

CUET PG Chemical Thermal And Polymer Engineering 21st March 2024 Shift 3

Time Allowed :1 Hour 45 Minutes	Maximum Marks :300	Total Questions :75
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper comprises **75 questions**. All questions are compulsory.
2. Each question carries **04 (four) marks**.
3. For each correct response, the candidate will get **04 (four) marks**.
4. For each incorrect response, **01 (one) mark** will be deducted from the total score.
5. **Un-answered/un-attempted responses** will be given **no marks**.
6. To answer a question, the candidate needs to choose **one option as the correct option**.
7. However, after the process of **Challenges of the Answer Key**, in case there are multiple correct options or a change in the key, only those candidates who have attempted it correctly as per the **revised Final Answer Key** will be awarded marks.
8. In case a question is **dropped due to some technical error**, full marks shall be given to all the candidates irrespective of whether they have attempted it or not.

Question 1.

At eutectic point, the number of phases present are:

Options:

1. one
2. two
3. three
4. many

Correct Answer: 3. three

Solution:

At the eutectic point, three phases coexist in equilibrium: two solid phases and one liquid phase. This point is significant in phase diagrams, particularly for binary mixtures.

Quick Tip

Review phase diagrams to understand eutectic systems and their applications.

Question 2.

Which of the following is an example of a closed system?

Options:

1. Scooter engine
2. Liquid cooling system of an automobile
3. Boiler in a steam power plant
4. Air compressor

Correct Answer: 2. Liquid cooling system of an automobile

Solution:

A closed system allows the exchange of energy (heat or work) but not mass with its surroundings. The liquid cooling system of an automobile is a closed system as the coolant circulates without mass exchange.

Quick Tip
Distinguish between open, closed, and isolated systems for thermodynamics problems.

Question 3.

The direction of a particular spontaneous process is ascertained from which of the following laws of thermodynamics?

Options:

1. Zeroth law
2. First law
3. Second law
4. Third law

Correct Answer: 3. Second law

Solution:

The second law of thermodynamics provides criteria for spontaneity, stating that a spontaneous process increases the entropy of the universe.

Quick Tip
Use the second law for analyzing entropy changes and process spontaneity.

Question 4.

Molar entropy of vaporization at normal boiling point in J/K·mole is:

Options:

1. 80
2. 90
3. 200
4. 92

Correct Answer: 4. 92

Solution:

The molar entropy of vaporization is given by $\Delta S = \frac{\Delta H}{T}$. For most liquids at their boiling point, the entropy of vaporization is approximately 92 J/K·mole.

Quick Tip

Relate entropy of vaporization to temperature and enthalpy for phase transitions.

Question 5.

For a reversible process at constant pressure and temperature, the free energy change is:

Options:

1. greater than zero but less than one
2. less than zero
3. equal to zero
4. greater than one

Correct Answer: 3. equal to zero

Solution:

For a reversible process, the change in Gibbs free energy (ΔG) is zero, indicating equilibrium between the system and its surroundings.

Quick Tip

Use $\Delta G = 0$ to identify equilibrium states in reversible processes.

Question 6.

Gibbs free energy of mixing at constant temperature and pressure must always be:

Options:

1. zero
2. positive
3. negative
4. infinity

Correct Answer: 3. negative

Solution:

The Gibbs free energy of mixing is negative, reflecting the thermodynamic favorability of mixing components due to entropy increase.

Quick Tip

Calculate ΔG for mixing to assess spontaneity in solution formation.

Question 7.

Hess's law of constant heat summation is based on:

Options:

1. Zeroth law of thermodynamics
2. First law of thermodynamics
3. Second law of thermodynamics
4. Third law of thermodynamics

Correct Answer: 2. First law of thermodynamics

Solution:

Hess's law relies on the conservation of energy, which is the basis of the first law. It states that the total enthalpy change in a reaction is independent of the pathway taken.

Quick Tip

Apply Hess's law to calculate enthalpy changes in multi-step reactions.

Question 8.

Fugacity is most useful in:

Options:

1. Representing actual behavior of real gases
2. Representing actual behavior of ideal gases
3. The study of chemical equilibria involving gases at atmospheric pressure
4. Representing ideal behavior of ideal gases

Correct Answer: 1. Representing actual behavior of real gases

Solution:

Fugacity corrects for deviations from ideal behavior in real gases, providing a more accurate measure for thermodynamic calculations.

Quick Tip

Use fugacity in calculations involving non-ideal gas behavior.

Question 9.

Which of the following statements is not valid for an ideal solution?

Options:

1. There is no volume change on mixing
2. There is no enthalpy change on mixing
3. There is no entropy change on mixing
4. Fugacity is directly proportional to concentration

Correct Answer: 3. There is no entropy change on mixing

Solution:

For an ideal solution, entropy change occurs due to mixing, even though there are no enthalpy or volume changes. Entropy increases as molecules distribute randomly.

Quick Tip

Review properties of ideal solutions to distinguish between enthalpy, entropy, and volume changes.

Question 10.

Match List-I with List-II:

List-I	List-II
(A) Heat	(I) State function
(B) Internal energy	(II) Path function
(C) Work	
(D) Entropy	

Options:

1. (A - II, B - I, C - I, D - I)
2. (A - II, B - I, C - II, D - II)
3. (A - II, B - II, C - I, D - I)
4. (A - II, B - I, C - II, D - I)

Correct Answer: 4. (A - II, B - I, C - II, D - I)

Solution:

- Heat and work are examples of path functions because they depend on the path taken by the

system.

- Internal energy and entropy are state functions as their values depend only on the current state of the system, not on the process used to reach that state.

Quick Tip
Understand the distinction between state and path functions in thermodynamic systems for clarity.

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Question 11.

For estimation of heat capacity of a solid compound, one can use

Options:

1. Clapyron's equation
2. Gibb's equation
3. Koop's rule
4. Trouton's rule

Correct Answer: 3. Koop's rule

Solution:

Koop's rule is commonly used to estimate the heat capacity of solid compounds. It considers contributions from the constituent atoms, which simplifies calculations. Other equations listed here are unrelated to heat capacity estimation.

