CHEM SE

24/02/2016
2016 A/L

De Mazenod College Kandana

2016 February Term Test | Grade 13

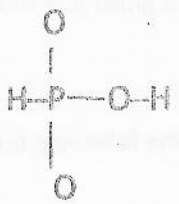
CHEMISTRY II | Time : 1 hour

Structured Essay (Answer all questions)

1. (a) Answer to the following questions using the elements, Na, Mg, Al, Si, P, S, Cl, Ar.

   i. The non metallic element/s which show/s the allotropism is/are.....
   ii. The element/s which react/s with NaOH(aq) and liberate $H_2(g)$is/ are.....
   iii. The element which reacts with KOH(aq) is.....
   iv. The element which has got the highest third ionization energy is.....
   v. The element which has got the highest electronegativity is.....
   vi. The element which react with NaOH but does not liberate $H_2(g)$ is.....
   vii. The element which has got the highest melting point is.....
   viii. Element/s which is/are capable of forming compounds which could act as Lewis acids is/ are.....
   ix. ..... can form nitrides when heated with $N_2(g)$
   x. The element which has got the lowest boiling point is.....

(b) Skeletal structure of $H_2PO_3^-$ is shown below,



i. Draw the most acceptable Lewis structure of the above ion

ii. Draw the resonance structures for the above ion and indicate their stabilities

iii. Deduce the shapes around the following atoms using the VSEPR theory.

a) Around O which is bonded to H

b) Around P

iv. Using the most acceptable Lewis structure of the above ion, indicate the electron pair geometries of the following,

a) Around O which is bonded to H.....

b) Around P.....

v. Indicate the hybridizations of the following atoms,

a) O which is bonded to H.....

b) P.....

vi. State the atomic/hybrid orbitals which do involve in the following bond formation.

a) O – H

b) O – P

(c) Graphically represent the variation of the boiling points of all hydrides formed by group 16 elements.

2. (a) X_2O_5 and Y_2O_5 are two compounds formed by elements X and Y which are present in two successive periods. XCl_3 and YCl_5 are the chlorides which are derived from the highest oxidation numbers of X and Y respectively.

i. Identify X and Y.

ii. Indicate balanced chemical equations to represent the reactions between water and X_2O_5, Y_2O_5, XCl_3 and YCl_5 using their actual symbols.

iii. Give formulae of four oxides formed by X

iv. State two equations to represent the synthesis of two above mentioned oxides.

(b) Following questions are based on Fe and its compounds.

i. To which sub energy level does the last electron of iron is filled?.....

ii. State the energy level which occupies the electron of highest energy in the Fe atom.....

iii. State the electron configuration of the Fe^{2+} ion ?.....

iv. Indicate a balanced chemical equation to represent the reaction between Fe and conc. H_2SO_4.

v. State the products and their colours if any when Fe^{3+} ions react with conc NH_3.

vi. Are the colours of the above mentioned copounds in (v) will be faded out with time ? explain your answer.

vii. How would you identify the $Fe^{3+}(aq)$ ions ?

viii. Explain why MnO is a basic oxide and Mn_2O_7 is an acidic oxide ?

3. The bromination of acetone can be catalyzed by acids.

$$CH_3COCH_3 + Br_2 \xrightarrow[\text{catalyst}]{\text{Acid}} CH_3COCH_2Br + H^+ + Br^-$$

At a certain temperature in different concentrations of acetone, bromine and acid the rate of the consumption of bromine was measured and recorded as follows,

Trial	$[CH_3COCH_3]$ (mol dm^{-3})	$[Br_2]$ (mol dm^{-3})	$[H^+]$ (mol dm^{-3})	Rate of consumption of bromine/ mol dm^{-3} s^{-1}
1	0.300	0.050	0.050	5.7×10^{-5}
2	0.300	0.100	0.050	5.7×10^{-5}
3	0.300	0.050	0.100	1.2×10^{-4}
4	0.400	0.050	0.200	3.1×10^{-4}
5	0.400	0.050	0.050	7.6×10^{-5}

I. Find out reaction orders with respect to acetone, bromine and the acid.

II. Find out overall order of the reaction

III. State the rate law for the reaction

IV. If the bromine concentration has changed to 0.2 M in the 2nd trial, calculate the new rate.

V. Find out the rate constant

VI. If a reaction order with respect to a certain reactant is zero, what does it mean to you? (state two points)

VII. NO_2Cl and chlorine free radical react together to form NO_2 and Cl_2. Also it is an exothermic reaction. Draw an energy diagram for this reaction. Mark the following features and propose an activation complex

