



**Answer ALL the questions. Write your answers in the spaces provided.**

**SECTION A**

1. Use the Periodic Table to identify the element that

(a) mainly consists of atoms which possess no neutrons.

..... (1)

(b) forms a covalent oxide and hydride whose molecules contain three and four atoms respectively.

..... (1)

(c) forms a bromide,  $XBr_2$ , with a molar mass of  $184 \text{ g mol}^{-1}$ .

..... (1)

(d) consists of atoms each weighing  $6.7 \times 10^{-24} \text{ g}$ .

[The Avogadro constant =  $6.0 \times 10^{23} \text{ mol}^{-1}$ ]

..... (1)

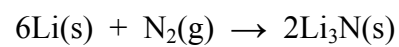
**(Total 4 marks)**

**Q1**



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2. Lithium reacts with nitrogen to form lithium nitride,  $\text{Li}_3\text{N}$ .



Calculate the volume of nitrogen, measured at room temperature, needed to make 10 g of lithium nitride.

Use the Periodic Table as a source of data.

[The molar volume of a gas is  $24 \text{ dm}^3 \text{ mol}^{-1}$  at room temperature]

Q2

(Total 3 marks)

3

Turn over

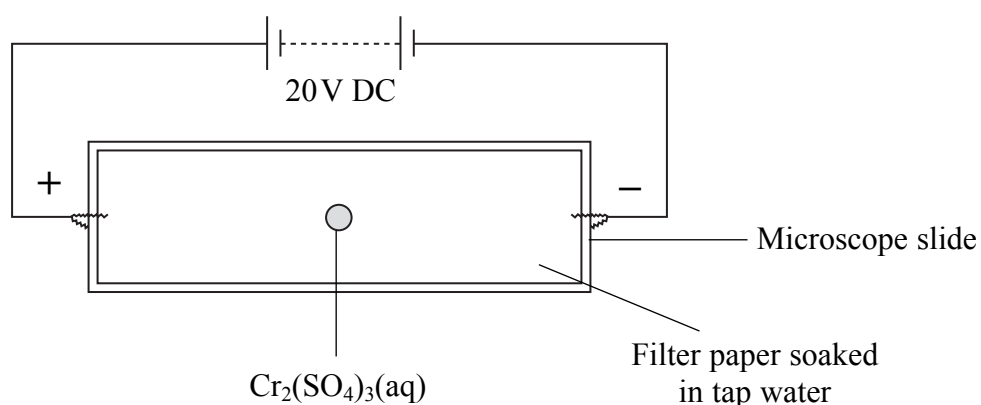


3. (a) Chromium sulphate,  $\text{Cr}_2(\text{SO}_4)_3$ , forms a deep green solution when dissolved in water.

Give the formula of the positive ion released into solution by the chromium sulphate.

.....  
**(1)**

(b) To show the migration of ions, an experiment was set up as shown in the diagram below. A small drop of concentrated chromium sulphate solution was placed in the centre of the paper.



Describe what would be seen after the current had flowed for about 10 minutes. Explain your observations.

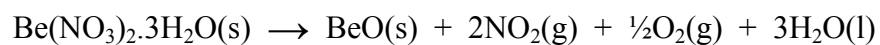
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**(2)** **Q3**

**(Total 3 marks)**



4. Hydrated beryllium nitrate decomposes on heating as follows.



(a) Write down TWO observations which can be made during this process.

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 .....

(2)

(b) Relevant standard enthalpy changes of formation are given in the table below.

	Standard enthalpy change of formation, $\Delta H_f^\ominus$ / kJ mol <sup>-1</sup>
Be(NO <sub>3</sub> ) <sub>2</sub> ·3H <sub>2</sub> O(s)	-787.8
BeO(s)	-609.6
NO <sub>2</sub> (g)	+33.2
O <sub>2</sub> (g)	0
H <sub>2</sub> O(l)	-285.8

(i) Why is the standard enthalpy change of formation of gaseous oxygen zero?

.....  
 .....

(1)

(ii) Calculate the standard enthalpy change for the decomposition of hydrated beryllium nitrate.

Remember to include a sign and units in your answer.

