CHEMICAL ENGINEERING

Q. No. 1 – 25 Carry One Mark Each

1. Match the polymerization mechanisms in Group I with the corresponding polymers in Group II:

GROUP - I	GROUP - II
P. Chain growth/addition polymerization	I. Polyethylene
Q. Step growth/condensation Polymerization	II. Polyvinyl chloride
	III. Polyethylene terephthalate

(A) P-III; Q-I, II (B) P-I, II; Q-III (C) P-II, III; Q-I (D) P-I; Q-II, III

Answer: (B)

2. Which ONE of the following sequence is arranged according to INCREASING calorific value?

(A) Produce gas, Water gas

(B) Natural gas, Producer gas, Water gas

(C) Produce gas, Water gas, Natural gas

(D) Water gas, Natural gas, Producer gas

Answer: (C)

3. The CORRECT sequence of process equipment used in the production of sulphuric acid from sulphur by process is

(A) burner, catalytic converter, 98% sulphuric acid absorption tower, oleum absorption column

(B) catalytic converter, oleum absorption column, 98% sulphuric acid absorption tower

(C) burner, catalytic converter,98% sulphur converter, 98% sulphuric acid absorption

(D) burner, oleum absorption column, catalytic converter, 98% sulphuric acid absorption tower

Answer: (C)

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4. Hydrotreating is used for

(A) removal of water from crude oil

(B) treatment of crude oil with water

(C) improving octane number of gasoline

(D) removal of sulphuric and nitrogen from petroleum fractions

Answer: (D)

5. Zeolite ZSM-5 is added to commercial FCC catalyst for

(A) promoting SO_2 reduction

(B) promoting CO oxidation

(C) improving tolerance to metal content in feed

(D) enhancing Octane number

Answer: (D)

6. Minimum input required to calculate the 'blank diameter' for a torispherical head is

(A) crown radius

(B) crown radius, knuckle radius and length of straight flange

(C) knuckle radius and straight flange

(D) crown radius and knuckle radius

Answer: (D)

7. Match the process parameters in Group I with the measuring instruments in Group II

GROUP - I	GROUP - II
P. Flame temperature	I. Thermocouple
Q. Composition of LPG	II. Radiation pyrometer
R. Liquid air temperature	III. Gas chromatograph

(A) P-III, Q-I, R-II

(B) P-I, Q-III, R- II

(C) P-II, Q-III, R-I

(D) P-II, Q-I, R-III

Answer: (C)

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8. The range of standard current signal in process instruments is 4 to 20 mA. Which ONE of the following is the reason for choosing the minimum signal as 4 mA instead of 0 mA?

(A) To minimize resistive heating in instruments

(B) To distinguish between signal failure and minimum signal condition

(C) To ensure a smaller difference between maximum and minimum signal

(D) To ensure compatibility with other instruments

Answer: (B)

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9. Minimum work (W) required to separate a binary gas mixture at a temperature T0 and pressure P0 is

$$W = -RT_0\left[y_1 In\left(\frac{f_1}{f_{pure,1}}\right) + y_2 In\left(\frac{f_2}{f_{pure,2}}\right)\right]$$

Where y_1 and y_2 are mole fractions, $f_{pure,1}$ and $f_{pure,2}$ are fugacities af pure species at T_0 and P_0 and f_1 and f_2 are fugacities of species in the mixture at T_0 ,P_0 and y_1. If the mixture is ideal then W is

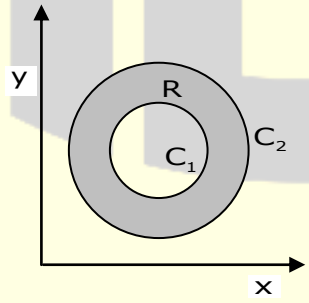
(A) 0 (B) $-RT\left[y_1 In\, y_2 + y_2 In\, y_2 \right]$

(C) $-RT_0\left[y_1 In\, y_1 + y_2 In\, y_2 \right]$ (D) RT_0

Answer: (B)

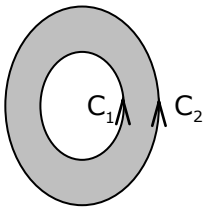
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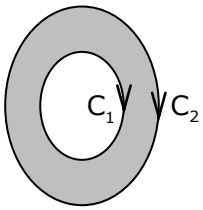
10. R is a closed planar region as shown by the shaded area in the figure below. Its boundary C consists of the circles C_1 and C_2.

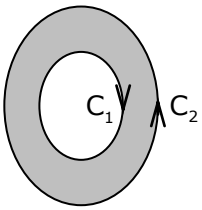


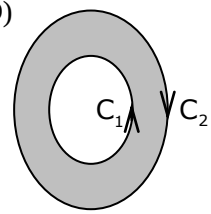
If $F_1(x,y), F_2(x,y)$, $\frac{\partial F_1}{\partial y}$ and $\frac{\partial F_2}{\partial X}$ are all continuous everywhere in R, Green's theorem states that $\iint_R \left(\frac{\partial F_2}{\partial x} - \frac{\partial F_1}{\partial y}\right) dxdy = \oint_C \left(F_1 dx + F_2 dy\right)$. Which ONE of the following alternatives CORRECTLY depicts the direction of integration along C?

