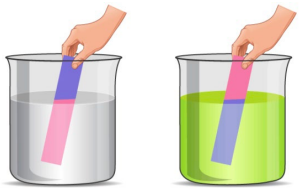
SAMPLE EXAMINATION QUESTIONS FOR THE CHEMISTRY GLOBAL FINAL - CATEGORY 1 (GRADES 7-8)

Q1. You have a sample of saltwater. You use distillation to separate the water from the salt. What does this tell you about saltwater?
A) Saltwater is an element because it can be separated.
B) Saltwater is a compound because it cannot be broken down further.
C) Saltwater is a mixture because its components can be physically separated.
D) Saltwater is a pure substance because it is found in nature.



Q2. You test a solution with litmus paper, and it turns red. Then, you add baking soda, and the color changes to blue. What can you conclude about the solution?
A) The solution was acidic, and baking soda made it neutral.
B) The solution was basic, and baking soda made it acidic.
C) The solution was acidic, and baking soda made it basic.
D) The solution was neutral, and baking soda had no effect.

Q3. You are studying the periodic table and notice that sodium and potassium are in the same group. Why do they share similar properties?
A) They have the same number of neutrons.
B) They have the same number of electrons in their outermost shell.
C) They are in the same period, so their atomic masses are similar.
D) They have the same number of protons.

Q4. You have a glass of orange juice with pulp. Is this a homogeneous or heterogeneous mixture, and why?
A) Homogeneous, because the pulp is evenly distributed throughout.
B) Heterogeneous, because you can see distinct parts like pulp and liquid.
C) Homogeneous, because it is a liquid.
D) Heterogeneous, because all mixtures are uneven.

Q5. In the reaction $2Mg + O_2 \rightarrow 2MgO$, magnesium loses electrons while oxygen gains them. What type of reaction is this?
A) Thermochemical reaction
B) Redox reaction
C) Neutralization reaction
D) Decomposition reaction

Q6. Consider two isotopes of chlorine: chlorine-35 and chlorine-37. How do their chemical properties compare, and why?
A) They have identical chemical properties because they have the same number of protons and electrons.
B) They have different chemical properties because they have different numbers of neutrons.

C) They have identical chemical properties but different physical properties due to different mass numbers.
D) They have different chemical properties because they belong to different groups.

Q7. Why does carbon dioxide have a linear, non polar molecular shape, even though oxygen is more electronegative than carbon?
A) Carbon and oxygen form ionic bonds, canceling out polarity.
B) The linear arrangement and symmetric distribution of polar bonds result in no net dipole moment.
C) Carbon shares electrons equally with oxygen, making it non polar.
D) Oxygen's electronegativity pulls electrons away, making it polar.

Q8. In the unbalanced reaction $NH_3 + O_2 \rightarrow NO + H_2O$, if you start with 10 moles of NH_3, how many moles of O_2 are required, and why is this stoichiometry important?

A) 12.5 moles of O_2, to ensure the reaction follows the law of conservation of mass.

B) 8 moles of O_2, to maximize the yield of NO.

C) 12.5 moles of O_2, to balance the electrons transferred in the reaction.

D) 10 moles of O_2, because the reactants must be equal.

Q9. If the concentration of CO_2 in the atmosphere increases, how might this affect the pH of ocean water, and what chemical process is responsible?
A) The pH increases due to photosynthesis in oceans.

B) The pH decreases due to the formation of carbonic acid from CO_2 dissolving in water.

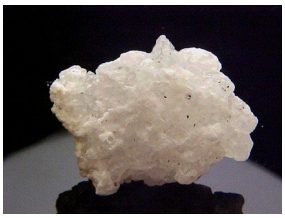
C) The pH remains unchanged because CO_2 is inert in water.

D) The pH increases due to the release of OH^- ions from CO_2.

Q10. An element has two isotopes: one with a mass of 10 amu (20% abundance) and another with a mass of 11 amu (80% abundance). Calculate the average atomic mass of the element.
A. 10.8 amu
B. 10.5 amu
C. 10.3 amu
D. 10.6 amu

Q11. A 26 g Prince's metal contains 25% zinc and copper powder by mass. This mixture reacts with excess hydrochloric acid in the reactions. Calculate the mass of zinc chloride after the reaction.
A) 30.4 g
B) 45.6 g
C) 15.4 g
D) 13.6 g

Q12. To determine the mass percentage of calcium oxide in a mixture with calcium carbonate, a sample of the mixture weighing 0.8 g was treated with an excess of hydrochloric acid solution. As a result, a gas with a volume of 112 ml was released at STP. Determine the mass percentage of calcium oxide in the mixture.
A) 20%
B) 25.6%
C) 30.5%
D) 37.5%



