Mark Scored:

KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2019

Level : B. Tech. | Course : ENVE 204
Year : II | Semester : I
Exam Roll No. : | Time: 30 mins. | F. M. : 20
Registration No.: | Date 05 MAR 2019

SECTION "A"
[20 Q. × 1= 20 marks]

Select the correct answer from the given choices.

1. Convert 58 lbm/s to its equivalent in kg/min.
(a) 2.13 (b) 26.4 (c) 1582 (d) 7656

2. A study found the temperature difference between the inside and outside of a room to be 75°F. What is the temperature difference (ΔT) in °C?
(a) 23.9 (b) 41.7 (c) 135 (d) 192.6

3. Suppose that it is known that the composition C varies with time, t, in the following manner: $C = 1.1 \exp(-12.3\, t)$ where t has the unit of seconds and 1.1 has the unit of kg/L. What is the unit associated with C?
(a) dimensionless (b) L/kg (c) kg/L (d) kg/L · s

4. The volumetric flow rate of nitrogen gas from a tank is 2.33 ft^3/min and its mass flow rate is 6 lbm/min. What is its specific volume?
(a) 0.39 ft^3/lbm (b) 2.6 lbm/ft^3 (c) 10.9 (ft^3)(lbm) (d) 14 ft^3/lbmol

5. A mixture of methanol and ethanol is flowing through a circular pipe at a flow rate of 3.0 m/s. The mixture contains 35.0 wt% methanol and 65.0 wt% ethanol. The specific gravity of the mixture is 0.75. If the inside diameter of the pipe is 0.10 m, what is the flow rate of the mixture in kg/s, kmol/s?
(a) 1.8E-5 (b) 0.018 (c) 17.7 (d) 70.7

6. Manometer fluid is mercury and change in mercury height, h is 10 in., and the manometer fluid is mercury (ρ = 13.6 g/cm^3), find the gauge pressure in psig.
(a) 0.76 (b) 4.9 (c) 48.2 (d) 3768

7. If gauge pressure is 10 psi, what is the absolute pressure?
(a) -4.7 (b) 0.68 (c) 24.7 (d) 147

8. What is the ratio of the amount reacted to the amount fed to the reactor?
(a) limiting reactant (b) selectivity (c) yield (d) conversion

9. What is ppmv of a pollutant?
(a) (volume of pollutant/mass of solution) x 10^9
(b) (volume of pollutant/mass of solution) x 10^6
(c) (volume of pollutant/volume of solution) x 10^9
(d) (volume of pollutant/volume of solution) x 10^6

10. Water enters a 5.00 m^3 tank at a rate of 6.50 kg/s and is withdrawn at a rate of 3.20 kg/s. The tank is initially half-full. The process is:
(a) batch and steady state (b) batch and transient
(c) continuous and steady state (d) continuous and transient

11. To choose a basis for a mass balance, if no stream amounts or flow rates are known:
(a) assume one stream amount, preferably a stream of known composition.
(b) choose the total mass or mass flow rate of stream having unknown composition.
(c) assume mass fraction of any stream given in the problem.
(d) choose the total number of moles of an unknown stream.

12. Cement is produced by roasting raw materials at high temperature in a rotating kiln. 3000 kg/min of raw material enters the kiln, producing 1900 kg/min of cement. It is known that gaseous by-products are produced during roasting. Determine the gases emission mass flow rate in lbm/min.
(a) 500 (b) 1100 (c) 2420 (d) 4900

13. What is used in chemical processes to include recovery of unconsumed reactants, recovery of catalyst, dilution of a process stream, and circulation of a working fluid?
(a) recycle (b) yield (c) separator (d) splitter

14. If you do not know the generation and/or consumption terms in a mass balance, which of the following method will you use to solve the problem?
(a) molecular (b) element (c) steady-state (d) open-system

15. Which of the following can be treated as ideal gas in the given conditions?
(a) Nitrogen at 100 kPa and 30°C (b) Nitrogen at 90000 kPa and 30°C
(c) Propane at 3000 kPa and 30°C (d) Water at 2000 kPa and 30°C

16. What is the temperature at which a vapor just begins to condense at a given pressure?
(a) critical point (b) bubble point (c) melting point (d) dew point

