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GENERAL ABILITY

Q. No. 1 – 5 Carry One Mark Each

1. A student is required to demonstrate a high level of <u>comprehension</u> of the subject, especially in the social sciences.

The word closest in meaning to <u>comprehension</u> is

(A) understanding   (B) meaning

(C) concentration   (D) stability

Answer: (A)

---

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

One of his biggest _____ was his ability to forgive.

(A) vice   (B) virtues   (C) choices   (D) strength

Answer: (B)

---

3. Rajan was not happy that Sajan decided to do the project on his own. On observing his unhappiness, Sajan explained to Rajan that he preferred to work independently.

Which one of the statements below is logically valid and can be inferred from the above sentences?

(A) Rajan has decided to work only in a group.

(B) Rajan and Sajan were formed into a group against their wishes.

(C) Sajan had decided to give in to Rajan's request to work with him.

(D) Rajan had believed that Sajan and he would be working together.

Answer: (D)

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4. If $y = 5x^2 + 3$, then the tangent at $x = 0$, $y = 3$

(A) passes through $x = 0$, $y = 0$ (B) has a slope of $+1$

(C) is parallel to the x-axis   (D) has a slope of -1

Answer: (C)

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5. A foundry has a fixed daily cost of Rs 50,000 whenever it operates and a variable cost of Rs 800Q, where Q is the daily production in tonnes. What is the cost of production in Rs per tonne for a daily production of 100 tonnes?

Answer: **(1300 to 1300)**

Q. No. 6 - 10 Carry Two Marks Each

6. Find the odd one in the following group: ALRVX, EPVZB, ITZDF, OYEIK

(A) ALRVX   (B) EPVZB   (C) ITZDF   (D) OYEIK

Answer: **(D)**

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7. Anuj, Bhola, Chandan, Dilip, Eswar and Faisal live on different floors in a six-storeyed building (the ground floor is numbered 1, the floor above it 2, and so on). Anuj lives on an even-numbered floor. Bhola does not live on an odd numbered floor. Chandan does not live on any of the floors below Faisal's floor. Dilip does not live on floor number 2. Eswar does not live on a floor immediately above or immediately below Bhola. Faisal lives three floors above Dilip. Which of the following floor-person combinations is correct?

	Anuj	Bhola	Chandan	Dilip	Eswar	Faisal
(A)	6	2	5	1	3	4
(B)	2	6	5	1	3	4
(C)	4	2	6	3	1	5
(D)	2	4	6	1	3	5

Answer: **(B)**

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8. The smallest angle of a triangle is equal to two thirds of the smallest angle of a quadrilateral. The ratio between the angles of the quadrilateral is 3:4:5:6. The largest angle of the triangle is twice its smallest angle. What is the sum, in degrees, of the second largest angle of the triangle and the largest angle of the quadrilateral?

Answer: **(180 to 180)**

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9. One percent of the people of country X are taller than 6 ft. Two percent of the people of country Y are taller than 6 ft. There are thrice as many people in country X as in country Y. Taking both countries together, what is the percentage of people taller than 6 ft?

(A) 3.0   (B) 2.5   (C) 1.5   (D) 1.25

Answer: (D)

10. The monthly rainfall chart based on 50 years of rainfall in Agra is shown in the following figure. Which of the following are true? (k percentile is the value such that k percent of the data fall below that value)
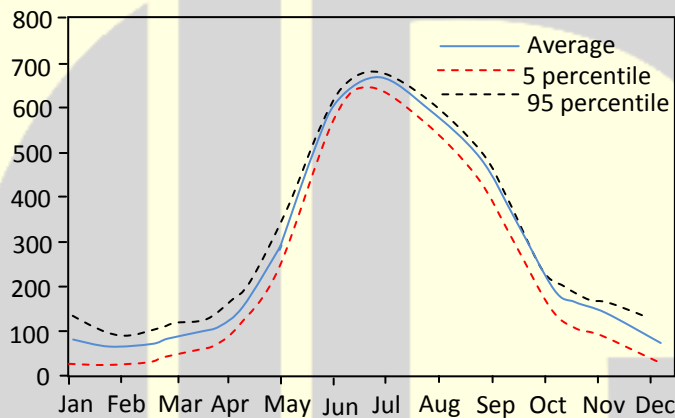
(i) On average, it rains more in July than in December

(ii) Every year, the amount of rainfall in August is more than that in January

(iii) July rainfall can be estimated with better confidence than February rainfall

(iv) In August, there is at least 500 mm of rainfall

(A) (i) and (ii)   (B) (i) and (iii)   (C) (ii) and (iii)   (D) (iii) and (iv)

Answer: (B)

CHEMICAL ENGINEERING

Q. No. 1 – 25 Carry One Mark Each

1. Gradient of a scalar variable is always

(A) a vector   (B) a scalar   (C) a dot product   (D) zero

Answer: **(A)**

---

2. For the time domain function, $f(t) = t^2$, which **ONE** of the following is the Laplace transform of $\int_0^t f(t)dt$?

