Name
Chemistry
Stoichiometry
Particles #2

- In the following reactions:
  - Complete the reaction(translate and predict products)
  - Determine amount of each reactant and product
  - Use Correct Significant figures (Multiplication/Division: use smallest # of sigfigs)

1. 502,300,000. molecules of Heptane (C_7H_{16}), the basic component of gasoline burns completely in excess Oxygen

$C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$

502,300,000 ? ? ?

$5.023\times10^8\ C_7H_{16} \times \frac{7\ CO_2}{1\ C_7H_{16}} = 3.516\times10^9\ CO_2$

$5.023\times10^8\ C_7H_{16} \times \frac{8H_2O}{1\ C_7H_{16}} = 4.018\times10^9\ H_2O$

$5.023\times10^8\ C_7H_{16} \times \frac{11\ O_2}{1 C_7H_{16}} = 5.525\times10^9\ O$

2. 253250. atoms of copper are reacted with excess Silver nitrate.

$Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$

253250 ? ? ?

$253250\ Cu \times \frac{2\ Ag}{1\ Cu} = 506500\ Ag$

$253250\ Cu \times \frac{1\ Cu(NO_3)_2}{1\ Cu} = 253250\ Cu(NO_3)_2$

$253250\ Cu \times \frac{2\ AgNO_3}{1\ Cu} = 506500\ AgN$

3. 1.786E58 molecules of nitrogen triodide decompose to elements.

$2NI_3 \rightarrow N_2 + 3I_2$

1.786×10^{58} ? ?

$1.786\times10^{58} \times \frac{1 N_2}{2 NI_3} = 8.930\times10^{57}\ N_2$

$1.786\times10^{58} \times \frac{3I_2}{2NI_3} = 2.679\times10^{58}\ I$

4. 7.8400 x 10^{23} molecules of sodium phosphate react with excess molecules of lead (II) nitrate. $2Na_3PO_4 + 3Pb(NO_3)_2 \rightarrow 6NaNO_3 + Pb_3(PO_4)_2$

$7.8400\times10^{23}\ Na_3PO_4 \times \frac{3\ Pb(NO_3)_2}{2\ Na_3PO_4} = 1.1760\times10^{24}\ Pb(NO_3)_2$

$7.8400\times10^{23}\ Na_3PO_4 \times \frac{6\ NaNO_3}{2\ Na_3PO_4} = 2.3520\times10^{24}\ NaNO_3$

$7.8400\times10^{23}\ Na_3PO_4 \times \frac{1\ Pb}{2\ Na} = 3.9200\times10^{2}\ Pb_3(PO$

5. 2,500,000,000. molecules of Nitric acid react with excess molecules of aluminum hydroxide $3HNO_3 + Al(OH)_3 \rightarrow 3HOH + Al(NO_3)_3$

$2.5\times10^9\ HNO_3 \times \frac{1\ Al(OH)_3}{3\ HNO_3} = 8.3\times10^8\ Al(OH)_3$

$2.5\times10^9\ HNO_3 \times \frac{3HOH}{3HNO_3} = 2.5\times10^9\ HOH$ 100

$2.5\times10^9\ HNO_3 \times \frac{Al(NO_3)_3}{3HNO_3} = 8.3\times10^8\ Al(NO_3)_3$

Name
Chemistry
Stoichiometry
Particles, Limiting and Excess #1

Review

1. PbS + 4 H_2O_2 → $PbSO_4$ + 4 H_2O

I 500 molecules ? ? ?

S -500 -2000 +500 +2000

E 0

500 PbS | 4 H_2O_2 / 1 PbS = 2000 H_2O_2

500 PbS | 1 $PbSO_4$ / 1 PbS = 500 $PbSO_4$

For the following problems determine the "?", limiting and excess. Balance and determine products as needed. **(Show all work)**

LR

2. 2 Al + 3 S → Al_2S_3

I 250 atoms 700 atoms ?

