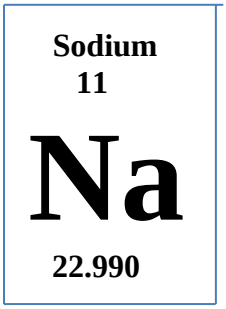
Chemistry Lecture #52: Mass and the Mole

The periodic chart is rigged so that the atomic mass number is also the mass of 1 mole of the element in grams. To illustrate, look for sodium on your periodic chart. You should find a box that looks something like the picture below.



The number 22.990 is the average mass of an individual sodium atom. Thus, a single sodium atom has an average mass of 22.990 atomic mass units (amu). An amu is a tiny amount.
1 amu = 1.66×10^{-24} g.

However, the number 22.990 also represents the mass of 1 mole of sodium atoms in grams. Thus, 6.02×10^{23} atoms of sodium will have a mass of 22.990 grams.

The mass of one mole of a substance is the molar mass.

What is the mass of 1 mole of carbon atoms?
Answer: 12.011 grams.

What is the mass of 2.00 moles of carbon atoms?
Answer:

moles ⟹ grams

1 mole C = 12.011 g C

$$\frac{2.00 \text{ moles C}}{1} \times \frac{12.011 \text{ g C}}{1 \text{ mole C}} = 24.0 \text{ g C}$$

What is the mass of 0.0450 moles of Cr?

moles ⟹ grams

1 mole Cr = 52.00 g Cr

$$\frac{0.0450 \text{ moles Cr}}{1} \times \frac{52.00 \text{ g Cr}}{1 \text{ mole Cr}} = 2.34 \text{ g Cr}$$

How many moles of calcium are in 525 g of Ca?

grams → moles

1 mole Ca = 40.08 g Ca

$$\frac{525 \text{ g Ca}}{1} \times \frac{\text{mole Ca}}{40.08 \text{ g Ca}} = 13.1 \text{ moles Ca}$$

Determine the number of moles in 145 g of Ne

grams → moles

molar mass of Ne = 20.180 g/mole

$$\frac{145 \text{ g Ne}}{1} \times \frac{\text{mole Ne}}{20.180 \text{ g Ne}} = 7.19 \text{ mole Ne}$$

How many atoms of gold are in a pure gold nugget with a mass of 25.0 g?

grams → moles → atoms

1 mole Au = 196.97 g Au
1 mole Au = 6.02×10^{23} atoms Au

$$\frac{25.0 \text{ g Au}}{1} \times \frac{\text{mole Au}}{196.97 \text{ g Au}} \times \frac{6.02 \times 10^{23} \text{ atoms Au}}{\text{mole Au}} = 7.65 \times 10^{22} \text{ atoms Au}$$

A silver coin contains 31.1 g of silver. How many silver atoms are in the coin?

grams → moles → atoms

1 mole Ag = 107.87 g Ag
1 mole Ag = 6.02×10^{23} atoms Ag

$$\frac{31.1 \text{ g Ag}}{1} \times \frac{\text{mole Ag}}{107.87 \text{ g Ag}} \times \frac{6.02 \times 10^{23} \text{ atoms Ag}}{\text{mole Ag}} = 1.74 \times 10^{23} \text{ atoms Ag}$$

A balloon contains 5.50×10^{22} atoms of He. What is the mass of He?

atoms → moles → grams

1 mole He = 6.02×10^{23} atoms

1 mole He = 4.00g He

$$\frac{5.50 \times 10^{22} \text{ atoms He}}{1} \times \frac{\text{mole He}}{6.02 \times 10^{23} \text{ atoms He}} \times \frac{4.00 \text{ g He}}{\text{mole He}} = 0.366 \text{ g He}$$

What is the mass of 3.42×10^{22} atoms of Xe?

atoms → moles → grams

1 mole Xe = 6.02×10^{23} atoms Xe

1 mole Xe = 131.29 g Xe

$$\frac{3.42 \times 10^{22} \text{ atoms Xe}}{1} \times \frac{\text{mole Xe}}{6.02 \times 10^{23} \text{ atoms Xe}} \times \frac{131.29 \text{ g Xe}}{\text{mole Xe}} = 7.46 \text{ g Xe}$$