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(A) 

(B) 

(C) 

(D) 

Answer: (C)

11. Which ONE of the following functions y(x) has the slope of its tangent equal to $\frac{ax}{y}$?

(Note: a and b are real constants)

(A) $y = \frac{x+b}{a}$ (B) $y = ax + b$ (C) $y = \sqrt{\frac{x^2+b}{a}}$ (D) $y = \sqrt{ax^2+b}$

Answer: (D)

12. Let $\lambda_1 = -1$ and $\lambda_2 = 3$ be the Eigen values and $\underrightarrow{V_1} = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\underrightarrow{V_2} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$ be the corresponding Eigen vectors of a real 2 × 2 matrix R. Given that P= $(V_1\ V_2)$, which ONE of the following matrices represents $P^{-1}R\ P$?

(A) $\begin{pmatrix} 0 & -1 \\ 3 & 0 \end{pmatrix}$ (B) $\begin{pmatrix} 0 & 3 \\ -1 & 0 \end{pmatrix}$ (C) $\begin{pmatrix} 3 & 0 \\ 0 & -1 \end{pmatrix}$ (D) $\begin{pmatrix} -1 & 0 \\ 0 & 3 \end{pmatrix}$

Answer: (D)

13. The partial molar enthalpies of mixing (in j/mol) for benzene (component I) and cyclohexane (component 2) at 300 K and I bar are given by $\overline{\Delta H_1} = 3600x_2^2$ and $\overline{\Delta H_2} = 3600x_1^2$ where x1 and x2 are the mole fraction s. When ONE mole of benzene is added to TWO moles of cyclohexane, the enthalpy change (in J) is

(A) 3600 (B) 2400 (C) 2000 (D) 800

Answer: (D)

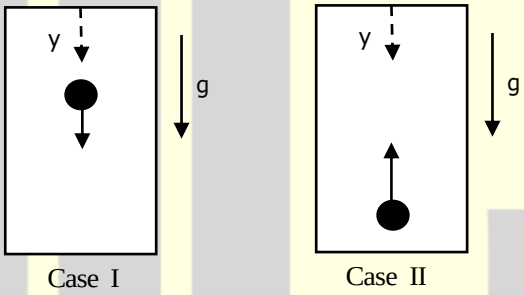
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14. One mole of methane is contained in a leak proof piston-cylinder assembly at 8 bar and 1000 k. The gas undergoes isothermal expansion to 4 bar under reversible conditions. Methane can be considered as an ideal gas under these conditions. The Value of universal gas constant is 8.314 jmol-1k-1. The heat transferred (in Kj) during the process is

(A) 11.52 (B) 5.76 (C) 4.15 (D) 2.38

Answer: (B)

15. Consider the following two cases of movement of particles. In Case I, the particle moves along the positive y-direction and in Case II, the particle moves along negative y-direction. Gravity acts along the positive y-direction. Which **ONE** of the following options corresponds to the **CORRECT** directions of buoyancy acting on the particles?



(A) Positive y-direction for both the cases

(B) Negative y-direction for Case I, positive y-direction for Case II

(C) Negative y-direction for both the cases

(D) Positive y-direction for Case I, negative y-direction for Case II

Answer: (C)

16. Match the pumps in **Group I** with the corresponding fluids in **Group II**

GROUP - I	GROUP - II
P. Gear pump	I. Highly viscous liquid
Q. Peristaltic pump	II. Aqueous sterile liquid
	III. Slurry

(A) P-III, Q-I, (B) P-II, Q-I (C) P-III, Q-II (D) P-I, Q-II

Answer: (D)

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17. Consider two black bodies with surfaces S_1 (area=1 m^2) and S_2 (area=4 m^2). They exchange heat only by radiation. 40% of the energy emitted by S_1 is received by S_2.The fraction of energy emitted by S_2 that is received by S_1 is

(A) 0.05 (B) 0.1 (C) 0.4 (D) 0.6

Answer: (B)

18. In film type condensation over a vertical tube, local heat transfer coefficient is

(A) inversely proportional to local film thickness

(B) directly proportional to local film thickness

(C) equal to local film thickness

(D) independent of local film thickness

Answer: (A)

19. Ammonia (component I) is evaporating from a partially filled bottle into surrounding air (component 2). The liquid level in the bottle and the concentration of ammonia at the top of the bottle are maintained constant. N_1 is the molar flux relative to a fixed location in space and J_1 is the molar flux with respect to the average molar velocity of the constituent species in the gas phase. Assume that air in the bottle is stagnant. Which **ONE** of the following is **CORRECT**?

(A) N_1=constant, N_2=0,$J_1+J_2=0$

(B) N+N=0, J+J=0

(C) $N_1+N_2=0$, J_1=costant, $J_2=0$

(D) N_1=constant, $N_2=0$, J_1=constant, $J_2=0$

Answer: (D)

20. Simultaneous heat and mass transfer is occurring in a fluid flowing over a flat plate. The flow is laminar. The concentration boundary layer will **COINCIDE** with the thermal boundary layer, when

(A) Sc = Nu (B) Sh = Nu (C) Sh = Pr (D) Sc = Pr

Answer: (D)

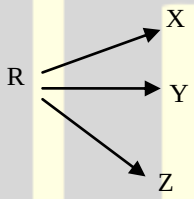
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21. Consider an irreversible, solid catalysed, liquid phase first order reaction. The diffusion and the reaction resistances are comparable. The overall rate constant (k_0) is related to the overall mass transfer coefficient (k_m) and the reaction rate constant (k) as

(A) $k_0 = \frac{kk_m}{k+k_m}$ (B) $k_0 = \frac{k+k_m}{kk_m}$ (C) $k_0 = \frac{k+k_m}{2}$ (D) $k_0 = k+k_m$

Answer: (A)

22. Reactant R forms three products X, Y and Z irreversibly, as shows below.



The reaction rates are given by $r_X = k_X C_R, r_Y = k_Y C_R^{1.5}$ and $r_Z = k_Z C_R$. The activation energies for formation of X,Y and Z are 40, 40 and 5kJ/mol respectively. The pre-exponential factors for all reactions are nearly same. The desired conditions for **MAXIMIZING** the yield of X are _____.

