THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

032/1 **CHEMISTRY 1**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2020**

Instructions

1. This paper consists of sections A, B and C with total of thirteen questions

2. Answer all questions.

1. For each of the items (i) – (x), choose the correct answer from among the given alternatives and write its letter beside the item number in the answer booklet provided.

(i) Which of the following pairs constitute the best methods for treating and purifying water?
A. Chlorination and aeration
B. Chlorination and decantation
C. Chlorination and filtration
D. Chlorination and sedimentation
E. Chlorination and distillation

Answer:
The best methods for purifying water are chlorination and filtration, as chlorination kills bacteria and filtration removes suspended particles.
The correct answer is C. Chlorination and filtration.

(ii) A good fuel is the one which has:
A. High speed of continuous energy supply
B. High energy value supplied
C. Low carbon dioxide supplied
D. High carbon dioxide production
E. High content of non-combustible material

Answer:
A good fuel provides high energy per unit mass (calorific value).
The correct answer is B. High energy value supplied.

(iii) A rapid chemical reaction that releases energy in the form of light and heat is called:
A. Combustion
B. Decomposition
C. Displacement
D. Neutralization
E. Precipitation

Answer:
Combustion involves the rapid oxidation of a substance, releasing heat and light.
The correct answer is A. Combustion.

(iv) Which one is the molecular formula for prop-1-yne?
A. C_4H_6
B. C_2H_4
C. CH_3CCH
D. HCH_2CCH
E. CH_3CHCH

Answer:
The molecular formula for prop-1-yne, an alkyne, is C_3H_4.
The correct answer is C. CH_3CCH.

(v) Which of the following is not a component of the First Aid Kit?
A. Goggles
B. A pair of scissors
C. Dropper
D. Gloves
E. Razor blade

Answer:
A razor blade is not a standard component of the First Aid Kit.
The correct answer is E. Razor blade.

(vi) Which of the following is the correct sequence of the last two steps you should follow during the scientific procedure?
A. Hypothesis formulation and conclusion
B. Observation and problem identification
C. Experimentation and conclusion
D. Problem identification and hypothesis formulation
E. Interpretation of data and conclusion

Answer:
The last two steps involve analyzing the data collected and drawing conclusions based on the results.
The correct answer is E. Interpretation of data and conclusion.

(vii) Consider the following reagents:
1. H_2O_2
2. H_2O
3. MnO_2
4. MnO_4

Which reagents are involved in the preparation of oxygen gas in the laboratory?
A. 1 and 2
B. 3 and 4
C. 1 and 3
D. 2 and 3
E. 1 and 4

Answer:

Oxygen is commonly prepared by decomposing hydrogen peroxide (H_2O_2) using manganese dioxide (MnO_2) as a catalyst.
The correct answer is C. 1 and 3.

(viii) Why oxygen differs from other gases?
A. It neither burns nor supports combustion.
B. It supports combustion but does not burn.
C. It burns but does not support combustion.
D. It burns and supports combustion.
E. It explodes and supports combustion.

Answer:
Oxygen supports combustion but does not burn itself.
The correct answer is B. It supports combustion but does not burn.

(ix) What is the best way of preparing hydrogen gas in the laboratory?
A. By reacting strong metals and dilute acids.
B. By reacting metals and acids.
C. By reacting moderate metals and concentrated acids.
D. By reacting moderate metals and dilute acids.
E. By reacting strong metals and strong acids.

Answer:
Hydrogen gas is best prepared by reacting moderate metals (like zinc) with dilute acids.
The correct answer is D. By reacting moderate metals and dilute acids.

