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: 2021**

Instructions

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

2. Answer all questions.

(i) Which among the following sets of materials can cause fire outbreak?
A. Oxygen, carbon dioxide, and fuel
B. Oxygen, heat, and fuel
C. Oxygen, heat, and carbon dioxide
D. Oxygen, foam, and fuel
E. Oxygen, heat, and foam

Answer:
Fire requires three components: oxygen, heat, and fuel, collectively known as the fire triangle. Without any one of these, a fire cannot start.
The correct answer is B. Oxygen, heat, and fuel.

(ii) What type of fire occurs in vapor air mixture over the surface of flammable liquids?
A. Class A
B. Class B
C. Class C
D. Class D
E. Class E

Answer:
Class B fires involve flammable liquids or gases, such as gasoline, kerosene, or oil, that produce vapor-air mixtures which can ignite.
The correct answer is B. Class B.

(iii) Which one of the following processes is a chemical change?
A. Butter melts on warm toast
B. Water evaporates from the surface
C. Juice in a bottle freezes
D. Food scrap turns into compost
E. Wet cloth dries

Answer:
A chemical change involves the formation of new substances. Food scraps decomposing into compost is a chemical process involving the breakdown of organic matter into simpler substances.
The correct answer is D. Food scrap turns into compost.

(iv) The simplest formula of a compound formed when combining 36 g of magnesium and 14 g of nitrogen is:
A. MgN
B. Mg_2N
C. Mg_3N_2
D. MgN_2
E. Mg_4N_2

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Answer:
Step 1: Calculate moles.
Moles of magnesium = 36 / 24 = 1.5
Moles of nitrogen = 14 / 14 = 1

Step 2: Find the simplest ratio.
1.5 : 1 → 3 : 2

The empirical formula is Mg_3N_2.
The correct answer is C. Mg_3N_2.

(v) What is the IUPAC name for H_2SO_4?
A. Sulphuric acid
B. Sulphuric (VI) acid
C. Hydrogen sulphate
D. Dihydrogen sulphate
E. Hydrogen tetrasulphate

Answer:
H_2SO_4 is commonly known as sulphuric acid in IUPAC nomenclature.
The correct answer is A. Sulphuric acid.

(vi) What type of chemical reaction is represented by the equation
$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$?
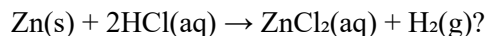
A. Displacement reaction
B. Combination reaction
C. Precipitation reaction
D. Decomposition reaction
E. Redox reaction

Answer:
This is a displacement reaction where zinc displaces hydrogen from hydrochloric acid to form zinc chloride and hydrogen gas.
The correct answer is A. Displacement reaction.

(vii) What does the random movement of pollen grains suspended in air demonstrate?
A. Matter is lighter in nature.
B. Matter is solid in nature.
C. Matter is particulate in nature.
D. Matter is gaseous in nature.
E. Matter is wave in nature.

Answer:

The random movement of pollen grains (Brownian motion) indicates that matter is made up of small particles in constant motion.

The correct answer is C. Matter is particulate in nature.

(viii) "Organic matter is among the components of soil." Which role does it play?

A. Improving water infiltration of the soil.

B. Accelerating breakdown of organic matter.

C. Reserving nutrients, thus providing soil fertility.

D. Converting of nitrogen into nitrates.

E. Providing a room for organic material such as nylons.

Answer:

Organic matter in soil retains nutrients, provides fertility, and improves soil structure.

The correct answer is C. Reserving nutrients, thus providing soil fertility.

(ix) Which of the following sets represents isotopes of an element?

A. $_7^{16}Z$, $_7^{17}Z$, and $_7^{18}Z$

B. $_{16}^{16}Z$, $_{17}^{16}Z$, and $_{18}^{16}Z$

C. $_8^{16}Z$, $_8^{17}Z$, and $_8^{18}Z$

D. $_{16}^{16}Z$, $_{16}^{17}Z$, and $_{16}^{18}Z$

E. $_{16}^{17}Z$, $_{16}^{18}Z$, and $_{16}^{19}Z$

Answer:

Isotopes are atoms of the same element with the same atomic number but different mass numbers.

