

JEE Main 2021 Paper 1 (B.E./B.Tech) 17 March 2021 Shift 2 Question Paper



Conducted by the National Testing Agency (NTA)

Time Allowed: 3 Hours

Paper 1: B.E./B.Tech.

Maximum Marks: 300

General Instructions

- (i) This paper is **Paper 1 (B.E./B.Tech.)** of **JEE (Main) 2021 - Session 2**, conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 17 March 2021, Shift 2. The total duration is **3 hours**.
- (ii) The paper has **90 questions**, of which **75 are to be attempted**, and a maximum of **300 marks**: Mathematics, Physics and Chemistry carry 30 questions (100 marks) each, in that order.
- (iii) Each subject has **two sections**. **Section A** has **20 multiple choice questions** (MCQs) with four options each. Select the most appropriate answer. **Section B** has **10 numerical value questions**; attempt **any 5** of them.
- (iv) **All Section A questions are compulsory**. Attempt only the specified number of Section B questions. For Section B, the answer is an integer value; the answer should be **rounded off to the nearest integer**. Use only the constants given in the question while calculating.
- (v) **Marking scheme**: MCQs carry **+4** for a correct answer and **-1** for an incorrect answer. Numerical questions carry **+4** for a correct answer and **0** for an incorrect answer. Unanswered questions carry **0**.
- (vi) All calculations and rough work are to be done on the rough sheets only. Calculators, log tables, slide rules and electronic gadgets are not allowed.

1. If the sides AB, BC and CA of a triangle ABC have 3, 5 and 6 interior points respectively, then the total number of triangles that can be constructed using these points as vertices, is equal to :

- (A) 240 (B) 360
(C) 333 (D) 364

2. Let a computer program generate only the digits 0 and 1 to form a string of binary numbers with probability of occurrence of 0 at even places be $\frac{1}{2}$ and probability of occurrence of 0 at the odd place be $\frac{1}{3}$. Then the probability that '10' is followed by '01' is equal to :

- (A) $\frac{1}{18}$
(B) $\frac{1}{3}$
(C) $\frac{1}{9}$
(D) $\frac{1}{6}$

3. Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be defined as $f(x) = e^{-x} \sin x$. If $F : [0, 1] \rightarrow \mathbb{R}$ is a differentiable function with that $F(x) = \int_0^x f(t) dt$, then the value of $\int_0^1 (F'(x) + f(x)) e^x dx$ lies in the interval

- (A) $\left[\frac{331}{360}, \frac{334}{360} \right]$
(B) $\left[\frac{330}{360}, \frac{331}{360} \right]$
(C) $\left[\frac{335}{360}, \frac{336}{360} \right]$
(D) $\left[\frac{327}{360}, \frac{329}{360} \right]$

4. Let S_1, S_2 and S_3 be three sets defined as

$$S_1 = \{z \in \mathbb{C} : |z - 1| \leq \sqrt{2}\}$$

$$S_2 = \{z \in \mathbb{C} : \operatorname{Re}((1 - i)z) \geq 1\}$$

$$S_3 = \{z \in \mathbb{C} : \operatorname{Im}(z) \leq 1\}$$

Then the set $S_1 \cap S_2 \cap S_3$:

- (A) has exactly three elements (B) is a singleton
(C) has infinitely many elements (D) has exactly two elements

5. The number of solutions of the equation

$$\sin^{-1} \left[x^2 + \frac{1}{3} \right] + \cos^{-1} \left[x^2 - \frac{2}{3} \right] = x^2$$

, for $x \in [-1, 1]$, and $[x]$ denotes the greatest integer less than or equal to x , is :

- (A) 0 (B) Infinite
(C) 2 (D) 4

6. If the curve $y = y(x)$ is the solution of the differential equation

$$2(x^2 + x^{5/4}) dy - y(x + x^{1/4}) dx = 2x^{9/4} dx, \quad x > 0$$

which passes through the point

$$\left(1, 1 - \frac{4}{3} \log_e 2 \right)$$

, then the value of $y(16)$ is equal to :

- (A) $4 \left(\frac{31}{3} - \frac{8}{3} \log_e 3 \right)$
(B) $\left(\frac{31}{3} - \frac{8}{3} \log_e 3 \right)$
(C) $\left(\frac{31}{3} + \frac{8}{3} \log_e 3 \right)$
(D) $4 \left(\frac{31}{3} + \frac{8}{3} \log_e 3 \right)$

7. Let O be the origin. Let

$$\vec{OP} = x\hat{i} + y\hat{j} - \hat{k}$$

and

$$\vec{OQ} = -\hat{i} + 2\hat{j} + 3x\hat{k}$$

, $x, y \in \mathbb{R}$, $x > 0$, be such that

$$|\vec{PQ}| = \sqrt{20}$$

and the vector $\vec{OP}$ is perpendicular $\vec{OQ}$. If $\vec{OR} = 3\hat{i} + z\hat{j} - 7\hat{k}$, $z \in \mathbb{R}$, is coplanar with $\vec{OP}$ and $\vec{OQ}$, then the value of $x^2 + y^2 + z^2$ is equal to :

- (A) 2 (B) 9
(C) 7 (D) 1

8. If the integral

$$\int_0^{10} \frac{[\sin 2\pi x]}{e^x - [x]} dx = \alpha e^{-1} + \beta e^{-\frac{1}{2}} + \gamma$$

, where α, β, γ are integers and $[x]$ denotes the greatest integer less than or equal to x , then the value of $\alpha + \beta + \gamma$ is equal to :

- (A) 0 (B) 10
(C) 20 (D) 25

9. The value of the limit

$$\lim_{\theta \rightarrow 0} \frac{\tan(\pi \cos^2 \theta)}{\sin(2\pi \sin^2 \theta)}$$

is equal to :

- (A) 0
(B) $-\frac{1}{2}$
(C) $\frac{1}{4}$
(D) $-\frac{1}{4}$

10. Consider the function $f : \mathbb{R} \rightarrow \mathbb{R}$ defined by

$$f(x) = \begin{cases} \left(2 - \sin\left(\frac{1}{x}\right)\right)|x|, & x \neq 0 \\ 0, & x = 0 \end{cases}$$

