Calculating Nitric Acid Volume

https://gemini.google.com/app/ca92dabc69c54b0f

Response: To find the correct expression for the required volume of 70.0% $(\frac{w}{w})$ concentrated $\mathrm{HNO_3}$, let's break down the calculation step-by-step:

1. Molar Mass of $\mathrm{HNO_3}$

$$\text{Molar mass of } \mathrm{HNO_3} = 1 + 14 + (3 \times 16) = 63 \text{ g mol}^{-1}$$

2. Required Amount of $\mathrm{HNO_3}$ (Moles)

To prepare 300 cm^3 of a $0.150 \text{ mol dm}^{-3}$ solution:

$$\text{Moles of } \mathrm{HNO_3} = \frac{0.150}{1000} \times 300 \text{ mol}$$

3. Required Mass of $\mathrm{HNO_3}$ (Grams)

$$\text{Mass of pure } \mathrm{HNO_3} = \left(\frac{0.150}{1000} \times 300 \right) \times 63 \text{ g}$$

4. Required Mass of Concentrated Acid Solution

Since the concentrated solution is 70.0% $(\frac{w}{w})$ $\mathrm{HNO_3}$, 70.0 g of pure acid is present in 100 g of solution:

$$\text{Mass of solution} = \text{Mass of pure } \mathrm{HNO_3} \times \frac{100}{70.0}$$

$$\text{Mass of solution} = 63 \times \left(\frac{0.150}{1000} \times 300 \right) \times \frac{100}{70.0} \text{ g}$$

5. Required Volume of Concentrated Acid (cm^3)

Using $\text{Volume} = \frac{\text{Mass}}{\text{Density}}$ (where density $= 1.42 \text{ g cm}^{-3}$):

$$\text{Volume} = \frac{1}{1.42} \times \text{Mass of solution}$$

$$\text{Volume} = \frac{100}{1.42} \times \frac{63}{70.0} \times \frac{0.150}{1000} \times 300 \text{ cm}^3$$

Conclusion

Comparing this with the given choices:

Correct Option: (2) $\frac{100}{1.42} \times \frac{63}{70.0} \times \frac{0.150}{1000} \times 300$