(2)

Q4

(Total 5 marks)

TOTAL FOR SECTION A: 15 MARKS



**SECTION B**

5. A sample of the element strontium consists of three isotopes,  $^{86}\text{Sr}$ ,  $^{87}\text{Sr}$  and  $^{88}\text{Sr}$ .

(a) (i) Use the Periodic Table to complete the table below, showing the atomic structure of each of these isotopes.

Isotope	Number of protons	Number of neutrons	Number of electrons
$^{86}\text{Sr}$			
$^{87}\text{Sr}$			
$^{88}\text{Sr}$			

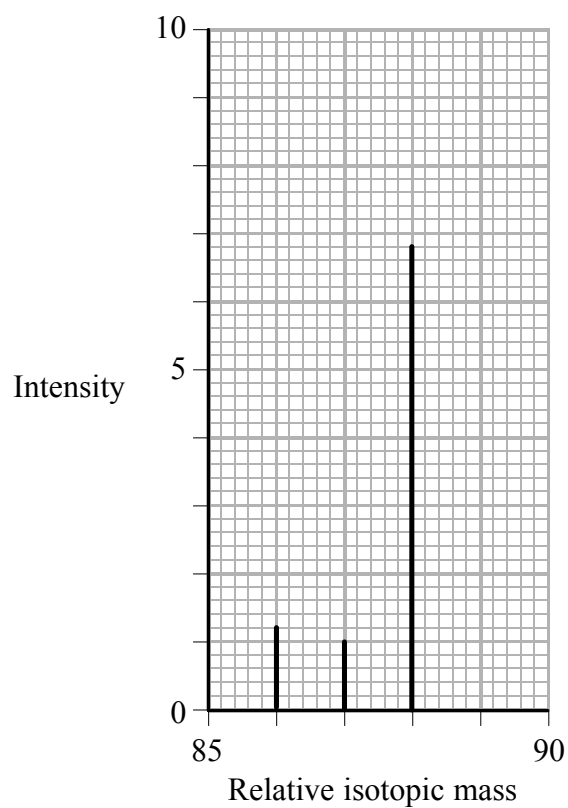
(2)

(ii) Complete the electronic configuration of a strontium atom.

$1s^2 2s^2 2p^6$  .....

(1)

(b) The mass spectrum of a sample of strontium is shown below.



(i) Write down the intensities of the three isotopes.

$^{86}\text{Sr}$  .....  $^{87}\text{Sr}$  .....  $^{88}\text{Sr}$  .....

(1)



(ii) Calculate the relative atomic mass of strontium in this sample. Give your answer to **three** significant figures.

(2)

(c) Some ionisation energies for strontium are shown in the table below.

	1st	2nd	3rd
Ionisation energy / kJ mol <sup>-1</sup>	550		4210

(i) Explain what is meant by the second ionisation energy of strontium.

.....  
 .....  
 .....

(2)

(ii) Estimate a value for the second ionisation energy of strontium.

.....

(1)

(d) You are provided with a small sample of a metal which is either strontium or barium. **Briefly** describe a test you could carry out to identify which of these metals is present. Give the observation you would make for **each** metal.

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 .....  
 .....  
 .....  
 .....

(3)

(Total 12 marks)

Q5

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6. The compound with the formula,  $\begin{array}{c} \text{CH}_2\text{OH} \\ | \\ \text{CH}_2\text{OH} \end{array}$ , was formerly known as ethylene glycol.

(a) (i) Give the systematic name for ethylene glycol.

.....  
(1)

(ii) Is ethylene glycol likely to be soluble in water? Give a reason for your answer.

.....  
.....  
.....  
(1)

(b) Write a balanced equation for the complete combustion of ethylene glycol.  
State symbols are **not** required.

(2)

(c) In each of the following cases, give the structural formula of the organic compound formed when

(i) **excess** sodium is added to ethylene glycol.

(2)

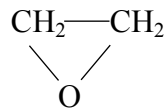
(ii) ethylene glycol is refluxed with excess acidified sodium dichromate(VI) solution.

(1)





(d) Ethylene glycol can be manufactured from epoxyethane, which has the following structural formula:



Suggest a reagent which could be added to epoxyethane to carry out this conversion.