The correct answer is D. $_{16}^{16}Z$, $_{16}^{17}Z$, and $_{16}^{18}Z$.

(x) What is to be considered when choosing the best method to extract a particular metal from its ore?

A. The metal's economic value.

B. Its availability in an area.

C. The metal's ore impurities.

D. How it reacts with other materials.

E. The metal's shininess.

Answer:

The method of extraction depends on the chemical reactivity of the metal and the nature of impurities in its ore.

The correct answer is C. The metal's ore impurities.

2. Match the uses of First Aid Kit items in List A with the respective items in List B by writing the letter of the correct response beside the item number in the answer booklet provided.

List A:
(i) Washing out foreign particle from eye and cleaning wounds.
(ii) Cleaning wounds to kill germs and bacteria.
(iii) Preventing the skin from moisture loss through evaporation.
(iv) Treating fungal infection.
(v) Washing hands, wounds, and equipment.

List B:
A. Antiseptic
B. Detergent
C. Gentian violet
D. Iodine tincture
E. Petroleum jelly
F. Saline
G. Sterile gauze

Answer:
(i) F. Saline
Explanation: Saline solution is used for washing out foreign particles and cleaning wounds.

(ii) D. Iodine tincture
Explanation: Iodine tincture is an antiseptic used for cleaning wounds to kill germs and bacteria.

(iii) E. Petroleum jelly
Explanation: Petroleum jelly prevents the skin from losing moisture by forming a protective layer.

(iv) C. Gentian violet
Explanation: Gentian violet is used for treating fungal infections.
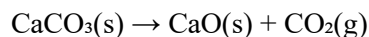
(v) B. Detergent
Explanation: Detergent is used for washing hands, wounds, and equipment.

3. (a) Different salts behave differently when heated. Use balanced chemical equations to show how carbonates and sulphates behave when subjected to heat.
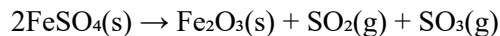
Answer:

i. Carbonates: Most metal carbonates decompose when heated, releasing carbon dioxide gas.
Example:

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$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

ii. Sulphates: Metal sulphates generally do not decompose easily, but some may decompose into oxides and sulfur trioxide.
Example:
$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$
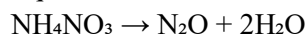

(b) Ammonium nitrate does not react like other nitrates (with the exception of alkali metal nitrates). Explain this fact with the aid of chemical equations.

Answer:
Ammonium nitrate decomposes upon heating to produce nitrous oxide (N_2O) and water instead of releasing oxygen like other nitrates.
Equation:
$NH_4NO_3 \rightarrow N_2O + 2H_2O$

Other nitrates decompose into metal oxides, nitrogen dioxide, and oxygen.
Example:
$2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

This unique behavior is due to the presence of both ammonium (NH_4^+) and nitrate (NO_3^-) ions in the same compound.

4. (a) A Form IV student was asked to react phosphate ion and sodium ion forming compound W. Suggest the IUPAC name of W and find the oxidation state of phosphorus in W.

Answer:
Compound W is sodium phosphate (Na_3PO_4).
Oxidation state of phosphorus:
Let x be the oxidation state of phosphorus.
$3(Na^+) + x + 4(O^{2-}) = 0$
$3(+1) + x + 4(-2) = 0$
$3 + x - 8 = 0$
$x = +5$

The oxidation state of phosphorus in Na_3PO_4 is +5.

(b) Calculate the percentage composition of lead in the compound $Pb(NO_3)_2$.

Answer:

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Molar mass of $Pb(NO_3)_2$ = Pb + 2(N + 3(O))
= 207 + 2(14 + 3(16))
= 207 + 2(62)
= 331 g/mol

Percentage of lead:
(207 / 331) × 100 = 62.54%

The percentage of lead in $Pb(NO_3)_2$ is 62.54%.

5. (a) How can the society minimize the energy loss encountered in the use of charcoal and firewood? Give two points.

