UEC TRIAL EXAMINATION (2010)
Senior Middle Level
CHEMISTRY

Date: 28th.september
Time Limit: 2 hours

Name: [ ] [ ] [ ] Seat no: ( ) Student number: _____
Class: Sc ( )

INSTRUCTIONS:

1. This paper comprises two papers:
   Paper 1: Multiple- choice questions (40%)
   Paper 2: Written questions (60%)

2. Attempt all the 20 questions in Paper 1. For each question, select the best answer.

3. Paper 2 consists of two sections:
   Section A: compulsory questions (24%)
   Section B: Elective question (36%)
4. Non- programmable electronic calculators may be used.

5. These papers consist of 6 printed pages.

PAPER 1 MULTIPLE-CHOICE QUESTIONS

1. Which of the following will not bleach colored cloth?
   A. calcium chloride solution B. calcium chlorate(I) solution
   C. Chlorine water D. Sodium chlorate (I) solution

2. Which of the following solution can be distinguished by using **only** lead (II) nitrate solution?
   A . hydrochloric acid, sodium carbonate, sodium chloride
   B. Chlorine, hydrochloric acid, sodium bromide
   D. barium chloride, sodium iodide, potassium iodide
   E. chlorine water, sodium bromide, potassium bromide

3. Mixing which combination produces a gaseous product?
   A. solid ammonium nitrate and solid calcium hydroxide
   B. copper metal and 0.10 mol/L hydrochloric acid
   C. solutions of barium hydroxide and 0.10 mol/L sulphuric acid
   D. solutions of aluminum nitrate and sodium chloride

4. A precipitate of copper (II) hydroxide dissolves in concentrated aqueous ammonia due to the formation of complex ion. Which complex ion is formed?
   A. $[Cu(NH_3)_2]^{2+}$ B. $[Cu(NH_3)_4]^{2+}$ C. $Cu(NH_3)_4\ (OH)_2$ D. $[Cu(NH_4)_4]^{2+}$

5. The half-life of a radioactive nuclide is 20 years. If a sample of this nuclide has an activity of 6400 disintegrations per minute (dis/min) today, its activity (dis/min) after 100 years would be
   A. 850 B. 1600 C. 200 D. 400
6. The commercial production of ammonia is represented by the equation:
   $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$
   If the rate of disappearance of $H_2(g)$ is 1.2×10^{-3} mol/min, what is the rate of appearance of $NH_3(g)$?
   A. 2.4×10^{-3} mol/min B. 1.8×10^{-3} mol/min
   C. 1.2×10^{-3} mol/min D. 8.0×10^{-4} mol/min

7. Use the thermodynamic information:
   $\frac{1}{2}\ N_2(g) + \frac{1}{2}O_2(g) \rightarrow NO(g)$ $\Delta H^\circ = 90.4$ kJ/mol
   $\frac{1}{2}N_2(g) + O_2(g) \rightarrow NO_2(g)$ $\Delta H^\circ = 33.8$ kJ/mol
   $2NO_2(g) \rightarrow N_2O_4(g)$ $\Delta H^\circ = -58.0$ kJ/mol
   Calculate ΔH° in kJ/mol for the reaction: $2\ NO(g) + O_2(g) \rightarrow N_2O_4(g)$
   A. −171.2 B. −114.6 C. 114.6 D. 171.2

8. For which reaction is $\Delta H_{rxn}°$ equal to $\Delta H_f°$ for $CuSO_4(s)$?
   A. $Cu^{2+}(aq) + SO_4^{2-}(aq) \rightarrow CuSO_4(s)$ B. $CuO(s) + SO_3(g) \rightarrow CuSO_4(s)$
   C. $CuS(s) + 2O_2(g) \rightarrow CuSO_4(s)$ D. $Cu(s) + S(s) + 2O_2(g) \rightarrow CuSO_4(s)$

9. The following system is at equilibrium in a closed container. Which of the following system will increase the yield of products when the volume of the system is **increased**?

   A. $2\ NO(g) + O_2(g) \leftrightarrows 2\ NO_2(g)$ B. $2\ NH_3(g) \leftrightarrows N_2(g) + 3\ H_2(g)$
   C. $H_2(g) + Cl_2(g) \leftrightarrows 2\ HCl(g)$ D. $CO(g) + H_2O(g) \leftrightarrows CO_2(g) + H_2(g)$

10. Titanium is manufactured from ilmenite which is a mixture of iron(II) titanate, $FeTiO_3$, and iron(III) titanate, $Fe_2(TiO_3)_3$.
    What are the oxidation numbers of titanium in these two compounds?
    A. +2, +3 B. +4, +2 C. +4, +3 D. +4, +4

