Analytical Chemistry Questions with Solutions

Ques 1. Michael's scale measures the mass of objects as consistently 2kg less than their actual mass. How would you describe the scale?

(a) It is neither accurate nor precise
(b) It is precise, but not accurate
(c) It is accurate, but not precise
(d) It is both accurate and precise

Answer: It is precise, but not accurate.

Ques 2. Which of the following substances can not be separated by distillation?

(a) A mixture of proteins
(b) Crude oil fractions
(c) Oxygen and nitrogen in air
(d) Water in salt solution

Answer: A mixture of proteins can not be separated by distillation.

Ques 3. Which of the following separation techniques is dependent on the difference in volatility?

(a) Distillation
(b) Crystallisation
(c) Magnetic separation
(d) Fractional crystallisation

Answer: The distillation process is dependent on the difference in volatility.

Ques 4. What is the use of TLC and HPLC?
Answer: TLC is used to check whether the reaction is completed or not. In contrast, HPLC is used to identify, quantify, and separate the mixture.

Ques 5. What is added to the iodometry and iodimetry analysis in redox titration?
Answer: For iodimetry, iodine is added to a starch solution, and the endpoint is signalled by the change of colour from a colourless solution to a blue colour.

Ques 6. What are the differences between qualitative and quantitative analysis?
Answer:

S. No.	Quantitative Analysis	Qualitative Analysis

1.	Quantitative Analysis says 'what' is in a sample.	Quantitative Analysis says 'how much is in a sample.
2.	It is expressed in numbers and graphs.	It is expressed in words.
3.	It is used in testing or confirming theories and assumptions.	It is used in understanding concepts, thoughts or experiences.
4.	It is used to establish generalisable facts about a topic.	It lets you gather in-depth insights on topics

Ques 7: What are the differences between molarity and normality?
Answer:

S. No.	Molarity	Normality
1.	Molarity refers to the number of moles of a compound present in 1l of solution.	Normality refers to the gram equivalent weight of solute present in 1l of solution.
2.	Its unit is mol/L.	Its unit is eq/L.
3.	It does not depend on the type of reaction the solute undergoes.	It depends on the type of reaction the solute undergoes.
4.	It depends on temperature, volume, addition of more solute, and solute solubility.	It depends on the reactive species present in the solution.

Ques 8. Match the following physical quantities with their units.

Column 1	Column 2
(a) Molarity	(1)Pascal
(b)Mole fraction	(2)mol kg^{-1}
©Mole	(3)mol
(d)Molality	(4)Unitless
(e)Pressure	(5)mol L^{-1}

Answer: a-5, b-4, c-3, d-2, e-1

Ques 9. Match the following.

Column 1	Column 2
(a) 88 g of CO_2	**(1)2 mol**
(b) 6.022 x 10^{23} molecules of H_2O	**(2)1 mol**
©5.6 litres of O_2 at STP	**(3)0.25 mol**
(d)96 g of O	**(4)3 mol**
(e)1 mol of any gas	**(5)6.022 x 10^{23} molecules**

Answer: a-5, b-4, c-3, d-2, e-1

Ques 10. What is the use of ion-pair reagents?

Answer: The chemical substances that pair each other to form complexes are ion-pair reagents. These can be used to stabilise one of the more active molecules or to colourifying etc.

Ques 11. A reaction between one mole of sodium and one mole of chloride should yield 42 grams of sodium chloride. In your experiment, the actual yield is 32.73 grams. Calculate the percent error of your experiment.
Answer: Given,
Theoretical Yield: 42g
Actual Yield: 32.73g
We know that,
Percent Error: Theoretical Yield - Actual Yield / Theoretical Yield * 100
Percent Error: 42 - 32.73 / 42 * 100
Percent Error: 22.07%

Ques 12. Calculate the mass percentage of the different elements present in sodium thiosulphateahte.

Answer: The molecular formula of sodium thiosulphate is $Na_2S_2O_4$, and its molar mass is 142g.
We are calculating the mass percentage of each element in the given compound.
Mass percentage of element = Mass of that element in the compound / Molar mass * 100
Hence, mass percent of Sodium = 46 / 142 * 100 = 32.4%
Mass percent of Sulphur = 32 / 142 * 100 = 22.57%
Mass percent of Oxygen = 64 / 142 * 100 = 45.05%

Ques 13. Determine the empirical formula of an oxide of iron that has 69.9% iron and 30.1% dioxygen by mass.

