1. The thermal conductivity k of a liquid metal is predicted via the empirical equation $k = A\exp(B/T)$, where k is in $Js^{-1}m^{-1}K^{-1}$ and T is absolute temperature in K. A and B are constants. The units of A and B are, respectively,

(A) $Js^{-1}m^{-1}K^{-1}$ and K^{-1} (B) $Js^{-1}m^{-1}K^{-1}$ and K

(C) $J^{-1}smK$ and K^{-1} (D) $J^{-1}smK$ and K

2. % Excess air for combustion process is defined as

(O2 entering the process-O2 required)

(A) % Excess air = $\dfrac{\text{(O2 entering the process} - \text{O2 required)}}{\text{O2 required}}$ x 100

(B) % Excess air = $\dfrac{\text{(O2 required} - \text{O2 entering the process)}}{\text{O2 entering the process}}$ x 100

(C) % Excess air = $\dfrac{\text{O2 required}}{\text{(O2 entering the process} - \text{O2 required)}}$ x 100

(D) % Excess air = $\dfrac{\text{O2 entering the process}}{\text{(O2 required} - \text{O2 entering the process)}}$ x 100

3. To prepare a solution of 50% sulfuric acid, a dilute waste acid containing 27% sulfuric acid is fortified with a fresh acid containing 96% sulfuric acid. The amount of fresh acid required for each 100 kg of dilute waste acid is

(A) 13.5 kg (B) 25 kg (C) 50 kg (D) 100 kg

4. A flue gas analysis gave 10% O2, 25% CO2 and 65% N2 at 160 °C and 760 mm Hg. The ratio of partial pressures of CO2 to O2 is equal to

(A) 1 (B) 2 (C) 2.5 (D) 4

5. In the extraction of nicotine from a nicotine-water solution by kerosene, the pressure and temperature are kept constant. The available degree(s) of freedom is/are

(A) 0 (B) 1 (C) 2 (D) 3

6. The hydrostatic equation of pressure P with height h of an incompressible fluid of density ρ and specific weight γ is

(A) $P = \rho/h$ (B) $P = \gamma / h$

(C) $P = \rho h$ (D) $P = \gamma h$

7. A gas is being compressed from an enthalpy of 489 kJ/kg to 509 kJ/kg in a steady state open process. The entry and exit velocities of the gas are zero and 60 m/s, respectively. Assume that there is no heat loss or gain, no reaction, and potential energy change is negligible. If the load is 100 kg/h of gas, the work done on the gas is equal to

(A) 2000 kJ (B) 2180 kJ (C) 2500 kJ (D) 3000 kJ

8. The corresponding Maxwell relation for the Gibbsian equation $dG = -SdT + VdP$ is

(A) (B)

(C) (D)

Statement for Linked Answer – Questions 9 and 10:

A system is taken from state A to state B along path ACB where 100 J of heat flows into the system and the system does 40 J of work.

9. How much heat flows into the system along path AEB if the work done by the system is 20 J?

(A) 20 J (B) 40 J (C) 60 J (D) 80 J

10. The system returns from B to A along path BDA. If the work done on the system is 30 J, what will be the amount of heat liberated/generated?

(A) -90 J (B) 90 J (C) 30 J (D) -30 J

11. Acentric factor for Argon is

(A) >1 (B) 1 (C) 0 (D)

12. Wet steam at 270 °C enters a throttling calorimeter with enthalpies of 1200 kJ/kg and 2800 kJ/kg in liquid and gas phase, respectively. It leaves as supersaturated steam at 0.1 MPa and 120 °C with an enthalpy of 2700 kJ/kg. The quality of steam is

(A) 14/16 (B) 13/16 (C) 15/16 (D) 27/40

13. Superheated steam at 3 MPa and 300°C having enthalpy of 3000 kJ/kg enters a turbine at the rate of 1 kg/sec and leaves as dry saturated steam at 60 °C with an enthalpy of 2600 kJ/kg. If kinetic and potential energy changes are ignored, the power output of the turbine is

(A) 400 kW (B) 5600 kW (C) 3000 kW (D) 2600 kW

Statement for Linked Answer – Questions 14 and 15:

A reversible heat engine absorbs 800 kJ as heat from a reservoir at 600 K and rejects 100 kJ energy as heat to a reservoir at 300 K, as shown in the following figure.

Q14. The heat interaction (Q) with reservoir at 400 K is

(A) − 600 kJ (B) 400 kJ (C) − 400 kJ (D) 600 kJ

15. The work done (W) by the engine is

(A) 500 kJ (B) 400 kJ (C) 350 kJ (D) 300 kJ

16. The partial volume of component A in a binary mixture (A − B) is 60 x 10-6 m3/mol. The mole% of A in the mixture is 60%. The density of the mixture is 760 kg/m3. What will be the partial volume (m3/mol) of B in the mixture?

(Given: Molar mass of A is 50 x 10-3 kg/mol; molar mass of B is 20 x 10-3 kg/mol)

(A) 30 x 10-6 (B) 35 x 10-6 (C) 40 x 10-6 (D) 60 x 10-6

17. The enthalpy of vaporization of water at 100 °C is 2300 kJ/kg. The isobaric heat capacities of liquid and vapor are, respectively, 4.0 kJ/kg-K and 2 kJ/kg-K. The enthalpy of vaporization at 150 °C will be

(A) 2400 kJ/kg (B) 2100 kJ/kg (C) 2500 kJ/kg (D) 2200 kJ/kg

18. The following equations have been proposed for an isothermal binary solution where the standard states are the pure components at the solution temperature and pressure:

γ1 = Ax1; γ2 = Bx2
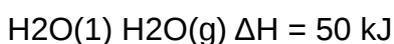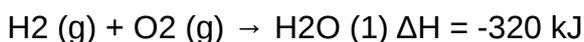
What can be said about the above relation?

(A) It satisfies Gibbs-Duhem equation
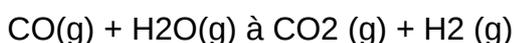
(B) It does not satisfy Gibbs-Duhem equation

(C) It is thermodynamically consistent

(D) It satisfies both (A) and (C)

19. The enthalpy change of some reactions are given below:

$CO (g) + O_2 (g) \rightarrow CO_2 (g)$ ΔH = -300 kJ

$H_2 (g) + O_2 (g) \rightarrow H_2O (1)$ ΔH = -320 kJ

$H_2O(1)$ $H_2O(g)$ ΔH = 50 kJ

What will be the enthalpy change for the following reaction:

$CO(g) + H_2O(g)$ à $CO_2 (g) + H_2 (g)$

(A) -70 kJ (B) 30 kJ (C) -30 kJ (D) 70 kJ

20. The decrease in the Helmholtz Free Energy for system in a given process for which initial and final temperatures are equal to the surrounding temperature indicates.

(A) Maximum work obtained from the system

(B) Minimum work obtained from the system

(C) Minimum work which can be done on the system

(D) Both (A) and (C)