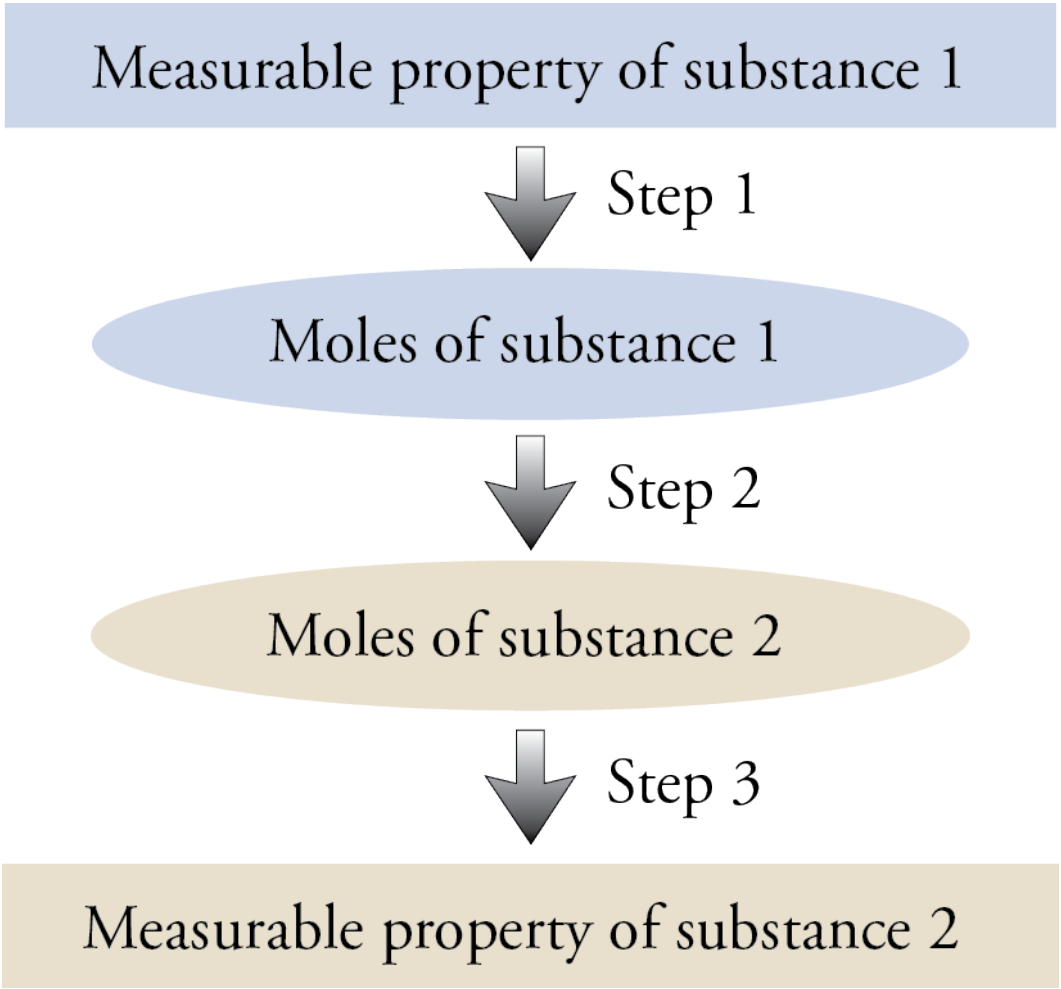
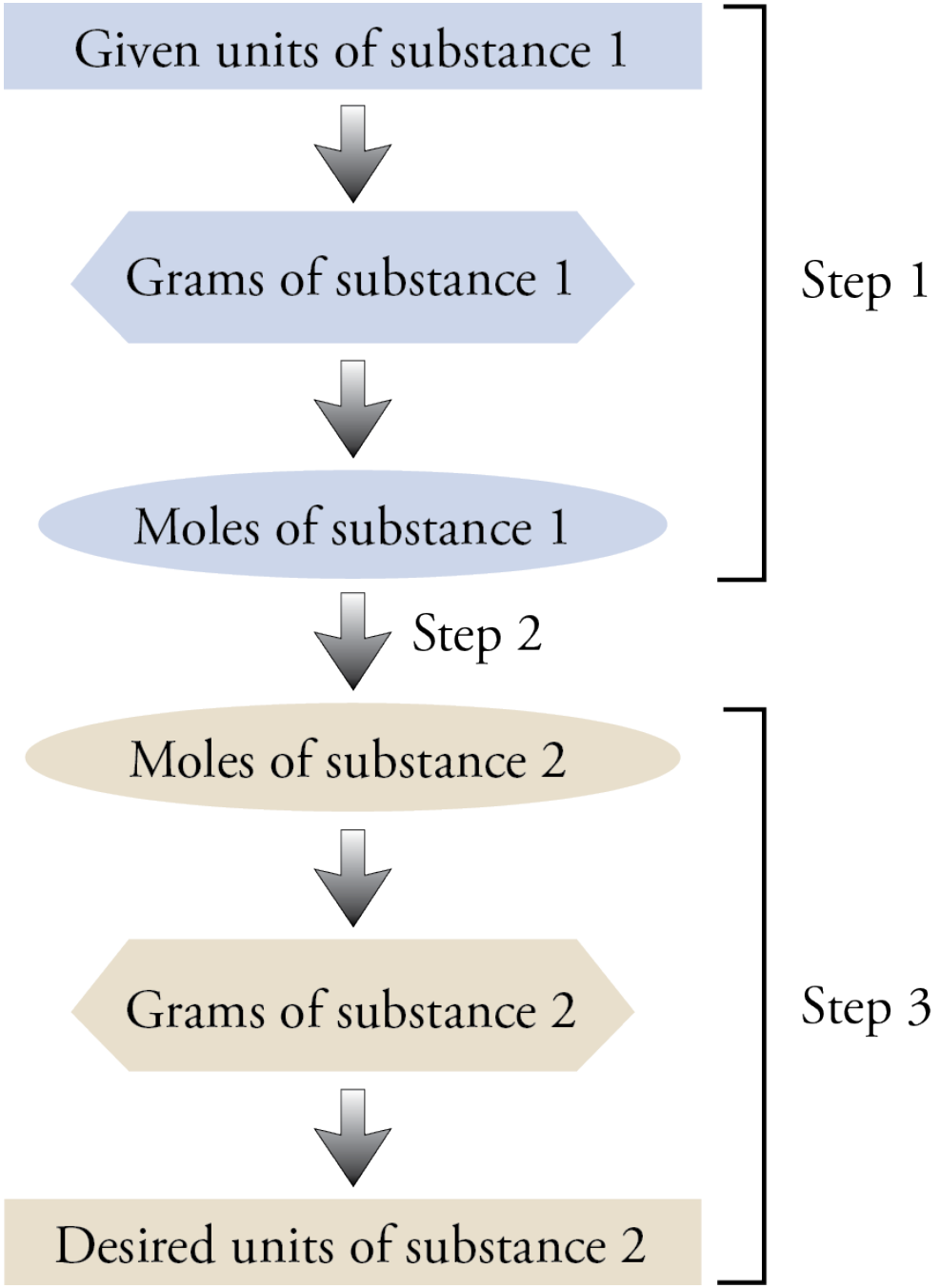
Important Skills from Previous Sections