17. The quantity of a variable depends solely on the state of the system. This type of variable is called:
(a) path function (b) point function (c) equilibrium state (d) quasi-equilibrium state

18. What is the mass of water vapor per mass of bone-dry air?
(a) humidity (b) relative saturation (c) relative humidity (d) dry adiabatic mass

19. The equation $\Delta U + \Delta KE + \Delta PE = Q + W$ is valid for:
(a) unsteady closed system (b) steady open system
(c) steady closed system (d) unsteady open system

20. If the steam quality is 0.912:
(a) The wet steam is 91.2 wt% vapor
(b) The wet steam is 91.2 wt% liquid water
(c) The dry steam is 91.2 wt% superheated vapor
(d) The wet steam is 91.2 wt% superheated vapor

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SECTION "B"

Answer *ALL* questions. The data or information not given in the questions should be assumed properly.

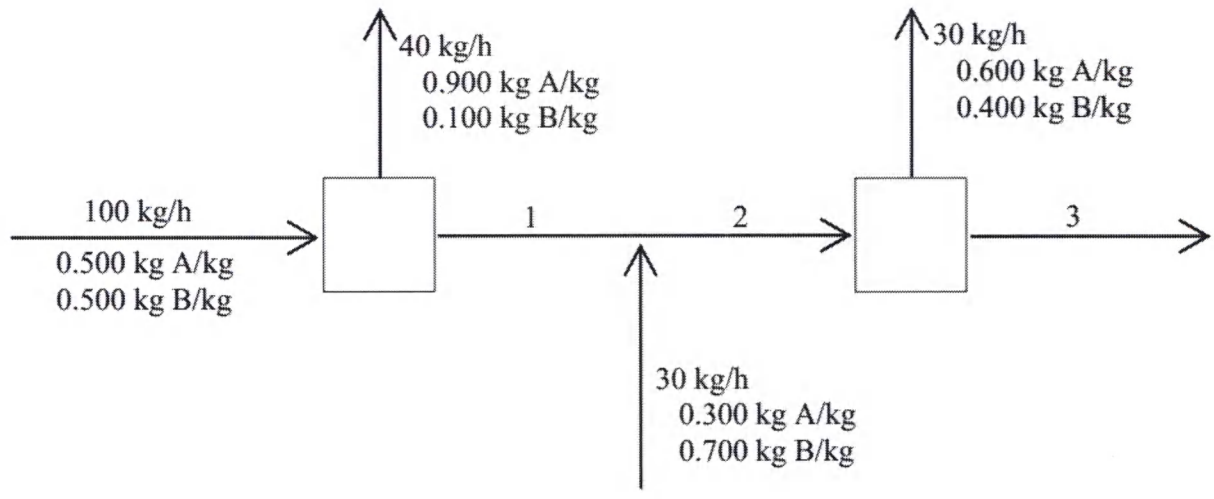
1. If 100 g of air consists of 77% by weight of nitrogen (N_2 , MW= 28), and 23% by weight of oxygen (O_2 , MW = 32), calculate (a) the mean molecular weight of air, (b) mole fraction of oxygen, (c) concentration of oxygen in kg/m^3 , if the total pressure is 1.4 atm and the temperature is 25°C. The value of R is 0.08206 L · atm/(mol · K). [3+1+2]

2. Hundred moles of SO_2 and 90 moles of O_2 are fed to a reactor and they react according to the reaction $2\ SO_2 + O_2 \rightarrow 2\ SO_3$. Find the limiting reactant, excess reactant, fractional excess and percentage excess. [2+2+2+1]

