The University of Jordan
School of Engineering
Chemical Engineering Department

0905211) Chemical Engineering Principles I — First Semester – 2019/2020

Quiz # 2 (Chapter 3)

Name: _____ ID # _____

Q1: A mixture of gases is analyzed and found to have the following molar composition: 18.0% CO_2, 37.0% CH_4, and 45.0% N_2. For the mixture calculate:

(a) The mixture average molecular weight.

(b) The mass fraction of each component.

a) $\overline{M} = \sum y_i M_{wi} = 0.18 \times 44 + 0.37 \times 16 + 0.45 \times 28 = 27$

	mol fraction	number of moles	mass	mass Fraction
CO_2	0.18	x100 → 18	792	0.30
CH_4	0.37	x100 → 37	592	0.22
N_2	0.45	x100 → 45	1260	0.48
total	1	x100 → 100	2644	1

basis = 100 mol

mass = n x Mw

mass Fraction = $\frac{m_i}{m_T}$

Q2: The density (ρ) of ammonia vapor might be estimated at different temperatures (T in °C) using the following relations:

$$\rho\,(g/cm^3) = \begin{cases} 0.0029e^{0.0402T} & ,T < 0\,°C \\ 2.0\times10^{-6}T^2 + 1.0\times10^{-4}T + 0.0036 & ,T \geq 0\,°C \end{cases}$$

(a) Calculate the density of ammonia vapor at 14 °F.

(b) Calculate the specific volume of ammonia vapor at 503 K.

4.75

a) $14°F \longrightarrow -10°C$

$P = 0.0029\,e^{0.0402T} = 0.0029\,e^{0.0402*-10} = 1.9\times10^{-3}\ g/cm^3$

b) $T(K) = T(c°) + 273.15$

$503 = T(c°) + 273.15 \longrightarrow T(c°) = 230°C$

$P = 2.0\times10^{-6}T^2 + 1.0\times10^{-4}T + 0.0036$

$= 2.0\times10^{-6}(230)^2 + 1.0\times10^{-4}\times230 + 0.0036 = 0.1324\ g/cm^3$

specific volume $= \frac{1}{\rho} = 7.55 \simeq 7.6\ cm^3/g$

0.1

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8.5/10

(0905211) Chemical Engineering Principles I — First Semester – 2019/2020

Quiz # 4 (Chapter 4)

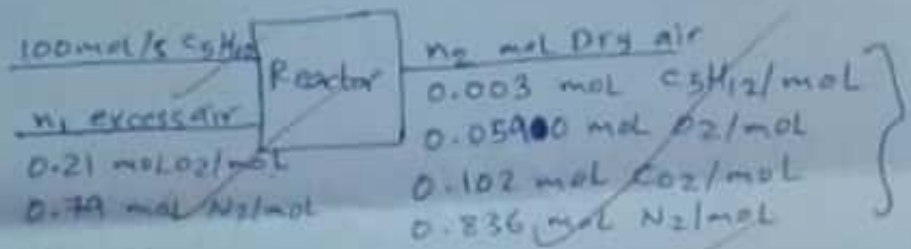
Name: [redacted] ID # [redacted]

100 mol/s of n-Pentane (C_5H_{12}) is burned with excess air in a continuous combustion chamber. A technician runs an analysis and reports that the product gas contains 0.300 mole% pentane, 5.90% oxygen, 10.2% carbon dioxide, and the balance nitrogen on a dry basis.

(a) Draw and label a flowchart, perform a degree-of-freedom analysis based on atomic species balances, and show that the system has -1 degrees of freedom. Interpret this result.

(b) Calculate the percent excess air fed to the reactor, the fractional conversion of pentane, and the mole water vapor/mol dry gas ratio.

(a) $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$



Dof = 3 − 2 − 1 = 0 − 1

n_1 C N_2 (Inert)
n_2 H
n_w O

C balance → input = output → $5 \times 100 = \underbrace{5 \times 0.003 n_2}_{0.015} + 0.102 \times n_2$

$0.117 n_2 = 500$ → $n_2 = 4274$ mol Dry air

N balance → $0.79 \times 2 \times n_1 = 0.836 \times 4274 \times 2$ → $n_1 = 2261$ mol Fed air

H balance → $12 \times 100 = 12 \times 0.003 \times 4274 + n_w \times 2$

→ $n_w = 1046$ mol H_2O $= 523$

O balance → $2 \times 0.21 \times n_1 = 2 \times 0.0590 \times n_2 + 2 \times 0.102 \times n_2 + n_w$

→ $0.42 n_1 = 0.322 n_2 + n_w$ all amount we determinate From Previous equation.

∴ no need For this balance (exce

(b)

$$\% \text{ excess air} = \frac{\text{air fed} - \text{air th}}{\text{air th}} \times 100\%$$

$$= \frac{2261 - 3809}{3809} \times 100\% = -40.6\%$$

$\times 2$

can't be -ve!

$$n_{O_2\,th} = 100 \times \frac{8 \text{ mol } O_2}{1 \text{ mol } C_5H_{12}} = 800 \text{ mol}$$

$$n_{air\,th} = 800 \times \frac{1 \text{ mol air}}{0.21 O_2} = 3810 \text{ mol}$$

$$f_{C_5H_{12}} = \frac{n_{reacted}}{n_{fed}} = \frac{100 - 0.003 \times 4274}{100} = \frac{87.2}{100} = 0.872$$

$$\frac{\text{mol water}}{\text{mol dry gas}} = \frac{1046}{4274} = 0.245 \text{ mol } H_2O / \text{mol dry gas.}$$

O.K

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Quiz # 1 (Chapter 2)

Name: _____ ID # _____

Q1: According to Archimedes' principle, the mass of a floating object equals the mass of the fluid displaced by the object. Use this principle to solve the following problem, paying attention to significant figures.

