Chemistry 152
Tuesday, 28 April 2009

In-Class Activity
Limiting Reactants

Answer Key

Mesa
San Diego College

---

1. Consider the following reaction: $5NaN_3\ (s) + NaNO_3\ (aq) \rightarrow 3Na_2O\ (s) + 8N_2\ (g)$

8

a. If you start with 52 moles of sodium azide and 12 moles of sodium nitrate, how many moles of nitrogen could be produced?

choice = 2

$52\ mol\ NaN_3 \left(\frac{8\ mol\ N_2}{5\ mol\ NaN_3}\right) = \boxed{83\ mol\ N_2}$ (1) (1) (1)

$12\ mol\ NaNO_3 \left(\frac{8\ mol\ N_2}{1\ mol\ NaNO_3}\right) = 96\ mol\ N_2$ (1) (1) (1)

2 b. What is the limiting reactant? $\boxed{NaN_3}$ (2)

2 c. What is the excess reactant? $\boxed{NaNO_3}$ (2)

4 d. How many moles of the excess reactant would remain after the limiting reactant is completely consumed?

$83\ mol\ N_2 \times \left(\frac{1\ mol\ NaNO_3}{8\ mol\ N_2}\right) = 10.4\ mol\ NaNO_3$ consumed (1) (1)

12 mol $NaNO_3$ available
− 10.4 mol $NaNO_3$ used (1)

$\boxed{1.6\ mol\ NaNO_3\ \text{left over}}$ (1)

96 mol N_2
− 83 mol N_2 (1)
13 mol N_2 could have formed

$13\ mol\ N_2 \left(\frac{1\ mol\ NaNO_3}{8\ mol\ N_2}\right) = \boxed{1.6\ mol\ NaNO_3\ \text{left over}}$ (1) (1)

16

Chemistry 152
Tuesday, 28 April 2009

In-Class Activity
Limiting Reactants

Answer Key

Mesa San Diego College

2. Write the balanced equation for the combustion of naphthalene ($C_{10}H_8$) in oxygen.

5

$$C_{10}H_8 + 12\,O_2 \longrightarrow 10\,CO_2 + 4\,H_2O$$

15 a. How many grams of carbon dioxide could be produced when 45 grams of naphthalene burns in 15 grams of oxygen?

Plan: g $C_{10}H_8$ → mol $C_{10}H_8$ → mol CO_2 → g CO_2
g O_2 → mol O_2 → mol CO_2 → g CO_2 } pick smaller

molar masses
$C_{10}H_8 = (12.01 \times 10) + (1.008 \times 8) = 128.164\,g/mol$ ①
$O_2 = (16.00 \times 2) = 32.00\,g/mol$ ①
$CO_2 = (12.01 \times 1) + (16.00 \times 2) = 44.01\,g/mol$ ①

$$45\,g\,C_{10}H_8 \left(\frac{1\,mol\,C_{10}H_8}{128.164\,g}\right)\left(\frac{10\,mol\,CO_2}{1\,mol\,C_{10}H_8}\right)\left(\frac{44.01\,g}{1\,mol}\right) = 155\,g\,CO_2$$

$$15\,g\,O_2 \left(\frac{1\,mol\,O_2}{32.00\,g}\right)\left(\frac{10\,mol\,CO_2}{12\,mol\,O_2}\right)\left(\frac{44.01\,g}{1\,mol}\right) = \boxed{17\,g\,CO_2}$$ — choice ②

2 b. Which is the limiting reactant O_2 ②
2 c. Which is the excess reactant? $C_{10}H_8$ ②
6 d. What mass of the excess reactant would remain after the reaction went to completion?

$$17\,g\,CO_2 \times \left(\frac{1\,mol\,CO_2}{44.01\,g}\right)\left(\frac{1\,mol\,C_{10}H_8}{10\,mol\,CO_2}\right)\left(\frac{128.164\,g}{1\,mol}\right) = 4.95\,g\,C_{10}H_8 \text{ used.}$$

45 g $C_{10}H_8$ available ①
− 4.95 g $C_{10}H_8$ used

40. g $C_{10}H_8$ left over ①

other method:

155 g ①
− 17 g
138 g CO_2

$$138\,g\,CO_2 \left(\frac{1\,mol\,CO_2}{44.01\,g}\right)\left(\frac{1\,mol\,C_{10}H_8}{10\,mol\,CO_2}\right)\left(\frac{128.164\,g}{1\,mol}\right) = \boxed{40.\,g \text{ leftover } C_{10}H_8}$$

30