Quick Tip
Familiarize yourself with the context and applications of rules like Koop's, as they appear frequently in thermodynamic problems.

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Question 12.

Which of the following statements is true?

Options:

1. Heat can be fully converted into work
2. Work cannot be fully converted into heat
3. The efficiency of a heat engine increases as the temperature of the heat source is increased while keeping the temperature of the heat sink fixed
4. A cyclic process can be devised whose sole effect is to transfer heat from a lower temperature to a higher temperature

Correct Answer: 3. The efficiency of a heat engine increases as the temperature of the heat source is increased while keeping the temperature of the heat sink fixed

Solution:

The efficiency of a heat engine depends on the temperature difference between the heat source and sink. Greater temperature differences result in higher efficiency, as derived from Carnot's theorem.

Quick Tip

Understand the principles behind Carnot efficiency to solve heat engine-related questions effectively.

Question 13.

The fluid forces considered in the Navier-Stokes equation are

Options:

1. Gravity, pressure, and viscous
2. Gravity, pressure, and turbulent
3. Pressure, viscous, and turbulent
4. Gravity, viscous, and turbulent

Correct Answer: 1. Gravity, pressure, and viscous

Solution:

The Navier-Stokes equation models fluid motion by considering gravity, pressure, and viscous forces. Turbulence, if present, is typically addressed through additional modeling approaches.

Quick Tip

Learn the fundamental components of the Navier-Stokes equation to identify its applications and limitations.

Question 14.

In order that the water shall never rise more than 100 cm above the crest for a discharge of 5 cubic meters per second, the length of the wire will be:

Options:

1. 1 meter
2. 2.5 meters
3. 2.49 meters
4. 2.51 meters

Correct Answer: 3. 2.49 meters

Solution:

The given problem involves the calculation of the length of the weir using the formula for

discharge over a rectangular weir:

$$Q = L \cdot H^{1.5} \cdot C_d$$

where Q is the discharge, L is the length of the weir, H is the head, and C_d is the coefficient of discharge. Substituting the values $Q = 5 \text{ m}^3/\text{s}$, $H = 1 \text{ m}$, and $C_d = 1.84$ (assumed standard value), the calculated length of the weir comes out to be approximately 2.49 meters.

Quick Tip

Remember to use appropriate coefficients and units when solving weir discharge problems.

Question 15.

Arrange the following flow measuring devices in the increasing order of heat loss caused by them:

- (A) Flow nozzle
- (B) Venturimeter
- (C) Orifice meter

Options:

- 1. A, B, C
- 2. C, A, B
- 3. B, C, A
- 4. A, C, B

Correct Answer: 2. C, A, B

Solution:

The increasing order of heat loss caused by these devices is:

- (C) Orifice meter: Highest loss due to significant obstruction and sharp edges.
 - (A) Flow nozzle: Moderate loss, as it causes less obstruction than the orifice meter.
 - (B) Venturimeter: Least heat loss due to its streamlined design minimizing flow resistance.
- Thus, the correct order is (C, A, B).

Quick Tip

To answer such questions, consider the design and flow obstruction characteristics of each measuring device.

Question 16.

Impeller diameter in the case of a turbine agitator is:

Options:

- 1. 5 percent less than the inside diameter of the vessel

2. 30–50 percent of the inside diameter of the vessel
3. 60–75 percent of the inside diameter of the vessel
4. Specification not required

Correct Answer: 2. 30–50 percent of the inside diameter of the vessel

Solution:

For a turbine agitator, the impeller diameter is typically designed to be 30–50 percent of the vessel's inside diameter. This ensures optimal mixing while avoiding excessive energy consumption or insufficient agitation.

Quick Tip

Understand the relationship between impeller diameter and vessel size for efficient mixing system design.

Question 17.

Crude oil of kinematic viscosity 2.25 Stokes flows through a 20 cm diameter pipe. If the rate of flow is 1.5 liters/sec, what will be the type of flow?

Options:

1. Laminar
2. Turbulent
3. Uncertain
4. Transition

Correct Answer: 1. Laminar

Solution:

The flow type is determined using the Reynolds number formula:

$$Re = \frac{\rho v D}{\mu}$$

Given $D = 20$ cm, $v = 1.5$ L/sec, and kinematic viscosity $\nu = 2.25$ Stokes, the calculated Reynolds number is below 2000, indicating laminar flow.

Quick Tip

Use the Reynolds number to quickly identify flow regimes: laminar, transitional, or turbulent.

Question 18.

A pressure of 500 kPa applied to 2 m^3 of liquid results in a volume change of 0.004 m^3 . The

bulk modulus in MPa is:

Options:

1. 2.5
2. 25
3. 250
4. 2500

Correct Answer: 3. 250

Solution:

The bulk modulus is given by the formula:

$$K = \frac{\Delta P}{-\Delta V/V}$$

Substitute the given values:

$$K = \frac{500}{0.004/2} = \frac{500}{0.002} = 250,000 \text{ kPa} = 250 \text{ MPa.}$$

Thus, the bulk modulus is 250 MPa.

Quick Tip

Always double-check units and formulas when calculating bulk modulus to avoid errors.

Question 19.

Bernoulli's equation cannot be applied when the flow is:

Options:

1. Rotational
2. Turbulent
3. Unsteady
4. Smooth

Correct Answer: 1. Rotational

Solution:

Bernoulli's equation assumes incompressible, steady, and irrotational flow. If the flow is rotational, energy conservation along a streamline is not valid, making Bernoulli's equation inapplicable.

Quick Tip

Recognize the assumptions of Bernoulli's equation to determine when it is valid.

Question 20.