. Then f is :

- (A) not monotonic on $(-\infty, 0)$ and $(0, \infty)$ only
(B) monotonic on $(0, \infty)$ only
(C) monotonic on $(-\infty, 0)$ only
(D) monotonic on $(-\infty, 0) \cup (0, \infty)$

11. The value of

$$\lim_{n \rightarrow \infty} \frac{[r] + [2r] + \dots + [nr]}{n^2}$$

, where r is a non-zero real number and $[r]$ denotes the greatest integer less than or equal to r , is equal to :

- (A) r
(B) $\frac{r}{2}$
(C) 0
(D) $2r$

12. If x, y, z are in arithmetic progression with common difference d , $x \neq 3d$, and the determinant of the matrix

$$\begin{bmatrix} 3 & 4\sqrt{2} & x \\ 4 & 5\sqrt{2} & y \\ 5 & k & z \end{bmatrix}$$

is zero, then the value of k^2 is :

- (A) 72 (B) 12
(C) 36 (D) 6

13. Let $y = y(x)$ be the solution of the differential equation

$$\cos x(3 \sin x + \cos x + 3)dy = (1 + y \sin x(3 \sin x + \cos x + 3))dx, 0 \leq x \leq \frac{\pi}{2}, y(0) = 0$$

. Then,

$$y\left(\frac{\pi}{3}\right)$$

is equal to :

- (A) $2\log_e\left(\frac{\sqrt{3} + 7}{2}\right)$
(B) $2\log_e\left(\frac{3\sqrt{3} - 8}{4}\right)$
(C) $2\log_e\left(\frac{2\sqrt{3} + 10}{11}\right)$
(D) $2\log_e\left(\frac{2\sqrt{3} + 9}{6}\right)$

14. Let L be a tangent line to the parabola $y^2 = 4x - 20$ at (6, 2). If L is also a tangent to the ellipse

$$\frac{x^2}{2} + \frac{y^2}{b} = 1$$

, then the value of b is equal to :

- (A) 20 (B) 14
(C) 16 (D) 11

15. Two tangents are drawn from a point P to the circle $x^2 + y^2 - 2x - 4y + 4 = 0$, such that the angle between these tangents is

$$\tan^{-1}\left(\frac{12}{5}\right)$$

, where

$$\tan^{-1}\left(\frac{12}{5}\right)$$

$\in (0, \pi)$. If the centre of the circle is denoted by C and these tangents touch the circle at points A and B, then the ratio of the areas of ΔPAB and ΔCAB is :

- (A) 3 : 1 (B) 9 : 4
(C) 2 : 1 (D) 11 : 4

16. The number of solutions of the equation $x + 2\tan x = \frac{\pi}{2}$ in the interval $[0, 2\pi]$ is :

- (A) 4 (B) 3
(C) 2 (D) 5

17. The value of

$$\sum_{r=0}^6 ({}^6C_r \cdot {}^6C_{6-r})$$

is equal to :

- (A) 924 (B) 1024
(C) 1124 (D) 1324

18. Let the tangent to the circle $x^2 + y^2 = 25$ at the point R(3, 4) meet x-axis and y-axis at points P and Q, respectively. If r is the radius of the circle passing through the origin O and having centre at the incentre of the triangle OPQ, then r^2 is equal to :

- (A) $\frac{585}{66}$
(B) $\frac{625}{72}$
(C) $\frac{529}{64}$
(D) $\frac{125}{72}$

19. If the Boolean expression $(p \wedge q) \odot (p \otimes q)$ is a tautology, then $\odot$ and $\otimes$ are respectively given by :

- (A) $\vee, \rightarrow$
(B) $\rightarrow$
, $\rightarrow$
(C) $\wedge$
, $\vee$
(D) $\wedge$
, $\rightarrow$

20. If the equation of plane passing through the mirror image of a point (2, 3, 1) with respect to line

$$\frac{x+1}{2} = \frac{y-3}{1} = \frac{z+2}{-1}$$

and containing the line

$$\frac{x-2}{3} = \frac{1-y}{2} = \frac{z+1}{1}$$

is $\alpha x + \beta y + \gamma z = 24$, then $\alpha + \beta + \gamma$ is equal to :

- (A) 21 (B) 19
(C) 18 (D) 20

21. Let

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

and

$$B = \begin{bmatrix} \alpha \\ \beta \end{bmatrix} \neq \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

such that $AB = B$ and $a + d = 2021$, then the value of $ad - bc$ is equal to _____.

22. Let the coefficients of third, fourth and fifth terms in the expansion of

$$\left(x + \frac{a}{x^2}\right)^n, x \neq 0$$

, be in the ratio $12 : 8 : 3$. Then the term independent of x in the expansion, is equal to _____.

23. Let $\tan \alpha, \tan \beta$ and $\tan \gamma; \alpha, \beta, \gamma \neq \frac{(2n-1)\pi}{2}$

, $n \in \mathbb{N}$ be the slopes of three line segments OA, OB and OC, respectively, where O is origin. If circumcentre of $\triangle ABC$ coincides with origin and its orthocentre lies on y-axis, then the value of

$$\left(\frac{\cos 3\alpha + \cos 3\beta + \cos 3\gamma}{\cos \alpha \cos \beta \cos \gamma}\right)^2$$

is equal to _____.

24. Let $\vec{x}$ be a vector in the plane containing vectors

$$\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$$

and

$$\vec{b} = \hat{i} + 2\hat{j} - \hat{k}$$

. If the vector $\vec{x}$ is perpendicular to $(3\hat{i} + 2\hat{j} - \hat{k})$ and its projection on $\vec{a}$ is

$$\frac{17\sqrt{6}}{2}$$

, then the value of $|\vec{x}|^2$ is equal to _____.

25. Let

$$I_n = \int_1^e x^{19} (\log|x|)^n dx$$

, where $n \in \mathbb{N}$. If $(20)I_{10} = \alpha I_9 + \beta I_8$, for natural numbers α and β , then $\alpha - \beta$ equals to _____.