Answer:
i. Use of improved cooking stoves: These stoves are more efficient and reduce heat loss during cooking.
ii. Adoption of alternative energy sources: Switching to solar or biogas reduces reliance on firewood and charcoal, conserving energy and resources.

(b) State whether the following processes are exothermic or endothermic.

(i) Dissolving ammonium chloride in water.
Answer: Endothermic.

(ii) Photosynthesis.
Answer: Endothermic.

(iii) Combustion reactions.
Answer: Exothermic.

(iv) Mixing water and potassium chloride.
Answer: Endothermic.

(v) Mixing water and strong acids such as concentrated sulphuric acid.
Answer: Exothermic.

6. (a) Briefly explain the concept of scientific procedure.

Answer:
Scientific procedure refers to a systematic approach used by scientists to investigate phenomena, acquire new knowledge, or validate existing knowledge. It involves clearly defined steps such as observation, hypothesis formulation, experimentation, data collection, analysis, and conclusion. These steps ensure accuracy, reliability, and reproducibility of results in any scientific investigation.

(b) What is the importance of the scientific procedure in daily life? Give two points.

Answer:
i. Helps solve problems systematically: Scientific procedures allow people to address challenges such as health issues, environmental concerns, and technological development in a logical and effective manner.
ii. Enhances decision-making: By using evidence-based analysis, scientific procedures ensure decisions are informed and based on facts rather than assumptions.

7. Use the following components to construct a diagram of the water cycle: clouds, animal, water in the soil, rain, plants, water spring, rivers, lakes, and water vapor in the atmosphere.
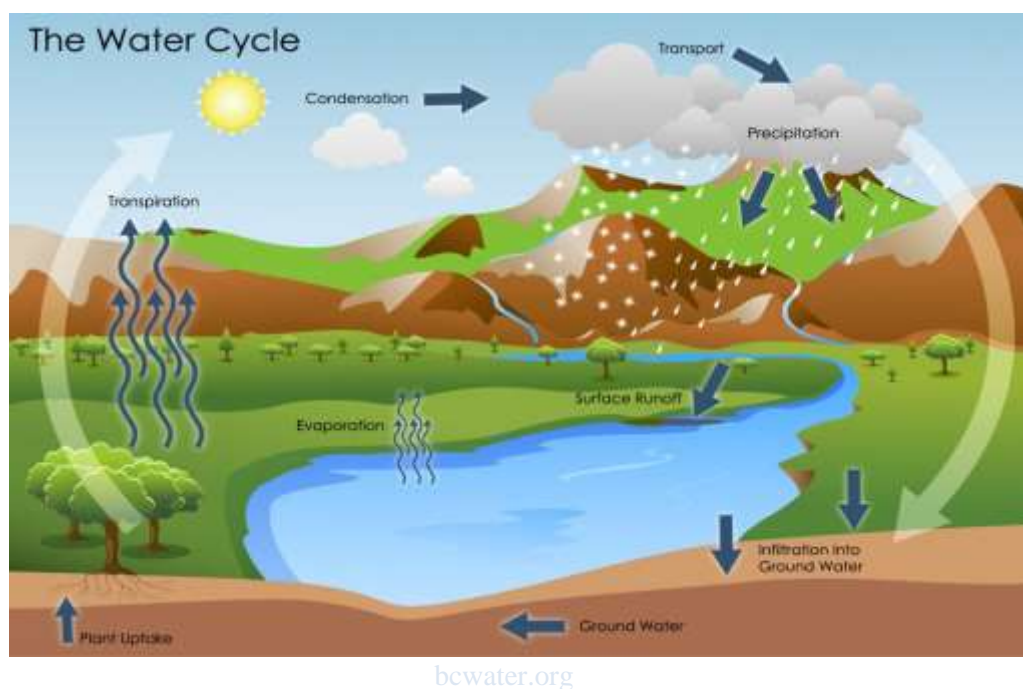
i. Evaporation: Water from rivers, lakes, and soil turns into vapor due to heat from the sun and rises into the atmosphere.
ii. Condensation: Water vapor cools and forms clouds.
iii. Precipitation: Water in the clouds falls as rain, snow, or hail.
iv. Infiltration: Rainwater soaks into the soil and replenishes groundwater.
v. Runoff: Excess water flows into rivers, lakes, and oceans.
vi. Transpiration: Plants release water vapor into the atmosphere through leaves.
vii. Respiration and excretion: Animals release water vapor through breathing and waste.

