

JEE Main – 2020

7th January 2020 (Morning Shift)

General Instructions

1. The test is of **3 hours** duration and the maximum marks is **300**.
2. The question paper consists of **3 Parts** (Part I: **Physics**, Part II: **Chemistry**, Part III: **Mathematics**). Each Part has **two** sections (Section 1 & Section 2).
3. **Section 1** contains **20 Multiple Choice Questions**. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE CHOICE** is correct.
4. **Section 2** contains **5 Numerical Value Type Questions**. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places.

Marking Scheme

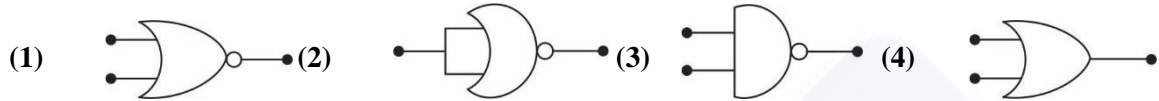
1. **Section – 1:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.
2. **Section – 2:** +4 for correct answer, 0 for all other cases. There is no negative marking.

SUBJECT I: PHYSICS	MARKS: 100
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SECTION 1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE CHOICE** is correct.

1. Which of the following gives a reversible operation?



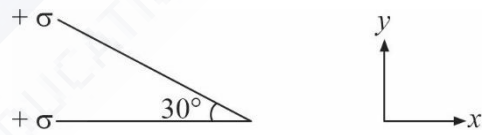
2. A 60 HP electric motor lifts an elevator having a maximum total load capacity of 2000 kg. If the frictional force on the elevator is 4000 N, the speed of the elevator at full load is close to: (1 HP = 746 W, $g = 10 \text{ ms}^{-2}$)

- (1) 1.9 ms^{-1} (2) 1.7 ms^{-1} (3) 1.5 ms^{-1} (4) 2.0 ms^{-1}

3. A long solenoid of radius R carries a time (t) – dependent current $I(t) = I_0 t(1-t)$. A ring of radius 2R is placed coaxially near its middle. During the time interval $0 \leq t \leq 1$, the induced current (I_R) and the induced $EMF(V_R)$ in the ring change as:

- (1) At $t = 0.5$ direction of I_R reverses and V_R is zero
 (2) At $t = 0.25$ direction of I_R reverses and V_R is maximum
 (3) Direction of I_R remains unchanged and V_R is maximum at $t = 0.5$
 (4) Direction of I_R remains unchanged and V_R is zero at $t = 0.25$

4. Two infinite planes each with uniform surface charge density $+\sigma$ are kept in such a way that the angle between them is 30° . The electric field in the region shown between them is given by:



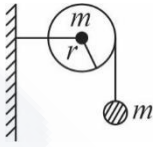
- (1) $\frac{\sigma}{\epsilon_0} \left[\left(1 + \frac{\sqrt{3}}{2}\right)y + \frac{x}{2} \right]$ (2) $\frac{\sigma}{2\epsilon_0} \left[\left(1 + \sqrt{3}\right)y - \frac{x}{2} \right]$
 (3) $\frac{\sigma}{2\epsilon_0} \left[\left(1 + \sqrt{3}\right)y + \frac{x}{2} \right]$ (4) $\frac{\sigma}{2\epsilon_0} \left[\left(1 - \frac{\sqrt{3}}{2}\right)y - \frac{x}{2} \right]$

5. Visible light of wavelength $6000 \times 10^{-8} \text{ cm}$ falls normally on a single slit and produces a diffraction pattern. It is found that the second diffraction minimum is at 60° from the central maximum. If the first minimum is produced at θ_1 , then θ_1 is close to:

