

Chemistry 1154 Fall 2022 Test 2

Thursday, October 27, 2022

Time: 1 hour 50 minutes

Name: ANSWERS

Student #: _____

This test consists of **eight** pages of questions, the formula sheet, and a periodic table. Please ensure that you have a complete test and, if you do not, obtain one from me **immediately**. There are **30** marks available. Good luck!

- 1) [3 marks] How many grams of 80.0-percent pure AgNO_3 (169.9 g/mol) are necessary to prepare 1075.4 mg of Ag_2CO_3 (275.744 g/mol) if the reaction



proceeds with a 62.5 percent yield?

$$1075.4 \text{ mg} \times \frac{100 \text{ theo}}{62.5 \text{ act}} = 1720.64 \text{ mg actual.}$$

$$1720.64 \text{ mg Ag}_2\text{CO}_3 \times \frac{1 \text{ mol}}{275.744 \text{ g}} \times \frac{2 \text{ AgNO}_3}{1 \text{ Ag}_2\text{CO}_3} \times \frac{169.9 \text{ g}}{\text{mol}}$$

$$= 2120.34 \dots \text{ mg AgNO}_3$$

$$2120.34 \dots \text{ mg AgNO}_3 \times \frac{100 \text{ g pure}}{80 \text{ AgNO}_3} = 2650.43 \dots \text{ mg}$$

$$= \boxed{2.6504 \dots \text{ g}}$$

2) [6 marks] If 25.0 mL of 0.15 M $\text{Ca}(\text{NO}_3)_2$ are mixed with 75.0 mL of 0.050 M Na_3PO_4 :



a) Identify the limiting reagent.

LIR

$$\frac{25 \text{ mL} \times 0.15 \text{ moles Ca}(\text{NO}_3)_2}{L} \times \frac{1 \text{ rxn}}{3 \text{ Ca}(\text{NO}_3)_2} = 1.25 \text{ mmol rxn}$$

$$\frac{75 \text{ mL} \times 0.05 \text{ moles Na}_3\text{PO}_4}{L} \times \frac{1 \text{ rxn}}{2 \text{ Na}_3\text{PO}_4} = 1.875 \text{ mmol rxn}$$

b) What should be the concentration of the NaNO_3 after reaction?

$$\frac{25 \text{ mL} \times 0.15 \text{ moles Ca}(\text{NO}_3)_2}{L} \times \frac{6 \text{ NaNO}_3}{3 \text{ Ca}(\text{NO}_3)_2} = \boxed{0.075 \text{ M}}$$

100 mL

c) What should be the concentration of the excess reagent after reaction?

$$\frac{75 \text{ mL} \times 0.05 \text{ moles Na}_3\text{PO}_4}{L} - \frac{25 \text{ mL} \times 0.15 \text{ moles Ca}(\text{NO}_3)_2}{L} \times \frac{2 \text{ Na}_3\text{PO}_4}{3 \text{ Ca}(\text{NO}_3)_2}$$

100 mL

$$= \boxed{0.0125 \text{ M Na}_3\text{PO}_4}$$

3) [2 marks] Calculate the density of SF₆ (146.053 g/mol) at 100 torr pressure and -5.0°C

$$D = \frac{MM \times P}{R \times T} = \frac{146.053 \times 100}{62.3635 \dots \times 268.15}$$

$$= 0.873 \frac{\text{g}}{\text{L}}$$

- 4) [4 marks] The molar mass of magnesium lab was carried out exactly as you'll do it in the lab, with the exception that instead of water (with a density of 1.00 g/cm^3), a mystery fluid was used. Your job is to use the data given to determine the density of the mystery fluid. You will also need to know that the density of mercury is 13.6 g/cm^3 and that, when the data was analyzed, the molar mass of Mg was determined to be 24.6 g/mol (instead of 24.3 g/mol). The reaction between Mg and HCl is:



Give your density in g/cm^3 .

Data (units)	value
Mass Mg (mg)	52.3
$T_{\text{sol'n}}$ ($^{\circ}\text{C}$)	21.4
P_{atm} (torr)	761.2
VP_{fluid} (torr)	20.3
h (mm)	141
V_{gas} (mL)	53.3

$$52.3 \text{ mg} \times \frac{1 \text{ mol}}{24.6 \text{ g}} \times \frac{1 \text{ H}_2}{1 \text{ Mg}} = 2.126016 \dots \text{ m mol H}_2$$

$$P_{\text{H}_2} = 761.2 - 20.3 - 141 \times \frac{D}{13.6}$$

$$= 740.9 - 10.36 \dots D$$

$$n_{\text{H}_2} = \frac{(740.9 - 10.36 \dots D)(53.3)}{(62.36359822)(294.55)}$$

$$= (0.0029 \dots)(740.9 - 10.36 \dots D)$$

$$= 2.126016 \dots$$

$$732.7056909 = 740.9 - 10.36 \dots D$$

$$10.36 D = 8.194309055$$

$$D = 0.790373072 \frac{\text{g}}{\text{cm}^3}$$

5) [4 marks] The following apparatus was assembled:

