



THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of JKUAT)
(A Centre of Excellence)

Faculty of Applied & Health Sciences

DEPARTMENT OF MEDICAL SCIENCES

DIPLOMA IN PHARMACEUTICAL TECHNOLOGY
(DPT 12J)

ACH 2214: PHYSICAL CHEMISTRY

END OF SEMESTER EXAMINATION

SERIES: AUGUST 2012

TIME: 3 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer Booklet*

Attempt **ALL** questions in section **A** by choosing the correct answer

Attempt **ALL** question in section **B** and any **TWO** question on section **C**

This paper consists of **NINE** printed pages

SECTION A (ANSWER ALL QUESTIONS – 1 MARK EACH)

- Which of the following is not consistent about redox reactions:
 - A redox reaction involves oxidation and reduction half reactions
 - A redox reaction may be viewed in terms of oxygen transfer among reactants
 - A redox reaction may be viewed in terms of electron transfer
 - A redox reaction may not involve hydrogen transfer
- Which of the following is not consistent about solubility
 - It is dependent on temperature
 - It is independent of temperature
 - It depends on the nature of solute
 - It depends on the nature of solvent
- The value of the equilibrium constant K_c for a given reaction is only dependent on:
 - Catalyst
 - Temperature
 - Concentration of species involved
 - Pressure
- An aqueous solution can best be defined as:
 - A homogeneous mixture
 - A heterogeneous mixture
 - A mixture of solute and solvent system of large molar mass
 - A uniform mixture where the solute is initially liquid or solid and the solvent is water
- Which of the following statements about the kinetics of the reaction.
$$\text{H}_{2(g)} + \text{Br}_{2(g)} \rightarrow 2\text{HBr}_{(g)}$$
 is definitely true? Given that $\text{Rate} = K [\text{Br}_2] [\text{H}_2]^2$
 - The reaction is first order with respect to bromine, Br_2
 - The reaction is second order overall
 - The presence of hydrogen bromide, HBr , inhibits the rate of the reaction
 - It is not possible to determine anything about the kinetics of the reaction from the stoichiometry
- Calculate the concentration of hydronium, H_3O^+ , ions in a solution whose $\text{PH} = 4.3$.
 - $2.0 \times 10^3 \text{ moldm}^{-3}$
 - $5.0 \times 10^{-5} \text{ moldm}^{-3}$
 - $14 \times 10^{-3} \text{ moldm}^{-3}$
 - 74 moldm^{-3}
- Calculate the concentration of OH^- ions in a solution whose $\text{PH} = 12.1$
 - 79.4 moldm^{-3}
 - $7.94 \times 10^{-13} \text{ moldm}^{-3}$
 - 1.90 moldm^{-3}

- d) $0.0126 \text{ mol dm}^{-3}$
8. Calculate the P^{H} of an aqueous solution of HCN acid of concentration 0.088M . The acidity constant for HCN is 4.9×10^{-10} .
- 6.57
 - 8.82
 - 5.18
 - 7.43
9. In a titration, 2.7cm^3 of 0.1M NaOH is added to 25.0cm^3 of 0.125M benzoic acid ($\text{C}_6\text{H}_5\text{COOH}$), solution. Calculate the PH of the resulting solution given that the PKa of benzoic acid is 4.19.
- 3.13
 - 5.25
 - 1.74
 - 6.67
10. Calculate the concentration of Cl^- ions in an aqueous solution formed by adding PbCl_2 to water. The solubility constant of PbCl_2 is $1.6 \times 10^{-5} \text{ mol dm}^{-3}$.
- $0.025 \text{ mol dm}^{-3}$
 - $0.004 \text{ mol dm}^{-3}$
 - $0.032 \text{ mol dm}^{-3}$
 - $0.050 \text{ mol dm}^{-3}$
11. During a chemical reaction the concentration of reactions:
- Does not change
 - Increases
 - Decreases
 - May increase
12. Chemical equilibrium establishes if a reaction takes place in:
- A closed system
 - An open system
 - Gaseous state
 - Liquid state
13. The decrease in concentration of reactants _____ as the increase in the concentration of products.
- May be the same
 - Is the same
 - Is not the same
 - May not be the same
14. _____ suggested a theory based on the transfer of hydrogen ion for defining acids and bases.
- Arrhenius
 - Bronsted
 - Lowry
 - Lewis