Answer: (B)

23. In an orifice meter, if the pressure drop across the orifice is overestimated by 5%, then the PERCENTAGE error in the measured flow rate is

(A) + 2.47 (B) +5 (C) –2.47 (D) –5

Answer: (A)

24. Two systems are available for compressing $6m^3/hr$ of ambient air to 10bar. The first one uses a single stage compressor (K1) and the second one uses a multistage compressor with inter-stage cooling (K2). Which ONE of the following statements is INCORRECT?

(A) K2 will have knockout pots in between the stages

(B) Discharge temperature of K1 will be higher than that of K2

(C) K2 will consume more power than K1

(D) Cost of K2 will be more than that of K1

Answer: (B)

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25. In a thin-walled cylindrical vessel of thickness t with inside radius r, the internal gauge pressure is p. The hoop stress and the longitudinal stress in the shell are σ_n and σ_1 respectively. Which ONE of the following statements is TRUE?

(A) $\sigma_n = \frac{pr}{t},\ \sigma_1 = \frac{pr}{4t}$ (B) $\sigma_n = \frac{pr}{4t},\ \sigma_1 = \frac{pr}{t}$

(C) $\sigma_n = \frac{pr}{2t},\ \sigma_1 = \frac{pr}{t}$ (D) $\sigma_n = \frac{pr}{t},\ \sigma_1 = \frac{pr}{2t}$

Answer: (D)

Q. No. 26 – 55 Carry Two Marks Each

26. Unit vectors in x and z directions are $\underline{i}$ and $\underline{k}$ respectively. Which ONE of the following is the directional derivative of the function $F(x,z) = \ln(x^2 + z^2)$ at the point P: (4,0), in the direction of $(\underline{i} - \underline{k})$?

(A) $\frac{\underline{i}}{2\sqrt{2}}$ (B) $\underline{i}$ (C) 1 (D) $\frac{1}{2\sqrt{2}}$

Answer: (D)

27. Which ONE of the following choices is a solution of the differential equation given below?

$$\frac{dy}{dx} = \frac{y^2}{x} + \frac{y}{x} - \frac{2}{x}$$

Note: c is a real constant

(A) $y = \frac{c - x^2}{c + 2x^2}$ (B) $y = \frac{c + 2x^2}{c - x^2}$

(C) $y = \frac{c - x^3}{c + 2x^3}$ (D) $y = \frac{c + 2x^3}{c - x^3}$

Answer: (D)

28. The value of the improper integral $\int_{-\infty}^{\infty} \frac{dx}{(1+x^2)}$ is

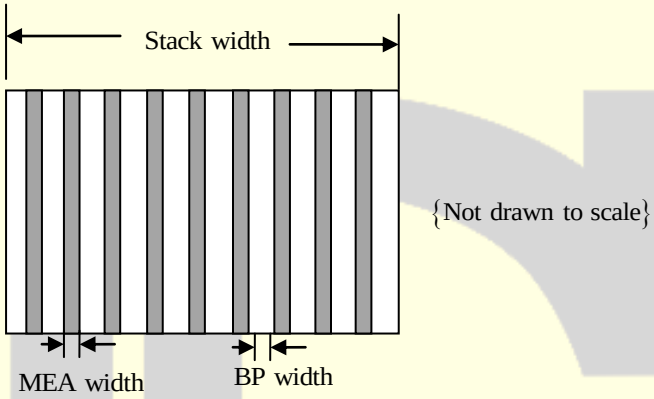
(A) -2π (B) 0 (C) π (D) 2π

Answer: (C)

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29. Fuel cell stacks are made of NINE membrane electrode assemblies (MEAs) interleaved between TEN bipolar plates (BPs) as illustrated below. The width of a membrane electrode assembly and a bipolar plate are normally distributed with $\mu_{MEA} = 0.15, \sigma_{MEA} = 0.01$ and $\mu_{BP} = 5$, $\sigma_{BP} = 0.1$ respectively. The widths of the different layers are independent of each other.

Which ONE of the following represents the CORRECT values of $(\mu_{stack}, \sigma_{stack})$ for the overall fuel cell stack width?

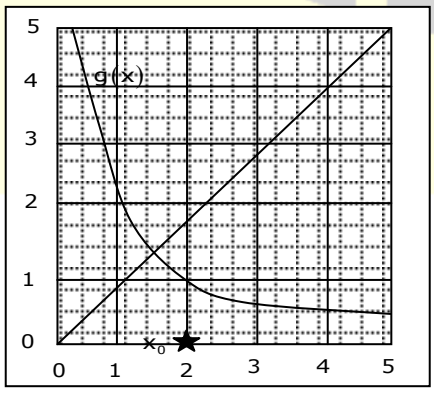


(A) $(51.35, 0.32)$ (B) $(51.35, 1.09)$ (C) $(5.15, 0.10)$ (D) $(5.15, 0.11)$

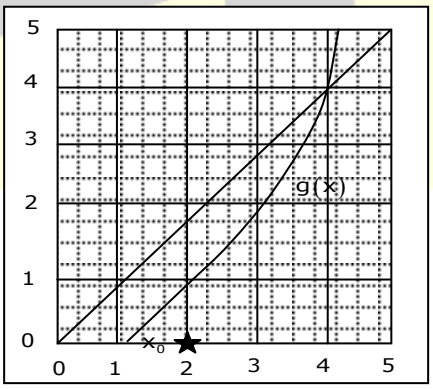
Answer: (*)

30. In the fixed point iteration method for solving equations of the form $x = g(x)$, the $(n+1)^{th}$ iteration value is $x_{n+1} = g(x_n)$, where x_n represents the n^{th} iteration value. $g(x)$ and corresponding initial guess value x_0 in the domain of interest are shown in the following choices. Which ONE of these choices leads to a converged solution for x?