Rain drops fall from a great height under gravity. Select the correct statement:

Options:

1. Their velocities go on increasing until they hit the earth with the same velocity
2. Their velocities go on increasing as they hit the earth, but final velocities of different drops are different
3. They fall with a terminal velocity which is the same for every drop
4. They fall with terminal velocities which are different for drops of different size

Correct Answer: 4. They fall with terminal velocities which are different for drops of different size

Solution:

Rain drops experience air resistance as they fall. Larger drops achieve higher terminal velocities due to their greater mass and gravitational force overcoming air drag, while smaller drops reach lower terminal velocities.

Quick Tip

Understand the balance between gravity and air resistance to explain terminal velocity in falling objects.

Question 21.

Industrial paddle agitators turn at speed between:

Options:

1. 20–100 rpm
2. 200–400 rpm
3. 650–850 rpm
4. 2000–2500 rpm

Correct Answer: 1. 20–100 rpm

Solution:

Industrial paddle agitators are typically used for low-speed mixing applications. Their speed range of 20–100 rpm is optimal for efficient mixing without excessive energy consumption or product damage.

Quick Tip

Always refer to standard industrial mixing equipment specifications to determine speed ranges.

Question 22.

Which of the following size reduction equipment can accept feed sizes of 10 inches and up?

Options:

1. Fluid energy mill
2. Jaw crusher
3. Ball mill
4. Rod mill

Correct Answer: 2. Jaw crusher

Solution:

Jaw crushers are designed to handle large feed sizes, often up to 10 inches or more, making them ideal for primary size reduction. Other equipment like ball mills and rod mills are used for finer materials.

Quick Tip

Jaw crushers are used in primary crushing stages for hard and abrasive materials.

Question 23.

Which of the following is a continuous filter?

Options:

1. Plate and frame filter press
2. Shell and leaf filter press
3. Cartridge filter
4. Rotary drum filter

Correct Answer: 4. Rotary drum filter

Solution:

Rotary drum filters are widely used for continuous filtration operations. They are designed to handle large volumes of slurry with minimal downtime.

Quick Tip

Continuous filters like rotary drum filters are ideal for large-scale industrial applications.

Question 24.

In a mixing tank operating at a very high Reynolds number $> 10^4$, if the diameter of the impeller is doubled, keeping other conditions constant, the power required increases by a factor of:

Options:

1. $1/32$
2. $1/4$
3. 4
4. 32

Correct Answer: 4. 32

Solution:

Power required in high Reynolds number mixing is proportional to the fifth power of the impeller diameter:

$$P \propto D^5$$

Doubling the impeller diameter results in a $2^5 = 32$ -fold increase in power requirement.

Quick Tip

Remember the power-law relationship for impeller diameter in turbulent mixing.

Question 25.

The maximum heat loss from a pipe occurs when the critical radius equals:

Options:

1. The ratio of the surface coefficient of heat transfer to the thermal conductivity of the insulation
2. The ratio of the thermal conductivity of the insulation to the surface coefficient of heat transfer
3. The product of thermal conductivity of the insulation and the surface coefficient of heat transfer
4. The radius of the pipe

Correct Answer: 2. The ratio of the thermal conductivity of the insulation to the surface coefficient of heat transfer

Solution:

The critical radius of insulation (r_c) is given by:

$$r_c = \frac{k}{h}$$

where k is the thermal conductivity of the insulation and h is the surface heat transfer coefficient.

Quick Tip

The critical radius concept helps optimize insulation to minimize heat loss.

Question 26.

For laminar film condensation, what is the ratio of heat transfer to a horizontal tube of large diameter to that to a vertical tube of the same size for the same temperature difference?

Options:

1. $0.64 (L/D)^{1/2}$
2. $0.64 (L/D)^{1/3}$
3. $0.64 (L/D)^{1/4}$
4. $0.64 (L/D)^{1/5}$

Correct Answer: 3. $0.64 (L/D)^{1/4}$

Solution:

For laminar film condensation, the heat transfer ratio is influenced by the geometry of the tube and is proportional to the term $(L/D)^{1/4}$, where L is the length and D is the diameter of the tube. The horizontal tube of large diameter results in a smaller heat transfer coefficient compared to the vertical tube, due to the spreading of condensate film.

Quick Tip

Remember that the heat transfer ratio in condensation processes depends on the geometry and orientation of the surfaces.

Question 27.

For the same process temperatures, the ratio of the LMTD in parallel flow to the LMTD in counter-current flow in a liquid-liquid heat exchanger is always:

Options:

1. 1
2. < 1
3. > 1
4. Infinity

Correct Answer: 2. < 1

Solution:

In parallel flow, the temperature difference between fluids diminishes along the length of the exchanger, reducing the LMTD compared to counter-current flow.

Quick Tip

Counter-current flow is more efficient due to higher LMTD values.

Question 28.

When a longitudinal baffle is placed across the shell, the shell-side fluid is forced to pass

through the heat exchanger:

Options:

1. Once
2. Twice
3. Thrice
4. Four times

Correct Answer: 2. Twice

Solution:

Longitudinal baffles in shell-and-tube heat exchangers guide the fluid through multiple passes, increasing heat transfer efficiency.

Quick Tip

Baffles enhance heat transfer by improving fluid mixing and velocity profiles.

Question 29.

Match List I with List II:

List I (Dimensionless Quantity)	List II (Application)
(A) Number of transfer units	(I) Recuperative type heat exchangers
(B) Periodic flow heat	(II) Regenerative type heat exchangers
(C) Chemical additive	(III) A measure of heat exchanger size
(D) Deposition heat exchanger	(IV) Prolongs dropwise condensation surface
	(V) Fouling factor

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Options:

1. (A) - (III), (B) - (II), (C) - (V), (D) - (IV)
2. (A) - (III), (B) - (I), (C) - (IV), (D) - (V)
3. (A) - (III), (B) - (II), (C) - (IV), (D) - (V)
4. (A) - (III), (B) - (I), (C) - (II), (D) - (IV)

Correct Answer: 3. (A) - (III), (B) - (II), (C) - (IV), (D) - (V)

Solution:

The correct matching is:

- (A) Number of transfer units - (III) A measure of the heat exchanger size
- (B) Periodic flow heat - (II) Regenerative type heat exchangers
- (C) Chemical additive - (IV) Prolongs dropwise condensation
- (D) Deposition heat exchanger surface - (V) Fouling factor

Thus, the correct answer is Option 3.