15. Hydrogen ion concentration is equal to hydroxyl ion concentration in.
- Pure water
 - Sodium hydroxide
 - Hydrogen chloride
 - CH_3COOH
16. The concentration of H^+ ion in pure water is:
- $1.0 \times 10^{-7} \text{ mol dm}^{-3}$
 - $-7.0 \times 10^1 \text{ mol dm}^{-3}$
 - 7.0 mol dm^{-3}
 - $7.0 \times 10^1 \text{ mol dm}^{-3}$
17. The P^{H} of an acidic solution is:
- 7
 - More than 7
 - Less than 7
 - Negative
18. The PH of basic solution is:
- 7
 - More than 7
 - Less than 7
 - Negative
19. A solution is neutral when its P^{H} is:
- 0
 - 7
 - 7
 - 10^{-7}
20. What is the unit of the rate of a reaction?
- Molar
 - Second
 - Molar/second
 - Mole/second
21. Which ion from the following is released from an acid according to Arrhenius theory?
- H^+
 - OH^-
 - N^-
 - O^{2-}
22. In PH scale the base of the logarithm of molar concentration of H_3O^+ is:
- 10

- b) 20
- c) 50
- d) 100

23. The reaction between an acid and a base is _____ reaction.

- a) Chlorination
- b) Hydrolysis
- c) Neutralization
- d) Hydrogenation

24. $p^H + p^{OH} =$ _____

- a) 0
- b) 7
- c) 14
- d) Between 0 and 7

25. What happens when a catalyst is added to a system at equilibrium?

- a) The reaction follows an alternative pathway of lower activation energy
- b) The heat of reaction decreases
- c) The potential energy of the reactions decreases
- d) The rate of chemical reaction decreases

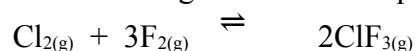
26. Identify the incorrect statement below regarding chemical equilibrium.

- a) All chemical reactions are, in principle, reversible
- b) Equilibrium is achieved when the forward reaction rate equals the reverse reaction rate.
- c) Equilibrium is achieved when the reaction quotient, Q , equals the equilibrium constant
- d) Equilibrium is achieved when reactant and product concentrations are equal.

27. The following reaction is at equilibrium. $CF_2Br_2 \rightleftharpoons CF_2 + 2Br$ $\Delta H = +424KJ/mol$. How will the system respond if the temperature is decreased?

- a) The reaction will shift to the left
- b) The reaction will shift to the right
- c) The reaction will shift right then shift left
- d) There will be no change to the equilibrium position

28. The following reaction is at equilibrium.



How will the system respond if the volume is increased at constant temperature?

- a) The reaction will shift to the left
- b) The reaction will shift to the right
- c) There will be no change to the equilibrium position
- d) The pressure will increase forcing the reaction to shift left.

29. Which one of the following is the strongest Arrhenius base given the degree of ionization?

- a) $Zn(OH)_2$, = 1%
- b) $LiOH$, = 100%
- c) $Fe(OH)_2$, = 2%
- d) $Ba(OH)_2$, = 90%

30. Identify the weakest electrolyte among the following;
- KOH
 - NH_4OH
 - $\text{Ca}(\text{OH})_2$
 - $\text{Mg}(\text{OH})_2$
31. If a reaction consists of a series of steps, the _____ is the rate determining step.
- Specific rate constant
 - Smallest
 - Slowest
 - Fastest
32. The slope of the graph for reactions or products is _____ at the beginning of a reaction.
- Slowest
 - Steepest
 - Vertical
 - Horizontal
33. The _____ of a reaction has units of concentration divided by time.
- Rate constant
 - Order
 - Rate
 - Kinetics
34. The sum of all the exponents to which the concentrations in a rate equation are raised is called:
- May or may not be the same
 - Order of reaction
 - Specific rate constant
 - Equilibrium constant
35. A reaction is _____ order if it is entirely independent of the concentration of reactants.
- Zero
 - First
 - Second
 - Third
36. The minimum amount of energy in addition to average kinetic energy which the particles should have in order to have effective collision is called:
- Collision frequency
 - Energy barrier
 - Activation energy
 - Thermal energy

37. When rate of forward reaction is equal to the rate of backward reaction, then the equilibrium established is called:
- Chemical equilibrium
 - Dynamic equilibrium
 - Static equilibrium
 - Physical equilibrium
38. Chemical equilibrium involving reactants and products in more than one phase is called:
- Static equilibrium
 - Dynamic equilibrium
 - Homogeneous equilibrium
 - Heterogeneous equilibrium
39. The value of K_p is greater than K_c for a gaseous reaction when:
- Number of molecules of products is greater than reactants.
 - Number of molecules of reactants is greater than the products
 - Number of molecules of reactants equal products
 - A catalyst is added
40. The equilibrium constant in terms of pressure is denoted:
- KC_1
 - K^1_c
 - K_p
 - K^1_p

SECTION B (ATTEMPT ALL QUESTIONS)

41. What is the pH of a 0.25M NaOH solution? **(4 marks)**
42. Given the molar concentration of hydroxide ion, $[OH^-] = 4.6 \times 10^{-13}$, calculate the concentration of hydrogen ion, $[H^+]$ **(4 marks)**
43. Briefly discuss each of the following:
- Bronsted base **(2 marks)**
 - Bronsted acid **(2 marks)**
44. Classify each of the following species in aqueous solutions as bronsted base or acid. Explain.
- HBr **(2 marks)**
 - NO_2^- **(2 marks)**

Use the following reaction to answer question 45 and 46.