26. If $1, \log_{10}(4^x - 2)$ and $\log_{10}\left(4^x + \frac{18}{5}\right)$

are in arithmetic progression for a real number x , then the value of the determinant

$$\begin{vmatrix} 2\left(x - \frac{1}{2}\right) & x-1 & x^2 \\ 1 & 0 & x \\ x & 1 & 0 \end{vmatrix}$$

is equal to :

27. Consider a set of $3n$ numbers having variance 4. In this set, the mean of first $2n$ numbers is 6 and the mean of the remaining n numbers is 3. A new set is constructed by adding 1 into each of first $2n$ numbers, and subtracting 1 from each of the remaining n numbers. If the variance of the new set is k , then $9k$ is equal to _____.

28. Let $f : [-1, 1] \rightarrow \mathbb{R}$ be defined as $f(x) = ax^2 + bx + c$ for all $x \in [-1, 1]$, where $a, b, c \in \mathbb{R}$ such that $f(-1) = 2, f'(1) = 1$ for $x \in (-1, 1)$ the maximum value of $f''(x)$ is $\frac{1}{2}$. If $f(x) \leq \alpha, x \in [-1, 1]$, then the least value of α is equal to _____.

29. Let $f : [-3, 1] \rightarrow \mathbb{R}$ be given as

$$f(x) = \begin{cases} \min \{(x+6), x^2\}, & -3 \leq x \leq 0 \\ \max \{\sqrt{x}, x^2\}, & 0 \leq x \leq 1. \end{cases}$$

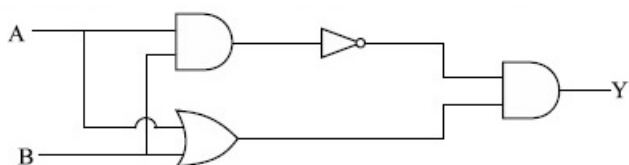
If the area bounded by $y = f(x)$ and x-axis is A , then the value of $6A$ is equal to _____.

30. Let P be an arbitrary point having sum of the squares of the distances from the planes $x + y + z = 0, lx - nz = 0$ and $x - 2y + z = 0$, equal to 9. If the locus of the point P is $x^2 + y^2 + z^2 = 9$, then the value of $l - n$ is equal to _____.

31. A sound wave of frequency 245 Hz travels with the speed of 300 ms^{-1} along the positive x-axis. Each point of the wave moves to and from through a total distance of 6 cm. What will be the mathematical expression of this travelling wave?

- (A) $Y(x, t) = 0.03 \left[\sin 5.1x - (0.2 \times 10^3)t \right]$ (B) $Y(x, t) = 0.03 \left[\sin 5.1x - (1.5 \times 10^3)t \right]$
 (C) $Y(x, t) = 0.06 \left[\sin 5.1x - (1.5 \times 10^3)t \right]$ (D) $Y(x, t) = 0.06 \left[\sin 0.8x - (0.5 \times 10^3)t \right]$

32. Which one of the following will be the output of the given circuit?



- (A) XOR Gate (B) NOR Gate
 (C) NAND Gate (D) AND Gate

33. Match List - I with List - II

	List - I		List - II
(a)	Phase difference between current and voltage in a purely resistive AC circuit	(i)	$\frac{\pi}{2}$; current leads voltage
(b)	Phase difference between current and voltage in a pure inductive AC circuit	(ii)	zero
(c)	Phase difference between current and voltage in a pure capacitive AC circuit	(iii)	$\frac{\pi}{2}$; current lags voltage
(d)	Phase difference between current and voltage in an LCR series circuit	(iv)	$\tan^{-1} \left(\frac{X_C - X_L}{R} \right)$

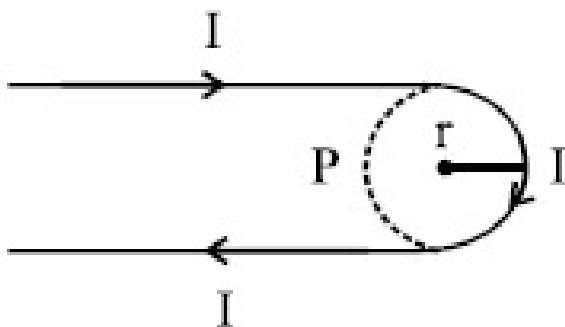
Choose the most appropriate answer from the options given below :

- (A) (a)-(ii), (b)-(iii), (c)-(i), (d)-(iv) (B) (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)
 (C) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i) (D) (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)

34. The atomic hydrogen emits a line spectrum consisting of various series. Which series of hydrogen atomic spectra is lying in the visible region?

- (A) Brackett series (B) Balmer series
 (C) Paschen series (D) Lyman series

35. A hairpin like shape as shown in figure is made by bending a long current carrying wire. What is the magnitude of a magnetic field at point P which lies on the centre of the semicircle?



- (A) $\frac{\mu_0 I}{4\pi r}(2 - \pi)$
 (B) $\frac{\mu_0 I}{2\pi r}(2 - \pi)$
 (C) $\frac{\mu_0 I}{4\pi r}(2 + \pi)$
 (D) $\frac{\mu_0 I}{2\pi r}(2 + \pi)$

36. Two identical photocathodes receive the light of frequencies f_1 and f_2 respectively. If the velocities of the photo-electrons coming out are v_1 and v_2 respectively, then

- (A) $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2) \right]^{\frac{1}{2}}$
 (B) $v_1^2 + v_2^2 = \frac{2h}{m}[f_1 + f_2]$
 (C) $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2) \right]^{\frac{1}{2}}$
 (D) $v_1^2 - v_2^2 = \frac{2h}{m}[f_1 - f_2]$

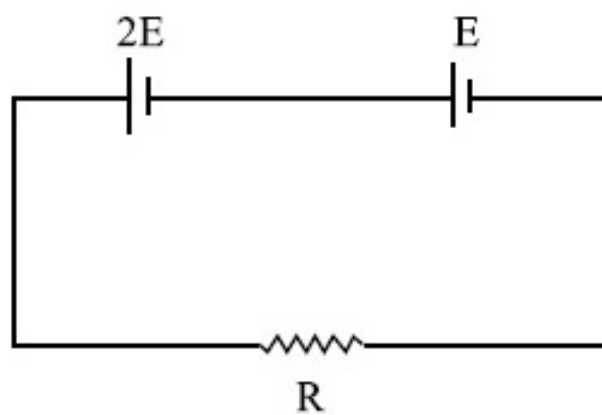
37. If one mole of the polyatomic gas is having two vibrational modes and β is the ratio of molar specific heats for polyatomic gas

$$\left(\beta = \frac{C_p}{C_v} \right)$$

then the value of β is :

