SIR ARTHUR LEWIS COMMUNITY COLLEGE

ACADEMIC YEAR (2024/2025) – SEMESTER TWO

END OF SEMESTER EXAMINATION

ALTERNATE

COURSE CODE	:	**CHM115**
COURSE TITLE	:	**Foundations in Chemistry**
LECTURER(S)	:	**Jada-Ann Vite´**
DATE	:	
TIME	:	
DURATION	:	**2 Hours**
STUDENT ID #	:	_____

GENERAL INFORMATION AND INSTRUCTIONS

- Students must sign **IN** and **OUT** on the examination class list.
- Write your ID number on the question paper.
- This paper has 2 compulsory sections and a periodic table. Answer ALL questions on this paper.
- Section 1 consists of 60 multiple choice questions.
- Section 2 consists of 2 short answer questions.

Section	Number	Marks Earned	Moderated Mark	Maximum Marks
Section 1	1-60			60
Section 2	1			8
	2			12
Total				80

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

Section A – Multiple Choice Questions.

Instruction: This section has 60 questions each worth ONE (1) mark. Answer all questions in this section. Circle the correct answer.

1. Which of the following is different in isotopes?
   A. Atomic number
   B. Chemical properties
   C. Mass number
   D. Number of protons

2. What is the molarity of 100 mL of solution in which 3.0 moles of sodium bromide is dissolved?
   A. 2.0M
   B. 0.40M
   C. 30M
   D. 3.0M

3. What mass of Na_2SO_4 is needed to make 2.5 dm^3 of 2.0M solution?
   (Na = 23 g; S = 32 g; O = 16 g)
   A. 178 g
   B. 356 g
   C. 284 g
   D. 710 g

4. What is the number of moles of solute in 250 cm^3 of a 0.6M solution?
   A. 0.15 mol
   B. 0.62 mol
   C. 0.18 mol
   D. 2.4 mol

5. How many grams of NaOH are needed to prepare 250 mL of a 0.5 M solution?
   A. 5.0 g
   B. 10.0 g
   C. 15.0 g
   D. 20.0 g

6. Which one of the following is not a form of chemical bonding?
   A. covalent bonding
   B. hydrogen bonding
   C. ionic bonding
   D. metallic bonding

7. There are two stable isotopes of bromine. The mass number of isotope 1 is 79. The mass number of isotope 2 is 81. Which statement is correct?
   A. The isotopes have the same number of neutrons.
   B. The isotopes have different chemical properties.
   C. The isotopes have different numbers of protons.
   D. The isotopes have the same number of outer electrons.

8. Which of the following places the atomic subshells in the correct order of relative energy, starting with the subshell of lowest energy?
   A. d, p, s
   B. s, d, p
   C. s, p, d
   D. p, s, d

9. Which one of the following is a linear molecule?
   A. $BeCl_2$
   B. BF_3
   C. CH_4
   D. H_2O

10. Which of the following terms is not involved in the ideal gas law?
   A. Pressure
   B. Volume
   C. Temperature
   D. Time

11. Which of the following is not true about ideal gas molecules?
   A. They have negligible size
   B. They do not have attractive forces
   C. They do not apply pressure
   D. They move in random motion

12. Colligative properties are all similar in that they all
   A. were discovered in college laboratories.
   B. are due to solvent molecules linked together.
   C. have no harmful side effects.
   D. depend on the concentration of particles in solution.
   E. involve pressure.

13. Which of the following is not a trigonal planar molecule?
   A. $AlCl_3$
   B. AlH_3
   C. BF_3
   D. NH_3

14. A crystal is placed in a solution and it does not dissolve. The solution must have been
   A. unsaturated.
   B. saturated.
   C. supersaturated.
   D. dilute.
   E. concentrated.

15. When the system A + B < ------ > C + D is at equilibrium,
   A. the sum of the concentrations of A and B must equal the sum of the concentrations of C and D.
   B. the forward reaction has stopped.
   C. both the forward and the reverse reactions have stopped.
   D. neither the forward nor the reverse reaction has stopped.

16. $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$
   The conventional equilibrium constant expression (K_c) for the system as described by the above equation is:
   A. $[SO_2]^2/[SO_3]$
   B. $[SO_2]^2[O_2]/[SO_3]^2$
   C. $[SO_3]^2/[SO_3]^2[O_2]$
   D. none of these

17. Suppose that the following endothermic reaction is at equilibrium:

$$2CO\ (g) + O_2(g) \rightleftharpoons 2CO_2(g)$$

Which of the following changes would cause the reaction to shift toward products?

A. Remove CO (g).
B. Increase the temperature.
C. Increase the volume of the container.
D. Remove O_2 (g)

18. What does it indicate having a higher equilibrium constant?
A. reaction occurs faster
B. rate of backward reaction is faster
C. both the backward and forward reactions are equal
D. reaction may be slower than usual

19. At equilibrium, _____.
A. the rates of the forward and reverse reactions are equal
B. the rate constants of the forward and reverse reactions are equal
C. all chemical reactions have ceased
D. the value of the equilibrium constant is 1
E. the limiting reagent has been consumed

20. Le Chatelier's principle applies to :
A. only homogeneous chemical reversible reactions
B. only heterogeneous chemical reversible reactions
C. only physical equilibria
D. all systems, chemical or physical in equilibrium.