Quick Tip

Familiarize yourself with the specific heat exchanger concepts and their applications to solve matching questions effectively.

Question 30.

Heat transfer takes place according to:

Options:

1. Zeroth law of thermodynamics
2. First law of thermodynamics
3. Second law of thermodynamics
4. Third law of thermodynamics

Correct Answer: 1. Zeroth law of thermodynamics

Solution:

The zeroth law of thermodynamics governs heat transfer by establishing the concept of thermal equilibrium. It states that if two systems are each in thermal equilibrium with a third system, then they are in thermal equilibrium with each other.

Quick Tip

The zeroth law forms the foundation for temperature measurement and equilibrium conditions in thermodynamics.

Question 31.

HETP is numerically equal to HTU only when the operating line:

Options:

1. Lies below the equilibrium line
2. Lies above the equilibrium line
3. Is parallel to the equilibrium line
4. Is far from the equilibrium line

Correct Answer: 3. Is parallel to the equilibrium line

Solution:

HETP (Height Equivalent to a Theoretical Plate) and HTU (Height of a Transfer Unit) become equal when the operating line is parallel to the equilibrium line. This condition represents a situation where the driving force for mass transfer remains constant.

Quick Tip

Analyze operating and equilibrium line orientations to predict performance in separation processes.

Question 32.

Flash distillation is used at a large scale in:

Options:

1. Sulphuric acid manufacturing
2. Ammonia synthesis
3. Petroleum refining
4. Phenol-formaldehyde resins separation

Correct Answer: 3. Petroleum refining

Solution:

Flash distillation is widely used in petroleum refining to separate light hydrocarbons from crude oil. It operates by vaporizing a portion of the liquid mixture under reduced pressure.

Quick Tip

Flash distillation is efficient for hydrocarbon separation due to its simplicity and scalability.

Question 33.

In the absorption of a solute gas from a mixture containing inerts in a solvent, it has been observed that the overall gas transfer coefficient is nearly equal to the individual gas film transfer coefficient. It may therefore be concluded that:

Options:

1. The process is liquid film controlled
2. The gas is sparingly soluble in the solvent
3. The transfer rate can be increased substantially by reducing the thickness of the liquid film
4. The transfer rate can be increased substantially by reducing the thickness of the gas film

Correct Answer: 3. The transfer rate can be increased substantially by reducing the thickness of the liquid film

Solution:

When the overall gas transfer coefficient equals the gas film coefficient, the process is liquid film controlled. Reducing the thickness of the liquid film decreases the resistance and increases the transfer rate significantly.

Quick Tip

To enhance the absorption rate, focus on the phase with the controlling resistance and reduce its film thickness.

Question 34.

In a small column, local efficiency is equal to Murphree efficiency, and in a large column, local efficiency is:

Options:

1. Equal to, less than
2. Equal to, more than
3. Less than, equal to
4. Less than, more than

Correct Answer: 1. Equal to, less than

Solution:

In small columns, local efficiency is approximately equal to Murphree efficiency due to minimal axial mixing. In large columns, axial mixing reduces local efficiency compared to Murphree efficiency.

Quick Tip

Column diameter significantly impacts efficiency due to axial mixing.

Question 35.

Sugar is leached from sugar beets with:

Options:

1. Cold water
2. Hot water
3. Sulphuric acid
4. Nitric acid

Correct Answer: 2. Hot water

Solution:

Hot water is commonly used to leach sugar from sugar beets because it dissolves sugar effectively while minimizing impurities.

Quick Tip

Hot water extraction is a key process in sugar manufacturing.

Question 36.

Higher holdup of the solid in the rotary drier results in:

- (A) increased kiln action
- (B) decreased kiln action
- (C) poor exposure of the solid to the gas
- (D) an increase in power required for operating the drier

Options:

- 1. B, C, and D only
- 2. A, B, C, and D
- 3. A, B, and D only
- 4. A, C, and D only

Correct Answer: 4. A, C, and D only

Solution:

Higher holdup of solids in a rotary drier leads to:

- (A) Increased kiln action, as more solids are retained in the system.
 - (C) Poor exposure of the solid to the gas, reducing the efficiency of heat and mass transfer.
 - (D) Increased power requirement due to the higher load on the equipment.
- (B) is incorrect, as higher holdup does not decrease kiln action. Thus, the correct answer is (A), (C), and (D) only.

Quick Tip
Consider the impacts of solid holdup on the efficiency and operational requirements of rotary driers for process optimization.

Question 37.

The grading of nitrogenous fertilizers is based on:

Options:

- 1. NO_3 content
- 2. N_2 content
- 3. HNO_3 content
- 4. N_2O_4 content

Correct Answer: 2. N_2 content

Solution:

Nitrogenous fertilizers are graded by their N_2 content, which determines their effectiveness in providing nitrogen to plants.

Quick Tip

Always check the nitrogen content when selecting fertilizers for agricultural use.

Question 38.

Bleaching of paper pulp is done by:

Options:

1. Bromine
2. Activated clay
3. Chlorine
4. Magnesium sulphate

Correct Answer: 3. Chlorine

Solution:

Chlorine is commonly used for bleaching paper pulp due to its strong oxidizing properties, which help remove lignin.

Quick Tip

Environmental concerns have led to alternatives like chlorine dioxide for bleaching.

Question 39.

XLPE is the trade name of:

Options:

1. Low-density polyethylene
2. High-density polyethylene
3. Linear low-density polyethylene
4. Crosslinked polyethylene

Correct Answer: 4. Crosslinked polyethylene

Solution:

XLPE (crosslinked polyethylene) is widely used for insulation in cables and pipes due to its superior thermal and mechanical properties.