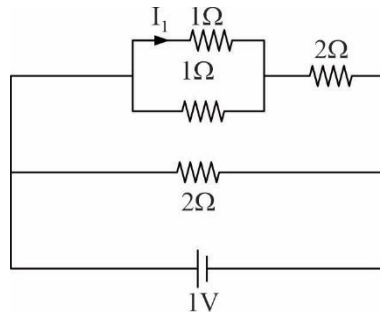
- (1) 30° (2) 45° (3) 20° (4) 25°

6. A satellite of mass m is launched vertically upwards with an initial speed u from the surface of the earth. After it reaches height R (R = radius of the earth), it ejects a rocket of mass $\frac{m}{10}$ so that subsequently the satellite moves in a circular orbit. The kinetic energy of the rocket is (G is the gravitational constant; M is the mass of the earth):

- (1) $5m \left(u^2 - \frac{119}{200} \frac{GM}{R} \right)$ (2) $\frac{m}{20} \left(u^2 + \frac{113}{200} \frac{GM}{R} \right)$
 (3) $\frac{3m}{8} \left(u + \sqrt{\frac{5GM}{6R}} \right)^2$ (4) $\frac{m}{20} \left(u - \sqrt{\frac{2GM}{3R}} \right)^2$

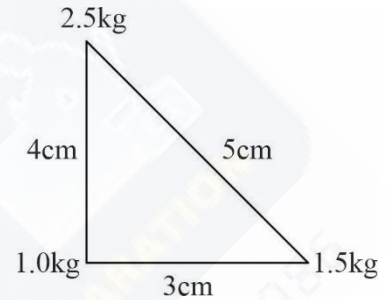
7. Two moles of an ideal gas with $\frac{C_P}{C_V} = \frac{5}{3}$ are mixed with 3 moles of another ideal gas with $\frac{C_P}{C_V} = \frac{4}{3}$. The value of $\frac{C_P}{C_V}$ for the mixture is:
 (1) 1.45 (2) 1.50 (3) 1.47 (4) 1.42
8. The time period of revolution of electron in its ground state orbit in a hydrogen atom is 1.6×10^{-16} s. The frequency of revolution of the electron in its first excited state ($\text{in } s^{-1}$) is:
 (1) 7.8×10^{14} (2) 6.2×10^{15} (3) 1.6×10^{14} (4) 5.6×10^{12}
9. As shown in the figure, a bob of mass m is tied by a massless string whose other end portion is wound on a fly wheel (disc) of radius r and mass m . When released from rest the bob starts falling vertically. When it has covered a distance of h , the angular speed of the wheel will be:
 (1) $r\sqrt{\frac{3}{2gh}}$ (2) $\frac{1}{r}\sqrt{\frac{4gh}{3}}$ (3) $\frac{1}{r}\sqrt{\frac{2gh}{3}}$ (4) $r\sqrt{\frac{3}{4gh}}$
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10. Consider a circular coil of wire carrying constant current I , forming a magnetic dipole. The magnetic flux through an infinite plane that contains the circular coil and excluding the circular coil area is given by ϕ_i . The magnetic flux through the area of the circular coil area is given by ϕ_0 . Which of the following option is correct?
 (1) $\phi_i = \phi_0$ (2) $\phi_i > \phi_0$ (3) $\phi_i = -\phi_0$ (4) $\phi_i < \phi_0$
11. A LCR circuit behaves like a damped harmonic oscillator. Comparing it with a physical spring-mass damped oscillator having damping constant 'b', the correct equivalence would be:
 (1) $L \leftrightarrow m, C \leftrightarrow \frac{1}{k}, R \leftrightarrow b$ (2) $L \leftrightarrow k, C \leftrightarrow b, R \leftrightarrow m$
 (3) $L \leftrightarrow m, C \leftrightarrow k, R \leftrightarrow b$ (4) $L \leftrightarrow \frac{1}{b}, C \leftrightarrow \frac{1}{m}, R \leftrightarrow \frac{1}{k}$
12. If we need a magnification of 375 from a compound microscope of tube length 150 mm and an objective of focal length 5 mm, the focal length of the eyepiece, should be close to:
 (1) 2 mm (2) 12 mm (3) 33 mm (4) 22 mm
13. If the magnetic field in a plane electromagnetic wave is given by $\vec{B} = 3 \times 10^{-8} \sin(1.6 \times 10^3 x + 48 \times 10^{10} t) \hat{j} T$, then what will be expression for electric field?
 (1) $\vec{E} = (3 \times 10^{-8} \sin(1.6 \times 10^3 x + 48 \times 10^{10} t) \hat{i} V / m)$
 (2) $\vec{E} = (3 \times 10^{-8} \sin(1.6 \times 10^3 x + 48 \times 10^{10} t) \hat{j} V / m)$
 (3) $\vec{E} = (60 \sin(1.6 \times 10^3 x + 48 \times 10^{10} t) \hat{k} V / m)$
 (4) $\vec{E} = (9 \sin(1.6 \times 10^3 x + 48 \times 10^{10} t) \hat{k} V / m)$
14. The radius of gyration of a uniform rod of length l , about an axis passing through a point $\frac{l}{4}$ away from the centre of the rod, and perpendicular to it, is:
 (1) $\sqrt{\frac{7}{48}} l$ (2) $\frac{1}{4} l$ (3) $\frac{1}{8} l$ (4) $\sqrt{\frac{3}{8}} l$

