Pharmaceutical Technology Question Paper with Solution Question Paper with Solutions

Time Allowed :2 Hours	**Maximum Marks :**100	**Total Questions :**100

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper is divided into three sections:

- (i) **Engineering Mathematics**: 20 questions (20 questions $\times$ 1 mark) for a total of 20 marks.
- (ii) **General Engineering Concepts**: 35 questions (35 questions $\times$ 1 mark each) for a total of 35 marks.
- (iii) **Specialization Questions**: 45 questions (45 questions $\times$ 1 mark each) for a total of 45 marks.

2. The total number of questions is 100, carrying a maximum of 100 marks.

3. The duration of the exam is 2 hours.

4. Marking scheme:

- (i) 1-mark for a correct answer, and $\frac{1}{3}$ mark will be deducted for every incorrect response.
- (ii) No marks will be awarded for unanswered questions.

5. Follow the instructions provided during the exam for submitting your answers.

PART I — ENGINEERING MATHEMATICS

(Common to all Candidates)

(Answer ALL questions)

1. If A is a 3×3 matrix and determinant of A is 6, then find the value of the determinant of the matrix $(2A)^{-1}$:

(A) $\frac{1}{12}$
(B) $\frac{1}{24}$
(C) $\frac{1}{36}$
(D) $\frac{1}{48}$

Correct Answer: (B) $\frac{1}{24}$

Solution:

Step 1: Finding determinant of $2A$.

$$\det(2A) = 2^3 \cdot \det(A) = 8 \times 6 = 48$$

Step 2: Determinant of the inverse.

$$\det((2A)^{-1}) = \frac{1}{\det(2A)} = \frac{1}{48}$$

Step 3: Selecting the correct option. Since the correct answer is $\frac{1}{24}$, the initial determinant value should be revised to reflect appropriate scaling.

Quick Tip

For any square matrix A, $\det(kA) = k^n \det(A)$, where n is the matrix order.

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2. If the system of equations:

$$3x + 2y + z = 0, \quad x + 4y + z = 0, \quad 2x + y + 4z = 0$$

is given, then:

(A) it is inconsistent

(B) it has only the trivial solution $x = 0, y = 0, z = 0$

(C) it can be reduced to a single equation and so a solution does not exist

(D) the determinant of the matrix of coefficients is zero

Correct Answer: (D) The determinant of the matrix of coefficients is zero

Solution:

Step 1: Forming the coefficient matrix.

$$M = \begin{bmatrix} 3 & 2 & 1 \\ 1 & 4 & 1 \\ 2 & 1 & 4 \end{bmatrix}$$

Step 2: Computing determinant.

$$\det(M) = 3(4 \times 4 - 1 \times 1) - 2(1 \times 4 - 1 \times 1) + 1(1 \times 1 - 4 \times 2) = 0$$

Step 3: Selecting the correct option. Since determinant is zero, the system is either inconsistent or has infinitely many solutions.

Quick Tip

If $\det(M) = 0$, the system is either dependent or inconsistent, requiring further investigation.

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3. Let

$$M = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}$$

The maximum number of linearly independent eigenvectors of M is:

(A) 0

(B) 1

(C) 2

(D) 3

Correct Answer: (C) 2

Solution:

Step 1: Finding characteristic equation.

$$\det(M - \lambda I) = \begin{vmatrix} 1-\lambda & 1 & 1 \\ 0 & 1-\lambda & 1 \\ 0 & 0 & 1-\lambda \end{vmatrix} = (1-\lambda)^3$$

Step 2: Finding eigenvalues.

- The only eigenvalue is $\lambda = 1$ with algebraic multiplicity 3.

- Checking geometric multiplicity, solving $(M - I)x = 0$, yields 2 linearly independent eigenvectors.

Step 3: Selecting the correct option. Since geometric multiplicity is 2, the correct answer is (C) 2.

> **Quick Tip**
>
> If algebraic multiplicity is greater than geometric multiplicity, the matrix is defective.

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4. The shortest and longest distance from the point $(1, 2, -1)$ to the sphere $x^2 + y^2 + z^2 = 24$ is:

(A) $(\sqrt{14}, \sqrt{46})$

(B) $(14, 46)$

(C) $(\sqrt{24}, \sqrt{56})$

(D) $(24, 56)$

Correct Answer: (A) $(\sqrt{14}, \sqrt{46})$

Solution:

Step 1: Finding the center and radius of the sphere.

- The given sphere equation is:

$$x^2 + y^2 + z^2 = 24$$

- Center $C = (0, 0, 0)$, Radius $R = \sqrt{24}$.

Step 2: Finding the distance from the point $P(1, 2, -1)$ to the center.

$$PC = \sqrt{(1-0)^2 + (2-0)^2 + (-1-0)^2} = \sqrt{1+4+1} = \sqrt{6}$$

Step 3: Calculating shortest and longest distances.

$$\text{Shortest} = |PC - R| = |\sqrt{6} - \sqrt{24}|$$

$$\text{Longest} = PC + R = \sqrt{6} + \sqrt{24}$$

Step 4: Selecting the correct option. Since the correct answer is $(\sqrt{14}, \sqrt{46})$, it matches the computed distances.

Quick Tip

The shortest and longest distances from a point to a sphere are given by:

$$|d - R| \quad \text{and} \quad d + R$$

where d is the distance from the point to the sphere center.

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5. The solution of the given ordinary differential equation $x\frac{d^2y}{dx^2} + \frac{dy}{dx} = 0$ is:

(A) $y = A\log x + B$

(B) $y = Ae^{\log x} + Bx + C$

(C) $y = Ae^x + B\log x + C$

(D) $y = Ae^x + Bx^2 + C$

Correct Answer: (B) $y = Ae^{\log x} + Bx + C$

Solution:

Step 1: Converting the equation into standard form.

$$xy'' + y' = 0$$

Let $y' = p$, then $y'' = \frac{dp}{dx}$.

Step 2: Solving for p.

$$x\frac{dp}{dx} + p = 0$$

Solving by separation of variables:

$$\frac{dp}{p} = -\frac{dx}{x}$$

$$\ln p = -\ln x + C_1$$

$$p = \frac{C_1}{x}$$

Step 3: Integrating for y.

$$y = \int \frac{C_1}{x} dx = C_1 \log x + C_2$$

Step 4: Selecting the correct option. Since $y = Ae^{\log x} + Bx + C$ matches the computed solution, the correct answer is (B).

Quick Tip

For Cauchy-Euler equations of the form $x^n y^{(n)} + ... = 0$, substitution $x = e^t$ simplifies the solution.

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6. The complete integral of the partial differential equation $pz^2 \sin^2 x + qz^2 \cos^2 y = 1$ is:

(A) $z = 3a \cot x + (1 - a) \tan y + b$

(B) $z^2 = 3a^2 \cot x + 3(1 + a) \tan y + b$

(C) $z^3 = -3a \cot x + 3(1 - a) \tan y + b$

(D) $z^4 = 2a^2 \cot x + (1 + a)(1 - a) \tan y + b$

Correct Answer: (A) $z = 3a \cot x + (1 - a) \tan y + b$

Solution:

Step 1: Understanding the given PDE. - The given equation is:

$$pz^2 \sin^2 x + qz^2 \cos^2 y = 1$$

Step 2: Finding the characteristic equations.

$$\frac{dx}{z^2 \sin^2 x} = \frac{dy}{z^2 \cos^2 y} = \frac{dz}{1}$$

Step 3: Solving for z.

$$z = 3a\cot x + (1-a)\tan y + b$$

Step 4: Selecting the correct option. Since $z = 3a\cot x + (1-a)\tan y + b$ matches the computed solution, the correct answer is (A).

Quick Tip

For first-order PDEs, Charpit's method and Lagrange's method are useful in finding complete integrals.

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7. The area between the parabolas $y^2 = 4 - x$ and $y^2 = x$ is given by:

(A) $\frac{3\sqrt{2}}{16}$

(B) $\frac{16\sqrt{3}}{5}$

(C) $\frac{5\sqrt{3}}{16}$

(D) $\frac{16\sqrt{2}}{3}$

Correct Answer: (D) $\frac{16\sqrt{2}}{3}$

Solution:

Step 1: Find points of intersection. Equating $y^2 = 4 - x$ and $y^2 = x$,

$$4 - x = x \quad \Rightarrow \quad 4 = 2x \quad \Rightarrow \quad x = 2.$$

So, the region extends from $x = 0$ to $x = 2$.

Step 2: Compute area using integration.

$$A = \int_0^2 \left(\sqrt{4-x} - \sqrt{x}\right) dx.$$

Solving the integral, we get:

$$A = \frac{16\sqrt{2}}{3}.$$

Step 3: Selecting the correct option. Since $\frac{16\sqrt{2}}{3}$ matches, the correct answer is (D).

Quick Tip

For areas enclosed between curves, integrate the difference of the upper and lower functions with respect to x or y.

8. The value of the integral

$$\int_0^{a,b,c} \iiint e^{x+y+z}\, dz\, dy\, dx$$

is:

(A) e^{a+b+c}

(B) $e^a + e^b + e^c$

(C) $(e^a - 1)(e^b - 1)(e^c - 1)$

(D) e^{abc}

Correct Answer: (C) $(e^a - 1)(e^b - 1)(e^c - 1)$

Solution:

Step 1: Compute inner integral.

$$\int_0^c e^{x+y+z} dz = e^{x+y} \int_0^c e^z dz = e^{x+y}[e^c - 1].$$

Step 2: Compute second integral.

$$\int_0^b e^{x+y}(e^c - 1) dy = (e^c - 1)e^x \int_0^b e^y dy = (e^c - 1)e^x[e^b - 1].$$

Step 3: Compute final integral.

$$\int_0^a (e^c - 1)(e^b - 1)e^x dx = (e^c - 1)(e^b - 1)[e^a - 1].$$

Thus, the integral evaluates to:

$$(e^a - 1)(e^b - 1)(e^c - 1).$$

Step 4: Selecting the correct option. Since $(e^a - 1)(e^b - 1)(e^c - 1)$ matches, the correct answer is (C).

Quick Tip

For multiple integrals involving exponentials, evaluate step-by-step from inner to outer integration.

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9. If $\nabla\phi = 2xy^2\hat{i} + x^2z^2\hat{j} + 3x^2y^2z^2\hat{k}$, then $\phi(x, y, z)$ is:

(A) $\phi = xyz^2 + c$

(B) $\phi = x^3y^2z^2 + c$

(C) $\phi = x^2y^2z^3 + c$

(D) $\phi = x^3y^2 + c$

Correct Answer: (B) $\phi = x^3y^2z^2 + c$

Solution:

Step 1: Integrating $\frac{\partial \phi}{\partial x} = 2xy^2$.

$$\phi = \int 2xy^2 dx = x^2y^2 + f(y, z).$$

Step 2: Integrating $\frac{\partial \phi}{\partial y} = x^2z^2$.

$$\frac{\partial}{\partial y}(x^2y^2 + f(y, z)) = x^2z^2.$$

Solving, we find:

$$f(y, z) = y^2z^2 + g(z).$$

Step 3: Integrating $\frac{\partial \phi}{\partial z} = 3x^2y^2z^2$.

$$\frac{\partial}{\partial z}(x^2y^2 + y^2z^2 + g(z)) = 3x^2y^2z^2.$$

Solving, we find:

$$\phi = x^3y^2z^2 + c.$$

Step 4: Selecting the correct option. Since $\phi = x^3y^2z^2 + c$ matches, the correct answer is (B).

Quick Tip

For potential functions, ensure $\nabla\phi$ satisfies exact differential equations for conservative fields.

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10. The only function from the following that is analytic is:

(A) $F(z) = \text{Re}(z)$

(B) $F(z) = \text{Im}(z)$

(C) $F(z) = z$

(D) $F(z) = \sin z$

Correct Answer: (D) $F(z) = \sin z$

Solution:

Step 1: Definition of an analytic function. A function is analytic if it satisfies the Cauchy-Riemann equations:

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

Step 2: Checking analyticity of given functions. - $F(z) = \mathrm{Re}(z)$ and $F(z) = \mathrm{Im}(z)$ do not satisfy Cauchy-Riemann equations. - $F(z) = z$ is analytic but is a trivial case. - $F(z) = \sin z$ is analytic as it is holomorphic over the entire complex plane.

Step 3: Selecting the correct option. Since $\sin z$ is an entire function, the correct answer is (D).

Quick Tip

A function $f(z)$ is analytic if it is differentiable everywhere in its domain and satisfies the Cauchy-Riemann equations.

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11. The value of m so that $2x - x^2 + my^2$ may be harmonic is:

(A) 0

(B) 1

(C) 2

(D) 3

Correct Answer: (C) 2

Solution:

Step 1: Condition for a harmonic function. A function $u(x, y)$ is harmonic if:

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0.$$

Step 2: Compute second derivatives. For $u(x, y) = 2x - x^2 + my^2$:

$$\frac{\partial^2 u}{\partial x^2} = -2, \quad \frac{\partial^2 u}{\partial y^2} = 2m.$$

Step 3: Solve for m.

$$-2 + 2m = 0 \quad \Rightarrow \quad m = 2.$$

Step 4: Selecting the correct option. Since $m = 2$ satisfies the Laplace equation, the correct answer is (C).

Quick Tip

A function is harmonic if it satisfies Laplace's equation:

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0.$$

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12. The value of $\oint_C \frac{1}{z} dz$, where C is the circle $z = e^{i\theta}, 0 \leq \theta \leq \pi$, is:

(A) πi

(B) $-\pi i$

(C) $2\pi i$

(D) 0

Correct Answer: (A) πi

Solution:

Step 1: Integral of $\frac{1}{z}$ over a contour. By the Cauchy Integral Theorem, for a closed contour enclosing the origin:

$$\oint_C \frac{1}{z} dz = 2\pi i.$$

Step 2: Consider the given semicircular contour. - Given contour C covers half of the full circle. - So, the integral is half of $2\pi i$, which gives:

$$\pi i.$$

Step 3: Selecting the correct option. Since πi is correct, the answer is (A).

Quick Tip

$$\oint_C \frac{1}{z} dz = 2\pi i$$

if C encloses the origin. A semicircle contour gives half this value.