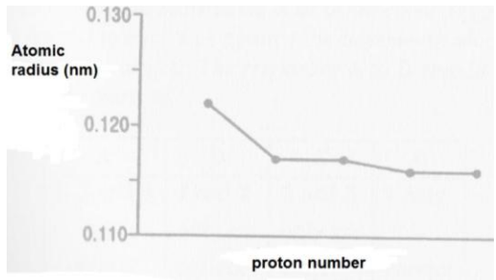
11. What is the ground state electron configuration of a $_{27}Co$ atom in the gas phase?
    A. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$ B. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$
    C. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^1$ D. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$

12. What is the pH of a solution made by mixing 200 mL of 0.0657 mol/L NaOH, 140 mL of 0.107 mol/L HCl , and 160 mL of H_2O?
    A.3.04 B. 2.74 C. 2.43 D. 2.27

13. Which pair of solutions forms a buffer solution when equal volumes of each are mixed?
    A. 0.20 M HCl and 0.20 M NaOH B. 0.40 M $HC_2H_3O_2$ and 0.20 M NaOH
    C. 0.20 M HCl and 0.20 M NH_3 D. 0.40 M HCl an 0.20 M NH_3

14. The sketch shows the atomic radii of the elements in order of increasing proton number.

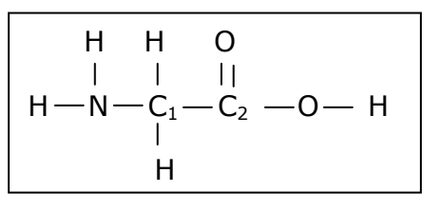
    In which part of the periodic table do these elements belong?
    A. Group IIA
    B. Group VIIA
    C. The period sodium to chlorine
    D. The transition metals.



15. The solubility of a compound X is 20g/100g of water at 15°C. What is the mass of the compound X in 500g saturated solution of X at the same temperature?
    A. 20g B. 22.8g C.83.3g D. 100g

16. What are the hybridizations of the carbon atoms labeled C_1 and C_2, respectively, in glycine?

	C_1	C_2
A.	sp^2	sp^2
B.	sp^2	sp^3
C.	sp^3	sp^2
D.	sp^3	sp^3



17. Consider the compound, $CH_2{=}CHCH_2COOH$. It would be expected to
    I. react with acidic solution of potassium manganate(vII) solution.
    II. react with ethanol to produce a compound that has fruity smell.
    III. reduce by $LiAlH_4$ to $CH_2{=}CHCH_2CHO$.
    IV. give a colorless gas with sodium.

    A. I,II,III B. I,II,IV C. II,III,IV D. I, II,III,IV

18. How many structural isomers have the formula C_5H_{12}?
    A. 2 B. 3 C. 4 D. 5

19. Which of the following chemical reaction are carried out in **correct reaction conditions**.
    I. $CH_3C{\equiv}CH + H_2O \xrightarrow{warm} CH_3COCH_3$

II. $CH_3CH=CH_2 \xrightarrow{hot,\ KMnO_4, H^+} CH_3COOH + CO_2 + H_2O$

III. $HCHO \xrightarrow{conc.NaOH} HCOONa + CH_3OH$

IV. $CH_3CH_2OH + HBr \xrightarrow{warm} CH_3CH_2Br + H_2O$

A. I, II, III B. II, III, IV C. II, IV D. I, III

20. What happens when one mole of methane is mixed in the dark at room temperature with four moles of chlorine?

A. There is no reaction. B. CH_3Cl and HCl are formed.

C. CH_2Cl_2 and HCl are formed. D. CCl_4 and HCl are formed.

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Paper 2 WRITTEN QUESTIONS (60%)
Section B Elective Questions (36%)

(Attempt any three, but not more than three from the six questions in this section. **Begin each answer on a fresh new page**.)

1.

a. An organic compound A has the following composition by mass C, 35.1%; H, 6.6%; Br, 58.3%. [C=12, H=1, Br=80]

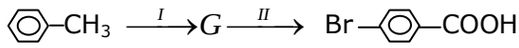
(i) Calculate the empirical formula of A. [2%]

(ii) When A is treated with aqueous sodium hydroxide, 2-methylpropan-2-ol is formed. Write an equation for this reaction. [1%]

(iii) When A is refluxed with ethanolic potassium hydroxide, an alkene B is formed. Give the displayed formula of B. [1%]

(iv) When B from (iii) reacts with hydrogen bromide, a compound C is formed. Give the displayed formula of C. [1%]

b. Describe a test (reagents and observations) that would distinguish CH_3COCH_3 and CH_3CH_2CHO. [3%]

c. Consider the following conversion: 

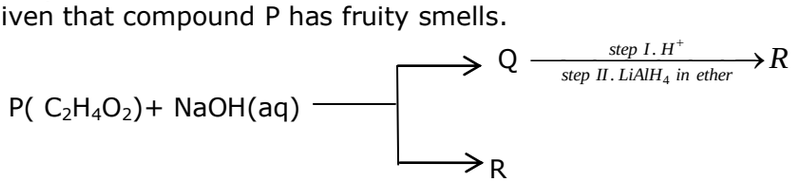
(i) IUPAC name of  [1%]

(ii) Suggest the reagents and conditions required for reaction I and II. [2%]

(iii) Identify the intermediate compound G. [1%]

2.

a. Study the reaction scheme below:
Given that compound P has fruity smells.