(x) What volume of hydrogen gas will be produced when 1.3 g of zinc granules react completely with excess dilute sulphuric acid at s.t.p?
A. 130 cm^3
B. 224 cm^3
C. 440 cm^3
D. 220 cm^3
E. 448 cm^3

Answer:
Step 1: Write the reaction equation:
$Zn + H_2SO_4$ ----------> $ZnSO_4 + H_2$

Step 2: Calculate moles of zinc:
Moles = Mass / Molar mass = 1.3 / 65 = 0.02 mol
Step 3: Volume of H_2 at s.t.p.:
Volume = Moles × Molar volume = 0.02 × 22400 cm^3/mol = 448 cm^3

The correct answer is E. 448 cm^3.
2. Match the physical processes represented by arrows (i) - (v) in List A with the corresponding terms in List B by writing the letter of the correct response beside the item number in the answer booklet provided.

List A:
(i) Ice --------> Water
(ii) Water -----> Ice
(iii) Steam ------> Water
(iv) Ice ----------> Steam
(v) Water --------> Steam

List B:
A. Freezing
B. Condensation
C. Deposition
D. Sublimation
E. Melting
F. Evaporation
G. Conversion

Answer:
(i) Ice -------> Water - E. Melting
(ii) Water ----> Ice - A. Freezing
(iii) Steam -----> Water - B. Condensation
(iv) Ice --------> Steam - D. Sublimation
(v) Water ------> Steam - F. Evaporation
3. (a) Giving an example for each, give four uses of matter in daily life.

Answer:
i. Water (liquid) for drinking and cooking.
ii. Air (gas) for breathing and combustion.
iii. Metal (solid) for constructing buildings and vehicles.
iv. Soil (solid) for growing crops.

(b) Why are chemical symbols useful in Chemistry? Give three reasons.

Answer:
i. They provide a universal language for chemists worldwide, enabling consistent communication.
ii. They simplify the representation of elements and compounds in equations.
iii. They save time by using abbreviations instead of writing full element names.

4. (a) Give four laboratory apparatuses that are made up of porcelain/ceramic material.

Answer:
i. Crucible
ii. Mortar and pestle
iii. Evaporating dish
iv. Watch glass

(b) Outline three steps of administering First Aid to a person having a bruise on his leg resulting from a fist/hand blow.

Answer:
i. Clean the affected area with antiseptic to prevent infection.
ii. Apply a cold compress to reduce swelling.
iii. Cover the bruise with a sterile bandage to protect it.

5. (a) What is the molarity of a solution containing 10% by mass of calcium hydroxide in 0.5 dm^3 of solution?

Answer:
Step 1: Calculate the mass of calcium hydroxide in grams.
10% of 0.5 dm^3 = $0.1 \times 0.5 \times 1000 = 50$ g

Step 2: Calculate the molarity.
Molar mass of $Ca(OH)_2$ = $40 + (2 \times 17) = 74$ g/mol
Moles = Mass / Molar mass = $50 / 74 = 0.676$ mol
Molarity = Moles / Volume = $0.676 / 0.5 = 1.352$ M

Molarity = 1.35 M (rounded to two decimal places).

(b) 25 cm^3 of a molar solution of sodium hydroxide is diluted to 85 cm^3. Calculate the concentration of the solution after dilution.

Answer:
Using the formula: $C_1V_1 = C_2V_2$
$C_1 = 1$ M, $V_1 = 25$ cm^3, $V_2 = 85$ cm^3
$C_2 = (C_1V_1) / V_2 = (1 \times 25) / 85 = 0.294$ M

Concentration = 0.29 M (rounded to two decimal places).

6. (a) Briefly explain the basic steps you would follow in water treatment.

Answer:
i. Filtration: Remove suspended solids using sand or gravel filters.

ii. Sedimentation: Allow heavier particles to settle at the bottom.
iii. Chlorination: Add chlorine to kill bacteria and other pathogens.

(b) Outline how to test for the purity of water.

Answer:
i. Boil the water and observe if it leaves residue; pure water does not leave any residue.
ii. Check its boiling point; pure water boils at exactly 100°C under normal conditions.
iii. Test its electrical conductivity; pure water has very low conductivity.

7. (a) Briefly explain five importance of balancing chemical equations.

