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 **Year: 2022**

Instructions

1. This paper consists of sections A, B and C with total of thirteen questions 2.

Answer all questions in section A and one question in section B

(i) Which is a chemical property of water? A.
It is a very good solvent.
B. It is neither acidic nor basic.
C. It has higher surface tension.
D. It can exist in three states of matter.
E. It expands when it freezes.

Answer:
The chemical property of water is its ability to act as a solvent. Water dissolves many substances due to its polarity, which allows it to interact with ionic and polar compounds chemically. The correct answer is A. It is a very good solvent.

(ii) What is the maximum number of electrons in the innermost shell of atoms? A.
3
B. 1
C. 4
D. 2
E. 8

Answer:
The innermost shell (K-shell) of an atom can hold a maximum of 2 electrons based on the $2n^2$ rule, where n is the principal quantum number.
The correct answer is D. 2

(iii) What feature is essential for a good fuel? 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 should supply a high amount of energy per unit mass (calorific value) efficiently without releasing excessive pollutants.
The correct answer is B. High energy value supplied.

(iv) What conclusion can be drawn from the random movement of pollen grains suspended in air? A.
Matter is lighter in nature.
B. Matter is particulate in nature.
C. Matter is wave in nature.
D. Matter is solid in nature.
E. Matter is gaseous in nature.

Answer:
The random movement of pollen grains (Brownian motion) provides evidence that matter is made of tiny particles that are in constant motion.
The correct answer is B. Matter is particulate in nature.

(v) Which energy source can be reused after being exploited? A.
Combustible source.
B. Non-renewable source.
C. Renewable source.
D. Synthetic source.
E. Natural source.

Answer:
Renewable energy sources, such as solar, wind, and hydro, can be reused indefinitely without depletion.
The correct answer is C. Renewable source.

(vi) Which one is the molecular formula for prop-1-ene?
A. C_5H_8
B. CH_3CCH
C. C_4H_8
D. HCH_2CCH
E. CH_2CHCH_3

Answer:
The molecular formula for prop-1-ene is C_3H_6, and its structural formula is $CH_2{=}CHCH_3$. The correct answer is E. CH_2CHCH_3

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

Answer:
A knife is not typically included in a First Aid Kit because it is not commonly used in first aid procedures.
The correct answer is C. Knife

(viii) Which element is oxidized in the following reaction?
$2FeSO_4 + Cl_2 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2HCl$

A. Chlorine

B. Hydrogen
C. Oxygen
D. Sulphur
E. Iron

Answer:
In this reaction, Fe^{2+} in $FeSO_4$ is oxidized to Fe^{3+} in $Fe_2(SO_4)_3$.
The correct answer is E. Iron

(ix) Which of the following are the components needed to start fire?
A. Match box, fire wood and kerosene
B. Match box, fire wood and oxygen
C. Oxygen, fuel and fire wood
D. Oxygen, heat and match box
E. Oxygen, fuel and heat

Answer:
The components needed to start a fire are oxygen, fuel, and heat, collectively known as the fire triangle.
The correct answer is E. Oxygen, fuel and heat

(x) Why is nitrogen formed first during the fractional distillation of air? A.
It has got high boiling point.
B. It has got low density.
C. It has got low melting point.
D. It has got high density.
E. It has got low boiling point.

Answer:
Nitrogen is separated first in fractional distillation because it has a lower boiling point (-196°C) compared to oxygen (-183°C).
The correct answer is E. It has got low boiling point.

2. Match the effects on the rate of chemical reactions in List A with the corresponding physical conditions in List B by writing the letter of the correct response beside the item number in the answer booklet provided.

List A:
(i) Increases colliding particles per time
(ii) Favours endothermic reaction
(iii) Increases the speed to reach equilibrium
(iv) Favours the side with fewer molecules
(v) Favours more products on opposite side

List B:

A. Increase in temperature
B. Increase in surface area
C. Increase in pressure
D. Increase in concentration
E. Introducing a catalyst
F. Decrease in temperature
G. Decrease in pressure

Answer:
(i) Increases colliding particles per time - B. Increase in surface area
Explanation: Increasing the surface area of reactants exposes more particles to collisions, thereby increasing the rate of reaction.

