CHEM 0011: Practice Test

QUESTION	MARK OBTAINED	MARK POSSIBLE
I	9	
II	8	
III	26	
IV	4	
TOTAL	47	

I. For the following reactions,

$$3\ CaCO_3 + 2\ FePO_4 \rightarrow Ca_3(PO_4)_2 + Fe_2(CO_3)_3$$

assuming we start with 100 grams of calcium carbonate and 45 grams of iron (II) phosphate.

find the following:

a) Which of the reagents is the limiting reagent? Explain. **[3 marks]**
b) What is the maximum amount of each product that can be formed? **[3 marks]**
c) How much of the other reagent is left over after the reaction is complete? **[3 marks]**

Molar mass($CaCO_3$) = 100.09 g/mole
Molar mass ($FePO_4$) = 150.8148 g/mole
Molar mass ($Ca_3(PO_4)_2$) = 310.1736 g/mole
Molar mass ($Fe_2(CO_3)_3$) = 291.714 g/mole

(a) 100 g $CaCO_3$ /100.09 g/mole = 0.99910 moles $CaCO_3$ = 1 mole $CaCO_3$

45 g $FePO_4$ / 150.8148 g/mole = 0.2984 moles $FePO_4$ = 0.30 mole $FePO_4$

The balanced equation shows that $CaCO_3$: $FePO_4$ has a 3:2 ratio.
To use up the 1 mole of $CaCO_3$, I would need

$$\frac{3}{0.99910} = \frac{2}{x}$$

x = 0.99910 ($^2/_3$) = 0.666 mole $FePO_4$

0.666 mole $FePO_4$. But I only have 0.30 mole of $FePO_4$. I don't have enough $FePO_4$ to use up 1 mole of $CaCO_3$. $FePO_4$ is the limiting reagent.

(b) Since $FePO_4$ is the limiting reagent, I must use the starting amount of $FePO_4$ (i.e. 0.30 mole) to calculate the products formed.

The ratio of $FePO_4$: $Ca_3(PO_4)_2$ is 2:1

$$\frac{2}{0.2984} = \frac{1}{x}$$

x =0.2984 ($^1/_2$) = 0.1492 mole $Ca_3(PO_4)_2$

Since the question did not specify the units of "amount", I could leave it in moles. Or, I could take it one step further to express in grams.

0.1492 mole · 310.1736 g/mole = 46.29 g = 46 g $Ca_3(PO_4)_2$

The ratio of $FePO_4$ $Fe_2(CO_3)_3$ is 2:1

$$\frac{2}{0.2984} = \frac{1}{x}$$

x =0.2984 ($^1/_2$) = 0.1492 mole $Fe_2(CO_3)_3$

Since the question did not specify the units of "amount", I could leave it in moles. Or, I could take it one step further to express in grams.

0.1492 mole · 291.714 g/mole = 43.53 g = 44 g $Ca_3(PO_4)_2$

(c) To use up all the $FePO_4$, I will need

$$\frac{3}{y} = \frac{2}{0.2984}$$

y = 0.2984 ($^3/_2$) = 0.44768 mole $CaCO_3$

0.45 mole of $CaCO_3$.

Therefore, the amount of $CaCO_3$ left over would be

0.99910 - 0.44768 = 0.55142 moles = 0.55 moles $CaCO_3$

Since the question did not specify the units of "amount", I could leave it in moles. Or, I could take it one step further to express in grams.

0.55142 moles $CaCO_3$ · 100.09 g/mole = 55.189 mole = 55.2 g $CaCO_3$

II. A 25.00 mL sample of a 0.5250 M H_2SO_4 solution is titrated with a NaOH solution using phenolphthalein as the indicator. It is found that 22.07 mL of the NaOH solution is needed to reach the endpoint of the titration.