(A) $\dfrac{3}{s^4}$ (B) $\dfrac{1}{4s^2}$ (C) $\dfrac{2}{s^3}$ (D) $\dfrac{2}{s^4}$

Answer: **(D)**

---

3. If f*(x) is the complex conjugate of $f(x) = \cos(x) + i\,\sin(x)$, then for real a and b, $\int_a^b f*(x)f(x)\,dx$ is ALWAYS ?

(A) Positive   (B) Negative   (C) Real   (D) Imaginary

Answer: **(C)**

---

4. If f(x) is a real and continuous function of x, the Taylor series expansion of f(x) about its minima will NEVER have a term containing

(A) first derivative   (B) second derivative

(C) third derivative   (D) any higher derivative

Answer: **(A)**

5. From the following list, identify the properties which are equal in both vapour and liquid phases at equilibrium

P. Density Q. Temperature

R. Chemical potential S. Enthalpy
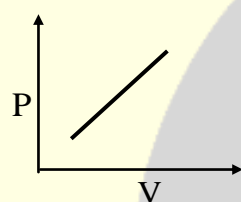
(A) P and Q only (B) Q and R only
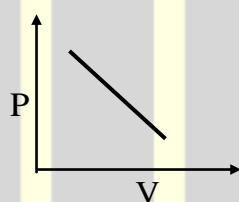
(C) R and S only (D) P and S only

Answer: (B)

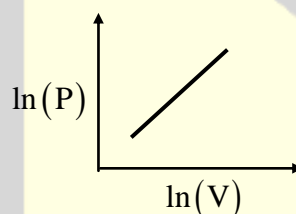**6.** In a closed system, the isentropic expansion of an ideal gas with constant specific heats is represented by
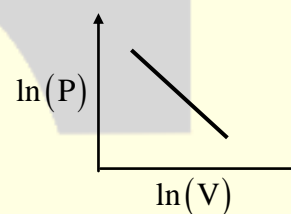
(A) (B) (C) (D)

Answer: (D)

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7. Match the following:

Group-1	Group-2
(P) $\left(\dfrac{\partial G}{\partial n_i}\right)_{T,P,n_{jet}}$	I. Arrhenius equation
(Q) $\left(\dfrac{\partial G}{\partial n_i}\right)_{S,V,n_{jet}}$	II. Reaction equilibrium constant
(R) $\exp\left(\dfrac{-\Delta G^0_{reaction}}{RT}\right)$	III. Chemical potential
(S) $\Sigma\left(n_i d\mu_i\right)_{T,P} = 0$	IV. Gibbs-Duhem equation

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

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

Answer: (C)

8. In order to achieve the same conversion under identical reaction conditions and feed flow rate for a non-autocatalytic reaction of positive order, the volume of an ideal CSTR is

(A) always greater than that of an ideal PFR

(B) always smaller than that of an ideal PFR

(C) same as that of an ideal PFR

(D) smaller than that of an ideal PFR only for first order reaction

Answer: **(A)**

9. Integral of the time-weighted absolute error (ITAE) is expressed as

(A) $\int\limits_{0}^{\infty} \dfrac{|\varepsilon(t)|}{t^2} dt$

(B) $\int\limits_{0}^{\infty} \dfrac{|\varepsilon(t)|}{t} dt$

(C) $\int\limits_{0}^{\infty} t|\varepsilon(t)| dt$

(D) $\int\limits_{0}^{\infty} t^2 |\varepsilon(t)| dt$

Answer: **(C)**

10. A unit **IMPULSE** response of a first order system with time constant τ and steady state gain K_p is given by

(A) $\dfrac{1}{K_p \tau} e^{t/\tau}$

(B) $K_p e^{-t/\tau}$

(C) $\tau K_p e^{-t/\tau}$

(D) $\dfrac{K_p}{\tau} e^{-t/\tau}$

Answer: **(D)**

11. In a completely opaque medium, if 50% of the incident monochromatic radiation is absorbed, then which of the following statements are **CORRECT**?