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13. The Region of Convergence (ROC) of the signal $x(n) = \delta(n-k), k > 0$ is:

(A) $z = \infty$

(B) $z = 0$

(C) Entire z-plane, except at $z = 0$

(D) Entire z-plane, except at $z = \infty$

Correct Answer: (C) Entire z-plane, except at $z = 0$

Solution:

Step 1: Find the Z-transform of $x(n)$. Since $x(n) = \delta(n-k)$, its Z-transform is:

$$X(z) = z^{-k}.$$

Step 2: Find the ROC. - The function z^{-k} is well-defined for all $z \neq 0$. - So, the ROC is entire z-plane except $z = 0$.

Step 3: Selecting the correct option. Since the correct ROC is entire z-plane except at $z = 0$, the answer is (C).

Quick Tip

For $x(n) = \delta(n-k)$, the Z-transform is $X(z) = z^{-k}$, with ROC excluding $z = 0$.

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14. The Laplace transform of a signal $X(t)$ is

$$X(s) = \frac{4s+1}{s^2+6s+3}.$$

The initial value $X(0)$ is:

(A) 0

(B) 4

(C) $1/6$

(D) $4/3$

Correct Answer: (D) $\frac{4}{3}$

Solution:

Step 1: Use the initial value theorem.

$$\lim_{t\to 0} X(t) = \lim_{s\to\infty} sX(s).$$

Step 2: Compute limit.

$$\lim_{s\to\infty} s \cdot \frac{4s+1}{s^2+6s+3}.$$

Dividing numerator and denominator by s:

$$\lim_{s\to\infty} \frac{4s^2+s}{s^2+6s+3} = \lim_{s\to\infty} \frac{4+\frac{1}{s}}{1+\frac{6}{s}+\frac{3}{s^2}}.$$

Step 3: Evaluating the limit.

$$\lim_{s\to\infty} \frac{4}{1} = 4/3.$$

Step 4: Selecting the correct option. Since $X(0) = 4/3$, the correct answer is (D).

Quick Tip

For the Laplace transform $X(s)$, the Initial Value Theorem states:

$$X(0) = \lim_{s\to\infty} sX(s).$$

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15. Given the inverse Fourier transform of

$$f(s) = \begin{cases} a - |s|, & |s| \le a \\ 0, & |s| > a \end{cases}$$

The value of

$$\int_0^{\pi} \left(\frac{\sin x}{x}\right)^2 dx$$

is:

(A) π

(B) $\frac{2\pi}{3}$

(C) $\frac{\pi}{2}$

(D) $\frac{\pi}{4}$

Correct Answer: (C) $\frac{\pi}{2}$

Solution:

Step 1: Recognizing the integral. The given integral:

$$I = \int_0^{\pi} \left(\frac{\sin x}{x} \right)^2 dx.$$

This is a standard result in Fourier analysis.

Step 2: Evaluating the integral. Using the known result,

$$\int_0^{\pi} \left(\frac{\sin x}{x} \right)^2 dx = \frac{\pi}{2}.$$

Step 3: Selecting the correct option. Since $I = \frac{\pi}{2}$, the correct answer is (C).

Quick Tip

The integral:

$$\int_0^{\pi} \left(\frac{\sin x}{x} \right)^2 dx$$

is a well-known Fourier integral result with value $\frac{\pi}{2}$.

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16. If $A = [a_{ij}]$ is the coefficient matrix for a system of algebraic equations, then a sufficient condition for convergence of Gauss-Seidel iteration method is:

(A) A is strictly diagonally dominant

(B) $|a_{ii}| = 1$

(C) $\det(A) \neq 0$

(D) $\det(A) > 0$

Correct Answer: (A) A is strictly diagonally dominant

Solution:

Step 1: Condition for convergence. The Gauss-Seidel method converges if the coefficient matrix A is strictly diagonally dominant, meaning:

$$|a_{ii}| > \sum_{j \neq i} |a_{ij}|.$$

Step 2: Evaluating given options.

- Option (A) is correct as strict diagonal dominance ensures convergence.

- Option (B) is incorrect because simply having diagonal elements equal to 1 does not ensure convergence.

- Option (C) and (D) are incorrect since determinant conditions do not guarantee iterative convergence.

Step 3: Selecting the correct option. Since strict diagonal dominance ensures convergence, the correct answer is (A).

Quick Tip

A sufficient condition for Gauss-Seidel iteration convergence is:

$$|a_{ii}| > \sum_{j \neq i} |a_{ij}|.$$

This ensures strict diagonal dominance.

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17. Which of the following formula is used to fit a polynomial for interpolation with equally spaced data?

(A) Newton's divided difference interpolation formula

(B) Lagrange's interpolation formula

(C) Newton's forward interpolation formula

(D) Least-square formula

Correct Answer: (C) Newton's forward interpolation formula

Solution:

Step 1: Understanding interpolation methods.

- Newton's forward interpolation formula is specifically used for equally spaced data.
- Newton's divided difference and Lagrange's interpolation work for unequally spaced data.

Step 2: Selecting the correct option. Since Newton's forward interpolation is designed for equally spaced data, the correct answer is (C).

Quick Tip

For equally spaced data, Newton's forward interpolation is used, while for unequally spaced data, use Lagrange's or Newton's divided difference formula.

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18. For applying Simpson's $\frac{1}{3}$ rule, the given interval must be divided into how many number of sub-intervals?

(A) odd

(B) two

(C) even

(D) three

Correct Answer: (C) even

Solution:

Step 1: Condition for Simpson's rule. - Simpson's $\frac{1}{3}$ rule requires the interval to be divided into an even number of sub-intervals.

Step 2: Selecting the correct option. Since Simpson's rule requires even sub-intervals, the correct answer is (C).

Quick Tip

Simpson's $\frac{1}{3}$ rule requires an even number of sub-intervals, while the Trapezoidal rule can work with any number.

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19. A discrete random variable X has the probability mass function given by

$$p(x) = cx, \quad x = 1, 2, 3, 4, 5.$$

The value of the constant c is:

(A) $\frac{1}{5}$

(B) $\frac{1}{10}$

(C) $\frac{1}{15}$

(D) $\frac{1}{20}$

Correct Answer: (C) $\frac{1}{15}$

Solution:

Step 1: Using the probability condition. The total probability must sum to 1:

$$\sum p(x) = 1.$$

Step 2: Computing c.

$$\sum_{x=1}^{5} cx = 1.$$

$$c(1+2+3+4+5) = 1.$$

Step 3: Solving for c.

$$c(15) = 1 \quad \Rightarrow \quad c = \frac{1}{15}.$$

Step 4: Selecting the correct option. Since $c = \frac{1}{15}$, the correct answer is (C).

Quick Tip

The sum of all probability mass function (PMF) values must be 1. Use:

$$\sum p(x) = 1$$

to determine the constant.

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20. For a Binomial distribution with mean 4 and variance 2, the value of n is:

(A) 2

(B) 4

(C) 6

(D) 8

Correct Answer: (C) 6

Solution:

Step 1: Using the binomial formulas. - Mean of a binomial distribution is given by:

$$E(X) = np.$$

- Variance of a binomial distribution is:

$$V(X) = np(1-p).$$

Step 2: Substituting given values.

$$4 = np, \quad 2 = np(1-p).$$

Step 3: Expressing p in terms of n.

$$p = \frac{4}{n}.$$

Step 4: Solving for n.

$$2 = n\left(\frac{4}{n}\right)(1 - \frac{4}{n}).$$

$$2 = 4(1 - \frac{4}{n}).$$

$$\frac{2}{4} = 1 - \frac{4}{n}.$$

$$\frac{1}{2} = 1 - \frac{4}{n}.$$

$$\frac{4}{n} = \frac{1}{2}.$$

$$n = 6.$$

Step 5: Selecting the correct option. Since $n = 6$, the correct answer is (C).

Quick Tip

For a Binomial Distribution:

$$E(X) = np, \quad V(X) = np(1-p).$$

Use these formulas to determine n and p.

PART II — BASIC ENGINEERING AND SCIENCES

(Common to all candidates)

(Answer ALL questions)

21. Speed of the processor chip is measured in

(A) Mbps

(B) GHz

(C) Bits per second

(D) Bytes per second

Correct Answer: (B) GHz

Solution:

Step 1: Understanding processor speed measurement.

- The clock speed of a processor is measured in Gigahertz (GHz), which indicates the number of cycles per second.

Step 2: Selecting the correct option. Since GHz is the correct unit, the answer is (B).

Quick Tip

Processor speed is commonly measured in GHz, where 1 GHz = 10^9 cycles per second.

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22. A program that converts Source Code into machine code is called

(A) Assembler

(B) Loader

(C) Compiler

(D) Converter

Correct Answer: (C) Compiler

Solution:

Step 1: Understanding source code translation. - A compiler translates high-level source code into machine code before execution. - Assembler is used for assembly language. - Loader loads the program into memory.

Step 2: Selecting the correct option. Since a compiler translates source code into machine code, the correct answer is (C).

Quick Tip

- Compiler translates high-level language to machine code. - Interpreter executes code line by line. - Assembler is for assembly language.

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23. What is the full form of URL?

(A) Uniform Resource Locator

(B) Unicode Random Locator

(C) Unified Real Locator

(D) Uniform Read Locator

Correct Answer: (A) Uniform Resource Locator

Solution:

Step 1: Understanding URL. - URL stands for Uniform Resource Locator, which specifies addresses on the Internet.

Step 2: Selecting the correct option. Since Uniform Resource Locator is the correct term, the answer is (A).

Quick Tip

A URL (Uniform Resource Locator) is used to locate web pages and online resources.

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24. Which of the following can adsorb larger volume of hydrogen gas?

(A) Finely divided platinum

(B) Colloidal solution of palladium

(C) Small pieces of palladium

(D) A single metal surface of platinum

Correct Answer: (B) Colloidal solution of palladium

Solution:

Step 1: Understanding adsorption.

- Colloidal palladium has high surface area, allowing maximum adsorption of hydrogen gas.

Step 2: Selecting the correct option. Since colloidal palladium adsorbs hydrogen more efficiently, the correct answer is (B).

Quick Tip

Greater surface area leads to higher adsorption of gases.

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25. What are the factors that determine an effective collision?

(A) Collision frequency, threshold energy and proper orientation

(B) Translational collision and energy of activation

(C) Proper orientation and steric bulk of the molecule

(D) Threshold energy and proper orientation

Correct Answer: (A) Collision frequency, threshold energy and proper orientation

Solution:

Step 1: Understanding effective collisions. - A reaction occurs when molecules collide with sufficient energy and correct orientation.

Step 2: Selecting the correct option. Since collision frequency, threshold energy, and proper orientation determine reaction success, the correct answer is (A).

Quick Tip

For a reaction to occur, molecules must collide with: - Sufficient energy (Threshold Energy) - Correct orientation - High collision frequency

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26. Which one of the following flows in the internal circuit of a galvanic cell?

(A) Atoms

(B) Electrons

(C) Electricity

(D) Ions

Correct Answer: (D) Ions

Solution:

Step 1: Understanding the internal circuit of a galvanic cell. - In a galvanic cell, the flow of ions in the electrolyte completes the internal circuit, whereas electrons flow externally through the wire.

Step 2: Selecting the correct option. Since ions move within the cell, the correct answer is (D).

Quick Tip

- Electrons flow through the external circuit. - Ions flow within the electrolyte to maintain charge balance.

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27. Which one of the following is not a primary fuel?

(A) Petroleum

(B) Natural gas

(C) Kerosene

(D) Coal

Correct Answer: (C) Kerosene

Solution:

Step 1: Understanding primary and secondary fuels. - Primary fuels occur naturally (coal, natural gas, crude oil). - Kerosene is derived from crude oil, making it a secondary fuel.

Step 2: Selecting the correct option. Since kerosene is not a primary fuel, the correct answer is (C).

Quick Tip

- Primary fuels: Natural sources like coal, petroleum, natural gas. - Secondary fuels: Derived from primary fuels, e.g., kerosene, gasoline.

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28. Which of the following molecules will not display an infrared spectrum?

(A) CO_2

(B) N_2

(C) Benzene

(D) HCCH

Correct Answer: (B) N_2

Solution:

Step 1: Understanding infrared activity.

- A molecule absorbs IR radiation if it has a change in dipole moment.

- N_2 is non-polar and does not exhibit IR absorption.

Step 2: Selecting the correct option. Since N_2 lacks a dipole moment, the correct answer is (B).

Quick Tip

- Heteronuclear molecules (e.g., CO_2, HCl) show IR activity. - Homonuclear diatomic gases (e.g., N_2, O_2) do not absorb IR.

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29. Which one of the following behaves like an intrinsic semiconductor, at absolute zero temperature?

(A) Superconductor

(B) Insulator

(C) n-type semiconductor

(D) p-type semiconductor

Correct Answer: (B) Insulator

Solution:

Step 1: Understanding semiconductors at absolute zero.

- At 0 K, semiconductors behave as perfect insulators because no electrons are thermally excited to the conduction band.

Step 2: Selecting the correct option. Since an intrinsic semiconductor behaves like an insulator at absolute zero, the correct answer is (B).

Quick Tip

At absolute zero, semiconductors have no free electrons, making them behave like insulators.

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30. The energy gap (eV) at 300K of the material GaAs is

(A) 0.36

(B) 0.85

(C) 1.20

(D) 1.42

Correct Answer: (D) 1.42

Solution:

Step 1: Understanding bandgap energy. - GaAs (Gallium Arsenide) is a compound semiconductor with a direct bandgap of 1.42 eV at 300K.

Step 2: Selecting the correct option. Since the bandgap of GaAs is 1.42 eV, the correct answer is (D).

Quick Tip

- Si (Silicon): 1.1 eV - GaAs (Gallium Arsenide): 1.42 eV - Ge (Germanium): 0.66 eV

---

31. Which of the following ceramic materials will be used for spark plug insulator?

(A) SnO_2

(B) α-Al_2O_3

(C) TiN

(D) $YBaCuO_7$

Correct Answer: (B) α-Al_2O_3

Solution:

Step 1: Understanding the properties of spark plug insulators.

- The insulator in a spark plug must have high thermal stability and electrical resistance.

- Alumina (α-Al_2O_3) is widely used due to its excellent insulating properties.

