18 minutes KEY

Mole Conversions Worksheet

There are three mole equalities. They are:

1 mol = 6.02×10^{23} particles
1 mol = g-formula-mass (periodic table)
1 mol = 22.4 L for a gas at STP

Each equality can be written as a set of two conversion factors. They are:

$$\left(\frac{1\ mole}{6.02x10^{23}\ particles}\right) \qquad \left(\frac{6.02x10^{23}\ particles}{1\ mole}\right)$$

$$\left(\frac{1\ mole}{g-formula-mass}\right) \qquad \left(\frac{g-formula-mass}{1\ mole}\right)$$

$$\left(\frac{1\ mole}{22.4\ L}\right) \qquad \left(\frac{22.4\ L}{1\ mole}\right)$$

Mole-Particle Conversions

1. How many moles of magnesium is 3.01×10^{22} atoms of magnesium?

$$\mathbf{3.01 \times 10^{22}\ atoms}\left(\frac{1\ mole}{6.02x10^{23}\ atoms}\right) = 5 \times 10^{-2}\ \text{moles}$$

2. How many molecules are there in 4.00 moles of glucose, $C_6H_{12}O_6$?

$$\mathbf{4.00\ moles}\left(\frac{6.02x10^{23}\ molecules}{1\ mole}\right) = 2.41 \times 10^{24}\ \text{molecules}$$

3. How many moles are 1.20×10^{25} atoms of phosphorous?

$\frac{1.20\times10^{25}\ \text{atoms P}}{1} \times \frac{1\ \text{mol P}}{6.02\times10^{23}\ \text{atoms P}} = 19.93\ \text{mol} = \boxed{19.9\ \text{mol P}}$

4. How many atoms are in 0.750 moles of zinc?

$\frac{.750\ \text{moles Zn}}{1} \times \frac{6.02\times10^{23}\ \text{atoms Zn}}{1\ \text{mol Zn}} = 4.515\times10^{23}\ \text{atoms Zn} = \boxed{4.52\times10^{23}\ \text{atoms Zn}}$

5. How many molecules are in 0.400 moles of N_2O_5?

$\frac{0.400\ \text{mol } N_2O_5}{1} \times \frac{6.02\times10^{23}\ \text{molecules } N_2O_5}{1\ \text{mol } N_2O_5} = \boxed{2.41\times10^{23}\ \text{molecules } N_2O_5}$

Mole-Mass Conversions

1. How many moles in 28 grams of CO_2 ?

Gram-formula-mass of CO_2 1 C = 1 x 12.01 g = 12.01 g
2 O = 2 x 16.00 g = 32.00 g
64.00 g/mol

$$\textbf{28 g } CO_2 \left(\frac{\textbf{1 mole}}{\textbf{44.00 g}}\right) = 0.64 \text{ moles } CO_2$$

2. What is the mass of 5 moles of Fe_2O_3 ?

Gram-formula-mass Fe_2O_3 2 Fe = 2 x 55.6 g = 111.2 g
3 O = 3 x 16.0 g = 48.0 g
159.2 g/mol

$$\textbf{5 moles } Fe_2O_3 \left(\frac{\textbf{159.2 g}}{\textbf{1 mole}}\right) = 800 \text{ grams } Fe_2O_3$$

3. Find the number of moles of argon in 452 g of argon.

$\frac{452\text{ g Ar}}{1} \times \frac{1\text{ mol Ar}}{39.948\text{ g Ar}} = 11.3\text{ mol Ar}$

4. Find the grams in 1.26×10^{-4} mol of $HC_2H_3O_2$.

$\frac{1.26\times10^{-4}\text{ mol } HC_2H_3O_2}{1} \times \frac{60.05256\text{ g } HC_2H_3O_2}{1\text{ mol } HC_2H_3O_2} = 0.007567\text{ g } HC_2H_3O_2$

$7.57\times10^{-3}\text{ g } HC_2H_3O_2$

5. Find the mass in 2.6 mol of lithium bromide.

$\frac{2.6\text{ mol LiBr}}{1} \times \frac{86.845\text{ g LiBr}}{1\text{ mol LiBr}} = 225.797\text{ g LiBr} = 230\text{ g LiBr}$

Mole-Volume Conversions

1. Determine the volume, in liters, occupied by 0.030 moles of a gas at STP.

$$0.030 \text{ mol} \left(\frac{\mathbf{22.4\ L}}{\mathbf{1\ mole}} \right) = 0.67 \text{ L}$$

2. How many moles of argon atoms are present in 11.2 L of argon gas at STP?

$$11.2 \text{ L} \left(\frac{\mathbf{1\ mole}}{\mathbf{22.4\ L}} \right) = \mathbf{0.500\ moles}$$

3. What is the volume of 0.05 mol of neon gas at STP?

$$\frac{0.05 \text{ mol Ne}}{1} \times \frac{22.4 \text{ L Ne}}{1 \text{ mol Ne}} = 1.12 \text{ L Ne}$$

