8 Math Skills

Converting Mass to Amount

Lithium (molar mass = 6.94 g/mol) is so light that a 0.001 m^3 (1 L) volume of it has a mass of only 534 g. What is the amount in moles represented by this mass of lithium?

1. **List the given and unknown values.**

Given:	mass of lithium = 534 g Li
	molar mass of lithium = 6.94 g/mol Li
Unknown:	amount of lithium = ? mol

2. **Write down the conversion factor that converts grams to moles.** The conversion factor you choose should have what you are trying to find (moles of Li) in the numerator and what you want to cancel (grams of Li) in the denominator.

$$\frac{1 \text{ mol Li}}{6.94 \text{ g Li}}$$

3. **Multiply the mass of lithium in grams by the conversion factor you have selected, and solve.**

$$534 \text{ g Li} \times \frac{1 \text{ mol Li}}{6.94 \text{ g Li}} = 76.9 \text{ mol Li}$$

Practice

1. The price of gold (molar mass = 196.97 g/mol) has varied so much over the last 30 years that with $100 you could buy as much as 2.6 troy ounces (81 g) of gold or as little as 0.13 troy ounces (4.0 g). Calculate the amount in moles that these two masses of gold represent.
2. Aluminum (molar mass = 26.98 g/mol) is the most common metal in Earth's crust. But before the discovery in 1886 of the process that allowed it to be cheaply extracted from bauxite, aluminum was expensive to process. In 1852, a pound of aluminum cost $545; in 1887 the price was $0.30. At those prices, $100 would buy only 83.2 g of aluminum in 1852 but 1.51×10^5 g in 1887. Determine the amount in moles that these two masses of aluminum represent.
3. Osmium (molar mass = 190.23 g/mol) and iridium (molar mass = 192.22 g/mol) have the highest densities of any elements. A cubic centimeter of either element has a mass of around 22.6 g. Determine the amount in moles of 22.6 g of each element.
4. Tungsten (molar mass = 183.84 g/mol), whose high melting point makes it suitable for light bulb filaments and certain types of steel, is one of the heavier elements; its name even means "heavy stone" in Swedish. What is the amount in moles contained in a 500.0 g sample of tungsten?

5. Carbon (molar mass = 12.01 g/mol) and lead (molar mass = 207.2 g/mol) are the lightest and heaviest members of their elemental group, respectively. Determine the amount in moles represented by 245 g of carbon and by 245 g of lead.

6. Potassium chloride (molar mass = 74.55 g/mol) is a fairly common salt. Although it is fatal in high doses, potassium chloride can be safely consumed in small quantities. It is often mixed in small proportions with sodium chloride to produce "low sodium" table salt. Determine the amount in moles in 150 g of potassium chloride.

7. Sulfur dioxide (molar mass = 64.07 g/mol), which is formed when heated sulfur is oxidized, is a pollutant that irritates lung tissue and makes it more sensitive to dust and other particles inhaled from the outside air. Determine the amount in moles that would be represented by 27 kg of sulfur dioxide.

8. Aluminum quickly oxidizes when it is exposed to air, so there is always a thin layer of aluminum oxide (molar mass = 101.96 g/mol) on any aluminum surface. This oxide layer protects the aluminum from further corrosion. If the aluminum oxide on several aluminum surfaces has a mass of 79 g, what amount in moles would be represented by this mass?

9. Sulfuric acid (molar mass = 98.09 g/mol) is widely used as a corrosive reactant. It is also used in making fertilizer, detergents, drugs, explosives, and paints, and in the production of other chemicals. The usefulness of sulfuric acid is so great that it is the most widely produced chemical in the United States. What is the amount in moles in a sample of sulfuric acid that has a mass of 165 g?

10. Aqua regia is a mixture of one-fourth nitric acid and three-fourths hydrochloric acid. Its name, which translates as "royal water," comes from its ability to react with and dissolve gold, which is one of the most unreactive metals. Determine the amount in moles of nitric acid (molar mass = 63.02 g/mol) present in 1 kg of aqua regia. Determine the amount in moles of hydrochloric acid (molar mass = 36.46 g/mol) present in the same 1 kg of aqua regia.

11. Formic acid (HCOOH) is an acid that is found in many species of ants, which in Latin are called *formica*. Formic acid (molar mass = 46.03 g/mol) causes the stings of ants, wasps, bees, and stinging nettles to be so painful. If a single ant contains 0.77 mg of formic acid at any one time, what is this amount of formic acid in moles?

12. Sucrose ($C_{12}H_{22}O_{11}$), or table sugar, is obtained from sugar cane or sugar beets. Sugar cane, which is a type of thick grass similar in appearance to bamboo, is cut down and crushed at a mill to extract the liquid sugar from the cane. This liquid is then purified to form molasses, brown sugar, and pure sucrose. An acre of sugar cane in Hawaii may produce about 8.0×10^3 kg of sucrose (molar mass = 342.34 g/mol). Determine the amount in moles of 8.0×10^3 kg of sucrose.

9 Math Skills

Writing Ionic Formulas

The following table lists most of the ionic formulas you will need for the Practice section. The charge on other positive ions will be indicated by a Roman numeral.

Table of Some Common Ions

Name	Formula	Name	Formula	Name	Formula
Aluminum ion	Al^{3+}	Bromide ion	Br^-	Carbonate ion	CO_3^{2-}
Ammonium ion	NH_4^+	Chloride ion	Cl^-	Cyanide ion	CN^-
Calcium ion	Ca^{2+}	Fluoride ion	F^-	Hydrogen carbonate ion	HCO_3^-
Lithium ion	Li^+	Iodide ion	I^-	Hydroxide ion	OH^-
Potassium ion	K^+	Nitride ion	N^{3-}	Nitrate ion	NO_3^-
Sodium ion	Na^+	Oxide ion	O^{2-}	Phosphate ion	PO_4^{3-}
Strontium ion	Sr^{2+}	Sulfide ion	S^{2-}	Sulfate ion	SO_4^{2-}

Sample Problem

Tungsten has the highest melting point of any element. It appears in nature in the mineral, *wolframite,* as the compound tungsten(VI) oxide. Write the ionic formula for this compound.

1. **List the symbols for each ion.**

   Symbol for tungsten(VI) ion: W^{6+} (*VI* indicates a charge of 6+)
   Symbol for oxide ion: O^{2-}

2. **Write the symbols for the ions, side by side, with the cation first.**

   $W^{6+}O^{2-}$

3. **Find the least common multiple of the ion's charges.**

   The least common multiple of 6 and 2 is 6. To get a neutral compound, you need a total of six positive charges and six negative charges.

   To get six positive charges, you need one W^{6+} ion, because $1 \times 6+ = 6+$.

   To get six negative charges, you need three O^{2-} ions, because $3 \times 2- = 6-$.

4. **Write the chemical formula, using subscripts to indicate how many of each ion are needed to make a neutral compound.**

   WO_3