AS LEVEL CHEMISTRY

PAPER 1

PRACTICE PAPER 22

(structured questions only)

Answer all questions

Max 80 marks

Name ………………………………………………………………..
Mark ……../80 ……....% Grade ………

Note – this paper only contains structured questions

1. **(a)** **(i)** Complete the electron arrangement of the selenium (Se) atom.

$1s^2$ ....

(1 mark)

(a) **(ii)** State the block in the Periodic Table to which selenium belongs. Explain your answer.

Block ....

Explanation ....

....

(2 marks)

(b) **(i)** State what is meant by the term *mass number* of an atom.

....

(1 mark)

(b) **(ii)** Deduce the symbol, including the mass number, of an atom that has four fewer protons and four fewer neutrons than an atom of ^{76}Se

....

(2 marks)

(c) **(i)** Explain how atoms are ionised in a mass spectrometer.

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(2 marks)

(c) **(ii)** State how the ions are detected when they collide with the detector in a mass spectrometer.

....

(1 mark)

(d) The table below gives the relative abundance of each isotope in a mass spectrum of a sample of selenium.

m/z	76	78	80	82
Relative abundance (%)	11.2	23.8	49.8	15.2

Use these data to calculate the relative atomic mass of this sample of selenium. Give your answer to **one** decimal place.

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(2 marks)

(Total 11 marks)

2.   (a) State the meaning of the term *first ionisation energy* of an atom.

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(2 marks)

(b) Explain why there is a general increase in the first ionisation energies of the Period 3 elements Na to Ar

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(2 marks)

(c)   State how the first ionisation energy of sulphur deviates from the general trend in part (b). Explain your answer.

Deviation of sulphur from the general trend ....

Explanation ....

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(3 marks)

(d)   (i)   Draw the shape of a BF_3 molecule and the shape of a H_2S molecule. In each case show any lone pairs of electrons.

              BF₃   *H₂S*

(d)   (ii)   Explain why a BF_3 molecule has the shape you have drawn.

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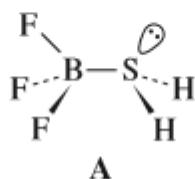
(4 marks)

(e)   Hydrogen sulphide, H_2S, reacts with boron trifluoride, BF_3, to form compound A.

       Predict the value of the H-S-H bond angle in compound A.

       ....

(1 mark)

(Total 12 marks)

3. Sodium carbonate neutralises hydrochloric acid as shown in the equation below.

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$$

(a) Sodium carbonate is used to neutralise a $100\,cm^3$ sample of $1.75\,mol\,dm^{-3}$ hydrochloric acid.

(i) Calculate the number of moles of HCl in the $100\,cm^3$ sample of $1.75\,mol\,dm^{-3}$ hydrochloric acid.

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(ii) Deduce the number of moles, and hence calculate the mass, of Na_2CO_3 ($M_r = 106.0$) required to neutralise this sample of hydrochloric acid.

Moles of Na$_2$CO$_3$ ....

Mass of Na$_2$CO$_3$ ....

....

(3 marks)

(b) Hydrated sodium carbonate has the formula $Na_2CO_3.10H_2O$

(i) Calculate the percentage, by mass, of Na_2CO_3 in hydrated sodium carbonate.

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....

(ii) Calculate the mass of hydrated sodium carbonate required to neutralise 0.267 mol of hydrochloric acid.

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(4 marks)

(c) A sample of sodium carbonate reacted with hydrochloric acid to produce 7.75×10^{-2} mol of CO_2

State the ideal gas equation and use it to calculate the volume of CO_2 produced, at 298 K and 101 kPa, in this reaction.

Ideal gas equation ....

Volume of CO₂ produced ....

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(4 marks)

(Total 11 marks)

4. (a) The table below gives the melting point for each of the Period 3 elements Na – Ar.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Melting point/K	371	923	933	1680	317	392	172	84

In terms of structure and bonding, explain why silicon has a high melting point, and why the melting point of sulphur is higher than that of phosphorus.

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(7)

(b) Draw a diagram to show the structure of sodium chloride. Explain, in terms of bonding, why sodium chloride has a high melting point.

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(4)
(Total 11 marks)

5. (a) The boiling point of H_2O is 373 K and that of H_2S is 212 K.

   (i) Name the strongest type of intermolecular attraction present in water.

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   (ii) Name the strongest type of intermolecular attraction present in hydrogen sulphide.

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   (iii) Explain why the boiling point of water is so much higher than that of hydrogen sulphide.

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   (4 marks)

(b) Define the term *electronegativity*.

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   (2 marks)

(c) State and explain the trend in electronegativity down Group II from Be to Ba.

Trend ....

Explanation ....

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(3 marks)

(Total 9 marks)

6. Nitrogen dioxide dissociates according to the following equation.

$$2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$$
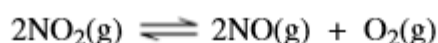
When 5.75 g of nitrogen dioxide were heated to a constant temperature, T, in a flask of volume 5.0 dm^3, an equilibrium mixture was formed which contained 1.60 g of oxygen.

(a) (i) Calculate the amount, in moles, of oxygen present in this equilibrium mixture and deduce the amount, in moles, of nitrogen monoxide also present in this equilibrium mixture.

Moles of O_2 at equilibrium ....

....

Moles of NO at equilibrium ....

(a) (ii) Calculate the amount, in moles, in the original 5.75 g of nitrogen dioxide and hence calculate the amount, in moles, of nitrogen dioxide present in this equilibrium mixture.

Original moles of NO_2 ....

....

Moles of NO_2 at equilibrium ....

....

(4 marks)

(b) Write an expression for the equilibrium constant, K_c, for this reaction. Calculate the value of this constant at temperature T and give its units.

Expression for K_c ....

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Calculation ....

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(4 marks)

(c) State the effect on the equilibrium yield of oxygen and on the value of K_c when the same mass of nitrogen dioxide is heated to the same temperature T, but in a different flask of greater volume.

Yield of oxygen ....

Value of K_c ....

(2 marks)

(Total 10 marks)

7.   (a) Deduce the oxidation state of S in SO_3^{2-} and in SO_4^{2-}

Oxidation state of S in SO_3^{2-} ....

Oxidation state of S in SO_4^{2-} ....

(2 marks)

(b) A redox reaction occurs when Cl_2 reacts with SO_3^{2-} ions in aqueous solution.

(i) Write a half-equation for the conversion of Cl_2 into Cl^- ions.

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(ii) Write a half-equation for the conversion of aqueous SO_3^{2-} ions into SO_4^{2-} ions.

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(iii) Hence, write an overall equation for the reaction between Cl_2 and SO_3^{2-} ions.

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(iv) Deduce the role of SO_3^{2-} ions in this overall reaction.

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(4 marks)

(Total 6 marks)

8. (a) State the trend in atomic radius down Group II from Mg to Ba and give a reason for this trend.

Trend ....

Reason ....

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(2 marks)

(b) State and explain the trend in melting points of the elements down Group II from Mg to Ba.

Trend ....

Explanation ....

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(3 marks)

(c) State the trend in reactivity with water of the elements down Group II from Mg to Ba. Write an equation for the reaction of magnesium with steam and an equation for the reaction of strontium with water.

Trend ....

Equation for magnesium ....

Equation for strontium..

(3 marks)

(d) Sulphates of the Group II elements from Mg to Ba have different solubilities. Give the formula of the least soluble of these sulphates and state **one** use that depends upon the insolubility of this sulphate.

Formula ....

Use ....

(2 marks)

(Total 10 marks)