(ii) Favours endothermic reaction - A. Increase in temperature
Explanation: Endothermic reactions absorb heat, so increasing the temperature shifts the equilibrium toward the products.

(iii) Increases the speed to reach equilibrium - E. Introducing a catalyst
Explanation: Catalysts lower the activation energy, allowing reactions to proceed faster and reach equilibrium more quickly.

(iv) Favours the side with fewer molecules - C. Increase in pressure
Explanation: An increase in pressure shifts the equilibrium toward the side with fewer gas molecules, as this reduces the pressure in the system.

(v) Favours more products on opposite side - G. Decrease in pressure
Explanation: A decrease in pressure shifts the equilibrium toward the side with more gas molecules, favoring the production of those products.

3. (a) How useful is matter in our daily life? Give four points with an example for each.

Answer:
i.Food and nutrition: Matter in the form of carbohydrates, proteins, and fats provides energy and nutrients necessary for survival. Example: Rice as a carbohydrate source.
ii. Clothing: Matter is used to produce fibers like cotton and polyester for making clothes. Example: Cotton is a natural fiber obtained from plants. iii. Construction materials. Matter in the form of concrete, steel, and wood is used in building infrastructure. Example: Steel is used for reinforcement in construction.
iv. Medicines. Matter in the form of chemical compounds is essential for curing diseases and improving health. Example: Paracetamol is a widely used pain reliever.

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

Answer:
i. Universal language. Chemical symbols provide a standardized way of representing elements, enabling scientists worldwide to communicate effectively. Example: H represents hydrogen universally. ii. Simplification. Symbols simplify the representation of chemical elements and compounds, making it easier to write and balance equations. Example: H_2O is simpler than writing "water." iii. Precise identification. Each symbol uniquely identifies an element, avoiding ambiguity. Example: Fe represents iron, which is distinct from other elements.

4. Zinc granules were placed in a beaker containing excess dilute sulphuric acid standing on a direct reading balance. The mass of the beaker and its contents were recorded after every two seconds as shown in Table 1.

(a) Why there was a loss in mass?
Answer:
The loss in mass is due to the release of hydrogen gas during the reaction between zinc granules and dilute sulphuric acid. The gas escapes into the atmosphere, reducing the total mass of the system. Reaction:
$Zn(s) + H_2SO_4(aq)$ -----> $ZnSO_4(aq) + H_2(g)$

(b) Why did the mass remain constant after the eight seconds?
Answer:
The mass remained constant after eight seconds because all the zinc granules had reacted completely with the sulphuric acid, and no more hydrogen gas was being produced. At this point, the reaction had stopped.

(c) Briefly explain what would happen to the rate of reaction if zinc powder was used instead of granules.
Answer:
If zinc powder were used, the rate of reaction would increase significantly. This is because the powder has a larger surface area compared to granules, allowing more contact between the zinc and sulphuric acid, leading to faster production of hydrogen gas.

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5. A certain compound with the molecular mass of 28 was analyzed and found to be composed of 0.6 g of carbon and 0.1 g of hydrogen.

(a) Work out its empirical formula and molecular formula.
Answer:
Step 1: Determine the moles of each element.
For carbon:
Moles = Mass / Molar mass = 0.6 / 12 = 0.05 For hydrogen:
Moles = Mass / Molar mass = 0.1 / 1 = 0.1

Step 2: Find the simplest mole ratio.
Carbon: 0.05 / 0.05 = 1
Hydrogen: 0.1 / 0.05 = 2

Empirical formula: CH_2

Step 3: Determine the molecular formula. Molecular mass = 28
Empirical formula mass = 12 + (2 × 1) = 14
Molecular formula = (Molecular mass / Empirical formula mass) × Empirical formula = 28 / 14 × CH_2 = C_2H_4

Molecular formula: C_2H_4
(b) Classify the compound to its homologous series. Answer:
The compound C_2H_4 belongs to the alkenes homologous series because it has a double bond between carbon atoms.
6. A Form Three student prepared an experiment to prepare a gas in the laboratory by decomposing a compound using electricity. A steady current was allowed to flow through the solution for 3 hours. A total of 4.12 dm^3 of the gas, which relighted the glowing splint, was produced.