(A)

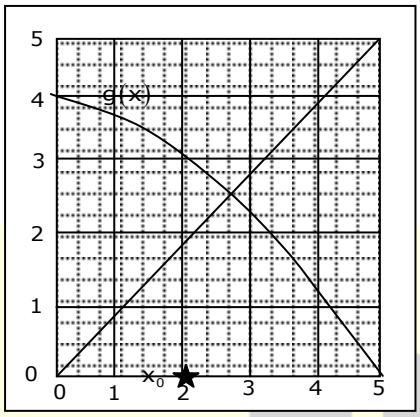


(B)

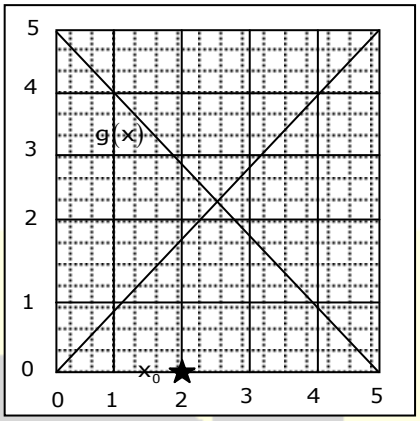


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(C)

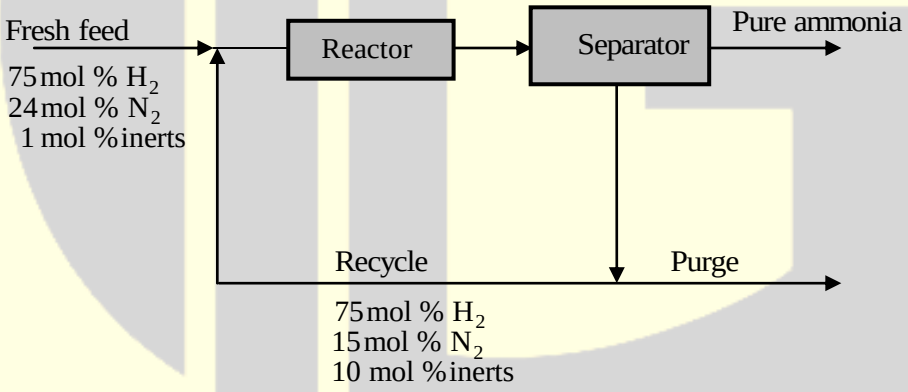


(D)



Answer: (*)

31. Ammonia is synthesized at 200bar and 773K by the reaction $N_2 + 3H_2 \longleftrightarrow 2NH_3$ The yield of ammonia is 0.45 mol/mol of fresh feed. Flow sheet for the process (along with available compositions) is shown below.



The single pass conversion for H_2 in the reactor is 20%. The amount of H_2 lost in the purge as a **PERCENTAGE** of H_2 in fresh feed is

(A) 10 (B) 20 (C) 45 (D) 55

Answer: (A)

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32. The following combustion reactions occur when methane is burnt.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

$$2CH_4 + 3O_2 \rightarrow 2CO + 4H_2O$$

20% excess air is supplied to the combustor. The conversion of methane is 80% and the molar ratio of CO to CO_2 in the flue gas is 1:3. Assume air to have 80mol % N_2 and rest O_2. The O_2 consumed as a **PERCENTAGE** of O_2 entering the combustor is

(A) 20 (B) 62.5 (C) 80 (D) 83.3

Answer: (D)

33. Consider a binary mixture of methyl ethyl ketone (component I) and toluene (component 2). At 323 K the activity coefficients γ_1 and γ_2 are given by

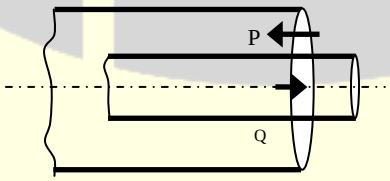
$$\ln \gamma_1 = x_2^2(\psi_1 - \psi_2 + 4\psi_2 x_1), \ln \gamma_2 = x_1^2(\psi_1 + \psi_2 - 4\psi_2 x_2)$$

Where x_1 and x_2 are the mole fractions in the liquid mixture, and ψ_1 and ψ_2 are parameters independent of composition. At the same temperature, the infinite dilution activity coefficients. γ_1^∞ and γ_2^∞ are given by $\ln\gamma_1^\infty = 0.4$ and $\ln\gamma_2^\infty = 0.2$. The vapour pressures of methyl ethyl ketone and toluene at 323K are 36.9 and 12.3kPa respectively. Assuming that the vapour phase is ideal, the equilibrium pressure (in kPa) of a liquid mixture containing 90 mol % toluene is

(A) 19 (B) 18 (C) 16 (D) 15

Answer: (C)

34. Two liquids (P and Q) having same viscosity are flowing through a double pipe heat exchanger as shown in the schematic below:



Densities of P and Q are 1000 and 800 kg/m^3 respectively. The average velocities of the liquids P and Q are 1 and 2.5 m/s respectively. The inner diameters of the pipes are 0.31 and 0.1m. Both pipes are 5mm thick. The ratio of the Reynolds numbers Re_P to Re_Q is

(A) 2.5 (B) 1.55 (C) 1 (D) 4

Answer: (C)

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35. The particle size distributions of the feed and collected solids (sampled for same duration) for a gas cyclone are given below.