4. What is the volume of 1.2 moles of water vapor at STP?

$$\frac{1.2 \text{ mol } H_2O}{1} \times \frac{22.4 \text{ L } H_2O}{1 \text{ mol } H_2O} = 26.88 \text{ L } H_2O = 27 \text{ L } H_2O$$

Mixed Mole Conversions

Given unit → Moles → Desired unit

1. How many oxygen molecules are in 3.36 L of oxygen gas at STP?

$$3.36 \text{ L} \left(\frac{\mathbf{1\ mole}}{\mathbf{22.4\ L}} \right) \left(\frac{\mathbf{6.02x10^{23}\ molecules}}{\mathbf{1\ mole}} \right) = 9.03 \times 10^{22} \text{ molecules}$$

2. Find the mass in grams of 2.00×10^{23} molecules of F_2. 12.624 g

Gram-formula-mass 2 F = 2 x 19 g = 38 g/mol

$$2.00 \times 10^{23} \text{ molecules} \left(\frac{\mathbf{1\ mole}}{\mathbf{6.02x10^{23}\ particles}} \right) \left(\frac{\mathbf{38\ g}}{\mathbf{1\ mole}} \right) = \mathbf{12.6\ g}$$

N_2

3. Determine the volume in liters occupied by 14 g of nitrogen gas at STP.

Ans. 11.2 L

$$\frac{14\text{ g } N_2}{1} \times \frac{1\text{ mol } N_2}{28.0135\text{ g } N_2} \times \frac{22.4\text{ L } N_2}{1\text{ mol } N_2} = 11.2\text{ L } N_2$$

4. Find the mass, in grams, of 1.00×10^{23} molecules of N_2.

Ans. 4.65 g

$$\frac{1.00\times10^{23}\text{ molecules } N_2}{1} \times \frac{1\text{ mol } N_2}{6.02\times10^{23}\text{ molecules } N_2} \times \frac{28.0135\text{ g } N_2}{1\text{ mol } N_2} = 4.65\text{ g } N_2$$

5. How many particles are there in 1.43 g of a molecular compound with a gram molecular mass of 233 g?

Ans. 3.69×10^{21}

$$\frac{1.43\text{ g X}}{1} \times \frac{1\text{ mol X}}{233\text{ g X}} \times \frac{6.02\times10^{23}\text{ particles X}}{1\text{ mol X}} = 3.69\times10^{21}\text{ particles X}$$

6. Aspartame is an artificial sweetener that is 160 times sweeter than sucrose (table sugar) when dissolved in water. It is marketed by G.D. Searle as *Nutra Sweet*. The molecular formula of aspartame is $C_{14}H_{18}N_2O_5$.

14 C	$14 \times 12.011 = 168.154$
18 H	$18 \times 1.00794 = 18.14292$
2 N	$2 \times 14.00674 = 28.01348$
5 O	$5 \times 15.9994 = 79.997$

294.3074 g/mol

a) Calculate the gram-formula-mass of aspartame.

294 g/mol

b) How many moles of molecules are in 10 g of aspartame?

3.4×10^{-2} moles

$$\frac{10\text{ g } C_{14}H_{18}N_2O_5}{1} \times \frac{1\text{ mol } C_{14}H_{18}N_2O_5}{294.307\text{ g } C_{14}H_{18}N_2O_5} = 0.03398\text{ mol} = 3.4\times10^{-2}\text{ mol}$$

c) What is the mass in grams of 1.56 moles of aspartame?

458.64 grams

$$\frac{1.56\text{ mol } C_{14}H_{18}N_2O_5}{1} \times \frac{294.307\text{ g } C_{14}H_{18}N_2O_5}{1\text{ mol } C_{14}H_{18}N_2O_5} = 459.12\text{ g } C_{14}H_{18}N_2O_5$$

d) How many molecules are in 5 **mg** of aspartame?

1.0238×10^{19}

$$\frac{.005\text{ g } C_{14}H_{18}N_2O_5}{1} \times \frac{1\text{ mol } C_{14}H_{18}N_2O_5}{294.307\text{ g } C_{14}H_{18}N_2O_5} \times \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol } C_{14}H_{18}N_2O_5} = 1.023\times10^{19}\text{ molecules}$$

e) How many atoms of nitrogen are in 1.2 grams of aspartame?

4.9143×10^{21}

$$\frac{1.2\text{ g } C_{14}H_{18}N_2O_5}{1} \times \frac{1\text{ mol } C_{14}H_{18}N_2O_5}{294.307\text{ g } C_{14}H_{18}N_2O_5} \times \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol } C_{14}H_{18}N_2O_5} \times \frac{2\text{ atoms N}}{1\text{ molecules } C_{14}H_{18}N_2O_5} = 4.909\times10^{21}\text{ atoms N}$$