- Determination of atomic mass, molecular mass, and formula mass
- Using molar mass to convert between mass and the number of particles expressed in moles
- How chemical formulas can be used to convert between moles of element and moles of compound containing that element.

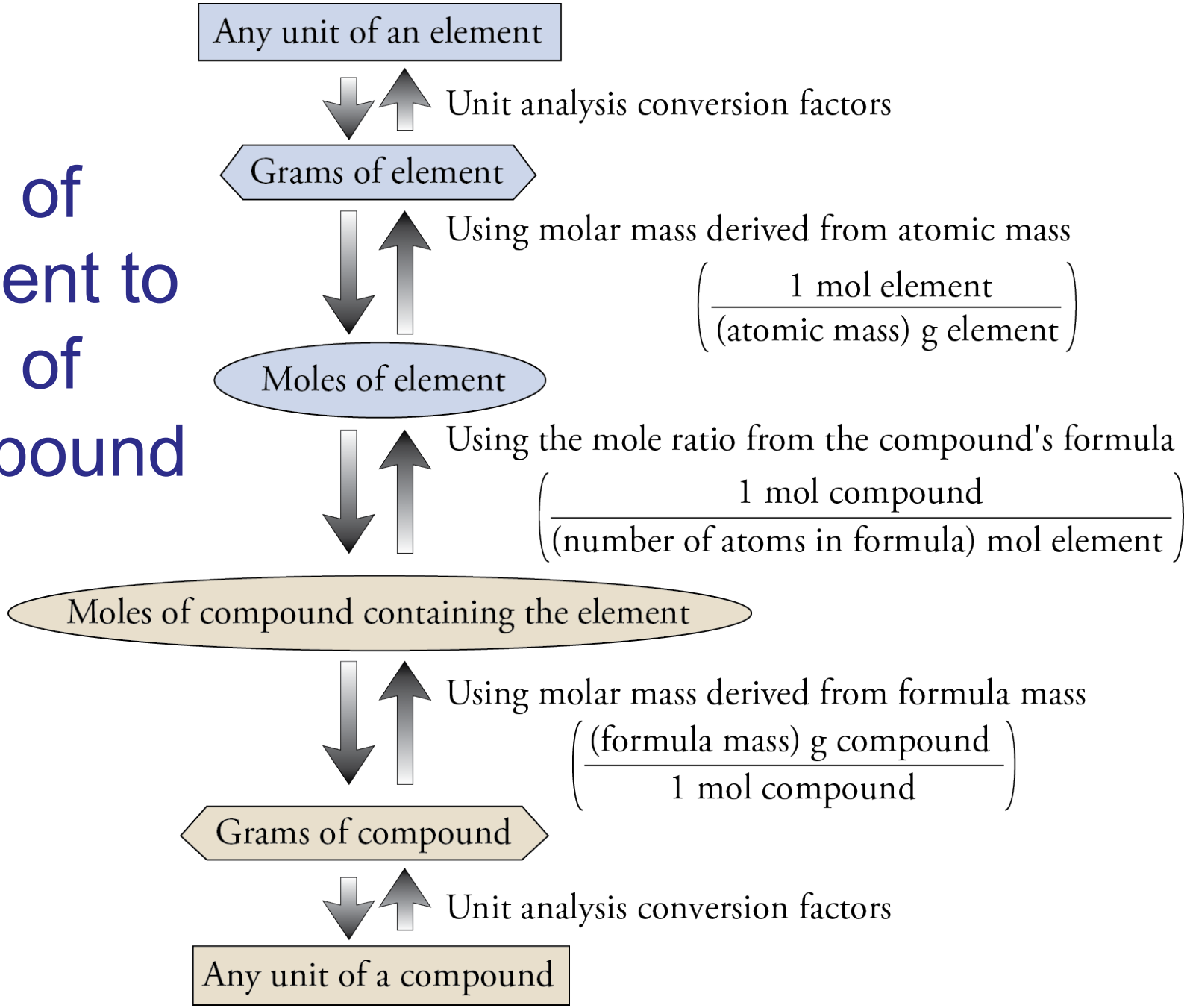
General Conversions



Units of One Substance to Units of Another



Units of Element to Units of Compound



Study Sheets

- Write a description of the “tip-off” that helps you to recognize the type of problem the calculation represents.
- Write a description of the general procedure involved in the particular type of problem.
- Write an example of the type of calculation.