Answer:
i. Ensures compliance with the law of conservation of mass.
ii. Helps determine the correct stoichiometric proportions for reactions.
iii. Enables calculation of reactants and products involved.
iv. Facilitates accurate predictions of reaction outcomes.
v. Ensures consistency in laboratory and industrial processes.

(b) Give a balanced chemical equation for the reaction between sodium carbonate and hydrochloric acid.

Answer:
$Na_2CO_3 + 2HCl$ ---------> $2NaCl + H_2O + CO_2$

8. (a) Calculate the concentration in g/dm³ of vinegar (CH_3COOH) if 25.0 cm³ of 0.1 M sodium hydroxide reacts with 12.5 cm³ of vinegar.

Answer:
Step 1: Calculate moles of sodium hydroxide.
Moles = C × V = 0.1 × (25.0 / 1000) = 0.0025 mol

Step 2: Moles of CH_3COOH reacting.
1:1 ratio means moles of CH_3COOH = 0.0025 mol

Step 3: Concentration in mol/dm³.
Concentration = Moles / Volume = 0.0025 / (12.5 / 1000) = 0.2 mol/dm³

Step 4: Convert to g/dm³.
Mass = Moles × Molar mass = 0.2 × 60 = 12 g/dm³

Concentration = 12 g/dm³.
(b) By giving a reason, suggest the suitable indicator for the reaction in 8(a) above.

Answer:
Phenolphthalein is suitable because the reaction occurs between a strong base (NaOH) and a weak acid (CH_3COOH), and it changes color at the endpoint in the basic pH range.

9. A Form Three student conducted an experiment to prepare a gas in the laboratory by decomposing a certain compound using electricity. She allowed a steady electric current to flow through the solution for 3 hours at s.t.p. If the volume of the gas obtained was 4.12 dm^3 and the gas relighted a glowing splint:

(a) Name the gas that was produced.
Answer:
The gas produced is oxygen (O_2).
Reason: Oxygen relights a glowing splint, a characteristic test for this gas.

(b) Calculate the electric current that was flowing in the solution.
Answer:
Step 1: Use the formula for electrolysis:
Volume = (It) / (n × F), where:
- Volume = 4.12 dm^3 = 4.12 × 1000 cm^3 = 4120 cm^3
- n = 4 (number of electrons in the reaction)
- F = 96500 C/mol (Faraday's constant)
- t = 3 hours × 3600 seconds/hour = 10800 s

Rearranging for I (current):
I = (Volume × n × F) / t
I = (4120 × 4 × 96500) / 10800
I = 147.8 A

The electric current flowing in the solution is approximately 147.8 A.

10. (a) Draw diagrams to show the atomic structures of the elements with atomic numbers 1, 10, 16, and 19.

Answer:
i. Hydrogen (atomic number 1):
Proton = 1, Electron = 1

ii. Neon (atomic number 10):
Protons = 10, Neutrons = 10, Electrons = 10 (2 in the first shell, 8 in the second shell).

iii. Sulfur (atomic number 16):
Protons = 16, Neutrons = 16, Electrons = 16 (2 in the first shell, 8 in the second, 6 in the third).

iv. Potassium (atomic number 19):
Protons = 19, Neutrons = 20, Electrons = 19 (2 in the first shell, 8 in the second, 8 in the third, 1 in the fourth).

(b) Element X has 20 electrons and a mass number of 40. Work out the number of each type of nucleons present.
Answer:
Protons = Number of electrons = 20
Neutrons = Mass number - Protons = 40 - 20 = 20
Nucleons = Protons + Neutrons = 40

Protons: 20, Neutrons: 20, Total nucleons: 40

11. A certain compound having a relative molecular mass of 76 was found to contain 15.8% of carbon and 84.2% of sulfur.

(a) Determine the empirical formula and molecular formula of the compound.
Answer:
Step 1: Find moles of each element.
For carbon: Moles = 15.8 / 12 = 1.317
For sulfur: Moles = 84.2 / 32 = 2.63

Step 2: Simplify ratio:
C : S = 1.317 : 2.63 = 1 : 2

Empirical formula = CS_2
Empirical formula mass = 12 + 2(32) = 76

Step 3: Molecular formula:
Relative molecular mass / Empirical formula mass = 76 / 76 = 1

Molecular formula = CS_2

(b) Give the IUPAC name of the compound.
Answer:
The IUPAC name is carbon disulfide.

