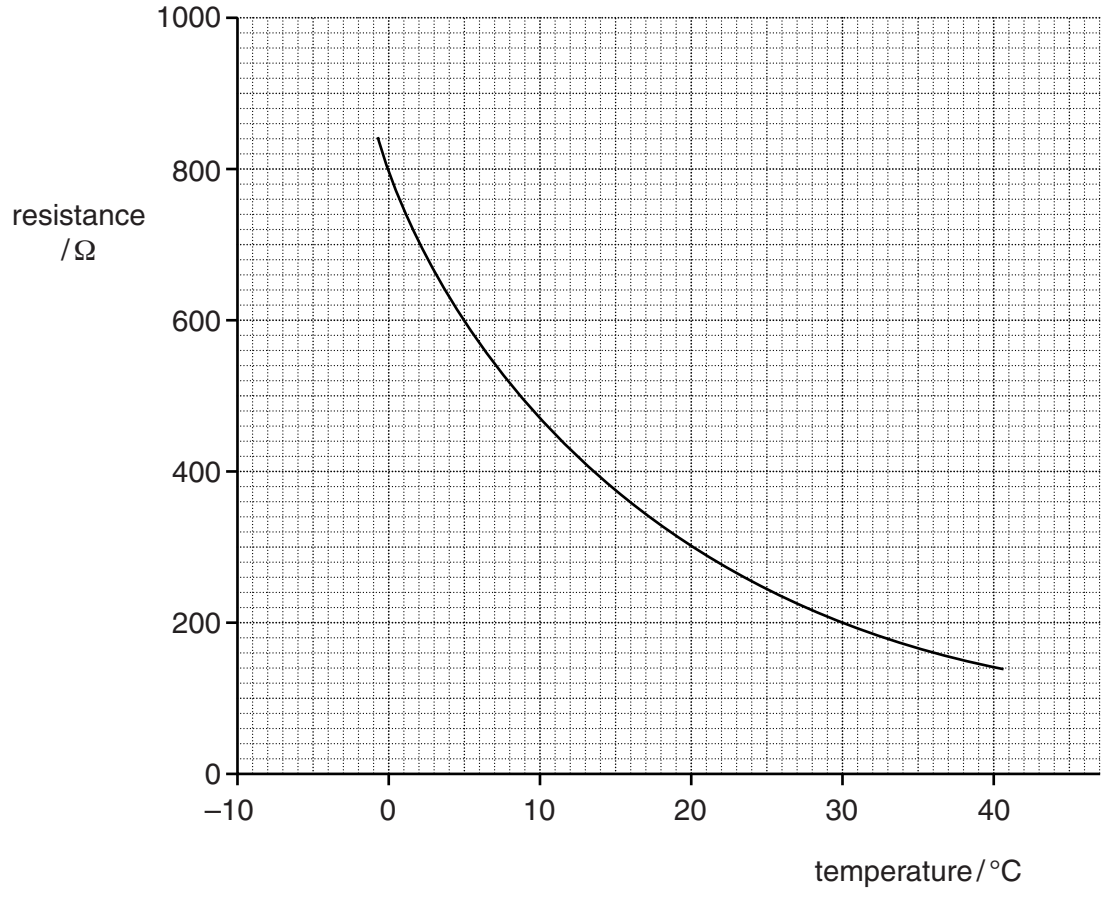


Fig. 9.3

(i) Show that the current in the line **DCB** = 0.015 A.

(ii) Use Figs. 9.2 and 9.3 to deduce the voltmeter reading when the temperature of the thermistor is 30 °C.

voltmeter reading = ... V [1]

(iii) Using Fig. 9.3, show that when the temperature of the thermistor is 5 °C, the current through the thermistor is half the value of the current in **DC**.

[3]

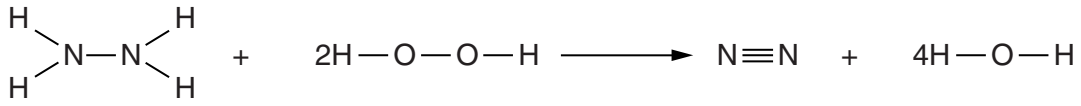
(iv) Use Kirchhoff's second law, for the loop **CAD**, to calculate the voltmeter reading when the thermistor is at 5 °C.

voltmeter reading = ... V [2]

[Total: 9]

10 Hydrazine, N_2H_4, is highly reactive and is used as a fuel in rocket engines. For this pu... is either reacted with another reagent or catalytically decomposed.

(a) The gas phase reaction between hydrazine and hydrogen peroxide is rapid. The reaction produces an increase both in the number of moles of gas and in the temperature of the mixture. The equation for this redox reaction is shown below.



(i) Use bond energy data from the Data Booklet to calculate the molar enthalpy change for this reaction.

enthalpy change = ... $kJ\,mol^{-1}$ [2]

(ii) Identify the element that is reduced and the element that is oxidised in this redox reaction. Explain your answers in terms of changes in oxidation numbers.

reduced .....

.....

oxidised .....

.....[2]

(b) Hydrazine undergoes an exothermic decomposition in the presence of a s... catalyst. Liquid hydrazine decomposes into its elements. There is a rapid increas... volume and temperature.

(i) The catalytic decomposition of hydrazine can occur by the reaction sequence shown below.

stage 1 $3N_2H_4 \longrightarrow 4NH_3 + N_2$

stage 2 $4NH_3 + N_2H_4 \longrightarrow 3N_2 + 8H_2$

Use these equations to show that the overall equation for this decomposition reaction is

$$N_2H_4 \longrightarrow N_2 + 2H_2$$

Show your working.

.....

.....

.....

..... [1]

(ii) In a sealed tank of volume 0.025 m^3, 400 g of hydrazine is decomposed completely into its elements. After decomposition, the temperature of the gaseous mixture is 950 K.

Calculate the pressure of the gaseous mixture in the tank. Show your working.

(A_r: H, 1.0; N, 14.0; R = 8.31 $J K^{-1} mol^{-1}$)

pressure in tank = ... kPa [4]

[Total: 9]

11 The Rutherford model of the atom was developed from the evidence of α-particle sca

(a) Outline the α-particle scattering experiment and the results obtained that led to th Rutherford model of the atom.

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..... [4]

(b) Explain how the results led Rutherford to the conclusion that

(i) there is a positively charged nucleus containing most of the mass of the atom,

.....

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.....

.....

(ii) the nucleus is very much smaller than the atom.

.....

..... [2]

[Total: 6]