(a) What is the molarity of the NaOH solution? **[4 marks]**

2.625×10^{-2} mol NaOH needed to reach the endpoint
Concentration of NaOH = 1.189 M NaOH

(b) Upon closer look, the pipette that was used to pipette the sample of acid was a 20.00 mL pipette. What is the molarity of the NaOH solution? **[4 marks]**

0.9515 M NaOH

III. There are 5 parts to this section. Predict, classify and write the reaction (if a reaction occurs). NOTE: The answer may be 'no reaction'. If (i) is no reaction, then there is no need to answer (ii), (iii), (iv).

1. When potassium metal is dipped into water. **[6 marks]**

(i) Will this reaction occur? **[1 mark]**
yes
(ii) If (i) is yes, classify the reaction. **[1 mark]**
single replacement
(iii) If (i) is yes, write the product(s) of the reaction. Include the physical states of the product(s). **[2 marks]**
$KOH\ (aq) + H_2\ (g)$
(iv) If (i) is yes, write the net ionic reaction. Include the physical states of the reactants and products. **[1 mark]**
$2\ K\ (s) + 2\ H_2O\ (l) \rightarrow 2\ K^+\ (aq) + 2\ OH^-\ (aq) + H_2\ (g)$
(v) Which species is oxidized? **[1 mark]** potassium metal, K(s)
(vi) Which specis is reduced? **[1 mark]** H^+ ion

2. Burning of methane gas, CH_4. **[4 marks]**

((i) Will this reaction occur? **[1 mark]**
yes
(ii) If (i) is yes, classify the reaction. **[1 mark]**
combustion
(iii) If (i) is yes, write the product(s) of the reaction. Include the physical states of the product(s). **[1 mark]**
$CO_2\ (g) + H_2O\ (l)$
(iv) If (i) is yes, write the balanced chemical reaction. Include the physical states of the reactants and products. **[1 mark]**
$CH_4\ (g) + 2\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ H_2O\ (l)$

3. Immerse copper metal into a zinc chloride, $ZnCl_2$, solution. **[6 marks]**

(i) Will this reaction occur? **[1 mark]**
No
(ii) If (i) is yes, classify the reaction. **[1 mark]**
N/A
(iii) If (i) is yes, write the product(s) of the reaction. Include the physical states of the product(s). **[1 mark]**
N/A
(iv) If (i) is yes, write the net ionic reaction. Include the physical states of the reactants and products. **[1 mark]**
N/A
(v) Which species is oxidized?. **[1 mark]** N/A
(vi) Which specis is reduced? **[1 mark]** N/A

4. Strontium hydroxide reacts with sulfuric acid. **[4 marks]**

(i) Will this reaction occur? **[1 mark]**
Yes
(ii) If (i) is yes, classify the reaction. **[1 mark]**
Neutralization or Double replacement
(iii) If (i) is yes, write the product(s) of the reaction. Include the physical states of the product(s). **[1 mark]**
$SrSO_4$ (s) + H_2O (l)
(iv) If (i) is yes, write the net ionic reaction. Include the physical states of the reactants and products. **[1 mark]**
Sr^{+2} (aq) + 2 OH^- (aq) + $2H^+$ (aq) + SO_4^{2-} (aq) → $SrSO_4$ (s) + 2 H_2O (l)

5. Iodine is immersed in a solution of KCl**. [6 marks]**

(i) Will this reaction occur? **[1 mark]**
No
(ii) If (i) is yes, classify the reaction. **[1 mark]**
N/A
(iii) If (i) is yes, write the product(s) of the reaction. Include the physical states of the product(s). **[1 mark]**
N/A
(iv) If (i) is yes, write the net ionic reaction. Include the physical states of the reactants and products. **[1 mark]**
N/A
(v) Which species is oxidized?. **[1 mark]** N/A
(vi) Which specis is reduced? **[1 mark]** N/A

V. Balance the following reaction: [4 marks]

(i) PCl_3 (aq) + 3 H_2O (l) $\rightarrow$ H_3PO_3 (aq) + 3 HCl (aq)

(ii) 6 P_2H_4 (l) $\rightarrow$ 8 PH_3 (g) + P_4 (g)