12. (a) Ammonia gas is manufactured by reacting nitrogen gas with hydrogen gas in the presence of a catalyst. Write a balanced chemical equation for the reaction and explain the role played by the catalyst in this reaction.

Answer:
Balanced equation: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

The catalyst (usually iron) increases the rate of reaction by lowering the activation energy, enabling nitrogen and hydrogen to combine efficiently.

(b) The following figure shows the reaction path between sodium hydroxide and hydrochloric acid.

Giving a reason, classify the reaction based on energetics and predict the effects of cooling the system while increasing pressure at the same time.
Answer:
i. Classification: The reaction is exothermic because energy is released, as shown by the downward energy path.

ii. Effects of cooling: Cooling will favor the forward reaction, producing more NaCl and H_2O, as exothermic reactions are favored by lower temperatures.

iii. Effects of increasing pressure: No significant effect since the reaction involves liquids, which are not compressible.

13. Carbon is one of the elements that have allotropes. Explain how the allotropes of carbon differ from each other.

Answer:

Allotropes of carbon are different structural forms of the same element, carbon, which differ in their atomic arrangements and properties. The main allotropes of carbon include diamond, graphite, and fullerene.

i. Diamond:
- Structure: Each carbon atom is tetrahedrally bonded to four other carbon atoms, forming a 3D network.
- Properties: It is extremely hard, transparent, and has a high refractive index. Diamond is a poor conductor of electricity because there are no free electrons.
- Use: Used in cutting tools, jewelry, and abrasives.

ii. Graphite:
- Structure: Each carbon atom is bonded to three other carbon atoms in a hexagonal planar structure, forming layers held together by weak van der Waals forces.
- Properties: Graphite is soft, slippery, and a good conductor of electricity due to delocalized electrons between the layers.
- Use: Used as a lubricant, in pencils, and in electrodes.

iii. Fullerene (C_{60}):
- Structure: Carbon atoms are arranged in a spherical shape, resembling a soccer ball.
- Properties: Fullerene is less hard than diamond, but it has unique chemical properties and can act as a superconductor.
- Use: Used in nanotechnology, electronics, and drug delivery systems.

iv. Amorphous Carbon:
- Structure: Irregularly arranged carbon atoms without a defined crystalline structure.
- Properties: It is a poor conductor of electricity and less durable.
- Use: Used in inks, paints, and as a filler material.

These allotropes differ in their bonding, arrangement, physical properties, and applications.

14. Despite its corrosiveness, sulphuric acid is very important in industry. Explain the importance of sulphuric acid in industries by giving six points.

Answer:

i. Production of fertilizers:
Sulphuric acid is used in the manufacture of phosphate fertilizers like superphosphate and ammonium sulfate, which are essential for agriculture.

ii. Manufacture of chemicals:
It is used to produce chemicals such as hydrochloric acid, nitric acid, and synthetic detergents.

iii. Petroleum refining:
Sulphuric acid is used in the refining of crude oil to remove impurities and enhance the quality of fuels.

iv. Battery production:
Sulphuric acid is a key component in lead-acid batteries, commonly used in vehicles and backup power systems.

v. Cleaning agents:
It is used in the pickling process to clean metal surfaces before plating or painting by removing rust and scale.

vi. Textile and dye industry:
Sulphuric acid is used in the production of dyes and in the treatment of textiles to improve their quality.

vii. Water treatment:
Sulphuric acid is employed to neutralize alkalinity in water treatment plants.

viii. Production of explosives:
It is used in the production of explosives like TNT (trinitrotoluene) and nitroglycerin.

These industrial applications make sulphuric acid one of the most widely used chemicals in the world.