(P) 50% of the incident radiation is reflected

(Q) 25% of the incident radiation is reflected

(R) 25% of the incident radiation is transmitted

(S) No incident radiation is transmitted

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

Answer: **(A)**

12. In case of a pressure driven laminar flow of a Newtonian fluid of viscosity (μ) through a horizontal circular pipe, the velocity of the fluid is proportional to

(A) μ (B) $\mu^{0.5}$ (C) μ^{-1} (D) $\mu^{-0.5}$

Answer: **(C)**

---

13. Which of the following statements are CORRECT?

(P)   For a rheopectic fluid, the apparent viscosity increases with time under a constant applied shear stress

(Q)   For a pseudoplastic fluid, the apparent viscosity decreases with time under a constant applied shear stress

(R)   For a Bingham plastic, the apparent viscosity increases exponentially with the deformation rate

(S)   For a dilatant fluid, the apparent viscosity increases with increasing deformation rate

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

Answer: **(D)**

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14. Assume that an ordinary mercury-in-glass thermometer follows first order dynamics with a time constant of 10s. It is at a steady state temperature of 0°C. At time t = 0, the thermometer is suddenly immersed in a constant temperature bath at 100°C. The time required (in s) for the thermometer to read 95°C, approximately is

(A)   60   (B)   40   (C)   30   (D)   20

Answer: **(C)**

---

15. Packed towers are preferred for gas-liquid mass transfer operations with foaming liquids because

(A)   in packed towers, high liquid to gas ratios are best handled

(B)   in packed towers, continuous contact of gas and liquid takes place

(C)   packed towers are packed with random packings

(D)   in packed towers, the gas is not bubbled through the liquid pool

Answer: **(D)**
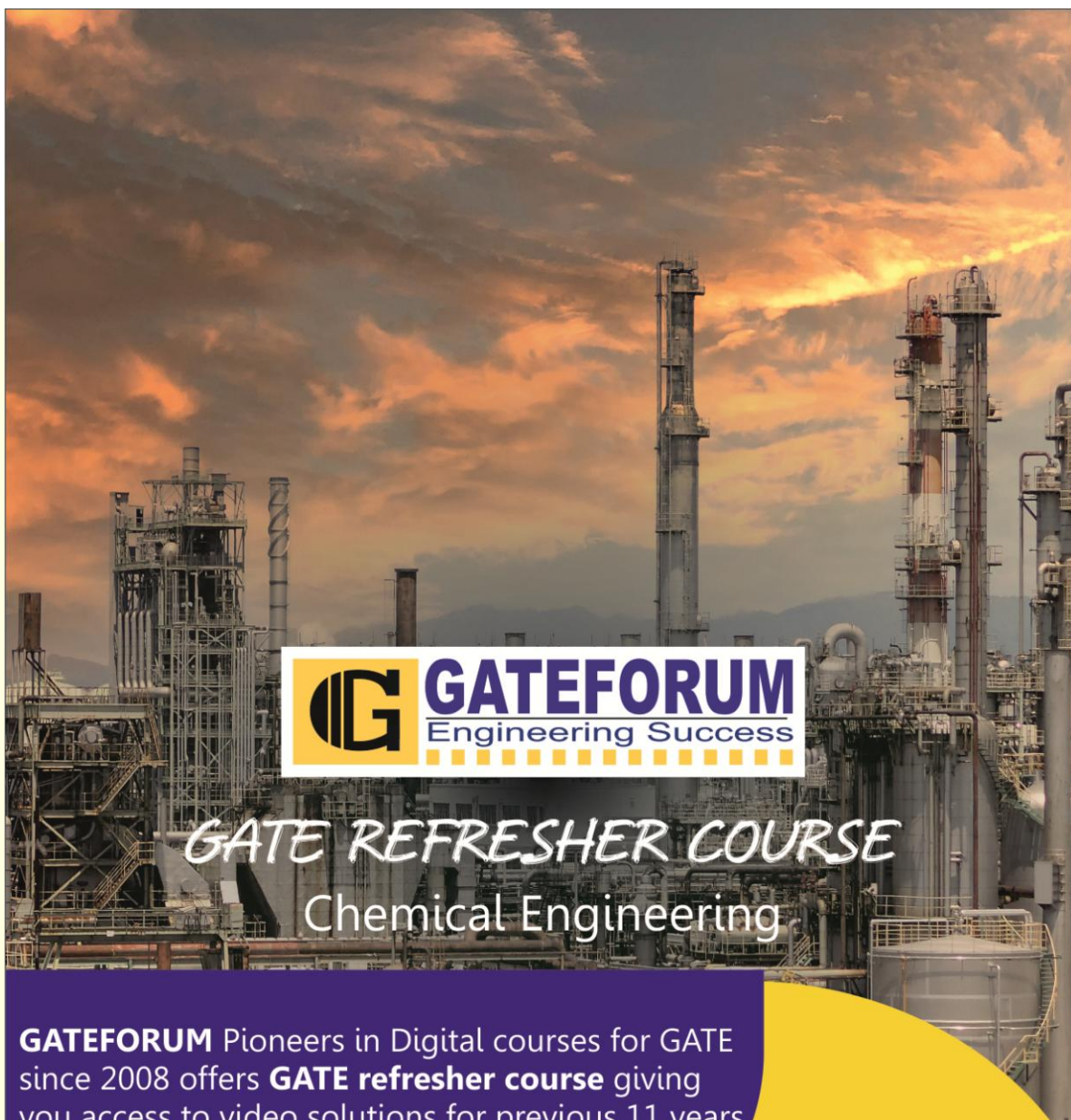
16. A spherical storage vessel is quarter–filled with toluene. The diameter of the vent at the top of the vessel is 1/20th of the diameter of the vessel. Under the steady state condition, the diffusive flux of toluene is maximum at