- (A) 1.02 (B) 1.35
 (C) 1.2 (D) 1.25

38. Two cells of emf $2E$ and E with internal resistance r_1 and r_2 respectively are connected in series to an external resistor R (see figure). The value of R , at which the potential difference across the terminals of the first cell becomes zero is

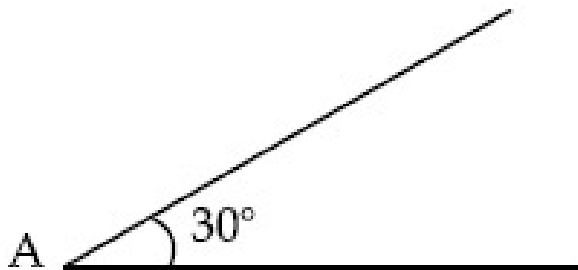


- (A) $r_1 - r_2$
 (B) $\frac{r_1}{2} - r_2$
 (C) $\frac{r_1}{2} + r_2$
 (D) $r_1 + r_2$

39. What happens to the inductive reactance and the current in a purely inductive circuit if the frequency is halved?

- (A) Both, inductive reactance and current will be doubled. (B) Inductive reactance will be doubled and current will be halved.
 (C) Both, inductive reactance and current will be halved. (D) Inductive reactance will be halved and current will be doubled.

40. A sphere of mass 2 kg and radius 0.5 m is rolling with an initial speed of 1 ms^{-1} goes up an inclined plane which makes an angle of 30° with the horizontal plane, without slipping. How long will the sphere take to return to the starting point A?



- (A) 0.60 s (B) 0.52 s
(C) 0.80 s (D) 0.57 s

41. Two particles A and B of equal masses are suspended from two massless springs of spring constants K_1 and K_2 respectively. If the maximum velocities during oscillations are equal, the ratio of the amplitude of A and B is

- (A) $\frac{K_1}{K_2}$
(B) $\sqrt{\frac{K_1}{K_2}}$
(C) $\frac{K_2}{K_1}$
(D) $\sqrt{\frac{K_2}{K_1}}$

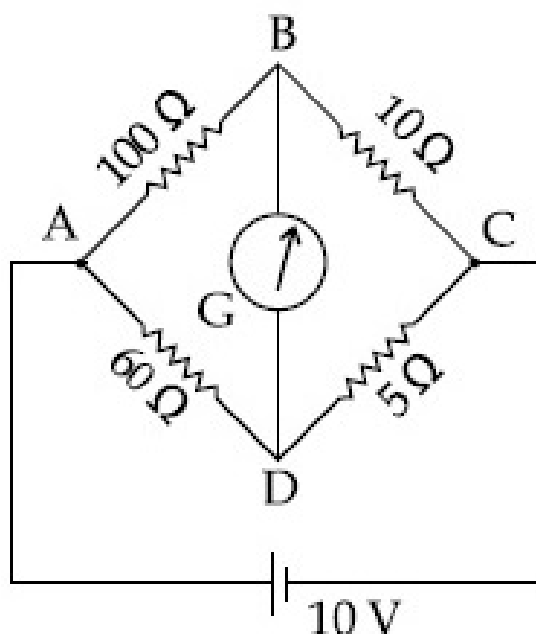
42. The velocity of a particle is $v = v_0 + gt + Ft^2$. Its position is $x = 0$ at $t = 0$; then its displacement after time ($t = 1$) is :

- (A) $v_0 + g + f$ (B) $v_0 + \frac{g}{2} + \frac{f}{3}$
(C) $v_0 + 2g + 3f$ (D) $v_0 + \frac{g}{2} + f$

43. A rubber ball is released from a height of 5 m above the floor. It bounces back repeatedly, always rising to $\frac{81}{100}$ of the height through which it falls. Find the average speed of the ball. (Take $g = 10 \text{ ms}^{-2}$)

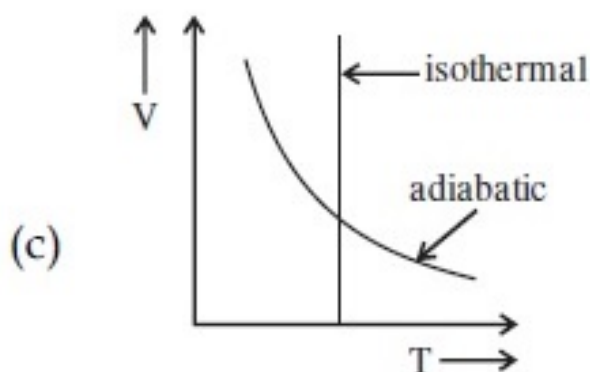
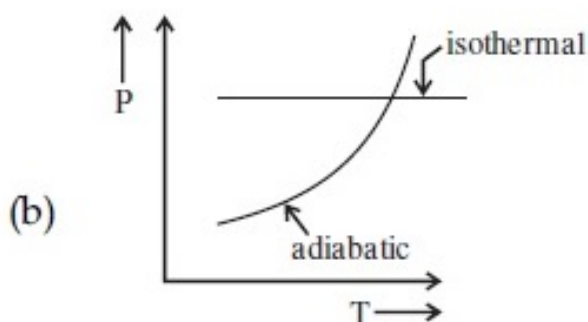
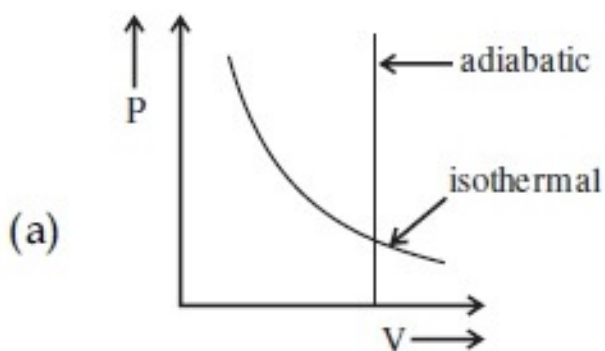
- (A) 2.50 ms^{-1} (B) 3.0 ms^{-1}
(C) 2.0 ms^{-1} (D) 3.50 ms^{-1}

44. The four arms of a Wheatstone bridge have resistances as shown in the figure. A galvanometer of 15Ω resistance is connected across BD. Calculate the current through the galvanometer when a potential difference of 10V is maintained across AC.

