Some Basic Concepts of Chemistry

Question1

Which of the following methods of expressing concentration are unitless?

KCET 2025

Options:

A.

Mole fraction and Mass percent (W/W)

B.

Molality and Mole fraction

C.

Mass percent (W/W) and Molality

D.

Molality and Molarity

Answer: A

Solution:

Option A is correct: mole fraction and mass percent (w/w) are both unitless.

Mole fraction

$x_i = \frac{n_i}{\sum_j n_j}$

It’s simply a ratio of moles, so no units.

Mass percent (w/w)

$$\text{mass \%} = \frac{\text{mass of solute}}{\text{total mass of solution}} \times 100\%$$

Again, a ratio of masses, giving a percentage without units.

By contrast, molality has units of mol/kg and molarity has mol/L, so neither is unitless.

Question2

Select the INCORRECT statement/s from the following:

(a) 22 books have infinite significant figures

(b) In the answer of calculation 2.5×1.25 has four significant figures,.

(c) Zero's preceding to first non-zero digit are significant

(d) In the answer of calculation $12.11 + 18.0 + 1.012$ has three significant figures

KCET 2025

Options:

A. b, c and d

B. b and c only

C. b and d only

D. a and b only

Answer: B

Solution:

Let's check each statement:

(a) "22 books have infinite significant figures."

• A counted quantity is exact ⇒ effectively infinite sig figs. ⇒ **Correct**

(b) "In the answer of 2.5×1.25 there are four significant figures."

• 2.5 has 2 sig figs, 1.25 has 3 ⇒ product limited to 2 sig figs ⇒ **Incorrect**

(c) "Zeros preceding the first non-zero digit are significant."

• Leading zeros are not significant ⇒ **Incorrect**

(d) "In $12.11 + 18.0 + 1.012$ the result has three significant figures."

• Add → match decimal places (fewest is 1 place) ⇒ result ≈31.1 ⇒ 3 sig figs ⇒ **Correct**

Incorrect statements are (b) and (c) only ⇒ **Option B**.

Question3

0.48 g of an organic compound on complete combustion produced 0.22 g of CO_2. The percentage of C in the given organic compound is

KCET 2024

Options:

A. 25

B. 50

C. 12.5

D. 87.5

Answer: C

Solution:

To determine the percentage of carbon in the given organic compound, follow these steps:

Amount of Carbon in CO_2:

The molecular weight of CO_2 is calculated as follows:

Carbon (C): 12 g/mol

Oxygen (O): 16 g/mol (so, O_2 is 32 g/mol)

Therefore, the molecular weight of CO_2 is:

$12 + 32 = 44$ g/mol

The amount of carbon in CO_2 is given by the ratio of the atomic weight of carbon to the molecular weight of carbon dioxide:

Fraction of Carbon in $CO_2 = \frac{12}{44}$

Calculate the Mass of Carbon:

Given that 0.22 g of CO_2 is produced, the mass of carbon from CO_2 is:

Mass of Carbon $= 0.22 \times \frac{12}{44} = 0.06$ g

Calculate the Percentage of Carbon:

The percentage of carbon in the original organic compound (0.48 g) is:

Percentage of Carbon $= \left(\frac{0.06}{0.48}\right) \times 100 = 12.5\%$

Therefore, the percentage of carbon in the organic compound is **12.5%** (Option C).

Question4

An aqueous solution of alcohol contains 18 g of water and 414 g of ethyl alcohol. The mole fraction of water is

KCET 2022

Options:

A. 0.4

B. 0.7

C. 0.9

D. 0.1

Answer: D

Solution:

Given, amount of ethylalcohol $= 414$ g

Amount of water $= 18$ g

Molar mass of water $= 18$

Molar mass of ethyl alcohol $= 46$

Mole of $C_2H_3OH = \frac{414}{46} = 9$

Mole of $H_2O = \frac{18}{18} = 1$

Mole fraction of $H_2O = \frac{1}{10} = 0.1$

Question5

A pure compound contains 2.4 g of C, 1.2×10^{23} atoms of H, 0.2 moles of oxygen atoms. Its empirical formula is

