80.0 mL of a 1.70 M solution is diluted to a total volume of 278 mL. A 139-mL portion of that solution is diluted by adding 167 mL of water. What is the final concentration? Assume the volumes are additive.

Solution

V_1 = 80.0 mL

c_1 = 1.70 M

V_2 = 278 mL

V_3 = 139 mL

$V(H_2O)$ = 167 mL

c_{final} -?

Find amount of chemical substance in the first solution:

As c_1 = 1.70 M is 1.70 mol/L, then we can determine and solve the proportion:

1000 mL of solution contains 1.70 mole of a solute

We have 80.0 mL of solution that contains x mol of solute

$$\frac{1000}{80} = \frac{1.70}{x}$$

x = 0.136,

n_1 = 0.136 mol.

Find concentration of the second solution.

$$c = \frac{n}{V}$$

$$c_2 = \frac{0.136 \text{ mol}}{0.278 \text{ L}} = 0.489 \frac{\text{mol}}{\text{L}} = 0.489 \text{ M}$$

Find amount of chemical substance in a 139 mL portion of second solution.

1000 mL of solution contains 0.489 mol of a solute

We have 139 mL of solution that contains y mol of solute

$$\frac{1000}{139} = \frac{0.489}{y}$$

y = 0.068

n= 0.068 mol

Find the final volume of a solution:

V_{final} = 139 mL+167 mL = 306 mL =0.306 L

Find concentration of the final solution:

$$c = \frac{n}{V}$$

$$c_{final} = \frac{0.068\ mol}{0.306\ L} = 0.222 \frac{mol}{L} = 0.222\ M$$

Answer: 0.222 M