UNKNOWN : KNOWN

1.6

1.6

Stoichiometry

Assignment

Answer the following questions:

1) In the cylinder of a car nitrogen reacts with oxygen according to the following unbalanced equation.

$\_1\_ N_2(g) + \_1\_ O_2(g) \rightarrow \_2\_ NO(g)$

Calculate the **number of moles of NO (g)** that would form if *7.8 moles of N_2 (g) reacted.*

NO : N_2
2 : 1
x : 7.8

$7.8\,mol\ N_2 \times \frac{2\,mol\ NO}{1\,mol\ N_2} = 15.6\,mol\ NO$

= 16 mol NO

2) An orange precipitate of iron(III) hydroxide is formed when iron(III) chloride reacts with sodium hydroxide. The unbalanced equation below describes the reaction.

$\_3\_ NaOH(aq) + \_1\_ FeCl_3(aq) \rightarrow \_1\_ Fe(OH)_3(s) + \_3\_ NaCl(aq)$

Calculate the number of moles of $Fe(OH)_3$ (s) that forms if 26.9 moles of NaOH (aq) reacts.

$Fe(OH)_3$: NaOH
1 : 3
x : 26.9 mol

$26.9\,mol\ NaOH \times \frac{1\,mol\ Fe(OH)_3}{3\,mol\ NaOH} = 8.96\,mol$

8.97 mol $Fe(OH)_3$

3) A black solid of Lithium nitride forms when Lithium is (exposed to the air) and combines with nitrogen. The unbalanced equation below describes this reaction.

$\_6\_ Li(s) + \_1\_ N_2(g) \rightarrow \_2\_ Li_3N(s)$

Calculate how many moles of Lithium nitride will form if 1.69 mol of Lithium reacts.

Li_3N : Li
2 : 6
x : 1.69 mol

$1.69\,mol\ Li \times \frac{2\,mol\ Li_3N}{6\,mol\ Li} = 0.563\,mol$

0.563 mol Li_3N

4) Carbon in the form of charcoal in briquettes is unsafe to burn indoor due to the production of carbon monoxide. Write a balanced chemical reaction for the burning of carbon in oxygen to form carbon monoxide. Predict how many moles of carbon monoxide would be produced by the burning of a 420 moles of carbon (charcoal briquettes ,approximately 5 Kg).

$2C + O_2 \rightarrow 2CO$

CO : C
2 : 2
420 : 420

$420\,mol\ C \times \frac{2\,mol\ CO}{2\,mol\ C} = 420\,mol\ CO$

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5) Sulfur dioxide may be catalytically oxidized to sulfur trioxide. How many grams of sulfur dioxide could be converted by this process if 100.0 grams of oxygen are available for the oxidation by the following **unbalanced chemical reaction**?

$$\_2\ SO_{2(g)} + \_1\ O_{2(g)} \rightarrow \_2\ SO_{3(g)}$$

$SO_2 : O_2$

2 : 1

gram: x : 100g

mol : 6.25 : 3.125

MM SO_2 : S (1×32.07)
O (2×16.00)
64.07g/mol

mm O_2 : 32.00g/mol

$$100g\ O_2 \times \frac{1mol\ O_2}{32.0g\ O_2} \times \frac{2\ mol\ SO_2}{1mol\ O_2} \times \frac{64.07g\ SO_2}{1mol\ SO_2}$$

400.4g SO_2

6) Ferric oxide (Iron (III) oxide) may be reduced to pure iron with coke (pure carbon) . If we have 150 Kg of Iron (III) oxide how much coke would be needed to completely convert it to iron by the **following unbalanced equation.** (in g)

$$\_2\ Fe_2O_{3(s)} + \_3\ C_{(s)} \rightarrow \_3\ CO_{2(g)} + \_4\ Fe_{(s)}$$

$Fe_2O_3 : C$

2 : 3

150kg : x

150000g : x

$$150000g\ Fe_2O_3 \times \frac{1mol\ Fe_2O_3}{159.7g} \times \frac{3\ mol\ C}{2mol\ Fe_2O_3} \times \frac{12.01g}{1mol\ C}$$

= 16907.2g

MM Fe_2O_3 : Fe (2×55.85g)
O (3×16.00g)
159.7g/mol

MM C : 12.01g/mol

17 Kg

1.7×10^4 g

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7) Sodium tetraborate is produced by combining boric acid with sodium hydroxide, according to the following unbalanced chemical reaction. How many grams of NaOH would we need to produce 5.00 grams of sodium tetraborate?

$$4\ H_3BO_3 + 2\ NaOH \rightarrow 7\ H_2O + 1\ Na_2B_4O_7$$

NaOH : $Na_2B_4O_7$

2 : 1

x : 5.00g

$$5.00g\ NaOH \times \frac{1mol\ Na_2B_4O_7}{201.22g} \times \frac{2\ mol\ NaOH}{1\ mol\ Na_2B_4O_7} \times \frac{40g}{1mol\ NaOH}$$

$= 1.99g\ NaOH$

MM NaOH : Na (22.99 × 1)
O (16.00 × 1)
H (1.01 × 1)
40g/mol

MM $Na_2B_4O_7$ Na (2 × 22.99)
B (4 × 10.81)
O (7 × 16.00) / 201.22g/mol

8) Gold will dissolve in the acid mixture known as aqua regia according to the following reaction.

$$2\ Au + 3\ HNO_3 + 6\ HCl \rightarrow 2\ AuCl_3 + 2\ NO + 4\ H_2O$$

How much gold (III) chloride would be produced if 250 grams of HCl is consumed in the reaction?