21. Consider the equilibrium system:

$2ICl(s) \rightleftharpoons I_2(s) + Cl_2(g)$

Which of the following changes will increase the total amount of Cl_2 that can be produced?
A. removing some of the I_2(s)
B. adding more ICl(s)
C. removing the Cl_2 as it is formed
D. decreasing the volume of the container
E. all of the above

22. Consider the reversible reaction at equilibrium at 392ºC:

$2A(g) + B(g) \rightleftharpoons C(g)$

The partial pressures are found to be: A: 6.70 atm, B: 10.1 atm, C: 3.60 atm. Evaluate K_p for this reaction.
A. 7.94×10^{-3}
B. 0.146
C. 0.0532
D. 121

23. Which of the following is not a strong acid?

A. Hydrochloric acid
B. Nitric acid
C. Sulfuric acid
D. Hydrofluoric acid

24. What is the constant in ideal gas equation known as?
A. Universal gas constant
B. Pressure constant
C. Temperature constant
D. Boltzmann constant

25. If the air inside a balloon is heated, the volume will:
    A. Increase
    B. Decrease
    C. Increase a little, then decrease.
    D. Decrease a little, then increase

26. Under conditions of fixed temperature and amount of gas, Boyle's law requires that
    I. $P_1V_1 = P_2V_2$
    II. PV = constant
    III. $P_1/P_2 = V_2/V_1$
    A. I only
    B. II only
    C. III only
    D. I, II, and III
    E. another combination

27. To use Charles' Law, which of the following needs to remain constant?
    A. Pressure and the number of moles of a gas
    B. Pressure and temperature
    C. Temperature and the number of moles of a gas
    D. Temperature and volume

28. A sample of hydrogen has a volume of 25 L under a pressure of 5 atm. What would the pressure of this gas be if the volume were decreased to 5 L?
    A. 25 atm
    B. 15 atm
    C. 10 atm
    D. 5 atm

29. T1/P1 = T2/P2 is Charles's Law
    A. True
    B. False

30. There are 65 liters of helium in a balloon at 35 K. If the temperature of the balloon is increased to 40 K, what will the new volume of the balloon be?

    A. 40 L
    B. 70 L
    C. 74.3 L
    D. 75.9 L

31. 1000 mL of a gas is cooled from 500 K to 250 K. What is its final volume?
    A. 500 mL
    B. 1000 mL
    C. 250 mL
    D. 2000 mL
    E. 750 mL

32. Which radiation is the easiest to shield?
    A. alpha radiation
    B. beta radiation
    C. gamma radiation
    D. neutron radiation

33. Radiation can be a hazard to living organisms because it
    A. produces ionization along its path of travel.
    B. disrupts chemical bonds.
    C. generates free polyatomic ions.
    D. all of the above.

34. Household ammonia has a $[H^+]$ of $1x10^{-12}$. How do you classify household ammonia?
    A. Acid
    B. Base
    C. Salt
    D. Neutral

35. For the following reaction, which of the following is an acid-conjugate base pair?

$$HC_2O_4^-(aq) + H_2O\ (l) < \text{-------} > H_3O^+\ (aq) + C_2O_4^{2-}(aq)$$

    A. $HC_2O_4^-$ and H_2O
    B. H_2O and $C_2O_4^{2-}$
    C. $HC_2O_4^-$ and H_3O^+
    D. $HC_2O_4^-$ and $C_2O_4^{2-}$

36. Which of the following is a characteristic of a strong acid?
    A. It dissociates partially in solution.
    B. It has a high pH.
    C. It dissociates completely in solution.
    D. Both B and C are correct.

37. This buffer system in the blood help maintain the pH at 7.35.
    A. Carbonic bicarbonate buffer
    B. Carboxylic acid and sodium carboxylate
    C. Sodium hydroxide and ethanoic acid
    D. Carbohydrate buffer

38. A Brønsted-Lowry acid is defined as _____, while a Brønsted-Lowry base is defined as _____.
    A. An H^+ donor; an H^+ acceptor
    B. An H^+ acceptor; an H^+ donor
    C. An H^+ donor; an OH^- acceptor
    D. An H^+ acceptor; an OH^- donor

39. Half-lives of radioactive isotopes are
    A. very short.
    B. very long.
    C. range from seconds to days.
    D. vary from shorter than a millisecond to millions of years.

40. Natural radiation from radioactive elements consists of
    A. protons and neutrons.
    B. alpha, beta, or gamma rays.
    C. mesons.
    D. baryons, leptons, and quarks.

