

JEE Main 2021 Paper 1 (B.E./B.Tech) 22 July 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 3**, conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 22 July 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. Let S_n denote the sum of first n -terms of an arithmetic progression. If $S_{10} = 530$, $S_5 = 140$, then $S_{20} - S_6$ is equal to:

- (A) 1862 (B) 1842
(C) 1852 (D) 1872

2. Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be defined as

$$f(x) = \begin{cases} -\frac{4}{3}x^3 + 2x^2 + 3x, & x > 0 \\ 3xe^x, & x \leq 0 \end{cases}$$

. Then f is increasing function in the interval

- (A) $\left(-\frac{1}{2}, 2\right)$
(B) $(0, 2)$
(C) $\left(-1, \frac{3}{2}\right)$
(D) $(-3, -1)$

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

$$\cos ec^2 x dy + 2dx = (1 + y \cos 2x) \cos ec^2 x dx$$

, with

$$y\left(\frac{\pi}{4}\right) = 0$$

. Then, the value of $(y(0) + 1)^2$ is equal to :

- (A) $e^{1/2}$ (B) $e^{-1/2}$
(C) e^{-1} (D) e

4. Four dice are thrown simultaneously and the numbers shown on these dice are recorded in 2×2 matrices. The probability that such formed matrix have all different entries and are non-singular, is :

- (A) $\frac{45}{162}$
(B) $\frac{21}{81}$
(C) $\frac{22}{81}$
(D) $\frac{43}{162}$

5. If

$$\int_0^{100\pi} \frac{\sin^2 x}{e^{\left(\frac{x}{\pi} - \left[\frac{x}{\pi}\right]\right)}} dx = \frac{\alpha\pi^3}{1 + 4\pi^2}, \alpha \in \mathbb{R}$$

where $[x]$ is the greatest integer less than or equal to x , then the value of α is :

- (A) $200(1 - e^{-1})$ (B) $100(1 - e)$
(C) $50(e - 1)$ (D) $150(e^{-1} - 1)$

6. The values of λ and μ such that the system of equations $x + y + z = 6$, $3x + 5y + 5z = 26$,
 $x + 2y + \lambda z = \mu$

has no solution, are :

- (A) $\lambda = 3, \mu = 5$ (B) $\lambda = 3, \mu \neq 10$
(C) $\lambda \neq 2, \mu = 10$ (D) $\lambda = 2, \mu \neq 10$

7. If the shortest distance between the straight lines

$$3(x - 1) = 6(y - 2) = 2(z - 1)$$

and

$$4(x - 2) = 2(y - \lambda) = (z - 3), \lambda \in \mathbb{R}$$

is

$$\frac{1}{\sqrt{38}}$$

, then the integral value of λ is equal to :

- (A) 3 (B) 2
(C) 5 (D) -1

8. Let $A = [a_{ij}]$ be a real matrix of order 3×3 , such that $a_{i1} + a_{i2} + a_{i3} = 1$, for $i = 1, 2, 3$. Then, the sum of all the entries of the matrix A^3 is equal to :

- (A) 2 (B) 1
(C) 3 (D) 9

9. Let $[x]$ denote the greatest integer less than or equal to x . Then, the values of $x \in \mathbb{R}$ satisfying the equation

$$[e^x]^2 + [e^x + 1] - 3 = 0$$

lie in the interval :

- (A) $\left[0, \frac{1}{e}\right)$
 (B) $[\log_e 2, \log_e 3)$
 (C) $[1, e)$
 (D) $[0, \log_e 2)$

10. Let the circle $S : 36x^2 + 36y^2 - 108x + 120y + C = 0$ be such that it neither intersects nor touches the co-ordinate axes. If the point of intersection of the lines, $x - 2y = 4$ and $2x - y = 5$ lies inside the circle S , then :

- (A) $\frac{25}{9} < C < \frac{13}{3}$
 (B) $100 < C < 165$
 (C) $81 < C < 156$
 (D) $100 < C < 156$

11. Let n denote the number of solutions of the equation $z^2 + 3\bar{z} = 0$, where z is a complex number. Then the value of

$$\sum_{k=0}^{\infty} \frac{1}{n^k}$$

is equal to :

- (A) 1
 (B) $\frac{4}{3}$
 (C) $\frac{3}{2}$
 (D) 2

12. If the domain of the function

$$f(x) = \frac{\cos^{-1} \sqrt{x^2 - x + 1}}{\sqrt{\sin^{-1} \left(\frac{2x-1}{2} \right)}}$$

is the interval $(\alpha, \beta]$, then $\alpha + \beta$ is equal to :

- (A) $\frac{3}{2}$
 (B) 2
 (C) $\frac{1}{2}$
 (D) 1

13. Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be defined as

$$f(x) = \begin{cases} \frac{x^3}{(1 - \cos 2x)^2} \log_e \left(\frac{1 + 2xe^{-2x}}{(1 - xe^{-x})^2} \right), & x \neq 0 \\ \alpha, & x = 0 \end{cases}$$

If f is continuous at $x = 0$, then α is equal to :