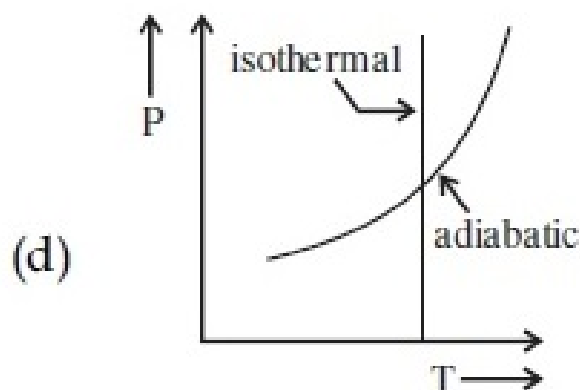


- (A) $4.87 \mu\text{A}$ (B) 4.87 mA
(C) 2.44 mA (D) $2.44 \mu\text{A}$

45. Which one is the correct option for the two different thermodynamic processes?

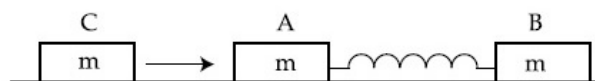


45. (continued)



- (A) (a) only (B) (c) and (d)
(C) (b) and (c) (D) (c) and (a)

46. Two identical blocks A and B each of mass m resting on the smooth horizontal floor are connected by a light spring of natural length L and spring constant K . A third block C of mass m moving with a speed v along the line joining A and B collides with A. The maximum compression in the spring is



- (A) $\sqrt{\frac{mv}{K}}$
(B) $\sqrt{\frac{m}{2K}}$
(C) $\sqrt{\frac{mv}{2K}}$
(D) $v\sqrt{\frac{m}{2K}}$

47. A geostationary satellite is orbiting around an arbitrary planet 'P' at a height of $11R$ above the surface of 'P', R being the radius of 'P'. The time period of another satellite in hours at a height of $2R$ from the surface of 'P' is _____. 'P' has the time period of 24 hours.

- (A) 3
(B) 5
(C) $6\sqrt{2}$
(D) $\frac{6}{\sqrt{2}}$

48. An object is located at 2 km beneath the surface of the water. If the fractional compression $\frac{\Delta V}{V}$

is 1.36%, the ratio of hydraulic stress to the corresponding hydraulic strain will be _____.

[Given : density of water is 1000 kgm^{-3} and $g = 9.8 \text{ ms}^{-2}$]

- (A) $1.44 \times 10^7 \text{ Nm}^{-2}$ (B) $1.44 \times 10^9 \text{ Nm}^{-2}$
(C) $1.96 \times 10^7 \text{ Nm}^{-2}$ (D) $2.26 \times 10^9 \text{ Nm}^{-2}$

49. A carrier signal $C(t) = 25 \sin(2.512 \times 10^{10}t)$ is amplitude modulated by a message signal $m(t) = 5 \sin(1.57 \times 10^8 t)$ and transmitted through an antenna. What will be the bandwidth of the modulated signal?

- (A) 50 MHz (B) 8 GHz
(C) 1987.5 MHz (D) 2.01 GHz

50. A block of mass 1 kg attached to a spring is made to oscillate with an initial amplitude of 12 cm. After 2 minutes the amplitude decreases to 6 cm. Determine the value of the damping constant for this motion. (take $\ln 2 = 0.693$)

- (A) $0.69 \times 10^2 \text{ kg s}^{-1}$ (B) $3.3 \times 10^2 \text{ kg s}^{-1}$
(C) $1.16 \times 10^{-2} \text{ kg s}^{-1}$ (D) $5.7 \times 10^{-3} \text{ kg s}^{-1}$

51. Suppose you have taken a dilute solution of oleic acid in such a way that its concentration becomes 0.01 cm^3 of oleic acid per cm^3 of the solution. Then you make a thin film of this solution (monomolecular thickness) of area 4 cm^2 by considering 100 spherical drops of radius

$$\left(\frac{3}{40\pi}\right)^{\frac{1}{3}} \times 10^{-3}$$

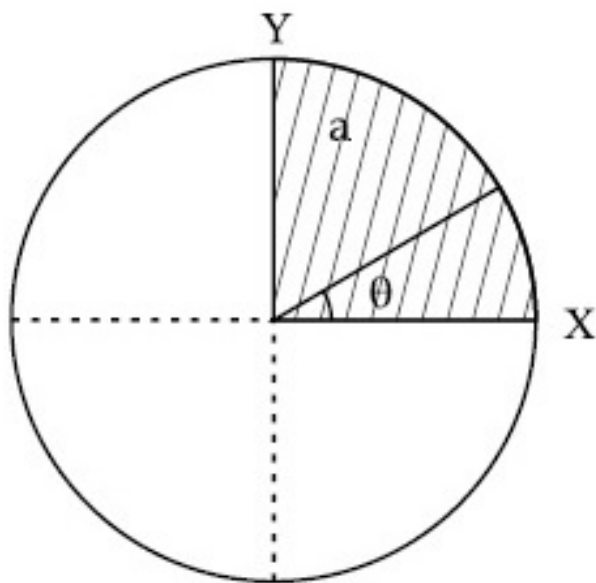
cm. Then the thickness of oleic acid layer will be $x \times 10^{-14} \text{ m}$. Where x is _____.

52. The disc of mass M with uniform surface mass density σ is shown in the figure. The centre of mass of the quarter disc (the shaded area) is at the position

$$\frac{xa}{3\pi}, \frac{xa}{3\pi}$$

where x is _____. (Round off to the Nearest Integer).