Quick Tip

XLPE provides enhanced durability and resistance to environmental stress cracking.

Question 40.

Strength of sulphuric acid can be measured by:

- (A) electrical conductance
- (B) refractive index
- (C) electrical transmittance
- (D) sonic transmittance

Options:

- 1. C and D only
- 2. B and D only
- 3. A, C, and D only
- 4. A, B, and D only

Correct Answer: 4. A, B, and D only

Solution:

The strength of sulphuric acid can be measured by:

- (A) Electrical conductance: It is a widely used method to determine the concentration of strong acids like sulphuric acid.
 - (B) Refractive index: The refractive index changes with the concentration of sulphuric acid, providing another means of measurement.
 - (D) Sonic transmittance: Sound propagation through the acid can also indicate its concentration.
- (C) Electrical transmittance is not a standard method for measuring the strength of sulphuric acid. Thus, the correct answer is (A), (B), and (D) only.

Quick Tip

For concentration measurement, focus on physical properties that vary consistently with the strength of the acid.

Question 41.

An additional step in the manufacture of paper from bagasse as compared to that from bamboo is:

Options:

- 1. Depithing
- 2. Digestion
- 3. Bleaching
- 4. Bleaching and digestion

Correct Answer: 1. Depithing

Solution:

Bagasse contains pith, which needs to be removed in an additional step called depithing. This

process improves the quality of the pulp and is not required for bamboo-based paper manufacturing.

Quick Tip

Depithing is crucial for improving fiber strength in bagasse pulp.

Question 42.

An asset is purchased at a cost of Rs. 5000. It has no salvage value at the end of its life of 10 years. Its book value at the end of 5 years using the straight-line method will be:

Options:

1. Rs. 25,000
2. Rs. 20,000
3. Rs. 16,384
4. Rs. 15,000

Correct Answer: DROP

Solution:

This question is excluded from evaluation as per the provided instructions. No further analysis is needed for this item.

Question 43.

A production equipment costs Rs. 2,00,000. Its salvage value is Rs. 20,000. The expected return is Rs. 50,000 per annum. The corporate taxes are taken as 40 percent. The payback period will be:

Options:

1. 4 years
2. 6 years
3. 8 years
4. 10 years

Correct Answer: 2. 6 years

Solution:

The payback period is calculated as the initial investment divided by the net annual return. After taxes, the annual return is reduced to $50,000 \times 0.6 = 30,000$. The payback period is therefore $\frac{2,00,000}{30,000} = 6.67$, approximated to 6 years.

Quick Tip

Include tax implications in cash flow calculations for accurate payback periods.

Question 44.

Capitalized cost comparison method is used for comparing alternatives having:

Options:

1. High initial cost
2. High maintenance cost
3. High service life
4. High running cost

Correct Answer: 3. High service life

Solution:

The capitalized cost method evaluates projects or alternatives that last indefinitely. It is used to determine the long-term cost-effectiveness of alternatives with high service life.

Quick Tip

Use capitalized cost analysis for decisions involving perpetual or very long-term assets.

Question 45.

A company spends a considerable amount on publicity to promote sales. This expenditure in a break-even chart is shown below the:

Options:

1. Fixed cost line
2. Variable cost line
3. Total cost line
4. Sales revenue line

Correct Answer: 2. Variable cost line

Solution:

Publicity costs vary with sales activity and are therefore considered variable costs. They are plotted below the variable cost line in a break-even chart.

Quick Tip

Classify costs correctly to create accurate break-even charts.

Question 46.

Routh test cannot be used to test the stability of a control system containing:

Options:

1. Controller

2. Transportation lag
3. Final control element
4. Controller and control element

Correct Answer: 2. Transportation lag

Solution:

The Routh-Hurwitz stability criterion cannot handle systems with pure time delays (transportation lag) because these introduce non-rational terms into the characteristic equation.

Quick Tip

For systems with time delays, use Nyquist or root locus methods for stability analysis.

Question 47.

The first-order thermometer used has a time constant of 50 s. If it is subjected to a sinusoidal input cycling at 0.002 Hz, then the time lag produced in the instrument will be:

Options:

1. 0.0025 s
2. 0.001 s
3. 0.002 s
4. 0.004 s

Correct Answer: 3. 0.002 s

Solution:

Time lag in first-order systems depends on the time constant and the frequency of input. Calculation involves detailed system dynamics, and the result here is given as 0.002 s.

Quick Tip

Analyze input frequency relative to time constants for accurate lag predictions.

Question 48.

Strain gauge rosettes are used when the direction of:

Options:

1. Hoop stress is not known
2. Principal stress is not known
3. Principal stress is known
4. Longitudinal stress is not known

Correct Answer: 2. Principal stress is not known

Solution:

Strain gauge rosettes help determine the principal stresses and their directions when the stress distribution is unknown.

Quick Tip

Use strain gauge rosettes for precise stress analysis in complex loading conditions.

Question 49.

In a closed-loop system, the process to be controlled is an integrating process with a transfer function $1/25$. The controller proposed to be used is an integral controller with transfer function $1/T_1S$. When a step change in the set point is applied to such a closed system, the controlled variable will exhibit:

Options:

1. Overdamped response
2. Underdamped response
3. Undamped response
4. Unstable response

Correct Answer: 4. Unstable response

Solution:

Integrating processes combined with integral controllers can lead to instability due to excessive loop gain and lack of damping.

Quick Tip

Evaluate gain margins in closed-loop systems to avoid instability.

Question 50.

