

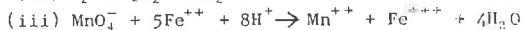
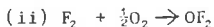
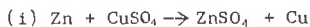
CHEMISTRY - HIGHER LEVEL

WEDNESDAY, 16th JUNE - MORNING, 9.30 to 12

Six questions to be answered.

1. Define oxidation and reduction in terms of electron transfer and illustrate your answer by means of an example, other than those given below. Why do oxidation and reduction occur simultaneously?

State the rules for oxidation numbers. How may change in oxidation number be used to show that oxidation or reduction has taken place? By this or other means, state which substance is oxidised and which is reduced in the following reactions:-

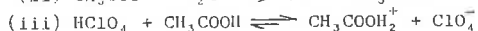
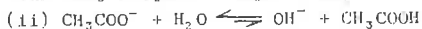
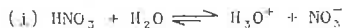


Comment on the use of reaction (iii) in analysis.

(66 marks)

2. What is meant by a conjugate acid-base pair in the Brønsted-Lowry theory?

In the case of each of the following reactions show which substance is acting as an acid and which is acting as a base:



Use example (ii) to illustrate the principle "the equilibrium lies on the side of the weaker pair".

(66 marks)

3. Define pH. What is the pH scale and what use may be made of it?

What is meant by the statement "the ionic product for water is 10^{-14} " ? Using the value for the ionic product of water, show that the pH of pure water is 7.

Calculate the pH of a solution (a) which contains 4 grams of sodium hydroxide per litre, (b) which contains 8 grams of sodium hydroxide per litre. (H = 1, O = 16, Na = 23; Mathematical Tables may be obtained from the Superintendent.)

Is the pH of a solution of ammonium chloride greater or less than 7? Give your reason.

(66 marks)

4. (i) What is meant by colligative properties of solutions? Describe with the aid of a diagram an experiment for the measurement of the molecular weight of a compound using either boiling point elevation or freezing point depression.

When 10 grams of urea, $CO(NH_2)_2$ are dissolved in a litre of water the freezing point of the solution is found to be $-0.31^\circ C$. When 30 grams of another compound are dissolved in a litre of water the freezing point of the solution is found to be $-0.50^\circ C$. Calculate the molecular weight of the other compound. (C = 12, N = 14, O = 16.)

(ii) State Raoult's law and comment on its application.

(66 marks)

5. Compare (i) the structure of, (ii) the bonding in, sodium hydride, methane, ammonia and hydrogen chloride.

Describe the reactions (if any) of these compounds with water and show how the behaviour towards water is related to the type of bonding or to the molecular structure. (66 marks)

6. What is the carbonyl group? Indicate the structure of (i) an aldehyde, (ii) a ketone.

Draw a sketch of the apparatus you would use to prepare acetaldehyde by oxidation of ethanol with acidified dichromate solution. What conditions are required so that acetaldehyde rather than acetic acid shall be obtained?

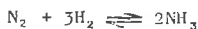
Use equations to illustrate (a) an addition reaction common to both acetaldehyde and acetone, (b) a chemical test which may be used to distinguish between acetaldehyde and acetone.

Show any two reactions in which benzaldehyde resembles the aliphatic aldehydes and any two reactions in which it does not resemble them.

(66 marks)

7. (a) The factors which influence the rate of reactions include (i) nature of reactants, (ii) concentration, (iii) pressure, (iv) temperature, (v) activation energy, (vi) catalyst. Discuss the effect of each of the factors and give an example in each case.

(b) State Le Chatelier's principle and discuss its application to the following exothermic reaction:-



(67 marks)

8. (i) What is a 'free radical'? Outline the mechanism for the reaction of chlorine with methane giving methyl chloride. Mention some evidence that a free radical reaction rather than an ionic reaction is involved.

(ii) What is the necessary condition for optical isomerism in a compound? Show how lactic acid fulfills this condition.

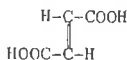
Which of the following compounds (a), (b), (c), (d), can exhibit optical isomerism? Give reasons for your answer.



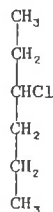
(a)



(b)



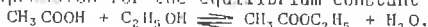
(c)



(d)

(67 marks)

9. Write the expression for the equilibrium constant of the reaction



Outline how the value of the equilibrium constant may be found experimentally. Suggest a method by which the yield of ester may be improved.

In an experiment 120 grams of acetic acid and 92 grams of ethanol were mixed and the system allowed to reach equilibrium. If the equilibrium constant is 4, calculate the number of moles of ethyl acetate formed. (H = 1, C = 12, O = 16).

Mention the physical properties of ethyl acetate and use an equation to show its reaction on heating with ammonia. Name the products formed.

(67 marks)

10. Answer any three of the following:-

- (i) Discuss the basicity of methylamine and ammonia.
- (ii) Contrast the electrolysis of fused sodium chloride with that of aqueous sodium chloride. Refer to the products in each case.
- (iii) A given salt may be a chloride, a bromide or an iodide. How would you detect and confirm which anion is present?
- (iv) What do you understand by the electronegativity of an element? Outline any two uses which you could make of a knowledge of the electronegativities of elements. (Refer to the table of electronegativities given in the Mathematical Tables, p.46).
- (v) Select any one group (other than the noble gases) in the periodic table (given in Mathematical Tables p. 44) and show from the configurations why the elements are placed in that group. Tabulate the principal chemical similarities and differences in the group you have selected.

(67 marks)