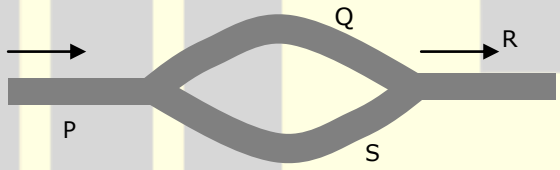
Size range (μm)	1-5	5-10	10-15	15-20	20-25	25-30
Weight of feed in the size range (g)	2.0	3.0	5.0	6.0	3.0	1.0
Weight of collected solids in the size range (g)	0.1	0.7	3.6	5.5	2.9	1.0

What is the collection efficiency (in PERCENTAGE) of the gas cyclone?

(A) 31 (B) 60 (C) 65 (D) 69

Answer: (C)

36. A liquid is flowing through the following piping network. The length of pipe sections P,Q,R and S shown in the schematic are equal. The diameters of the sections P and R are equal and the diameter of the section Q is twice that of S. The flow is steady and laminar. Neglecting curvature and entrance effects, the ratio of the volumetric flow rate in the pipe section Q to that in S is



(A) 16 (B) 8 (C) 2 (D) 1

Answer: (B)

37. Oil at 120^0C is used to heat water at 30°C in a 1-1 co-current shell and tube heat exchanger. The available heat exchange area is S_1. The exit temperatures of the oil and the water streams are 90°C and 60°C respectively. The co-current heat exchanger is replaced by a 1-1 counter – current heat exchanger having heat exchange area S_2. If the exit temperatures and the overall heat transfer coefficients are same, the ratio of S_1 and S_2 is

(A) ∞ (B) 1.1 (C) 0.91 (D) 0

Answer: (B)

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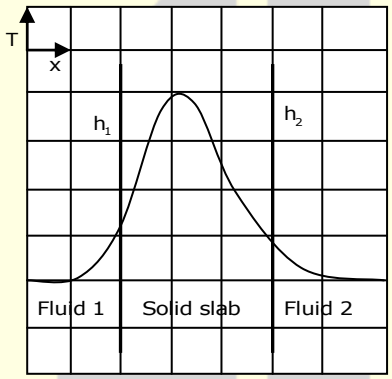
38. An aqueous sodium chloride solution (10wt %) is fed into a single effect evaporator at a rate of 10000kg/hr. It is concentrated to a 20wt % sodium chloride solution. The rate of consumption of steam in the evaporator is 8000 kg/hr. The evaporator capacity (kg/hr) and economy are

(A) 5000, 0.625 (B) 10000,0.625 (C) 5000,1.6 (D) 10000,1.6

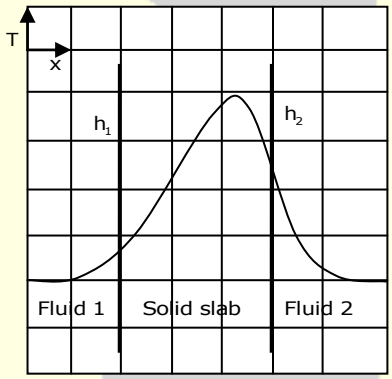
Answer: (A)

39. Heat is generated uniformly within a solid slab. The slab separates fluid 1 from fluid 2. The heat transfer coefficients between the solid slab and the fluids are h_1 and h_2 $(h_2 > h_1)$ respectively. The steady state temperature profile (T vs. x) for one – dimensional heat transfer is CORRECTLY shown by

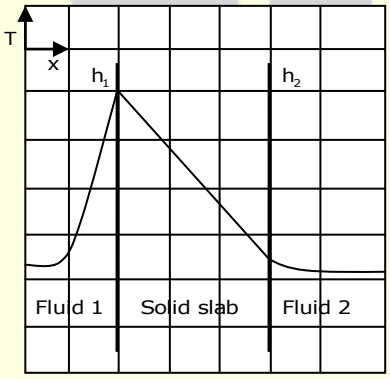
(A)



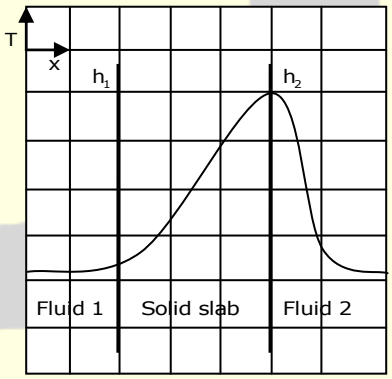
(B)



(C)



(D)



Answer: (C)

40. A gas mixture is in contact with a liquid. Component P in the gas mixture is highly soluble in the liquid. Possible concentration profiles during absorption of P are shown in the choices, where

X: mole fraction of P in bulk liquid

Y : mole fraction of P in bulk gas

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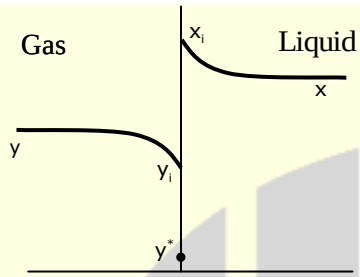
x_i : mole fraction of P at the interface in liquid

y_i : mole fraction of P at the interface in gas

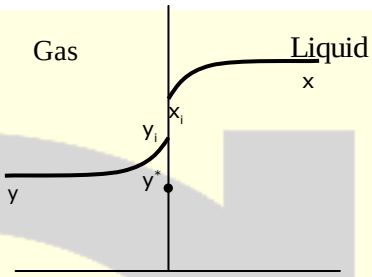
y^* : equilibrium gas phase mole fraction corresponding to x_i