(A) the surface of the liquid

(B) the mid-plane of the vessel

(C) the vent

(D) a distance 20 times the diameter of the vent away from the vent

Answer: **(C)**

17. In order to produce fine solid particles between 5 and 10 μm, the appropriate size reducing equipment is

(A) fluid energy mill   (B) hammer mill

(C) jaw crusher   (D) smooth roll crusher

Answer: **(A)**

18. Slurries are most conveniently pumped by a

(A) syringe pump   (B) diaphragm pump

(C) vacuum pump   (D) gear pump

Answer: **(B)**

19. Assuming the mass transfer coefficients in the gas and the liquid phases are comparable, the absorption of CO_2 from reformer gas (CO_2+H_2) into an aqueous solution of diethanolamine is controlled by

(A) gas phase resistance

(B) liquid phase resistance

(C) both gas and liquid phase resistances

(D) composition of the reformer gas

Answer: **(A)**

20. Which ONE of the following statements is CORRECT for the surface renewal theory?

(A) Mass transfer takes place at steady state

(B) Mass transfer takes place at unsteady state

(C)   Contact time is same for all the liquid elements

(D)   Mass transfer depends only on the film resistance

Answer: (B)

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21.   Steam economy of a multiple effect evaporator system is defined as

(A)   kilogram of steam used per hour

(B)   kilogram of steam consumed in all the effects for each kilogram of steam fed

(C)   kilogram of steam used in all the effects for each kilogram of water vaporized per hour

(D)   kilogram of water vaporized from all the effects for each kilogram of steam fed to the first effect

Answer: (D)

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22.   Decomposition efficiency (η_D) of an electrolytic cell used for producing NaOH is defined as

(A) η_D = (grams of NaOH produced / grams of NaCl decomposed) x 100

(B) η_D = (grams of NaOH produced / grams of NaCl charged) x 100

(C) η_D = (gram equivalents of NaOH produced / gram equivalents of NaCl charged) x 100

(D) η_D = (theoretical current to produce one gram equivalent / actual current to produce one gram equivalent) x 100

Answer: (C)

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23.   The vessel dispersion number for an ideal CSTR is

(A)   −1   (B)   0   (C)   1   (D)   ∞

Answer: (D)

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24.   Catalytic cracking is

(A)   a hydrogen addition process   (B)   a carbon rejection process

(C)   an exothermic process   (D)   a coking process

Answer: (B)

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25. Which ONE of the following statements is CORRECT?

   (A)   The major components of biodiesel are triglycerides

   (B)   Biodiesel is essentially a mixture of ethyl esters

   (C)   Biodiesel is highly aromatic

   (D)   Biodiesel has a very low aniline point

Answer: **(B)**

Q. No. 26 – 55 Carry Two Marks Each

26. Consider the following differential equation

$$\frac{dy}{dx} = x + \ln(y); \; y = 2 \text{ at } x = 0$$

The solution of this equation at x = 0.4 using Euler method with a step size of h= 0.2 is _____.