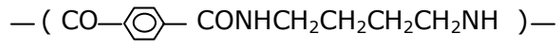


(i) Write displayed formulae of P, Q and R. [1%x3]

(ii) Which compounds (P, Q, R) will reduces Tollens' reagent? [1%]

b. Write chemical equations to show the conversion of
ethanol $\rightarrow$ 2-hydroxyprpanoic acid ($CH_3\underset{\underset{OH}{|}}{C}HCOOH$) [2%]

c. The following formula represents a section of a polymer.

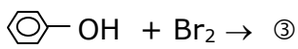


(i) What type of polymer is this? [1%]
(ii) Write the structural formula of each of the monomers that make up this polymer. [2%]

d. Write the displayed formula of organic products of the following reactions. [1%x3]

(i) $CH_3CH_2OH \xrightarrow{\text{conc. } H_2SO_4,\ 140°C} ①$

(ii) $CH_3CHO + CH_3MgBr \xrightarrow{in\ \text{dry ether}} \xrightarrow{H_2O,\ H^+} ②$

(iii)  ③

3.

a. Consider the following hydrogen halides, HF, HCl, HBr and HI

(i) Arrange them in order of increasing boiling point. [1%]

(ii) Arrange them in order of increasing thermal stability. Explain. [2%]

(iii) Which aqueous solution of hydrogen halides is the stronger acid? [1%]

(iv) Describe what you would see when a test tube filled with hydrogen chloride gas is exposed in air. [1%]

b. An experiment as shown in fig. 1 is carried out to produce hydrogen chloride gas, HCl.

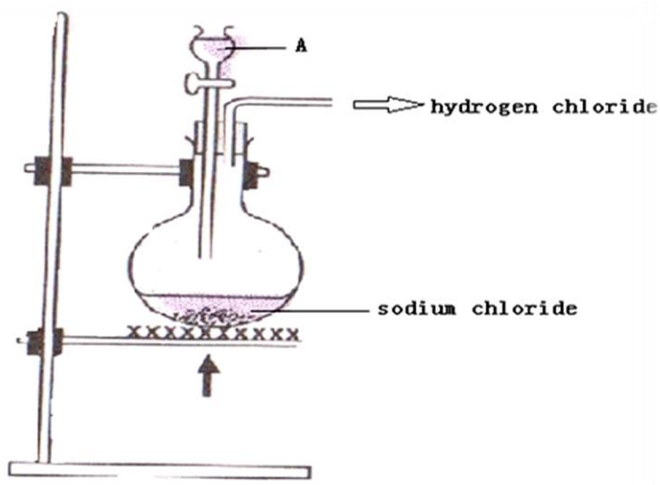
(i) What is A? [1%]

(ii) Write an equation for the reaction to produce hydrogen chloride gas.[1%]

(iii) Draw a diagram to show the collection of **dry** hydrogen chloride gas. [2%]

(iv) A student wants to prepare hydrogen bromide gas, sodium chloride is replaced with sodium bromide and compound A is _____. [1%]

Fig.1



c. Hydrogen chloride gas is oxidized by oxygen gas according to equation:

$4\ HCl\ (g) + O_2\ (g) \rightarrow 2Cl_2\ (g) + 2H_2O\ (l)$

If 48.0L of HCl gas and 2.0 moles of O_2 react completely, Calculate volume of the gas produced measured at rt.p. [Gas molar volume = 24L/mol] [2%]

4.

An experiment as shown in fig.2 is carried out.

a. Name the gas produced? [1%]

b. Write an equation for the reaction between conc.HCl and manganese (IV) oxide, MnO_2. [2%]

c. **Describe what would you see**, if solution B is

(i) litmus solution. [1%]

(ii) potassium iodide solution. Then the resulting solution is shaken with CCl_4 and left for some time. Explain [2%]

(iii) lead (II) nitrate solution. Then an excess amount of gas is continuously passed through it. [2%]

(iv) sodium sulphite, Na_2SO_3 solution.[1%]

d. Write an **equation** for the reaction takes place in c (iv). In this reaction stating which substance is oxidizing agent and which is reducing agent. [1%x3]