KCET 2021

Options:

A. C_2HO

B. $C_2H_2O_2$

C. CH_2O

D. CHO

Answer: D

Solution:

Moles of carbon $= \frac{w}{M} = \frac{2.4}{12} = 0.2$ mol

$$\begin{aligned}\text{Moles of H in } 1.2 \times 10^{23} \text{ atoms of H} &= \frac{1.2 \times 10^{23}}{6 \times 10^{23}} \\ &= 0.2 \text{ mol}\end{aligned}$$

Moles of oxygen atoms $= 0.2$ moles

Now, simplest ratio of the moles of C, H and O is as follows

$$\begin{aligned}&= \mathrm{C} : \mathrm{H} : \mathrm{O} \\ &= 0.2 : 0.2 : 0.2 = \mathrm{CHO}\end{aligned}$$

Thus, the empirical formula of the compound is CHO.

Question6

0.4 g of dihydrogen is made to react with 7.4 g of dichlorine to form hydrogen chloride. The volume of hydrogen chloride formed at 273 K and 1 bar pressure is

KCET 2020

Options:

A. 9.08 L

B. 4.67 L

C. 90.8 L

D. 45.4 L

Answer: B

Solution:

$$H_2 + Cl_2 \longrightarrow 2HCl$$

1 mol	1 mol	2 mol or (2 × 22.4 L at STP)
2g	71g	73g

71 gCl_2 requires 2 gH_2, than 7.4 gCl_2 will require, how much gram H_2.

$\therefore H_2$ required $= \frac{2\times7.4}{71} = 0.208$ gm

$\therefore Cl_2$ is limiting reagent $[\because H_2$ is in excess $]$

$\therefore$ Amount of HCl formed will depend on Cl_2 gas

71 gm Cl_2 44.8 L HCl
7.4 gm Cl_2 x L HCl

$\therefore \quad x = \frac{7.4\times44.8}{71}$

$x = 4.67$ L of HCl gas is formed.

Question7

A gas mixture contains 25% He and 75% CH_4 by volume at a given temperature and pressure. The percentage by mass of methane in the mixture is approximately _________.

KCET 2020

Options:

A. 75%

B. 25%

C. 92%

D. 8%

Answer: C

Solution:

Gas mixture contains 25% He and 75% CH_4 by volumes. We have to calculate the mass percentage of methane in the mixture.

molar mass of He $= 4$molar mass of $CH_4 = 16$

$\therefore$ Mass percentage of methane in the mixture shall be $= \frac{75\times16}{25\times4+75\times16} \times 100 = 92\%$

Question8

A metal exists as an oxide with formula $M_{0.96}$ O. Metal, M can exist as M^{2+} and M^{3+} in its oxide $M_{0.96}$O. The percentage of M^{3+} in the oxide is nearly

KCET 2020

Options:

A. 8.3%

B. 4.6%

C. 5%

D. 9.6%

Answer: A

Solution:

We are given metal oxide with formula $M_{0.96}\mathrm{O}$. Here, M can exist as M^{2+} as well as M^{3+}. Here, for every 100 oxide ions there are $96M$ ions. Let out of this 96M toms, M^{2+} exists $= x$ and M^{3+} will be $= (96 - x)$.

Total positive charge on 96M-atoms $= 2 \times x + 3 \times (96 - x)$

Total negative charge on 100O-atoms $= 100 \times 2$

$= 200$

As per electrical neutrality concept

$$\begin{aligned} 2x + 3(96 - x) &= 200 \\ 2x + 288 - 3x &= 200 \\ -x &= 200 - 288 \\ -x &= -88 \text{ or } x = 88 \\ 96 - 88 &= 8 \end{aligned}$$

So, the ratio of M^{3+} will be $\frac{8}{96} \times 100 = 8.3\%$

Question9

The mass of AgCl precipitated when a solution containing 11.70 g of NaCl is added to a solution containing 3.4 g of $\mathrm{AgNO_3}$ is [Atomic mass of $\mathrm{Ag} = 108$, Atomic mass of $\mathrm{Na} = 23$]

KCET 2019

Options:

A. 5.74 g

B. 1.17 g

C. 2.87 g

D. 6.8 g

Answer: C

Solution:

To determine the mass of AgCl precipitated, we need to analyze the reaction between NaCl and $AgNO_3$. The balanced chemical equation for the reaction is:

$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

From the equation, we can see that one mole of NaCl reacts with one mole of $AgNO_3$ to produce one mole of AgCl.