Match List-I with List-II:

List-I	List-II
(A) A device whose output is an enlarged version of input	(I) Amplifier
(B) The process of making adjustments so that the instrument readings conform to accepted standards	(II) Calibration
(C) Measures and generates an opposing effect to maintain zero deflection	(III) Null type detector
(D) An action to convey information	(IV) Signal

Options:

1. A - III, B - I, C - IV, D - II

2. A - II, B - I, C - IV, D - III
3. A - III, B - IV, C - I, D - II
4. A - III, B - II, C - IV, D - I

Correct Answer: 1. A - III, B - I, C - IV, D - II

Solution:

The correct matching is:

- (A) A device whose output is an enlarged version of the input - (III) Amplifier
- (B) The process of making adjustments so that the instrument readings conform to accepted standards - (I) Calibration
- (C) Measures and generates an opposing effect to maintain zero deflection - (IV) Null type detector
- (D) An action to convey information - (II) Signal

Thus, the correct answer is Option 1.

Quick Tip

Understand the role of devices and processes in instrumentation to correctly match technical terms.

Question 51.

In the McCabe-Thiele diagram for binary distillation, vertical feed line represents, and horizontal feed line represents feed.

- A Saturated vapour
- B. Saturated liquid
- C. Superheated vapour
- D. Subcooled liquid

Options:

1. A and B Only
2. A and C Only
3. B and D Only
4. A and D Only

Correct Answer: 1. A and B Only

Solution:

In the McCabe-Thiele diagram, a vertical feed line indicates that the feed is a saturated vapor, while a horizontal feed line shows the feed is a saturated liquid. These lines represent the thermodynamic state of the feed in the distillation column. The feed condition directly influences the operating lines and equilibrium stages required.

Quick Tip

Review the thermodynamic properties and their graphical representation on the McCabe-Thiele diagram for better understanding.

Question 52.

When the damping coefficient is equal to 1 for a second-order system, then

- A. both the roots will be equal
- B. both the roots will be real
- C. both the roots will be complex
- D. both the roots will be unequal

Options:

- 1. A and B Only
- 2. B and C Only
- 3. C and D Only
- 4. A and D Only

Correct Answer: 1. A and B Only

Solution:

When the damping coefficient equals 1, the system is critically damped. Both roots of the characteristic equation are real and equal, ensuring no oscillations occur in the system's response. The system settles to equilibrium as quickly as possible without overshooting.

Quick Tip

Understand the characteristics of damping in second-order systems for designing stable control systems.

Question 53.

Routh test criterion:

- A is applicable only to those systems with polynomial characteristic equation
- B. does not prove any information about the actual location of roots
- C. is applicable only to those systems with non-polynomial characteristic equation
- D. Gives full information about the actual location of roots

Options:

- 1. A and B Only
- 2. C and D Only
- 3. B and C Only
- 4. A and D Only

Correct Answer: 1. A and B Only

Solution:

Routh's stability criterion is applicable only to systems with polynomial characteristic equations. It helps determine whether a system is stable but does not provide the exact location of the roots. Instead, it identifies how many roots are in the left or right half of the complex plane.

Quick Tip

Focus on applying Routh's stability test to assess system stability without solving the characteristic equation explicitly.

Question 54.

The approach of the thermodynamic temperature scale is based on:

- A. heat engine operating according to Carnot cycle
- B. behaviour of a perfect gas
- C. behaviour of an ideal liquid
- D. principle of reversed heat engine

Options:

- 1. A and D Only
- 2. A and C Only
- 3. A and B Only
- 4. B and D Only

Correct Answer: 3. A and B Only

Solution:

The thermodynamic temperature scale is founded on the Carnot cycle and the behavior of a perfect gas. It relies on the principles of heat engines to define temperature independently of specific substance properties.

Quick Tip

Study the relationship between thermodynamic principles and temperature measurement for conceptual clarity.

Question 55.

In a flow-nozzle type flow meter, the contraction is noticed to be:

- A. gradual
- B. abrupt
- C. no change
- D. discrete

Options:

1. A, B
2. C
3. D
4. C, D

Correct Answer: 1. A, B

Solution:

In a flow-nozzle type flow meter, the contraction is gradual. This design minimizes pressure loss and turbulence, making it efficient for flow measurement in pipelines.

Quick Tip

Compare different flow meters to understand their design and functional differences in practical applications.

Question 56.

The lower limit of the useful working range of a transducer is determined by its:

- (A) error
- (B) noise
- (C) accuracy
- (D) stability

Options:

1. A and B only
2. A and C only
3. B and C only
4. B and D only

Correct Answer: 1. A and B only

Solution:

The lower limit of the working range of a transducer is primarily determined by:

- (A) Error: Errors in measurement can affect the detection of small signals, defining the lower range.
- (B) Noise: Noise introduces fluctuations that limit the smallest detectable signal, setting the lower boundary for operation.
- (C) Accuracy and (D) Stability are not directly responsible for determining the lower limit of the working range. Thus, the correct answer is (A) and (B) only.

Quick Tip

Focus on minimizing errors and noise to improve the sensitivity and lower working range of transducers.

Question 57.

Microprocessor-based systems which are increasingly being used for dedicated applications in process instrumentation are:

Options:

1. Intelligent instrumentation systems
2. Dumb instrumentation systems
3. Control instrumentation systems
4. Robust instrumentation systems

Correct Answer: 3. Control instrumentation systems

Solution:

Control instrumentation systems utilize microprocessors to manage, monitor, and control processes in real-time. These systems are specifically designed for dedicated applications in process instrumentation, providing precision and automation in control tasks.

Quick Tip

Understand the role of control instrumentation systems in integrating microprocessor technology for improved process management.

Question 58.

Dynamic response of a system consists of:

- (A) steady state response only
- (B) transient state response only
- (C) unsteady state response only
- (D) non-transient state response only

Options:

1. A and B only
2. A and D only
3. C and D only
4. B and C only

Correct Answer: 1. A and B only

Solution:

The dynamic response of a system consists of two parts:

- (A) Steady state response: This occurs after the transient effects have settled, representing the long-term behavior.
- (B) Transient state response: This occurs immediately after a disturbance or change in input, as the system adjusts towards a steady state.
- (C) Unsteady state response and (D) Non-transient state response are incorrect as these do not accurately describe the components of dynamic response. Thus, the correct answer is (A) and (B) only.

Quick Tip

Focus on both transient and steady-state responses to understand the complete behavior of dynamic systems.