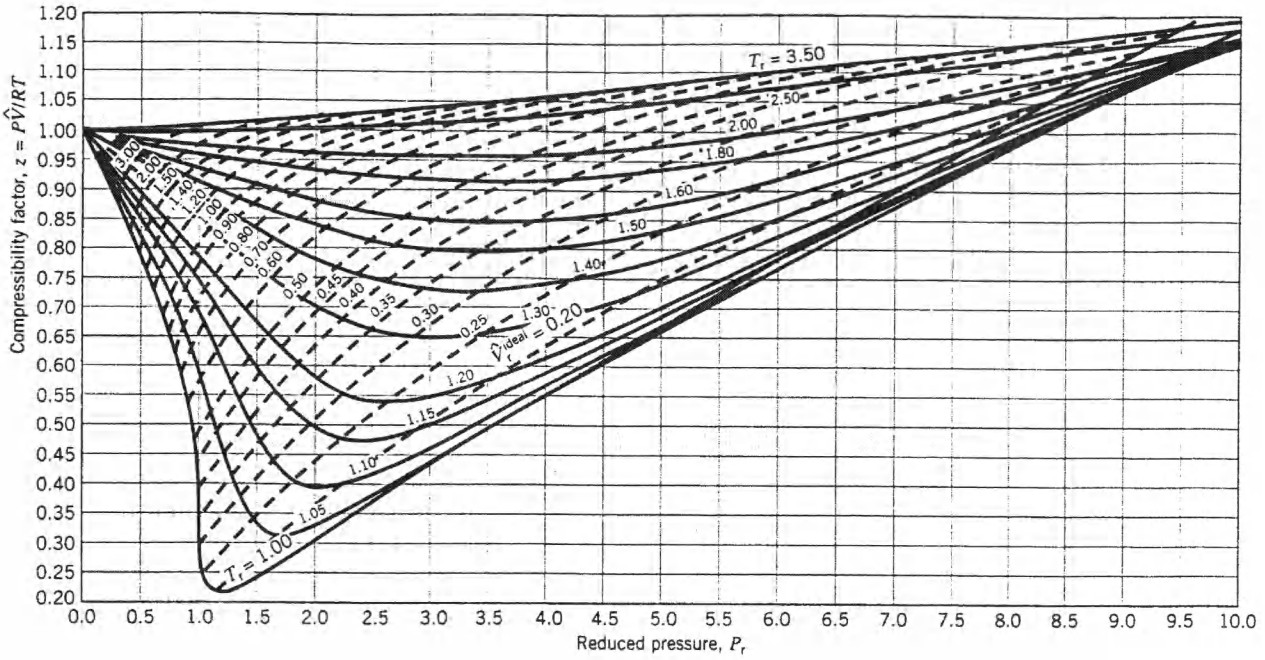
3. A stream containing 25 wt% methanol in water is to be diluted with a second stream containing 10% methanol in water to form a product solution containing 17% methanol. Calculate the ratio of the mass flow of the solution that consists of 25% methanol to that with 10% methanol. [7]

4. A natural gas of an unknown composition is burned with air. An analysis of the product gas yields 0.125 mole H_2O/mole wet gas. Orsat analysis of flue gas is: 1.4% CO, 6.1% CO_2, 8.2% O_2 and 84.3% N_2. Calculate the ratio of hydrogen to carbon in the gas. [8]

5. In the figure shown below, each stream contains two components, A and B, in different proportions. Calculate the unknown flow rates and compositions of streams 1, 2, and 3. [5+3]



6. A gas mixture contains 30% CO_2 and 70% CO at 202.73 K and 92.04 atm. The molecular weight, critical temperature, and pressure for CO_2 are 44 g/mol, 304 K, 72.9 atm, respectively. The molecular weight, critical temperature, and pressure for CO are 28 g/mol, 133 K, and 34.5 atm, respectively. The value of R is 0.08206 L · atm/(mol · K). Find the molar volume of the gas mixture using Kay's method. Use the provided compressibility chart. [7]



7. Humid air at 80°C, 1.1 atm, and 30% relative humidity is fed into a process unit at a rate of 1000 m^3/h. Determine [2+1+1+2]
   (a) the mole fraction of water in humid air,
   (b) the molar flow rate of humid air,
   (c) the molal humidity, and
   (d) the dew point.

8. Use the attached property tables. Steam enters a turbine at a pressure of 9.0 bar (absolute) and a temperature of 610°C. The enthalpy of the input steam is 3697 kJ/kg. The steam leaving the turbine is at 1 atm (absolute) pressure and is of 90% quality. How much steam has to go into the turbine to yield 2.1×10^6 kW of shaft work? Use the attached property tables. [6]