First, we need to find the number of moles of NaCl and $AgNO_3$ present in the given masses.

The molar mass of NaCl is:

$M_{NaCl} = 23 + 35.5 = 58.5\,g/mol$

So, the number of moles of NaCl in 11.70 g is:

$n_{NaCl} = \frac{11.70\,g}{58.5\,g/mol} = 0.20\,mol$

The molar mass of $AgNO_3$ is:

$M_{AgNO_3} = 108 + 14 + (3 \times 16) = 108 + 14 + 48 = 170\,g/mol$

So, the number of moles of $AgNO_3$ in 3.4 g is:

$n_{AgNO_3} = \frac{3.4\,g}{170\,g/mol} = 0.02\,mol$

Since the ratio of NaCl to $AgNO_3$ in the reaction is 1:1, the limiting reagent is $AgNO_3$, because it has fewer moles (0.02 moles) compared to NaCl (0.20 moles).

Now, we calculate the mass of AgCl produced from 0.02 moles of $AgNO_3$.

The molar mass of AgCl is:

$M_{AgCl} = 108 + 35.5 = 143.5\,g/mol$

So, the mass of AgCl produced from 0.02 moles is:

$m_{AgCl} = 0.02\,mol \times 143.5\,g/mol = 2.87\,g$

Therefore, the mass of AgCl precipitated is 2.87 g, making the correct answer:

Option C: 2.87 g

Question10

1.0 g of Mg is burnt with 0.28 g of O_2 in a closed vessel. Which reactant is left in excess and how much?

KCET 2018

Options:

A. Mg, 5.8 g

B. Mg, 0.58 g

C. O_2, 0.24 g

D. O_2, 2.4 g

Answer: B

Solution:

The burning of magnesium (Mg) occurs according to the following reaction:

$2Mg + O_2 \rightarrow 2MgO$

From the balanced equation, we see:

Molar mass of Mg: 24 g/mol

Molar mass of O_2: 32 g/mol

48 g of Mg (2 moles) reacts with 32 g of O_2 (1 mole).

To find how much magnesium is needed to react with 0.28 g of O_2:

$\frac{48 \text{ g Mg}}{32 \text{ g O}_2} = x \text{ g Mg}/0.28 \text{ g O}_2$

Solving for x:

$x = \frac{48 \times 0.28}{32} = 0.42 \text{ g Mg}$

Since only 0.42 g of Mg is required to completely react with 0.28 g of O_2, and we started with 1.0 g of Mg, the amount of magnesium left in excess is:

$1.0 \text{ g Mg} - 0.42 \text{ g Mg} = 0.58 \text{ g Mg}$

Therefore, magnesium is the reactant left in excess, with 0.58 g remaining.

Question11

Select wrong chemical reaction among the following.

KCET 2017

Options:

A. $8NH_3 + 3Cl_2 \rightarrow 6NH_4Cl + N_2$

B. $2Ca(OH)_2 + 2Cl_2 \rightarrow Ca(OCl)_2 + CaCl_2 + 2H_2O$

C. $2NaOH + Cl_2 \rightarrow 2NaCl + H_2 + O_2$

D. $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

Answer: C

Solution:

Let's examine each reaction step by step:

Option A: $8\,NH_3 + 3\,Cl_2 \rightarrow 6\,NH_4Cl + N_2$

Checking the atom counts:

Nitrogen: Left has 8 (from 8 NH_3); Right has 6 (from 6 NH_4Cl) + 2 (from N_2) = 8.

Hydrogen: Left has 8×3 = 24; Right has 6×4 = 24.

