Volumetric Analysis Chemistry Questions with Solutions

Q1: How does Potassium permanganate act as a self indicator?

Answer: A self indicator is a substance that along with itself participating in the reaction, indicates the end point of the reaction. Potassium permanganate is a violet-coloured solution. It acts as a strong oxidizing agent and thus, turns colourless when added to oxalic acid solution in the acidic medium. However, at the end point, it gives a faint pink colour in the acidic solution.

Q2. In the titration of Potassium permanganate with Oxalic acid, why is the oxalic acid solution warmed in the beginning?

Answer: In order to speed up the reaction, the oxalic acid solution is heated up to 50-60 ^{o}C. In the beginning of the reaction, manganous sulphate is formed which catalyses the reduction of $KMnO_4$. This leads to the slowed rate of the reaction. The reaction gets auto-catalysed as it proceeds forward.

Q3. How is the strength of a solution calculated?

Answer: The strength of a solution is determined by calculating the amount of solute in grams present in 1 Litre of the solution. The unit of strength is g L^{-1}.

Therefore, Strength = Mass of Solute (g) / Volume of solution (L)

Strength of a solution can also be calculated as:

Strength = Molarity x Molar mass

Q4. How many grams of NaOH is required to make 250 cm^3 solution of 0.025 M NaOH solution?

Answer: Given: 0.025 M NaOH solution which means that 0.025 moles of NaOH are present in 1 L of solution.
1000 cm^3 0.025 M NaOH solution contains NaOH = 0.025 mol.
250 cm^3 0.025 M NaOH solution contains NaOH = (0.025/1000) x 250 mol = 0.00625 mol
The molar mass of NaOH is 40 g/mol.
Hence, the mass of 0.00625 moles of NaOH = 0.00625 x 40 g = 0.25 g

Q5. List some limitations of the volumetric analysis.

Answer: Some of the major limitations of the volumetric analysis are given below:

a. Large amounts of chemicals are used and discarded.

b. This method has limited accuracy.
c. Failure in observing the end point may lead to disturbed calculations.
d. Natural factors such as temperature, pressure and humidity may affect the titration reaction as the titration is carried out in an open vessel/flask.
e. Indicators are required to detect the end point of the reaction.
f. Liquid-phase reactions for the titration are required.

Q6. What volume of concentrated sulphuric acid is required to make 5 litre of 0.5 M H_2SO_4 solution? The concentrated sulphuric acid is 98% H_2SO_4 by mass and its density is 1.84 g cm^{-3}.

Answer: Given 98% H_2SO_4 by mass means 98 g H_2SO_4 is present in 100 g of solution.
From the given density, the volume of the concentrated H_2SO_4 is calculated as:
Volume = mass/ density
Hence, volume of the concentrated H_2SO_4 is 100 / 1.84 cm^3 = 54.35 cm^3 = 0.5435 L
The molar mass of H_2SO_4 is 98 g/mol i,e. 98 g H_2SO_4 equals 1 mole of H_2SO_4.
Hence, the molarity of the given concentrated H_2SO_4 is 1 mol / 0.5435 L = 18.4 M
Now, to determine the required amount of concentrated H_2SO_4, the molarity formula is applied as: $M_1V_1 = M_2V_2$
Where, M_1 = Molarity of concentrated H_2SO_4 solution
V_1 = Required volume of concentrated H_2SO_4 solution
M_2 = 0.5 M
V_2 = 5 L
Hence, 18.4 M x V_1 = 5 L x 0.5 M
V_1 = 0.136 L = 136 cm^3
Thus, the volume of concentrated sulphuric acid required to make 5 litre of 0.5 M H_2SO_4 solution is 136 cm^3.

Q7. What is the specific name that is given to potassium permanganate solution?

Answer: The potassium permanganate solution is also known as Baeyer's Reagent.

Q8. Why in permanganate titrations the burette with the pinch-cock regulator not used?

