KATHMANDU UNIVERSITY
End Semester Examination
February / March, 2018

Marks Scored:

Level : B. E
Year : II

Course : CHEG 201
Semester : I

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Exam Roll No. :
Time: 30 mins.
F. M. : 10
Registration No.:
Date MAR: 1 9 2018

SECTION "A"
[20 Q. × 0.5 = 10 marks]

Attempt *ALL* questions. Tick the most appropriate answer.

1. Which pressure is the highest one?
a. 1 atm b. 1 bar c. 1 psi d. 1 mm Hg

2. One degree of temperature difference in Fahrenheit is equivalent to
a. 1.8 degree of temperature difference in Kelvin
b. 1.8 degree of temperature difference in Celsius
c. 0.56 degree of temperature difference in Celsius
d. 1.8 degree of temperature difference in degree Rankine

3. One pascal is equivalent to
a. 1 lb_f per square inch
b. 1 Newton per m^2
1 mm Hg
d. 1 mm H_2O

he heat capacity of a material at constant pressure is
a. independent of temperature
b. J pe mol in unit
c. dep dent on temperature
lo than the heat capacity of the material at constant volume

ht of a student was measured to be 1.70 m. The significant number of the

a. b. 2 c. 3 d. unknown

6. 1 L of water was put in a pot and was heated by turning on power. The heating of the water is a
a. continuous process
b. steady state process
mi-batch process
d. unsteady state process.

7. 18 g of water (MW = 18) was mixed with 32 g of methanol (MW = 32). The mole fraction of methanol in the mixture is
a. 0.64 b. 0.5 c. 1.0 d. 0.36

8. In a material balance, the input is 1 g, the output is 5 g, and the generation is 1 g. The amount of accumulation is
a. -3 g b. 0 g c. 3 g d. 7 g

9. In a reaction represented by $2CO + O_2 = 2CO_2$, 10 g moles of carbon monoxide was completely reacted. The extent of reaction in g mole is
a. 1 b. 5 c. 10 d. indeterminable

10. The conversion for a reaction is defined by
    a. the fraction of the limiting reactant that is converted into products .
    b. the ratio of the moles of desired product to the moles of undesired product.
    c. the amount of a product obtained by the theoretical amount of the product.
    d. the amount of desired product obtained by the amount of the key reactant fed.

11. The partial pressure of a component in the vapor phase for vapor-liquid equilibrium of ideal mixtures at low pressures can be calculated by
    a. ideal gas law
    b. Antoine equation
    c. Soave-Redlich-Kwong (SRK) equation
    d. Raoult's law

12. The compressibility factor for an ideal gas is
    a. 0.5 b. 1 c. 2 d. indeterminable

13. For a mixture of water and methanol
    a. the mixture is in vapor state when the system pressure is higher than the bubble point pressure.
    b. the mixture is in liquid state when the system pressure is higher than the dew point pressure.
    c. two phases exist at system pressures in between the bubble and dew point pressures.
    d. the first bubble appears at the dew point pressure.

14. The partial pressure of water vapor in an air is equal to
    a. dew point pressure b. critical pressure c. vapor pressure d. boiling pressure

15. A gas at P_0 was expanded against an external pressure of P_1 irreversibly. The work done by the expansion from the volume of V_1 to V_2 is
    a. $-P_0(V_2-V_1)$ b. $-(P_0-P_1)(V_2-V_1)$ c. $-P_1(V_2-V_1)$ d. $-\int_{V_1}^{V_2} PdV$

16. The internal energy (U) of a material is related to the enthalpy (H) of the material as
    a. $H = U - PV$ where P is the pressure and V is the volume of the material
    b. $H = U$
    c. $H = U + R$ where R is the gas constant
    d. $H = U + PV$

17. When an acid is dissolved in water the solution temperature increases. This temperature increase means that
    a. the dissolution is endothermic b. the dissolution is exothermic.
    c. the dissolution is adiabatic d. the dissolution is isothermal.

18. The standard heat of reaction is
    a. independent of reaction temperature
    b. can be calculated from the standard heat of formations of associated species
    c. can be calculated from the extent of the reaction
    d. depends on the mole fractions of the species involved in the reaction

19. Humidity is defined as
    a. the mass of water vapor per unit mass of dry air.
    b. the mass of water vapor per unit mass of dry air at the dew point.
    c. partial pressure of water vapor divided by the vapor pressure of water.
    d. the mass of water vapor per unit mass of wet air.

20. Which information is not available from the humidity chart?
    a. relative humidity b. wet bulb temperature
    c. specific enthalpy d. vapor pressure of water

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Time : 2 hrs. 30 mins.

