

981 75A9F "B: C

**SECTION A (CGCEB 2013)**

**General and Physical Chemistry**

1. (a) What do you understand by,

(i) Avogadro's number -----

(ii) Amount of a substance -----

**2 marks**

(b) A solution was made by dissolving 9.0g of hydrated aluminium sulphate ( $\text{Al}_2(\text{SO}_4)_3 \cdot 6\text{H}_2\text{O}$ ) in 250 cm<sup>3</sup> of solution. (RAM: Al = 27; O = 16; S = 32; H = 1).

Calculate:

(i) The number of moles of hydrated aluminium sulphate solution. -----

(ii) The number of moles of sulphate ions in this solution. -----

(iii) The concentration (mol dm<sup>-3</sup>) of the hydrated aluminium sulphate. -----

**3 marks**

(c) (i) What is a nuclear reaction? Give a suitable example of a nuclear reaction. -----

(ii). In a transformation  ${}^{238}_{92}\text{U}$  decays to  ${}^{226}_{88}\text{Ra}$ . How many alpha and beta particles are emitted?

A. Alpha particles: -----

B. Beta particles: -----

3 marks

(d) Iron burns in chlorine to form a chloride. An experiment showed that 5.60g of iron combined with 10.65g of the chlorine to form a chloride. (RAM: Fe=56, Cl=35.5). Determine:

(i). The number of moles of chlorine used. -----

(ii). The number of moles of iron used. -----

(iii). The equation for the reaction. -----

3 marks

(e) (i) Define bond energy term. -----

(ii). Write an equation to represent the lattice energy of calcium chloride. -----

2 marks

(f) Given the following data:

$$\Delta H_{\text{at}}^{\ominus}[\text{C}_{(\text{s})}] = +717 \text{ kJmol}^{-1}$$

$$\Delta H_{\text{at}}^{\ominus}[\text{H}_{2(\text{g})}] = +218 \text{ kJmol}^{-1} \text{ of gaseous hydrogen atoms}$$

$$\Delta H_{\text{f}}^{\ominus}[\text{CH}_{4(\text{g})}] = -75 \text{ kJmol}^{-1}$$

Determine the C-H bond energy in methane. -----

3 marks

(g) Theoretical and experimental values of lattice energy of a compound may differ.

(i). Explain why the values may differ. -----

(ii). Give an example of a halide in each case where the values of the lattice energies

A. Are different:-----

B. Are similar:-----

(iii). Why is the Born Haber cycle used to determine the lattice energies of ionic compound? -----

4 marks

Total = 20 marks

2. (a) what do you understand by

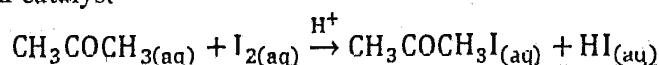
(i). *Initial rate of reaction.*(ii). *Order of reaction.*

2 marks

(b) Why is the order of reaction important in the study of rate of reaction?

1 mark

(c) The data below was obtained for the reaction between iodine and propanone in the presence of an acid catalyst



Experiment	Concentration			Rate/mol dm <sup>-3</sup> s <sup>-1</sup>
	[CH <sub>3</sub> COCH <sub>3</sub> (aq)]/ (mol dm <sup>-3</sup> )	[I <sub>2</sub> (aq)]/ (mol dm <sup>-3</sup> )	[H <sup>+</sup> (aq)]/ mol dm <sup>-3</sup>	
1	0.30	0.05	0.05	5.7 x 10 <sup>-5</sup>
2	0.30	0.10	0.05	5.7 x 10 <sup>-5</sup>
3	0.30	0.05	0.10	1.2 x 10 <sup>-4</sup>
4	0.40	0.05	0.20	3.1 x 10 <sup>-4</sup>
5	0.36	0.05	0.05	7.1 x 10 <sup>-5</sup>

(i). Deduce the order of the reaction with respect to:

[CH<sub>3</sub>COCH<sub>3</sub>(aq)].[I<sub>2</sub>(aq)].[H<sup>+</sup>(aq)].

(ii). What is the overall order of the reaction?

(iii). Write the rate expression for the reaction.

(iv). Calculate the value of the rate constant indicating its units.

- (v). State a method you would use to measure the rate of the reaction above without quenching the reaction. -----  
-----

7 marks

- (d) What is an ideal solution? -----

1 mark

- (e) Methanol and ethanol form an ideal solution. The vapour pressure of pure ethanol and pure methanol at 20 °C is 44 mmHg and 94 mmHg respectively. A mixture of 30 g of methanol (CH<sub>3</sub>OH) and 45 g of ethanol (CH<sub>3</sub>CH<sub>2</sub>OH) is prepared. (RAM: C = 12; O = 16; H = 1). Calculate

- (i). The mole fraction of methanol in the solution. -----  
-----
- (ii). The total pressure of the vapour above the solution at 20 °C. -----  
-----
- (iii). The mole fraction of methanol in the vapour above the solution. -----  
-----

3 marks

- (f) (i). Suggest a method of separating the components of a solution containing methanol and ethanol. -----

