Technical University of Mombasa

Faculty of Applied and Health Sciences

DEPARTMENT OF **MEDICAL SCIENCES**

DIPLOMA IN PHARMACEUTICAL TECHNOLOGY
(DPT 12M)

ACH 2214: PHYSICAL CHEMISTRY II

SPECIAL/SUPPLEMENTARY: EXAMINATIONS

SERIES: February 2013

TIME: 2 HOURS

INSTRUCTIONS:

You should have the following for this examination
- *Answer booklet*

This paper consists of **THREE sections A, B and C.**
Answer all questions in section **A** and **B** and choose **THREE** out of **FIVE** questions in section **C.**

*This paper consists of **10 PRINTED** pages*

SECTION A (40MARKS)

1. For the following reaction of HOCl (hypochlorus acid) with matter;

$$HOCl_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + OCl^-_{(aq)}$$

What would be the effect of adding sodium hypochlorite (NaOCl) to the reaction equilibrium?

a) The concentrations of both HOCl and H_3O^+ would increase.
b) The concentrations of both HOCl and H_3O^+ would decrease
c) The concentration of HOCl would increase and the concentration of H_3O^+ would decrease
d) The concentration of HOCl would decrease and the concentration of H_3O^+ would increase

2. Given three separate solutions containing equal concentrations of formic acid (Ka = 1.7 x 10^{-4}) phenol (Ka = 1.3 x 10-10) and acetic acid (Ka = 1.8 x 10-5) select the response below that has the acids arranged in order of increasing percent dissociation at equilibrium.
   a) Formic < phenol < acetic
   b) Formic <acetic < phenol
   c) Acetic < formic < phenol
   d) Phenol < acetic < formic

3. From the following choices, which one is the strongest base?
   a) NH_4OH
   b) NaOH
   c) $Ba(OH)_2$
   d) $Mg(OH)_2$

4. Identify the acid that is monoprotic
   a) CH_3COOH
   b) H_2SO_4
   c) H_3PO_4
   d) H_2CO_3

5. A solution is basic when its pH is:
   a) Less than 7
   b) 7
   c) Greater than 7
   d) Between O and 7

6. Which one of the following is the strongest acid given the equilibrium dissociation constant value ?
   a) HF Ka = 7.2 x 10^{-4}
   b) HCl Ka = 1.0 x 10^{6}

c) HBr Ka = 1.0 x 10^{9}
d) HI Ka = 3.0 x 10^{9}

7. Which of the following weak acid dissociation constants would result in the smallest degree of dissociation?
   a) Ka = 1.0 x 10^{-2}
   b) Ka = 1.0 x 10^{-3}
   c) Ka = 1.0 x 10^{-3}
   d) Ka = 1.0 x 10^{-5}

8. In an acid-base filtration, the point at which an indicator changes colour is called the
   a) Endpoint
   b) Equivalence point
   c) Equilibrium point
   d) Half-equivalence point

9. The dissociation of an indicator in aqueous solution can be described as

$$HIn_{(aq)} \rightleftharpoons H^{+}_{(aq)} + In_{(aq)}$$

(yellow) Colourless (Blue)

In the presence of an acid , the colour of the resulting solution would be:
   a) Yellow
   b) Colourless
   c) Blue
   d) Yellow-Blue

10. Select the statement below that is correct
   a) All carbonates (CO_3^{2-}) are soluble
   b) All nitrates (NO_3^{-}) are soluble
   c) All hydroxides (OH^{-}) are soluble
   d) All chloride (Cl^{-}) are soluble

11. The addition of Ag^{+} ions into a solution containing NaCl would lead to the formation of
   a) A colourless solution
   b) A salty solution
   c) A white precipitation
   d) An emulsion

12. Given the following partially soluble salts and their solubility-product constants, which salt would be most soluble in water?
   a) AgCl, Ks.p = 1.8 x 10^{-10}
   b) AgBr, Ks.p = 5.0 x 10^{-15}
   c) AgI, Ks.p = 8.3 x 10^{-17}
   d) AuCl Ks.P = 2.0 x 10^{-13}

13. Addition of calcium nitrate to a saturated solution of calcium phosphate would:
   a) Have no effect on the solubility of calcium phosphate

b) Cause the solubility of calcium phosphate to decrease
c) Would cause the solubility of calcium phosphate to increase
d) None of the above