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Semester : I
F. M. : 40

SECTION "B"

Attempt *ALL* questions.

1. How many of each of the followings are contained in 44 g of CO_2 (MW = 44)?
   a. g-mole CO_2
   b. lb-mole CO_2
   c. g O_2
   d. g-mol C
   [4]

2. 10 cm^3/min of liquid water (MW = 18, density = 1.0 g/cm^3) was evaporated into a dry air stream (29 mol% O_2, 79 mol% N_2) to produce a moist air containing 2 mol% water vapor. Calculate the flow rate of the dry air and the molar composition of the moist air leaving the system. [4]

3. The binary system of acetonitrile (1)/nitromethane (2) is assumed to follow the Raoult's law. The Antoine equations are as follows:

   $\ln P_1^{sat} = 14.2724 - \frac{2945.47}{T-49.15}$, $\ln P_2^{sat} = 14.2043 - \frac{2972.64}{T-64.15}$ where P_1^{sat} and P_2^{sat} are the vapor pressures of components (1) and (2), respectively, in kPa at a given temperature (T) in K.
   a. At $x_1 = 0.5$ and 80 °C, determine the bubble point pressure and the mole fraction of acetonitrile in the first bubble.
   b. At $y_1 = 0.5$ and 80 °C, determine the dew point pressure and the mole fraction of acetonitrile in the first condensate.
   [6]

4. 100 kg/h of ethanol vapor at 1 atm and 100 °C is condensed in a heat exchanger to liquid ethanol at 40 °C by using a cooling water at 20 °C. The temperature of the cooling water leaving the exchanger is 30 °C. Calculate the mass flow rate of the cooling water. Boiling point of ethanol at 1 atm is 78.37 °C. The latent heat of ethanol is 38.56 kJ/mol, C_p of ethanol vapor is 85 J mol^{-1} K^{-1}, C_p of liquid ethanol is 131 J mol^{-1} K^{-1}, and C_p of liquid water is 75.2 J mol^{-1} K^{-1}. [5]

5. 1 g mole/s of CO at 25 °C is completely burned with 7 g moles/s of air which is at 25 °C. Calculate the adiabatic product temperature using the following data:
   The heat capacities of the species involved in the reaction are assumed to be constant at 29 J $gmol^{-1}$ K^{-1} for CO, 29 J $gmol^{-1}$ K^{-1} for O_2, 29 J $gmol^{-1}$ K^{-1} for N_2 , and 37 J $gmol^{-1}$ K^{-1} for CO_2. The heat of formations at 25 °C are -110.52 kJ/g mol for CO, 0 kJ/g mol for O_2, and -393.51 kJ/g mol for CO_2. [5]

$$Q = \sum n_{i,0} \int_{T_{i,0}}^{T} C_{P,i}^{0}\, dT + \xi\,(\Delta H_r^0(25^\circ C) + \sum \int_{298.15}^{T} \upsilon_i C_{P,i}^{0} dT)$$

SECTION "C"

Attempt *ALL* questions.

6. Calculate and give the answers in proper number of significant figures.
$5.20 \times 25.25/0.01500$ [4]

OR

Calculate and give the answers in proper number of significant figures.
$1.585 - 10.0 + 20.75$

7. A pressure gauge in a tank gives a reading of 50 psig. The barometric pressure is 28.6 in. Hg. Calculate the absolute pressure in the tank in $lb_f\ ft^{-2}$. 1 psi = 2.036 in Hg =6.893 kPa. [4]

OR

A pressure gauge in a tank gives a reading of 50 psig. The barometric pressure is 28.6 in. Hg. Calculate the absolute pressure in the tank in ft of water. Specific gravity of Hg = 13.6.

8. The heat capacity of carbon dioxide gas in the temperature range 0 to 1500 K is $C_p = 2.675 \times 10^4 + 42.27\ T - 1.425 \times 10^{-2}\ T^2$ (J Kg mol^{-1} K^{-1}). Calculate the amount of heat in KJ that is required to heat 1 kg of carbon dioxide gas from 25 °C to 50 °C in an open system. [4]