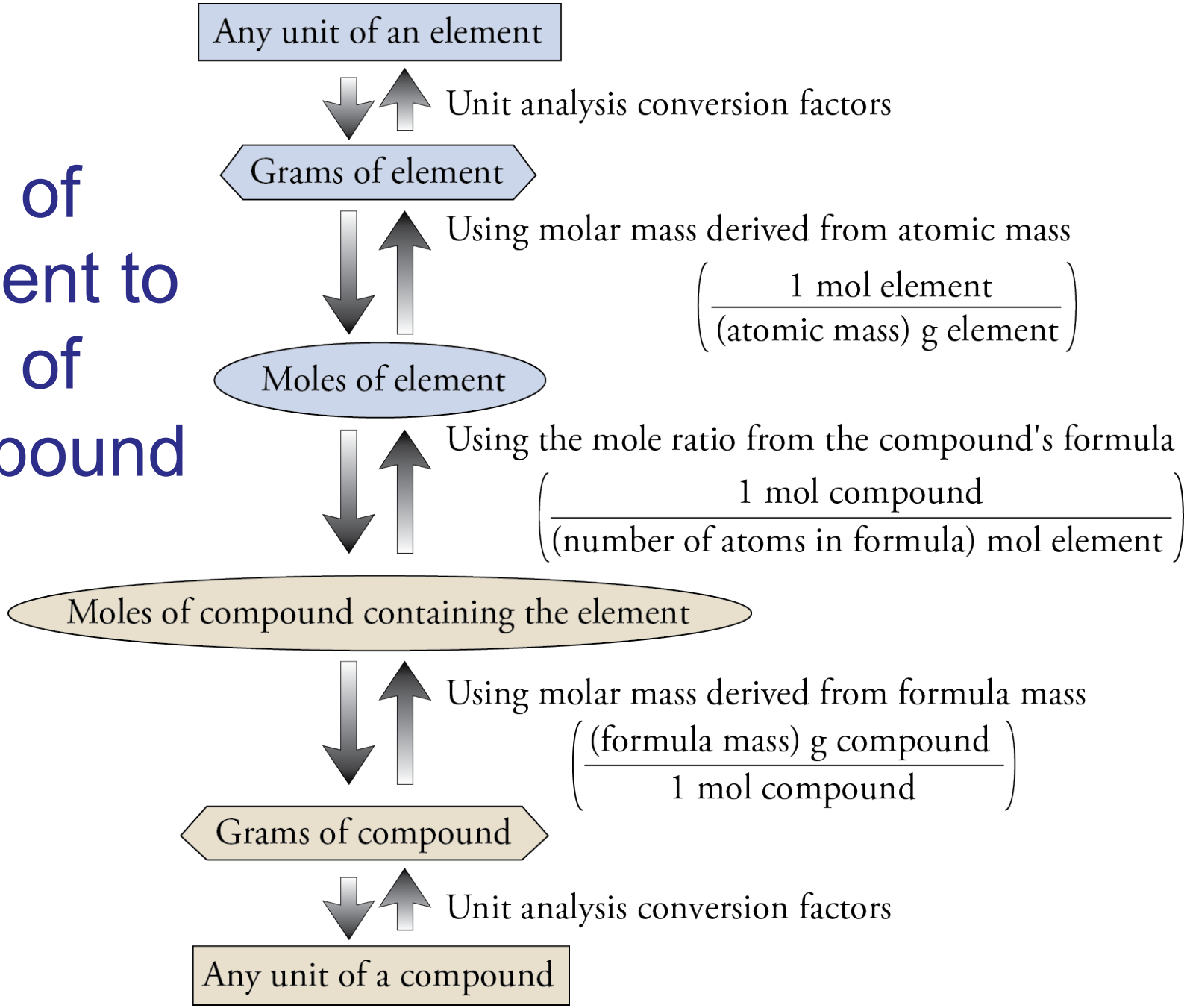
Sample Study Sheet: Converting Between Mass of Element and Mass of Compound Containing the Element

- **Tip-off:** When you analyze the type of unit you have and the type of unit you want, you recognize that you are converting between a unit associated with an element and a unit associated with a compound containing that element.

Sample Study Sheet (2) – General Steps

- If necessary, convert from the given unit to grams.
- Convert grams to moles of the first substance using its molar mass.
- Convert moles of the first substance to moles of the second substance using the molar ratio derived from the formula for the compound.
- Convert moles of the second substance to grams of the second substance using its molar mass.
- If necessary, convert from grams to the desired unit.

Units of Element to Units of Compound



Exercise 1 – First Steps

- Disulfur dichloride, S_2Cl_2, is used in vulcanizing rubber and hardening soft woods. It can be made from the reaction of pure sulfur with chlorine gas. What is the mass of S_2Cl_2 that contains 123.8 g S?
- First steps.

$$? \text{ g } S_2Cl_2 = 123.8 \cancel{\text{g}} \text{ S} \left(\frac{\text{ }}{\cancel{\text{g}}} \right)$$

Exercise 1

- Grams to moles 1, using the molar mass of sulfur that comes from its atomic mass on the periodic table.

$$? \text{ g } S_2Cl_2 = 123.8 \cancel{\text{ g S}} \left(\frac{1 \cancel{\text{ mol S}}}{32.066 \cancel{\text{ g S}}} \right)$$

- Moles 1 to moles 2, using the molar ratio that comes from the formula.

$$? \text{ g } S_2Cl_2 = 123.8 \cancel{\text{ g S}} \left(\frac{1 \cancel{\text{ mol S}}}{32.066 \cancel{\text{ g S}}} \right) \left(\frac{1 \text{ mol } S_2Cl_2}{2 \cancel{\text{ mol S}}} \right)$$

Exercise 1

- Moles of 2 to grams 2.

$$? \text{ g } S_2Cl_2 = 123.8 \cancel{\text{ g S}} \left(\frac{1 \cancel{\text{ mol S}}}{32.066 \cancel{\text{ g S}}} \right) \left(\frac{1 \cancel{\text{ mol } S_2Cl_2}}{2 \cancel{\text{ mol S}}} \right) \left(\frac{135.037 \text{ g } S_2Cl_2}{1 \cancel{\text{ mol } S_2Cl_2}} \right)$$

- Final calculations.

