

KATHMANDU UNIVERSITY  
End Semester Examination  
February/March, 2019

Marks Scored:

Level : B.E.  
Year : II

Course : CHEG 201  
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date :

SECTION "A"

[20 Q.  $\times$  0.5 = 10 marks]

Tick the most appropriate answer.

- Which temperature is the highest one?  
a. 0 °C                      b. 30 °F                      c. 280 K                      d. 460 °R
- The weight of an object  
a. varies with altitude.  
b. is the amount of work done by the object under gravitational attraction.  
c. equals the mass of the object.  
d. in the moon is similar to that in the earth.
- One psi is equivalent to  
a. 1 lb<sub>f</sub>/inch<sup>2</sup>                      b. 1 lb<sub>f</sub>/ft<sup>2</sup>                      c. 1 Newton/inch<sup>2</sup>                      d. 1 Newton/m<sup>2</sup>
- The heat capacity of liquid water  
a. is independent of temperature.  
b. is Btu per pound in unit.  
c. is similar to the heat capacity of water vapor.  
d. at constant volume is similar to that at constant pressure.
- The height of a mountain was measured to be 2700 m. The significant number of the height is  
a. 1                      b. 2                      c. 3                      d. 4
- 10 L of 1 M HCl solution and 10 L of 1 M NaOH solution were put in a jar together and stirred for neutralization. This is a  
a. continuous process.                      b. steady-state process.  
c. semi-batch process.                      d. batch process.
- The oxygen content in the air is known to be 21%. Assume that the air is composed of oxygen (MW=32) and nitrogen (MW=28) only. The mass fraction of nitrogen is  
a. 0.79                      b. higher than 0.79                      c. lower than 0.79                      d. indeterminable
- 1 L of water was charged in a pot and boiled to have one-third of the water vented into the atmosphere as steam from the pot. By taking the pot as a system, the accumulation in the material balance is  
a. 0 L                      b. -1/3 L                      c. 2/3 L                      d. -2/3 L
- 100 moles of methane was reacted with 200 moles of hydrogen to produce 40 moles of methanol through the reaction of  $\text{CH}_4 + 2\text{H}_2 = \text{CH}_3\text{OH}$ . The extent of reaction is  
a. 40 moles                      b. 50 moles                      c. 60 moles                      d. 100 moles
- The yield for a reaction is defined by  
a. the fraction of the excess reactant that is converted into the products.  
b. the ratio of the moles of desired product to the moles of undesired product.  
c. the ratio of actual amount of a product to theoretically expected amount of the product.  
d. the fraction of the limiting reactant that is converted into the products.

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11. For a mixture of water-ethanol,
  - a. the partial pressure of water vapor can be determined using the Raoult's law.
  - b. the partial pressure of ethanol vapor can be determined using the Henry's law.
  - c. the partial pressure of water vapor can be determined using the Raoult's law only if the mole fraction of water in the liquid phase is close 1.0.
  - d. the partial pressure of ethanol vapor can be determined using the Henry's law only if the mole fraction of ethanol in the liquid phase is close to 1.0.
12. Antoine equation is used to predict the ..... of a material.
  - a. vapor pressure
  - b. partial pressure
  - c. system pressure
  - d. boiling pressure
13. In a T-x-y diagram for a binary mixture at constant pressure,
  - a. the bubble point line lies above the dew point line.
  - b. at a temperature higher than the dew point line the mixture is a vapor.
  - c. the bubble point line is a straight line, while the dew point line is a curved line.
  - d. the first bubble appears at the dew point temperature.
14. At the dew point, the partial pressure of water vapor in an air is equal to the
  - a. critical pressure.
  - b. system pressure.
  - c. boiling pressure.
  - d. vapor pressure.
15. The energy balance equation for an adiabatic steady-state process is
  - a.  $0 = W - \Delta(H + KE + PE)$
  - b.  $\Delta E = Q + W - \Delta(H + KE + PE)$ .
  - c.  $0 = \Delta H$
  - d.  $\Delta H = Q + W$
16. The enthalpy of a material
  - a. is smaller than the internal energy of the material.
  - b. is about the same as the internal energy for liquid and solid materials.
  - c. is about the same as the internal energy at the standard condition.
  - d. is independent of temperature.
17. For an adiabatic reaction represented by  $A+B = C$ , the enthalpy change associated with the reaction
  - a. is negative if the reaction is endothermic.
  - b. is negative if the reaction is exothermic.
  - c. is zero.
  - d. is indeterminable unless further information is provided.
18. For a gas-phase reaction of  $CH_4 + H_2O = CO + 3H_2$ ,
  - a. the standard reaction enthalpy is the difference in standard enthalpy per mole between products and reactants.
  - b. the standard reaction enthalpy can be determined from the concentrations of the species involved in the reaction.
  - c. the standard reaction enthalpy is invariant to reaction temperature.
  - d. the standard reaction enthalpy varies with the extent of reaction.
19. The wet bulb temperature of an air at 50% relative humidity
  - a. is lower than the dry bulb temperature of the air.
  - b. is higher than the dew point temperature.
  - c. is independent of the dry bulb temperature.
  - d. increases with decreasing the dry bulb temperature.
20. 1 kg of a dry air contains 0.01 kg of water vapor. The dry air can contain up to 0.02 kg of water vapor at saturation. The relative humidity of the air is
  - a. 10%
  - b. 20%
  - c. 50%
  - d. indeterminable.