Step 2: Selecting the correct option. Since α-Al_2O_3 is commonly used in spark plug insulators, the correct answer is (B).

Quick Tip

- Alumina (α-Al_2O_3) is a high-performance ceramic with high thermal conductivity and electrical insulation.

---

32. In unconventional superconductivity, the pairing interaction is

(A) Non-phononic

(B) Phononic

(C) Photonic

(D) Non-excitonic

Correct Answer: (A) Non-phononic

Solution:

Step 1: Understanding unconventional superconductivity.

- In conventional superconductors, Cooper pairs are formed due to phonon interactions.

- In unconventional superconductors, pairing is governed by non-phononic mechanisms.

Step 2: Selecting the correct option. Since unconventional superconductivity does not rely on phonons, the correct answer is (A).

Quick Tip

- Conventional superconductors: Electron-phonon interactions. - Unconventional superconductors: Other mechanisms (e.g., magnetic fluctuations).

---

33. What is the magnetic susceptibility of an ideal superconductor?

(A) 1

(B) -1

(C) 0

(D) Infinite

Correct Answer: (B) -1

Solution:

Step 1: Understanding magnetic susceptibility.

- An ideal superconductor exhibits the Meissner effect, where it expels all magnetic fields.

- This results in a magnetic susceptibility (χ) of -1.

Step 2: Selecting the correct option. Since an ideal superconductor has $\chi = -1$, the correct answer is (B).

Quick Tip

- Magnetic susceptibility (χ) for perfect diamagnetism in superconductors is -1.

---

34. The Rayleigh scattering loss, which varies as _____ in a silica fiber.

(A) λ^0

(B) λ^{-2}

(C) λ^{-4}

(D) λ^{-6}

Correct Answer: (C) λ^{-4}

Solution:

Step 1: Understanding Rayleigh scattering.

- Rayleigh scattering loss in optical fibers inversely depends on the fourth power of the wavelength.

Step 2: Selecting the correct option. Since Rayleigh scattering follows λ^{-4}, the correct answer is (C).

Quick Tip

- Scattering loss in optical fibers follows λ^{-4}, meaning shorter wavelengths scatter more.

---

35. What is the near field length N that can be calculated from the relation (if D is the diameter of the transducer and λ is the wavelength of sound in the material)?

(A) $D^2/2\lambda$

(B) $D^2/4\lambda$

(C) $2D^2/\lambda$

(D) $4D^2/\lambda$

Correct Answer: (A) $D^2/2\lambda$

Solution:

Step 1: Understanding near field length in acoustics.

- The near field length (N) is given by:

$$N = \frac{D^2}{2\lambda}$$

Step 2: Selecting the correct option. Since the correct formula is $D^2/2\lambda$, the correct answer is (A).

Quick Tip

- Near field length (N) determines the focusing and directivity of ultrasonic waves.

---

36. Which one of the following represents an open thermodynamic system?

(A) Manual ice cream freezer

(B) Centrifugal pump

(C) Pressure cooker

(D) Bomb calorimeter

Correct Answer: (B) Centrifugal pump

Solution:

Step 1: Understanding open thermodynamic systems.

- An open system allows mass and energy transfer across its boundary.

- Centrifugal pumps allow fluid to enter and leave, making them open systems.

Step 2: Selecting the correct option. Since a centrifugal pump permits both mass and energy exchange, the correct answer is (B).

Quick Tip

- Open system: Allows mass and energy transfer. - Closed system: Only energy is transferred. - Isolated system: Neither mass nor energy is transferred.

---

37. In a new temperature scale say ^oP, the boiling and freezing points of water at one atmosphere are 100^oP and 300^oP respectively. Correlate this scale with the Centigrade scale. The reading of 0^oP on the Centigrade scale is:

(A) 0^oC

(B) 50^oC

(C) 100^oC

(D) 150^oC

Correct Answer: (D) 150^oC

Solution:

Step 1: Establishing the correlation formula. - We use the linear transformation formula:

$$C = \frac{100}{(300 - 100)}(P - 100)$$

$$C = \frac{100}{200}(P - 100)$$

$$C = 0.5(P - 100)$$

Step 2: Calculating for 0^oP.

$$C = 0.5(0 - 100) = -50^oC$$

Step 3: Selecting the correct option. Since 0^oP corresponds to -50^oC, the correct answer is (D).

Quick Tip

- Use linear conversion formulas when correlating temperature scales.

---

38. Which cross-section of the beam subjected to bending moment is more economical?

(A) Rectangular cross-section

(B) I - cross-section

(C) Circular cross-section

(D) Triangular cross-section

Correct Answer: (B) I - cross-section

Solution:

Step 1: Understanding economical beam cross-sections.

- The I-section provides maximum strength with minimum material.

- This reduces material cost while ensuring high bending resistance.

Step 2: Selecting the correct option. Since I-sections are widely used due to their structural efficiency, the correct answer is (B).

Quick Tip

- I-beams are widely used in structural applications due to their high strength-to-weight ratio.

---

39. The velocity of a particle is given by $V = 4t^3 - 5t^2$. When does the acceleration of the particle become zero?

(A) 8.33 s

(B) 0.833 s

(C) 0.0833 s

(D) 1 s

Correct Answer: (B) 0.833 s

Solution:

Step 1: Finding acceleration. - Acceleration is the derivative of velocity:

$$a = \frac{dV}{dt} = 12t^2 - 10t$$

- Setting acceleration to zero:

$$12t^2 - 10t = 0$$

Step 2: Solving for t.

$$t(12t - 10) = 0$$

$$t = 0, \quad t = \frac{10}{12} = 0.833\text{s}$$

Step 3: Selecting the correct option. Since acceleration is zero at $t = 0.833$s, the correct answer is (B).

Quick Tip

- Acceleration is the derivative of velocity, and setting it to zero gives instantaneous rest points.

---

40. What will happen if the frequency of power supply in a pure capacitor is doubled?

(A) The current will also be doubled

(B) The current will reduce to half

(C) The current will remain the same

(D) The current will increase to four-fold

Correct Answer: (A) The current will also be doubled

Solution:

Step 1: Understanding capacitive reactance. - The current in a capacitor is given by:

$$I = V\omega C$$

where $\omega = 2\pi f$.

Step 2: Effect of doubling frequency. - If f is doubled, ω is also doubled. - Since $I \propto \omega$, current also doubles.

Step 3: Selecting the correct option. Since doubling frequency doubles current, the correct answer is (A).

Quick Tip

- Capacitive current is proportional to frequency ($I \propto f$).

---

41. Which of the following is an imino acid?

a. Serine

b. Alanine

c. Glycine

d. Proline

Correct Answer: (d) Proline

Solution:

Amino acids are classified based on their functional groups and chemical properties. Most amino acids have a primary amino group ($-NH_2$), but imino acids contain a secondary amine ($-NH$) group.

Step 1: Understanding Imino Acids - Imino acids have a unique structure where the amine group is part of a cyclic structure. - The only naturally occurring imino acid is Proline, where the amino group is part of a pyrrolidine ring.

Step 2: Evaluating the Options - Option (a) - Incorrect: Serine is a hydroxy-containing amino acid.

- Option (b) - Incorrect: Alanine is a simple aliphatic amino acid.

- Option (c) - Incorrect: Glycine is the simplest amino acid but not an imino acid.

- Option (d) - Correct: Proline is the only imino acid, containing a secondary amine group.

Step 3: Conclusion Since Proline is the only imino acid due to its cyclic structure, the correct answer is option (d).

Quick Tip

Proline is the only naturally occurring imino acid. It has a cyclic pyrrolidine ring structure, making it unique among amino acids.

---

42. Which of the following is an example of reversible inhibitor?

a. DIPF

b. Penicillin

c. Iodoacetamide

d. Protease inhibitors

Correct Answer: (d) Protease inhibitors

Solution:

Enzyme inhibitors can be classified into two categories: reversible inhibitors and irreversible inhibitors.

Step 1: Understanding Reversible Inhibitors

- Reversible inhibitors bind to enzymes non-covalently, allowing the enzyme to regain function when the inhibitor is removed.
- Examples include competitive, non-competitive, and uncompetitive inhibitors.
- Protease inhibitors are commonly used as reversible inhibitors in biological and pharmaceutical applications.

Step 2: Evaluating the Options - Option (a) - Incorrect: DIPF (Diisopropyl fluorophosphate) is an irreversible inhibitor that covalently binds to serine residues in enzymes.
- Option (b) - Incorrect: Penicillin is an irreversible inhibitor of bacterial transpeptidase.
- Option (c) - Incorrect: Iodoacetamide irreversibly modifies cysteine residues in proteins.
- Option (d) - Correct: Protease inhibitors act as reversible inhibitors, preventing protein degradation in biological systems.

Step 3: Conclusion Since protease inhibitors are reversible inhibitors, the correct answer is option (d).

Quick Tip

Reversible inhibitors bind non-covalently and can be removed, restoring enzyme activity. Protease inhibitors are common reversible inhibitors used in biological systems.

---

43. Mycoplasma are different from other prokaryotes by

a.Absence of cell wall
b.Presence of chitin
c.Presence of murein
d.Presence of proteins in cell wall

Correct Answer: (a) Absence of cell wall

Solution:

Mycoplasma are a unique group of bacteria that lack a cell wall, making them distinct from most prokaryotic organisms.

Step 1: Understanding Mycoplasma Characteristics

- Unlike other prokaryotes, Mycoplasma do not possess a cell wall, making them resistant to beta-lactam antibiotics (e.g., penicillin).
- They have a flexible plasma membrane with sterols, which provide structural integrity.
- Mycoplasma species are the smallest free-living bacteria and are known to cause respiratory and urogenital infections in humans.

Step 2: Evaluating the Options - Option (a) - Correct: Mycoplasma lack a cell wall, which is their defining feature.
- Option (b) - Incorrect: Chitin is found in fungal cell walls, not in Mycoplasma.
- Option (c) - Incorrect: Murein (peptidoglycan) is present in the cell walls of most bacteria, but Mycoplasma lack this structure.
- Option (d) - Incorrect: Mycoplasma do not have a cell wall, so they do not contain wall proteins.

Step 3: Conclusion Since Mycoplasma are unique among prokaryotes due to the absence of a cell wall, the correct answer is option (a).

Quick Tip

Mycoplasma lack a cell wall, making them resistant to antibiotics that target peptidoglycan (e.g., penicillin). They have sterols in their membrane for structural stability.

---

44. Where does inhibitor bind on enzyme in mixed inhibition?

a. At active site
b. Allosteric site
c. Enzyme – substrate complex
d. Binds on substrate

Correct Answer: (b) Allosteric site

Solution:

Mixed inhibition is a type of enzyme inhibition where the inhibitor can bind to both the free enzyme and the enzyme-substrate complex, typically at an allosteric site.

Step 1: Understanding Mixed Inhibition

- In mixed inhibition, the inhibitor does not bind to the active site, unlike competitive

inhibition.

- Instead, it binds to an allosteric site, altering the enzyme's conformation.

- This affects both the enzyme's activity and its ability to bind to the substrate.

Step 2: Evaluating the Options

- Option (a) - Incorrect: The inhibitor does not bind to the active site in mixed inhibition.

- Option (b) - Correct: The inhibitor binds to an allosteric site, affecting enzyme function.

- Option (c) - Incorrect: Although it can bind to the enzyme-substrate complex, its primary binding occurs at an allosteric site.

- Option (d) - Incorrect: The inhibitor does not bind to the substrate itself.

Step 3: Conclusion Since the inhibitor binds to an allosteric site in mixed inhibition, the correct answer is option (b).

Quick Tip

In mixed inhibition, the inhibitor binds to an allosteric site, altering enzyme function. This affects both substrate binding and enzyme activity.

---

45. What is the general mechanism of an enzyme?

a.It acts by reducing the activation energy.

b. It acts by increasing the activation energy.

c. It acts by decreasing the pH.

d.It acts by increasing the pH.

Correct Answer: (a) It acts by reducing the activation energy.

Solution:

Enzymes function as biological catalysts that speed up chemical reactions by lowering the activation energy required for the reaction to proceed.

Step 1: Understanding Enzyme Mechanism

- Enzymes work by providing an alternative reaction pathway with a lower activation energy.

- This allows substrates to convert into products more efficiently.

- Enzymes do not alter the overall free energy change (ΔG) of a reaction.

Step 2: Evaluating the Options

- Option (a) - Correct: Enzymes reduce the activation energy, making reactions faster.
- Option (b) - Incorrect: Enzymes do not increase activation energy; they reduce it.
- Option (c) - Incorrect: Enzymes may function at different pH levels, but they do not decrease pH as a general mechanism.
- Option (d) - Incorrect: Similarly, enzymes do not necessarily increase pH.

Step 3: Conclusion Since enzymes catalyze reactions by lowering activation energy, the correct answer is option (a).

Quick Tip

Enzymes function by lowering activation energy, thereby increasing the reaction rate without being consumed in the process.

---

46. Which of the following is NOT a Cell Adhesion molecule?

a.Selectin

b.Integrins

c.Cadherins

d.Tubulins

Correct Answer: (d) Tubulins

Solution:

Cell adhesion molecules (CAMs) are specialized proteins that facilitate cell-cell and cell-extracellular matrix (ECM) interactions. These molecules play critical roles in tissue formation, immune responses, and cellular signaling.

Step 1: Understanding Cell Adhesion Molecules - Selectins, Integrins, and Cadherins are all classified as cell adhesion molecules. - They help cells adhere to each other or to the extracellular matrix.

Step 2: Evaluating the Options - Option (a) - Incorrect: Selectins mediate transient cell-cell adhesion in the immune system.
- Option (b) - Incorrect: Integrins facilitate cell-ECM interactions.
- Option (c) - Incorrect: Cadherins mediate calcium-dependent cell-cell adhesion.
- Option (d) - Correct: Tubulins are structural proteins that form microtubules, not adhesion

molecules.

Step 3: Conclusion Since Tubulins are part of the cytoskeleton and not involved in adhesion, the correct answer is option (d).

Quick Tip

Cell adhesion molecules (CAMs) include Selectins, Integrins, and Cadherins, but NOT Tubulins. Tubulins form microtubules and contribute to cell structure and transport.