The **CORRECT** profile is

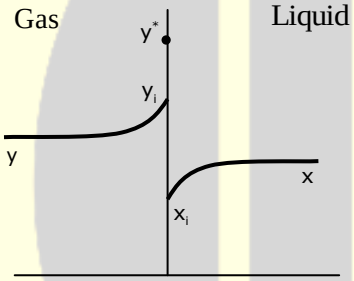
(A)



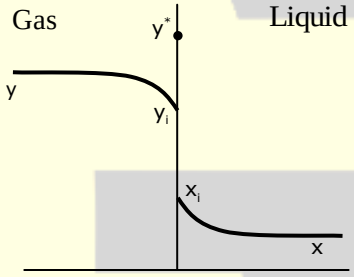
(B)



(C)

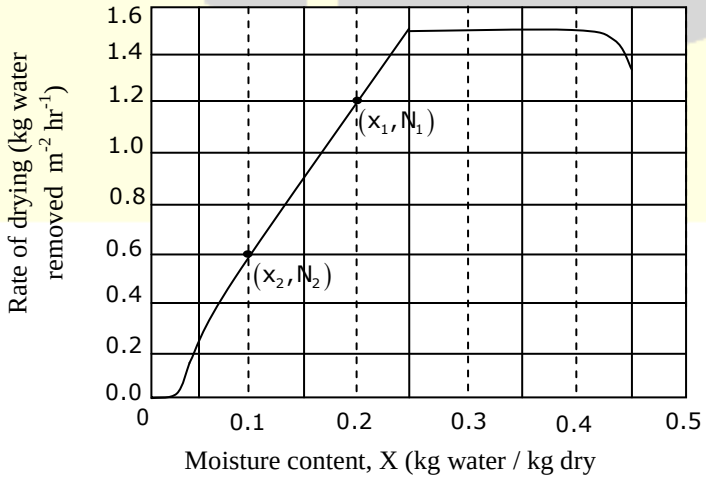


(D)



Answer: (A)

41. A batch of 120kg wet solid has initial moisture content of 0.2kg water/kg dry solid. The exposed area for drying is $0.05 m^2$ / kg dry solid. The rate of drying follows the curve given below.



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The time required (in hours) for drying this batch to a moisture content of 0.1kg water /kg dry solid is

(A) 0.033 (B) 0.43 (C) 0.6 (D) 2.31

Answer: (D)

---

42. For a first order catalytic reaction the Thiele modulus (ϕ) of a spherical pellet is defined as

$$\phi = \frac{R_s}{3}\sqrt{\frac{k\rho_p}{D_e}}$$

Where

ρ_p = Pellet density R_s = pellet radius

D_e = Effective diffusivity k= first order reaction rate constant

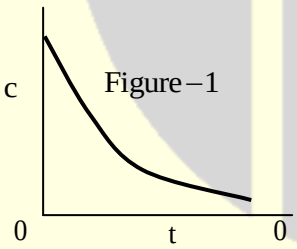
If $\phi > 5$, then the apparent activation energy (E_a) is related to the intrinsic (or true) activation energy (E) as

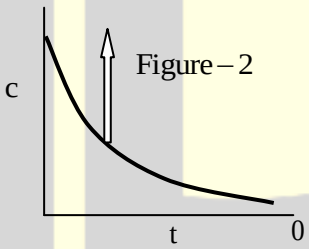
(A) $E_a = E^{0.5}$ (B) $E_a = 0.5E$ (C) $E_a = 2E$ (D) $E_a = E^2$

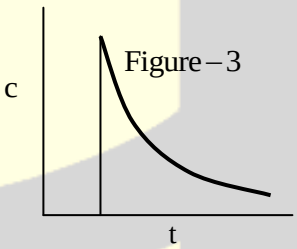
Answer: (B)

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43. The following figures show the outlet tracer concentration profiles (c vs. t) for a pulse input.







Match the figures in Group – I with the reactor configurations in Group – II.

Group – I	Group – II
P. Figure 1	I. PFR
Q. Figure 2	II. CSTR
R. Figure 3	III. PFR and CSTR in series
	IV. PFR and CSTR in parallel

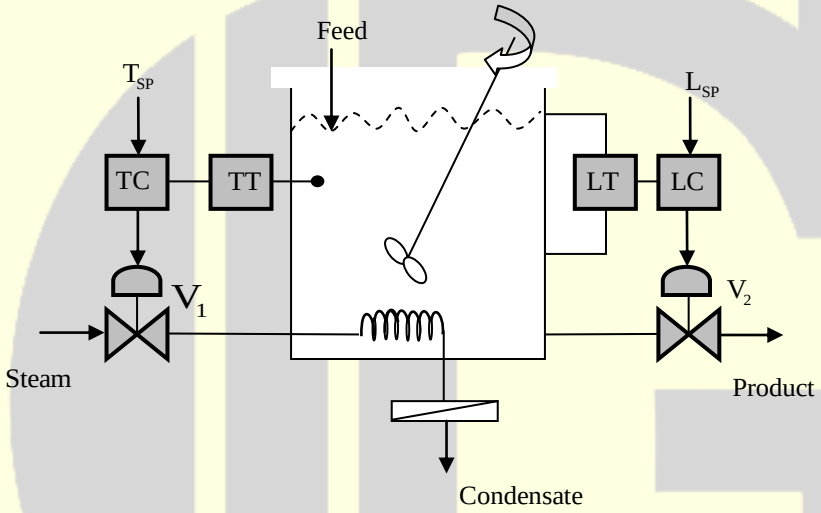
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(A) P-III, Q-IV, R-III (B) P-IV, Q-III, R-I

(C) P-III, Q-IV, R-II (D) P-I, Q-III, R-II

Answer: (A)

44. The following diagram shows a CSTR with two control loops. A liquid phase, endothermic reaction is taking place in the CSTR, and the system is initially at steady state. Assume that the changes in physical properties of the system are negligible.