$AuCl_3$: HCl

2 : 6

x : 250g

MM HCl : H (1 × 1.01)
Cl (1 × 35.45)
36.46g/mol

MM $AuCl_3$ Au (1 × 196.97)
Cl (3 × 35.45)
303.32g/mol

$$250g\ HCl \times \frac{1mol\ HCl}{36.46g} \times \frac{2\ mol\ AuCl_3}{6mol\ HCl} \times \frac{303.32g}{1mol\ AuCl_3} = 693.27g\ AuCl_3$$

$= 690g\ AuCl_3$

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9) How many grams of ammonia will be evolved when 34 grams of ammonium chloride is added to an excess of potassium hydroxide, by the following equation.

$$\_\_NH_4Cl + \_\_KOH \rightarrow \_\_NH_3 + \_\_H_2O + \_\_KCl$$

$NH_3 : NH_4Cl$

1 : 1

x : 34g

mm NH_4Cl: N (1 x 14.01), H (4 x 1.01), Cl (1 x 35.45) = 53.5 g/mol

MM NH_3: N (1 x 14.01), H (3 x 1.01) = 17.04 g/mol

$$34\text{g } NH_4Cl \times \frac{1\text{mol } NH_4Cl}{53.5\text{g}} \times \frac{1\text{mol } NH_3}{1\text{mol } NH_4Cl} \times \frac{17.04\text{g}}{1\text{mol } NH_3} = 10.829\text{g}$$

$= 11\text{g } NH_3$

10) Lightning discharges in the atmosphere catalyze the conversion of nitrogen gas to nitric oxide gas. How many grams of nitrogen gas would be required to make 55 kL of nitric oxide?

$$\_2\_N_2(g) + \_1\_O_2(g) \rightarrow \_2\_N_2O(g) \quad @SATP$$

$N_2 : N_2O$

2 : 2

: 55 kL = 55000 L

MM N_2: N (2 x 14.01) = 28.02 g/mol

$$55000\text{ L } N_2O \times \frac{1\text{mol } N_2O}{24.8\text{ L}} \times \frac{2\text{mol } N_2}{2\text{mol } N_2O} \times \frac{28.02\text{g}}{1\text{mol } N_2} = 62141.129\text{g } N_2$$

$= 6.2 \times 10^4\text{g } N_2$

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11) What mass of sulfur will be required to produce 150 L of sulfur dioxide when it is burned in oxygen gas, according to the following unbalanced reaction.

$$\_1\_ S_8(s) + \_12\_ O_2(g) \rightarrow \_8\_ SO_3(g)$$

$S_8 : SO_3$

$1 : 8$

$\_\_\_ : 150\ L$

L

g?

MM $S_8 \Rightarrow S(8 \times 32.07)$

$256.56\ g/mol$

$$150\ L\ SO_3 \times \frac{1\ mol\ SO_3}{22.4\ L} \times \frac{1\ mol\ S_8}{8\ mol\ SO_3} \times \frac{256.56\ g}{1\ mol\ S_8} = 214.75\ g\ S_8$$

$= 220\ g\ S_8$

12) How much carbon monoxide in kL (at SATP) will be produced when 150 grams of calcium phosphate reacts with enough silicon dioxide and carbon, according to the following unbalanced reaction.

$$\_2\_ Ca_3(PO_4)_2 + \_6\_ SiO_2 + \_10\_ C \rightarrow \_6\_ CaSiO_3 + \_10\_ CO + \_1\_ P_4$$

$CO : Ca_3(PO_4)_2$

$10 : 2$

$x : 150\ g$

MM $Ca_3(PO_4)_2$: Ca $3(40.08)$, P $2(30.97)$, O $8(16.00)$

$310.17\ g/mol$

$$150\ g\ Ca_3(PO_4)_2 \times \frac{1\ mol\ Ca_3(PO_4)_2}{310.17\ g} \times \frac{10\ mol\ CO}{2\ mol\ Ca_3(PO_4)_2} \times \frac{24.8\ L}{1\ mol\ CO} = 59.967\ L\ CO$$

$0.060\ kL\ CO$

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13) Calcium phosphide when added to water produces phosphine gas (PH_3). How many kL at SATP of the gas will be produced when 350 grams of calcium phosphide is added to an excess amount of water.

2 sf.

$$1\ Ca_3P_2 + 3\ H_2O \rightarrow 2\ PH_3 + 3\ CaO$$

$Ca_3P_2 : PH_3$

1 : 2

350g : —

L?

MM Ca_3P_2: Ca (3 × 40.08)
P (2 × 30.97)
182.18 g/mol

$$350\text{g } Ca_3P_2 \times \frac{1\text{mol } Ca_3P_2}{182.18\text{g}} \times \frac{2\text{ mol } PH_3}{1\text{mol } Ca_3P_2} \times \frac{24.8\text{L}}{1\text{mol } PH_3} = 95.29\text{L}$$

$$= \boxed{0.095\text{kL } PH_3}$$

3 sig figs

14) What mass of O_2 is consumed in the complete synthesis of water if 6.86 g of H_2 participate in the reaction?

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$$

$$6.86\text{g } H_2 \times \frac{1\text{mol } H_2}{2.02\text{g } H_2} \times \frac{1\text{mol } O_2}{2\text{ mol } H_2} \times \frac{32.00\text{g } O_2}{1\text{mol } O_2} =$$

$$\boxed{= 54.4\text{g } O_2}$$