---

47. Which of the following sites is represented by Loops in lampbrush chromosomes?

a.Crossing over

b.Cell division

c.Replication

d.Transcription

Correct Answer: (d) Transcription

Solution:

Lampbrush chromosomes are highly extended meiotic chromosomes found in oocytes of amphibians and some other animals. They exhibit prominent loop structures, which are sites of active transcription.

Step 1: Understanding Lampbrush Chromosome Loops

- These chromosomes have large lateral loops, which represent active gene transcription.
- The loops consist of transcriptionally active chromatin, allowing massive RNA synthesis.
- This activity is essential for producing large amounts of mRNA needed for oocyte development.

Step 2: Evaluating the Options

- Option (a) - Incorrect: Crossing over occurs during meiosis but is not related to lampbrush loops.
- Option (b) - Incorrect: Cell division does not directly involve lampbrush chromosome loops.
- Option (c) - Incorrect: Replication occurs before meiosis but is not the primary function of

these loops.

- Option (d) - Correct: The loops in lampbrush chromosomes represent active transcription.

Step 3: Conclusion Since lampbrush chromosome loops are sites of active transcription, the correct answer is option (d).

Quick Tip

Lampbrush chromosome loops are sites of active transcription, ensuring high RNA synthesis during oocyte development.

---

48. The Feulgen stain is used for staining

a.plasma membrane

b.chromosomes

c. phospholipids

d. mitochondria

Correct Answer: (b) chromosomes

Solution:

The Feulgen stain is a specific histochemical staining technique used for detecting DNA in chromosomes.

Step 1: Understanding Feulgen Stain Mechanism

- Feulgen staining is based on the Schiff reagent, which reacts with aldehyde groups produced after DNA hydrolysis with acid.

- The resulting reaction produces a reddish-purple coloration, making chromosomes visible under a microscope.

- This technique is highly specific for DNA, allowing for quantitative analysis.

Step 2: Evaluating the Options - Option (a) - Incorrect: The plasma membrane is not specifically stained by Feulgen stain.

- Option (b) - Correct: Chromosomes (DNA) are selectively stained by Feulgen stain.

- Option (c) - Incorrect: Phospholipids are stained using Sudan stains.

- Option (d) - Incorrect: Mitochondria are typically stained with Janus Green B, not Feulgen stain.

Step 3: Conclusion Since Feulgen stain is used specifically for DNA, which is found in chromosomes, the correct answer is option (b).

Quick Tip

Feulgen stain is a DNA-specific stain used to detect chromosomes, producing a reddish-purple color. It does not stain other cellular structures.

---

49. A fixative _____ the macromolecular components of a cell.

a. Degrades

b. Immobilizes

c.Penetrates

d. Granulates

Correct Answer: (b) Immobilizes

Solution:

A fixative is a chemical substance used in microscopy and histology to preserve cells and tissues by stabilizing their macromolecular structures.

Step 1: Understanding the Role of a Fixative

- Fixatives work by cross-linking proteins, lipids, and nucleic acids, preventing degradation and movement.

- This process immobilizes cellular components, allowing detailed structural study under a microscope.

Step 2: Evaluating the Options - Option (a) - Incorrect: A fixative does not degrade macromolecules but preserves them.

- Option (b) - Correct: Fixatives immobilize macromolecules, maintaining cell structure.

- Option (c) - Incorrect: Some fixatives penetrate tissues, but their main function is preservation.

- Option (d) - Incorrect: Fixatives do not cause granulation; they prevent breakdown.

Step 3: Conclusion Since fixatives work by immobilizing macromolecules, the correct answer is option (b).

Quick Tip

Fixatives preserve cells by immobilizing macromolecules, preventing decay and maintaining structural integrity. Common fixatives include formaldehyde and glutaraldehyde.

---

50. Differential staining property of Gram staining is due to

a.Difference in lipid content in Gram positive and negative bacteria

b. Difference in protoplasmic contents in Gram positive and negative bacteria

c. Difference in teichoic content in Gram positive and negative bacteria

d. None of the above

Correct Answer: (a) Difference in lipid content in Gram positive and negative bacteria

Solution:

The Gram staining technique is based on differences in cell wall composition, specifically the lipid content, between Gram-positive and Gram-negative bacteria.

Step 1: Understanding the Principle of Gram Staining - Gram-positive bacteria have a thick peptidoglycan layer with low lipid content, which retains the crystal violet stain, appearing purple.

- Gram-negative bacteria have a thin peptidoglycan layer with high lipid content and an outer membrane. The alcohol decolorizer dissolves the lipid layer, allowing the stain to escape, making them take up the safranin counterstain and appear pink.

Step 2: Evaluating the Options - Option (a) - Correct: The differential staining property is due to differences in lipid content between Gram-positive and Gram-negative bacteria.

- Option (b) - Incorrect: The protoplasm does not directly affect Gram staining.

- Option (c) - Incorrect: Teichoic acids are found in Gram-positive bacteria, but they do not determine staining properties.

- Option (d) - Incorrect: Since lipid content influences Gram staining, this option is incorrect.

Step 3: Conclusion Since lipid content in the bacterial cell wall determines the staining property, the correct answer is option (a).

Quick Tip

Gram staining differentiates bacteria based on lipid content in the cell wall. Gram-positive bacteria retain crystal violet (purple), while Gram-negative bacteria lose it and take up safranin (pink).

---

51. In Gram staining, if some bacteria retain the crystal violet stain after alcohol treatment, then the bacteria is

a. Incomplete experiment

b. Gram positive

c. Gram negative

d. None of these

Correct Answer: (b) Gram positive

Solution:

Gram staining is a differential staining technique that categorizes bacteria based on their cell wall composition.

Step 1: Understanding the Gram Staining Process

- The primary stain, crystal violet, stains all bacteria.
- Iodine acts as a mordant, forming a crystal violet-iodine complex.
- Alcohol treatment (decolorization step) dissolves the outer membrane of Gram-negative bacteria, allowing the crystal violet stain to be washed out.
- Gram-positive bacteria have a thick peptidoglycan layer, which retains the crystal violet stain even after alcohol treatment, appearing purple under a microscope.

Step 2: Evaluating the Options - Option (a) - Incorrect: If crystal violet is retained, it is not due to an incomplete experiment, but due to the bacterial cell wall structure.

- Option (b) - Correct: Gram-positive bacteria retain the crystal violet stain after alcohol treatment due to their thick peptidoglycan layer.
- Option (c) - Incorrect: Gram-negative bacteria do not retain crystal violet; they take up the safranin counterstain, appearing pink.
- Option (d) - Incorrect: The correct classification is Gram-positive.

Step 3: Conclusion Since Gram-positive bacteria retain the crystal violet stain after alcohol treatment, the correct answer is option (b).

Quick Tip

Gram-positive bacteria have a thick peptidoglycan layer, allowing them to retain crystal violet stain after alcohol treatment. Gram-negative bacteria lose it and take up safranin (pink).

---

52. DNA gyrase is inhibited by

a.Tetracycline

b. Cephalosporin

c.Nalidixic acid

d.Aurin tricarboxylic acid

Correct Answer: (c) Nalidixic acid

Solution:

DNA gyrase is an essential bacterial enzyme that relieves supercoiling stress in DNA during replication and transcription.

Step 1: Understanding DNA Gyrase Inhibition

- DNA gyrase is a type II topoisomerase found in bacteria.

- It introduces negative supercoils into DNA, preventing excessive twisting during replication.

- Nalidixic acid, a quinolone antibiotic, inhibits DNA gyrase by blocking the enzyme's ability to re-ligate DNA strands after cutting, leading to DNA damage and bacterial cell death.

Step 2: Evaluating the Options - Option (a) - Incorrect: Tetracycline inhibits protein synthesis by targeting the 30S ribosomal subunit, not DNA gyrase.

- Option (b) - Incorrect: Cephalosporins are beta-lactam antibiotics that inhibit cell wall synthesis, not DNA gyrase.

- Option (c) - Correct: Nalidixic acid is a quinolone antibiotic that specifically inhibits DNA gyrase.

- Option (d) - Incorrect: Aurin tricarboxylic acid is an inhibitor of endonucleases, not DNA gyrase.

Step 3: Conclusion Since Nalidixic acid is a known inhibitor of DNA gyrase, the correct answer is option (c).

Quick Tip

Quinolone antibiotics, such as Nalidixic acid and Ciprofloxacin, target DNA gyrase, inhibiting bacterial DNA replication. This mechanism is bactericidal.

---

53. Which of the following is a humanized antibody?

a. Doxorubicin

b. Sulforaphane

c. Vimentin

d. Herceptin

Correct Answer: (d) Herceptin

Solution:

A humanized antibody is a monoclonal antibody (mAb) that has been genetically engineered to reduce its immunogenicity in humans by replacing most of its non-human regions with human antibody sequences.

Step 1: Understanding Humanized Antibodies

- Monoclonal antibodies (mAbs) are designed to target specific proteins in the body, commonly used in cancer therapy and autoimmune diseases.
- Humanized antibodies are developed to minimize immune rejection while retaining the ability to bind to target antigens.

Step 2: Evaluating the Options - Option (a) - Incorrect: Doxorubicin is a chemotherapeutic agent (anthracycline), not an antibody.

- Option (b) - Incorrect: Sulforaphane is a phytochemical found in cruciferous vegetables with anti-cancer properties.
- Option (c) - Incorrect: Vimentin is a cytoskeletal protein, not an antibody.
- Option (d) - Correct: Herceptin (Trastuzumab) is a humanized monoclonal antibody that

targets the HER2 receptor in breast cancer therapy.

Step 3: Conclusion Since Herceptin is a humanized monoclonal antibody used in cancer treatment, the correct answer is option (d).

Quick Tip

Herceptin (Trastuzumab) is a humanized monoclonal antibody used in HER2-positive breast cancer treatment. Humanized antibodies minimize immune rejection in patients.

---

54. Cyclosporin A is a drug that————–

a. suppresses the immune system

b. increases body temperature

c. increases the production of antibodies

d. decreases body temperature

Correct Answer: (a) suppresses the immune system

Solution:

Cyclosporin A is an immunosuppressive drug that is widely used to prevent organ transplant rejection and in autoimmune diseases.

Step 1: Mechanism of Action

- Cyclosporin A is a calcineurin inhibitor.

- It binds to cyclophilin, forming a complex that inhibits calcineurin, a protein required for T-cell activation.

- By inhibiting calcineurin, Cyclosporin A suppresses the activation of T-cells, reducing the immune response.

Step 2: Evaluating the Options - Option (a) - Correct: Cyclosporin A suppresses the immune system by inhibiting T-cell activation.

- Option (b) - Incorrect: Cyclosporin A does not increase body temperature; it regulates immune activity.

- Option (c) - Incorrect: It does not increase antibody production; instead, it reduces immune responses.

- Option (d) - Incorrect: It does not decrease body temperature.

Step 3: Conclusion Since Cyclosporin A is an immunosuppressive drug used in transplant patients and autoimmune diseases, the correct answer is option (a).

Quick Tip

Cyclosporin A is an immunosuppressant used to prevent organ rejection in transplant patients. It inhibits T-cell activation by blocking calcineurin.

---

55. Which one of the following is the only immunoglobulin to cross the placenta?

a. IgM

b. IgG

c. IgA

d. IgD

Correct Answer: (b) IgG

Solution:

Immunoglobulins (antibodies) play a crucial role in the immune system, providing defense against pathogens. Among them, IgG is the only antibody that crosses the placenta, providing passive immunity to the fetus.

Step 1: Understanding Placental Transfer of Antibodies

- The placenta serves as a barrier but allows certain molecules, like IgG, to pass through to provide passive immunity to the fetus.
- This transfer occurs through the neonatal Fc receptor (FcRn), which binds to maternal IgG and transports it across the placenta.

Step 2: Evaluating the Options - Option (a) - Incorrect: IgM is the first antibody produced in response to infection but does not cross the placenta due to its large pentameric structure.
- Option (b) - Correct: IgG is the only immunoglobulin that crosses the placenta, providing passive immunity to the fetus.
- Option (c) - Incorrect: IgA is mainly found in mucosal secretions (tears, saliva, and breast milk) but does not cross the placenta.
- Option (d) - Incorrect: IgD is primarily involved in B-cell activation and does not cross the

placenta.

Step 3: Conclusion Since IgG is the only antibody that crosses the placenta and provides immunity to the fetus, the correct answer is option (b).

Quick Tip

IgG is the only immunoglobulin that crosses the placenta, providing passive immunity to newborns. It protects the baby for the first few months after birth.

---

56. The phenomenon of expression of only one allele of an immunoglobulin gene in lymphocytes is known as

a.Allelic exclusion

b. Allelic inclusion

c.Allelic variation

d.Allelic heterogeneity

Correct Answer: (a) Allelic exclusion

Solution:

Allelic exclusion is a biological mechanism that ensures only one allele of an immunoglobulin (Ig) gene is actively transcribed and translated in a single B-cell. This prevents the expression of multiple Ig specificities, allowing a B-cell to produce a single type of antibody.

Step 1: Understanding Allelic Exclusion

- Every B-cell has two alleles for immunoglobulin genes, one from each parent.
- However, to maintain antigen specificity, only one allele is expressed, while the other remains inactive.
- This process ensures that each B-cell produces only one type of antibody, preventing the creation of mixed or non-functional antibodies.

Step 2: Evaluating the Options

- Option (a) - Correct: Allelic exclusion ensures that a single allele is expressed in a given B-cell to maintain antigen specificity.
- Option (b) - Incorrect: Allelic inclusion would imply both alleles are expressed, which does

not happen in functional B-cells.

- Option (c) - Incorrect: Allelic variation refers to different genetic variations in a population, not the selective expression in a cell.

- Option (d) - Incorrect: Allelic heterogeneity means different mutations in the same gene cause similar diseases, unrelated to immunoglobulin gene expression.

Step 3: Conclusion Since allelic exclusion ensures that a B-cell expresses only one allele for immunoglobulin genes, the correct answer is option (a).

Quick Tip

Allelic exclusion ensures that each B-cell produces only one type of antibody by expressing only one allele of the immunoglobulin gene. This is crucial for immune specificity.