Answer: This is because the permanganate solution attacks the rubber.

Q9. Would you consider the upper or lower meniscus of potassium permanganate solution in the burette?

Answer: As the potassium permanganate solution is a deeply coloured solution, the upper meniscus of the burette is considered.

Q10. Why HNO_3 or HCl are not used in permanganate titrations?

Answer: HNO_3 is not used as it is a stronger oxidizing agent. However, HCl reacts with $KMnO_4$ and disturbs the reaction.

Q11. What are primary and secondary standards?

Answer: The primary standard substances are stable, pure, readily soluble in most of the solutions and remain unaffected by the presence of moisture and air. The solutions of these substances remain as such for a number of days. While, the secondary standard substances do not possess the aforementioned characteristics.

Q12. What is the equivalent mass of $KMnO_4$ in acidic medium?

Answer: $KMnO_4$ acts as an oxidizing agent and loses 5 electrons per molecule during the reaction. Hence, the equivalent mass of $KMnO_4$ in acidic medium is mol. Mass / Total positive valency. The equivalent mass of $KMnO_4$ = 158 / 5 = 31.6 g.

Q13. What is the Basicity of H_3PO_4 solution?

Answer: Basicity of an acid is the total number of displaceable H^+ ions present in 1 molecule of the acid. Hence, the Basicity of H_3PO_4 solution is 3.

Q14. Write the principle of Volumetric analysis.

Answer: The principle of Volumetric analysis is based on the fact that the unknown concentration of the known solution can be determined by titrating it with the known volume of another solution with known concentration.

Q15. Are the equivalence point and end point the same?

Answer: The equivalence point is the point when the reactants just react completely. It does not bring any change in the appearance of the colour of the solution. However, an end point is achieved right after the equivalence point, and the excess of the titrant added gives the end colour of the reaction. Hence, the equivalence point and endpoint are not the same.

Practise Questions on Volumetric Analysis

Q1. During the titration of $KMnO_4$ with Mohr's salt, the solution of Mohr's salt is not heated. Why?

Answer: This is because the salt Ferrous ammonium sulphate (Mohr's salt) itself reacts at a high rate even at room temperature. Also, at higher temperature, the ferrous ions can get oxidized to ferric ions in the presence of air leading to a different result.

Q2. Calculate the molarity of commercially available concentrated HCl acid.

Answer: The commercially available concentrated HCl contains 38% by mass of HCl. Hence, this implies that 38 g HCl is present in 100 g of the solution. The density of concentrated HCl is 1.19 g/cm^3.
Volume of 100 g HCl solution = mass / density = 100 / 1.19 cm^3 = 84.03 cm^3 = 0.0840 L
The molar mass of HCl is 36.5 g/mol. Hence, 38 g HCl has moles = 38 / 36.5 mol = 1.04 mol
Therefore, the molarity of the given commercially available concentrated HCl solution is given by:
Molarity = no. of moles / Vol. of solution in L = 1.04 mol / 0.084 L = 12.38 mol / L.
The molarity of the given solution is 12.38 M.

Q3. In the titration of Na_2CO_3 with HCl, methyl orange is used as an indicator. Why?

Answer: This is because, near the end point of the titration, the solution becomes weakly acidic. And to determine the end point at this pH, methyl orange is used since methyl orange is a mid-acid indicator.

Q4. What is the relationship between Normality, molarity, equivalent mass and molecular mass?

Answer: Normality (N) x Equivalent mass = Molarity x Molecular mass

Q5. Why is $KMnO_4$ not regarded as the primary standard?

Answer: The reasons determining why $KMnO_4$ is not considered as primary standard are:

a. $KMnO_4$ cannot be obtained in its pure state i,e. MnO_2 is always found in the $KMnO_4$ solution.
b. $KMnO_4$ is very reactive and decomposes in the presence of sunlight.
c. It reacts even with the trace amounts of reducing agents and/or other organic compounds present in the solution.