S -250 -375 +125

E 0 375 excess

LR 250 Al | 1 Al_2S_3 / 2 Al = 125 Al_2S_3 250 Al | 3 S / 2 Al = 375 S

~~700 S | 1 Al_2S_3 / 3 S = 233 Al_2S_3~~

3. 2 CH_3OH + 3 O_2 → 2 CO_2 + 4 H_2O

I 99,000 molecules 15,000. molecules

S -10,000 -15,000 10,000 20,000

E 89,000 0

LR is O_2

99000 CH_3OH | 2 CO_2 / 2 CH_3OH = 99,000 CO_2 15,000 O_2 | 2 CO_2 / 3 O_2 = 10,000 CO_2

LR

4. 2 NH_3 + CuO + O_2 → N_2 + 3 H_2O + Cu

I 3000 molecules Excess 2700molecules ? ? ?

S -3000 -1500 +1500 4500 1500

E – 1200 excess

3000 NH_3 | 1 N_2 / 2 NH_3 = 1500 N_2 3000 NH_3 | 1 O_2 / 2 NH_3 = 1500 O_2

2700 O_2 | 1 N_2 / 1 O_2 = ~~2700~~ N_2 3000 NH_3 | 3 H_2O / 2 NH_3 = 4500 H_2O

5. Solutions of silver nitrate and sodium chromate are mixed containing 250 and 440 particles respectively. 2 $AgNO_3$ + Na_2CrO_4 → Ag_2CrO_4 + 2 $NaNO_3$

I 250 440

S -250 -125 +125 +250

E 0 315 125 250

(LR) 250 $AgNO_3$ | 2 $NaNO_3$ / 2 $AgNO_3$ = 250 $NaNO_3$ 440 Na_2CrO_4 | 2 $NaNO_3$ / 1 Na_2CrO_4 = 880 $NaNO_3$

10 / 10

NAME
CHEMISTRY
Moles Limiting and Excess #1

What are the two factors that affect which substance will be the limiting reactant?

1. rate consumed

2. quantity

If needed, what is the general method one uses to solve for the limiting reactant?

Compare initial quantity of each reactant to see which will make less product.

Determine the "?", Limiting and excess for the following reactions. Complete the product and balance where necessary.

1. $2C_3H_7OH + 9O_2 \rightarrow 6CO_2 + 8H_2O$

2.5 moles (LR) ? ? ?

2.5 mol C_3H_7OH | $\frac{9 O_2}{2 C_3H_7OH}$ = 11.25 mol O_2

2.5 mol C_3H_7OH | $\frac{8 H_2O}{2 C_3H_7OH}$ = 10 mol H_2O

2.5 mol C_3H_7OH | $\frac{6 CO_2}{2 C_3H_7OH}$ = 7.5 mol CO_2

2. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

2.5 moles 5.0 moles ? ?

2.5 5.0 2.5 mol 2.5 mol

Both LR, no excess

3. $2Na + 2H_2O$ (LR) $\rightarrow 2NaOH + H_2$

7.2 moles 6.5 moles ? ?

−6.5 −6.5 +6.5 +3.25

0.7 6.5 mol 3.25 mol

All same rate

4. $CaSO_3 \rightarrow CaO + SO_2$

? ? 11.6 moles

11.6 mol 11.6 mol

5. $SnCl_2 + 2FeCl_3 \rightarrow SnCl_4 + 2FeCl_2$

(LR) 3.21 moles 9.9 moles 0 0

3.21 mol $SnCl_2$ | $\frac{2 FeCl_3}{1 SnCl_2}$ = 6.4 mol 3.21 mol +6.4 mol

excess $FeCl_3$
9.9 mol
−6.4
3.5 mol excess $FeCl_3$

6. $2C_8H_{18} + 25O_2$ (LR) $\rightarrow 16CO_2 + 18H_2O$

10 moles 16 moles 10.24 11.52

−1.28 16

16 mol O_2 | $\frac{2 \text{ mol } C_8H_{18}}{25 \text{ mol } O_2}$ 16 mol O_2 | $\frac{16 CO_2}{25 O_2}$ 16 mol O_2 | $\frac{18 H_2O}{25 O_2}$

105

Name
Chemistry
Stoichiometry
Molar Mass #1

- Mass is a means to measure number of particles.
- The only mathematical operation that can be performed on mass is to convert to moles.
- Mass is deceiving
- 207g Pb = 2g H_2 This have the same number of particles, 1 mole.

1. Molar mass is the mass of one mole of any chemical substance.
2. In order to calculate the mass of one mole of a compound one should add up the atomic mass units of each of the elements present in the compound.