8. Suppose that two gas jars; one containing gas "A" and another one containing gas "B" are made available to you. Gas "A" is used in hardening of margarine whereas gas "B" is used by mountain climbers.

(a) What tests will you conduct to identify each of the two gases?

Answer:
i. Gas "A" (Hydrogen gas):
- Perform the burning splint test. If the gas produces a "pop" sound, it is hydrogen gas.

ii. Gas "B" (Oxygen gas):
- Perform the glowing splint test. If the glowing splint reignites, it confirms the gas is oxygen.

(b) Give two physical properties and three chemical properties that can be used to distinguish gas "A" from gas "B".

Answer:
Physical properties:
i. Gas "A" (hydrogen) is lighter than air, while gas "B" (oxygen) is slightly heavier than air.
ii. Gas "A" is colorless and odorless, and gas "B" is also colorless and odorless.

Chemical properties:
i. Gas "A" burns with a pale blue flame, while gas "B" supports combustion but does not burn.
ii. Gas "A" reacts with oxygen to form water, while gas "B" reacts with hydrogen to support the formation of water.
iii. Gas "B" reacts with fuels to produce heat and energy, but gas "A" does not support combustion without oxygen.

9. Two experiments A and B were conducted to prepare hydrogen gas by varying the size of zinc granules which were reacted with dilute hydrochloric acid. All other factors were kept constant in the two experiments. Data obtained were used to plot the following graph:

(a) Briefly explain the differences in the results of experiments A and B.
Answer:
- Experiment A shows a higher volume of hydrogen gas evolved in a shorter period compared to experiment B.
- This difference is due to the size of the zinc granules. In experiment A, smaller zinc granules were used, providing a larger surface area for the reaction, leading to a faster rate of reaction.
- In experiment B, larger zinc granules were used, resulting in a slower reaction due to the reduced surface area available for the reaction.

(b) What factors can be adjusted to increase the yield of the product?
Answer:

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i. Increase the concentration of hydrochloric acid to provide more H^+ ions for the reaction.
ii. Increase the temperature of the reaction to accelerate the rate of reaction.
iii. Use an excess of zinc to ensure all the acid reacts.

10. If 2.0 g of $CaCO_3$ were reacted with excess dilute HCl acid:

(a) What volume of CO_2 would be given out at s.t.p.?
Answer:
Step 1: Write the balanced equation:
$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$
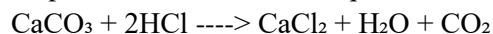
Step 2: Calculate moles of $CaCO_3$:
Moles = Mass / Molar mass = 2.0 / 100 = 0.02 mol

Step 3: Determine moles of CO_2:
From the equation, 1 mol of $CaCO_3$ produces 1 mol of CO_2.
Moles of CO_2 = 0.02 mol

Step 4: Calculate volume at s.t.p.:
Volume = Moles × Molar volume (22.4 L/mol) = 0.02 × 22.4 = 0.448 L

Volume of CO_2 = 0.448 L (448 cm³).

(b) Calculate the mass of CO_2 produced.
Answer:
Mass = Moles × Molar mass = 0.02 × 44 = 0.88 g

Mass of CO_2 produced = 0.88 g.

11. (a) In three points, differentiate homogeneous mixtures from heterogeneous mixtures.
Answer:
i. Homogeneous mixtures have a uniform composition throughout, while heterogeneous mixtures do not.
ii. In homogeneous mixtures, the components are indistinguishable, whereas in heterogeneous mixtures, the components are visible or easily separated.
iii. Homogeneous mixtures include solutions like saltwater, while heterogeneous mixtures include suspensions like muddy water.