- (A) 1
 (B) 3
 (C) 0
 (D) 2

14. Let

$$E_1 : \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, a > b$$

. Let E_2 be another ellipse such that it touches the end points of major axis of E_1 and the foci of E_2 are the end points of minor axis of E_1 . If E_1 and E_2 have same eccentricities, then its value is :

- (A) $\frac{-1 + \sqrt{5}}{2}$
 (B) $\frac{-1 + \sqrt{8}}{2}$
 (C) $\frac{-1 + \sqrt{3}}{2}$
 (D) $\frac{-1 + \sqrt{6}}{2}$

15. Let L be the line of intersection of planes

$$\vec{r} \cdot (\hat{i} - \hat{j} + 2\hat{k}) = 2$$

and

$$\vec{r} \cdot (2\hat{i} + \hat{j} - \hat{k}) = 2$$

. If $P(\alpha, \beta, \gamma)$ is the foot of perpendicular on L from the point (1, 2, 0), then the value of $35(\alpha + \beta + \gamma)$ is equal to :

- (A) 101 (B) 119
(C) 143 (D) 134

16. Let a vector $\vec{a}$ be coplanar with vectors

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

and

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

. If $\vec{a}$ is perpendicular to

$$\vec{d} = 3\hat{i} + 2\hat{j} + 6\hat{k}$$

, and

$$|\vec{a}| = \sqrt{10}$$

. Then a possible value of

$$[\vec{a} \ \vec{b} \ \vec{c}] + [\vec{a} \ \vec{b} \ \vec{d}] + [\vec{a} \ \vec{c} \ \vec{d}]$$

is equal to :

- (A) -42 (B) -40
(C) -29 (D) -38

17. Let three vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ be such that

$$\vec{a} \times \vec{b} = \vec{c}$$

,

$$\vec{b} \times \vec{c} = \vec{a}$$

and

$$|\vec{a}| = 2$$

. Then which one of the following is not true?

(A) $\vec{a} \times ((\vec{b} + \vec{c}) \times (\vec{b} \times \vec{c})) = \vec{0}$

(B) Projection of $\vec{a}$ on $(\vec{b} \times \vec{c})$ is 2

(C) $\begin{vmatrix} \vec{a} & \vec{b} & \vec{c} \end{vmatrix} + \begin{vmatrix} \vec{c} & \vec{a} & \vec{b} \end{vmatrix} = 8$

(D) $|3\vec{a} + \vec{b} - 2\vec{c}|^2 = 51$

18. Which of the following Boolean expressions is not a tautology?

(A) $(p \Rightarrow q) \vee (\sim q \Rightarrow p)$ (B) $(q \Rightarrow p) \vee (\sim q \Rightarrow p)$

(C) $(p \Rightarrow \sim q) \vee (\sim q \Rightarrow p)$ (D) $(\sim p \Rightarrow q) \vee (\sim q \Rightarrow p)$

19. The number of solutions of $\sin^7 x + \cos^7 x = 1$, $x \in [0, 4\pi]$ is equal to

- (A) 11 (B) 7
(C) 5 (D) 9

20. Let a line $L : 2x + y = k$, $k > 0$ be a tangent to the hyperbola $x^2 - y^2 = 3$. If L is also a tangent to the parabola $y^2 = \alpha x$, then α is equal to :

- (A) 12 (B) -12
(C) 24 (D) -24

21. Let $A = \{0, 1, 2, 3, 4, 5, 6, 7\}$. Then the number of bijective functions $f : A \rightarrow A$ such that $f(1) + f(2) = 3 - f(3)$ is equal to _____.

22. If the digits are not allowed to repeat in any number formed by using the digits 0, 2, 4, 6, 8, then the number of all numbers greater than 10,000 is equal to _____.

23. Let

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

. Then the number of 3×3 matrices B with entries from the set $\{1, 2, 3, 4, 5\}$ and satisfying $AB = BA$ is _____.

24. Consider the following frequency distribution :

Class :	0-6	6-12	12-18	18-24
Frequency :	a	b	12	9

If mean = $\frac{309}{22}$ and median = 14, then the value $(a - b)^2$ is equal to _____.

25. The sum of all the elements in the set $\{n \in \{1, 2, \dots, 100\} \mid \text{H.C.F. of } n \text{ and } 2040 \text{ is } 1\}$ is equal to _____.

26. The area (in sq. units) of the region bounded by the curves $x^2 + 2y - 1 = 0$, $y^2 + 4x - 4 = 0$ and $y^2 - 4x - 4 = 0$, in the upper half plane is _____.

27. Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be a function defined as

$$f(x) = \begin{cases} 3\left(1 - \frac{|x|}{2}\right) & \text{if } |x| \leq 2 \\ 0 & \text{if } |x| > 2 \end{cases}$$

Let $g : \mathbb{R} \rightarrow \mathbb{R}$ be given by

$$g(x) = f(x+2) - f(x-2)$$

. If n and m denote the number of points in $\mathbb{R}$ where g is not continuous and not differentiable, respectively, then $n + m$ is equal to _____.

28. If the constant term, in binomial expansion of

$$\left(2x^r + \frac{1}{x^2}\right)^{10}$$

is 180, then r is equal to _____.