Compute the molar mass of the following.

3. N_2 2x14 = 28 g/mol
4. I_2 2x127 = 254 g/mol
5. $C_6H_{12}O_6$ (6x12)+(12x1)+(6x16) = 180g/mol
6. Na^+ 23 g/mole
7. CO_3^{-2} 12 + (3x16) = 60 g/mol
8. $Al(HCO)_3$ 27(1+12+16)3 114 g/mol
9. Potassium Chloride KCl 74.5g/mol
10. Sulfate SO_4^{-2} 96 g/mol
11. Magnesium phosphate $Mg_3(PO_4)_2$ 136g/mol
12. Sulfuric Acid H_2SO_4 98g/mol
13. Carbon Tetrachloride CCl_4 154g/mol
14. H_2O 18g/mol

Using the factor label method determine the number of moles in the following.

15. 64.0 g O_2 → 32 g/mol → 64g O_2 | 1mol / 32g = 2mol (2mol O_2)
16. 58.9g NH_3 17 g/mol (3.5mol NH_3)
17. .205g Cl^- 35.5 g/mol (0.0058mol)
18. .205g Cl_2 71 g/mol (0.0029mol)
19. 12.0g sodium chloride 58.5g/mol → 12g NaCl | 1mol / 58.5g = 0.205 mol NaCl (0.205 mol NaCl)

Using the factor label method determine the number of grams in the following.

20. 1.5 moles H_2O — 1.5 mol H_2O | 18g / 1mol = 27 g H_2O
21. .52 moles $AgNO_3$ — 0.52 mol $AgNO_3$ | 170g / 1mol = 88 g $AgNO_3$
22. 1.98 moles $PbCl_4$ 349g/mol (691g $PbCl_4$)
23. 26.5 moles SO_4^{-2} 96 g/mol = 2500 g SO_4^{-2}
24. 1.5E-4 moles Ammonium sulfite $(NH_4)_2SO_3$ N=2x14 H=1x8 S 32 O 3x16=48 — 1.5×10^{-4} mol $(NH_4)_2SO_3$ | 116 g / 1mol = 0.017g $(NH_4)_2SO_3$

Using the factor label method determine the number of particles for the following.

25. 90.5 g Mg^{2+} — (25) 90.5g Mg^{+2} | 1mol / 24g | 6.02×10^{23} / 1mol = 2.27×10^{22} Mg^{+2}
26. 125g Nitric Acid — (26) 125g HNO_3 | 1mol / 63g | 6.02×10^{23} / 1mol = 1.2×10^{24} HNO_3
27. 1.5 moles Copper (II) Hydroxide — 1.5mol $Cu(OH)_2$ | 6.02×10^{23} / 1mol = 9.03×10^{23} $Cu(OH)_2$
28. 2.5 kg of SO_2 (careful) — (28) 2.5 kg SO_2 | 1000g / 1kg | mol / 64g | 6.02×10^{23} / 1mol = 2.35×10^{25} SO_2 107
29. 2.5 mL Mercury (Density: 1g = 13.2 mL) — (29) 2.5mL Hg | 1g / 13.2mL | 1mol / 201g | 6.02×10^{23} / 1mol = 5.67×10^{20} atoms Hg

NAME
CHEMISTRY
MOLES AND MOLAR MASS
MOLAR MASS #2

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1. A mole = 6.02 $\times 10^{23}$
2. The molar mass is the mass of one mole.
3. The molar mass of an element is equal to its atomic mass unit (average atomic mass)
4. The molar mass of a compound is the mass of all the atomic masses of each element present.

Moles:

