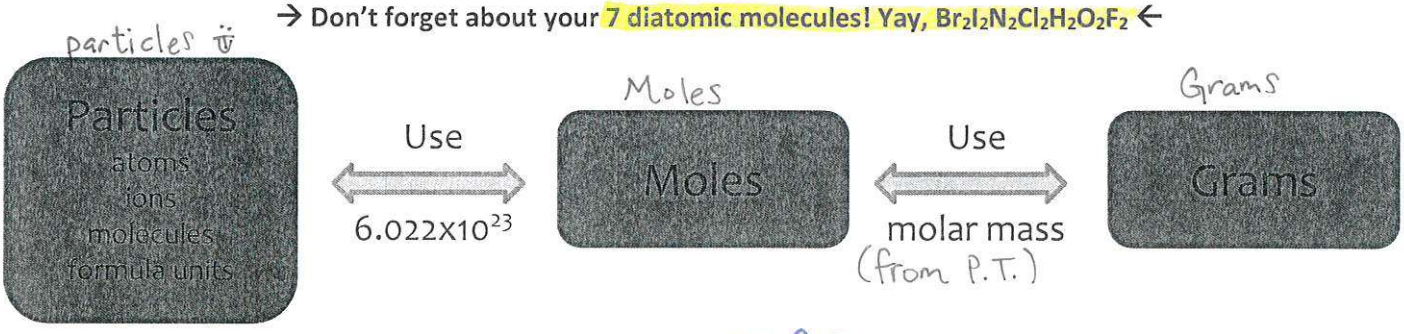
Here and Back Again: A Mole-ish Review

Part I: The Mole – Massively Important

Type of Particle	Definition	Example
atom	single element	Si, C, Mg, Ca, Cu, Zn, S Br, I, N, Cl, H, O, F
ion	charged element/polyatomic	N^{3-}, SO_4^{2-}, PO_4^{3-}
molecule	covalent compound (diatomic elements are considered molecules)	C_2H_6, H_2O Br_2, I_2, N_2, Cl_2, H_2, O_2, F_2
formula unit	ionic compound	$CuCl_2$, Na_2SO_4, KBr

→ **Don't forget about your 7 diatomic molecules! Yay, $Br_2I_2N_2Cl_2H_2O_2F_2$** ←



Examples and Practice:

What is the mass in grams of 1.60×10^{24} molecules of B_3Br_6?

511.83 g/mol

$$1.60\text{E}24 \text{ molec.} \times \frac{1 \text{ mol}}{6.022\text{E}23 \text{ molec.}} \times \frac{511.83 \text{ g}}{1 \text{ mol}} = 1359.89 = 1{,}360 \text{ g } B_3Br_6$$

1.60E24 molec. → 3 s.f.; 1359.89 → 3 sf

2. How many moles of nitrogen gas are found in a 57.2 g sample?

$$57.2 \text{ g } N_2 \times \frac{1 \text{ mol}}{28.02 \text{ g}} = 2.04 \text{ mol } N_2$$

3. How many formula units of $MgCO_3$ are contained in a 2.34 mol sample?

$$2.34 \text{ mol} \times \frac{6.022\text{E}23 \text{ f.u.}}{1 \text{ mol}} = 1.41 \times 10^{24} \text{ formula units } MgCO_3$$

Mole Conversions Using a Chemical Formula

- A chemical formula shows the kinds of elements and numbers of atoms or moles of each element in the smallest representative unit of a substance.
- You can use a chemical formula as a mole ratio to convert between moles of a compound and moles of an atom within a compound

***If a problem give a compound but asks for atoms or ions (or the opposite), then an extra conversion fraction is required!**

Examples and Practice:

1. A student measures out 2.0 moles of Li_3PO_4. How many moles of lithium ions, Li^+, are in the sample?

$$2.0\ \text{mol}\ Li_3PO_4 \times \frac{3\ \text{mol}\ Li^+}{1\ \text{mol}\ Li_3PO_4} = 6.0\ \text{mol}\ Li^+$$

2 sf; 2 sf

2. Freon, which has the formula CCl_2F_2, is used as a refrigerant in air conditioners and as a propellant in aerosol cans. Given a 5.56 mg sample of Freon, calculate the number of molecules of freon in that sample.

$$5.56\ \text{mg} \times \frac{1\ \text{g}}{1000\ \text{mg}} \times \frac{1\ \text{mol}}{120.91\ \text{g}} \times \frac{6.022\text{E}23\ \text{molec.}}{1\ \text{mol}} = 2.77 \times 10^{19}\ \text{molec.}\ CCl_2F_2$$

3. If two atoms of carbon combine with four atoms of hydrogen in the compound ethene (C_2H_4), how many grams of hydrogen would be needed to combine completely with 6.0 grams of carbon?

$$6.0\ \text{g C} \times \frac{1\ \text{mol C}}{12.01\ \text{g C}} \times \frac{4\ \text{mol H}}{2\ \text{mol C}} \times \frac{1.008\ \text{g H}}{1\ \text{mol H}} = 1.0\ \text{g H}$$

($\frac{4\ \text{mol H}}{2\ \text{mol C}}$ = C_2H_4)

4. How many total protons are present in a 4.10 mole sample of CH_4?

C: $6\ p^+$; H: $4(1\ p^+)$; $6\ p^+ + 4(1\ p^+) = 10\ p^+$

$$4.10\ \text{mol}\ CH_4 \times \frac{6.022\text{E}23\ \text{molec.}\ CH_4}{1\ \text{mol}\ CH_4} \times \frac{10\ \text{protons}}{1\ \text{molec.}\ CH_4} = 2.47 \times 10^{25}\ p^+$$

5. Given a sample of 3.56×10^{24} molecules of C_4H_8, how many moles of carbon are in the sample?

$$3.56\text{E}24\ \text{molec.}\ C_4H_8 \times \frac{1\ \text{mol}\ C_4H_8}{6.022\text{E}23\ \text{molec.}\ C_4H_8} \times \frac{4\ \text{mol C}}{1\ \text{mol}\ C_4H_8} = 23.6\ \text{mol C}$$