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

$$\left((x+2)e^{\left(\frac{y+1}{x+2}\right)} + (y+1)\right)dx = (x+2)dy$$

, $y(1) = 1$. If the domain of $y = y(x)$ is an open interval (α, β) , then $|\alpha + \beta|$ is equal to _____.

30. The number of elements in the set $\{n \in \{1, 2, 3, \dots, 100\} \mid (11)^n > (10)^n + (9)^n\}$ is _____.

31. What will be the projection of vector

$$\vec{A} = \hat{i} + \hat{j} + \hat{k}$$

on vector

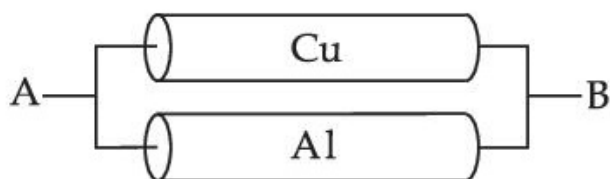
$$\vec{B} = \hat{i} + \hat{j}$$

?

- (A) $\sqrt{2} (\hat{i} + \hat{j} + \hat{k})$
 (B) $(\hat{i} + \hat{j})$
 (C) $\sqrt{2} (\hat{i} + \hat{j})$
 (D) $2(\hat{i} + \hat{j} + \hat{k})$

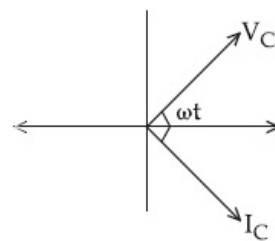
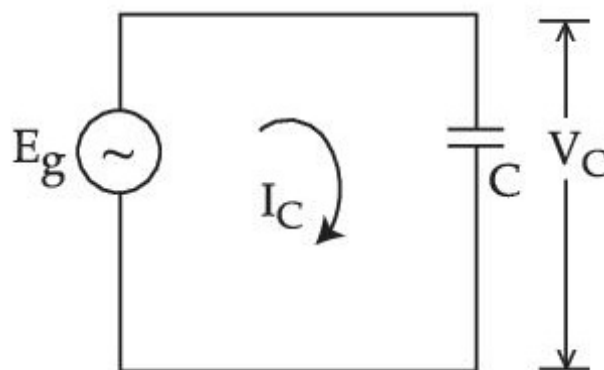
32. A Copper (Cu) rod of length 25 cm and cross-sectional area 3 mm^2 is joined with a similar Aluminium (Al) rod as shown in figure. Find the resistance of the combination between the ends A and B.

(Take Resistivity of Copper = $1.7 \times 10^{-8} \Omega\text{m}$ and Resistivity of Aluminium = $2.6 \times 10^{-8} \Omega\text{m}$)

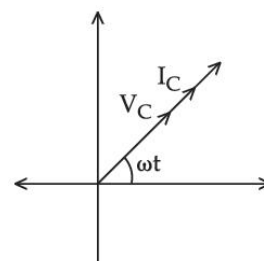


- (A) 0.0858 mΩ (B) 1.420 mΩ
 (C) 0.858 mΩ (D) 2.170 mΩ

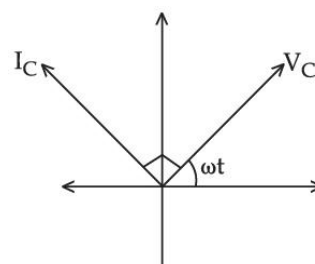
33. In a circuit consisting of a capacitance and a generator with alternating emf $E_g = E_{g0} \sin \omega t$, V_C and I_C are the voltage and current. Correct phasor diagram for such circuit is



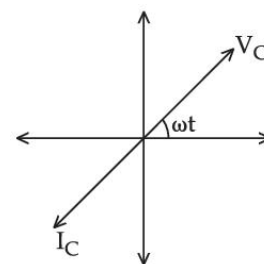
(A)



(B)



(C)



(D)

34. A porter lifts a heavy suitcase of mass 80 kg and at the destination lowers it down by a distance of 80 cm with a constant velocity. Calculate the work done by the porter in lowering the suitcase.

(take $g = 9.8 \text{ ms}^{-2}$)

- (A) +627.2 J (B) -62720.0 J
(C) -627.2 J (D) 784.0 J

35. Consider a situation in which a ring, a solid cylinder and a solid sphere roll down on the same inclined plane without slipping. Assume that they start rolling from rest and having identical diameter.

The correct statement for this situation is

- (A) All of them will have same velocity. (B) The ring has the greatest and the cylinder has the least velocity of the centre of mass at the bottom of the inclined plane.
(C) The sphere has the greatest and the ring has the least velocity of the centre of mass at the bottom of the inclined plane. (D) The cylinder has the greatest and the sphere has the least velocity of the centre of mass at the bottom of the inclined plane.

36. Intensity of sunlight is observed as 0.092 Wm^{-2} at a point in free space. What will be the peak value of magnetic field at the point?