Answer: **(2.3 to 2.4)**

27. The integrating factor for the differential equation

$$\frac{dy}{dx} - \frac{y}{1+x} = (1+x) \text{ is}$$

   (A) $\dfrac{1}{1+x}$ (B) $(1+x)$ (C) $x(1+x)$ (D) $\dfrac{x}{1+x}$

Answer: **(A)**

28. The differential equation $\dfrac{d^2 y}{dx^2} + x^2 \dfrac{dy}{dx} + x^3 y = e^x$ is a

   (A)   non-linear differential equation of first degree

   (B)   linear differential equation of first degree

   (C)   linear differential equation of second degree

   (D)   non-linear differential equation of second degree

Answer: **(B)**

29. Consider the following two normal distributions

$$f_1(x) = \exp(-\pi x^2)$$

$$f_2(x) = \frac{1}{2\pi}\exp\left\{-\frac{1}{4\pi}(x^2 + 2x + 1)\right\}$$

If μ and σ denote the mean and standard deviation, respectively, then

(A) $\mu_1 < \mu_2$ and $\sigma_1^2 < \sigma_2^2$

(B) $\mu_1 < \mu_2$ and $\sigma_1^2 > \sigma_2^2$

(C) $\mu_1 > \mu_2$ and $\sigma_1^2 < \sigma_2^2$

(D) $\mu_1 > \mu_2$ and $\sigma_1^2 > \sigma_2^2$

Answer: **(C)**

30. In rolling of two fair dice, the outcome of an experiment is considered to be the sum of the numbers appearing on the dice. The probability is highest for the outcome of _____.

Answer: **(6.99 to 7.01)**

31. A spherical ball of benzoic acid (diameter = 1.5 cm) is submerged in a pool of still water. The solubility and diffusivity of benzoic acid in water are 0.03 kmol/m³ and 1.25 x 10⁻⁹ m²/s respectively. Sherwood number is given as $Sh = 2.0 + 0.6\ Re^{0.5} Sc^{0.33}$. The initial rate of dissolution (in kmol/s) of benzoic acid approximately is

(A) 3.54×10^{-11}
(B) 3.54×10^{-12}
(C) 3.54×10^{-13}
(D) 3.54×10^{-14}

Answer: **(B)**

32. A wet solid of 100 kg is dried from a moisture content of 40wt% to 10wt%. The critical moisture content is 15wt% and the equilibrium moisture content is negligible. All moisture contents are on dry basis. The falling rate is considered to be linear. It takes 5 hours to dry the material in the constant rate period. The duration (in hours) of the falling rate period is _____.

Answer: **(1.1 to 1.3)**

33. A brick wall of 20 cm thickness has thermal conductivity of 0.7 W m^{-1} K^{-1}. An insulation of thermal conductivity 0.2 W m^{-1} K^{-1} is to be applied on one side of the wall, so that the heat transfer through the wall is reduced by 75%. The same temperature difference is maintained across the wall before and after applying the insulation. The required thickness (in cm) of the insulation is _____.

Answer: **(17.0 to 17.3)**

34. An oil with a flow rate of 1000 kg/h is to be cooled using water in a double-pipe counter-flow heat exchanger from a temperature of 70°C to 40°C. Water enters the exchanger at 25°C and leaves at 40°C. The specific heats of oil and water are 2 kJ kg^{-1} K^{-1} and 4.2 kJ kg^{-1} K^{-1}, respectively. The overall heat transfer coefficient is 0.2 kW m^{-2} K^{-1}. The minimum heat exchanger area (in m^2) required for this operation is _____.

Answer: **(3.75 to 3.95)**

35. Which **ONE** of the following is **CORRECT** for an ideal gas in a closed system?

(A) $\left(\dfrac{\partial U}{\partial V}\right)_S V = nR\left(\dfrac{\partial U}{\partial S}\right)_v$

(B) $-\left(\dfrac{\partial H}{\partial P}\right)_S P = nR\left(\dfrac{\partial H}{\partial S}\right)_P$

(C) $\left(\dfrac{\partial U}{\partial V}\right)_S V = nR\left(\dfrac{\partial H}{\partial S}\right)_P$

(D) $\left(\dfrac{\partial H}{\partial P}\right)_S P = nR\left(\dfrac{\partial U}{\partial S}\right)_v$

Answer: **(D)**

36. A binary distillation column is operating with a mixed feed containing 20 mol% vapour. If the feed quality is changed to 80 mol% vapour, the change in the slope of the q-line is _____.