- E1 = Activation energy of the reaction
- ΔH = enthalpy change of the reaction
- E2= Activation energy of the backward reaction

4. (a) i. What is the characteristic reaction type shown by alkenes?

ii. What is the characteristic reaction type shown by benzene ?

iii. Consider the reaction between toluene and the nitration mixture. In this reaction,

a. State the major product

b. Name of the mechanism

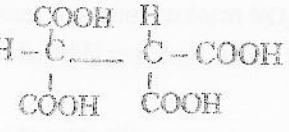
c. Main activated species

d. Colour of the obtained species..

(b) 1- bromopropane reacts with KOH in two different ways to produce two different compounds. State the two different methods and their reaction mechanism type and the reaction mechanisms separately.

Perform the following organic conversions.

(e) $CH_3CH_2CH_2Br \longrightarrow CH_3-NH-CH_2-\underset{\underset{CH_3}{|}}{CH}-(CH_2)_2-NH-CH_3$

$CH_3CH_2Br \longrightarrow$ 

CHEM B

25/02/2016
2016 A/L

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2016 February Term Test — Grade 13

CHEMISTRY II — Time : 3 hours

Part B (Answer two questions only)

5. (a) 8 mol of SO_2 and 4 mol of O_2 were mixed together and an equilibrium was established at 450 °C. At the equilibrium it was found that 90 % of the initial SO_2 had reacted to establish the equilibrium.

i. Write an expression to represent the relationship between Kp and Kc for the above equilibrium
ii. Find out the number of moles of SO_2, O_2 and SO_3 present in the equilibrium mixture
iii. Calculate the Kp for the system ,at 2×10^7 Pa equilibrium pressure
iv. Calculate the Kc value
v. Propose two methods , which could be implemented to increase the decomposition percentage of SO_2. How do those individual methods work to increase the decomposition percentage?

(b) Consider the following equilibrium,

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

The above equilibrium was established in a closed rigid vessel of 1 dm3. At the equilibrium 0.2 mol CO, 0.3 mol of $H_2O(g)$ and 0.9 mol of H_2 were found in the equilibrium mixture. If the equilibrium constant of the system is 5,

i. Write an expression for Kc
ii. Find out the amount of CO_2 at the equilibrium
iii. At the same temperature some amount of $H_2(g)$ was introduced to the system and simultaneously some amount of $H_2O(g)$ were removed from the system. Then the system had established a new equilibrium having 0.4 mol of CO, 0.3 mol of $H_2O(g)$ and 1.2 mol of $H_2(g)$. Calculate the amount of CO_2 formed in the new equilibrium system.

6. (a) Give balanced chemical to represent the following standard enthalpies,

i. Standard enthalpy of combustion of $C_{10}H_{21}COOH$
ii. Standard enthalpy of atomization of iodine
iii. Standard enthalpy of formation of KCl
iv. Standard enthalpy of the first electron gain of bromine
v. Standard enthalpy of mend dissociation of O_2

(b) Hydrazine (N_2H_4) which is used as a rocket fuel can be combusted as follows,

$$N_2H_4(g) + O_2(g) \longrightarrow N_2(g) + 2H_2O(g)$$

1.83 x 104 kJ energy is liberated when 1 kg of Hydrazine is combusted with the presence of excess oxygen. Using this combustion data and the following bond dissociation data, find out the standard enthalpy of bond dissociation of N – N bond.

Bond	$\Delta H^\ominus$ / kJ mol^{-1}
N – N	+ 388
N≡N	+ 944
O=O	+ 496
O – H	+ 463

(c) i.Define the standard enthalpy of solution

ii. MCl_2 is an ionic compound. Calculate its standard enthalpy of solution using the following data.

