

Stoichiometry

What is Avogadro's number?

$6.022 \times 10^{23}$   
atoms  
molecules  
formula units

How many moles are in 16g of lithium?

$g \text{ Li} \rightarrow \text{moles Li}$

$$\frac{16g \text{ Li}}{6.94g \text{ Li}} \times \frac{1 \text{ mol Li}}{1} = 2.3 \text{ mol Li}$$

How many atoms are in 1.70mol of sodium carbonate?

$\text{Na}^+ \text{CO}_3^{2-} \text{Na}_2\text{CO}_3$

$$\frac{1.70 \text{ mol Na}_2\text{CO}_3}{1 \text{ mol Na}_2\text{CO}_3} \times \frac{6.022 \times 10^{23} \text{ atoms Na}_2\text{CO}_3}{1} = 1.02 \times 10^{24} \text{ atoms Na}_2\text{CO}_3$$

How many nitric acid molecules are in 4.60g of HNO<sub>3</sub>?

$g \text{ HNO}_3 \rightarrow \text{molecules HNO}_3$

$$\frac{4.60g \text{ HNO}_3}{63.012g \text{ HNO}_3} \times \frac{1 \text{ mol HNO}_3}{1} \times \frac{6.022 \times 10^{23} \text{ molecules HNO}_3}{1} = 4.40 \times 10^{22} \text{ molecules HNO}_3$$

How many moles of Fe are in 11.0 moles of O<sub>2</sub>? Convert 28.5 grams of Fe to grams of Fe<sub>2</sub>O<sub>3</sub>?

(MW of Fe<sub>2</sub>O<sub>3</sub> = 159.687g)

$g \text{ Fe} \rightarrow g \text{ Fe}_2\text{O}_3 \rightarrow \text{moles O}_2 \rightarrow \text{moles Fe}$



$$\frac{11.0 \text{ moles O}_2}{3 \text{ moles O}_2} \times \frac{4 \text{ mol Fe}}{1} = 14.7 \text{ mol Fe}$$

$$= 40.7g \text{ Fe}_2\text{O}_3$$

$$\frac{28.5g \text{ Fe}}{55.845g \text{ Fe}} \times \frac{1 \text{ mol Fe}}{1} \times \frac{2 \text{ mol Fe}_2\text{O}_3}{4 \text{ mol Fe}} \times \frac{159.687g \text{ Fe}_2\text{O}_3}{1 \text{ mol Fe}_2\text{O}_3}$$

How many grams of Na are in 2.00 grams of sodium phosphate?  $\text{Na}_3\text{PO}_4$   
(MW of  $\text{Na}_3\text{PO}_4 = 163.940\text{g}$ )

1 mole of  $\text{Na}_3\text{PO}_4 = 3$  moles of Na + 1 mole of P + 4 moles of O

|                                |                                   |                                |            |
|--------------------------------|-----------------------------------|--------------------------------|------------|
| 2.00g $\text{Na}_3\text{PO}_4$ | 1 mol $\text{Na}_3\text{PO}_4$    | 3 mol Na                       | 22.990g Na |
|                                | 163.940g $\text{Na}_3\text{PO}_4$ | 1 mol $\text{Na}_3\text{PO}_4$ | 1 mol Na   |

= 10.841g Na

What is the empirical formula of carbon (61.31%), hydrogen (5.14%), nitrogen (10.21%), and oxygen (23.33%)?

|          |           |
|----------|-----------|
| 61.31g C | 1 mole C  |
|          | 12.011g C |

= 5.104 mol C

|          |           |
|----------|-----------|
| 23.33g O | 1 mol O   |
|          | 15.999g O |

= 1.458 mol O

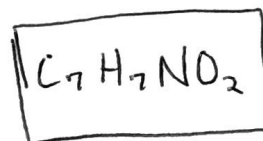
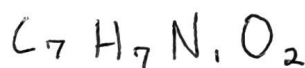
|         |          |
|---------|----------|
| 5.14g H | 1 mol H  |
|         | 1.008g H |

= 5.099 mol H

|         |         |         |         |
|---------|---------|---------|---------|
| C 5.104 | H 5.099 | N 0.729 | O 1.458 |
| 0.729   | 0.729   | 0.729   | 0.729   |

|          |           |
|----------|-----------|
| 10.21g N | 1 mol N   |
|          | 14.007g N |

= 0.729 mol N



What is the empirical formula of carbon (40.92%), hydrogen (4.58%), and oxygen (54.50%) by mass?