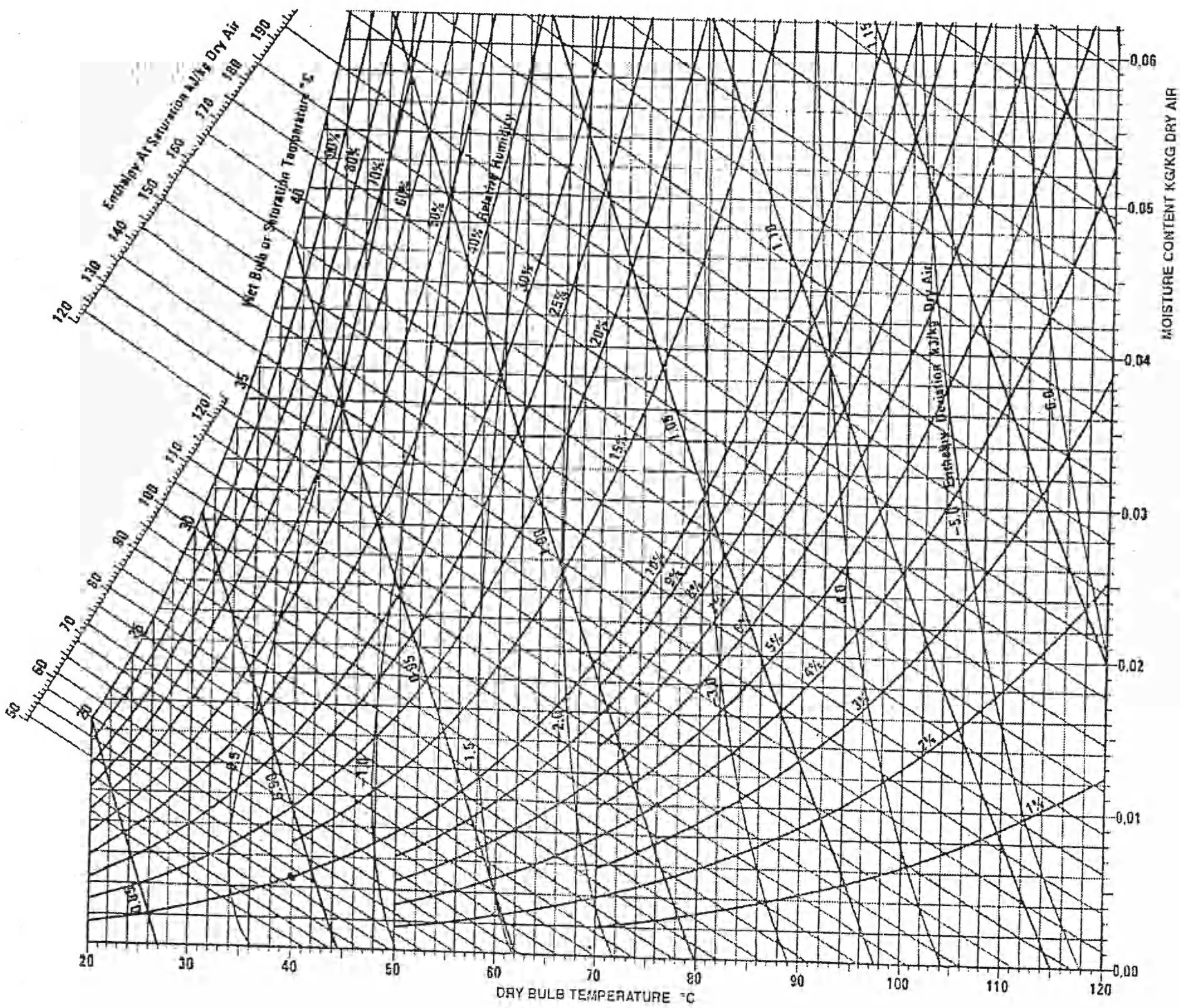
OR

A fluid at 20 °C is flown through an electrical heater and heated to 40 °C at a rate of 5 g/min. Calculate the amount of electric power in watt that is required to be supplied to the heater assuming the heat loss from the heater to the surroundings is negligible. The specific heat of the fluid is 4.5 J $g^{-1}{}^{o}C^{-1}$.

9. Air at 30 °C and 80% relative humidity is cooled to 20 °C at a constant pressure of 1 atm. Ujsing the attached psychrometric chart, determine the wet bulb temperature at the initial condition. Calculate the fraction of the water that condenses and the rate at which heat must be removed to deliver 5 m^3/min of humid air at the initial condition. [4]

OR

The air at 50 °C and 40% relative humidity is conditioned to 30 °C and 60% relative humidity by three steps: (1) cooling to the dew point; (2) condensation; (3) heating to 30 °C. For each step, estimate the rate of heat to be added to or removed per 5 m^3/min of humid air at the initial condition


Enthalpy At Saturation kJ/kg Dry Air
Wet Bulb or Saturation Temperature °C
Relative Humidity
Enthalpy Deviation kJ/kg Dry Air
DRY BULB TEMPERATURE °C
MOISTURE CONTENT KG/KG DRY AIR
20
30
40
50
60
70
80
90
100
110
120
0,00
0,01
0,02
0,03
0,04
0,05
0,06