KATHMANDU UNIVERSITY
End Semester Examination [C]
May/June, 2019

Marks scored:

Level : B.E./B.Sc./B. Pharm./B.Tech.
Year : I

Course :CHEM 101
Semester : I

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Time: 30 mins

F. M. : 20

Registration No.:

Date 09 JUN 2019

SECTION "A"
[20Q. × 1 = 20 marks]

Choose the most appropriate answer.

1. One gram of a gaseous compound of carbon and hydrogen gave upon combustion 3.30 g CO_2 and 0.899 g H_2O. The ratio between "number of carbon atoms" and "number of hydrogen atoms" in that compound should be
[ ] 4/3 [ ] 2/3 [ ] 3/2 [ ] 3/4

2. The normal boiling point of diethyl ether, n-hexane, ethanol and water are 33.2 ^{0}C, 68 ^{0}C, 87.5 ^{0}C and 100 ^{0}C respectively. When 100 g of each solvent in separate vessels are heated to 30 ^{0}C, which solvent, among four possess the lowest vapor pressure?
[ ] water [ ] n-hexane [ ] diethyl ether [ ] ethanol

3. A pure NH_4Cl solution possessing 0.1 M chloride ion concentration will have pH of .....*[given hydrolysis constant, K_h for NH_4Cl is 5.5 ×10^{-10}]*
[ ] 5.1 [ ] 8.9 [ ] 1.0 [ ] 6.8

4. Precipitates of CaF_2 (K_{sp} = 1.7 × 10^{-10}) is obtained when equal volume of the following, Ca-ion and F-ion solutions are mixed together.
[ ] 10^{-4} M Ca^{2+} and 10^{-4} M F^-
[ ] 10^{-5} M Ca^{2+} and 10^{-3} M F^-
[ ] 10^{-2} M Ca^{2+} and 10^{-3} M F^-
[ ] 10^{-3} M Ca^{2+} and 10^{-5} M F^-

5. For the following reaction, which one of the given statement is correct?
$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$, ΔH = 43.5 kCal
[ ] $K_p = K_c RT$
[ ] on doubling the total pressure, more NO is formed
[ ] on increasing temperature, the value of K_p increases
[ ] on increasing concentration of O_2, the value of K_p increases

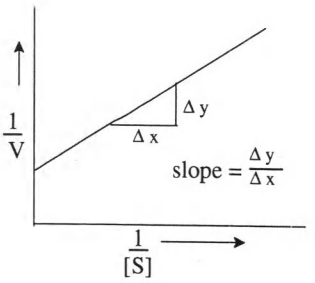
6. Which of the following statement is ***wrong*** about the given galvanic cell?
$Zn_{(s)} + Fe^{2+}_{(aq)} \rightleftharpoons Fe_{(s)} + Zn^{++}_{(aq)}$ ΔE = 0.32 V
[ ] zinc is the positive electrode
[ ] cell potential is affected by the concentration of Zn^{++} ions
[ ] electron flow from zinc to iron electrode
[ ] reduction occurs at cathode

7. An endothermic reaction A ⟶ Product, proceeds spontaneously at standard conditions. Which of the following is correct?
[ ] ΔH^0 is positive and $\Delta H^0 > \Delta S^0$
[ ] ΔS^0 and ΔH^0 both are negative
[ ] ΔS^0 is positive and $T\Delta S^0 > \Delta H^0$
[ ] ΔS^0 is negative and $T\Delta S^0 > \Delta H^0$

8. The step in chain reaction that produces more radicals or chain carriers than they consume is named as
[ ] chain initiation
[ ] chain propagation
[ ] chain branching
[ ] chain termination

9. For enzyme catalysis reaction, $E + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ES$

$ES \xrightarrow{k_2} E + P$



The slope of line obtained by plotting 1/rate vs 1/[substrate] is

[ ] $\frac{1}{k_2 [E_0]}$ [ ] $\frac{K_m}{k_2 [E_0]}$ [ ] $\frac{k_{-1} + k_2}{k_1}$ [ ] $\frac{k_1 \times k_2}{k_{-1}}$

10. Which of the following thermodynamic process is not feasible?
[ ] spontaneous isothermal expansion of ideal gas
[ ] reversible isothermal expansion of ideal gas
[ ] spontaneous isothermal compression of ideal gas
[ ] reversible isothermal compression of ideal gas

Fill in the blanks with most appropriate answer.

11. The ΔE^o for the reaction, $Fe_{(s)} + Zn^{++}_{(aq)} \rightleftharpoons Zn_{(s)} + Fe^{2+}_{(aq)}$ is - 0.32V. Equilibrium concentration of Fe^{++} when a piece of iron is placed in a 0.20M Zn^{++} ion solution is _____.

