THE CHEMISTRY DEPARTMENT

2022

CHEMISTRY

TEST ONE , TERM III, Paper 2

2 hours 30 minutes

INSTRUCTIONS:

Answer **five** questions including **three** questions from section **A** and any **two** from section **B**.

Write the answers in the answer booklet(s) provided.

Begin each question on a fresh page.

Mathematical tables and graph papers are provided.

Non-programmable scientific calculators may be used.

Use equations where necessary to illustrate your answers.

Where necessary, use the following;
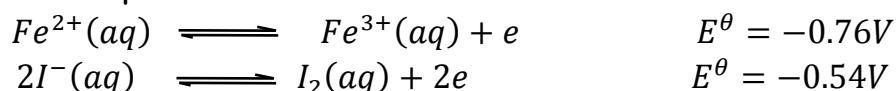
$$(1 Faraday = 96500\ Coulombs)$$

SECTION A : (60 MARKS)

*Answer **three** questions from this section.*

1. (a) Explain what is meant by the terms
       (i)   Standard electrode potential   (2 marks)
       (ii)   Standard hydrogen electrode   (1 ½ marks)

   (b) Describe an experiment to determine the standard electrode potential of iron with the aid of a labelled diagram.   (7 marks)

   (c) The electrode potentials for some half-cell reactions are shown below.

   $$Fe^{2+}(aq) \rightleftharpoons Fe^{3+}(aq) + e \qquad E^{\theta} = -0.76V$$
   $$2I^{-}(aq) \rightleftharpoons I_2(aq) + 2e \qquad E^{\theta} = -0.54V$$

   Write the;
       (i)   Cell convention for the cell formed by combining the two half cells   (1 mark)
       (ii)   equation for the cell reaction   (1 ½ marks)

   (d) State what is observed at the:
       (i) anode   (1 mark)
       (ii) cathode   (1 mark)

   (e) Calculate the:
       (i) e.m.f of the cell   (1 ½ marks)
       (ii) maximum amount of work that can be done by the cell   (1 ½ mark)

   (f) State three factors that affect the value of an electrode potential.   (1 ½ marks)

2. (a) (i) What is meant by the term ore?   (1 mark)
       (ii)   Zinc can be extracted from a sulphide ore. Write the name and formula of the sulphide ore from which zinc can be extracted.   (1 mark)
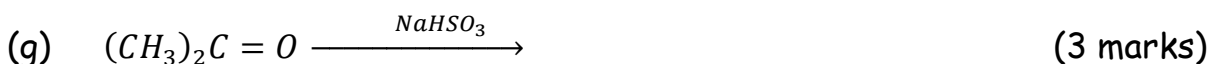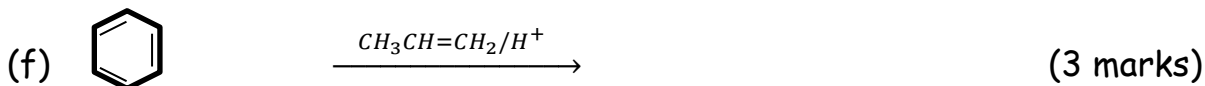
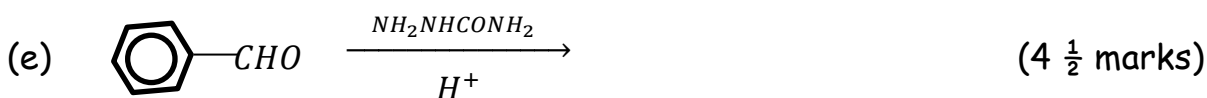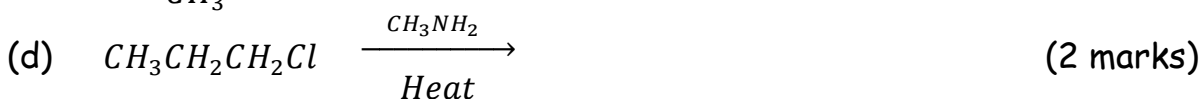   (b) Describe how:
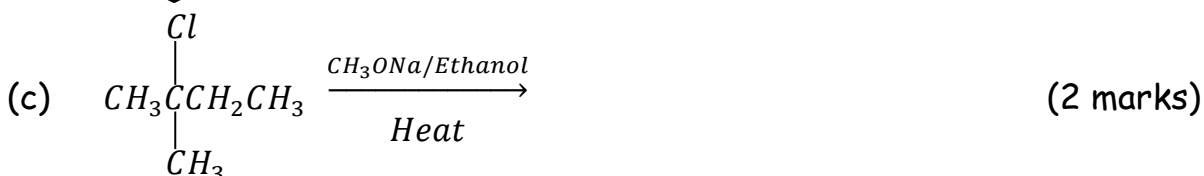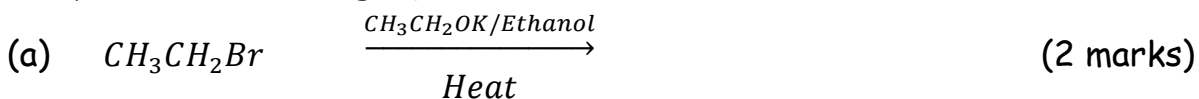   (i) the ore in a(ii) can be concentrated.   (3 marks)
   (ii) pure zinc can be obtained from the concentrated ore.   (6 ½ marks)
   (c) Discuss the reactions of zinc with:
   (i) air
   (ii) sulphuric acid   (6 marks)