- Standard enthalpy of formation of $MCl_2(s)$ = -642 kJ mol^{-1}
- Standard enthalpy of hydration of $M^{2+}(g)$ = -1890 kJ mol^{-1}
- Standard enthalpy of hydration of $Cl^-(g)$ = -380 kJ mol^{-1}
- Standard enthalpy of sublimation of M(s) = + 147 kJ mol^{-1}
- Sum of the standard enthalpies of first and the second ionizations of M(g) = 2186 kJ mol^{-1}
- Standard enthalpy of the first electron affinity of Cl(g) = -349 kJ mol^{-1}
- Standard enthalpy of the bond dissociation of $Cl_2(g)$ = 242 kJ mol^{-1}

(d) i The change of a factor *x* can be given as,

Δx = *x* (products) + *x* (reactants)

Factors like x can be identified by using a common name. What is that common name ?

ii State two examples for these factors.

iii. $\Delta G^\ominus = \Delta H^\ominus + T\Delta S^\ominus$; What are represented by $\Delta G^\ominus$, $\Delta H^\ominus$, T and $\Delta S^\ominus$

7. (a) i) Explain why alkyl halides tend to undergo nucleophilic substitution reactions.
ii)Explain why chlorobenzene does not undergo nucleophilic substitution ractions readily.
iii) Provide a mechanism for chlorination of benzene in the presence of $FeCl_3$.

(b) i) X is an alkyl monobromide and it contains 53% of Br by mass. Deduce the molecular formula of X. (Br = 80, C =12, H=1)
ii) If X has got 3 methyl groups, indicate different structural formulae, which could be drawn for it.
iii) If X has got a least possibility of removing a HBr molecule, identify the correct structure.
iv) Indicate the IUPAC name of X.

(c) How would you perform the following organic conversions using minimum number of steps ?
I. Acetylene → 1- ethyl-3-methyl benzene
II. Ethanol → hex-3-yne

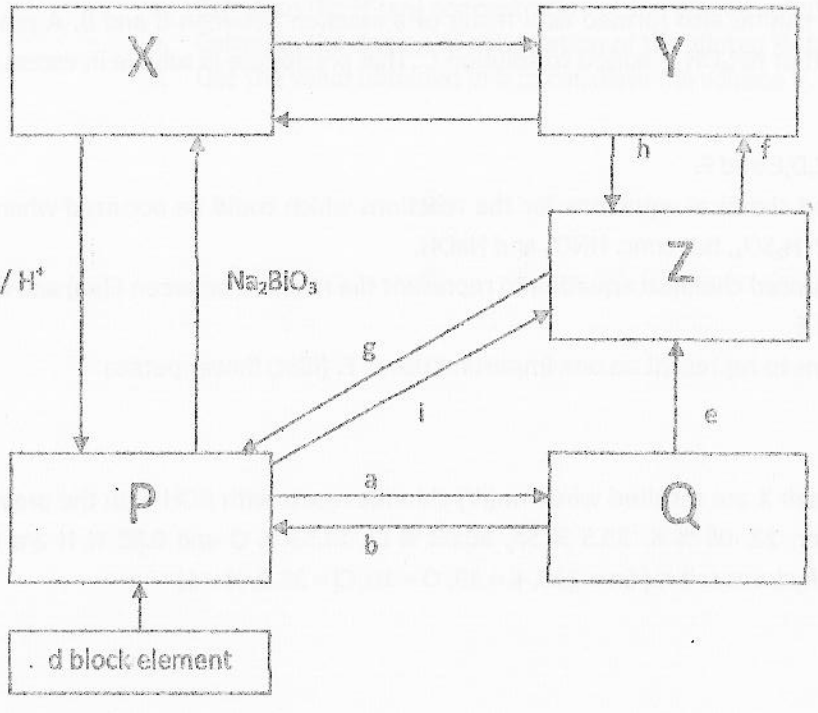
(d) Compound B can be formed by heating compound A ($C_4H_{10}O$) with conc. H_2SO_4. With the presence of a mineral acid, B reacts with water and compound C can be formed. C and A have got similar functional group. If C is heated with conc. H_2SO_4, compound B can be formed. A reacts with PCC and compound D is formed. Identify compounds A-D and state a method which can be implemented to differentiate A and C. Also state your observations. PCC is used to oxidize an alcohol to an aldehyde)

Part C (Answer two questions only)

8. (a) A certain element (M) of d block forms two different (x and y) having different oxidation numbers but the same numbeof oxygen atoms. Aqueous solution of x is purple in colour.