Bulb 1:

Chemical: $\text{NH}_3(\text{g})$

Pressure: 2 bar

Volume: 7 litres

Bulb 2:

Chemical: $\text{O}_2(\text{g})$

Pressure: 5 bar

Volume: 3 litres

The bulbs were connected by a valve, and both bulbs were maintained at a temperature of 929.57°C at all times. When the valves were opened, the following reaction occurred:



Calculate the mole fractions of all species after reaction.

$$n_{\text{NH}_3} = \frac{14}{RT}; \quad n_{\text{O}_2} = \frac{15}{RT}$$

LR:

$$\frac{14}{RT} \text{ moles NH}_3 \times \frac{1 \text{ rxn}}{4 \text{ NH}_3} = \frac{3.5}{RT} \text{ moles rxn}$$

$$\frac{15}{RT} \text{ moles O}_2 \times \frac{1 \text{ rxn}}{5 \text{ O}_2} = \frac{3}{RT} \text{ moles rxn}$$

$$\text{NO: } \frac{15}{RT} \text{ moles O}_2 \times \frac{4 \text{ NO}}{5 \text{ O}_2} = \frac{12}{RT} \text{ moles NO}$$

$$\text{H}_2\text{O: } \frac{15}{RT} \text{ moles O}_2 \times \frac{6 \text{ H}_2\text{O}}{5 \text{ O}_2} = \frac{18}{RT} \text{ moles H}_2\text{O}$$

$$\text{NH}_3 \text{ L.O.: } \frac{14}{RT} \text{ moles NH}_3 - \frac{15}{RT} \text{ moles O}_2 \times \frac{4 \text{ NH}_3}{5 \text{ O}_2} = \frac{2}{RT}$$

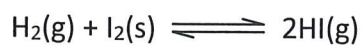
$$\text{Total moles} = \frac{12}{RT} + \frac{18}{RT} + \frac{2}{RT} = \frac{32}{RT}$$

$$X_{\text{NH}_3} = \frac{\frac{2}{RT}}{\frac{32}{RT}} = \frac{1}{16}$$

$$X_{\text{NO}} = \frac{\frac{12}{RT}}{\frac{32}{RT}} = \frac{3}{8}$$

$$X_{\text{H}_2\text{O}} = \frac{\frac{18}{RT}}{\frac{32}{RT}} = \frac{9}{16}$$

6) [3 marks] For the reaction:



Which of the following changes should drive the reaction forward (that is, create more products), and which should change the value of K_p for the reaction? Circle your choice in each case. If the change does not affect K_p or drive the reaction forward, circle "Neither."

Adding some $\text{H}_2(\text{g})$	Forward	K_p	Neither
Decreasing the volume of the reaction container	Forward	K_p	Neither
Adding some NaOH (reacts with HI)	Forward	K_p	Neither

7) [8 marks] Given the equilibrium:



a) K_p for the reaction



at 150°C would be:

- i) -396.01
- ii) -39.8
- iii) 0.00253
- iv) 0.0251

b) K_c for the reaction



at 150°C would be:

- i) 2.46×10^4
- ii) 2.46×10^8
- iii) 3.05×10^7
- iv) 3.05×10^{15}

$$(19.9)(RT)^2$$

$$K_p = K_c (RT)^{-2}$$

$$K_c = K_p (RT)^2$$

c) K_p for the reaction



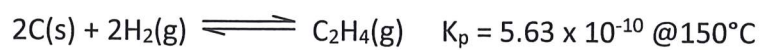
at 175°C would be:

- i) 2.9×10^{-57}
- ii) 0.00132
- iii) 5.25
- iv) 19.9

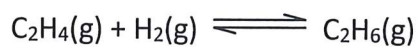
$$\ln\left(\frac{K}{19.9}\right) = \frac{-84000}{8.31} \times \left(\frac{448.15 - 423.15}{448.15 \times 423.15}\right)$$

$$\Rightarrow K =$$

d) Given the additional reaction



then K_p for the reaction



at 150°C would be

i) -1.12×10^{-8}

ii) 1.12×10^{-8}

iii) 19.9

iv) 3.53×10^{10}