|          |           |
|----------|-----------|
| 40.92g C | 1 mol C   |
|          | 12.011g C |

= 3.407 mol C

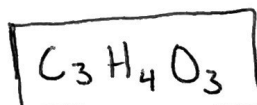
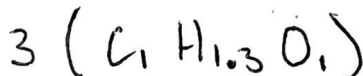
|          |           |
|----------|-----------|
| 54.50g O | 1 mol O   |
|          | 15.999g O |

= 3.406 mol O

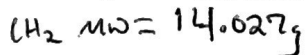
|         |          |
|---------|----------|
| 4.58g H | 1 mol H  |
|         | 1.008g H |

= 4.544 mol H

|         |         |         |
|---------|---------|---------|
| C 3.407 | H 4.544 | O 3.406 |
| 3.406   | 3.406   | 3.406   |

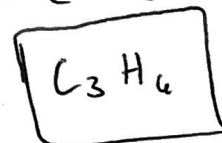
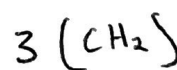


Cyclobutane has the empirical formula  $\text{CH}_2$ . Its molar mass is 42g/mol. What is its molecular formula?



$$\frac{\text{molar mass}}{\text{empirical molar mass}} = \frac{M}{E}$$

$$\frac{42\text{g/mol}}{14.027\text{g/mol}} = 3$$



Rules

0.0 - 0.2 ✓  
0.3 - 0.7 X  
0.8 - 0.9 ✓

What is a limiting reactant?

Reactant present in the smallest amount

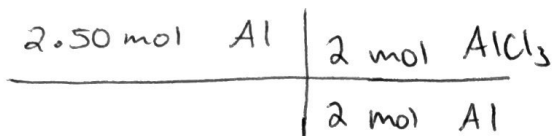
↳ Reactant that will run out first

EX: 1 sandwich = 2 pieces of bread + 1 ham slice

Given 4 bread + 2 ham = 2 sandwiches

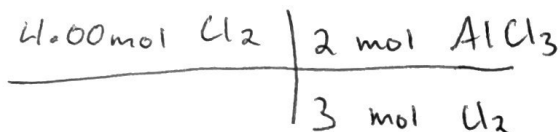
Given 5 bread + 3 ham = 2 sandwiches ← bread = limiting reactant

What is the limiting reactant when 2.50 mol of Al and 4.00 mol of  $\text{Cl}_2$  combine?



$$= 2.50 \text{ mol } \text{AlCl}_3$$

Al is the limiting reactant



$$= 2.67 \text{ mol } \text{AlCl}_3$$

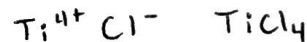
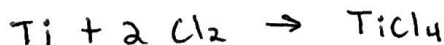
What is the formula for percent yield?

$$\% \text{ yield} = \frac{\text{actual (grams)}}{\text{theoretical (grams)}} \times 100$$

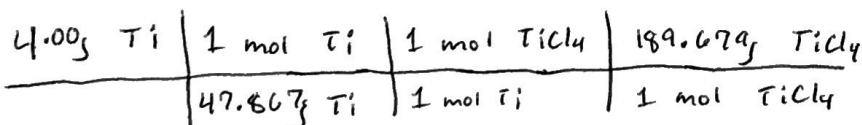
What is the percent yield of adipic acid when you obtain 32.5g and the theoretical yield is 47.4g.

$$\% \text{ yield} = \frac{32.5\text{g}}{47.4\text{g}} \times 100 = 68.6\%$$

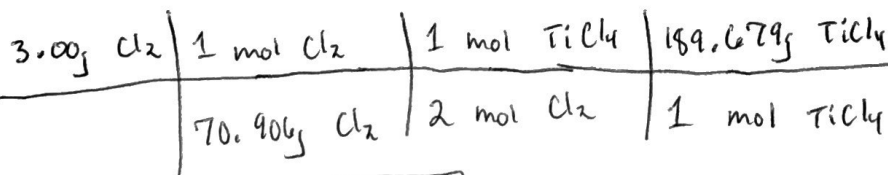
Extra:



What is the limiting reactant if 4.00g Ti reacts with 3.00g chlorine to form 7.4g titanium (IV) chloride? what is the percent yield of the product?



$$= 15.9 \text{ TiCl}_4$$



$$= 4.0\text{g } \text{TiCl}_4$$

$$\% \text{ yield} = \frac{7.4\text{g}}{4.0\text{g}} \times 100$$

$$= 180\% \text{ TiCl}_4$$

$\text{Cl}_2$  = limiting reactant

BRINC/HOF