I. Identify x. What is the oxidation number of M in x?
II. Identify Y and state the colour of its aqueous solution.
III. Which reagent can be used to convert x into y.
IV. Indicate a balanced chemical reaction for the above change (iii)

(b)



Q is a hydroxide formed by a +2 ion of a 3d element. Z is a metallic oxide. X is oxi anion whose, aqueous solution has got a purple colour. P has got a pale pink colour in an aqueous solution.

I. Identify a,b, e, f, g, h,i.
II. Give a balanced chemical equation to represent the reaction between conc. HCl and Z
III. State the colours of Q and Z
IV. Give a balanced chemical equation to represent the thermal decomposition of the potassium salt of X.
V. State a use of an above mentioned d block element
VI. Give a reaction to represent the change occurred when an aqueous solution is acidified.
VII. State one use of each of the following elements except the formation of alloys.(Cr,Ti,Co,Ni,Cu)
VIII. Ti metal is used to build fuselage of airplanes. Why is specifically used for that purpose?
IX. Why Ti metal does not undergo corrosion?

(c) Excess aqueous soldium hydroxide is applied to 1 mol dm^{-3} $Br_2(aq)$. Because of this addition Br_2 undergoes disproportionation forming $Br^-(aq)$ and $BrO^-(aq)$. Formed $Br^-(aq)$ is removed from the system and OH^- content is neutralized by adding an acid. The resultant solution is completely reduced by a 1.5 g of calcium oxalate which is having some inert impurities.

I. What is meant by the term "disproportionation" ?
II. Calculate the percentage purity of calcium oxalate sample by mass. (Ca= 40, O = 16, C = 12)

9. (a) Colourless gas B and a colourless solution C are resulted when solute A reacts with dil. H_2SO_4. A green coloured solution and a pale colured precipitate D can be formed when B gas is bubbled through a solution of acidified $K_2Cr_2O_7$. Gas E can be formed as a resuge itcenta of combusting D. D and a colourless solution can be also formed as a result of a reaction between E and B. A precipitate is formed when dil NaOH or NH_4OH is added to solution C. That precipitate is soluble in excess dil. NaOH of NH_4OH.

I. Identify A,B,C,D,E and F.
II. State balanced chemical equations for the reactions which could be occurred when D reacts with hot conc. H_2SO_4, hot conc. HNO_3 and NaOH.
III. Indicate a balanced chemical equation to represent the reaction between E(aq) and Cl_2.
IV. State a use of E
V. State equations to represent an one important use of E. (hint; flower petals)

(b) KCl and an anhydrous salt X are resulted when tin(IV) chloride reacts with KOH with the presence of a small amount of water. 22. 05 % K, 33.5 % Sn, 30.03 % Cl, 13.53 % O and 0.85 % H are the mass percentages of the anhydrous salt X.(Sn = 119, K = 39, O = 16, Cl = 35.5, H = 1)

I. Find out the empirical formula of X
II. Indicate the anion of X with its charge
III. Give the IUPAC name of the above anion
IV. Write down a balanced chemical equation to represent the above reaction

10. (a) Give balanced chemical equations to represent the following reactions

I. $Ba(OH)_2(aq) + N_2O_4$
II. $NaHSO_4(aq) + KNO_2$
III. $FeCl_3(aq) + SO_2$
IV. Thermal decomposition of $HgCO_3$
V. $Ag_2O + H_2O_2$

(b) Four unlabelled beakers contain dilute aqueous solutions of Na2CO3, AgNO3, KCl and $AgNO_3$ separately.

I. How would you identify these four solutions separately using HCl as the only chemical reagent ?
II. Indicate all balanced chemical equations to represent the above identification reactions.
III. Phosphene can be used to reduce Cu^{2+} to Cu metal. In here phosphene will be oxidized into H_3PO_4.
a) Write balanced oxidation and reduction half reactions
b) Give the balanced chemical equation.

(c) In an aqueous medium, the ionization constant, K_a of the weak monobasic acid HA is 1.8×10^{-5} mol dm^{-3} at 25° C. ($Kw = 1.0 \times 10^{-14}$ mol^2 dm^{-6})

I. Calculate the pH of a HA solution with an initial concentration of 0.5 mol dm^{-3}.
II. 1.0 dm^3 of that particular solution was diluted up to V dm^3 in order to double the hydrogen ion concentration.
a. Calculate the $H^+(aq)$ concentration of the diluted solution
b. Calculate the degree of dissociation of the diluted HA(aq)
c. Use the value obtained in b to calculate the volume V.