41. Catenation is a property of the carbon atom which describes its ability to
    A. bond with other carbon atoms
    B. form double and triple bonds
    C. exist in plant and animal form
    D. form bonds in its ground state

42. Compounds with the same molecular formula but different structural formulas are called
    A. Alkoxides
    B. Iso compounds
    C. Isomers
    D. Ortho compounds

43. Hydrocarbons are
    A. insoluble in water
    B. composed of carbon and hydrogen
    C. both (a) and (b)
    D. None of these

44. What is the value of the equilibrium constant for the reaction
    H_2 (g) + I_2 (g) < ----- > 2HI if the equilibrium mixture contains 0.092M H_2, 0.023M I_2, and 0.056M HI?
    A. 0.015
    B. 0.15
    C. 1.5
    D. 15
    E. 150

45. In the following reaction, which is a Brønsted-Lowry base?
    $HC_2O_4^-$(aq) + H_2O (l) ---------- H_3O^+ (aq) + $C_2O_4^{2-}$(aq)
    A. H_2O
    B. $HC_2O_4^-$
    C. H_3O^+
    D. None of these

46. How many optical isomers are possible for 2-hydroxypropanoic acid?
    A. 2
    B. 4
    C. 6
    D. 8

47. Ethanol (CH_3CH_2OH) and dimethyl ether (CH_3OCH_3) are best considered:
    A. structural isomers
    B. stereoisomers
    C. enantiomers
    D. diastereomers

48. How many isomers are possible for the compound with molecular formula C_4H_8?
    A. 2
    B. 4
    C. 6
    D. 8

49. Alkenes show geometrical isomerism due to:
    A. Asymmetry
    B. Rotation around a single bond
    C. Resonance
    D. Restricted rotation around a double bond

50. Which of the following compounds may exist as cis-trans isomers?
    A. 1-Butene
    B. 2-Butene
    C. Cyclopropane
    D. Acetone

51. A molecule is said to be chiral
    A. if it contains plane of symmetry
    B. if it contains centre of symmetry
    C. if it cannot be superimposed on its mirror image
    D. if it can be superimposed on its mirror image

52. An optically active compound
    A. must contain at least four carbons
    B. when in solution rotate the plane of polarized light
    C. must always contain an asymmetric carbon atom
    D. in solution always give a negative reading in polarimeter.

53. For a specific reaction, which of the following statements can be made about K, the equilibrium constant?
    A. It always remains the same at different reaction conditions.
    B. It increases if the concentration of one of the products is increased.
    C. It changes with changes in the temperature.
    D. It may be changed by the addition of a catalyst.

54. Which statement is false?
    A. Many alkanes are soluble in water.
    B. All alkanes have a lower density than water.
    C. At room temperature some alkanes are liquids, some solids, some gases.
    D. All alkanes burn.

55. The combustion of one mole of propane, C_3H_8, produces how many moles of H_2O?
    A. 2
    B. 3
    C. 4
    D. 5.

56. Which of the following reagents will react with propene?
    A. Hot alkaline $KMnO_4$
    B. Sodium metal
    C. Cold dilute HNO_3
    D. $LiAlH_4$

57. Which of the following will give a negative test when treated with bromine in carbon tetrachloride?
    A. Butane
    B. 2-Butene
    C. Pent-2-ene
    D. Propene

58. What is the functional group in a carboxylic acid?
    A. Carbon-carbon double bond
    B. NH_2
    C. OH
    D. COOH

59. In the conversion of wine to vinegar
    A. Ethanol is oxidized to acetic acid
    B. Ethanol is reduced to acetic acid
    C. Methanol is oxidized to acetic acid
    D. Methanol is reduced to acetic acid

60. The appearance of a silver mirror in Tollens' test indicates the presence of:
    A. an aldehyde
    B. a ketone
    C. an alcohol
    D. an alkene

Section B – Short Answer Questions.

Instruction: Answer all the questions in the spaces provided.

Question 1 **[8 marks]**

(a) The statement below lists some physical properties of a pair of substances.

- Identify the types of forces operating.
- Account for any differences in the strengths of these forces and relate the nature and strength of the forces to the properties indicated in each pair.

CO_2 and SiO_2 are both covalent molecules. However, CO_2 is a gas and SiO_2 is a solid with a high melting point.

(4)

(b) State the equation for the general gas law.

(1)

(c) According to Charles' Law, what happens to the volume of a gas when temperature increases at constant pressure?

(1)

(d) The volume of a gas is 4.0 L at 300 K. If the temperature increases to 600 K at constant pressure, what is the new volume?

(2)

Question 2 **[12 marks]**

(a) Explain the effect of temperature and concentration on a system at equilibrium using Le Chatelier's Principle.

(2)

(b) Using the following equilibrium, state what would happen to the equilibrium concentration of CH3OH gas when each of the following changes are made:

$CO(g) + 2H_2(g) \leftrightharpoons CH_3OH(g)$ $\Delta H = -75.2$ kJ

i. CO gas is added to the container

(1)

ii. The temperature is increased.

(1)

iii. The total pressure of the system is increased.

(1)

iv. H_2 gas is removed from the system

(1)

v. A catalyst is added

(1)

vi. The total volume of the container is increased.

(1)

vii. Write the equation for the equilibrium constant, K_c for the reaction.

(1)

(e) What is the pH of 0.0040 $moldm^{-3}$ HCl (aq)?

(2)

(f) Explain what is meant by the term dynamic equilibrium.

(1)

END OF EXAMINATION