TC : Temperature controller, LC : Level controller, TT : Temperature transmitter, LT: Level transmitter, V_1 and V_2 : Control valves

Which ONE of the following statements is TRUE?

(A) Changing the level controller set point affects the opening of V_2 ONLY

(B) Changing the temperature controller set point affects the opening of V_2 ONLY

(C) Changing the temperature controller set point affects the opening of BOTH V_1 and V_2

(D) Changing the level controller set point affects the opening of BOTH V_1 and V_2

Answer: (D)

45. A process plant has a life of 7 years and its salvage value is 30%. For what MINIMUM fixed – percentage factor will the depreciation amount for the second year, calculated by declining balance method be EQUAL to that calculated by the straight line depreciation method?

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(A) 0.1 (B) 0.113 (C) 0.527 (D) 0.887

Answer: (B)

46. A continuous fractionators system is being designed. The following cost figures are estimated for a reflux ratio of 1.4.

Fixed cost including all accessories (Rs.) for			Operating cost (Rs./year) for	
Column	Condenser	Reboiler	Condenser cooling water	Reboiler heating steam
6×10^6	2×10^6	5×10^6	8×10^6	1×10^6

The annualized fixed charge is 15% of the fixed cost. The total annualized cost (in Rs.) is

(A) 10.8×10^6 (B) 13.35×10^6 (C) 15.9×10^6 (D) 3.15×10^6

Answer: (A)

47. Match the reactions in Group – I with the products in Group – II

Group – I	Group – II
P. Ammoxidation	I. Aniline from benzene
Q. Nitration	II. Benzoic acid from toluene
R. Dehydrogenation	III. Acrylonitrile from propylene
S. Oxidation	IV. Styrene from ethyl benzene

(A) P-III, Q-I, R-IV, S-II (B) P-IV, Q-I, R-III,S-II

(C) P-I, Q-III, R-IV,S-II (D) P-I, Q-II, R-III,S-IV

Answer: (A)

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Common Data Questions: 48 & 49

For a liquid flowing through a packed bed, the pressure drop per unit length of the bed $\frac{\Delta P}{L}$ is

$$\frac{\Delta P}{L}=\frac{150\mu_f \bar{V}_0}{\left(\phi_s \bar{d}_p\right)^2}\frac{(1-\varepsilon)^2}{\varepsilon^3}+\frac{1.75\rho_f \bar{V}_0^2(1-\varepsilon)}{\phi_s \bar{d}_p \varepsilon^3}$$

Where $\bar{V}_0$ is the superficial liquid velocity, ε is the bed porosity, $\bar{d}_p$ is average particle size, ϕ_s is particle sphericity, ρ_f is liquid density and μ_f is liquid viscosity.

Given data : $\bar{d}_p=1\times10^{-3}\text{m}, \phi_s=0.8, \rho_f=1000\text{kg/m}^3, \mu_f=1\times10^{-3}\text{kgm}^{-1}\text{s}^{-1}$.

Particle density, $\rho_p=2500\text{kg/m}^3$ and acceleration due to gravity, $g=9.8\text{m/s}^2$

48. When $\bar{V}_0$ is 0.005 m/s and $\varepsilon=0.5$, which ONE of the following is the CORRECT value for the ratio of the viscous loss to the kinetic energy loss?

(A) 0.09 (B) 1.07 (C) 10.71 (D) 93

Answer: (C)

49. On further increasing $\bar{V}_0$, incipient fluidization is achieved. Assuming that the porosity of the bed remains unaltered, the pressure drop per unit length (in Pa/m) under incipient fluidization condition is

(A) 3675 (B) 7350 (C) 14700 (D) 73501

Answer: (B)

Common Data Questions: 50 & 51

A binary feed mixture containing equimolar quantities of components S and T is to be distilled in a fractionating tower at atmospheric pressure. The distillate contains 96 mol % S. the q – line (feed line) intersects the equilibrium line at $x'=0.46$ and $y'=0.66$, where x' and y' are mole fractions. Assume that the McCabe – Thiele method is applicable and the relative volatility is constant.

50. The MINIMUM reflux ratio is

(A) 1.6 (B) 1.5 (C) 0.66 (D) 0.6

Answer: (B)

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51. The feed is

(A) at dew point (B) at bubble point

(C) superheated vapour (D) partially vapour

Answer: (D)

Statement for Linked Answer Questions: 52 & 53

52. In an aqueous solution, reaction $P \rightarrow Q$ occurs under isothermal conditions following first order kinetics. The feed rate is 500 cm^3/min and concentration of P in the feed is $1.5\times10^{-4} mol/cm^3$. The reaction is carried out in a 5 litre CSTR. At steady state, 60% conversion is observed.

The rate constant (in min^{-1}) is

(A) 0.06 (B) 0.15 (C) 0.21 (D) 0.28

Answer: (B)

53. The 5 litre CSTR is replaced by five CSTRs in series. If the capacity of each new CSTR is 1 litre, then the overall conversion (in%) is

(A) 65 (B) 67 (C) 73 (D) 81

Answer: (C)

Statement for Linked Answer Questions: 54 & 55

A PID controller output p(t), in time domain, is given by

$$p(t) = 30 + 5e(t) + 1.25\int_0^t e(t)dt + 15\frac{de(t)}{dt}$$

Where e(t) is the error at time t. The transfer function of the process to be controlled is $G_P(s) = \frac{10}{(200s+1)}$. The measurement of the controlled variable is instantaneous and accurate.