Question 59.

Tubeless tyres can be made from:

Options:

1. SBR
2. Butyl rubber
3. Silicone rubber
4. Nitrile rubber

Correct Answer: 2. Butyl rubber

Solution:

Butyl rubber is used in tubeless tyres due to its excellent impermeability to air, ensuring better retention of inflation pressure.

Quick Tip

Explore materials like butyl rubber for their unique properties in automotive applications.

Question 60.

The effect of smoke in the preparation of smoked rubber sheet is:

- A. to make the rubber brown
- B. to serve as a preservative
- C. to make the rubber soft
- D. to make the rubber blistering

Options:

1. A and B Only
2. A and C Only
3. B and D Only
4. A and D Only

Correct Answer: 1. A and B Only

Solution:

Smoke imparts a brown color to the rubber and acts as a preservative, enhancing its longevity and resistance to microbial degradation.

Quick Tip

Understand the chemical and physical impacts of traditional rubber processing techniques for industrial applications.

Question 61.

The characteristic that deteriorates when more styrene is added to butadiene to get SBR during polymerization is:

Options:

1. Resilience
2. Strength
3. Elongation
4. Freezing point

Correct Answer: 1. Resilience

Solution:

When styrene content increases in SBR (Styrene-Butadiene Rubber), resilience decreases as the material becomes harder and less elastic. This adjustment can improve strength but sacrifices bounce-back ability.

Quick Tip

Balance styrene content to optimize properties like resilience and strength in SBR.

Question 62.

Bicycle pedal is an example of:

Options:

1. Blow moulding
2. Injection moulding
3. Thermoforming
4. Compression moulding

Correct Answer: 1. Blow moulding

Solution:

Bicycle pedals are often manufactured using blow moulding, a process ideal for creating hollow components with lightweight and durable properties. This method ensures the required strength while maintaining the pedal's structural integrity.

Quick Tip

Blow moulding is commonly used for hollow and lightweight components in various applications.

Question 63.

In extrusion, the primary function of the transition zone is to:

- A. compress the polymer
- B. melt the polymer
- C. support the screen pack
- D. contribute for the back pressure

Options:

- 1. A and B only
- 2. A and C only
- 3. B and D only
- 4. A and D only

Correct Answer: 1. A and B only

Solution:

The transition zone in extrusion is responsible for compressing and melting the polymer, ensuring smooth flow toward the die for further shaping.

Quick Tip

The transition zone is critical for proper polymer melting and compression in extrusion processes.

Question 64.

Diglycidyl ether of bisphenol-A and 4,4-diamino diphenyl sulfone system can be used to obtain glass-reinforced composites by the process of:

Options:

- 1. Wet-lay-up technique
- 2. Dry-lay-up technique
- 3. Dry-wet-up technique
- 4. Wet-dry-up technique

Correct Answer: 2. Dry-lay-up technique

Solution:

The dry-lay-up technique involves the use of pre-impregnated resin layers (prepregs) that are

laid out without liquid resin during the initial stages. This method is suitable for obtaining high-quality, glass-reinforced composites, ensuring uniformity and precision.

Quick Tip

Dry-lay-up techniques are ideal for high-strength composite materials with controlled resin content.

Question 65.

Self-polymerization of reactive styrene at room temperature can be prevented by the addition of:

Options:

1. Dicumyl peroxide
2. P-tetra butyl catechol
3. Diazo carbonamide
4. Chromium oxide

Correct Answer: 2. P-tetra butyl catechol

Solution:

P-tetra butyl catechol acts as an inhibitor by scavenging free radicals that initiate polymerization, preventing the self-polymerization of styrene.

Quick Tip

Free radical inhibitors like P-tetra butyl catechol are crucial in stabilizing reactive monomers.

Question 66.

Polymer having high tensile strength, tensile modulus, stiffness, melting point, and heat distortion temperature combined with low specific gravity and excellent resistance to environmental stress cracking is:

Options:

1. LDPE
2. Polypropylene
3. HDPE
4. Styrene-butadiene rubber

Correct Answer: 2. Polypropylene

Solution:

Polypropylene exhibits a combination of high strength, stiffness, and resistance to environmental stress cracking, making it ideal for industrial applications.

Quick Tip

Polypropylene's versatile properties make it a preferred choice in packaging and automotive industries.

Question 67.

The polymer —A—A—A—B—B—AAA—B—B—B—B represents:

Options:

1. Block copolymer
2. Graft copolymer
3. Random copolymer
4. Alternate copolymer

Correct Answer: 1. Block copolymer

Solution:

In block copolymers, monomers are grouped into distinct blocks (e.g., A-A-A and B-B), giving the polymer unique mechanical and thermal properties. This structure allows for enhanced strength and elasticity compared to other copolymer types.

Quick Tip

Block copolymers are used in creating advanced materials like thermoplastic elastomers due to their versatile properties.

Question 68.

The kinetics and degree of polymerization of polymer during emulsion polymerization depends upon:

Options:

1. Time of process, quality of initiator
2. Quantity of initiator, intensity of agitator
3. Intensity of agitator, temperature of process
4. Temperature and time of process, quantity of initiator, and intensity of agitator

Correct Answer: 4. Temperature and time of process, quantity of initiator, and intensity of agitator

Solution:

Emulsion polymerization involves controlling several parameters such as temperature, time, initiator concentration, and agitation intensity to ensure optimal kinetics and polymerization degree. These factors influence the size, distribution, and properties of the resulting polymer.

Quick Tip

Optimizing process parameters in emulsion polymerization enhances product uniformity and efficiency.

Question 69.

For the manufacture of Nylon-6 by condensation polymerization of caprolactam, the temperature maintained in the reactor is about:

Options:

1. 60–80°C
2. 130–140°C
3. 240–280°C
4. 400–450°C

Correct Answer: 3. 240–280°C

Solution:

Nylon-6 is manufactured via the condensation polymerization of caprolactam under high temperatures (240–280°C). This temperature facilitates the opening of the caprolactam ring and the subsequent polymerization process.

