

THE UNIVERSITY OF ZAMBIA

IN ASSOCIATION WITH

TECHNICAL AND VOCATIONAL TEACHERS' COLLEGE

DIPLOMA IN MATHEMATICS AND CHEMISTRY TEACHER EDUCATION

SUBJECT: CHEMISTRY (CH 335)

FINAL EXAMINATION

April, 2020

TIME ALLOWED: 3 HOURS

INSTRUCTIONS TO CANDIDATES:

1. **DO NOT** turn the paper until you are told to do so.
2. Answer **ALL** the questions in section A and B
3. . Attempt any **Two (02)** questions in section C
4. Cell phones and programmable calculators are not allowed in the examination room

SECTION A- 20 marks

There are twenty multiple choice questions in this section and each question carries 1 mark. Pick the most appropriate and indicate the letter in the provided booklet.

Question 1

Which of the following processes is quantitative in nature?

- a) Distillation
- b) Chromatography
- c) Precipitation
- d) Gravimetric analysis

Question 2

Which of the following does not affect the rate of a chemical reaction?

- a) Surface area of solid reactants
- b) Concentration of liquid reactants
- c) Pressure of a gaseous reactant
- d) Density of a solid reactant

Question 3

The rate of a certain reaction was established to be; $Rate = C^2D$, where C and D are concentrations of the reactants. What is the order of this reaction?

- a) First order
- b) Second order
- c) Third order
- d) Fourth order

Question 4

After carrying out a titration, you find that 15.0cm^3 of hydrochloric acid neutralize 25.0cm^3 of a 0.1 mol/dm^3 solution of sodium hydroxide. Calculate the concentration of hydrochloric acid.

- a) 0.1667mol/dm^3
- b) 0.2275mol/dm^3
- c) 0.06mol/dm^3
- d) 1.005mol/dm^3

Question 5

Which metal requires the most energy to raise 1.00 g of it by 1.00°C ?

- a) Aluminum
- b) Copper
- c) Lead
- d) Nickel

Question 6

What is the ΔH value for an exothermic energy change?

- a) Always negative
- b) Always positive
- c) Could be positive or negative
- d) Depends on the potential energy of the reactants

Question 7

If 9.54 kJ of heat is required to raise the temperature of 225.0 g of a liquid hydrocarbon from 20.5°C to 45.0°C. What is the heat capacity of this hydrocarbon?

- a) 0.94 J/g°C
- b) 1.73 J/g°C
- c) 1.88 J/g°C
- d) 9.42 J/g°C

Question 8

Which statement about enthalpy is true?

- a) Heat is given off to the surroundings in endothermic reactions.
- b) Some substances have a negative specific heat capacity.
- c) Specific heat capacity is the same for all liquids.
- d) The sign of ΔH is always negative in exothermic reactions.

Question 9

A Bronsted-Lowry base is defined as:

- a) A proton acceptor
- b) A proton donor
- c) A hydroxide acceptor
- d) An electron pair acceptor

Question 10

The pH of a solution with $[H^+] = 1.25 \times 10^{-3} \text{ M}$ is....

- a) 2.9
- b) 11.1
- c) 10.9
- d) 3.1

Question 11

A substance which increases rate of reaction but itself remain chemically unchanged is called a

- a) substrate
- b) enzyme
- c) reactant
- d) product

Question 12

If the proportion of particles with energy greater than activation energy is high, the reaction will

- a) slow down
- b) speed up
- c) remains constant
- d) end up

Question 13

What happens to the value of ΔH for a thermochemical reaction if the reaction is reversed?

- a) ΔH has the same numerical value, and the sign changes.
- b) ΔH has the same numerical value, and the sign remains the same.
- c) ΔH is the reciprocal of the original value, and the sign changes.
- d) ΔH is the reciprocal of the original value, and the sign remains the same.

Question 14

Which process is an exothermic process?

- a) Ice melting
- b) Water evaporating
- c) Water boiling
- d) Steam condensing

Question 15

All the following are Chemical properties, except;

- a) corrosiveness
- b) ability to undergo combustion
- c) electron affinity
- d) density

Question 16

How many moles of alanine, $\text{C}_3\text{H}_7\text{NO}_2$, are there in 159g of alanine?