.....

(1)

(Total 8 marks)

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Q6



N 3 4 3 7 4 A 0 9 1 6

7. (a) The table below gives the atomic and ionic radii of three metals in Group 2.

Metal	Atomic radius / nm	Ionic radius / nm
Calcium	0.174	0.100
Strontium	0.191	0.113
Barium	0.198	0.136

(i) Why is the atomic radius of strontium greater than that of calcium?

.....  
 .....  
**(1)**

(ii) Give TWO reasons why the ionic radius of each metal is so much smaller than its atomic radius.

.....  
 .....  
 .....  
 .....  
**(2)**

(b) Bone consists of a complex mixture of calcium compounds, such as calcium phosphate,  $\text{Ca}_3(\text{PO}_4)_2$ .

In an experiment to estimate the percentage of calcium present, 2.0 g of bone were crushed and heated strongly until there was no further loss in mass. The calcium phosphate decomposed, forming calcium oxide and evolving gaseous phosphorus(V) oxide,  $\text{P}_2\text{O}_5$ . An excess of water was added to the residue, and, after filtration, a solution of calcium hydroxide was obtained.

(i) Write down the formulae of the TWO ions present in calcium phosphate.

.....  
**(1)**



Leave  
blank

(ii) Write a balanced equation for the reaction which occurs when calcium phosphate is heated. State symbols are **not** required.

(1)

(iii) Assuming that 0.0060 mol of calcium hydroxide is present in the solution, calculate the percentage by mass of calcium in the bone sample.

(2)

(iv) Assuming that the practical work has been carried out accurately, suggest TWO reasons why the answer obtained in (iii) might have been too low.

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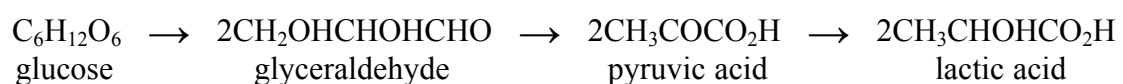
(2)

Q7

(Total 9 marks)



8. If oxygen supplies are limited, human muscle cells are able to break down glucose into lactic acid by way of the simplified stages shown below. The names given are not the systematic names of the compounds.



- (a) (i) Draw a circle around a **secondary** alcohol group in one of the formulae above. (1)

- (ii) On the formula below draw a circle around the group in pyruvic acid which causes it to be classified as an acid.



(1)

- (iii) Into which other group of compounds can pyruvic acid be classified, apart from being a carboxylic acid?

..... (1)

- (iv) Draw the fully displayed formula for glyceraldehyde.

(1)

- (v) Explain why the conversion of pyruvic acid into lactic acid is a reduction.

..... (1)



- (b) The concentration of a solution of lactic acid was determined by measuring the temperature change in its reaction with sodium hydrogencarbonate,  $\text{NaHCO}_3$ .

25.0 cm<sup>3</sup> of the lactic acid solution were placed in a polystyrene cup and the initial temperature was taken. An excess of solid sodium hydrogencarbonate was added in small portions until the reaction was complete. The final temperature was recorded.

The results are given below.

Volume of aqueous lactic acid / cm <sup>3</sup>	25.0
Initial temperature / °C	22.2
Final temperature / °C	15.6

- (i) Identify the gas evolved when lactic acid reacts with sodium hydrogencarbonate.

.....  
(1)

- (ii) Why was the sodium hydrogencarbonate added in *small portions*?

.....  
.....  
(1)

- (iii) Calculate the energy change occurring during this experiment. Give a unit with your answer.

You may assume that

- the specific heat capacity of the solution is 4.2 J g<sup>-1</sup> °C<sup>-1</sup>
- the volume of solution remains constant during the addition of the sodium hydrogencarbonate
- the density of the solution is 1.00 g cm<sup>-3</sup>.

(2)





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(d) Suggest TWO reasons why the value for the concentration of lactic acid obtained by measuring the temperature change is usually lower than that determined by titration.

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(2)

Q8

(Total 16 marks)

**TOTAL FOR SECTION B: 45 MARKS**

**TOTAL FOR PAPER: 60 MARKS**

**END**