12. Which two among the following solutions possess equal osmotic pressure?
0.1 M NaCl solution, 0.2 M $CaCl_2$ solution , 0.3 M NaCl solution and 0.3 M $CaCl_2$ solution *(assume all salts are completely dissociated and produce ideal solution)*
i. _____ and *ii.* _____.

13. Potassium chlorate dissociates on heating as, $KClO_3(s) \xrightarrow{heat} KCl(s) + 3/2O_2(g)$. The mass of $KClO_3$ (MW 122.5) required to generate 0.637 liter of oxygen at 273 K and 1 atm pressure is _____ g.

14. PCl_5 with initial pressure 1.5 atm was dissociated into PCl_3 and Cl_2 at 300 ^{0}C, (*keeping the volume constant).* The total pressure at equilibrium becomes 2.84 atm. What will be the pressure of PCl_5 at equilibrium? _____.

15. The molar heat of fusion and sublimation of molecular iodine are 15.7 kJ/mole and 62.30 kJ/mole respectively. The molar heat of vaporization of liquid iodine is _____.

16. Phenol red is an acid type indicator whose dissociation can be written as

HIn **(Red)** + $H_2O \rightleftharpoons H_3O^+$ + In^- **(Yellow)** $K_I = \frac{[H_3O^+][In^-]}{[HIn]} = 1 \times 10^{-8}$.

When one drop of this indicator is added in 0.02M HCl solution, the colour will be _____.

17. Change in internal energy is equal to the heat added to the system if the _____ is constant.

18. The work done in the reversible process is always _____ than the irreversible process.

19. The unit of rate constant of a first order reaction is _____.

20. Non ideal solution formed by evolution of heat shows _____ deviation from Raoult's law.

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Time : 2 hrs. 30 mins.

Course : CHEM 101
Semester: I
F. M. : 55

SECTION "B"

Attempt *ANY FIVE* questions. ***(Question number 3 is compulsory)***

1.

a. What do you understand by the title "Principle of atom conservation"?
1.50 g of $BaBr_2$ when heated in a stream of chlorine gas gave 1.05 g $BaCl_2$. Calculate the atomic weight of Ba metal. *[AW Cl = 35.5 and AW Br = 79.90]* [3]

b. What types of ions will give hydrolysis reaction and why? Consider a reaction,
$HCOO^- + H_2O \rightleftharpoons HCOOH + OH^-$ [K_a of HCOOH is 1.8×10^{-4}]
(i) Write down the expression for hydrolysis constant.
(ii) Calculate the hydrolysis constant for the reaction at 25^0C.
[1+1+1]

2.

a. To a solution containing 0.1M Ca^{2+} and 0.1M Ba^{2+}, Na_2SO_4 is added slowly.
(K_{sp} $CaSO_4 = 2.4 \times 10^{-5}$ and K_{sp} $BaSO_4 = 1.0 \times 10^{-10}$)
(i) Which ion will precipitate first? [1]
(ii) Calculate the concentration of sulphate ion at the instant of precipitation of first precipitate and second precipitate. [1]
(iii) What concentration of ion (that start precipitation first) is remained in the solution before precipitation of second ion? [1]

b. What are colligative properties? How could you justify that the lowering of freezing point is a colligative property? [1+2]

3.

a. What are unimolecular and bimolecular process? Give one example for each. [2]

b. Benzene and toluene form nearly ideal solution. If mole fraction of benzene in the solution is 0.33 and vapour pressure of pure benzene and toluene are 75.0 mm and 22.0 mm respectively, calculate the composition of vapor in the unit of mole fraction. [3]

c. Consider the galvanic cell constructed by connecting two half cells at 25°C. [2]

$Mg^{2+} + 2\,e^- \longrightarrow Mg$ $\quad E^o = -2.36V$
$Ni^{2+} + 2e^- \longrightarrow Ni$ $\quad E^o = -0.25\ V$

(i) Write complete spontaneous reaction taking place at anode and cathode.
(ii) Calculate the cell potential (ΔE^0) at standard condition.
(iii) How does the potential of the cell change if concentration of Mg^{2+} is kept constant and concentration of Ni^{++} is changed?
(iv) Calculate potential of above cell if $[Ni^{2+}] = 0.1M$ & $[Mg^{2+}] = 0.01M$.