- a) 0.000142
- b) 1.78
- c) 0.56
- d) 3.31

Question 17

The neutral atoms of all the isotopes of the same element have

- a) Different number of protons
- b) Equal number of neutrons
- c) The same number of electrons

- d) The same masses

Question 18

How many protons are there in a neutral atom of carbon?

- a) 12
- b) 18
- c) 24
- d) 6

Question 19

A cube of 1.2 inches on the side has a mass of 36grams. What is the density in g/cm^3 ?

- a) 21
- b) 2.2
- c) 30
- d) 1.3

Question 20

What is the atomic weight of a hypothetical element consisting of two isotopes, one with mass =64.23 amu (26.0%) and one with mass = 65.32 amu?

- a) 65.3 amu
- b) 64.4amu
- c) 65.0amu
- d) 64.8 amu

SECTION B 40 marks

Answer ALL the questions

Question 1

- a) Briefly explain the difference between qualitative and quantitative analysis in the laboratory. [4marks]
- b) Briefly explain one real life situation where both qualitative and quantitative analysis is applied. [4marks]

Question 2

- a) Matter can be classified according to state such as solids, liquids or gases. Clearly explain how particles are arranged in each of the three states. [6marks]
- b) Explain the meaning of pH of a solution. [2marks]

Question 3

A first year student at TVTC wanted see what happens when sulphuric acid is reacted with sodium hydroxide in the laboratory.

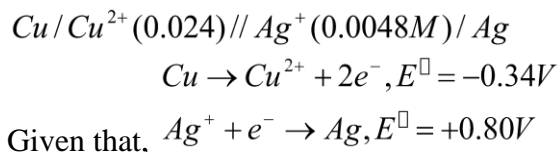
- a) Write a balanced chemical equation for this reaction. [4marks]
- b) If 8grams of sodium hydroxide was used, calculate how much sodium sulphate was produced. [4marks]

Question 4

- a) Explain how the properties of the elements on the periodic table vary across and down the table. [4marks]
- b) Using a good example explain the collision theory [4marks]

Question 5

- a) Clearly define the following terms;
 - i. Enthalpy [1marks]
 - ii. Chemical equilibrium [1mark]
 - iii. Distillation [1mark]
 - iv. Chromatography [1mark]
- b) Calculate the cell potential for the following system: [4marks]



SECTION C(40)marks

Attempt any TWO questions

Question 6

- a) Differentiate between physical and chemical change, and give an example of each [4marks]
- b) Clearly define the following terms [10marks]
- Activation energy
 - Endothermic reaction
 - Specific heat of combustion
 - Specific heat neutralization
 - Entropy
- c) 25cm^3 of 1.0mol/dm^3 hydrochloric acid at 21.5°C is placed in a polystyrene cup, and 25cm^3 of 1.0mol/dm^3 sodium hydroxide were added. After the mixture was stirred, the temperature rose to 28.2°C . If the density of both solutions is 1.0g/cm^3 and the specific heat capacity of each is solution is $4.18\text{JK}^{-1}\text{g}^{-1}$. Calculate the standard molar enthalpy of neutralization. [6 marks]

Question 7

- a) A certain compound consists of 93.71% Carbon and 6.29% Hydrogen. If its molecular weight is approximately 130u, determine its molecular formula. [10marks]
- b) A chemistry student reacted 20 grams of potassium reacts with 30grams of oxygen in the laboratory according to the equation; $4K + O_2 \rightarrow 2K_2O$
- Determine the reactant that is in excess [5marks]
 - Calculate the mass of K_2O formed. [5marks]

Question 8

- a) Clearly explain the difference between a saturated solution and a concentrated solution.
[5marks]
- b) State and explain the technique that you can use to separate two pure liquids.
[5marks]
- c) Polyvinyl chloride is a very useful material in contraction and engineering. Clearly demonstrate the process by which this material is formed and list four uses for PVC.
[10marks]