[a is an area as shown in the figure]



53. The image of an object placed in air formed by a convex refracting surface is at a distance of 10 m behind the surface. The image is real and is at $\frac{2^{rd}}{3}$ of the distance of the object from the surface. The wavelength of light inside the surface is $\frac{2}{3}$ times the wavelength in air. The radius of the curved surface is $\frac{x}{13} \text{ m}$. The value of 'x' is _____.

54. The electric field intensity produced by the radiation coming from a 100 W bulb at a distance of 3 m is E. The electric field intensity produced by the radiation coming from 60W at the same distance is

$$\sqrt{\frac{x}{5}}$$

E. Where the value of x = _____.

55. The electric field in a region is given by

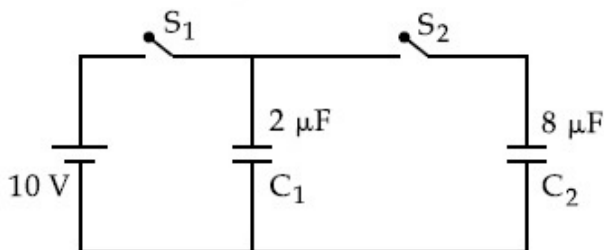
$$\vec{E} = \frac{2}{5}E_0\hat{i} + \frac{3}{5}E_0\hat{j}$$

with

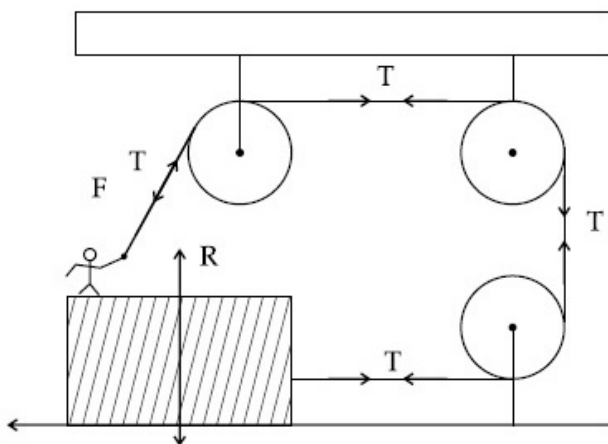
$$E_0 = 4.0 \times 10^3 \frac{\text{N}}{\text{C}}$$

. The flux of this field through a rectangular surface area 0.4 m^2 parallel to the Y-Z plane is _____ Nm^2C^{-1} .

56. A $2\mu\text{F}$ capacitor C_1 is first charged to a potential difference of 10V using a battery. Then the battery is removed and the capacitor is connected to an uncharged capacitor C_2 of $8\mu\text{F}$. The charge in C_2 on equilibrium condition is _____ μC . (Round off to the Nearest Integer)



57. A boy of mass 4 kg is standing on a piece of wood having mass 5 kg . If the coefficient of friction between the wood and the floor is 0.5 , the maximum force that the boy can exert on the rope so that the piece of wood does not move from its place is _____ N . (Round off to the Nearest Integer) [Take $g = 10\text{ ms}^{-2}$]



58. A body of mass 1 kg rests on a horizontal floor with which it has a coefficient of static friction

$$\frac{1}{\sqrt{3}}$$

. It is desired to make the body move by applying the minimum possible force $F\text{ N}$. The value of F will be _____. (Round off to the Nearest Integer) [Take $g = 10\text{ ms}^{-2}$]

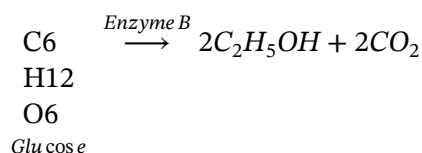
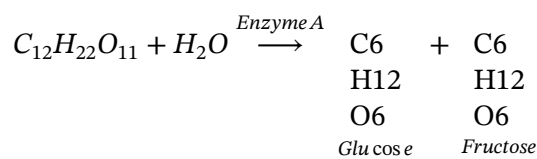
59. A particle of mass m moves in a circular orbit in a central potential field $U(r) = U_0 r^4$. If Bohr's quantization conditions are applied, radii of possible orbitals r_n vary with $n^{\frac{1}{\alpha}}$, where α is _____.

60. Seawater at a frequency $f = 9 \times 10^2\text{ Hz}$, has permittivity $\epsilon = 80\epsilon_0$ and resistivity $\rho = 0.25\ \Omega\text{m}$. Imagine a parallel plate capacitor is immersed in seawater and is driven by an alternating voltage source $V(t) = V_0 \sin(2\pi ft)$. Then the conduction current density becomes 10^x times the displacement current density after time $t = \frac{1}{800}\text{ s}$. The value of x is _____.

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$$

Nm^2C^{-2})

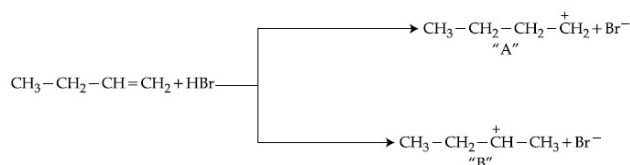
61.



In the above reactions, the enzyme A and enzyme B respectively are :

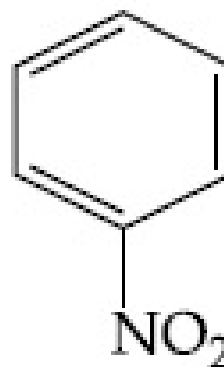
- (A) Zymase and Invertase (B) Invertase and Amylase
(C) Amylase and Invertase (D) Invertase and Zymase

62. Choose the correct statement regarding the formation of carbocations A and B given.

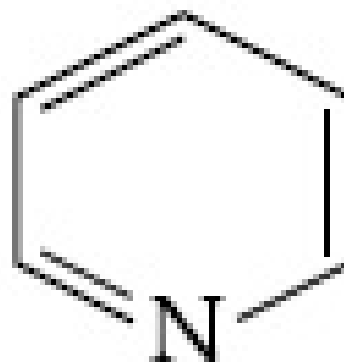


- (A) Carbocation A is more stable and formed relatively at faster rate (B) Carbocation B is more stable and formed relatively at slow rate
(C) Carbocation B is more stable and formed relatively at faster rate (D) Carbocation A is more stable and formed relatively at slow rate

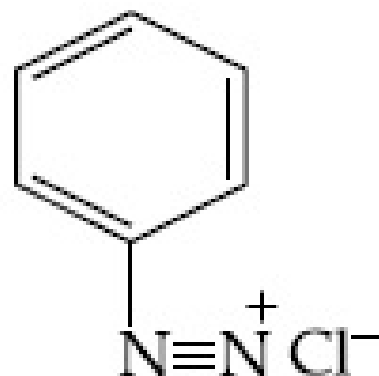
63. Nitrogen can be estimated by Kjeldahl's method for which of the following compound?