Q13. When evaporating a sodium sulfate solution, the salt precipitates as the crystal hydrate $Na_2SO_4 \cdot 10H_2O$. What mass of the crystal hydrate can be obtained from a solution with a volume of 200 mL, a mass percentage of sodium sulfate of 15%, and a density of 1.14 g/mL?
A) 77.6g
B) 53.4g
C) 33.5g
D) 65.7g

Q14. Upon partial reduction of cobalt(II) oxide with a mass of 30 g using hydrogen, a mixture of the oxide and metal with a mass of 26.8 g was obtained. What amount of substance (in moles) of hydrogen reacted?
A) 0.1 mole
B) 0.3 mole
C) 0.4 mole
D) 0.2 mole

Q15. Hydrogen was burned in an excess of oxygen. The volume of the gas mixture, reduced to normal conditions, decreased by 240 mL. Determine the initial volume of hydrogen. Calculate the volume under normal conditions.
A) 160 ml
B) 145 ml
C) 150 ml
D) 140 ml

Q16. When water acts on a 0.84 g sample of a metal hydride, hydrogen gas is released, with a volume of 896 mL under normal conditions. Determine the hydride of which element was used, given that this element exhibits an oxidation state of +2. Provide your solutions
Q17. A 36 g sample of hydrogen reacts with 128 g of oxygen in the reaction

$$2H_2 + O_2 \rightarrow 2H_2O.$$

a. Determine the limiting reagent.
b. Calculate the mass of water formed if the reaction achieves 75% yield.
c. What percentage of the excess reactant remains unreacted?

Q18. Upon photo-decomposition of a 18.7 g solution of hydrogen peroxide, a gas with a volume of 672 mL was released (under normal conditions). Sulfuric acid and an excess of

potassium iodide solution were added to the remaining hydrogen peroxide solution, resulting in the formation of 12.7 g of iodine. Determine the mass fraction of hydrogen peroxide in the original solution. Provide your solutions

Q19. The gas obtained by the action of an excess of hydrochloric acid solution on 40 g of calcium carbonate was absorbed by a sodium hydroxide solution. As a result, sodium carbonate was formed. Calculate the volume of a solution with a mass fraction of sodium hydroxide of 20% and a density of 1.22 g/mL that was used to absorb the gas produced.Provide your solutions

Q20. A sample of colorless gas **Y** was divided into two equal parts. When the first part was passed through an excess of lead nitrate solution, a yellow precipitate with a mass of 78.37 g was formed. The second part was mixed with a colorless gas **X**, resulting in equal volume fractions of the components in the resulting mixture, with the mass fraction of gas **X** being 1/3.

a. Identify the substances **X** and **Y**, considering that both gases turn litmus solution red.

b. Determine the mass of the precipitate formed when the resulting gas mixture is passed through an excess of limewater. Include in your answer the equations for all reactions described in the problem.

c. Write no more than 2 chemical reaction equations leading to the formation of gas **X**, and no more than 2 chemical reaction equations illustrating its chemical properties.

Answer key

1) C
2) C
3) B
4) B
5) B
6) C
7) B
8) A
9) B
10) A
11) D
12) D
13) A
14) D
15) A

Open ended problem's solutions

We represent the formula of the hydride of an element as EH_2.
Its molar mass is:
$M(EH_2) = M(E) + 2M(H)$; $M(EH_2) = [M(E) + 2]$ g/mol.

We determine the amount of substance of the hydride that participated in the reaction:

$$n(\mathrm{EH_2}) = \frac{m(\mathrm{EH_2})}{M(\mathrm{EH_2})} = \frac{0.84}{M(\mathrm{E}) + 2}\ \mathrm{mol}.$$

The amount of substance of hydrogen gas released during the decomposition of the hydride is:

$$V(\mathrm{H_2}) = 0.896\ \mathrm{L},$$

$$n(\mathrm{H_2}) = \frac{V(\mathrm{H_2})}{V_m} = \frac{0.896}{22.4}\ \mathrm{mol} = 0.04\ \mathrm{mol}.$$

We write the reaction equation for the interaction of the hydride with water:

$$\mathrm{EH_2} + 2\mathrm{H_2O} = \mathrm{E(OH)_2} + 2\mathrm{H_2}.$$

From the reaction equation, it follows that:

Q16.

- **Molar masses:** H_2 = 2 g/mol, O_2 = 32 g/mol, H_2O = 18 g/mol.
- **Moles:** Moles of H_2 = 36 g / 2 g/mol = 18 mol, moles of O_2 = 128 g / 32 g/mol = 4 mol.
- **Stoichiometry:** 2 mol H_2 react with 1 mol O_2. 18 mol H_2 require 18 / 2 = 9 mol O_2, but we have 4 mol O_2, so O_2 is limiting.
- **a. Limiting reagent:** O_2 is limiting.
- **b. Water formed:** 1 mol O_2 produces 2 mol H_2O. 4 mol O_2 produce 8 mol H_2O. Mass = 8 mol × 18 g/mol = 144 g. At 75% yield, mass = 0.75 × 144 = 108 g.
- **c. Excess reactant (H_2):** Moles of H_2 used = 4 mol O_2 × (2 mol H_2 / 1 mol O_2) = 8 mol. Moles remaining = 18 - 8 = 10 mol. Mass remaining = 10 mol × 2 g/mol = 20 g. Percentage remaining = (20 g / 36 g) × 100% ≈ 55.6%.