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F. M. : 40

SECTION "B"

Attempt ALL questions.

- Identify the number of significant figures in each of the followings: [4]
  - (1.1) 32.05
  - (1.2) 5.75 (pH)
  - (1.3) 0.0032
  - (1.4)  $1.025 \times 10^3$
- Convert  $1 \text{ kgf/cm}^2$  into its equivalent in psi. ( $1 \text{ psi} = 6.893 \text{ kPa}$ ) [4]
- The mass composition of a gas in a tank at atmospheric pressure was measured to be as follows: [3]  
 $\text{CO}_2$  19.3%;  $\text{O}_2$  6.5%;  $\text{H}_2\text{O}$  2.1%;  $\text{N}_2$  72.1%  
Calculate the average molecular weight of the gas.
- 10 kg of 1 N HCl solution is to be produced by mixing 35.5 wt% HCl solution with distilled water. Determine the required masses of 35.5 wt% HCl solution and distilled water, respectively. Assume that the molecular weight of HCl is 36.5 and that distilled water is pure water and the molecular weight of water is 18.0. The density of 1 N HCl solution is  $1.1 \text{ g/cm}^3$ . [4]
- Vapor pressure data on benzene and toluene are given as follows: [6]

<u>Temperature (°C)</u>	<u>vapor pressure (mm Hg)</u>	
	<u>benzene (1)</u>	<u>toluene (2)</u>
80	760	300
92	1078	432
100	1344	559
110.4	1748	760

- Determine the boiling points of benzene and toluene, respectively, under the pressure of 760 mmHg or 1 atm.
  - Determine the mole fraction of benzene in the first bubble formed at  $100 \text{ }^\circ\text{C}$  from a liquid mixture of 40 mol% benzene and 60 mol% toluene.
  - Construct a  $P$ - $x_1$ - $y_1$  diagram at  $100 \text{ }^\circ\text{C}$ .
- 100 kg/min of  $\text{CO}_2$  gas at  $500 \text{ }^\circ\text{C}$  was cooled in an adiabatic heat exchanger to  $200 \text{ }^\circ\text{C}$  by transferring heat to the liquid water that enters at  $20 \text{ }^\circ\text{C}$  and exits at  $40 \text{ }^\circ\text{C}$ . Calculate the mass flow rate of the water in kg/min, assuming that the molar heat capacity of  $\text{CO}_2$  gas is  $40 \text{ J mol}^{-1} \text{ K}^{-1}$  and the molar heat capacity of liquid water is  $75 \text{ J mol}^{-1} \text{ K}^{-1}$ . [5]

7. 10 g moles of  $\text{CH}_4(\text{g})$  at  $200^\circ\text{C}$  is reacted with 20 g moles of  $\text{O}_2(\text{g})$  at  $100^\circ\text{C}$  to produce  $\text{CO}_2(\text{g})$  and  $\text{H}_2\text{O}(\text{g})$  in an adiabatic reactor. The reaction is represented by  $\text{CH}_4 + 2\text{O}_2 = \text{CO}_2 + 2\text{H}_2\text{O}$ . The standard heats of formation at  $25^\circ\text{C}$  for  $\text{CH}_4$ ,  $\text{O}_2$ ,  $\text{CO}_2$ , and  $\text{H}_2\text{O}$  are  $-74.84\text{ kJ/mol}$ ,  $0\text{ kJ/mol}$ ,  $-393.51\text{ kJ/mol}$ , and  $-241.826\text{ kJ/mol}$ , respectively while, the molar heat capacities of  $\text{CH}_4$ ,  $\text{O}_2$ ,  $\text{CO}_2$ , and  $\text{H}_2\text{O}$  are  $35\text{ J mol}^{-1}\text{ K}^{-1}$ ,  $29\text{ J mol}^{-1}\text{ K}^{-1}$ ,  $37\text{ J mol}^{-1}\text{ K}^{-1}$ , and  $34\text{ J mol}^{-1}\text{ K}^{-1}$ , respectively. [6]

- Determine the standard reaction enthalpy at  $25^\circ\text{C}$ .
- At the conversion of 50% for  $\text{CH}_4$ , determine the number of moles of each species in the product stream.
- Determine the adiabatic temperature of the product gas stream.

8. An air containing 2 g of  $\text{H}_2\text{O}$  vapor per 100 g of dry air is fed to a humidifier at a rate of 10 kg per hour (dry air basis) where it is mixed with steam to produce an air containing 4 g  $\text{H}_2\text{O}$  vapor per 100 g of dry air. Calculate the mass flow rate of the steam that is to be supplied to the humidifier. [4]

9. Moist air at  $38^\circ\text{C}$  and 50% relative humidity is heated to  $80^\circ\text{C}$  at a constant pressure of 1 atm. Using the attached humidity chart,
- determine the wet bulb temperature of the air before heating.
  - determine the humidity and the dew point temperature after heating.
  - determine the amount of heat to be added per cubic meter of initial moist air.

[4]

