KATHMANDU UNIVERSITY
End Semester Examination
March/ April, 2017

Marks Scored:

Level : B. E.
Year : II

Course : CHEG 201
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : APR 10 2017

SECTION "A"
[20 Q × 0.5 = 10 marks]

Tick the most appropriate answer.

1. Choose one that is not the unit for pressure.
a. mole b. psi c. pascal d. mmHg

2. Five degrees of temperature difference in Celsius is equivalent to
a. five degrees of temperature difference in Fahrenheit.
b. seven degrees of temperature difference in Fahrenheit.
c. nine degrees of temperature difference in Fahrenheit.
d. forty one degrees of temperature difference in Fahrenheit.

3. Which one is the highest in precision?
a. 1234 b. 123.4 c. 12.34 d. 1.234

4. One pascal is equivalent to
a. 1 N/m^2
b. 1 pound-force per square inch
c. 1 mmHg
d. 1 mmH_2O

5. The pH of a solution was measured to be 3.752. The number of significant figures of 3.752 is
a. 4 b. 3 c. 2 d. 1

6. In soup preparation, all the ingredients are placed in an empty pot, heated, stirred and finally removed from the pot. This is a
a. continuous process
b. batch process
c. semi-batch process
d. steady-state process

7. 100 g of water is mixed with 100 g of alcohol. What is the mole fraction of water in the mixture? Molecular weights of water and alcohol are 18 and 46, respectively.
a. 0.50 b. 0.65 c. 0.72 d. 0.81

8. In a material balance, there are 4 unknown variables. How many independent equations are required to solve the material balance problem?
a. 2 b. 3 c. 4 d. 5

9. If 20 moles of CO are combined with 10 moles of O_2 to from 15 moles of CO_2, the reaction of which is represented by $2CO + O_2 \rightarrow 2CO_2$, the extent of reaction is
a. 7.5 moles b. 10 moles c. 15 moles d. 20 moles

10. The selectivity in a chemical reaction is defined as
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 divided by the theoretical amount of the product.
d. the amount of desired product obtained divided by the amount of the key reactant fed.

11. The equation used to calculate the vapor pressure of a pure liquid is
a. Raoult's law
b. Antoine equation
c. Henry's law
d. Soave-Redlich-Kwong (SRK) equation

12. The specific volume of a gas is 0.5 L/g-mol. How many moles of the gas are contained in 1 liter?
a. 0.5 b. 1.0 c. 1.5 d. 2.0

13. At the dew point of a vapor in the air, the partial pressure of the vapor is
a. equal to the vapor pressure of the volatile liquid.
b. lower than the vapor pressure of the volatile liquid.
c. higher than the vapor pressure of the volatile liquid.
d. equal to the total pressure of the system.

14. For an ideal solution, the partial pressure of a component in the vapor phase can be estimated by
a. Raoult's law b. Boyle's law c. Dalton's law d. Avogadro's law

15. In a P-x-y diagram for a mixture of A and B,
a. at the system pressure higher than the bubble point pressure, the mixture is vapor.
b. at the system pressure lower than the dew point pressure, the mixture is liquid.
c. at the system pressure equal to the dew point pressure, a first bubble appears.
d. at the system pressure in between the bubble point and dew point pressures, there exists two phases: liquid and vapor.

16. What is the relationship between internal energy (U) and enthalpy (H)?
a. $H = U$
b. $H = U + R$, where R is the gas constant
c. $H = U + pV$, where p is the pressure and V is the volume of the system
d. $H = U - pV$

17. Adiabatic condition means that
a. there is no heat transfer across the boundary between system and surrounding.
b. there is no mass transfer across the boundary between system and surrounding.
c. the system is kept at constant temperature.
d. the system is kept at constant pressure.

18. The general energy balance equation is known to be $\Delta E = Q + W - \Delta(H + KE + PE)$. For a flow reactor at the steady state, the energy balance equation is simplified to
a. $\Delta E = Q + W - \Delta H$
b. $0 = Q + W - \Delta H$
c. $\Delta E = Q + W$
d. $0 = Q + W$

19. The standard heat of reaction for $C_6H_6(g) + 3H_2(g) = C_6H_{12}(g)$ is reported to be -207.0 kJ. The standard heat of reaction per mole of H_2 is
a. -207.0 kJ
b. -103.5 kJ
c. -69.0 kJ
d. indeterminable with given information

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

KATHMANDU UNIVERSITY
End Semester Examination
March/ April, 2017

APR 10 2017

Level : B. E.
Year : II
Time : 2 hrs. 30 mins.

Course : CHEG 201
Semester : I
F. M. : 40

SECTION "B"

Attempt *ALL* questions.