54. The transfer function of the controller is

(A) $\frac{5(12s^2+4s+1)}{3s}$ (B) $\frac{5(12s^2+3s+1)}{3s}$

(C) $\frac{5(12s^2+4s+1)}{4s}$ (D) $\frac{5(12s^2+3s+1)}{4s}$

Answer: (C)

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55. The characteristic equation of the closed loop is

(A) $6s^2+102s+1=0$ (B) $700s^2+102s+25=0$

(C) $100s^2-196s-25=0$ (D) $240s^3+812s^2+204s+1=0$

Answer: (B)

GENERAL APTITUDE

Q. No. 56 – 60 Carry One Mark Each

56. Choose the most appropriate word(s) from the options given below to complete the following sentence.

"I contemplated _____ Singapore for my vacation but decided against it."

(A) to visit (B) having to visit (C) visiting (D) for a visit

Answer: (C)

57. If Log (P) = (1/2)Log (Q) = (1/3) Log (R), then which of the following options is TRUE?

(A) $P^2=Q^3R^2$ (B) $Q^2=PR$ (C) $Q^2=R^3P$ (D) $R=P^2Q^2$

Answer: (B)

58. Which of the following options is the closest in the meaning to the word below:

' **Inexplicable'**

(A) Incomprehensible (B) Indelible

(C) Inextricable (D) Infallible

Answer: (A)

59. Choose the word from the options given below that is most nearly opposite in meaning to the given word:

'Amalgamate'

(A) merge (B) split (C) collect (D) separate

Answer: (D)

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60. Choose the most appropriate word from the options given below to complete the following sentence.

"If you are trying to make a strong impression on your audience, you cannot do so by being understand, tentative or _____".

(A) hyperbolic (B) restrained (C) argumentative (D) indifferent

Answer: (B)

Q. No. 61 – 65 Carry Two Mark Each

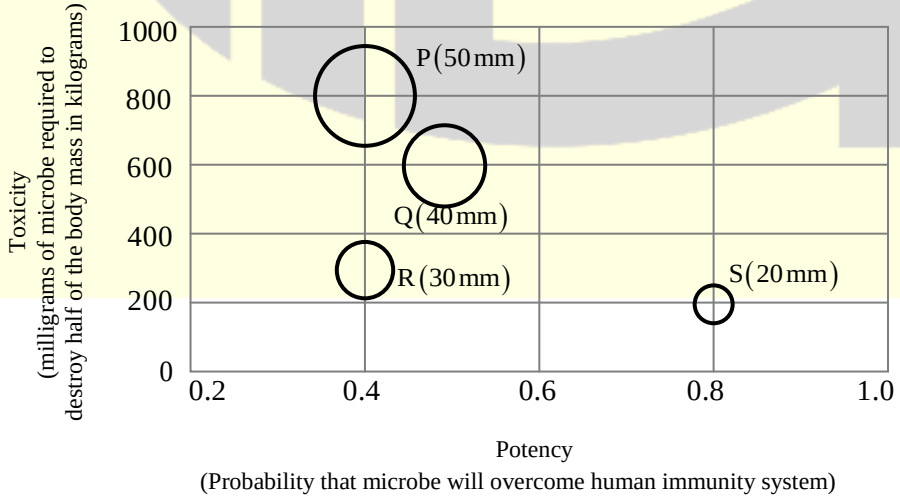
61. The variable cost (V) of manufacturing a product varies according to the equation V= 4q, where q is the quantity produced. The fixed cost (F) of production of same product reduces with q according to the equation F = 100/q. How many units should be produced to minimize the total cost (V+F)?

(A) 5 (B) 4 (C) 7 (D) 6

Answer: (A)

62. P, Q, R and S are four types of dangerous microbes recently found in a human habitat. The area of each circle with its diameter printed in brackets represents the growth of a single microbe surviving human immunity system within 24 hours of entering the body.

The danger to human beings varies propor-tionately with the toxicity, potency and growth attributed to a microbe shown in the figure below:



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A pharmaceutical company is contem-plating the development of a vaccine against the most dangerous microbe. Which microbe should the company target in its first attempt?

(A) P (B) Q (C) R (D) S

Answer: (D)

63. "Few school curricula include a unit on how to deal with bereavement and grief, and yet all students at some point in their lives suffer from losses through death and parting."

Based on the above passage which topic would not be included in a unit on bereavement?

(A) How to write a letter of condolence

(B) What emotional staged are passed through in the healing process

(C) What the leading causes of death are

(D) How to give support to a grieving friend

Answer: (C)

64. A container originally contains 10 litres of pure spirit. From this container 1 litre of spirit is replaced with 1 litre of water. Subsequently, 1 litre of the mixture is again replaced with 1 litre of water and this process is repeated one more time. How much spirit is now left in the container?

(A) 7.58 litres (B) 7.84 litres

(C) 7 litres (D) 7.29 litres

Answer: (D)

65. A transporter receives the same number of orders each day. Currently, he has some pending orders (backlog) to be shipped. If he uses 7 trucks, then at the end of the 4th day he can clear all the orders. Alternatively, if he uses only 3 trucks, then all the orders are cleared at the end of the 10th day. What is the minimum number of trucks required so that there will be no pending order at the end of the 5th day?

(A) 4 (B) 5 (C) 6 (D) 7

Answer: (C)

★★★ **END OF THE PAPER** ★★★

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