Concentration of Solutions

Answer Key

1. **Answer**: B

Explanation: Based on our knowledge of acids and bases, we know that NH_3 is a weak base that can generate 1 mole of hydroxide(^-OH) ions in an aqueous solution according to the reaction:

$$NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + {}^-OH_{(aq)}$$

Therefore, its equivalent weight is just equal to its molar mass, which is 17 g/equivalent.

2. **Answer:** B

Explanation: To convert concentration to %(w/v), we need to know the weight of ethanol in grams and the volume of the solution. Since no volume of solution was given, we can assume a volume of 100 mL. From that 100 mL, the volume of ethanol is 30 mL since the concentration is 30 %(v/v). To determine the mass of that 30 mL ethanol, we can use the density as a conversion factor. That would be

$$30\ mL\ ethanol\ x\ \frac{0.80\ g\ ethanol}{1\ mL\ ethanol}\ =\ 24\ g\ ethanol$$

Now that we know the mass of that 30 mL ethanol, we can determine the concentration in %(w/v):

$$\%\ w/v\ = \frac{mass\ of\ solute\ (in\ g)}{volume\ of\ solution\ (in\ mL)}\ x\ 100$$

$$\%\ w/v\ = \frac{24\ g\ ethanol}{100\ mL\ solution}\ x\ 100\ =\ 24\ \%(w/v)$$

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3. **Answer:** C

Explanation: To convert %(v/v) to %(w/w), we need to know the mass of ethanol and the mass of the solution. From problem 2, we've already determined that the mass of ethanol in a 100 mL solution is 24 g. Now, we need to determine the mass of the 100 mL solution. Like what we've done in problem 2, we can use the density of the solution as a conversion factor to convert volume to mass. That is

$$100\ mL\ solution\ x\ \frac{0.90\ g\ solution}{1\ mL\ solution}\ =\ 90\ g\ solution$$

Now that we both know the mass of ethanol and mass of the solution, we can proceed with the calculation of %(w/w).

$$\%\ w/w\ =\frac{mass\ of\ solute\ (in\ g)}{mass\ of\ solution\ (in\ g)}\ x\ 100$$

$$\%\ w/w\ =\frac{24\ g\ ethanol}{90\ g\ solution}\ x\ 100\ =\ 27\ \%(w/w)$$

4. **Answer:** C

Explanation: Recall that molarity pertains to the number of moles of solute over the volume of solution in liters. To get the number of moles of solute, we need the mass and the molar mass of the solute. The problem gives us the molar mass of ethanol, while our calculation in problem 2 provides us with the mass of ethanol in 100 mL solution, which happens to be 24 g. To calculate

$$No.\ of\ moles\ of\ solute\ =\frac{mass\ of\ solute}{molar\ mass\ of\ solute}$$

$$No.\ of\ moles\ of\ ethanol\ =\frac{24\ g\ ethanol}{46\ g/mol\ ethanol}\ =\ 0.52\ mol\ ethanol$$

$$M\ =\frac{no.\ of\ moles\ of\ solute}{volume\ of\ solution\ (in\ L)}\ =\ \frac{0.52\ mol\ ethanol}{0.100\ L\ solution}\ =\ 5.2\ M$$

5. **Answer:** D

Explanation: Recall that molality pertains to the number of moles of solute over the mass of solvent in kilograms. Again, considering 100 mL of the solution, we've already determined the number of moles of ethanol in problem 4, which is 0.52 mol.

Furthermore, we've already calculated the mass of the solution in problem 3, which happens to be 90 g. However, we cannot use this mass right away because this is the mass of ethanol (solute) and the solvent combined, and we only need the mass of the solvent. To determine this, we need to subtract the mass of ethanol (24 g based on our calculations in previous questions) from 90 g. That would be

mass of solvent = 90 g - 24 g = 66 g

$$m = \frac{no.\ of\ moles\ of\ solute}{mass\ of\ solvent\ (in\ kg)} = \frac{0.52\ mol\ ethanol}{0.066\ kg\ solvent} = 7.88\ m$$