Quick Tip

Maintaining the optimal temperature is critical for achieving high-quality Nylon-6 during polymerization.

Question 70.

The catalyst used during the condensation of phenol and formaldehyde to obtain the highest electrical properties is:

Options:

1. Liquid ammonia
2. Caustic soda solution
3. Sulphuric acid
4. Hydrochloric acid

Correct Answer: 1. Liquid ammonia

Solution:

Liquid ammonia is used as a catalyst during the condensation of phenol and formaldehyde when high electrical properties are desired. It aids in precise polymerization, ensuring a well-structured and cross-linked phenolic resin with superior insulating properties.

Quick Tip

Choose catalysts carefully during polymerization, as they significantly influence the thermal and electrical properties of the final product.

Question 71.

If the function $f(z) = x^2 + axy + by^2 + i(cx^2 + dxy + y^2)$ is analytic, then the values of a, b, c , and d are given by:

Options:

1. $a = 2, b = -1, c = 1, d = -2$
2. $a = 2, b = 1, c = -1, d = 2$
3. $a = 2, b = 1, c = 1, d = 2$
4. $a = 2, b = -1, c = -1, d = 2$

Correct Answer: 4. $a = 2, b = -1, c = -1, d = 2$

Solution:

For $f(z)$ to be analytic, it must satisfy the Cauchy-Riemann equations:

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}, \quad \frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$$

Solving these equations for the given function, the values of a, b, c , and d are found as $a = 2, b = -1, c = -1, d = 2$.

Quick Tip

Check analyticity by applying the Cauchy-Riemann equations and verifying their consistency.

Question 72.

Which of the following is not correct?

Options:

1. If A and B are two matrices of order 2×3 and 3×4 respectively, then their product AB is of order 2×4 .
2. If A and B are square matrices of the same order, then $AB = BA$.
3. The augmented matrix of the system of linear equations in matrix form $Ax = B$ is given by $(A|B)$.
4. Any homogeneous system of linear equations has at least one solution.

Correct Answer: 2. If A and B are square matrices of the same order, then $AB = BA$.

Solution:

For square matrices A and B , the commutative property $AB = BA$ does not hold in general. Matrix multiplication is associative but not commutative.

Quick Tip

Remember that matrix multiplication is not commutative unless A and B commute.

Question 73.

The first-order partial derivative of the function $\log(\sin x + \cos y)$ with respect to the variables x and y , respectively, are given by:

Options:

1. $\frac{\cos x}{\sin x + \cos y}, \frac{-\sin y}{\sin x + \cos y}$
2. $\frac{\sin x}{\sin x + \cos y}, \frac{\cos y}{\sin x + \cos y}$
3. $\frac{-\cos x}{\sin x + \cos y}, \frac{-\sin y}{\sin x + \cos y}$
4. $\frac{\cos x}{\sin x + \cos y}, \frac{\sin y}{\sin x + \cos y}$

Correct Answer: 1. $\frac{\cos x}{\sin x + \cos y}, \frac{-\sin y}{\sin x + \cos y}$

Solution:

Using partial differentiation:

$$\frac{\partial}{\partial x} \log(\sin x + \cos y) = \frac{\cos x}{\sin x + \cos y}, \quad \frac{\partial}{\partial y} \log(\sin x + \cos y) = \frac{-\sin y}{\sin x + \cos y}.$$

Quick Tip

Apply the chain rule carefully for logarithmic functions involving multiple variables.

Question 74.

The complementary function of the differential equation:

$$\frac{d^2 y}{dx^2} + 16y = x \sin \mu x, \mu = \pm 4$$

is given by:

Options:

1. $\alpha \cos 16x + \beta \sin 16x$, where α and β are constants.
2. $\alpha \cos 4x + \beta \sin 4x$, where α and β are constants.
3. $\alpha \cos 8x + \beta \sin 8x$, where α and β are constants.
4. $\alpha \cos 2x + \beta \sin 2x$, where α and β are constants.

Correct Answer: 2. $\alpha \cos 4x + \beta \sin 4x$

Solution:

The differential equation $\frac{d^2y}{dx^2} + 16y = x \sin \mu x$ has a complementary function that depends on the roots of the characteristic equation $m^2 + 16 = 0$. Solving for m , we get $m = \pm 4i$. Hence, the complementary function is given by:

$$y_c = \alpha \cos 4x + \beta \sin 4x,$$

where α and β are arbitrary constants.

Quick Tip

To find the complementary function, solve the characteristic equation and use the form corresponding to its roots.

Question 75.

Which of the following is correct?

Options:

1. The Cauchy-Riemann equations are given by $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial x}$ and $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial y}$.
2. The function $f(z) = z$ is analytic everywhere.
3. If $f(z)$ is analytic inside and on a simple closed curve c , and a is any point inside c , then $f(a)$ is given by $\int_c \frac{f(z)}{z-a} dz$.
4. If $f(z)$ is analytic inside and on a simple closed curve c except at a finite number of points $a, b, c, \dots$ inside c at which the residues are $\alpha, \beta, \gamma, \dots$, respectively, then $\int_c f(z) dz = 2\pi i(\alpha + \beta + \gamma + \dots)$.

Correct Answer: 4. If $f(z)$ is analytic inside and on a simple closed curve c except at a finite number of points $a, b, c, \dots$ inside c at which the residues are $\alpha, \beta, \gamma, \dots$, respectively, then $\int_c f(z) dz = 2\pi i(\alpha + \beta + \gamma + \dots)$.

Solution:

The correct statement is based on the residue theorem, which states that if $f(z)$ is analytic except for isolated singularities within the closed curve c , the integral around c is equal to $2\pi i$ times the sum of the residues at those singularities. This theorem is a fundamental result in complex analysis.

Quick Tip

The residue theorem simplifies evaluating complex integrals by relating them to the residues of singularities inside the closed curve.