KATHMANDU UNIVERSITY
End Semester Examination
June/July, 2023

Marks Scored:

Level : B.E./B.Tech.
Year : II
Course : CHEG 201
Semester : I

Exam Roll No. :
Time: 30 mins.
F. M. : 10

Registration No.:
Date 30 JUN 2023

SECTION "A"
[20 Q. × 0.5 = 10 marks]

Encircle the most appropriate alternative from the given set of choices.

1. Convert 23 lbm.ft/min^2 to its equivalent in kg.cm/s^2.
   a. 0.075 b. 0.088 c. 0.12 d. 0.25

2. How many significant figures does the number 0.03500 have?
   a. 1 b. 2 c. 3 d. 4

3. Consider the equation D (ft) = 3t(s) + 4. What is the dimension of the constant 3?
   a. Length b. Time c. Length/time d. Mass

4. What is the volume occupied by 215 kg of mercury? The specific gravity of mercury is 13.5?
   a. 0.011 b. 0.013 c. 0.016 d. 0.018

5. How many moles of oxygen atom are present in the 100 gm of CO_2?
   a. 1.27 b. 2.37 c. 3.54 d. 4.55

6. A liquid that is almost entirely water is reported to contain 125 ppm phenol. What is the mass fraction of phenol in the liquid?
   a. 1.25×10^{-4} b. 1.25×10^{-6} c. 1.25×10^{-9} d. 125×10^{-9}

7. For which of these processes, the feed is charged into a vessel at the beginning of the process and the vessel contents are removed sometime later?
   a. Batch b. Semi batch c. Continuous d. Semi continuous

8. Suppose 3 kg/min of benzene and 1 kg/min of toluene are mixed. What is the mass fraction of benzene in the output?
   a. 0.25 b. 0.5 c. 0.75 d. 1

9. 100 mol/h of methane is burned with 30% excess air in a combustion reactor. Calculate the stoichiometric amount of air required for the combustion process?
   a. 350 mol/h b. 600 mol/h c. 825 mol/h d. 952 mol/h

10. For the problem described in question 9, what is the actual flow rate of oxygen fed to the reactor?
    a. 166 mol/h b. 260 mol/h c. 399 mol/h d. 449 mol/h

11. 1 lb mol of ideal gas occupies _____ at standard temperature and pressure?
    a. 22.415 m^3 b. 22.415 L c. 359.05 ft^3 d. 380 ft^3

12. In one process, the off gas analyzes 14% CO_2, 6% O_2 and 80% N_2. If the temperature and pressure are 300 F and 765 mm Hg respectively, what is the partial pressure of oxygen?
a. 45.9 mm Hg b. 107.1 mm Hg c. 612 mm Hg d. 765 mm Hg

13. Which of the following is **NOT** an equation of state?
a. Soave-Redlich-Kwong
b. Peng-Robinson
c. Benedict-Webb-Rubin
d. Onnes-Watson-Schrodinger

14. Gibbs phase rule is concerned with _____.
a. Intensive properties of the system
b. Extensive properties of the system
c. Both intensive and extensive properties of the system
d. Non equilibrium systems

15. At dew point, the _____ of the vapor is equal to the _____ of the volatile liquid.
a. Boiling point, condensation point
b. Partial pressure, vapor pressure
c. Bubble point, dew point
d. Partial pressure, bubble pressure

16. The total energy of a stationary system is equivalent to _____.
a. The kinetic energy of the system
b. The potential energy of the system
c. The internal energy of the system
d. The sum of kinetic, potential and internal energies of the system

17. The mathematical relation used to estimate the vapor pressure is called _____.
a. Raoult's law b. Henry's law c. Hess's law d. Antoine's equation

18. Which of the following in **NOT** an intensive variable?
a. Pressure b. Volume c. Density d. Specific volume

19. 100 kg of wet solids are to be dried from 50% to 10% moisture by weight. The mass of moisture to be removed in Kg is _____.
a. 5.55 b. 38.26 c. 44.44 d. 50.45

