Chemistry 20 - Unit 2 - Dilution and Distillation

Name: _____

You may find the following formulas useful:

$C = \frac{n}{V}$ $m = Mn$	$d = \frac{m}{V}$ $C_1V_1 = C_2V_2$

1. To test the hardness of water, an industrial chemist performs an analysis using 100.0 mL of a 0.250 mol/L standard solution of ammonium oxalate. What mass of ammonium oxalate is needed to make this solution?

$(NH_4)_2OOCCOO$

$M = 36.08 + 88.02 = 124.10\ g/mol$ $(NH_4)_2$

$\frac{0.250\ mol}{1\ L} \times 0.1000\ L = 0.0250\ mol$

$m = \frac{124.10\ g}{1\ mol} \times 0.0250\ mol = \boxed{3.10\ g}$

2. Calculate the mass of solid sodium hydroxide needed to make 500 mL of a 10.0 mol/L cleaning solution.

NaOH $M = 40.00\ g/mol$

$n = \frac{10.0\ mol}{1\ L} \times 0.500\ L = 5.00\ mol$

$m = \frac{40.00\ g}{1\ mol} \times 5.00\ mol = \boxed{200\ g}$

3. When acidified, potassium permanganate is a lethally powerful oxidizing agent. Mr. Pruden's dog, Maggie, decides to prepare 500.0 mL of a 0.0750 mol/L potassium permanganate solution. What mass of potassium permanganate is required to prepare this solution?

$KMnO_4$ $(M = 158.04\ g/mol)$

$n = \frac{0.0750\ mol}{1\ L} \times 0.5000\ L = 0.0375\ mol$

$m = 0.0375\ mol \times \frac{158.04\ g}{1\ mol} = \boxed{5.93\ g}$

4. Maggie realizes that her solution is too weak, but with the help of a distillation apparatus, manages to reduce 500.0 mL of the 0.0750 mol/L solution to a volume of 200.0 mL. What is the resulting concentration?

$C_1V_1 = C_2V_2$

$\frac{(0.0750\ mol/L) \cdot 500.0\ mL}{200.0\ mL} = \boxed{0.188\ M}$

5. The next step in Maggie's nefarious plan is to produce 4.00 L of a 10.0% hydrochloric acid solution, using a 36.0% stock solution. How much of the stock solution will Maggie need to use?

$C_1V_1 = C_2V_2$

$\frac{(10.0\%)(4.00\text{L})}{36.0\%} = V_1$ $\boxed{V_1 = 1.11\text{L}}$

6. Maggie mixes her potassium permanganate with his hydrochloric acid, but alas, the reaction does not work as desired. Undeterred, my dog decides to produce 2.00 L of 0.200 mol/L sulfuric acid solution from a 17.8 mol/L stock solution. How much of the stock solution is necessary?

$C_1V_1 = C_2V_2$

$V_1 = \frac{0.200\text{mol/L} \times 2.00\text{L}}{17.8\text{mol/L}} = 0.0225\text{L}$ $\boxed{22.5\text{mL}}$

7. In a rage, Mr. Pruden kicks over Maggie's doghouse and scolds his dog for getting into his chemicals again. Afterwards, Mr. Pruden takes 5.00 mL of a 0.005000 mol/L $CuSO_{4(aq)}$ solution and dilutes it to a final volume of 100.0 mL. What is the final concentration of the diluted solution?

$C_1V_1 = C_2V_2$

$C_2 = \frac{(5.00\text{mL})(0.005000\text{mol/L})}{100.0\text{mL}}$

$C_2 = 0.000250\text{M}$ or 0.250mmol/L

8. Maggie's antics will not stop! She seizes 50.00 mL of a 1.50 mol/L nitric acid solution and adds 950.00 mL of water to it. What is the new concentration of nitric acid?

$C_1V_1 = C_2V_2$

$\frac{(1.50\frac{\text{mol}}{\text{L}})(50.00\text{mL})}{(1000.00\text{mL})} = C_2$ $\boxed{C_2 = 0.075\text{M}}$

9. 15.00 grams of potassium dichromate is added to water, preparing 100.00 mL of solution.
   a. What is the concentration of this solution?

$K_2Cr_2O_7$

$M = 294.20\text{g/mol}$

$n = 15.00\text{g} \times \frac{1\text{mol}}{294.20\text{g}} = 0.0510\text{mol}$

$C = \frac{0.0510\text{mol}}{0.10000\text{L}} = \boxed{0.510\text{M}}$

   b. If 200.00 mL of water are added to the solution, what is the resulting concentration?

$C_1V_1 = C_2V_2$

$C_2 = \frac{(0.510\text{M})(100.00\text{mL})}{(300.00\text{mL})} = \boxed{0.170\text{M}}$