(a) What terminology is used to refer to such experimental setup?
Answer:
The experimental setup is called electrolysis.

(b) Work out the current flowing in the circuit.
Answer:
To calculate the current, use the equation:
Volume of gas (dm^3) = (It) / (z × F)

Where:
z = number of electrons (2 for oxygen) F
= Faraday's constant (96500 C/mol)
t = time in seconds (3 hours × 60 × 60 = 10800 s)

Rearranging for I:
I = (Volume × z × F) / t
I = (4.12 × 2 × 96500) / 10800
I = 73.8 A

The current flowing in the circuit is approximately 73.8 A.

7. Classify the following salts on the basis of solubility in water: Sodium carbonate, Lead nitrate, Silver chloride, Copper(II) sulphate, Barium sulphate, Zinc chloride, and Lead sulphate.

Answer:

Soluble salts:
i. Sodium carbonate
ii. Lead nitrate iii.
Copper(II) sulphate
iv. Zinc chloride

Insoluble salts:
i. Silver chloride ii.
Barium sulphate
iii. Lead sulphate

Explanation: Solubility rules state that nitrates, chlorides (except silver and lead), and most carbonates of alkali metals are soluble. Sulphates are generally soluble except for barium, lead, and calcium sulphates.

8. Table 2 shows the volume of soap solution needed to form lather with three samples of water of equal volumes. Use the data from the table to answer the questions that follow:

(a) Identify two things other than the volume of water that must be kept constant for such data to be meaningful.
Answer:
i. The concentration of the soap solution. ii.
The temperature of the water samples.

Explanation: These factors affect the reaction between soap and water, so keeping them constant ensures reliable comparison of the results.

(b) (i) Identify which water sample has the highest hardness. Give a reason.
Answer:
Sample E has the highest hardness.
Reason: It requires the largest volume of soap solution (6.5 cm^3) to form lather, indicating the presence of more dissolved ions that react with soap.

(ii) Give three causes of hardness of water. Answer:
i. Presence of calcium ions (Ca^{2+}) in the water, often from dissolved calcium carbonate or gypsum.
ii. Presence of magnesium ions (Mg^{2+}) from magnesium salts. iii. Dissolved bicarbonates (HCO_3^-) and sulphates (SO_4^{2-}) in the water.

9. Consider the following substances: milk, copper, soap, steel, chlorine, and sugar.

(a) Identify the elements, compounds, and mixtures from the list. Answer:

i. Elements: Copper, chlorine.
ii. Compounds: Soap, sugar, steel.
iii. Mixtures: Milk.

Explanation:
- Copper and chlorine are pure substances consisting of a single type of atom.
- Soap, sugar, and steel are chemical compounds formed from two or more elements chemically bonded together.
- Milk is a mixture of water, proteins, fats, and carbohydrates.

(b) Give four differences between the elements identified in 9(a). Answer:

i. Copper is a metal, while chlorine is a non-metal.
ii. Copper is a solid at room temperature, while chlorine is a gas.

iii. Copper is a good conductor of electricity, while chlorine does not conduct electricity. iv. Copper atoms form metallic bonds, while chlorine atoms form covalent or ionic bonds.

10. (a) Explain the function of coke and hot air in the extraction of iron from its ore. Answer:

i. Coke: Coke serves as a reducing agent in the blast furnace. It reacts with oxygen to produce carbon monoxide, which reduces iron(III) oxide (Fe_2O_3) to molten iron. Reaction: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

ii. Hot air: Hot air is blown into the blast furnace to provide the oxygen necessary for coke combustion. This reaction generates heat to maintain the high temperatures required for the reduction of iron ore.
Reaction: $C + O_2$ ----> CO_2

(b) Account for the fact that aluminium is a vital element in our daily life. Give four points. Answer:

i. Lightweight: Aluminium has a low density, making it ideal for applications where weight is a concern, such as in aircraft and vehicles. ii. Corrosion resistance: Aluminium forms a natural oxide layer that protects it from rust, making it suitable for outdoor applications like roofing and window frames. iii. Good conductor: Aluminium is an excellent conductor of electricity, widely used in electrical transmission lines. iv. Recyclability: Aluminium can be recycled indefinitely without losing its properties, reducing environmental impact and production costs.