(d) A few drops of potassium hexacyanoferrate(III) solution were added to zinc sulphate solution.

(i) State what was observed. (1 mark)

(ii) Write equation for the reaction. (1 $\frac{1}{2}$ marks)

3. Complete the following equations and outline the mechanisms

(a) CH_3CH_2Br $\xrightarrow[\text{Heat}]{CH_3CH_2OK/Ethanol}$ (2 marks)

(b) $\bigcirc$ $\xrightarrow{fuming\ H_2SO_4}$ (3 $\frac{1}{2}$ marks)

(c) $CH_3\overset{\overset{\displaystyle Cl}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}CH_2CH_3$ $\xrightarrow[\text{Heat}]{CH_3ONa/Ethanol}$ (2 marks)

(d) $CH_3CH_2CH_2Cl$ $\xrightarrow[\text{Heat}]{CH_3NH_2}$ (2 marks)

(e) $\bigcirc\!\!-CHO$ $\xrightarrow[H^+]{NH_2NHCONH_2}$ (4 $\frac{1}{2}$ marks)

(f) $\bigcirc$ $\xrightarrow{CH_3CH=CH_2/H^+}$ (3 marks)

(g) $(CH_3)_2C = O$ $\xrightarrow{NaHSO_3}$ (3 marks)

4. (a) Ethanoic acid is a weak acid and has a pKa value of 4.74

(i) State what is meant by the term weak acid. (1 mark)

(ii) Write an equation for the ionisation of ethanoic acid (1 mark)

(iii) Calculate the pH of a 0.75M ethanoic acid solution. (2 marks)

(b) Ammonia undergoes the following reaction in water.

$$NH_3(g) + H_2O(l) \rightleftharpoons NH_4^+(aq) + \bar{O}H(aq)$$

(i) Write the expression for the ionisation constant, K_b for the reaction. (1 mark)

(ii) If the ionisation constant, K_b for ammonia is $1.8 \times 10^{-5}\ moldm^{-3}$. Calculate the pH of a 0.1M solution of aqueous ammonia. (3 marks)

(c) The solubility product of a sparingly soluble base $M(OH)_2$ is $6.0 \times 10^{-14} \, mol^3 dm^{-9}$.