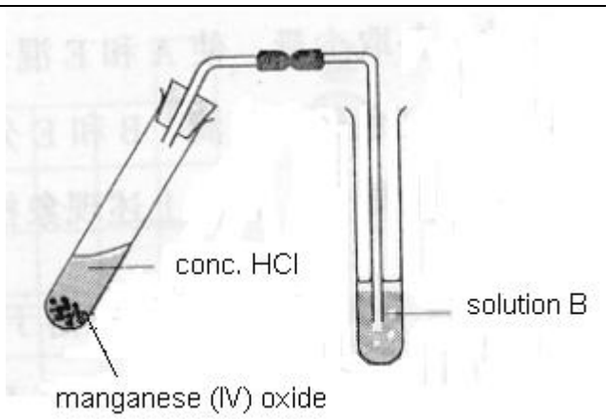


Fig.2

5.

a. Solid carbon and carbon dioxide gas at 1160K were placed in a 2.0L container. The equation of reaction is $C(s) + CO_2(g) \rightleftharpoons 2\ CO(g)$

As the reaction proceeded, the total pressure in the container was monitored. Results are recorded in table below.

Time(hours)	0.0	2.0	4.0	6.0	8.0	10.0
Total pressure of gases in container at 1160K	5.00	6.26	7.09	7.75	8.37	8.37

(i) Write the expression for the equilibrium constant, k_p, for the reaction. [1%]

(ii) Calculate the number of moles of $CO_2(g)$ initially placed in the container. [2%]
[R = 0.0821 $L.atm.mol^{-1}K^{-1}$]

(iii) At1160K, the partial pressure of $CO_2(g)$ is 1.63 atm. Calculate partial pressure of CO(g). [1%]

(iv) Hence, calculate the equilibrium constant ,K_p. [1%]

b. Given K_{sp} of calcium sulphate, $CaSO_4$ is 2.0×10^{-5}.

(i) Write the K_{sp} expression for calcium sulphate. [1%]

(ii) Calculate molar solubility, S, of $CaSO_4$ in mol/L. [2%]

(iii) When 300 mL of 0.05 mol/L Na_2SO_4 is mixed with 50 mL of 0.08 mol/L $Ca(NO_3)_2$. Will a precipitation occurs? [2%]

c. A student is given with a 20.0 mL of 0.06 mol/L ethanoic acid solution ($K_a = 1.8 \times 10^{-5}$). Calculate the degree of ionization of ethanoic acid. [2%]

6.

a. Fig. 3 shows the apparatus set up for electrolysis of two solutions. Electrode A and B are graphite electrode. Electrode C and D are copper.

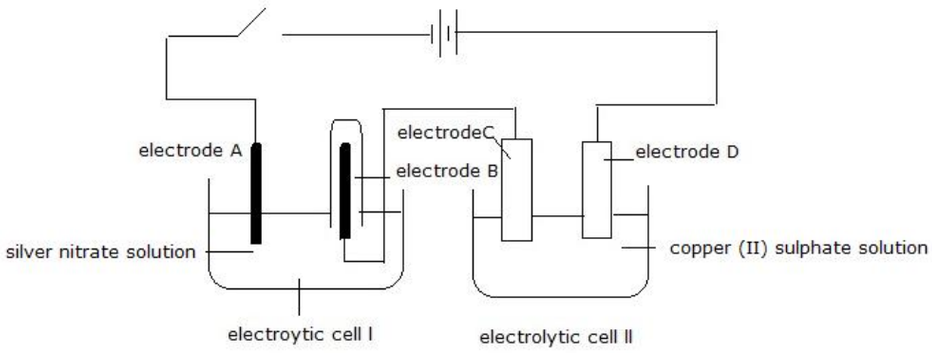


Fig.3

A current of 0.50A is passed through the electrolytic cell I containing aqueous silver nitrate, $AgNO_3$ as electrolyte. 0.50g of silver is deposited at the electrode A. [Ag=108]

(i) Write the half reaction equation that occurred at the electrodes A. [1%]

(ii) Calculate the time required. [2%]

(iii) Write the half reaction equation that occurred at the electrodes B.[1%]

(iv) Write an overall equation for the reaction takes place in electrolytic cell I. [2%]

(v) What changes you will see at electrode D? [1%]

b. The electrode potential for three half reactions are given below:

$X^{3+}(aq) + 3e \rightarrow X(s)$ $\varphi^\circ = -0.74V$

$Y^{2+}(aq) + 2e \rightarrow Y(s)$ $\varphi^\circ = -2.89V$

$Z^{3+}(aq) + 3e \rightarrow Z(s)$ $\varphi^\circ = +1.50V$

(i) Arrange the three **elements** in order of increasing reducing strength. [1%]

(ii) Which two metals will be used as electrodes to build up an electrochemical cell that will produce the greatest standard e.m.f? [2%]

(iii) Write an equation for the reaction occur and calculate the standard e.m.f of the electrochemical cell in b (ii). [2%]

========== The End ==========