Chlorine: Left has 3×2 = 6; Right has 6 (from 6 NH_4Cl).

This reaction is correctly balanced and is known to occur under certain conditions where chlorine reacts with ammonia to yield ammonium chloride and nitrogen.

Option B: $2\,Ca(OH)_2 + 2\,Cl_2 \rightarrow Ca(OCl)_2 + CaCl_2 + 2\,H_2O$

Checking the atom counts:

Calcium: 2 on both sides.

Chlorine: Left has 2×2 = 4; Right has 2 (in $Ca(OCl)_2$) + 2 (in $CaCl_2$) = 4.

Oxygen: Left has 2×2 = 4 (from $Ca(OH)_2$); Right has 2 (from $Ca(OCl)_2$) + 2 (from 2 H_2O) = 4.

Hydrogen: Left has 2×2 = 4; Right has 2×2 = 4.

This reaction is balanced and represents a known process for producing bleaching powder (calcium hypochlorite).

Option C: $2\,NaOH + Cl_2 \rightarrow 2\,NaCl + H_2 + O_2$

Checking the atom counts:

Sodium: 2 on both sides.

Chlorine: Left has 2 (from Cl_2); Right has 2 (from 2 NaCl).

Oxygen: Left has 2 (from 2 NaOH); Right has 2 (from O_2).

Hydrogen: Left has 2 (from 2 NaOH); Right has 2 (from H_2).

Although the equation is balanced in terms of atoms, it is not chemically plausible. In reality, when chlorine reacts with sodium hydroxide, the typical reactions are:

Under cold conditions:

$Cl_2 + 2\,NaOH \rightarrow NaCl + NaOCl + H_2O$

Under hot or concentrated conditions:

$3\,Cl_2 + 6\,NaOH \rightarrow 5\,NaCl + NaClO_3 + 3\,H_2O$

There is no common or accepted reaction where sodium hydroxide and chlorine yield hydrogen gas (H_2) and oxygen gas (O_2) as the sole products. Thus, Option C is not a valid reaction under normal conditions.

Option D: $MnO_2 + 4\,HCl \rightarrow MnCl_2 + Cl_2 + 2\,H_2O$

Checking the atom counts:

Manganese: 1 on both sides.

Oxygen: 2 (from MnO_2) equals 2 (from 2 H_2O).

Hydrogen: 4 (from 4 HCl) equals 4 (from 2 H_2O).

Chlorine: 4 (from 4 HCl) equals 2 (from $MnCl_2$) + 2 (from Cl_2) = 4.

This is a well-known reaction where manganese dioxide oxidizes chloride ions in acid, releasing chlorine gas.

Based on the above analysis, the incorrect (or wrong) chemical reaction is:

Option C

Question12

If 3.01×10^{20} molecules are removed from 98 mg of H_2SO_4, then number of moles of H_2SO_4 left are

KCET 2017

Options:

A. 0.1×10^{-3} mol

B. 9.95×10^{-2} mol

C. 0.5×10^{-3} mol

D. 1.66×10^{-3} mol

Answer: C

Solution:

To determine the number of moles of H_2SO_4 left after removal of molecules, we start by considering the initial amount.

Initial Calculation:

Given 98 mg of H_2SO_4, the number of molecules is 6.02×10^{20}.

Molecules Removed:

The problem states that 3.01×10^{20} molecules are removed.

Molecules Remaining:

Calculation:

$6.02 \times 10^{20} - 3.01 \times 10^{20} = 3.01 \times 10^{20}$

Finding Moles of H_2SO_4 Remaining:

Using the formula $n = \frac{N}{N_A}$, where n is the number of moles, N is the number of molecules, and N_A (Avogadro's number) is 6.02×10^{23}.

Substitute the values in:

$n = \frac{3.01 \times 10^{20}}{6.02 \times 10^{23}}$

Simplifying the expression gives:

$n = 0.5 \times 10^{-3}$ mol

Thus, the number of moles of H_2SO_4 left after removing 3.01×10^{20} molecules is 0.5×10^{-3} mol.