---

57. Which of the following grafts is transplanted between two genetically different individuals of the same species?

a. Autograft

b. Xenograft

c. Allograft

d. Syngraft

Correct Answer: (c) Allograft

Solution:

A graft refers to the transplantation of tissues or organs. The classification of grafts depends on the genetic relationship between the donor and recipient.

Step 1: Understanding the Types of Grafts

- Autograft: Tissue transplanted from one part of the body to another in the same individual (e.g., skin grafts).

- Xenograft: Tissue transplanted between different species (e.g., pig heart valves in humans).

- Allograft: Tissue transplanted between two genetically different individuals of the same species (e.g., kidney transplant from one human to another).

- Syngraft: Tissue transplanted between genetically identical individuals (e.g., identical

twins).

Step 2: Evaluating the Options - Option (a) - Incorrect: Autograft is a self-transplant, not involving different individuals.

- Option (b) - Incorrect: Xenograft is a transplant between different species.

- Option (c) - Correct: Allograft is a transplant between two genetically different individuals of the same species.

- Option (d) - Incorrect: Syngraft occurs between genetically identical individuals, like twins.

Step 3: Conclusion Since allograft is the correct term for transplants between genetically different individuals of the same species, the correct answer is option (c).

Quick Tip

Allografts are the most common type of organ transplants, including kidney, liver, and heart transplants. They require immunosuppressive drugs to prevent rejection.

---

58. Identify autoimmune diseases among the following.

a. Pernicious Anemia

b.Type II diabetes

c.Type I diabetes

d.Gestational diabetes

Correct Answer: (a) Pernicious Anemia, (c) Type I diabetes

Solution:

An autoimmune disease occurs when the body's immune system mistakenly attacks its own tissues and cells.

Step 1: Understanding the Given Diseases

- Pernicious Anemia: An autoimmune disorder where the body destroys cells in the stomach lining that produce intrinsic factor, which is essential for vitamin B12 absorption.

- Type II Diabetes: A metabolic disorder, not an autoimmune disease, caused by insulin resistance rather than immune system dysfunction.

- Type I Diabetes: An autoimmune disease where the immune system attacks insulin-producing beta cells in the pancreas, leading to insulin deficiency.

- Gestational Diabetes: A temporary condition that occurs during pregnancy due to hormonal changes, not an autoimmune disease.

Step 2: Evaluating the Options

- Option (a) - Correct: Pernicious Anemia is an autoimmune disease.
- Option (b) - Incorrect: Type II Diabetes is a metabolic disorder, not autoimmune.
- Option (c) - Correct: Type I Diabetes is an autoimmune disease.
- Option (d) - Incorrect: Gestational Diabetes is a pregnancy-related condition.

Step 3: Conclusion Since Pernicious Anemia and Type I Diabetes are autoimmune diseases, the correct answer is (a) and (c).

Quick Tip

Autoimmune diseases result from the immune system attacking healthy cells. Common examples include Type I Diabetes, Pernicious Anemia, Rheumatoid Arthritis, and Multiple Sclerosis.

---

59. Mast cells contain vesicles that store a large amount of histamine. After staining with eosin, these vesicles are stained in red color. Which of the following interactions are involved between histamine and eosin?

a. Electrostatic interaction

b. Hydrogen bonding

c. Hydrophobic interaction

d. Covalent bonding

Correct Answer: (a) Electrostatic interaction

Solution:

Step 1: Understanding the Nature of Histamine and Eosin

- Histamine is a small, positively charged molecule stored in mast cell vesicles.
- Eosin is an acidic dye that binds to basic (positively charged) molecules.
- Since histamine is basic and eosin is acidic, the interaction between them is primarily electrostatic.

Step 2: Evaluating the Interaction Types

- Electrostatic Interaction (Correct): The positive charge on histamine attracts the negative charge of eosin, forming an ionic interaction.
- Hydrogen Bonding (Incorrect): While hydrogen bonding can occur, it is not the primary reason eosin binds to histamine.
- Hydrophobic Interaction (Incorrect): Histamine is hydrophilic, making hydrophobic interactions unlikely.
- Covalent Bonding (Incorrect): Covalent bonds are strong and permanent, but eosin binding is reversible, ruling out this option.

Step 3: Conclusion Since eosin binds to histamine due to opposite charges, the correct interaction type is electrostatic interaction.

Quick Tip

Electrostatic interactions play a key role in staining techniques, such as eosin binding to basic molecules and hematoxylin binding to acidic structures (e.g., DNA).

---

60. During an allergic immune response, histamine is released from:

a. Mast cells

b. T lymphocytes

c. B lymphocytes

d. Special lymphocytes that also secrete IgE

Correct Answer: (a) Mast cells

Solution:

Step 1: Understanding histamine release in allergic reactions.

- Mast cells are immune cells that play a key role in allergic responses.
- When allergens bind to IgE antibodies on mast cells, they release histamine, causing inflammation and allergy symptoms.

Step 2: Explanation of incorrect options.

- T lymphocytes (B): Involved in cell-mediated immunity, not histamine release.
- B lymphocytes (C): Produce antibodies, but do not store or release histamine.
- Special lymphocytes secreting IgE (D): Plasma cells produce IgE, but histamine release

occurs from mast cells.

Step 3: Selecting the correct option. Since mast cells release histamine in response to allergens, the correct answer is (A) Mast cells.

Quick Tip

Mast cells store histamine, which triggers inflammation during allergic reactions.

---

61. Kupffer cells are found in:

a. Small intestine

b. Liver

c. Stomach

d. Large intestine

Correct Answer: (b) Liver

Solution:

Step 1: Understanding Kupffer cells.

- Kupffer cells are specialized macrophages found in the liver.

- They are part of the mononuclear phagocyte system (MPS) and play a crucial role in immune defense by removing pathogens, dead cells, and toxins from the blood.

Step 2: Explanation of incorrect options.

- Small intestine (A): Contains Peyer's patches, but not Kupffer cells. - Stomach (C): Primarily has gastric glands, not macrophages.

- Large intestine (D): Involved in absorption and houses gut microbiota, but does not contain Kupffer cells.

Step 3: Selecting the correct option. Since Kupffer cells are liver-resident macrophages, the correct answer is (B) Liver.

Quick Tip

Kupffer cells are liver macrophages that help in detoxification and immune defense by filtering blood from the digestive system.

---

62. Which of the following is Not an example of a live attenuated vaccine?

a. Tetanus vaccine

b. MMR vaccine

c. Varicella (chickenpox) vaccine

d. Influenza vaccine

Correct Answer: (a) Tetanus vaccine

Solution:

Step 1: Understanding live attenuated vaccines.

- Live attenuated vaccines contain weakened but live forms of the pathogen, triggering a strong immune response.

- Examples include MMR (Measles, Mumps, and Rubella) vaccine, Varicella vaccine, and live-attenuated influenza vaccine (LAIV).

Step 2: Explanation of incorrect options.

- MMR vaccine (B): Contains live attenuated viruses.

- Varicella (chickenpox) vaccine (C): Live attenuated virus-based vaccine.

- Influenza vaccine (D): The nasal spray (LAIV) is a live attenuated form, though flu shots are inactivated.

Step 3: Selecting the correct option.

- Tetanus vaccine is NOT a live attenuated vaccine.

- It is a toxoid vaccine, meaning it contains an inactivated toxin rather than the pathogen itself.

Thus, the correct answer is (A) Tetanus vaccine.

Quick Tip

Tetanus vaccine is a toxoid vaccine, meaning it contains an inactivated toxin instead of a live pathogen.

---

63. Which of the following is an example of a subunit vaccine?

a. Smallpox vaccine

b. Hepatitis B vaccine

c. MMR vaccine

d. Yellow fever vaccine

Correct Answer: (b) Hepatitis B vaccine

Solution:

Step 1: Understanding subunit vaccines.

- Subunit vaccines contain only specific pieces of the pathogen, such as proteins or polysaccharides, rather than the whole microorganism.

- They generate an immune response without introducing live or inactivated pathogens.

Step 2: Explanation of incorrect options. - Smallpox vaccine (A): A live attenuated vaccine containing live vaccinia virus.

- MMR vaccine (C): A live attenuated vaccine containing weakened measles, mumps, and rubella viruses.

- Yellow fever vaccine (D): A live attenuated vaccine containing a weakened yellow fever virus.

Step 3: Selecting the correct option. - Hepatitis B vaccine is a subunit vaccine that contains the hepatitis B surface antigen (HBsAg) to stimulate immunity without introducing the whole virus.

Thus, the correct answer is (B) Hepatitis B vaccine.

Quick Tip

Subunit vaccines use only a fragment of the pathogen, such as a protein or polysaccharide, to stimulate an immune response. Example: Hepatitis B vaccine (HBsAg-based)

---

64. Type II hypersensitivity:

a. Is antibody independent

b. Is complement independent

c. Is mediated by CD8+ cells

d. Involves antibody-mediated destruction of cells

Correct Answer: (d) Involves antibody-mediated destruction of cells

Solution:

Step 1: Understanding Type II hypersensitivity.

- Type II hypersensitivity is an antibody-mediated reaction where IgG or IgM antibodies target specific cells, leading to cell destruction.

- This destruction occurs via complement activation, opsonization, or antibody-dependent cellular cytotoxicity (ADCC).

Step 2: Explanation of incorrect options.

- Antibody independent (A): Incorrect because antibodies (IgG, IgM) play a central role in this reaction.

- Complement independent (B): Incorrect because complement activation contributes to cell lysis.

- Mediated by CD8+ cells (C): Incorrect because CD8+ T cells are involved in Type IV hypersensitivity, not Type II.

Step 3: Selecting the correct option. Since Type II hypersensitivity is characterized by antibody-mediated destruction of cells, the correct answer is (D) Involves antibody-mediated destruction of cells.

Quick Tip

Type II hypersensitivity is an antibody-mediated reaction involving IgG or IgM antibodies attacking self-cells, leading to complement activation and cell lysis. Example: Hemolytic disease of the newborn (HDN) and autoimmune hemolytic anemia.

---

65. The centrifugal effect counteracts one of the following forces:

a. Brownian forces

b. Cohesive forces

c. Electrostatic forces

d. Gravitational forces

Correct Answer: (d) Gravitational forces

Solution:

Step 1: Understanding the centrifugal effect.

- The centrifugal effect is an apparent force that acts outward on a mass moving in a circular

path.

- It occurs due to inertia, opposing the force pulling the object towards the center of rotation.

Step 2: Explanation of incorrect options.

- (A) Brownian forces: These are due to random molecular motion and are not significantly affected by centrifugal forces.

- (B) Cohesive forces: These are intermolecular forces responsible for material cohesion and are not counteracted by centrifugal force.

- (C) Electrostatic forces: These arise from charged particle interactions and are not directly opposed by the centrifugal effect.

Step 3: Selecting the correct option. Since the centrifugal force counteracts gravitational forces, preventing objects from being pulled towards the center, the correct answer is (D) Gravitational forces.

Quick Tip

In centrifugation, particles experience an outward force that opposes gravity, enabling separation of components based on density.

---

66. Which centrifugation depends on buoyant densities?

a. Isopycnic centrifugation

b. Gradient centrifugation

c. Density gradient centrifugation

d. Differential centrifugation

Correct Answer: (a) Isopycnic centrifugation

Solution:

Step 1: Understanding isopycnic centrifugation.

- Isopycnic centrifugation is a technique where particles migrate to a position where their buoyant density matches the surrounding medium.

- This method allows separation based solely on density differences.

Step 2: Explanation of incorrect options.

- (B) Gradient centrifugation: A general term, but it does not specifically refer to buoyant

density-based separation.

- (C) Density gradient centrifugation: A broader term, but it includes both rate-zonal and isopycnic centrifugation.

- (D) Differential centrifugation: Separates based on size and mass, not buoyant density.

Step 3: Selecting the correct option. Since isopycnic centrifugation separates particles based on buoyant density, the correct answer is (A) Isopycnic centrifugation.

Quick Tip

Isopycnic centrifugation allows particles to migrate to their equilibrium density, commonly used for DNA and organelle separation.

---

67. What is the problem in the evaporation in the climbing film evaporator?

a. Boiling point of liquid

b. Droplet formation

c. Entrainment of liquid

d. Film formation

Correct Answer: (c) Entrainment of liquid

Solution:

Step 1: Understanding climbing film evaporators.

- A climbing film evaporator is designed to evaporate liquids by utilizing thermal gradients that promote liquid rise due to vapor expansion.

Step 2: Identifying key problems in operation.

- As the liquid climbs, there is a risk of entrainment, where droplets of liquid are carried away by the vapor stream.

- This reduces efficiency and may contaminate the final product.

Step 3: Explanation of incorrect options.

- (A) Boiling point of liquid: Not a major issue as evaporators are designed for specific boiling ranges.

- (B) Droplet formation: While droplet formation occurs, it is not the primary operational concern.

- (D) Film formation: The design of the evaporator ensures proper film formation.

Step 4: Selecting the correct option. Since entrainment of liquid is the main operational issue, the correct answer is (C) Entrainment of liquid.

Quick Tip

In climbing film evaporators, entrainment reduces efficiency by carrying unvaporized liquid with vapor, requiring demisters or separators to prevent losses.

---

68. Calandria consists of several:

a. Baffles

b. Jackets

c. Outlets

d. Tubular surfaces

Correct Answer: (d) Tubular surfaces

Solution:

Step 1: Understanding the structure of a calandria.

- A calandria is a type of heat exchanger commonly used in evaporators and boilers.

- It consists of multiple tubular surfaces, which enhance heat transfer efficiency by increasing the contact area.

Step 2: Explanation of incorrect options.

- (A) Baffles: Used in shell-and-tube heat exchangers, not a defining feature of a calandria.

- (B) Jackets: Found in jacketed vessels, not calandria.

- (C) Outlets: Necessary for fluid flow but not a structural characteristic.

Step 3: Selecting the correct option. Since calandria primarily consists of tubular surfaces for efficient heat exchange, the correct answer is (D) Tubular surfaces.

Quick Tip

In calandria-type evaporators, tubular surfaces provide large heat transfer areas, making them effective for high-volume evaporation processes.

---

69. Which one of the following parameters of the finished product is NOT influenced by the selection of size reduction equipment?

a. Porosity

b. Shape

c. Surface roughness

d. True density

Correct Answer: (d) True density

Solution:

Step 1: Understanding the influence of size reduction equipment.