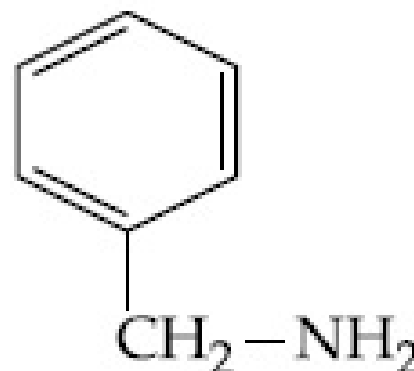
(A)



(B)



(C)



(D)

64. Amongst the following, the linear species is :

- (A) O_3 (B) Cl_2O
(C) N_3^- (D) NO_2

65. The correct pair(s) of the ambident nucleophiles is(are)

- (A) $AgCN/KCN$
(B) $RCOOAg/RCOOK$
(C) $AgNO_2/KNO_2$
(D) AgI/KI

- (A) (B) and (C) only (B) (B) only
(C) (A) and (C) only (D) (A) only

66. Given below are two statements :

Statement I : 2-methylbutane on oxidation with $KMnO_4$ gives 2-methylbutan-2-ol.

Statement II : n-alkanes can be easily oxidised to corresponding alcohols with $KMnO_4$.

Choose the correct option :

- (A) Both statement I and statement II are incorrect (B) Both statement I and statement II are correct
(C) Statement I is correct but statement II is incorrect (D) Statement I is incorrect but statement II is correct

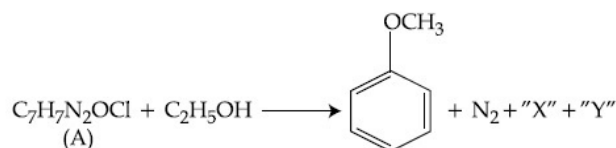
67. During which of the following processes, does entropy decrease?

- (A) Freezing of water to ice at $0^\circ C$
(B) Freezing of water to ice at $-10^\circ C$
(C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
(D) Adsorption of $CO(g)$ on lead surface.
(E) Dissolution of $NaCl$ in water

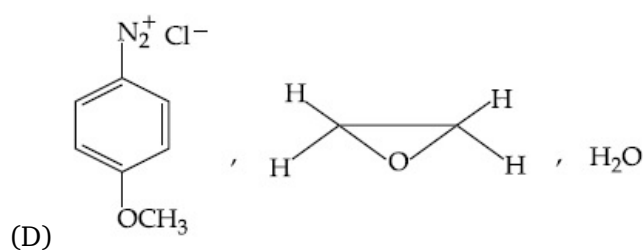
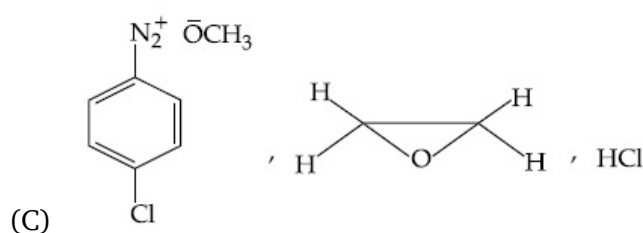
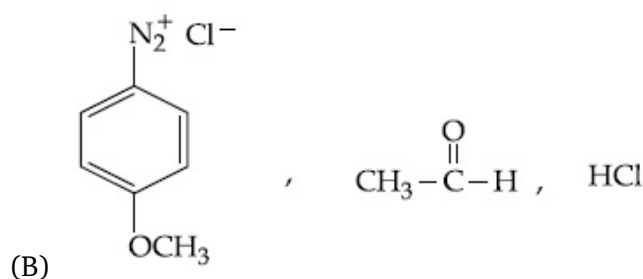
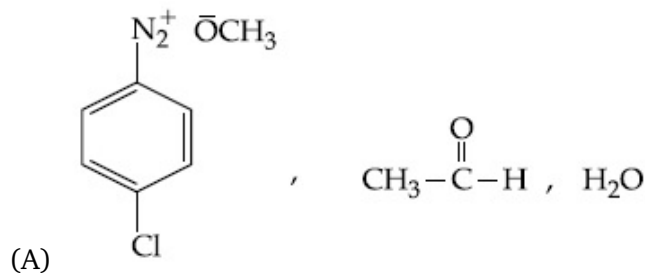
Choose the correct answer from the options given below :

- (A) (A), (C) and (E) only (B) (B) and (C) only
(C) (A), (B), (C) and (D) only (D) (A) and (E) only

68.