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SOLUTIONS FOR OPTION TWO

SOLUTIONS

SECTION A

1. d
2. d
3. c

4. a

5. a

6. a

7. b

8. d

9. a

10. a

11. b

12. b

13. a

14. d

15. d

16. b

17. c

18. d

19. d

20. c

SECTION B

Question 1

- a) In chemistry, **Qualitative** analysis is the determination of the chemical composition of a sample. It encompasses a set of analytical chemistry techniques that provide non-numerical information about a specimen. Qualitative analysis can tell you whether an atom, ion, functional group, or compound is present or absent in a sample, but it doesn't provide information about its quantity. Quantitative analysis in contrast, is called quantification of data. **Quantitative** analysis refers to the determination of how much of a given component is present in a sample. The quantity may be expressed in terms of mass, concentration, or relative abundance of one or all components of a sample
- b) In most cases, qualitative and quantitative analysis is applied together. For instance, at the hospital when a blood sample is taken for analysis in the laboratory. Firstly qualitative methods are used to determine the type of parasites present in the blood sample. For instance, it can be established that the sample contains malaria parasites. This is purely qualitative.

Secondly, the amount of parasites present can be determined in order to decide the type of medication to administer. E.g. 5000 parasites per given volume of the sample. This is quantitative.

Question 2

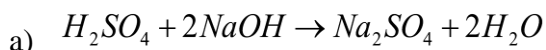
- a) A solid has a fixed shape and volume. The particles are tightly packed together and no spaces between them can be observed with naked eyes. The particles vibrate but do not move from place to place as particles in liquids and gases do.

Liquids have a fixed volume and take the shape of their container, because their particles can move around each other. Liquids cannot be compressed, because their particles are close together and have no space to move into.

Gases don't have a fixed shape or volume. They are able to flow and completely fill their container, because their particles can move quickly in all directions. Gases can be compressed, because their particles are far apart and have space to move into

- b) pH is the measure of the hydrogen ion concentration $[H^+]$ in a solution. It is a measure of the acidity and alkalinity of a given solution. $pH = -\log[H^+]$

Question 3



b) Using the balanced equation above,

$2\text{moles} : 1\text{mole}$

$$n = 8g / 40 = 0.2\text{moles}$$

$2 : 1$

$0.2 : X$

$$X = 0.4\text{moles}$$

$$\text{mass} = nMM$$

$$\text{mass} = 0.4 \times 142g = 56.8\text{grams}$$

Question 4

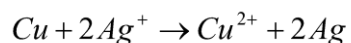
- a) The forces of attraction increase going up periodic table because there is one fewer energy level of electrons that will separate the outer electrons from the nucleus. The forces also increase going right across periodic table because the nucleus gains protons and the atom has the same number of energy levels as you move across a period. The first ionization energy increases going up the table because there are fewer levels and so the outer electrons are more tightly held by the nucleus. Metallic reactivity increases going left because metals are on the left side of the periodic table and they have fewer protons in their nucleus that are holding in the atom's electrons. Non metallic reactivity Increases going right because non-metals are on the right side of the periodic table and they have more protons in their nucleus that attract outer electrons
- b) **Collision theory** explains why different reactions occur at different rates, and suggests ways to change the rate of a reaction. Collision theory states that for a chemical reaction to occur, the reacting particles must collide with one another. The rate of the reaction depends on the frequency of collisions. The theory also tells us that reacting particles often collide *without* reacting. For collisions to be successful, reacting particles must collide with sufficient energy, and with the proper orientation.

Question 5

a) The definition of the terms;

- i. Enthalpy is the measure of heat change that accompanies a chemical reaction.
- ii. In a chemical reaction, chemical equilibrium is the state in which both reactants and products are present in concentrations which have no further tendency to change with time, so that there is no observable change in the properties of the system. It is the state at which the forward reaction and the reverse reaction proceed at the same rate.
- iii. **Distillation** is the process of separating the components or substances from a liquid mixture by using their difference in boiling and condensation.
- iv. **Chromatography** is a laboratory technique for the separation of a mixture. The mixture is dissolved in a fluid called the mobile phase, which carries it through a structure holding another material called the stationary phase. The various constituents of the mixture travel at different speeds, causing them to separate. The separation is based on differential partitioning between the mobile and stationary phases.