($\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$)

- (A) $2.77 \times 10^{-8} \text{ T}$ (B) $1.96 \times 10^{-8} \text{ T}$
(C) 8.31 T (D) 5.88 T

37. A body is projected vertically upwards from the surface of earth with a velocity sufficient enough to carry it to infinity. The time taken by it to reach height h is _____ s.

- (A) $\sqrt{\frac{2R_e}{g}} \left[\left(1 + \frac{h}{R_e} \right)^{\frac{3}{2}} - 1 \right]$
(B) $\frac{1}{3} \sqrt{\frac{R_e}{2g}} \left[\left(1 + \frac{h}{R_e} \right)^{\frac{3}{2}} - 1 \right]$
(C) $\sqrt{\frac{R_e}{2g}} \left[\left(1 + \frac{h}{R_e} \right)^{\frac{3}{2}} - 1 \right]$
(D) $\frac{1}{3} \sqrt{\frac{2R_e}{g}} \left[\left(1 + \frac{h}{R_e} \right)^{\frac{3}{2}} - 1 \right]$

38. An electric dipole is placed on x-axis in proximity to a line charge of linear charge density $3.0 \times 10^{-6} \text{ C/m}$. Line charge is placed on z-axis and positive and negative charge of dipole is at a distance of 10 mm and 12 mm from the origin respectively. If total force of 4N is exerted on the dipole, find out the amount of positive or negative charge of the dipole.

- (A) 0.485 mC (B) 815.1 nC
(C) $8.8 \mu\text{C}$ (D) $4.44 \mu\text{C}$

39. A nucleus with mass number 184 initially at rest emits an α -particle. If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of the α -particle.

- (A) 5.5 MeV (B) 5.0 MeV
(C) 5.38 MeV (D) 0.12 MeV

40. A bullet of '4 g' mass is fired from a gun of mass 4 kg. If the bullet moves with the muzzle speed of 50 ms^{-1} , the impulse imparted to the gun and velocity of recoil of gun are :

- (A) 0.2 kg ms^{-1} , 0.1 ms^{-1} (B) 0.4 kg ms^{-1} , 0.05 ms^{-1}
 (C) 0.2 kg ms^{-1} , 0.05 ms^{-1} (D) 0.4 kg ms^{-1} , 0.1 ms^{-1}

41. Statement I : The ferromagnetic property depends on temperature. At high temperature, ferromagnet becomes paramagnet.

Statement II : At high temperature, the domain wall area of a ferromagnetic substance increases. In the light of the above statements, choose the most appropriate answer from the options given below :

- (A) Statement I is false but Statement II is true (B) Statement I is true but Statement II is false
 (C) Both Statement I and Statement II are false (D) Both Statement I and Statement II are true

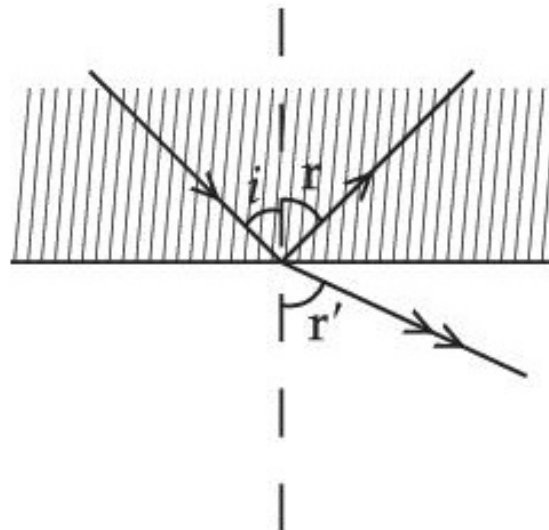
42. Match List - I with List - II

	List - I		List - II
(a)	$\omega L > \frac{1}{\omega C}$	(i)	Current is in phase with emf
(b)	$\omega L = \frac{1}{\omega C}$	(ii)	Current lags behind the applied emf
(c)	$\omega L < \frac{1}{\omega C}$	(iii)	Maximum current occurs
(d)	Resonant frequency	(iv)	Current leads the emf

Choose the correct answer from the options given below

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

43. A ray of light passes from a denser medium to a rarer medium at an angle of incidence i . The reflected and refracted rays make an angle of 90° with each other. The angle of reflection and refraction are respectively r and r' . The critical angle is given by



- (A) $\sin^{-1}(\tan r)$ (B) $\sin^{-1}(\cot r)$
 (C) $\sin^{-1}(\tan r')$ (D) $\tan^{-1}(\sin i)$

44. An electron of mass m_e and a proton of mass m_p are accelerated through the same potential difference. The ratio of the de-Broglie wavelength associated with the electron to that with the proton is

- (A) $\frac{m_e}{m_p}$
 (B) 1
 (C) $\frac{m_p}{m_e}$
 (D) $\sqrt{\frac{m_p}{m_e}}$

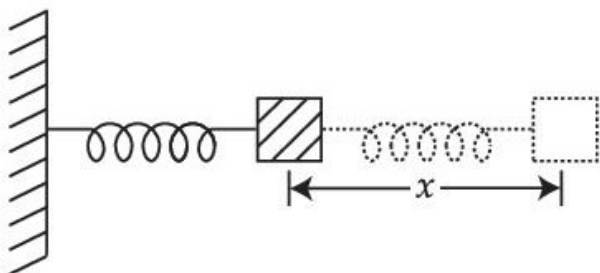
45. What will be the average value of energy for a monoatomic gas in thermal equilibrium at temperature T ?