1. The heat capacity of a species is represented by $C_p \left(\frac{Btu}{lb_m \cdot {}^oF}\right) = 0.5 + 1.0 \times 10^{-4}\, T({}^oF)$. Determine the expression for C_p in $\frac{J}{g \cdot {}^oC}$ in terms of T(°C). (1 Btu = 1.055×10^3 J; 1 lb_m = 454 g) [4]

2. Ethane is dehydrated to produce ethylene as follows:
$C_2H_6 \rightarrow C_2H_4 + H_2$; $C_2H_6 + H_2 \rightarrow 2CH_4$
The molar composition of the product is: C_2H_6 44%; C_2H_4 23%; H_2; 13%; CH_4 20%
Calculate the conversion of C_2H_6 and the yield of C_2H_4. [5]

3. Air at 20 °C and 1 atm has a dew point of 10 °C. Determine the partial pressure of water vapor in the air and the humidity.
$\text{Log}(P) = A - \frac{B}{T+C}$, where P is water vapor pressure in mmHg, A=8.07131, B=1730.63, C=233.426, and T is temperature in °C. [4]

4. The Antoine equations for benzene and toluene are given as follows:
$\text{Ln}(P) = A - \frac{B}{T+C}$, where P is in mmHg and T is in Kelvin.
For benzene: A=11.513, B = 723.983, C = -204.958
For toluene: A = 14.130, B = 2068.798, C = -107.940
Construct a P-x-y diagram at 100 °C, calculate the dew point pressure of a 40-60 mol% benzene- toluene vapor at 100 °C, and determine the mole fraction of the first condensate obtained from that vapor. [4]

5. 50 g moles/s of CO at 100 °C is completely burned with 400 g moles/s of air which is at 100 °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.
$Q = \sum n_{i,0} \int_{T_{i,0}}^{T} C_{P,i}^0\, dT + \xi \left(\Delta H_r^0(25°C) + \sum \int_{298.15}^{T} \upsilon_i C_{P,i}^0 dT\right)$ [6]

SECTION "C"

Attempt *ALL* questions.

6. What would be the rounded answers for $(5.2 \times 10^{-3}) \times (0.1675 \times 10^7) / (2.65 \times 10^2)$? [4]

OR

What is the sum of 3.1472, 32.05, 1234, 8.9426, 0.0032 and 9.0 to the correct number of significant figures?

7. A multiple-stage evaporator concentrates a weak NaOH solution from 3% to 18% by evaporation of water and processes 2 tons of feed solution per day. How much product (18% NaOH solution) is made per day? How much water is evaporated per day? [5]

OR

1000 kg/h of a mixture of benzene (B) and toluene (T) containing 50% benzene by mass is separated by distillation. The mass flow rate of benzene in the top product is 450 kg/h and that of toluene in the bottom product is 475 kg/h. The operation is at the steady state. Write material balances and calculate the mass flow rates of the two products.

8. Using the steam table below, determine the vapor pressure of water at 90.5 °C, and the specific enthalpy of the saturated steam at 90.5 °C. [3]

OR

Using the steam table below, show that the difference between specific internal energy and specific enthalpy can be calculated from the relationship, $H = U + pV$.
V = specific volume, $cm^3\ g^{-1}$
U = specific internal energy, $kJ\ kg^{-1}$
H = specific enthalpy, $kJ\ kg^{-1}$

t, °C	T, K	p, kPa	V			U			H		
			sat. liq.	evap.	sat. vap.	sat. liq.	evap.	sat. vap.	sat. liq.	evap.	sat. vap.
88	361.15	64.95	1.035	2535.4	2536,5	368.5	2123.7	2492.2	368.5	2299.4	2656.9
89	362.15	67.49	1.035	2446.0	2447.0	372.7	2120.7	2493.4	372.7	2285.8	2658.5
90	363.15	70.11	1.036	2360.3	2361.3	376.9	2117.7	2494.6	376.9	2283.2	2660.1
91	364.15	72.81	1.037	2278.0	2279.1	381.1	2114.7	2495.8	381.1	2280.6	2661.7
92	365.15	75.61	1.038	2199.2	2200.2	385.3	2111.7	2497.0	385.4	2278.0	2663.4

Use the psychrometric chart below to answer the following questions.

9. Estimate the absolute humidity, wet-bulb temperature, humid volume, and specific enthalpy of humid air at 40 °C, 1 atm and 30% relative humidity, and the amount of water in 100 m^3 of air at these conditions. [5]

OR

The air at 50 °C and 40% relative humidity is conditioned to 30 °C and 60% relative humidity by three steps: (i) cooling to the dew point; (ii) condensation; (iii) heating to 30 °C. For each step, estimate the amount of heat to be added to or removed from per 1 kg of dry air.