1 mark

- (ii). Sketch and label a diagram of boiling point against composition for the mixture of trichloromethane (b.pt 334 K) and propanone (b.pt 329 K). -----  
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- (iii). Can a mixture of trichloromethane and propanone be separated into the pure components by fractional distillation? -----

Explain. -----  
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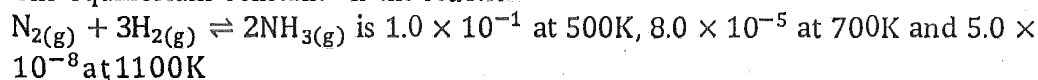
5 marks

Total = 20 marks

3. (a) State the equilibrium law. -----  
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1 mark

- (b) The equilibrium constant for the reaction



- (i). From the data, predict and explain whether the reaction is endothermic or exothermic. -----  
-----
- (ii). Predict and explain the shift of equilibrium position of the reaction above in response to the following changes. -
- A. Increasing the temperature at constant pressure. -----  
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B. Increasing the pressure at constant temperature. -----  
-----

C. Adding a catalyst at constant temperature and pressure. -----  
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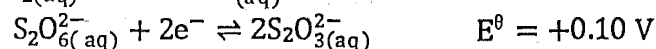
(iii). What is the effect of increase in temperature at constant pressure on the value of the equilibrium constant? -----  
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6 marks

(c) Define 'standard electrode potential' of an electrode system. -----  
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1 mark

(d) Given the following redox potentials



(i). Select the species which is the strongest

A. Reducing agent. -----  
-----

B. Oxidising agent. -----  
-----

(ii). Write the cell diagram when the half cells are coupled and calculate the emf of the cell. -----  
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4 marks

(e) Explain the following observations:

(i). The bond dissociation energy of the hydrogen molecule ( $H_2$ ) is greater than that of the hydrogen molecule ion ( $H_2^+$ ) -----  
-----

(ii). Both aluminium and carbon are solid, aluminium forms sheets whereas carbon breaks into pieces when hammered. -----  
-----

(iii). Ammonia boils at  $-33.3^\circ C$  while phosphine boils at  $-87.7^\circ C$ . -----  
-----

3 marks

(f) (i) state and briefly explain the shapes of the following substances:

Substance	Shape	Explanation
$NH_3$		
$BF_3$		

(ii). Draw the electron density map for the hydrogen chloride molecule. -----  
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5 marks

Total = 20marks

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**SECTION B (CGCEB 2013)**  
**Inorganic (Mineral) Chemistry**

4. (a) The elements, F, Cl, Br, and I belong to **GROUP VII** (GR 17) of the Periodic Table.  
State and explain the trend of

(i). Physical state of the elements down the group. -----

(ii). Oxidising power of the elements up the group. -----

(iii). Acid strength of the hydrogen halides (HX) down the group.-----

6 marks

(b) (i) What is a disproportionation reaction? -----

(ii) Give balanced equations for the reaction of chlorine with

A. Cold dilute potassium hydroxide. -----

B. Hot concentrated potassium hydroxide. -----

3 marks

(c) (i) Give balanced equations for the reaction of concentrated sulphuric acid with:

A. Solid sodium chloride. -----

B. Solid sodium iodide. -----

(ii) Explain the difference, if any, in the reactions of solid sodium chloride and solid sodium iodide with concentrated sulphuric acid. -----

3 marks

(d) Write the formula and name of the compounds in which sulphur has the following oxidation states.

Oxidation state	Formula of compound	Name of compound
+6		
+4		
+2		
-2		

4 marks

(e) Give a redox reaction in which the oxidation state of sulphur

(i). Increases from reactants to products. -----

(ii). Decreases from reactants to products -----

2 marks

(f) What is the consequence on the environment of the release of sulphur dioxide into the atmosphere?-----

1 mark

(g) Give one important use of a nitrogen compound in agriculture. -----

1 mark

5. (a) (i) Distinguish between a d-block element and a transition element. -----

(ii) Give a suitable example in each case

A. d-block element -----

B. Transition element -----

3 marks

(iii). Thermal stability of Group II (Group 2) carbonates. -----  
-----  
-----

3 marks

(f) What would be observed if excess aqueous sodium hydroxide were added drop wise to aqueous solutions of

(i). Magnesium chloride. -----  
-----

(ii). Barium chloride. -----  
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2 marks

(g) Account for the observations in (f) giving any relevant ionic equations. -----  
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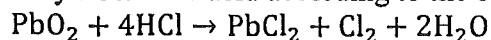
2 marks

6. (a) From the compounds of the Group IV (Group 14) elements (C-Pb), choose an appropriate example for each of the following:

	Type of compounds	Name or formula of example
(i)	A strongly reducing oxide	
(ii)	A giant covalent oxide	
(iii)	A strongly reducing chloride	
(iv)	A covalent chloride which is not hydrolysed by water	

4 marks

(b) Lead (IV) oxide reacts with hydrochloric acid according to the equation



Why is lead (IV) oxide oxidising hydrochloric acid in this reaction? -----

-----1 mark

(c) (i) Which are the two stable crystalline forms of carbon? -----  
-----

(ii) Which of the forms is a better conductor of electricity? -----  
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