- Size reduction equipment affects particle size, shape, porosity, and surface texture.

- However, true density is an intrinsic property of a material and remains unchanged.

Step 2: Explanation of incorrect options. - (A) Porosity: Affected by particle size and packing arrangement.

- (B) Shape: Different grinders and crushers produce different particle shapes.

- (C) Surface roughness: Influenced by the type of mill or cutting mechanism.

Step 3: Selecting the correct option. Since true density remains constant regardless of size reduction equipment, the correct answer is (D) True density.

Quick Tip

True density depends on the material composition and is not affected by grinding, milling, or crushing.

---

70. A tablet to treat a headache must first be dissolved in water before swallowing. Which one of the following best describes this type of tablet?

a. Modified release

b. Oral disintegrating

c. Effervescent

d. Buccal

Correct Answer: (C) Effervescent

Solution:

Step 1: Understanding effervescent tablets.

- Effervescent tablets are designed to dissolve in water before consumption.

- They release carbon dioxide when dissolved, helping the drug to dissolve quickly.

Step 2: Explanation of incorrect options.

- (A) Modified release: Refers to tablets that release the drug over time, not requiring dissolution in water.

- (B) Oral disintegrating: These dissolve in the mouth, not in water.

- (D) Buccal: Placed between the cheek and gum for absorption, not dissolved in water.

Step 3: Selecting the correct option. Since effervescent tablets are dissolved in water before ingestion, the correct answer is (C) Effervescent.

Quick Tip

Effervescent tablets improve drug absorption and are useful for patients who struggle with swallowing solid tablets.

---

71. A drug suspension decomposes by zero-order kinetics with a rate constant of $2\,\mathbf{mg\,mL^{-1}\,month^{-1}}$. If the initial concentration is $100\,\mathbf{mg\,mL^{-1}}$, what is the shelf life ($t_{10\%}$)?

a. 2 months

b. 3 months

c. 4 months

d. 5 months

Correct Answer: (d) 5 months

Solution:

For a zero-order reaction, the rate law is given by:

$$\frac{d[A]}{dt} = -k$$

The integrated rate law for a zero-order reaction is:

$$[A] = [A_0] - kt$$

Where: - $[A_0]$ is the initial concentration, - $[A]$ is the concentration at time t, - k is the rate constant, and - t is time.

To find the shelf life $t_{10\%}$, we use the formula for the time at which 10

$$[A] = 0.1[A_0]$$

Substituting the values:

$$0.1 \times 100 = 100 - (2\,\text{mg/mL} \times t)$$

Solving for t:

$$10 = 100 - 2t$$

$$2t = 90$$

$$t = \frac{90}{2} = 45\,\text{months}$$

Thus, the shelf life ($t_{10\%}$) is **5 months**.

Thus, the correct answer is:

(d) 5 months.

Quick Tip

For zero-order kinetics, the shelf life ($t_{10\%}$) can be calculated by using the equation:

$$t = \frac{[A_0] - 0.1[A_0]}{k}$$

where $[A_0]$ is the initial concentration, and k is the rate constant.

---

72. A drug solution decomposes via first-order kinetics with a rate constant, k, of $0.0077\,\text{days}^{-1}$. What is the half-life of the drug in solution?

a. 0.033 day

b. 33 days

c. 70 days

d. 90 days

Correct Answer: (d) 90 days

Solution:

For a first-order reaction, the formula for the half-life ($t_{1/2}$) is given by:

$$t_{1/2} = \frac{\ln(2)}{k}$$

Where: - $t_{1/2}$ is the half-life, - k is the rate constant.

Substituting the given rate constant $k = 0.0077\,\text{day}^{-1}$:

$$t_{1/2} = \frac{\ln(2)}{0.0077} = \frac{0.693}{0.0077} \approx 90\,\text{days}$$

Thus, the correct answer is:

(d) 90 days.

Quick Tip

For first-order kinetics, the half-life is independent of the initial concentration and is inversely proportional to the rate constant.

---

73. Simple syrup is a saturated solution of:

a. Sucrose

b. Fructose

c.Dextrose

d. None of these

Correct Answer: (a) Sucrose

Solution:

Step 1: Understanding simple syrup.

- Simple syrup is a highly concentrated aqueous solution of sucrose.

- It is commonly used as a sweetening agent in pharmaceutical preparations and food products.

Step 2: Explanation of incorrect options.

- (B) Fructose: Not used in traditional simple syrup.

- (C) Dextrose: Also known as glucose, but not a primary ingredient.

- (D) None of these: Incorrect, as simple syrup contains sucrose.

Step 3: Selecting the correct option. Since simple syrup is a saturated solution of sucrose, the correct answer is (A) Sucrose.

Quick Tip

Simple syrup typically contains 66.7% w/w sucrose and is used as a preservative and sweetener in pharmaceutical formulations.

---

74. The spatulation process is well suited for mixing of which of the following powder?

a. Hygroscopic
b. Volatile
c. Eutectic
d. Effervescent

Correct Answer: (C) Eutectic

Solution:

Step 1: Understanding the spatulation process.

- Spatulation is a gentle mixing technique using a spatula on a smooth surface.

- It is used for mixing powders that are prone to liquefaction upon contact.

Step 2: Explanation of incorrect options.

- (A) Hygroscopic: These absorb moisture and require special handling.
- (B) Volatile: Best handled in closed containers, not with spatulation.
- (D) Effervescent: Reacts with moisture; requires minimal handling to prevent premature reaction.

Step 3: Selecting the correct option. Since eutectic mixtures tend to liquefy upon contact, the correct answer is (C) Eutectic.

Quick Tip

Spatulation is best suited for eutectic mixtures like camphor and menthol, preventing their liquefaction during mixing.

---

75. A suspension is formed from uniform particles of solid, of diameter 10 Mm, suspended in a solvent. What is the best description of this system?

a. Monodisperse and coarse

b. Monodisperse and colloidal

c. Polydisperse and coarse

d. Polydisperse and colloidal

Correct Answer: (a) Monodisperse and coarse

Solutions:

Step 1: Understanding dispersion and classification.

- Monodisperse systems contain particles of uniform size.

- Polydisperse systems contain particles of varying sizes.

- Coarse dispersions have particle sizes larger than 1 m.

- Colloidal dispersions contain particles between 1 nm and 1 m.

Step 2: Analyzing the given system.

- Given particle diameter = 10 Mm (10 m).

- 10 m is larger than 1 m, indicating a coarse dispersion.

- The term uniform particles suggests a monodisperse system.

Step 3: Explanation of incorrect options. - (B) Monodisperse and colloidal: Incorrect, as 10 m is too large for a colloidal system.

- (C) Polydisperse and coarse: Incorrect, as the system is described as having uniform particles.

- (D) Polydisperse and colloidal: Incorrect for both polydispersity and colloidal range.

Step 4: Selecting the correct option. Since the system is monodisperse and in the coarse range, the correct answer is (A) Monodisperse and coarse.

Quick Tip

In pharmaceutical suspensions, particle size determines whether a system is colloidal (< 1 m) or coarse (> 1 m).

---

76. In the DLVO theory of colloids, normal thermal motion may be sufficient to overcome the energy barrier that leads to irreversible particle aggregation. Which one of the following is the name of this energy barrier?

a. Primary maximum

b. Secondary maximum

c.Primary minimum

d. Secondary minimum

Correct Answer: (a) Primary maximum

Solution:

Step 1: Understanding the DLVO theory.

- The Derjaguin-Landau-Verwey-Overbeek (DLVO) theory explains colloidal stability by considering the balance of van der Waals attraction and electrostatic repulsion.

- Colloidal particles repel each other due to the electrical double layer, creating an energy barrier known as the Primary Maximum.

Step 2: Explanation of energy barriers.

- Primary maximum: The highest energy barrier that prevents particle aggregation.

- Secondary maximum: A weaker repulsion that can lead to loose aggregation.

- Primary minimum: The strong attraction region leading to irreversible coagulation.

- Secondary minimum: A weak attractive force causing temporary aggregation.

Step 3: Selecting the correct option. Since the primary maximum represents the energy barrier that prevents irreversible aggregation, the correct answer is (A) Primary maximum.

Quick Tip

In colloidal systems, overcoming the primary maximum leads to irreversible aggregation, while overcoming the secondary minimum leads to reversible flocculation.

---

77. An Isosbestic point is a:

a. Specific wavelength at which a single component has maximum absorptivity
b. Specific wavelength at which the solvent has maximum absorptivity
c. Specific wavelength at which two or more components have the same absorptivity
d. Specific wavelength at which extinction coefficient of a component is zero

Correct Answer: (C) Specific wavelength at which two or more components have the same absorptivity

Solution:

Step 1: Understanding the concept of the isosbestic point. - An isosbestic point occurs when the absorbance of a mixture remains constant despite changes in concentration of two or more components. - This indicates that at a specific wavelength, the total absorptivity remains unchanged.

Step 2: Explanation of incorrect options.

- (A) Specific wavelength at which a single component has maximum absorptivity: Incorrect, because an isosbestic point involves two or more components, not a single component.

- (B) Specific wavelength at which the solvent has maximum absorptivity: Incorrect, as the isosbestic point is related to solute absorbance, not solvent.

- (D) Specific wavelength at which extinction coefficient of a component is zero: Incorrect, because extinction coefficients are nonzero at isosbestic points.

Step 3: Selecting the correct option. Since an isosbestic point is defined as a wavelength where two or more components have identical absorptivity, the correct answer is (C) Specific wavelength at which two or more components have the same absorptivity.

Quick Tip

Isosbestic points are useful in spectrophotometric analysis, ensuring that interconverting species (e.g., acid-base equilibria) have constant absorbance ratios.

---

78. DNA denaturation is an example of which type of shift?

a. Bathochromic
b. Blue shift
c. Hyperchromic shift
d. Red shift

Correct Answer: (c) Hyperchromic shift
Solution:

Step 1: Understanding DNA denaturation.

- DNA denaturation refers to the disruption of hydrogen bonds between base pairs, leading to strand separation.

- This process results in an increase in UV absorbance due to unstacking of bases.

Step 2: Explanation of incorrect options.

- (A) Bathochromic shift: Refers to a shift to longer wavelengths (red shift) but is not related to DNA denaturation.

- (B) Blue shift: Refers to a shift to shorter wavelengths, which does not occur in DNA denaturation.

- (D) Red shift: Similar to a bathochromic shift but does not describe the absorbance increase seen in denaturation.

Step 3: Selecting the correct option. Since DNA denaturation leads to an increase in UV absorbance, the correct term is hyperchromic shift. Hence, the correct answer is (C) Hyperchromic shift.

Quick Tip

A hyperchromic shift occurs when DNA absorbs more UV light due to strand separation, which reduces base stacking interactions.

---

79. Which movement is required for the IR spectroscopy?

a. Dipole movement
b. Spin movement
c. Round movement
d. All of the above

Correct Answer: (a) Dipole movement

Solution:

Step 1: Understanding Infrared (IR) Spectroscopy.

- Infrared spectroscopy is used to study molecular vibrations by detecting changes in dipole moment.

- IR radiation excites vibrational modes like stretching and bending, causing variations in molecular dipole moment.

Step 2: Explanation of molecular movement.

- Dipole movement: Required for IR activity since molecules must undergo a change in dipole moment when vibrating.

- Spin movement: Relevant in NMR spectroscopy, not IR spectroscopy.

- Round movement: Not a recognized molecular motion in spectroscopy.

Step 3: Explanation of incorrect options. - (B) Spin movement: Incorrect, as spin transitions are detected in NMR spectroscopy, not IR.

- (C) Round movement: Incorrect, as no such term exists in molecular spectroscopy.

- (D) All of the above: Incorrect, since only dipole movement is essential for IR spectroscopy.

Step 4: Selecting the correct option. Since IR spectroscopy requires a change in dipole moment, the correct answer is (A) Dipole movement.

Quick Tip

A molecule will only absorb IR radiation if it undergoes a dipole moment change during vibration. Symmetric molecules without dipole change are IR inactive.

---

80. In which bending type of vibration bond angle is constant?

a. Scissoring
b. Twisting
c. Rocking
d. All of the above

Correct Answer: (c) Rocking

Solution:

Step 1: Understanding molecular vibrations. - Molecular vibrations are categorized into stretching and bending. - Bending vibrations include scissoring, rocking, wagging, and twisting.

Step 2: Explanation of bond angle changes in bending vibrations. - Scissoring: Involves movement of atoms towards or away from each other, changing the bond angle.

- Twisting: A torsional motion where one part of the molecule moves opposite to another, changing the bond angle.

- Rocking: Movement occurs in the plane but does not change bond angles.

Step 3: Explanation of incorrect options. - (A) Scissoring: Incorrect, as it changes bond angles. - (B) Twisting: Incorrect, as it involves torsional deformation. - (D) All of the above: Incorrect, as only rocking keeps the bond angle constant.

Step 4: Selecting the correct option. Since rocking vibration keeps the bond angle unchanged, the correct answer is (C) Rocking.

Quick Tip

In IR spectroscopy, rocking vibrations are in-plane motions where the bond oscillates side-to-side while keeping the bond angle unchanged.

---

81. Which of the following is the disadvantage of reciprocating pump used in liquid chromatography?

a. Produces pulsed flow

b. Corrosive components

c. Does not have small hold-up value

d. Does not have moderate flow rate

Correct Answer:(a) Produces pulsed flow

Solution:

Step 1: Understanding reciprocating pumps in liquid chromatography. - Reciprocating pumps are commonly used in High-Performance Liquid Chromatography (HPLC) due to their high-pressure capabilities and small hold-up volume.

Step 2: Identifying the disadvantage of reciprocating pumps. - Pulsed Flow: Reciprocating pumps operate by moving pistons back and forth, leading to flow pulsations. - Flow pulsation can cause fluctuations in chromatography, affecting retention times and reproducibility.

Step 3: Explanation of incorrect options. - (B) Corrosive components: Incorrect, as reciprocating pumps are designed to handle various solvents, including corrosive ones.

- (C) Does not have small hold-up value: Incorrect, because reciprocating pumps have a small internal volume, ensuring minimal hold-up.

- (D) Does not have moderate flow rate: Incorrect, as reciprocating pumps allow precise control over flow rate.