20. The human body is _____ system.
a. Adiabatic b. Open c. Closed d. Isolated

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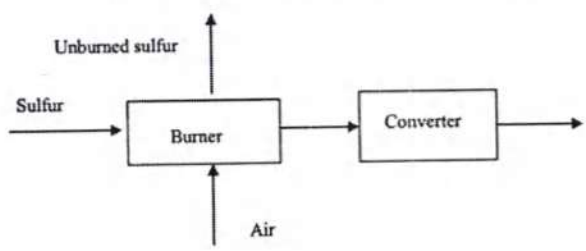
SECTION "B"

Attempt *ALL* questions.

1. A simplified process for the production of SO_3 is illustrated in the figure below. Sulfur (MW = 32) is burned with 100% excess air in the burner. Only 90% conversion of sulfur to SO_2 is achieved in the burner. In the converter, the conversion of SO_2 to SO_3 is 95% complete. Calculate
   a. The lb of air required per 100 lb of sulfur burned [3]
   b. Mole fractions of components in the exit gas from the burner [4]
   c. Mole fraction of the components in the gas from the converter [3]



2. Ethane (C_2H_6) is burned with 20% excess air in a furnace operating at a pressure of 101 kPa. Assume complete combustion occurs. Determine the dew point temperature of the flue gas. [6]

3. Consider a furnace where methane is mixed with 50% excess air for the conversion of limestone to lime. Methane and limestone both enter the furnace at 25 °C. The product gases leave the furnace at 200 °C while the lime comes out at 900 °C. Assume the furnace is well insulated. Also, consider 24.5 kg of lime is produced per kg of methane burned.
   a. Write the equations for the combustion of methane and conversion of limestone to lime. [1.5]
   b. Calculate the molar amount of input and output of the system. List the values in the table. [1.5]
   c. Calculate the total inlet enthalpy of the system. [2]
   d. Calculate the total outlet enthalpy of the system. [5]

   The following information is given.

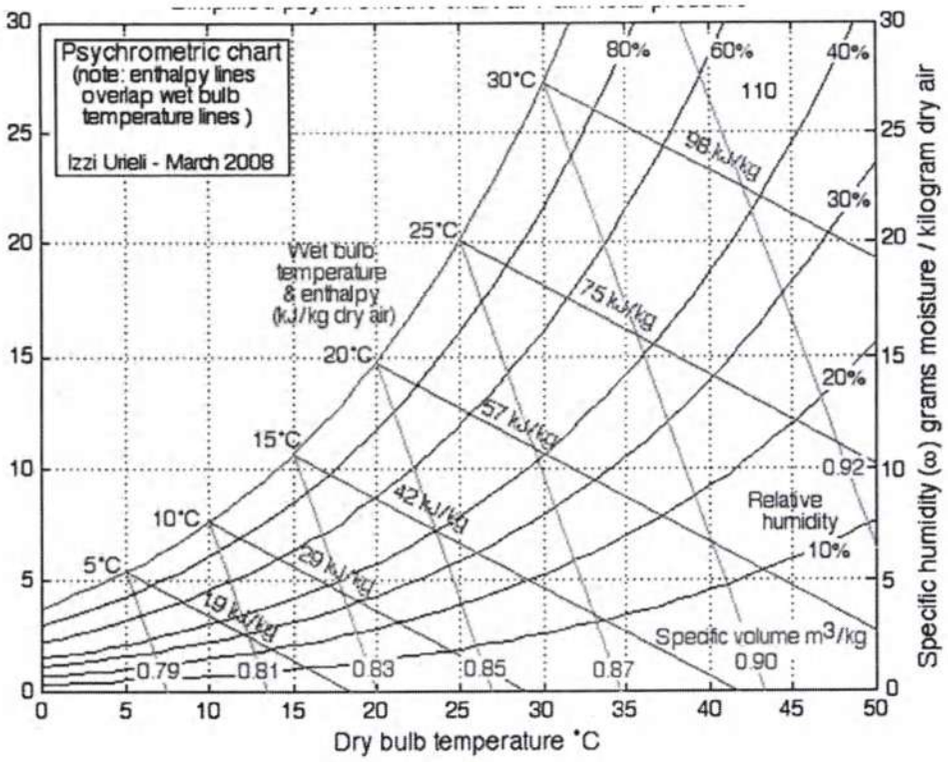
Components	Cp	ΔH_f^0
O_2	$30.255 + 4.207\times10^{-3}T - 1.887\times10^{5}T^{-2}$	-
N_2	$27.270 + 4.93\times10^{-3}T + 0.333\times10^{5}T^{-2}$	-
CO_2	$45.369 + 8.688\times10^{-3}T - 9.619\times10^{5}T^{-2}$	-393,509
H_2O	$28.850 + 12.055\times10^{-3}T - 1.006\times10^{5}T^{-2}$	-241,818
CaO	$50.749 + 3.683\times10^{-3}T - 8.705\times10^{5}T^{-2}$	-635,090
CH_4		-74,520
$CaCO_3$		-1,206,920
All values have units of J/g mol		