- (A) $\frac{3}{2}k_B T$
 (B) $k_B T$
 (C) $\frac{2}{3}k_B T$
 (D) $\frac{1}{2}k_B T$

46. T_0 is the time period of a simple pendulum at a place. If the length of the pendulum is reduced to $\frac{1}{16}$ times of its initial value, the modified time period is :

- (A) $4 T_0$ (B) $\frac{1}{4} T_0$
(C) T_0 (D) $8\pi T_0$

47. The motion of a mass on a spring, with spring constant K is as shown in figure.



The equation of motion is given by $x(t) = A \sin \omega t + B \cos \omega t$ with $\omega =$

$$\sqrt{\frac{K}{m}}$$

Suppose that at time $t = 0$, the position of mass is $x(0)$ and velocity $v(0)$, then its displacement can also be represented as $x(t) = C \cos(\omega t - \phi)$, where C and ϕ are :

- (A) $C = \sqrt{\frac{2v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{x(0)\omega}{2v(0)}\right)$
(B) $C = \sqrt{\frac{v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{x(0)\omega}{v(0)}\right)$
(C) $C = \sqrt{\frac{v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{v(0)}{x(0)\omega}\right)$
(D) $C = \sqrt{\frac{2v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{v(0)}{x(0)\omega}\right)$

48. Consider a situation in which reverse biased current of a particular P-N junction increases when it is exposed to a light of wavelength ≤ 621 nm. During this process, enhancement in carrier concentration takes place due to generation of hole-electron pairs. The value of band gap is nearly.

- (A) 1 eV (B) 4 eV
(C) 0.5 eV (D) 2 eV

49. Choose the correct option

- (A) True dip is always equal to apparent dip. (B) True dip is not mathematically related to apparent dip.
(C) True dip is less than the apparent dip. (D) True dip is always greater than the apparent dip.

50. What should be the height of transmitting antenna and the population covered if the television telecast is to cover a radius of 150 km? The average population density around the tower is $2000/\text{km}^2$ and the value of $R_e = 6.5 \times 10^6$ m.

- (A) Height = 1241 m (B) Height = 1731 m

Population covered = 7×10^5 Population covered = 1413×10^5

- (C) Height = 1800 m (D) Height = 1600 m

Population covered = 1413×10^8 Population covered = 2×10^5

51. A ray of light passing through a prism ($\mu = \sqrt{3}$) suffers minimum deviation. It is found that the angle of incidence is double the angle of refraction within the prism. Then, the angle of prism is _____ (in degrees).

52. Three students S_1 , S_2 and S_3 perform an experiment for determining the acceleration due to gravity (g) using a simple pendulum. They use different lengths of pendulum and record time for different number of oscillations. The observations are as shown in the table.

St u d e n t N o.	Length of Pendulum (cm)	N o. of os ci ll at io n s (n)	Total time for n oscillations	Time period (s)
1	64.0	8	128.0	16.0
2	64.0	4	64.0	16.0
3	20.0	4	36.0	9.0

(Least count of length = 0.1 cm and Least count for time = 0.1 s)

If E_1 , E_2 and E_3 are the percentage errors in ' g ' for students 1, 2 and 3 respectively, then the minimum percentage error is obtained by student no. _____.

53. Three particles P, Q and R are moving along the vectors

$$\vec{A} = \hat{i} + \hat{j}$$

,

$$\vec{B} = \hat{j} + \hat{k}$$

and

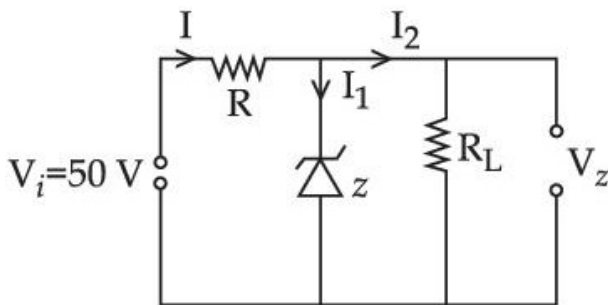
$$\vec{C} = -\hat{i} + \hat{j}$$

respectively. They strike on a point and start to move in different directions. Now particle P is moving normal to the plane which contains vector $\vec{A}$ and $\vec{B}$. Similarly particle Q is moving normal to the plane which contains vector $\vec{A}$ and $\vec{C}$. The angle between the direction of motion of P and Q is

$$\cos^{-1}\left(\frac{1}{\sqrt{x}}\right)$$

. Then the value of x is _____.

54. In a given circuit diagram, a 5 V zener diode along with a series resistance is connected across a 50 V power supply. The minimum value of the resistance required, if the maximum zener current is 90 mA will be _____ Ω .