Answer: Percent of iron by mass = 69.9%
Percent of oxygen by mass = 30.1%
Relative moles of iron = Per cent of iron by mass / Atomic mass of iron
Relative moles of iron = 69.9 / 55.85
Relative moles of iron = 1.25
Relative moles of oxygen = Per cent of oxygen by mass / Atomic mass of oxygen
Relative moles of oxygen = 30.1 / 16
Relative moles of oxygen = 1.88
Since we have relative moles of both the elements so, we can calculate the simpler molar ratio.
1.25:1.88
1:1.5
2:3
Hence, the empirical formula of iron oxide will be Fe_2O_3.

Ques 14. A pigment moved 3.4 cm during a chromatography experiment, while the solvent moved 4.8 cm. Calculate the Rf value.

Answer: Given
Distance moved by the pigment = 3.4
Distance moved by the solvent = 4.8
We know that
Rf = Distance moved by the pigment / Distance moved by the solvent
Rf = 3.4 / 4.8
Rf = 0.7083 = 0.71

Ques 15. How many grams of hydrogen chloride, HCl are required to prepare 4 Litre of 5M HCl in water.

Answer: Given,
Molarity = 5 M
Volume = 4 L
Moles of HCl = Molarity * Volume
Moles of HCl = 5 * 4
Moles of HCl = 20 moles
1 mole of HCl = 36.5 g
20 moles of HCl = 36.5 * 20
20 moles of HCl = 730g

Hence 730 g of HCl is required to prepare 4 Litre of 5M HCl in water.

Practise Questions on Analytical Questions

Ques 1. In the following reaction, eight moles of sodium hydroxide are broken down into four moles of sodium oxide and four moles of water. What is the percent error if your experiment yields 195 grams of sodium oxide?

$$2\ NaOH \rightarrow Na_2O + H_2O$$

Answer: Converting moles of sodium oxide into grams.
4 moles of Na_2O * 62 g / 1 mol = 248g of Na_2O
Theoretical Yield: 248 g
Actual Yield: 195 g
We know that,
Per cent Error: Theoretical Yield - Actual Yield / Theoretical Yield * 100
Per cent Error: 248 - 195 / 248 * 100
Per cent Error: 21.37%.

Ques 2. 18.0 g of water completely vapourises at 100°C and 1 bar pressure, and the enthalpy change in the process is 40.79 kJ/mol. What will be the enthalpy change for vapourising two moles of water under the same conditions? What is the standard enthalpy of vaporisation for water?

Answer: Given, the amount of water is 18.0 g, and the pressure is 1 bar.

We know that 18.0 g H_2O = 1 mole H_2O.

The enthalpy change for vaporising 1 mole of H_2O = 40.79 kJ / mol

∴ Enthalpy change for vaporising 2 moles of H_2O = 2 × 40.79 kJ = 81.358 kJ

Standard enthalpy of vaporisation at 100℃ and 1 bar pressure,

Δvap H_2O = + 40.79 k J / mol.

Ques 3. Why is sulphide ore of copper heated in a furnace after mixing with silica?

Answer: Iron oxide is present as an impurity in sulphide ore of copper forms slag, which is iron silicate and copper is produced in the form of copper matter.

$FeO + SiO_2 \rightarrow FeSiO_3$

Ques 4. Give the structure of compound $C_{10}H_{12}O$, whose mass spectrum shows m/z values of 15,43, 57, 91, 105 and 148.

Answer: A peak at m/z = 15 suggests a CH_3 group. As 43 - 15 = 28, the mass of CO, the m/z value of 43, maybe due to an acetyl group, CH_3CO group in the compound. The highest peak gives the molar mass. Cleaving an acetyl group (m/z = 43) from the 148 gives 105, an observed peak. Next below 105 is 91, a difference of 14; this suggests a CH_2 group attached to CH_3CO. So far, we have CH_3COCH_2 adding up to 57, leaving 148 - 57 = 91. This peak is likely to be [C7H7]+, whose precursor is the stable benzyl cation, C6H5CH2+. Piecing together all this information, the structure is $CH_3COCH_2CH_2C_6H_5$
TLC is used to check whether the reaction is completed or not. In contrast, HPLC is used to identify, quantify, and separate the mixture.

Ques 5. The pH of a solution of a strong acid is 5.0. What will be the pH of the solution obtained after diluting the given solution 100 times?

Answer: pH = 5 means $[H^+] = 10^{-5}$

On diluting 100 times,

$[H^+] = 10^{-5} / 100 = 10^{-7}$
On calculating the pH using the equation pH = − log $[H^+]$, the pH value comes out to be 7, which is impossible.

Hence, Total H^+ ion concentration = H^+ ions from acid + H^+ ion from water

$[H^+] = 10^{-7} + 10^{-7}$ M
$[H^+] = 2 \text{ X } 10^{-7}$
pH = 7 – 0.3010
pH = 6.699