Noteset 7C – Mass Stoichiometry

Stoichiometry Chart _A ⟶ _B

Step 1	Step 2	Step 3
Mass A ⟶ mol A	mol A ⟶ mol B	mol B ⟶ mass B
start ~~A g~~ | 1 mol A / MM ~~A g~~	___ ~~mol A~~ | ratio mol B / ratio ~~mol A~~	___ ~~mol B~~ | MM B g / 1 ~~mol B~~
= ___ mol A	= ___ mol B	= ___ g B

One step (mol A ⟶ mol B) [step 2]

$TiCl_4 + 4Na \longrightarrow Ti + 4NaCl$

3.50 mol Na, convert to mol Ti

1 mol $TiCl_4$: 4 mol Na : 1 mol Ti : 4 mol NaCl

$$3.50\ \text{mol Na} \left| \frac{1\ \text{mol Ti}\ (B)}{4\ \text{mol Na}\ (A)} \right. = 0.88\ \text{mol Ti}$$

ratio B on top ratio A on bottom

Two Step (mol A → mol B → mass B)
(steps 2 and 3)

$3HBr + Mn(OH)_3 \longrightarrow MnBr_3 + 3HOH$

3 mol HBr : 1 mol $Mn(OH)_3$: 1 mol $MnBr_3$: 3 mol HOH (H_2O, water)

2.30 mol $Mn(OH)_3$, Convert to mass $MnBr_3$

Steps (1) 2.30 mol $Mn(OH)_3$ → mol $MnBr_3$

(2) mol $MnBr_3$ → mass $MnBr_3$

(1) $$\frac{2.30\ \text{mol}\ Mn(OH)_3 \mid 1\ \text{mol}\ MnBr_3}{1\ \text{mol}\ Mn(OH)_3} = 2.30\ \text{mol}\ MnBr_3$$

(2) $$\frac{2.30\ \text{mol}\ MnBr_3 \mid 294.64\ \text{g}\ MnBr_3}{1\ \text{mol}\ MnBr_3} = 677.67\ \text{g}\ MnBr_3$$

($MM_{MnBr_3} = 294.64$ g/mol)

HBr + $Mn(OH)_3$ is an acid / base neutralization reaction, always producing an ionic salt and water (H_2O)

acid (H^+) base (OH^-)

Two step (mass A → mol A → mol B)
[step 1 and step 2]

$$2V(NO_3)_3 + 3Zn_2SO_4 \rightarrow V_2(SO_4)_3 + 6ZnNO_3$$

2 mol $V(NO_3)_3$: 3 mol Zn_2SO_4 : 1 mol $V_2(SO_4)_3$: 6 mol $ZnNO_3$

140.3 g $V(NO_3)_3$, convert to ~~mass~~ mol $ZnNO_3$

Steps (1) 140.3 g $V(NO_3)_3$ → mol $V(NO_3)_3$
(2) mol $V(NO_3)_3$ → mol $ZnNO_3$

(1) $$\frac{140.3\ \text{g}\ V(NO_3)_3}{236.97\ \text{g}\ V(NO_3)_3} \left| \frac{1\ \text{mol}\ V(NO_3)_3}{} \right. = 0.59\ \text{mol}\ V(NO_3)_3$$

(MM $V(NO_3)_3$ = 236.97 g/mol)

(2) $$\frac{0.59\ \text{mol}\ V(NO_3)_3}{2\ \text{mol}\ V(NO_3)_3} \left| \frac{6\ \text{mol}\ ZnNO_3}{} \right. = 1.77\ \text{mol}\ ZnNO_3$$

Two step problems are rare. Most stoichiometry problems are three step (mass A → mass B) or just the mol ratio (one step, mol A → mol B)

Three Step (mass A → mol A → mol B → mass B)

[step 1, 2, and 3]

$$2Cr(BrO_3)_3 + 3Ca(OH)_2 \rightarrow 2Cr(OH)_3 + 3Ca(BrO_3)_2$$

2 mol $Cr(BrO_3)_3$: 3 mol $Ca(OH)_2$: 2 mol $Cr(OH)_3$: 3 mol $Ca(BrO_3)_2$

310.6 g $Ca(OH)_2$, convert to mass $Cr(OH)_3$

Steps
(1) 310.6 g $Ca(OH)_2$ → mol $Ca(OH)_2$
(2) ___ mol $Ca(OH)_2$ → ___ mol $Cr(OH)_3$
(3) ___ mol $Cr(OH)_3$ → mass $Cr(OH)_3$

(1) $$\frac{310.6\ g\ Ca(OH)_2 \mid 1\ mol\ Ca(OH)_2}{74.10\ g\ Ca(OH)_2} = 4.19\ mol\ Ca(OH)_2$$

($MM\ Ca(OH)_2 = 74.10\ g/mol$)

(2) $$\frac{4.19\ mol\ Ca(OH)_2 \mid 2\ mol\ Cr(OH)_3}{3\ mol\ Ca(OH)_2} = 2.79\ mol\ Cr(OH)_3$$

(3) $$\frac{2.79\ mol\ Cr(OH)_3 \mid 103.03\ g\ Cr(OH)_3}{1\ mol\ Cr(OH)_3} = 287.45\ g\ Cr(OH)_3$$

($MM\ Cr(OH)_3 = 103.03\ g/mol$)

Mass to Mass Stoichiometry is only one variant of threestep

you can start or end w/ Molarity (solution), mass (MolarMass), # particles (Avagadro's #) OR Volume gas (@ STP) (standard T and P)