45. State and explain the observations made in the above reaction. **(4 marks)**
46. From the reaction above, identify the:

a) Oxidizing agent (2 marks)

b) Reducing agent (2 marks)

47. Indicate changes in the oxidation numbers of elements in the following reaction.



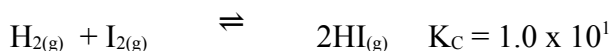
48. How many gram of potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) are required to prepare a 250ml solution whose concentration is 2.16M? (4 marks)

49. Describe how you would prepare 500ml of a 1.75M H_2SO_4 solution, starting with an 8.62M stock solution of H_2SO_4 . (4 marks)

50. Determine the volume of a 0.610M NaOH solution need to neutralize 20.0ml of 0.245M H_2SO_4 solution. (4 marks)

SECTION C (ATTEMPT ANY TWO QUESTIONS)

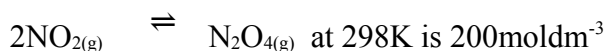
51. (a) The equilibrium constants for the synthesis of HCl, HBr and HI in a particular temperature are given below:



i) What do the values of K_C tell you about the extent of each reaction? (6 marks)

ii) Which of these reactions would you regard as virtually complete conversion? Explain your answer. (4 marks)

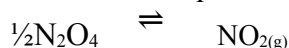
(b) The equilibrium constant for the reaction.



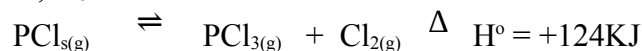
i) Write an expression for the equilibrium constant for the reaction. (2 marks)

ii) If the $[\text{N}_2\text{O}_4] = 2.0 \times 10^{-2} \text{ mol dm}^{-3}$ at 298K, what is the concentration of NO_2 ? (5 marks)

iii) Calculate the equilibrium constant at 298K for the reaction. (3 marks)



52. (a) At 200°C, K_C for the reaction



Has a numerical value of 8.0×10^{-3}

i) Write an expression for K_C for this reaction. (2 marks)

ii) What are the units of K_C , (1 marks)

iii) What is the value of K_C for the reverse reaction at 200°C and what are its units? **(1 mark)**

iv) Predict what will happen to the reaction when:

- a) More PCl_5 is added. **(2 marks)**
- b) The pressure is increased **(2 marks)**
- c) The temperature is increased **(2 marks)**

v) 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 $0.5 \times 10^{-1} \text{ mol dm}^{-3}$. What are the concentrations of PCl_3 and Cl_2 at equilibrium? **(4 marks)**

(b) What is the PH of a 0.40 mol dm^{-3} ammonia solution (NH_4OH) given that K_b for ammonia? solution is $1.8 \times 10^{-5} \text{ mol dm}^{-3}$ at 25°C **(6 marks)**

53. (a) Benzoic acid ($\text{C}_6\text{H}_5\text{COOH}$), is a weak monobasic acid, ($K_a = 6.4 \times 10^{-5} \text{ mol dm}^{-3}$)

i) Explain how a mixture of benzoic acid and sodium benzoate ($\text{C}_6\text{H}_5\text{COONa}$) can act as a buffer on the addition of small amounts of either $\text{HCl}_{(\text{aq})}$ or $\text{NaOH}_{(\text{aq})}$ **(3 marks)**

ii) What is the hydrogen ion concentration in 0.02 mol dm^{-3} benzoic acid? **(2 marks)**

iii) What is the P^{H} of 0.02 mol dm^{-3} benzoic acid? **(2 marks)**

iv) What is the P^{H} of a solution containing 7.2g of sodium benzoate in 1L solution of 0.02 mol dm^{-3} benzoic acid? **(4 marks)**

v) By how much will the PH change if 1 cm^3 of 1.0 mol dm^{-3} NaOH is added to the buffer in part (d) above? **(3 marks)**

(b) Explain the following terms:

- i) Rate constant **(3 marks)**
- ii) Activated state **(3 marks)**