4. Antoine equations for benzene and toluene are given as follows: [7]
Ln (P) = A – B / (T + C) where P is in mm Hg 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 = -107.94

Calculate the dew point and bubble point pressure of a 50-50 mol% benzene and toluene mixture at 100 °C and determine the mole fraction of the condensate and the bubble.

5. A lecture theatre is to be maintained at a temperature of 25 °C dry bulb and 19 °C wet bulb temperature. To maintain this temperature, 88 kW (kJ/s) of heat load and 58 kg/hr of moisture (water) must be removed from the room. For this, air is supplied to the lecture theatre at 18 °C. The heat capacity of air is given to be 1.0062 kJ/kg.K. Determine:
   a. The mass flow rate of supply air. [3]
   b. The dew point, RH and wet bulb temperature of supply air. [4]



Properties of saturated water

Temp. T, °C	Saturation Pressure P_{sat}, kPa	Density ρ, kg/m³ Liquid	Density ρ, kg/m³ Vapor	Enthalpy of Vaporization h_{fg}, kJ/kg	Specific Heat c_p, J/kg·K Liquid	Specific Heat c_p, J/kg·K Vapor
0.01	0.6113	999.8	0.0048	2501	4217	1854
5	0.8721	999.9	0.0068	2490	4205	1857
10	1.2276	999.7	0.0094	2478	4194	1862
15	1.7051	999.1	0.0128	2466	4185	1863
20	2.339	998.0	0.0173	2454	4182	1867
25	3.169	997.0	0.0231	2442	4180	1870
30	4.246	996.0	0.0304	2431	4178	1875
35	5.628	994.0	0.0397	2419	4178	1880
40	7.384	992.1	0.0512	2407	4179	1885
45	9.593	990.1	0.0655	2395	4180	1892
50	12.35	988.1	0.0831	2383	4181	1900
55	15.76	985.2	0.1045	2371	4183	1908
60	19.94	983.3	0.1304	2359	4185	1916
65	25.03	980.4	0.1614	2346	4187	1926
70	31.19	977.5	0.1983	2334	4190	1936
75	38.58	974.7	0.2421	2321	4193	1948
80	47.39	971.8	0.2935	2309	4197	1962
85	57.83	968.1	0.3536	2296	4201	1977
90	70.14	965.3	0.4235	2283	4206	1993
95	84.55	961.5	0.5045	2270	4212	2010
100	101.33	957.9	0.5978	2257	4217	2029
110	143.27	950.6	0.8263	2230	4229	2071
120	198.53	943.4	1.121	2203	4244	2120
130	270.1	934.6	1.496	2174	4263	2177
140	361.3	921.7	1.965	2145	4286	2244
150	475.8	916.6	2.546	2114	4311	2314