4.

a. Balance the following chemical equations using ion electron method. [3]
(*Indicate steps that are followed*)

(i) $ClO^- + CrO_2^- \longrightarrow CrO_4^{--} + Cl^-$ (basic medium)
(ii) $ClO_3^- + As_2S_3 \longrightarrow Cl^- + H_2AsO_4^- + SO_4^{--}$ (acidic medium)

b. A solution is prepared by adding 2.05 g of sodium acetate $NaC_2H_3O_2$ (MW 73) to 100 mL of 0.1 M acetic acid solution.
What is the resulting concentration of H_3O^+? [K_a of acid $= 1.85 \times 10^{-5}$] [3]

5.

a. Consider the reaction $C_2H_5I + OH^- \longrightarrow C_2H_5OH + I^-$,
$k = 5.03 \times 10^{-2}\ M^{-1}sec^{-1}$ at 289 ^{0}K and $k = 6.71\ M^{-1}sec^{-1}$ at 333 ^{0}K
(i) Calculate the activation energy of the reaction.
(ii) What is rate constant at 305 ^{0}K? [2]

b. At 375 ^{0}K equilibrium constant K_P of the reaction, $SO_2Cl_{2(g)} \rightleftharpoons SO_{2(g} + Cl_{2(g)}$ is 2.4 when the pressures are expressed in atmosphere. 6.7 g of SO_2Cl_2 are placed in a 1-litre bulb and temperature is raised to 375 ^{0}K. What would be the pressure of SO_2Cl_2 if none of it is dissociated? What are the pressures of SO_2, Cl_2 and SO_2Cl_2 at equilibrium? Calculate the fraction of dissociation for SO_2Cl_2. [1+2+1]

6.

a. The proposed reaction mechanism for the reaction $Cl_2 + CO \longrightarrow Cl_2CO$ is

$$Cl_2 + M \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2Cl + M \quad \text{(fast equilibrium)}$$

$$Cl + CO + M \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} ClCO + M \quad \text{(fast equilibrium)}$$

$$ClCO + Cl_2 \xrightarrow{k_3} Cl_2CO + Cl \quad \text{(slow)}$$

(i) Derive rate law equation. [2]
(ii) How experimental rate constant is related to elementary step rate constants? [1]

b. Define enthalpy of formation. Calculate the standard enthalpy of formation of $CH_{4(g)}$ from the following information. [1+2]

$C(s) + ½\ O_2(g) \longrightarrow CO_2(g)\ \Delta H_f^0 = -94.1$ kcal

$H_2(g) + ½\ O_2(g) \longrightarrow H_2O(l)\ \Delta H_f^0 = -68.3$ kcal

$CH_4(g) + 2\ O_2(g) \longrightarrow CO_2(g) + H_2O(l)\ \Delta H^0 = -212.8$ kcal

7.

a. Derive the relation $\Delta S_{(gas)} = nR \ln \frac{V_2}{V_1}$ and also justify that irreversible isothermal compression of ideal gas is not a feasible process. [2+2]

b. Find ΔH at 398 ^{0}K for the reaction $CO(g) + ½O_2(g) \longrightarrow CO_2(g)$ $\Delta H^0 = 67{,}640$ cal.
[$C_P(CO) = 6.97$, $C_P(O_2) = 7.05$ and $C_P(CO_2) = 8.96$] [2]

SECTION "C"

[3Q. × 8 = 24 marks]

Attempt *ANY THREE* questions.

8.

a. Write explanatory note on positive deviation from Raoult's law. [4]

b. What is a fuel cell? Explain about hydrogen oxygen fuel cell. Point out merits and demerits of hydrogen oxygen fuel cell. [1+2+1]

9.

a. Explain the working mechanism of basic buffer solution. [4]

b. How does reversible process differ from irreversible process? Show that the work done in isothermal expansion of gas is greater for irreversible process than the corresponding reversible process. [1+ 3]

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10.

a. (i) What are the important features of equilibrium state? [2]

(ii) How is the LeChatelier's principle applicable to get maximum yield of SO_3 in the following reaction? [2]

$$SO_2(g) + 1/2O_2(g) \rightleftharpoons SO_3(g) \qquad \Delta H = -23.5 \text{ Kcal}$$

b. Establish the relation between Gibb's free energy and electrical work for electrochemical cell. How is it useful to deduce Nernst equation? [3+1]

11.

a. Derive the relation $n\overline{G} - n\overline{G}^0 = n\,RT \ln P$. *(symbols have the usual meaning)* [3]

b. Derive differential and integrated rate law for first order reaction. [3]

c. What is a concentration cell? Give an appropriate example. [2]

12. Write short notes (*ANY TWO*): [4+4]

a. Chain reaction

b. Bronsted theory of acid and base

c. First law of thermodynamics