55. The total charge enclosed in an incremental volume of $2 \times 10^{-9} \text{ m}^3$ located at the origin is _____ nC, if electric flux density of its field is found as

$$D = e^{-x} \sin y \hat{i} - e^{-x} \cos y \hat{j} + 2z \hat{k} \text{ C/m}^2$$

56. The position of the centre of mass of a uniform semi-circular wire of radius 'R' placed in x-y plane with its centre at the origin and the line joining its ends as x-axis is given by

$$\left(0, \frac{xR}{\pi}\right)$$

. Then, the value of | x | is _____.

57. In an electric circuit, a cell of certain emf provides a potential difference of 1.25 V across a load resistance of 5Ω . However, it provides a potential difference of 1 V across a load resistance of 2Ω . The emf of the cell is given by $\frac{x}{10}V$. Then the value of x is _____.

58. The area of cross-section of a railway track is 0.01 m^2 . The temperature variation is 10°C . Coefficient of liner expansion of material of track is $10^{-5}/^\circ\text{C}$. The energy stored per meter in the track is _____ J/m.

(Young's modulus of material of track is 10^{11} Nm^{-2})

59. The centre of a wheel rolling on a plane surface moves with a speed v_0 . A particle on the rim of the wheel at the same level as the centre will be moving at a speed $\sqrt{x}v_0$. Then the value of x is _____.

60. In 5 minutes, a body cools from 75°C to 65°C at room temperature of 25°C . The temperature of body at the end of next 5 minutes is _____ $^\circ\text{C}$.

Chemistry - Section A · Multiple Choice Questions

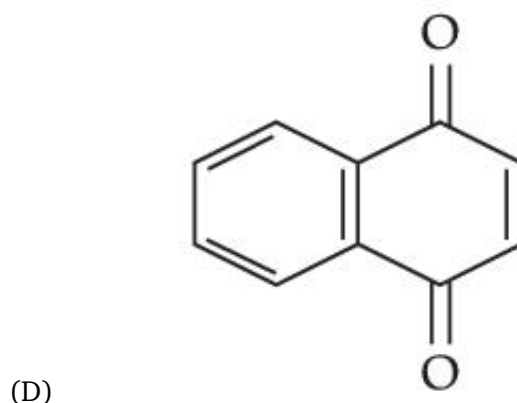
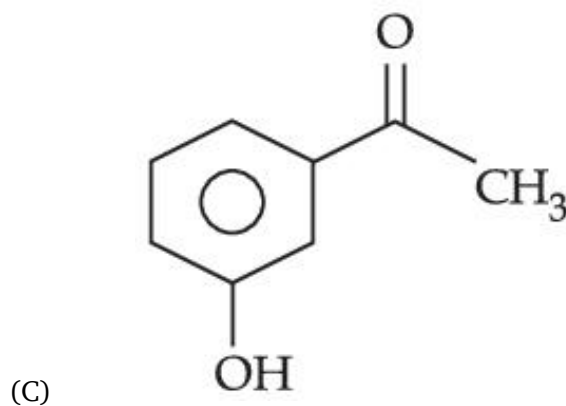
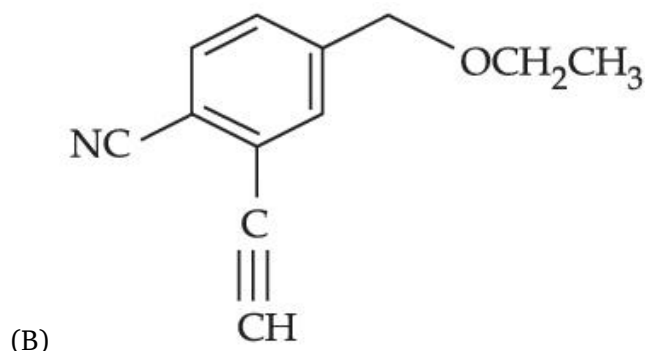
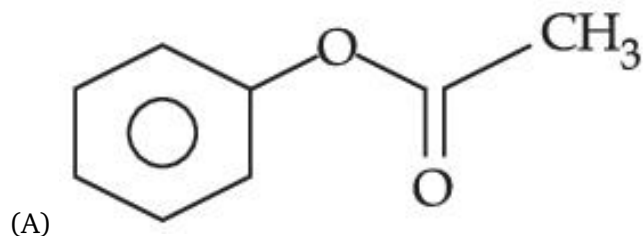
61. Which one of the following statements for D.I. Mendeleeff, is incorrect?

- | | |
|--|--|
| (A) He authored the textbook - Principles of Chemistry | (B) At the time, he proposed Periodic Table of elements structure of atom was known. |
| (C) Element with atomic number 101 is named after him. | (D) He invented accurate barometer. |

62. Which purification technique is used for high boiling organic liquid compound (decomposes near its boiling point)?

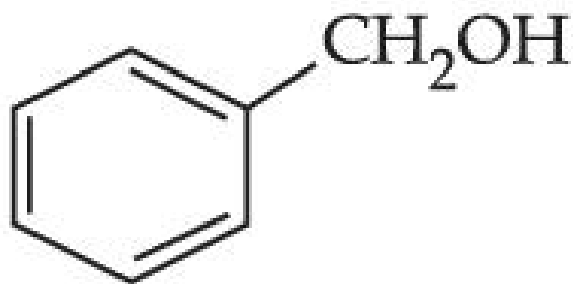
- | | |
|-----------------------------|-----------------------------------|
| (A) Simple distillation | (B) Steam distillation |
| (C) Fractional distillation | (D) Reduced pressure distillation |

63. Which of the following compounds will provide a tertiary alcohol or reaction with excess of CH_3MgBr followed by hydrolysis?