In the above reaction, the structural formula of (A), "X" and "Y" respectively are :



69. Primary, secondary and tertiary amines can be separated using:

- (A) Chloroform and KOH (B) Acetyl amide
(C) Benzene sulphonic acid (D) para-Toluene sulphonyl chloride

70. Match List - I with List - II :

	List - I		List - II
(a)	$[Co(NH_3)_6][Cr(CN)_6]$	(i)	Linkage isomerism
(b)	$[Co(NH_3)_3(NO_2)_3]$	(ii)	Solvate isomerism
(c)	$[Cr(H_2O)_6]Cl_3$	(iii)	Co-ordination isomerism
(d)	<i>cis</i> – $[CrCl_2(ox)_2]^{3-}$	(iv)	Optical isomerism

Choose the correct answer from the options given below :

- (A) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv) (B) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)
(C) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv) (D) (a)-(iv), (b)-(ii), (c)-(iii), (d)-(i)

71. Fructose is an example of :

- (A) Heptose (B) Pyranose
(C) Ketohexose (D) Aldohexose

72. The common positive oxidation states for an element with atomic number 24, are :

- (A) +1 and +3 (B) +2 to +6
(C) +1 to +6 (D) +1 and +3 to +6

73. The set that represents the pair of neutral oxides of nitrogen is :

- (A) NO and N₂O (B) N₂O and NO₂
(C) NO and NO₂ (D) N₂O and N₂O₃

74. The set of elements that differ in mutual relationship from those of the other sets is :

- (A) Li - Na (B) Be - Al
(C) B - Si (D) Li - Mg

75. For the coagulation of a negative sol, the species below, that has the highest flocculating power is :

- (A) Na⁺ (B) Ba²⁺
(C) PO₄³⁻ (D) SO₄²⁻

76. Match List - I with List - II.

	List - I Chemical Compound		List - II Used as
(a)	Sucralose	(i)	Synthetic detergent
(b)	Glyceryl ester of stearic acid	(ii)	Artificial sweetener
(c)	Sodium benzoate	(iii)	Antiseptic
(d)	Bithionol	(iv)	Food preservative

Choose the correct match :

- (A) (a)-(i), (b)-(ii), (c)-(iv), (d)-(iii) (B) (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)
 (C) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i) (D) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

77. Which of the following statement(s) is (are) incorrect reason for eutrophication?

- (A) excess usage of fertilisers
 (B) excess usage of detergents
 (C) dense plant population in water bodies
 (D) lack of nutrients in water bodies that prevent plant growth

Choose the most appropriate answer from the options given below :

- (A) (A) Only (B) (B) and (D) only
 (C) (C) only (D) (D) only

78. Match List - I with List - II :

	List - I		List - II
(a)	Haematite	(i)	$Al_2O_3 \cdot xH_2O$
(b)	Bauxite	(ii)	Fe_2O_3
(c)	Magnetite	(iii)	$CuCO_3 \cdot Cu(OH)_2$
(d)	Malachite	(iv)	Fe_3O_4

Choose the correct answer from the options given below :

- (A) (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv) (B) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)
 (C) (a)-(ii), (b)-(iii), (c)-(i), (d)-(iv) (D) (a)-(iv), (b)-(i), (c)-(ii), (d)-(iii)

79. The functional groups that are responsible for the ion-exchange property of cation and anion exchange resins, respectively, are :

- (A) $-SO_3H$ and $-NH_2$ (B) $-NH_2$ and $COOH$
 (C) $-NH_2$ and $-SO_3H$ (D) $-SO_3H$ and $COOH$

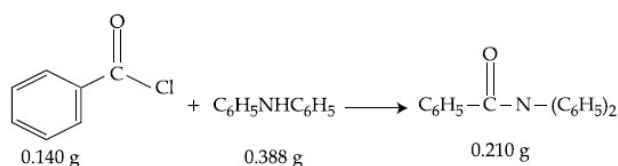
80. One of the by-products formed during the recovery of NH_3 from Solvay process is :

- (A) $Ca(OH)_2$ (B) NH_4Cl
 (C) $NaHCO_3$ (D) $CaCl_2$

81. A KCl solution of conductivity 0.14 S m^{-1} shows a resistance of 4.19Ω in a conductivity cell. If the same cell is filled with an HCl solution, the resistance drops to 1.03Ω . The conductivity of the HCl solution is $\text{_____} \times 10^{-2} \text{ S m}^{-1}$. (Round off to the Nearest Integer).

82. On complete reaction of FeCl_3 with oxalic acid in aqueous solution containing KOH, resulted in the formation of product A. The secondary valency of Fe in the product A is _____. (Round off to the Nearest Integer).

83.



Consider the above reaction. The percentage yield of amide product is _____. (Round off to the Nearest Integer).
(Given : Atomic mass : C : 12.0 u, H : 1.0 u, N : 14.0 u, O : 16.0 u, Cl : 35.5 u)

84. The reaction $2\text{A} + \text{B}_2 \rightarrow 2\text{AB}$ is an elementary reaction. For a certain quantity of reactants, if the volume of the reaction vessel is reduced by a factor of 3, the rate of the reaction increases by a factor of _____. (Round off to the Nearest Integer).

85. Consider the reaction

$$\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$$

The temperature at which $K_C = 20.4$ and $K_P = 600.1$, is _____ K. (Round off to the Nearest Integer). [Assume all gases are ideal and $R = 0.0831 \text{ L bar K}^{-1} \text{ mol}^{-1}$]

86. In the ground state of atomic Fe ($Z = 26$), the spin-only magnetic moment is $\text{_____} \times 10^{-1} \text{ BM}$. (Round off to the Nearest Integer). [Given :

$$\sqrt{3} = 1.73, \sqrt{2} = 1.41]$$

87. A 1 molal $\text{K}_4\text{Fe}(\text{CN})_6$ solution has a degree of dissociation of 0.4. Its boiling point is equal to that of another solution which contains 18.1 weight percent of a non electrolytic solute A. The molar mass of A is _____ u. (Round off to the Nearest Integer). [Density of water = 1.0 g cm^{-3}]

88. The total number of C-C sigma bond/s in mesityl oxide ($\text{C}_6\text{H}_8\text{O}$) is _____. (Round off to the Nearest Integer).

89. KBr is doped with 10^{-5} mole percent of SrBr_2 . The number of cationic vacancies in 1g of KBr crystal is _____ 10^{14} . (Round off to the Nearest Integer).
[Atomic Mass : K : 39.1 u, Br : 79.9 u $N_A = 6.023 \times 10^{23}$]

90. The number of chlorine atoms in 20 mL of chlorine gas at STP is _____ 10^{21} . (Round off to the Nearest Integer).
[Assume chlorine is an ideal gas at STP
 $R = 0.083 \text{ L bar mol}^{-1} \text{ K}^{-1}$, $N_A = 6.023 \times 10^{23}$]

- End of Question Paper -