Mole Conversion and Preparing Solutions Review Questions

1. How many moles of $MgSO_4$ do you have in a 7.9 g sample?

mass → moles

Molar mass = (24.3 g/mol) + (32.1 g/mol) + 4(16.0 g/mol) = 120.4 g/mol

$$7.9\ g\ MgSO_4 \times \frac{1\ mol}{120.4\ g} = \boxed{0.066\ mol\ MgSO_4}$$

2. What volume at STP does 4.38 moles of an unknown gas have?

moles → Volume of gas

$$4.38\ moles \times \frac{22.4\ L}{1\ mol} = \boxed{98.1\ L}$$

3. How many moles of oxygen gas (O_2) do you have if a sample contains 3.48×10^{24} molecules (O_2)?

molecules of O_2 → moles of O_2

$$3.48 \times 10^{24}\ molecules\ O_2 \times \frac{1\ mol\ O_2}{6.022 \times 10^{23}\ molecules\ O_2} = \boxed{5.78\ mol\ O_2}$$

4. A chemistry teacher needs to make up a solution of 0.30 M $CaCl_2$. He thinks that he will need about 2.0 L to have enough for all of his students. What mass of solid $CaCl_2$ will he need to dissolve in 2.0 L of water to make this solution?

$$M = \frac{n}{V} \qquad n = M \cdot V = \left(0.30\ \frac{mol}{L}\right)(2.0\ L) = 0.60\ mol$$

moles → mass

molar mass = (40.1 g/mol) + 2(35.45 g/mol) = 111.0 g/mol

$$0.60\ mol\ CaCl_2 \times \frac{111.0\ g}{mol} = \boxed{66.6\ g\ CaCl_2}$$

5. How many molecules of $MgSO_4$ do you have in a 3.22 g sample?

Molar mass = 120.4 g/mol

mass → moles → molecules

$$3.22\ g\ MgSO_4 \times \frac{1\ mol\ MgSO_4}{120.4\ g\ MgSO_4} \times \frac{6.022 \times 10^{23}\ molecules}{1\ mol} = \boxed{1.61 \times 10^{22}\ molecules\ MgSO_4}$$

6. What is the mass of a 5.35 L sample of SO_3 gas?

Volume of gas → moles → mass

molar mass = (32.1 g/mol) + 3(16.0 g/mol) = 80.1 g/mol

$$5.35\ L\ SO_3 \times \frac{1\ mol}{22.4\ L} \times \frac{80.1\ g}{1\ mol} = \boxed{19.1\ g\ SO_3}$$

7. How many oxygen atoms are contained in a 23.5 L sample of SO_3 gas at STP?

Volume of SO_3 gas → moles of SO_3 → molecules of SO_3 → atoms of O

$$23.5\ L\ SO_3 \times \frac{1\ mol\ SO_3}{22.4\ L\ SO_3} \times \frac{6.022 \times 10^{23}\ molecules\ SO_3}{1\ mol\ SO_3} \times \frac{3\ atoms\ O}{1\ molecule\ SO_3}$$

$$= \boxed{1.90 \times 10^{24}\ atoms\ O}$$

8. 6.92 g of $Sr(OH)_2$ contains how many moles of hydrogen atoms?

mass of $Sr(OH)_2$ → moles of $Sr(OH)_2$ → moles of H atoms

molar mass = (87.6 g/mol) + 2(16.0 g/mol) + 2(1.0 g/mol) = 121.6 g/mol

$$6.92\ g\ Sr(OH)_2 \times \frac{1\ mol\ Sr(OH)_2}{121.6\ g\ Sr(OH)_2} \times \frac{2\ mol\ H\ atoms}{1\ mol\ Sr(OH)_2} = \boxed{0.114\ mol\ H\ atoms}$$

9. What volume does 1.3×10^{13} molecules of carbon dioxide occupy at STP?

molecules → mole → volume of gas

$$1.3 \times 10^{13}\ molecules\ CO_2 \times \frac{1\ mol}{6.022 \times 10^{23}\ molecules} \times \frac{22.4\ L}{1\ mol} = \boxed{4.8 \times 10^{-10}\ L}$$

10. A pharmacist wants to test a medication by seeing how quickly it dissolves in a potassium chloride electrolyte solution. She decides that she needs 500. mL of 1.50M solution to perform the test. Complete the calculations and describe the steps (include the names of any required equipment) the pharmacist must take to make the solution.

Molar mass of KCl = (39.1 g/mol) + (35.45 g/mol) = 74.55 g/mol

moles of KCl required

$M = 1.50\ mol/L$
$V = 0.500\ L$
$n = ?$

$$M = \frac{n}{V} \qquad n = MV = \left(1.50\ \frac{mol}{L}\right)(0.500\ L) = 0.750\ mol$$

mass of KCl required

$$0.750\ mol\ KCl \times \frac{74.55\ g}{1\ mol} = \boxed{55.91\ g\ KCl}$$

Steps

1. measure 55.91 g of KCl on a balance
2. Quantitatively transfer the KCl into a 500 mL volumetric flask
3. Add some water to the flask and swirl until KCl is dissolved.
4. Add water to the flask (use eyedroppers is necessary) until the meniscus just touches the volume line on the flask.
5. Stopper the flask and invert a few times to mix the solution thoroughly.