14. Which of the following hydroxides is least soluble in water?
a) $Ba(OH)_2$, Ks.p = 5.0×10^{-3}
b) $Ca(OH)_2$, Ks.p = 5.5×10^{-6}
c) $Ca(OH)_2$, Ks.p = 2.5×10^{-14}
d) $Zn(OH)_2$, Ks.p = 1.2×10^{-17}

15. What is the correct expression for the solubility product constant for the reaction

$$Bi_2S_3(s) \rightleftharpoons 2Bi^{3+}(aq) + 3S^{2-}(aq)$$

a) Ks.p = $[Bi^{3+}]^2 [S^{2-}]^3$
b) Ks.p = $[3Bi^{3+}]^2[2S^{2-}]^3$
c) Ks.p = $[2Bi^{3+}]^2 [3S^{2-}]^3$
d) Ks.p = $2[Bi^{3+}]^2[S^{2-}]^3$

16. The solubility of Ag_2S in pure water is 2.5×10^{-17}m. What is the solubility product constant for Ag_2S?
a) 6.3×10^{-24}
b) 2.5×10^{-17}
c) 6.2×10^{-50}
d) 1.6×10^{-50}

17. Chemical equilibrium involving reactants and products in more than one phase is called
a) Static
b) Dynamic
c) Homogeneous
d) Heterogeneous

18. The value of Kp is greater than Kc for a gaseous reaction when;
a) Number of molecules of products is greater than the reactants
b) Number of molecules of reactants is greater than the products
c) Number of molecules of reactants equal products
d) A catalyst is added

19. The homogeneous equilibrium constant in terms of pressure is denoted
a) Kc
b) K^1c
c) Kp

d) K^1p

20. A weak electrolyte undergoes
    a) Complete dissociation in water
    b) Partial dissociation in water
    c) Both (a) and (b)
    d) None of the above

21. The solubility of a solute in a solvent mainly depends on:
    a) Equilibrium conditions
    b) Temperature of solvent
    c) Surface tension of solvent
    d) Viscosity of solvent

22. A reaction whose rate is independent of the concentration of reactants is said to be:
    a) Zero order
    b) First order
    c) Second order
    d) Third order

23. The minimum amount of energy, in addition to average kinetic energy which the particles should have in order to have effective collision is called
    a) Collision frequency
    b) Energy barrier
    c) Activation energy
    d) Thermal energy

24. The collision theory stipulates that for products to be formed _____
    a) Reactants must collide with products
    b) Actuation energy need be towered
    c) Reactants must collide with each other in the right orientation
    d) Products must collide to form reactants and more products.

25. When rate of forward reaction equals rate of backward reaction, then the equilibrium established is called
    a) Chemical equilibrium
    b) Dynamic equilibrium
    c) Static equilibrium
    d) Physical equilibrium

26. For a reaction of the form
    $aA + bB \rightleftharpoons cC + dD$
    and rate law is given as rate = $K[A]^x[B]^y$

The overall order of the reaction is

a) x
b) y
c) x + y
d) x – y

27. The slope of the graph for reactants or products is _____ at the beginning of reaction.
    a) Slowest
    b) Steepest
    c) Vertical
    d) Horizontal

28. Identify the weakest electrolyte among the following
    a) KOH (aq)
    b) $NH_4OH(aq)$
    c) $Ca(OH)_2(aq)$
    d) $Mg(OH)_2(aq)$

29. A solute in a solution is the chemical species present in
    a) large amount
    b) Excess amount
    c) Small amount
    d) equal amount as the solvent

30. Which of the following affects the value of the equilibrium constant, Kc.
    a) Pressure
    b) Concentration of species
    c) Temperature
    d) Catalyst

31. The equilibrium position for an aqueous endothermic reaction can be charged to form more products by:
    a) Increasing temperature
    b) Describing temperature
    c) Increasing pressure
    d) Decreasing pressure

32. A chemical equilibrium reaction is said to be
    a) Reversible
    b) Irreversible
    c) Constant in all respects

d) None of the above

33. A neutralization reaction yields
a) Salts only
b) Water only
c) Water and salt only
d) None of the above

34. In pH scale , the base of the logarithm of molar concentration of H3O+ is
a) 10
b) 100
c) 2
d) 3

35. Generally, pH + pOH
a) 7
b) 0
c) 14
d) -14

36. According to Arrhenius, an acid is a species that dissolves in water to form
a) H^+
b) OH^-
c) O^{2-}
d) NH_4^+

37. What are the writes of reaction rate?
a) M
b) MS^{-1}
c) SM^{-1}
d) $S^{-1}M^{-1}$

38. A solution is neutral when its pH is
a) O
b) 7
c) -7
d) None of the above

39. The pH of a basic solution is
a) 7
b) more than 7
c) less than 7
d) none of the above

40. The pH of an acidic solution is
    a) 7
    b) More than 7
    c) Less than 7
    d) none of the above

SECTION B (Answer ALL questions)