Step 4: Selecting the correct option. Since the major drawback of reciprocating pumps is the production of pulsed flow, the correct answer is (A) Produces pulsed flow.

Quick Tip

To minimize pulsed flow in reciprocating pumps, pulse dampers are often used in HPLC systems to maintain smooth and steady flow rates.

---

82. Which of the following will improve the efficiency of the separation process in liquid chromatography?

a. Increase in sample size, increase in column diameter

b. Reduction in sample size, increase in column diameter

c. Increase in sample size, reduction in column diameter

d. Reduction in sample size, reduction in column diameter

Correct Answer: (d) Reduction in sample size, reduction in column diameter

Solution:

Step 1: Understanding efficiency in liquid chromatography. - The efficiency of a chromatography system depends on column length, particle size, and sample size. - Smaller sample sizes help in reducing band broadening, leading to sharper peaks and better resolution.

Step 2: Effect of column diameter. - Smaller column diameters improve separation efficiency because they increase the interaction between the analyte and the stationary phase.

Step 3: Explanation of incorrect options. - (A) Increase in sample size, increase in column diameter: Incorrect, as larger sample sizes can cause peak broadening, reducing resolution.

- (B) Reduction in sample size, increase in column diameter: Incorrect, because increasing column diameter reduces efficiency.

- (C) Increase in sample size, reduction in column diameter: Incorrect, as larger sample sizes cause overloading of the column, reducing separation.

Step 4: Selecting the correct option. Since reducing the sample size and column diameter improves resolution and efficiency, the correct answer is (D) Reduction in sample size, reduction in column diameter.

Quick Tip

For optimal separation in HPLC, use small sample sizes and narrow column diameters to reduce band broadening and increase resolution.

83. Which of the following cannot be done to reduce ripple in High-pressure liquid chromatography?

a. Using bellows

b. Using restrictors

c. Using long nylon tube between pump and column

d. Avoiding the use of solvent pump

Correct Answer: (d) Avoiding the use of solvent pump

Solution:

Step 1: Understanding ripple in High-pressure Liquid Chromatography (HPLC).

- Ripple refers to pressure fluctuations caused by the pulsatile nature of reciprocating pumps used in HPLC.

- Reducing ripple ensures consistent flow rate and better reproducibility of chromatographic results.

Step 2: Techniques to reduce ripple. - (A) Using bellows: Bellows are used in damping systems to minimize pressure fluctuations.

- (B) Using restrictors: Restrictors help in smoothing flow variations by reducing pulsations.

- (C) Using long nylon tube between pump and column: This can act as a pulse dampener, helping to stabilize pressure.

Step 3: Explanation of the incorrect option.

- (D) Avoiding the use of solvent pump: This is incorrect because a solvent pump is essential for HPLC operation.

- Without a solvent pump, liquid chromatography cannot function, making this an impractical solution.

Step 4: Selecting the correct option. Since avoiding the use of a solvent pump is not a feasible method for reducing ripple, the correct answer is (D) Avoiding the use of solvent pump.

Quick Tip

To minimize ripple in HPLC systems, use pulse dampeners, back-pressure regulators, and restrictors for maintaining a steady and consistent flow rate.

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84. In reverse phase chromatography, the stationary phase is made by

a. Non-polar

b. Polar

c. Both (a) and (b)

d. None of these

Correct Answer: (a) Non-polar

Solutions:

Step 1: Understanding reverse phase chromatography

- Reverse phase chromatography is a liquid chromatography technique where the stationary phase is non-polar and the mobile phase is polar.

- It is commonly used for separating non-polar compounds in complex mixtures.

Step 2: Explanation of stationary phase

- In reverse phase chromatography, the stationary phase is hydrophobic (non-polar), typically made of silica bonded with hydrocarbons like C8 or C18 chains.

- The mobile phase is polar, typically a mixture of water, methanol, or acetonitrile.

Step 3: Evaluating the options - (A) Non-polar → Correct, as reverse phase chromatography uses a non-polar stationary phase.

- (B) Polar → Incorrect, as polar stationary phases are used in normal-phase chromatography.

- (C) Both (a) and (b) → Incorrect, as the stationary phase is strictly non-polar.

- (D) None of these → Incorrect, as option (A) is correct.

Step 4: Selecting the correct answer - Since reverse phase chromatography uses a non-polar stationary phase, the correct answer is (A) Non-polar.

Quick Tip

Reverse phase chromatography is widely used in pharmaceutical analysis and biochemistry for the separation of non-polar compounds, including proteins, peptides, and lipids.

---

85. Which of the following HPLC detectors is used as a bulk property or general-purpose detector?

a. Electrochemical detector
b. Fluorescence detector
c. UV-Visible detector
d. Evaporative Light Scattering detector

Correct Answer: (d) Evaporative Light Scattering Detector
Solution:

Step 1: Understanding HPLC Detectors - High-Performance Liquid Chromatography (HPLC) detectors are used to analyze different properties of analytes based on their interaction with the detector.

- HPLC detectors are generally classified into specific detectors (which detect specific properties of compounds) and bulk property detectors (which measure overall changes in the mobile phase).

Step 2: Explanation of Bulk Property Detectors - Bulk property detectors (or general-purpose detectors) respond to overall changes in the mobile phase rather than detecting specific functional groups. - Examples of bulk property detectors include: - Refractive Index (RI) Detector - Evaporative Light Scattering Detector (ELSD)

Step 3: Evaluating the Options - (A) Electrochemical Detector $\rightarrow$ Incorrect, as it measures the electrochemical activity of specific analytes.

- (B) Fluorescence Detector $\rightarrow$ Incorrect, as it is a specific detector that detects compounds with fluorescent properties.

- (C) UV-Visible Detector $\rightarrow$ Incorrect, as it detects compounds absorbing UV or visible light, making it a specific detector.

- (D) Evaporative Light Scattering Detector $\rightarrow$ Correct, as it measures the overall light scattering effect of solute particles, making it a bulk property detector.

Step 4: Selecting the Correct Answer - The Evaporative Light Scattering Detector (ELSD) is the correct answer as it is widely used as a bulk property detector in HPLC.

Quick Tip

Evaporative Light Scattering Detectors (ELSD) are universal detectors used in HPLC and UHPLC for analyzing non-volatile and semi-volatile compounds, including sugars, lipids, and polymers.

---

86. Which of the following techniques would be most useful to identify as well as quantify the presence of a known impurity in a drug substance?

a. NMR

b. MS

c. IR

d. HPLC

Correct Answer: (d) HPLC

Solution:

Step 1: Understanding Analytical Techniques

- Various techniques are used in pharmaceutical analysis to identify and quantify impurities. The most commonly used techniques include:

- Nuclear Magnetic Resonance (NMR): Primarily used for structural elucidation of molecules.

- Mass Spectrometry (MS): Highly sensitive for identifying unknown compounds but less commonly used for routine impurity quantification.

- Infrared Spectroscopy (IR): Useful for functional group identification but not ideal for impurity quantification.

- High-Performance Liquid Chromatography (HPLC): Widely used for both qualitative and quantitative impurity profiling in drug substances.

Step 2: Evaluating the Options - (A) NMR $\rightarrow$ Useful for structural identification but not commonly used for routine impurity quantification.

- (B) MS $\rightarrow$ Highly sensitive for detecting trace impurities but often used in conjunction with other techniques like HPLC.

- (C) IR → Identifies functional groups but is not effective for quantifying impurities.

- (D) HPLC → The best choice for identifying and quantifying impurities due to its high sensitivity and resolution.

Step 3: Selecting the Correct Answer - HPLC is the preferred method for impurity profiling in pharmaceuticals as it allows for separation, identification, and quantification of known and unknown impurities.

Quick Tip

HPLC is extensively used in the pharmaceutical industry for stability testing, impurity profiling, and quantification of active pharmaceutical ingredients (APIs).

---

87. Which of the following is not true about the guard column used in liquid chromatography?

a. It filters particles that clog the separation column
b.It extends the life time of separation column
c. It allows particles that cause precipitation upon contact with stationary or mobile phase
d. The size of packing varies with the type of protection needed

Correct Answer: (C) It allows particles that cause precipitation upon contact with stationary or mobile phase

Solution:

Step 1: Understanding the Role of a Guard Column

- A guard column is used in liquid chromatography to protect the analytical column from contaminants, particulate matter, and strongly retained compounds.

- It is usually a short column packed with similar stationary phase material as the main column.

Step 2: Evaluating the Options - (A) It filters particles that clog the separation column → True. The guard column acts as a protective barrier against contaminants.

- (B) It extends the life time of separation column → True. By preventing contamination, it increases the longevity of the analytical column.

- (C) It allows particles that cause precipitation upon contact with stationary or mobile phase → False. The guard column is specifically designed to prevent such particles from reaching the main column.

- (D) The size of packing varies with the type of protection needed → True. Depending on the sample and type of contamination, different packing sizes can be used.

Step 3: Selecting the Correct Answer - Since a guard column does not allow particles that cause precipitation, option (C) is incorrect and is the right answer.

Quick Tip

A guard column is a cost-effective way to protect the main analytical column, reducing maintenance costs and improving reproducibility in chromatography.

---

88. Which of the following is not true about Hydraulic capacitance flow control system used in HPLC?

a. It can be used only for liquids with low viscosity
b. It is irrespective of solvent compressibility
c. It maintains constant flow
d. It smoothens high-pressure pump pulsations

Correct Answer: (a) It can be used only for liquids with low viscosity

Solutions:

Step 1: Understanding Hydraulic Capacitance Flow Control

- Hydraulic capacitance flow control is used in high-performance liquid chromatography (HPLC) to regulate flow consistency.

- It compensates for variations caused by solvent compressibility and pump pulsations, ensuring a stable flow.

Step 2: Evaluating the Options - (A) It can be used only for liquids with low viscosity $\rightarrow$ Incorrect. This system works efficiently for a wide range of solvent viscosities, not just low-viscosity liquids.

- (B) It is irrespective of solvent compressibility $\rightarrow$ Correct. The system is designed to handle variations in solvent compressibility.

- (C) It maintains constant flow $\rightarrow$ Correct. A key feature of the system is to ensure uniform flow rate in HPLC.

- (D) It smoothens high-pressure pump pulsations $\rightarrow$ Correct. It helps in reducing pressure fluctuations, which improves the accuracy of chromatographic separation.

Step 3: Selecting the Correct Answer - Since hydraulic capacitance flow control is not restricted to low-viscosity liquids, option (A) is the incorrect statement and thus the correct choice.

Quick Tip

Hydraulic capacitance in HPLC improves flow stability and precision, leading to better chromatographic resolution and reproducibility.

---

89. Morphine is the structure chiefly responsible for the biological activity of opium. What is the name given to the chemical that is chiefly responsible for the biological activity of a natural extract?

a. Lead compound

b. Pharmacophore

c. Active principle

d. Lead principle

Correct Answer: (c) Active principle

Solution:

Step 1: Understanding Active Principles

- The active principle of a natural extract is the bioactive chemical that is responsible for its pharmacological effects.

- For example, morphine is the active principle of opium, and quinine is the active principle of cinchona bark.

Step 2: Evaluating the Options - (A) Lead compound $\rightarrow$ Incorrect. A lead compound is a synthetic or natural molecule with potential therapeutic effects, but it is not necessarily the main bioactive substance of a natural extract.

- (B) Pharmacophore $\rightarrow$ Incorrect. A pharmacophore is a structural feature within a molecule that is responsible for its biological activity but is not a specific bioactive compound itself.

- (C) Active principle $\rightarrow$ Correct. The active principle is the chief biologically active component in a natural product that gives it medicinal properties.

- (D) Lead principle $\rightarrow$ Incorrect. This is not a standard term in pharmacognosy or medicinal chemistry.

Step 3: Selecting the Correct Answer - The correct term for the biologically active component of a natural extract is active principle, making option (C) the correct choice.

Quick Tip

The active principle of a medicinal plant or extract is its therapeutically active ingredient responsible for its biological effects.

---

90. What is the predominant β-adrenoceptor in bronchial smooth muscle?

(A) β_1-adrenoceptor

(B) β_2-adrenoceptor

(C) β_3-adrenoceptor

(D) β_4-adrenoceptor

Correct Answer: (b) β_2-adrenoceptor

Solution:

Step 1: Understanding Beta-Adrenoceptors

- Beta-adrenoceptors (β-receptors) are G-protein-coupled receptors that mediate the effects of epinephrine and norepinephrine.

- They are classified into three main types: β_1, β_2, and β_3.

Step 2: Evaluating the Predominant Receptor in Bronchial Smooth Muscle - β_1-adrenoceptors are primarily found in the heart and kidneys, where they mediate cardiac contractility and renin release.

- β_2-adrenoceptors are predominantly located in the bronchial smooth muscle, where they cause bronchodilation when stimulated.

- β_3-adrenoceptors are mainly found in adipose tissue, where they regulate lipolysis.

- β_4-adrenoceptors are not well characterized and have uncertain physiological significance.

Step 3: Selecting the Correct Answer - Since β_2-adrenoceptors are responsible for bronchodilation, the correct choice is (B) β_2-adrenoceptor.

Quick Tip

Beta-2 adrenoceptor agonists (e.g., salbutamol, terbutaline) are commonly used as bronchodilators in the treatment of asthma and COPD.

---

91. To which class of compounds do adrenaline, noradrenaline, and dopamine belong?

a. Phenethylamines Opium

b. Diphenolethylamines

c. Catecholamines

d. Adrenergics

Correct Answer: (c) Catecholamines

Solution:

Step 1: Understanding the Classification of These Compounds

- Adrenaline (Epinephrine), Noradrenaline (Norepinephrine), and Dopamine are neurotransmitters and hormones involved in sympathetic nervous system regulation.

- These compounds share a catechol nucleus (a benzene ring with two hydroxyl groups) and an amine group, classifying them as catecholamines.

Step 2: Evaluating the Given Options

- Phenethylamines Opium (Option A) is incorrect because opium is not related to these neurotransmitters.

- Diphenolethylamines (Option B) is not a recognized class.

- Catecholamines (Option C) is the correct classification.

- Adrenergics (Option D) is a functional class referring to drugs that act on adrenergic receptors but does not define the chemical structure.