5. What is the mass of one mole of sulfur?
   32. g/mol
6. If I have 64 g of sulfur do I have more or less than 1 mole? more
7. How many moles of sulfur do I have? 64 g | 1 mol / 32 g = 2 mol S
8. If I have 25g Sulfur how many moles do I have?
   25g S | 1 mol / 32g = 0.78 mol S
9. What is the molar mass of Water?
   H 2×1 = 2, O 1×16 = 16 } 18 g/mol
10. If I have 15 grams of water how many moles do I have?
    15g | 1 mol / 18g = 5.6 mol H_2O
11. If I have 100 grams of water how many moles do I have ?
    100g H_2O | 1 mol / 18g =
12. What is the molar mass of Hydrochloric acid?
    H, Cl 35.5 } 36.5 g/mol
13. What is the molar mass of Hypochlourous acid?
    HClO   H, Cl 35.5, O
14. How many atoms are present in 1 mole of gold? 6.02 $\times 10^{23}$ atoms
15. How many atoms are present in 1 mole of Sodium Chloride? 6.02 $\times 10^{23}$ atoms
16. How many atoms are present in ½ a mole of Aluminum?
    0.5 mol Al | 6.02 $\times 10^{23}$ / 1 mol = 3.01 $\times 10^{23}$ atoms
17. How many atoms are present in .3 moles of He?
    0.3 mol He | 6.02 $\times 10^{23}$ atoms / 1 mol = 1.806 $\times 10^{23}$
18. How many atoms are present in 1.5 moles of Zinc?
    1.5 mol Zn | 6.02 $\times 10^{23}$ atoms / 1 mol
    9.03 $\times 10^{23}$

NAME
STOICHIOMETRY
Mass, Limiting and Excess #1

Note: 1 mole of any gas = 22.4 L of Volume at STP

IN THE FOLLOWING PROBLEMS DETERMINE THE FOLLOWING:

- BALANCE REACTION
- ANSWER ? IN CORRECT UNITS
- DETERMINE LIMITING REAGENTS
- DETERMINE AMOUNT OF EXCESS

30g/mol 32g/mol 44g/mol

1. $2\,C_2H_{6(aq)} + 7\,O_{2(g)} \rightarrow 4\,CO_{2(g)} + 6\,H_2O_{(g)}$
12.5g 38.9g 15.6
L.R. LITERS

38.9g O2 | 1mol O2 / 32g O2 | 2mol C2H6 / 7mol O2 | 30g C2H6 / 1mol C2H6 = 10.4g C2H6

12.5 − 10.4 = 2.1g C2H6 excess

determine L.R. 12.5g C2H6 | 1 mol C2H6 / 30g C2H6 | 4 mol CO2 / 2 mol C2H6 | 22.4L CO2 / 1 mol CO2 = ~~18.7L CO2~~

L.R. → 38.9g O2 | 1mol O2 / 32g O2 | 4 mol CO2 / 7mol O2 | 22.4L CO2 / 1 mol CO2 = 15.6 CO2

(23) (71) (58.5)
2. $2Na + Cl_2 \rightarrow 2NaCl$
50g 50g ?
moles

50g Na | 1mol Na / 23g Na | 2mol NaCl / 1mol Na = 4.~~35~~ mol NaCl

L.R. 50g Cl2 | 1mol Cl2 / 71g Cl2 | 2mol NaCl / 1mol Cl2 = 1.41 mol NaCl

50g Cl2 | 1mol Cl2 / 71g Cl2 | 2mol Na / 1mol Cl2 | 23g Na / 1mol Na = 32.4g Na

50g − 32.4g = 17.6g Na excess

108 14 48
AgNO3
170g/mol

3. $2AgNO_{3(aq)} + Cu_{(s)} \rightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$
175.5g 70g ? ?
molecules grams

L.R. 175.5g AgNO3 | 1mol AgNO3 / 170g AgNO3 | 2mol Ag / 2mol AgNO3 | 108g Ag / 1mol Ag = 111.5 g Ag

~~70g Cu | 1mol Cu / 63.5g Cu | 2mol Ag / 1mol Cu | 108g Ag / 1mol Ag = 238.1g Ag~~

175.5g AgNO3 | 1mol AgNO3 / 170g AgNO3 | 1 mol Cu / 2 mol AgNO3 | 63.5g Cu / 1mol Cu = 32.7g Cu

70g Cu − 32.7g = 37.3g Cu excess

175.5g AgNO3 | 1mol AgNO3 / 170g AgNO3 | 1 mol Cu(NO3)2 / 2mol AgNO3 | 6.02×10^23 Cu(NO3)2 molecules / 1mol Cu(NO3)2 → 3.10×10^23 Cu(NO3)2 molecules

4. $NaCl_{(aq)} + AgNO_{3(aq)} \rightarrow NaNO_{3(aq)} + AgCl_{(s)}$
31.5g 150.0g ?moles?