Answer: **(3.6 to 3.9)**

37. A homogeneous reaction $(R \rightarrow P)$ occurs in a batch reactor. The conversion of the reactant R is 67% after 10 minutes and 80% after 20 minutes. The rate equation for this reaction is

(A) $-r_R = k$

(B) $-r_R = kC_R^2$

(C) $-r_R = kC_R^3$

(D) $-r_R = kC_R^{0.5}$

Answer: **(B)**

38. A vapour phase catalytic reaction $(Q + R \rightarrow S)$ follows Rideal mechanism (R and S are not adsorbed). Initially, the mixture contains only the reactants in equimolar ratio. The surface reaction step is rate controlling. With constants a and b, the initial rate of reaction $(-r_0)$ in terms of total pressure (P_T) is given by

(A) $-r_0 = \dfrac{aP_T}{1 + bP_T}$ (B) $-r_0 = \dfrac{aP_T}{1 + bP_T^2}$ (C) $-r_0 = \dfrac{aP_T^2}{1 + bP_T}$ (D) $-r_0 = \dfrac{aP_T^2}{(1 + bP_T)^2}$

Answer: **(C)**

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39. A incompressible fluid is flowing through a contraction section of length L and has a 1-D (x direction) steady state velocity distribution, $u = u_0\left(1 + \dfrac{2x}{L}\right)$. If $u_0 = 2\,m/s$ and L = 3m, the convective acceleration (in m/s^2) of the fluid at L is _____.

Answer: **(7.99 to 8.01)**

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40. Match the following:

Group - 1		Group - 2	
(P)	Tank in series model	(I)	Non-isothermal reaction
(Q)	Liquid-liquid extraction	(II)	Mixer-settler
(R)	Optimum temperature progression	(III)	PFR with axial mixing
(S)	Thiele modulus	(IV)	Solid catalyzed reaction

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

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

Answer: **(D)**

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41. Two elemental gases (*A* and *B*) are reacting to form a liquid (*C*) in a steady state process as per the reaction. $A + B \rightarrow C$. The single-pass conversion of the reaction is only 20% and hence recycle is used. The product is separated completely in pure form. The fresh feed has 49 mol% of A and B each along with 2 mol% impurities. The maximum allowable impurities in the recycle stream is 20 mol%. The amount of purge stream (in moles) per 100 moles of the fresh feed is _____.

Answer: **(9.99 to 10.01)**

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42. Carbon monoxide (CO) is burnt in presence of 200% excess pure oxygen and the flame temperature achieved is 2298 K. The inlet streams are at 25 °C. The standard heat of formation (at 25 °C) of CO and CO_2 are -110kJ mol^{-1} and -390kJ mol^{-1}, respectively. The heat capacities (in J mol^{-1} K^{-1}) of the components are

$$C_{p_{O_2}} = 25 + 14 \times 10^{-3}T$$

where,

$$C_{p_{CO_2}} = 25 + 42 \times 10^{-3}T$$

T is the temperature in K. The heat loss (in kJ) per mole of CO burnt is_____.

Answer: **(32.0 to 38.0)**

43. A cash flow of Rs. 12,000 per year is received at the end of each year (uniform periodic payment) for 7 consecutive years. The rate of interest is 9% per year compounded annually. The present worth (in Rs.) of such cash flow at time zero is _____.

Answer: **(60000 to 61000)**

44. A polymer plant with a production capacity of 10,000 tons per year has an overall yield of 70%, on mass basis (kg of product per kg of raw material). The raw material costs Rs. 50,000 per ton. A process modification is proposed to increase the overall yield to 75% with an investment of Rs. 12.5 crore. In how many years can the invested amount be recovered with the additional profit? _____.