Define the term solubility product. (1 mark)

Calculate its solubility in:

(i)   Water (4 marks)

(ii)   0.1M sodium hydroxide solution. (3 marks)

(d) Explain the differences in your answers in c(i) and (ii) above (4 marks)

SECTION B : (40 MARKS)
Answer any **two** *questions from this section*

5. (a) Explain the trend in boiling points of group(VII) elements   (3 marks)

(b) Explain why hydrogen fluoride:

(i) is a weaker acid in dilute aqueous solution than in concentrated solution (3 marks)

(ii) has a higher boiling point than hydrogen iodide (3 marks)

(c) Write equation for the reaction between hydrogen fluoride and silicon(IV) oxide. (1 mark)

(d) Describe the reactions of group(VII) elements with hydrogen

(5 marks)

(e) Chlorine gas was bubbled through potassium sulphite solution and to the resultant solution was added barium nitrate solution. State what was observed and write an equation(s) for the reaction.   (4 marks)

(f) Write equation between sulphuric acid and sodium chloride   (1 mark)

6. Explain the following observations

(a) Ammonium nitrate solution gives effervescence with magnesium ribbon whereas sodium benzoate solution gives a green precipitate that dissolves in excess with aqueous chromium(III) sulphate solution.

(7 marks)

(b) An aqueous solution of benzoic acid liberates carbon dioxide from a solution of sodium hydrogencarbonate whereas an aqueous solution of phenol does not. *(4 marks)*

(c) The melting point of 4-nitrophenol is higher than that of 2-nitrophenol. *(4 marks)*

(d) When sodium hydroxide solution is added to a solution of manganese(II) sulphate , a white precipitate is formed which is insoluble in excess alkali. The precipitate turns brown on standing.

(5 marks)

7. (a) Explain what is meant by:
(i)   Addition polymerization   (1 mark)
(ii)   Condensation polymerization   (1 mark)
(b) Natural rubber is a natural polymer formed by addition polymerization. Write the structural formula and name of the monomer of natural rubber.   (2 marks)
(c) One stage involved in processing of rubber is vulcanization.
(i)   Describe how vulcanization is carried out.   (2 marks)
(ii)   What is the effect of vulcanization on the properties of rubber?   (1 mark)
(iii)   Give one use of rubber   (1 mark)
(d) Write the structural formula and name of the monomer of synthetic rubber.   (2 marks)
(e) Polyphenylethene is another polymer formed by addition polymerization. Write equations to show how polyphenylethene is prepared starting from benzene.   (5 marks)
(f) Nylon-6,6 is also a polymer formed by condensation polymerization.
(i)   Write the structural formula(e) and name(s) of the monomer(s) of nylon-6,6.   (4 marks)
(ii)   Write the equation leading to formation of nylon-6,6.(1 mark)

8. (a) Explain the following terms:
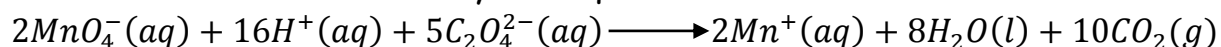(i) Rate of reaction
(ii) Rate law
(iii)   Activation energy   (5 marks)
(b) Describe an experiment to show that iodination of propanone is zero order with respect to iodine.   (6 marks)
(c) The reaction between manganate(VII) ions and ethanedioate ions in acidic medium is described by the equation;

$$2MnO_4^-(aq) + 16H^+(aq) + 5C_2O_4^{2-}(aq) \longrightarrow 2Mn^+(aq) + 8H_2O(l) + 10CO_2(g)$$

The reaction was studied at different temperature and the following values for the rate constant, **K** were obtained.

Temperature(K)	293	308	318	338
Rate constant, **K** (S^{-1})	1.76×10^{-5}	1.35×10^{-4}	4.98×10^{-4}	4.87×10^{-3}

(i)   Plot a graph of $\log_{10} K$ against $^1/_T$.   (4 marks)

(ii)   Use your graph to determine the activation energy for the reaction
                                                                        (2 marks)

(iii) Determine the value of the pre-exponential constant, A.
                                                                        (1 mark)

(iv) Explain the effect of temperature on the rate of a chemical reaction   (2 marks)

END