41. Differentiate between valency and oxidation number **(4marks)**

42. Determine the oxidation number of Cr in $Cr_2O_7^{2-}$ **(4marks)**

43. Calculate the molarity of a solution made by dissolving 12g NaOH in 500ml deionized water. (molar mass of NaOH = 40glmol). **(4marks)**

44. What is the pOH of a solution made by dissolving 0.1M HCl **(4marks)**

45. The reaction between acetic acid (CH3COOH) with water is given as

$$\underset{(aq)}{CH_3COOH} + \underset{(l)}{H_2O} \rightleftharpoons \underset{(aq)}{CH_3COO^-} + \underset{(aq)}{H_3O^+}$$

Explain the effect of adding a solution containing H+ ions to the equilibrium **(4marks)**

46. Differentiate between bronsted acid and bronsted base. **(4marks)**

47. By the use of oxidation number, state which species undergo oxidation or reduction in the following reaction

$$\underset{(s)}{Zn} + \underset{(l)}{H_2O} \longrightarrow \underset{(s)}{ZnO} + \underset{(q)}{H_2}$$

(4marks)

48. You need to prepare as 0.0250M solution of $KMnO_4$ for an experiment. How many grams of $KMnO_4$ should be added wit sufficient distilled water to a 1.00l volumetric flask to give the desired solution. (Molar mass of $KMnO_4$) = 158.03 g/mol) **(4marks)**

49. Briefly define the following
    a) Strong base **(2marks)**
    b) Weak electrolyte **(2marks)**

50. What is the pH of 0.02M KOH solution **(4marks)**

SECTION C

51. a) The equilibrium constant for the reaction

$$2NO_2 \rightleftharpoons N_2O_4$$ at 29 & K is 200mol dm^{-3}.

    i) Write an expression for the equilibrium constant Kc for the reaction **(2marks)**
    ii) If $[N_2O_4] = 2.0 \times 10^{-2} molm^{-3}$, what is the $[NO_2]$ in the equilibrium mixture at this temperature. **(4marks)**

    b) At 200˚C, Kc for the reaction

$PCl_5 \rightleftharpoons PCl_3 + Cl_2$ $\Delta H^\circ = +124KJ$ has a numerical value of 8×10^{-3}

i) Write an expression for Kc for this reaction **(2marks)**

ii) What are the units of Kc **(2marks)**

iii) Predict what will happen to the reaction when:

a) More PCl_5 is added **(2marks)**

b) The pressure is increased **(2marks)**

c) The temperature is increased **(2marks)**

iv) A sample of pure PCl_5 was introduced into an evacuated vessel at 200˚C. When equilibrium was obtained, the concentration of PCl_5 was 0.5×10^{-1} $moldm^{-3}$. What are the concentrations of PCl_3 and Cl_2 at equilibrium? **(4marks)**

52. i) Explain the following terms

a) order of reaction **(2marks)**

b) Rate constant **(2marks)**

c) Half-life **(2marks)**

ii) Metallic copper and dilute nitric acid react according to this redox equation.

$Cu_{(s)} + HNO_{3(aq)} \longrightarrow Cu(NO_3)_{2(aq)} + NO_{(g)} + H_2O_{(l)}$

a) Balance the equation **(3marks)**

b) Assign oxidation numbers for each atom in the equation **(5marks)**

c) Identify which element has been oxidized and which has been reduced **(2marks)**

53. i) For each of the following , does the oxidation number increase or decrease in the course of a redox reaction?

a) An Oxidizing agent **(2marks)**

b) A reducing agent **(2marks)**

c) A substance undergoing oxidation **(2marks)**

d) A substance undergoing reduction **(2marks)**

ii) 4.90grams of pure H_2SO_4, solution was dissolved in water, the resulting total volume was $250cm^3$. $21cm^3$ of this solution was found on titration to completely neutralize $10cm^3$ of NaOH solution (S=32, H =1 and O =16)

a) Write a balanced equation for the titration reaction **(4marks)**

b) Calculate the molarity of the H_2SO_4 solution **(4marks)**

c) Calculate the moles of H_2SO_4 solution neutralized **(2marks)**

d) Calculate the moles of NaOH neutralized **(2marks)**

e) Calculate the molarity of NaOH solution **(2marks)**