64. Which of the following compounds does not exhibit resonance?

(A) $\text{CH}_3\text{CH}_2\text{OCH}=\text{CH}_2$

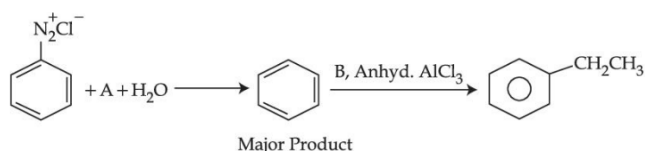


(B)

(C) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CONH}_2$

(D) $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{NH}_2$

65.



In the chemical reactions given above A and B respectively are :

- (A) H_3PO_2 and $\text{CH}_3\text{CH}_2\text{Cl}$ (B) $\text{CH}_3\text{CH}_2\text{OH}$ and H_3PO_2
 (C) H_3PO_2 and $\text{CH}_3\text{CH}_2\text{OH}$ (D) $\text{CH}_3\text{CH}_2\text{Cl}$ and H_3PO_2

66. Isotope(s) of hydrogen which emits low energy β^- particles with $t_{1/2}$ value > 12 years is/are

- (A) Protium (B) Tritium
 (C) Deuterium (D) Deuterium and Tritium

67. Match List-I with List-II :

	List-I (Species)		List-II (Hybrid Orbitals)
(a)	SF_4	(i)	sp^3d^2
(b)	IF_5	(ii)	d^2sp^3
(c)	NO_2^+	(ii)	sp^3d
(d)	NH_4^+	(i)	sp^3
		(v)	sp

Choose the correct answer from the options given below :

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

68. Which of the following molecules does not show stereo isomerism?

- (A) 3, 4-Dimethylhex-3-ene (B) 3-Methylhex-1-ene
 (C) 3-Ethylhex-3-ene (D) 4-Methylhex-1-ene

69. Which one of the following group-15 hydride is the strongest reducing agent?

- (A) AsH_3 (B) BiH_3
 (C) PH_3 (D) SbH_3

70. The set having ions which are coloured and paramagnetic both is :

- (A) Cu^{2+} , Cr^{3+} , Sc^{3+} (B) Cu^{2+} , Zn^{2+} , Mn^{4+}
 (C) Sc^{3+} , V^{5+} , Ti^{4+} (D) Ni^{2+} , Mn^{7+} , Hg^{2+}

71. Thiamine and pyridoxine are also known respectively as :

- (A) Vitamin B₂ and Vitamin E (B) Vitamin E and Vitamin B₂
 (C) Vitamin B₆ and Vitamin B₂ (D) Vitamin B₁ and Vitamin B₆

72. An organic compound A ($\text{C}_6\text{H}_6\text{O}$) gives dark green colouration with ferric chloride. On treatment with CHCl_3 and KOH , followed by acidification gives compound B. Compound B can also be obtained from compound C on reaction with pyridinium chlorochromate (PCC). Identify A, B and C.

- (A) $\text{A} = \text{C}_6\text{H}_5\text{OH}$, $\text{B} = \text{C}_6\text{H}_4(\text{OH})(\text{CHO})$, $\text{C} = \text{C}_6\text{H}_4(\text{OH})(\text{CH}_2\text{OH})$
 (B) $\text{A} = \text{C}_6\text{H}_5\text{OH}$, $\text{B} = \text{C}_6\text{H}_4(\text{CH}_2\text{OH})(\text{OH})$, $\text{C} = \text{C}_6\text{H}_4(\text{OH})(\text{CHO})$
 (C) $\text{A} = \text{C}_6\text{H}_4(\text{CH}_2\text{OH})(\text{OH})$, $\text{B} = \text{C}_6\text{H}_4(\text{OH})(\text{CHO})$, $\text{C} = \text{C}_6\text{H}_5\text{OH}$
 (D) $\text{A} = \text{C}_6\text{H}_4(\text{HO})(\text{CHO})$, $\text{B} = \text{C}_6\text{H}_4(\text{CH}_2\text{OH})(\text{OH})$, $\text{C} = \text{C}_6\text{H}_5\text{OH}$