Answer:
a. Oxygen (O_2) is the limiting reagent.
b. 108 g of water is formed at 75% yield.
c. 55.6% of hydrogen remains unreacted.

$$\frac{n(\mathrm{EH_2})}{n(\mathrm{H_2})} = \frac{1}{2},$$

or

$$\frac{0.84}{M(\mathrm{E}) + 2} \div 0.04 = \frac{1}{2}.$$

From this, we find that $M(\mathrm{E}) = 40\ \mathrm{g/mol}$. Therefore, the chemical element forming the hydride is calcium.

Q17.

Hydrogen peroxide decomposes under light as follows:

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

The gas released is oxygen, with a volume of 672 mL = 0.672 L. Under normal conditions (0°C, 1 atm), the molar volume of a gas is 22.4 L/mol. So, the moles of O_2 produced are:

$$n(O_2) = \frac{0.672}{22.4} = 0.03\,\text{mol}$$

From the reaction, 2 moles of H_2O_2 produce 1 mole of O_2. Thus, the moles of H_2O_2 decomposed are:

$$n(H_2O_2)_{\text{decomposed}} = 2 \times 0.03 = 0.06\,\text{mol}$$

The molar mass of H_2O_2 is 34 g/mol (2×1 + 2×16), so the mass decomposed is:

$$m(H_2O_2)_{\text{decomposed}} = 0.06 \times 34 = 2.04\,\text{g}$$

Q18.

The remaining H_2O_2 reacts with KI in acidic conditions (via H_2SO_4):

$$H_2O_2 + 2KI + H_2SO_4 \rightarrow I_2 + K_2SO_4 + 2H_2O$$

Here, 1 mole of H_2O_2 produces 1 mole of I_2. The mass of I_2 formed is 12.7 g, and the molar mass of I_2 is 254 g/mol (127×2). So, the moles of I_2 are:

$$n(I_2) = \frac{12.7}{254} = 0.05\,\text{mol}$$

Thus, the moles of H_2O_2 that remained and reacted are:

$$n(H_2O_2)_{\text{remaining}} = 0.05\,\text{mol}$$

The total mass of the solution is 18.7 g. The mass fraction of H_2O_2 is:

$$w(H_2O_2) = \frac{m(H_2O_2)_{\text{total}}}{m_{\text{solution}}} = \frac{3.74}{18.7} = 0.2 = 20\%$$

- Reaction: $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$
- Moles of $CaCO_3$: $\frac{40}{100} = 0.4\,\text{mol}$
- Moles of CO_2: 0.4 mol
- Reaction with NaOH: $CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$
- Moles of NaOH: $2 \times 0.4 = 0.8\,\text{mol}$
- Mass of NaOH: $0.8 \times 40 = 32\,\text{g}$
- Mass of NaOH solution (20% w/w): $\frac{32}{0.2} = 160\,\text{g}$
- Volume of solution: $\frac{160}{1.22} \approx 131.15\,\text{mL}$

Final Answer: The volume of the sodium hydroxide solution used is approximately **131.15 mL**.

Q19.

$$\mathrm{Ca(OH)_2 + 2HI \rightarrow CaI_2 + 2H_2O}$$

(1 point)

$$n(\mathrm{PbI_2}) = \frac{78.37}{461} = 0.17\ \mathrm{mol},\ \text{then}\ n(\mathrm{HI}) = 0.34\ \mathrm{mol}$$

(1 point)

Since the volume fractions are equal, $n(\mathrm{SO_2}) = 0.34\ \mathrm{mol}$. (1 point)

$$n(\mathrm{CaSO_3}) = n(\mathrm{SO_2}) = 0.34\ \mathrm{mol}$$

(1 point)

$$m = 0.34 \times 120 = 40.8\ \mathrm{g}$$

(1 point)

3. We accept any two of the first written and chemically meaningful equations for each section (formation and properties), for example:

- Formation of SO_2:

$$\mathrm{S + O_2 \rightarrow SO_2}$$

$$\mathrm{Na_2SO_3 + 2HCl \rightarrow 2NaCl + SO_2 + H_2O}$$

- Properties of SO_2:

$$\mathrm{2SO_2 + O_2 \rightarrow 2SO_3}$$

$$\mathrm{SO_2 + CaO \rightarrow CaSO_3}$$

Each equation is worth 1 point, totaling 4 points (2 points for formation reactions, 2 points for illustrating properties).

Q20.