11. An unknown green sample was mixed with dilute HNO_3 and gave a blue solution and a gas which precipitated lime water. The resulting solution was evaporated to dryness and upon further heating, a black residue was formed together with a brown gas which relighted a glowing splint.

(a) Identify the green sample, blue solution, black solid, and the two gases. Answer:

i. Green sample: Copper(II) carbonate ($CuCO_3$). ii.
Blue solution: Copper(II) nitrate ($Cu(NO_3)_2$). iii.
Black solid: Copper(II) oxide (CuO).
iv. Gas 1: Carbon dioxide (CO_2).
v. Gas 2: Oxygen (O_2).

(b) Give a balanced chemical equation for the reaction between the green sample and nitric acid. Answer:
$CuCO_3(s) + 2HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + H_2O(l) + CO_2(g)$

(c) Give the equation for the formation of the black residues. Answer:
$2Cu(NO_3)_2$ --------> $2CuO(s) + 4NO_2(g) + O_2(g)$

12. (a) Distinguish alkanes from alkenes by giving three points. Answer:

i. Alkanes are saturated hydrocarbons with single bonds, while alkenes are unsaturated hydrocarbons with at least one double bond. ii. Alkanes do not decolorize bromine water, while alkenes decolorize bromine water due to their double bond. iii. Alkanes follow the general formula CnH2n+2, while alkenes follow the formula CnH2n.

(b) Why has carbon been given special attention in organic chemistry rather than other elements? Give four reasons.
Answer:

i. Carbon forms stable covalent bonds, allowing the creation of a wide variety of compounds. ii. Carbon atoms can bond with other carbon atoms to form long chains and rings, providing the backbone for organic compounds. iii. Carbon can form multiple bonds (single, double, and triple), adding to the diversity of organic compounds.
iv. Carbon is the basis of life, as all biological macromolecules (proteins, carbohydrates, lipids, and nucleic acids) are composed of carbon-based compounds.

13. Explain six effects of water pollution in Tanzania.

Answer:

i. Health issues: Polluted water carries harmful pathogens, leading to waterborne diseases like cholera, dysentery, and typhoid, which are prevalent in Tanzania.
ii. Loss of aquatic life: Discharge of toxic chemicals, sewage, and industrial waste into water bodies kills fish and other aquatic organisms, reducing biodiversity.
iii. Reduced agricultural productivity: Polluted water used for irrigation affects soil quality and contaminates crops, reducing yields and threatening food security.
iv. Economic losses: Water pollution negatively impacts fishing, tourism, and agriculture, leading to reduced income for communities relying on these sectors.
v. Contamination of drinking water sources: Pollutants infiltrate rivers, lakes, and underground water, making them unsafe for consumption without expensive treatment.
vi. Eutrophication: Excess nutrients like phosphates and nitrates in water bodies result in algal blooms, depleting oxygen levels and causing the death of aquatic species.

14. Describe six ways that can be adopted by farmers to maintain soil fertility in Tanzania.

Answer:

i. Crop rotation: Alternating crops with different nutrient requirements helps to maintain a balance of nutrients in the soil and prevents depletion of specific nutrients.

ii. Use of organic manure: Adding compost, animal dung, or plant residues improves soil fertility by increasing organic matter and providing essential nutrients. iii. Planting cover crops: Cover crops like legumes prevent soil erosion, improve soil structure, and fix nitrogen, enriching the soil naturally.

iv. Contour farming: Cultivating along the contours of slopes reduces soil erosion and water runoff, conserving soil nutrients.

v. Agroforestry: Integrating trees with crops stabilizes the soil, prevents erosion, and provides shade, which improves soil moisture and organic matter. vi. Application of fertilizers: Using chemical fertilizers in appropriate amounts replenishes nutrients like nitrogen, phosphorus, and potassium, boosting soil fertility.