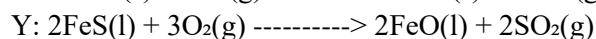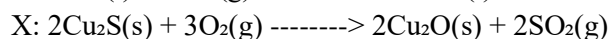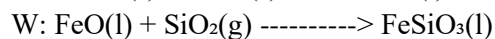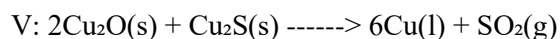(b) By giving four points, justify the fact that common salt is a compound.
Answer:

i. Common salt (NaCl) is made up of two elements, sodium and chlorine, chemically combined in a fixed ratio.

ii. It has distinct properties different from its constituent elements (e.g., Na is reactive, Cl is poisonous, but NaCl is safe).

iii. It cannot be separated into its components by physical means but requires chemical processes.

iv. The chemical formula NaCl indicates a consistent composition throughout.

12. (a) Give three ways in which environmental destruction is likely to occur during the extraction of metals.
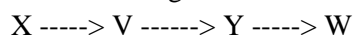
Answer:

i. Deforestation: Clearing land for mining destroys habitats and reduces biodiversity.

ii. Soil degradation: Mining disturbs the soil structure, leading to erosion and loss of fertility.

iii. Water pollution: Toxic chemicals and heavy metals from mining runoff contaminate water bodies.

(b) The following equations represent the steps involved in the conversion stages of iron extraction in the Bessemer converter. Arrange the equations in chronological order from the first step to the last by writing the respective letter so as to get a complete explanation of the conversion stage.

V: $2Cu_2O(s) + Cu_2S(s) \text{ ------>} 6Cu(l) + SO_2(g)$

W: $FeO(l) + SiO_2(g) \text{ ---------->} FeSiO_3(l)$

X: $2Cu_2S(s) + 3O_2(g) \text{ -------->} 2Cu_2O(s) + 2SO_2(g)$

Y: $2FeS(l) + 3O_2(g) \text{ ---------->} 2FeO(l) + 2SO_2(g)$

Answer:

The chronological order is:

X -----> V ------> Y -----> W

Explanation:

- Step X: Copper(I) sulfide reacts with oxygen to form copper(I) oxide and sulfur dioxide.
- Step V: Copper(I) oxide reacts with copper(I) sulfide to produce molten copper and sulfur dioxide.
- Step Y: Iron(II) sulfide reacts with oxygen to form iron(II) oxide and sulfur dioxide.
- Step W: Iron(II) oxide reacts with silicon dioxide to form slag (iron silicate).

13. By giving six points, explain how to maintain soil fertility of a particular area.

Answer:

i. Crop rotation: Growing different types of crops in a sequence prevents nutrient depletion and promotes balanced soil nutrition.

ii. Use of organic manure: Adding compost, animal manure, or green manure increases soil organic matter and improves fertility.

iii. Planting cover crops: Cover crops like legumes fix nitrogen in the soil and prevent erosion.

iv. Mulching: Covering the soil with organic or inorganic materials helps retain moisture, reduce erosion, and add organic matter.

v. Conservation tillage: Minimal disturbance of the soil structure reduces erosion and preserves soil nutrients.

vi. Use of fertilizers: Proper application of chemical fertilizers replenishes essential nutrients like nitrogen, phosphorus, and potassium.

14. How electrolysis is applied in industries? Describe by giving six points.

Answer:

i. Extraction of metals: Electrolysis is used to extract reactive metals like aluminum and sodium from their ores. Example: Electrolysis of molten alumina in the Hall-Héroult process.

ii. Electroplating: Electrolysis is used to coat materials with a thin layer of metal, enhancing their appearance and resistance to corrosion. Example: Electroplating of silver on utensils.

iii. Production of chlorine and caustic soda: Electrolysis of brine (NaCl solution) produces chlorine gas, hydrogen gas, and sodium hydroxide.

iv. Refining of metals: Electrolysis purifies metals like copper, removing impurities. Example: Electrolytic refining of copper.

v. Production of hydrogen and oxygen: Electrolysis of water is used to produce hydrogen and oxygen for industrial and medical purposes.

vi. Manufacturing batteries: Electrolysis is utilized in rechargeable batteries, such as lithium-ion batteries, to facilitate charging and discharging processes.