$$? \text{ g } S_2Cl_2 = 123.8 \cancel{\text{ g S}} \left(\frac{1 \cancel{\text{ mol S}}}{32.066 \cancel{\text{ g S}}} \right) \left(\frac{1 \cancel{\text{ mol } S_2Cl_2}}{2 \cancel{\text{ mol S}}} \right) \left(\frac{135.037 \text{ g } S_2Cl_2}{1 \cancel{\text{ mol } S_2Cl_2}} \right)$$

$$= 260.7 \text{ g } S_2Cl_2$$

Exercise 2

- Vanadium metal, used as a component of steel and to catalyze various industrial reactions, is produced from the reaction of vanadium(V) oxide, V_2O_5, and calcium metal. What is the mass in kilograms of vanadium in 2.3 kilograms of V_2O_5?
- First steps.

$$? \text{ kg V} = 2.3 \text{ kg } V_2O_5 \left(\frac{}{\text{kg}} \right)$$

- Given unit to grams 1.

$$? \text{ kg V} = 2.3 \text{ kg } V_2O_5 \left(\frac{10^3 \text{ g}}{1 \text{ kg}} \right)$$

Exercise 2

- Grams of 1 to moles 1, using the molar mass of V_2O_5 that comes from the sum of the atomic masses of 2 vanadium atoms and 5 oxygen atoms.

$$? \text{ kg V} = 2.3 \cancel{\text{kg}}\ \cancel{V_2O_5} \left(\frac{10^3 \cancel{\text{g}}}{1 \cancel{\text{kg}}}\right)\left(\frac{1 \text{ mol } V_2O_5}{181.880 \cancel{\text{g}}\ \cancel{V_2O_5}}\right)$$

- Moles 1 to moles 2.

$$? \text{ kg V} = 2.3 \cancel{\text{kg}}\ \cancel{V_2O_5} \left(\frac{10^3 \cancel{\text{g}}}{1 \cancel{\text{kg}}}\right)\left(\frac{1 \cancel{\text{mol } V_2O_5}}{181.880 \cancel{\text{g}}\ \cancel{V_2O_5}}\right)\left(\frac{2 \text{ mol V}}{1 \cancel{\text{mol } V_2O_5}}\right)$$

- Moles 2 to grams 2.

$$? \text{ kg V} = 2.3 \cancel{\text{kg}}\ \cancel{V_2O_5} \left(\frac{10^3 \cancel{\text{g}}}{1 \cancel{\text{kg}}}\right)\left(\frac{1 \cancel{\text{mol } V_2O_5}}{181.880 \cancel{\text{g}}\ \cancel{V_2O_5}}\right)\left(\frac{2 \cancel{\text{mol V}}}{1 \cancel{\text{mol } V_2O_5}}\right)\left(\frac{50.9415 \text{ g V}}{1 \cancel{\text{mol V}}}\right)$$

Exercise 2

- Grams to the desired unit.

$$? \text{ kg V} = 2.3 \cancel{\text{kg}}\ \cancel{\text{V}_2\text{O}_5} \left(\frac{10^3\ \cancel{\text{g}}}{1\ \cancel{\text{kg}}}\right)\left(\frac{1\ \cancel{\text{mol V}_2\text{O}_5}}{181.880\ \cancel{\text{g V}_2\text{O}_5}}\right)\left(\frac{\cancel{2\ \text{mol V}}}{1\ \cancel{\text{mol V}_2\text{O}_5}}\right)\left(\frac{50.9415\ \cancel{\text{g}}\ \text{V}}{1\ \cancel{\text{mol V}}}\right)\left(\frac{1\ \text{kg}}{10^3\ \cancel{\text{g}}}\right)$$

- Complete the calculation.

$$? \text{ kg V} = 2.3 \cancel{\text{kg}}\ \cancel{\text{V}_2\text{O}_5} \left(\frac{10^3\ \cancel{\text{g}}}{1\ \cancel{\text{kg}}}\right)\left(\frac{1\ \cancel{\text{mol V}_2\text{O}_5}}{181.880\ \cancel{\text{g V}_2\text{O}_5}}\right)\left(\frac{\cancel{2\ \text{mol V}}}{1\ \cancel{\text{mol V}_2\text{O}_5}}\right)\left(\frac{50.9415\ \cancel{\text{g}}\ \text{V}}{1\ \cancel{\text{mol V}}}\right)\left(\frac{1\ \text{kg}}{10^3\ \cancel{\text{g}}}\right)$$

$$= \mathbf{1.3\ kg\ V}$$