Answer: **(2.55 to 2.70)**

45. A step change of magnitude 2 is introduced into a system having the following transfer function :
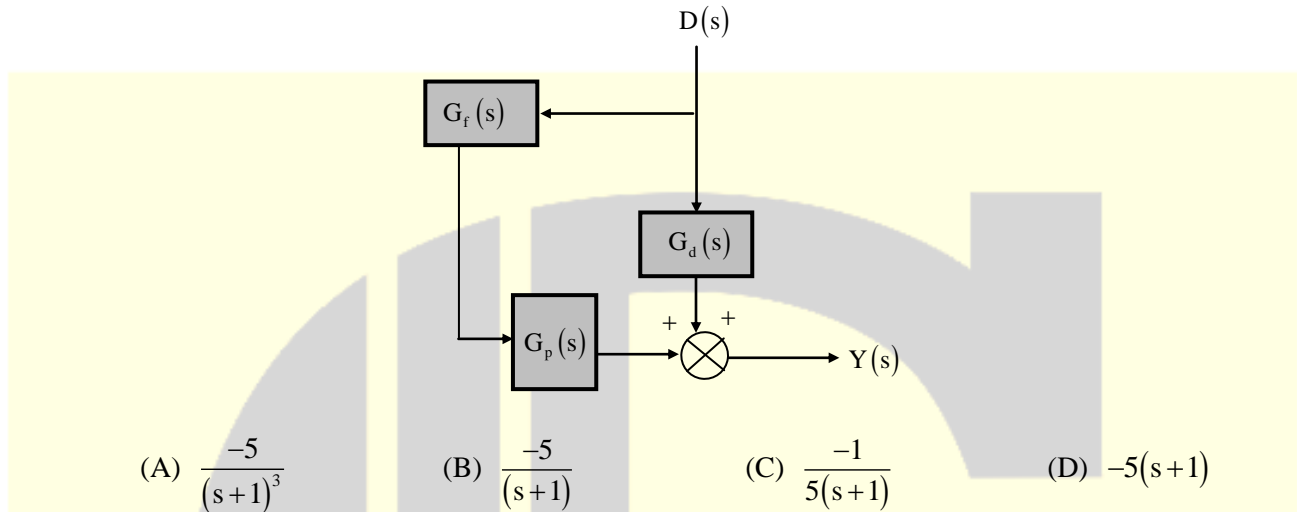
$$G(s) = \frac{2}{s^2 + 2s + 4}$$

The percent overshoot is _____.

Answer: **(16.0 to 16.8)**

46. Given below is a simplified block diagram of a feedforward control system.

The transfer function of the process is $G_P = \dfrac{5}{s+1}$ and the disturbance transfer function is

$G_d = \dfrac{1}{s^2 + 2s + 1}$. The transfer function of the **PERFECT** feed forward controller, $G_f(s)$ is

D(s)

$G_f(s)$

$G_d(s)$

$G_p(s)$

+ +

Y(s)

(A) $\dfrac{-5}{(s+1)^3}$ (B) $\dfrac{-5}{(s+1)}$ (C) $\dfrac{-1}{5(s+1)}$ (D) $-5(s+1)$

Answer: **(C)**

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47. The bottom face of a horizontal slab of thickness 6 mm is maintained at $300^{\circ}C$. The top face is exposed to a flowing gas at $30^{\circ}C$. The thermal conductivity of the slab is $1.5 \text{ W m}^{-1}\text{K}^{-1}$ and the convective heat transfer coefficient is $30 \text{ W m}^{-2}\text{K}^{-1}$. At steady state, the temperature (in $^{\circ}C$) of the top face is _____.

Answer: **(268 to 274)**

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48. In a steady incompressible flow, the velocity distribution is given by $\overline{V} = 3x\hat{I} - Py\hat{J} + 5z\hat{k}$, where, V is in m/s and x, y, and z are in m. In order to satisfy the mass conservation, the value of the constant P (in s^{-1}) is _____.

Answer: **(7.99 to 8.01)**

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49. Match the following:

	Group I		Group II
(P)	Turbulence	(I)	Reciprocating pump
(Q)	NPSH	(II)	Packed bed

(R)	Ergun equation	(III)	Fluctuating velocity
(S)	Rotameter	(IV)	Impeller
(T)	Power number	(V)	Vena contracta

(A) P-III, R-II, T-IV
(B) Q-V, R-II, S-III
(C) P-III, R-IV, T-II
(D) Q-III, S-V, T-IV

Answer: **(A)**

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50. In a steady and incompressible flow of a fluid (density = 1.25 kg m^{-3}), the difference between stagnation and static pressures at the same location in the flow is 30 mm of mercury (density = 13600 kg m^{-3}). Considering gravitational acceleration as 10 m s^{-2}, the fluid speed (in m s^{-1}) is _____.

Answer: **(79 to 82)**

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51. Consider a binary liquid mixture at equilibrium with its vapour at 25°C. Antoine equation for this system is given as $\log_{10} p_1^{sat} = A - \dfrac{B}{t + C}$ where t is in °C and p in Torr.

The Antoine constants (*A*, *B*, and *C*) for the system are given in the following table.