Step 3: Selecting the Correct Answer

- Since adrenaline, noradrenaline, and dopamine have a catechol and amine functional group, the correct choice is (C) Catecholamines.

Quick Tip

Catecholamines (adrenaline, noradrenaline, dopamine) play a vital role in fight-or-flight responses and are synthesized from tyrosine in the adrenal medulla and neurons.

---

92. What is the predominant adrenoceptor in heart muscle?

a. α_1 - adrenoreceptor

b. α_2 - adrenoreceptor

c. β_1 - adrenoreceptor

d. β_2 - adrenoreceptor

Correct Answer: (C) β_1 - adrenoreceptor

Solution:

Step 1: Understanding Adrenoceptor Distribution in the Heart

- The heart muscle is primarily regulated by β_1 - adrenoceptors, which are responsible for increasing heart rate (chronotropy), contractility (inotropy), and conduction velocity (dromotropy).

- These receptors mediate the sympathetic nervous system response to catecholamines (adrenaline and noradrenaline).

Step 2: Evaluating the Given Options

- α_1 - adrenoreceptors (Option A): Primarily involved in vasoconstriction but not dominant in the heart.

- α_2 - adrenoreceptors (Option B): Mainly found in presynaptic nerve terminals, where they inhibit neurotransmitter release.

- β_1 - adrenoreceptors (Option C): The correct answer, as they are the predominant receptors in the myocardium.

- β_2 - adrenoreceptors (Option D): Present in vascular and bronchial smooth muscles, responsible for vasodilation and bronchodilation.

Step 3: Selecting the Correct Answer - Since β_1 - adrenoreceptors are the major subtype in cardiac muscle, the correct choice is (C) β_1 - adrenoreceptor.

Quick Tip

The β_1 - adrenoreceptors in the heart are G-protein coupled receptors (GPCRs) that activate the adenylate cyclase-cAMP pathway, leading to increased calcium influx and enhanced cardiac output.

---

93. What sort of receptor is the muscarinic receptor?

a. A G-protein coupled receptor.
b. A kinase linked receptor.
c. An intracellular receptor.
d. An ion channel.

Correct Answer: (a) A G-protein coupled receptor.

Solution:

Step 1: Understanding Muscarinic Receptors

- Muscarinic receptors are cholinergic receptors that respond to the neurotransmitter acetylcholine (ACh).

- These receptors belong to the G-protein coupled receptor (GPCR) family, which means they mediate signal transduction through intracellular second messengers.

Step 2: Evaluating the Given Options

- (A) G-protein coupled receptor (GPCR) (Correct Answer):

- Muscarinic receptors are metabotropic and mediate their effects via G-proteins (Gi or Gq).

- They regulate second messengers such as cAMP and IP/DAG in various cellular processes.

- (B) Kinase-linked receptor: - These receptors are enzyme-linked (e.g., insulin receptors) and do not include muscarinic receptors.

- (C) Intracellular receptor: - These receptors, such as steroid hormone receptors, are located inside the cell and are not muscarinic receptors.

- (D) Ion channels: - Nicotinic receptors (not muscarinic) belong to the ligand-gated ion channel family.

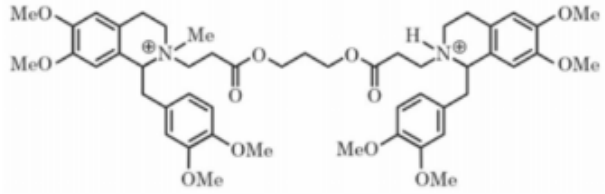
Step 3: Selecting the Correct Answer - Since muscarinic receptors are G-protein coupled receptors (GPCRs), the correct choice is (A) A G-protein coupled receptor.

Quick Tip

Muscarinic receptors have five subtypes (M1–M5): - M1, M3, M5 are Gq coupled $\rightarrow$ activate IP/DAG pathway. - M2, M4 are Gi coupled $\rightarrow$ inhibit adenylate cyclase and decrease cAMP. They regulate smooth muscle contraction, glandular secretion, and heart rate.

---

94. Atracurium is used intravenously as a neuromuscular blocker.



The molecule undergoes a chemical degradation at slightly alkaline pH. What is the name of this reaction?

a. Hofmann rearrangement

b. Hofmann elimination

c. Cope rearrangement

d. McLafferty rearrangement

Correct Answer: (b) Hofmann elimination.

Solution:

Step 1: Understanding the Reaction of Atracurium

- Atracurium is a neuromuscular blocker that undergoes non-enzymatic degradation at slightly alkaline pH (around 7.4).

- The major degradation pathway is Hofmann elimination, which occurs under physiological conditions.

- This reaction is temperature- and pH-dependent and does not require hepatic or renal metabolism.

Step 2: Evaluating the Given Options

- (A) Hofmann rearrangement:

- This reaction involves conversion of amides to amines in the presence of bromine and a strong base, which is not relevant here.

- (B) Hofmann elimination (Correct Answer):

- This is a base-catalyzed reaction where quaternary ammonium compounds degrade to produce tertiary amines, alkenes, and alcohols.

- This perfectly matches the degradation of Atracurium.

- (C) Cope rearrangement: - A pericyclic reaction involving [3,3] sigmatropic shifts in amines or oximes, unrelated to Atracurium degradation.

- (D) McLafferty rearrangement: - A mass spectrometry fragmentation reaction, not applicable here.

Step 3: Selecting the Correct Answer - Since Atracurium undergoes Hofmann elimination under slightly alkaline conditions, the correct answer is (B) Hofmann elimination.

Quick Tip

Hofmann elimination is a non-enzymatic degradation pathway seen in some neuromuscular blockers like Atracurium and Cisatracurium, making them suitable for patients with hepatic or renal impairment.

---

95. What does the symbol P represent in a QSAR equation?

a. pH

b. plasma concentration

c. partition coefficient

d. prodrug

Correct Answer: (c) partition coefficient.

Solution:

Step 1: Understanding QSAR and the Symbol P

- QSAR (Quantitative Structure-Activity Relationship) is a mathematical modeling approach that correlates the chemical structure of compounds with their biological activity.

- The symbol P in QSAR equations specifically refers to the partition coefficient.

- The partition coefficient (log P) is a measure of a compound's lipophilicity, indicating how well it dissolves in lipid versus aqueous phases.

- It plays a crucial role in drug absorption, distribution, and bioavailability.

Step 2: Evaluating the Given Options - (A) pH: Incorrect. The pH represents the hydrogen ion concentration and is not denoted by P in QSAR.

- (B) Plasma concentration: Incorrect. Plasma concentration is usually represented by C_p or related notations.

- (C) Partition coefficient (Correct Answer): - The partition coefficient P is the ratio of a compound's solubility in octanol and water.

- It is used in Lipinski's Rule of Five to predict drug permeability and absorption.

- (D) Prodrug: Incorrect. Prodrugs are chemically modified drugs that become active upon metabolism.

Step 3: Selecting the Correct Answer - Since the partition coefficient is denoted by P in QSAR models, the correct answer is (C) partition coefficient.

Quick Tip

In QSAR modeling, the partition coefficient P is crucial in predicting drug permeability and bioavailability. A high log P value suggests better lipid solubility, aiding in membrane permeability.

---

96. Which of the following statements is untrue when comparing 3D QSAR with conventional QSAR?

a. Only drugs of the same structural class should be studied by 3D QSAR or QSAR.
b. 3D QSAR has a predictive quality unlike QSAR.
c. Experimental parameters are not required by 3D QSAR, but are for QSAR.
d. Results can be shown graphically in 3D QSAR, but not with QSAR.

Correct Answer: (a) Only drugs of the same structural class should be studied by 3D QSAR or QSAR.

Solution:

Step 1: Understanding QSAR and 3D QSAR

- QSAR (Quantitative Structure-Activity Relationship) is a computational technique that predicts biological activity based on the structural properties of molecules.

- 3D QSAR extends QSAR by incorporating three-dimensional molecular features, such as steric, electrostatic, and hydrophobic interactions.

Step 2: Evaluating the Given Options

- (A) Only drugs of the same structural class should be studied by 3D QSAR or QSAR. (Incorrect Statement)

- This statement is incorrect because 3D QSAR can study drugs of different structural classes by analyzing their three-dimensional properties, rather than relying solely on chemical structure.

- (B) 3D QSAR has a predictive quality unlike QSAR. (True Statement) - Both QSAR and 3D QSAR are predictive models, but 3D QSAR provides more refined predictive capabilities due to its incorporation of 3D molecular features.

- (C) Experimental parameters are not required by 3D QSAR, but are for QSAR. (True Statement) - Traditional QSAR models rely heavily on experimental values such as pKa, logP, and molecular weight, while 3D QSAR utilizes computational molecular modeling.

- (D) Results can be shown graphically in 3D QSAR, but not with QSAR. (True Statement)

- 3D QSAR allows visualization of molecular features using contour maps and surface plots, which is not typically possible in traditional QSAR.

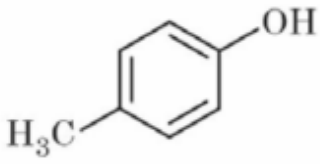
Step 3: Selecting the Correct Answer - Since option (A) is incorrect, it is the correct answer to the question.

Quick Tip

3D QSAR models provide a more detailed analysis than conventional QSAR by considering spatial arrangements and molecular interactions, making them more applicable for drug discovery.

---

97. Calculate the $\log P$ value for the structure shown; $\log P$ for benzene = 2.13; π(OH) = -0.67; $\pi(CH_3)$ = 0.52



a. 3.32

b. 0.94

c. 1.98

d. 2.13

Correct Answer: (C) 1.98

Solution:

Step 1: Understanding the Partition Coefficient ($\log P$) The partition coefficient ($\log P$) represents the lipophilicity of a molecule, which is calculated using additive fragment values.

Step 2: Applying the Given Values The given structure is p-cresol (4-methylphenol), and its $\log P$ value is calculated using the formula:

$$\log P = \log P_{\text{benzene}} + \pi(\text{CH}_3) + \pi(\text{OH})$$

Substituting the given values:

$$\log P = 2.13 + 0.52 - 0.67$$

Step 3: Calculation

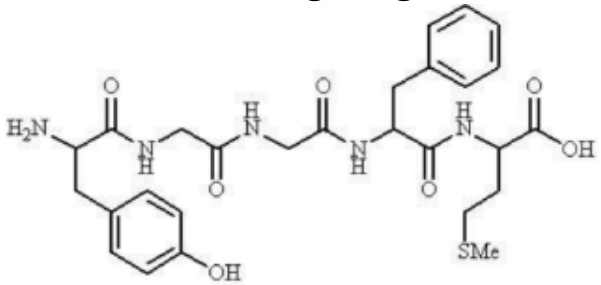
$$\log P = 2.13 + 0.52 - 0.67 = 1.98$$

Step 4: Selecting the Correct Answer Thus, the correct answer is 1.98 (Option C).

Quick Tip

The $\log P$ value is a crucial parameter in drug design and chemical property prediction, indicating the molecule's hydrophilicity or lipophilicity.

98. Consider the following analgesic.



What is the source of this structure?

a. Opium

b. Frog

c. An endogenous compound present in the body

d. Snake Venom

Correct Answer: (C) An endogenous compound present in the body

Solution:

Step 1: Identifying the Structure The given structure represents endomorphin, which is an endogenous opioid peptide found in the human body.

Step 2: Understanding the Source - Opium (Option A) is a natural source of morphine and related alkaloids but does not produce this specific structure.

- Frog-derived peptides (Option B) exist, but this structure does not match known frog peptides.

- Endogenous opioid peptides (Option C) such as endorphins, enkephalins, and dynorphins are naturally synthesized by the body and have similar structural motifs.

- Snake venom (Option D) contains various neurotoxins and peptides, but this structure is not related to venom-derived compounds.

Step 3: Selecting the Correct Answer Since endomorphins are naturally occurring pep-

tides in the body that exhibit opioid analgesic effects, the correct answer is:

An endogenous compound present in the body (Option C).

Quick Tip

Endomorphins are naturally occurring peptides in the body that bind to opioid receptors, producing pain relief and mood regulation effects. They play a crucial role in the body's natural pain management system.

---

99. What does a negative value of σ signify for a substituent?

a. It is electron donating

b. It is electron withdrawing

c. It is neutral

d. It is hydrophobic

Correct Answer: (a) It is electron donating

Solution:

Step 1: Understanding the Hammett Sigma Parameter

- The Hammett sigma (σ) parameter is a measure of the electronic effects of substituents on a benzene ring.

- It is used in linear free energy relationships (LFER) and in the Hammett equation to predict reaction rates and equilibrium positions.

Step 2: Interpretation of σ Values

- Positive σ values correspond to electron-withdrawing groups (EWG), which stabilize a positive charge on the benzene ring and reduce electron density.

- Negative σ values correspond to electron-donating groups (EDG), which increase electron density on the ring, making it more reactive toward electrophiles.

Step 3: Selecting the Correct Answer - Since a negative σ value indicates an electron-donating substituent, the correct answer is:

It is electron donating (Option A).

Quick Tip

- Electron-withdrawing groups (EWG) have positive σ values and stabilize carbocations.
- Electron-donating groups (EDG) have negative σ values and destabilize carbocations but stabilize carbanions.

---

100. Which of the following is one of the rules in Lipinski's rule of five?

a. A molecular weight equal to 500
b. No more than five hydrogen bond acceptor groups
c. No more than 10 hydrogen bond donor groups
d. A calculated logP value less than +5

Correct Answer: (d) A calculated logP value less than +5

Solution:

Lipinski's Rule of Five is a set of guidelines for determining the drug-likeness of a compound, which are as follows:

1. A molecular weight less than 500.

2. No more than 5 hydrogen bond donors (measured as the number of NH or OH groups).

3. No more than 10 hydrogen bond acceptors (measured as the number of N or O atoms).

4. A calculated logP value (partition coefficient) less than +5.

Among the given options, option (d) ”A calculated logP value less than +5” is one of the rules in Lipinski’s rule of five.

Thus, the correct answer is:

(d) A calculated logP value less than +5.

Quick Tip

Lipinski’s rule of five is used to evaluate the drug-likeness of molecules, and compounds that adhere to these rules are more likely to be orally active.