- A wooden cylinder 30.0 cm high floats vertically in a tub of water (density = 1.00 g/cm³). The top of the cylinder is 14.1 cm above the surface of the liquid. What is the density of the wood?

$D = \frac{m}{V}$

$30.0 - 14.1 = 15.9$ cm

$V = \pi r^2 h$

mass of cylinder $= (D \times V)_{H_2O} = \frac{1.00\ g}{cm^3} \left| (15.9)^3\ cm^3 \right| = 4020\ g$

$D_{cylinder} = \frac{m}{V} = \frac{4020\ g}{(30.0)^3\ cm^3}$

$= 0.149\ g/cm^3$

Q2: Using the dimensional equations convert: 921 kg/m³ to lb_m/ft^3

$$\frac{921\ kg}{m^3} \left| \frac{1\ m^3}{35.3145\ ft^3} \right| \frac{2.20462\ lb_m}{1\ kg} = 57.5\ lb_m/ft^3$$

Q3: Choose the correct answer:

1. The mass of a watch glass was measured four times. The masses were 99.997 g, 100.008 g, 100.011 g, and 100.005 g. What is the average mass of the watch glass?

   a. 100.00525 g
   c. 100.005 g
   b. 100.0 g
   d. 100.01 g

2. How many significant figures are in the measurement 102.400 meters?

   a. three
   c. four
   b. five
   d. six

3. Round the following measurement to three significant figures: 0.90985 cm2

   a. 0.909 cm^2
   c. 0.9099 cm^2
   b. 0.91 cm^2
   d. 0.910 cm^2

4. Subtract: 7.987 m - 0.54 m

   a. 7.447 m
   c. 7.45 m
   b. 7.4 m
   d. 7.5 m

5. When performing the calculation 34.530 g + 12.1 g + 1,222.34 g, the final answer must have:

   a. Only one decimal piace
   c. Three decimal places
   b. Units of g^3
   d. Three significant figures

6. A piece of stone has a mass of 24.595 grams and a volume of 5.34 cm^3. What is the density of the stone?

   a. 0.22 cm^3/g
   c. 4.606 g/cm^3
   b. 4.61 g/cm^3
   d. 0.217 cm^3/g

$$D = \frac{m}{V} = \frac{24.595\ g}{5.34\ cm^3} = 4.6058 \approx 4.61$$

Mass	1 kg = 1000 g = 0.001 metric ton = 2.20462 lb_m = 35.27392 oz 1 lb_m = 16 oz = 5×10^{-4} ton = 453.593 g = 0.453593 kg
Length	1 m = 100 cm = 1000 mm = 10^6 microns (μm) = 10^{10} angstroms (Å) = 39.37 in. = 3.2808 ft = 1.0936 yd = 0.0006214 mile 1 ft = 12 in. = 1/3 yd = 0.3048 m = 30.48 cm
Volume	1 m^3 = 1000 L = 10^6 cm^3 = 10^6 mL = 35.3145 ft^3 = 220.83 imperial gallons = 264.17 gal = 1056.68 qt 1 ft^3 = 1728 $in.^3$ = 7.4805 gal = 0.028317 m^3 = 28.317 L = 28,317 cm^3

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85/10

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Quiz # 1 (Chapter 2)

Name: [redacted] ID # [redacted]

Q1: According to Archimedes' principle, the mass of a floating object equals the mass of the fluid displaced by the object. Use this principle to solve the following problem, paying attention to significant figures.

- **A wooden cylinder 30.0 cm high (density = 0.6 g/cm³) floats vertically in a liquid of unknown density. The top of the cylinder is 20.7 cm above the surface of the liquid. What is the liquid density?**

$(30.0 - 20.7)\ cm = 9.3\ cm$ ✓

0.5

4

2

Q2: Using the dimensional equations convert: 21 lb_m/ft^3 to kg/m³

2/

$$\frac{21\ lb_m}{ft^3} \left| \frac{0.453593\ kg}{1\ lb_m} \right| \frac{35.3145\ ft^3}{1\ m^3} = 336.4\ kg/m^3$$

$= 340\ kg/m^3$

~~340 kg/m³~~

~~33~~

Q3: Choose the correct answer:

1. The mass of a watch glass was measured four times. The masses were 99.997 g, 100.008 g, 100.011 g, and 100.005 g. What is the average mass of the watch glass?

   a. 100.00525 g
   c. 100.005 g
   b. 100.0 g
   d. 100.01 g

2. How many significant figures are in the measurement 0.00130 cm?

   a. four
   c. two
   b. three
   d. five

3. Round the following measurement to four significant figures: 0.90985 cm2

   a. 0.9098 cm^2
   c. 0.9099 cm^2
   b. 0.909 cm^2
   d. 0.910 cm^2

4. Solve: 13.004 m + 3.09 m + 112.947 m = ?

   a. 129 m
   c. 129.04 m
   b. 129.041 m
   d. 129.0 m

5. When performing the calculation 34.530 g – 12.1 g – 1,222.34 g, the final answer must have:

   a. Only one decimal place
   c. Three decimal places
   b. Units of g^3
   d. Three significant figures

6. A piece of stone has a mass of 923 grams and a volume of 20,312 cm^3. What is the density of the stone?

   a. 4.00×10^{-2} g/cm^3
   c. 0.045 g/cm^3
   b. 0.04 g/cm^3
   d. 0.0454 g/cm^3

Mass	1 kg = 1000 g = 0.001 metric ton = 2.20462 lb_m = 35.27392 oz 1 lb_m = 16 oz = 5×10^{-4} ton = 453.593 g = 0.453593 kg
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