73. Which one of the following reactions does not occur?

- (A) $\text{C}_6\text{H}_5\text{NH}_2 + (\text{CH}_3\text{CO})_2\text{O} / \text{Pyridine} \rightarrow \text{C}_6\text{H}_5\text{NHCOCH}_3$
 (B) $\text{C}_6\text{H}_5\text{NH}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{C}_6\text{H}_4(\text{NH}_2)(\text{SO}_3\text{H})$
 (C) $\text{C}_6\text{H}_5\text{NH}_2 + \text{AlCl}_3 + \text{CH}_3\text{Cl} \rightarrow \text{C}_6\text{H}_4(\text{NH}_2)(\text{CH}_3)$
 (D) $\text{C}_6\text{H}_5\text{NH}_2 + \text{HNO}_3 / \text{H}_2\text{SO}_4 \rightarrow \text{C}_6\text{H}_4(\text{NH}_2)(\text{NO}_2)$

74. Which one of the following 0.06 M aqueous solutions has lowest freezing point?

- (A) $\text{Al}_2(\text{SO}_4)_3$ (B) $\text{C}_6\text{H}_{12}\text{O}_6$
 (C) KI (D) K_2SO_4

75. The water having more dissolved O_2 is :

- (A) boiling water (B) water at $80^\circ C$
(C) polluted water (D) water at $4^\circ C$

76. Match List-I with List-II

	List-I (Elements)		List-II (Properties)
(a)	Ba	(i)	Organic solvent soluble compounds
(b)	Ca	(ii)	Outer electronic configuration $6s^2$
(c)	Li	(iii)	Oxalate insoluble in water
(d)	Na	(iv)	Formation of very strong monoacidic base

Choose the correct answer from the options given below :

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

77. When silver nitrate solution is added to potassium iodide solution then the sol produced is :

- (A) AgI / I^- (B) AgI / Ag^+
(C) KI / NO_3^- (D) $AgNO_3 / NO_3^-$

78. Given below are the statements about diborane

(a) Diborane is prepared by the oxidation of $NaBH_4$ with I_2

(b) Each boron atom is in sp^2 hybridized state

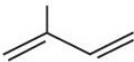
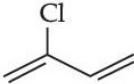
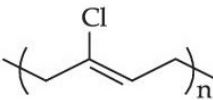
(c) Diborane has one bridged 3 centre-2-electron bond

(d) Diborane is a planar molecule

The option with correct statements is :

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

79. Match List-I with List-II :

List - I	List - II
(a) Chloroprene	(i) 
(b) Neoprene	(ii) 
(c) Acrylonitrile	(iii) 
(d) Isoprene	(iv) $CH_2=CH-CN$

Choose the correct answer from the options given below :

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

80. Sulphide ion is soft base and its ores are common for metals.

(a) Pb (b) Al (c) Ag (d) Mg

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

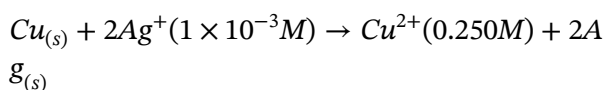
Chemistry - Section B · Numerical Value Questions

81. The total number of unpaired electrons present in $[\text{Co}(\text{NH}_3)_6]\text{Cl}_2$ and $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ is :

82. Methylation of 10 g of benzene gave 9.2 g of toluene. Calculate the percentage yield of toluene _____. (Nearest integer)

83. The number of acyclic structural isomers (including geometrical isomers) for pentene are _____

84. Assume a cell with the following reaction



$$E_{\text{cell}}^{\ominus} = 2.97$$

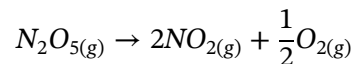
V
 E_{cell} for the above reaction is _____ V.
 (Nearest integer)
 [Given : $\log 2.5 = 0.3979$, $T = 298\text{ K}$]

85. Value of K_p for the equilibrium reaction $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ at 288 K is 47.9. The K_c for this reaction at same temperature is _____. (Nearest integer)
 ($R = 0.083\text{ L bar K}^{-1}\text{ mol}^{-1}$)

86. If the standard molar enthalpy change for combustion of graphite powder is $-2.48 \times 10^2\text{ kJ mol}^{-1}$, the amount of heat generated on combustion of 1 g of graphite powder is _____ kJ. (Nearest integer)

87. Number of electrons that Vanadium ($Z = 23$) has in p-orbitals is equal to _____

88.



In the above first order reaction the initial concentration of N_2O_5 is $2.40 \times 10^{-2}\text{ mol L}^{-1}$ at 318 K. The concentration of N_2O_5 after 1 hour was $1.60 \times 10^{-2}\text{ mol L}^{-1}$. The rate constant of the reaction at 318 K is _____ $\times 10^{-3}\text{ min}^{-1}$. (Nearest integer)
 [Given : $\log 3 = 0.477$, $\log 5 = 0.699$]

89. If the concentration of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) in blood is 0.72 g L^{-1} , the molarity of glucose in blood is _____ $\times 10^{-3}\text{ M}$. (Nearest integer)
 [Given : Atomic mass of C = 12, H = 1, O = 16 u]

90. A copper complex crystallising in a CCP lattice with a cell edge of 0.4518 nm has been revealed by employing X-ray diffraction studies. The density of a copper complex is found to be 7.62 g cm^{-3} . The molar mass of copper complex is _____ g mol^{-1} . (Nearest integer)
 [Given : $N_A = 6.022 \times 10^{23}\text{ mol}^{-1}$]

- End of Question Paper -