L.R. 31.5g NaCl | 1mol NaCl / 58.5g NaCl | 1mol AgCl / 1mol NaCl = 0.54 mol AgCl

150.0g AgNO3 | 1mol AgNO3 / 170g AgNO3 | 1mol AgCl / 1mol AgNO3 = 0.88 mol AgCl

NAME

STOICHIOMETRY

Mass, Limiting and Excess #2

IN THE FOLLOWING PROBLEMS DETERMINE THE FOLLOWING:

- BALANCE REACTION
- ANSWER "?" IN CORRECT UNITS
- DETERMINE LIMITING REAGENTS
- DETERMINE AMOUNT OF EXCESS IN GRAMS

1. $NaOH$ + H_3PO_4 → NaH_2PO_4 + H_2O (Balanced)

5g   15g   ? Liters

LR: 5g NaOH | 1 mol NaOH / 40g NaOH | 1 mol H_2O / 1 mol NaOH | 22.4L H_2O / 1 mol H_2O = 2.8L H_2O

15g H_3PO_4 | 1 mol H_3PO_4 / 98g H_3PO_4 | 1 mol H_2O / 1 mol H_3PO_4 | 22.4L H_2O / 1 mol H_2O = 3.4 ~~L~~ H_2O

5g NaOH | 1 mol / 40g NaOH | 1 mol H_3PO_4 / 1 mol NaOH | 98g H_3PO_4 / 1 mol H_3PO_4 = 12.25g H_3PO_4

15g − 12.25 = 2.75g excess H_3PO_4

2. F_2 + H_2 → 2HF

10g   50g   ? (grams)

LR. 10g F_2 | 1 mol F_2 / 38g F_2 | 2 mol HF / 1 mol F_2 | 20g HF / 1 mol = 10.5g HF

50g | 1 mol H_2 / 2g H_2 | 2 mol HF / 1 mol H_2 | 20g HF / 1 mol = 1000g H_2

10g F_2 | 1 mol F_2 / 38g F_2 | 1 mol H_2 / 1 mol F_2 | 2g H_2 / 1 mol H_2 = 0.52g H_2

50g − 0.52g = 49.5g H_2 excess

3. CO_2 + 2NaOH → CO_3^{2-} + $H_2O_{(g)}$ + 2Na^+

10g   10g   ?   ? Liters   ? # of ions

10g CO_2 | 1 mol CO_2 / 44g CO_2 | 1 mol H_2O / 1 mol CO_2 | 22.4L / 1 mol H_2O = 5.1L H_2O

LR. 10g NaOH | 1 mol NaOH / 40g NaOH | 1 mol H_2O / 2 mol NaOH | 22.4L H_2O / 1 mol H_2O = 2.8L H_2O

10g NaOH | 1 mol NaOH / 40g NaOH | 2 mol Na^+ / 2 mol NaOH | 6.02×10^{23} Na^+ / 1 mol Na^+ = 1.51×10^{23} Na^+

10g NaOH | 1 mol NaOH / 40g NaOH | 1 mol CO_2 / 2 mol NaOH | 44g CO_2 / 1 mol CO_2 = 5.5g CO_2

10g − 5.5 = 4.5g excess CO_2

4. $NaHCO_3$ + HCl → NaCl + $CO_{2(g)}$ + H_2O

289.g   300g   ? Grams   ? Liters

LR. 289g $NaHCO_3$ | 1 mol $NaHCO_3$ / 84g $NaHCO_3$ | 1 mol NaCl / 1 mol $NaHCO_3$ | 58.5g NaCl / 1 mol NaCl = 201g NaCl

300g HCl | 1 mol HCl / 36.5g HCl | 1 mol NaCl / 1 mol HCl | 58.5g / 1 mol NaCl = ~~481~~ g NaCl

289 $NaHCO_3$ | 1 mol $NaHCO_3$ / 84g $NaHCO_3$ | 1 mol CO_2 / 1 mol $NaHCO_3$ | 22.4L CO_2 / 1 mol CO_2 = 77.1L CO_2

289 $NaHCO_3$ | 1 mol $NaHCO_3$ / 84g $NaHCO_3$ | 1 mol HCl / 1 mol $NaHCO_3$ | 36.5g HCl / 1 mol HCl = 126g HCl

300g − 126 = 174g HCl excess