b) The balanced overall equation;



$$E = E^\ominus - \frac{0.0257}{2} \ln \frac{0.024}{0.0048^2}$$

$$E = 0.46 - 0.089 = 0.371\text{V}$$

SECTION C

QUESTION SIX

- a) A physical change is change that can be easily observed or measured without altering the composition of the substance. A chemical change is a change that can only be observed by carrying out a reaction. Ice melting is a physical change, while electrolysis of water is a chemical change.
- b) Definition of the terms;
- Activation energy is the minimum energy the reacting species must have in order for the reaction to take place.
 - Endothermic reaction is a type of reaction that absorbs energy from the surrounding.
 - Specific heat capacity of combustion is the energy released when completely burn one gram of a substance in air at 1atm
 - Specific heat of neutralization is the heat absorbed per mole when an acid and a base react to form a salt and water under standard conditions.
 - Entropy is the thermodynamic measure of the extent of disorder in a system.

- c) First get the mass of the combined volume,

$$\text{mass} = \text{density} \times \text{volume} = 1\text{g} / \text{cm}^3 \times 50\text{cm}^3 = 50\text{g}$$

$$\text{Heat} = mc\Delta T$$

$$\text{Heat} = 50 \times 4.18(28.2 - 21.5)$$

$$\text{Heat} = 1400\text{J}$$

$$\text{Standard molar enthalpy} = 1400\text{J} / 0.025\text{mols} = 56\text{kJ}$$

QUESTION 7

- a) The total percentage adds up to 100%, therefore,

C	H
Mass 93.71%=93.71g	6.29%=6.29g
Moles=93.71g/12.01g	6.29g/1.01
Moles= 7.803C	6.228C

6.228/6.228

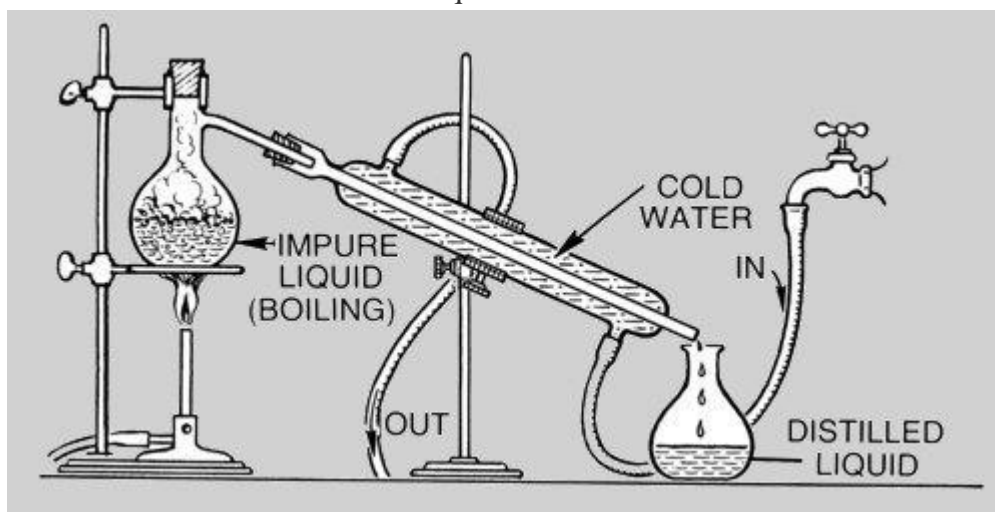
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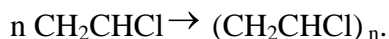
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SECTION 8

- a) A saturated solution is a solution that contains the maximum amount of solute dissolved in a given volume of solvent at a particular temperature. A concentrated solution, on the other hand is a solution that contains lots of solute dissolved in it. The amount of solute in a concentrated solution may/may not be the maximum amount which can be dissolved in the solution.
- b) When mixtures consist of two or more pure liquids then distillation is used. Here the components of a liquid mixture are vaporized, condensed and then isolated. The mixture is heated and the component which is volatile vaporizes first. The vapour moves through a condenser and is collected in a liquid state as shown below.



- c) PVC is formed by the process of addition polymerization. The monomer is chloroethene and the chain is as shown



- PVC is used for making plumbing pipes.
- PVC is used for insulating and sheathing of electrical conductors.
- PVC is used for making kitchen items such as cups and buckets.
- PVC is used for making floor tiles.