Component	A	B	C
1	7.0	1210	230
2	6.5	1206	223

The vapour phase is assumed to be ideal and the activity coefficients $\left(\gamma_i\right)$ for the non-ideal liquid phase are given by

$$\ln\left(\gamma_1\right) = x_2^2 \left[2 - 0.6x_1\right]$$
$$\ln\left(\gamma_2\right) = x_1^2 \left[1.7 + 0.6x_2\right]$$

If the mole fraction of component 1 in liquid phase (*x₁*) is 0.11, then the mole fraction of component 1 in vapour phase (*y₁*) is _____

**Answer:** **(0.65 to 0.75)**

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52. A process with transfer function, $G_P = \dfrac{2}{s-1}$ is to be controlled by a feedback proportional controller with a gain K_c. If the transfer functions of all other elements in the control loop are unity, then which **ONE** of the following conditions produces a stable closed loop response?

(A) $K_C = 0.25$

(B) $0 < K_C < 0.25$

(C) $0.25 < K_C < 0.5$

(D) $K_C > 0.5$

Answer: (D)

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53. Consider the following block diagram for a closed-loop feedback control system
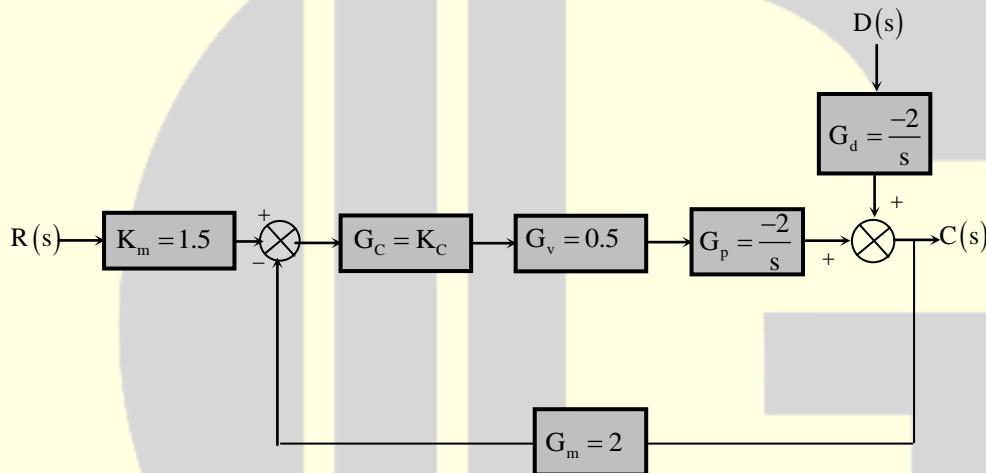
A proportional controller is being used with $K_C = -4$. If a step change in disturbance of magnitude 2 affects the system, then the value of the offset is _____.

Answer: (0.49 to 0.51)

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54. Determine the correctness or otherwise of the following Assertion [a] and Reason [r].

Assertion: Significant combustion of coke takes place only if it is heated at higher temperature in presence of air.

Reason: $C + O_2 \rightarrow CO_2$ is an exothermic reaction.

(A)   Both [a] and [r] are true and [r] is the correct reason for [a]

(B)   Both [a] and [r] are true but [r] is not the correct reason for [a]

(C)   [a] is correct but [r] is false

(D)   Both [a] and [r] are false

Answer: (B)

55.   Match the raw materials of Groups 1 and 2 with the final products of Group 3

Group 1	Group 2	Group 3
P_1: Ethylene	Q_1: Ammonia	R_1: Synthetic fibre
P_2: Propylene	Q_2: 1-Butene	R_2: Nylon 66
P_3: Adipic acid	Q_3: Ethylene glycol	R_3: LLDPE
P_4: Terephthalic acid	Q_4: Hexamethylene diamine	R_4: Acrylonitrile

(A) $P_1 + Q_2 \rightarrow R_3; P_2 + Q_1 \rightarrow R_4; P_3 + Q_4 \rightarrow R_2; P_4 + Q_3 \rightarrow R_1$

(B) $P_1 + Q_1 \rightarrow R_3; P_2 + Q_3 \rightarrow R_4; P_3 + Q_4 \rightarrow R_4; P_4 + Q_2 \rightarrow R_2$

(C) $P_1 + Q_2 \rightarrow R_2; P_2 + Q_3 \rightarrow R_1; P_3 + Q_4 \rightarrow R_3; P_4 + Q_1 \rightarrow R_4$

(D) $P_1 + Q_1 \rightarrow R_4; P_2 + Q_2 \rightarrow R_3; P_3 + Q_4 \rightarrow R_2; P_4 + Q_3 \rightarrow R_1$

Answer: (A)

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