15. The current I_1 (in A) flowing through 1Ω resistor in the following circuit is:



- (1) 0.5 (2) 0.4 (3) 0.25 (4) 0.2

16. Three point particles of masses 1.0 kg, 1.5 kg and 2.5 kg are placed at three corners of a right angle triangle of sides 4.0 cm, 3.0 cm and 5.0 cm as shown in the figure. The centre of mass of the system is at a point:

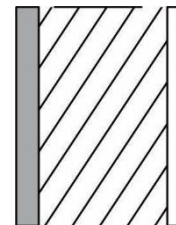


- (1) 1.5 cm right and 1.2 cm above 1 kg mass
 (2) 2.0 cm right and 0.9 cm above 1 kg mass
 (3) 0.6 cm right and 2.0 cm above 1 kg mass
 (4) 0.9 cm right and 2.0 cm above 1 kg mass

17. A polarizer-analyser set is adjusted such that the intensity of light coming out of the analyser is just 10% of the original intensity. Assuming that the polarizer-analyser set does not absorb any light, the angle by which the analyser need to be rotated further to reduce the output intensity to be zero, is:

- (1) 18.4° (2) 90° (3) 45° (4) 71.6°

18. A parallel plate capacitor has plates of area A separated by distance ' d ' between them. It is filled with a dielectric which has a dielectric constant that varies as $k(x) = K(1 + \alpha x)$ where ' x ' is the distance measured from one of the plates. If $(\alpha d) \ll 1$, the total capacitance of the system is best given by the expression:



- (1) $\frac{A\epsilon_0 k}{d} \left(1 + \left(\frac{\alpha d}{2} \right)^2 \right)$ (2) $\frac{AK\epsilon_0}{d} (1 + \alpha d)$
 (3) $\frac{A\epsilon_0 K}{d} \left(1 + \frac{\alpha^2 d^2}{2} \right)$ (4) $\frac{AK\epsilon_0}{d} \left(1 + \frac{\alpha d}{2} \right)$

19. Speed of a transverse wave on a straight wire (mass 6.0 g, length 60cm and area of cross-section 1.0 mm^2) is 90 ms^{-1} . If the Young's modulus of wire is $16 \times 10^{11} \text{ Nm}^{-2}$, the extension of wire over its natural length is:

- (1) 0.03 mm (2) 0.04 mm (3) 0.02 mm (4) 0.01 mm

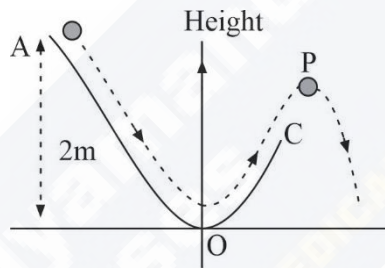
20. A litre of dry air at STP expands adiabatically to a volume of 3 litres. If $\gamma = 1.40$, the work done by air is: ($3^{1.4} = 4.6555$) [Take air to be an ideal gas]

- (1) 90.5 J (2) 100.8 J (3) 60.7 J (4) 48 J

SECTION 2

This section has FIVE (05) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places.

21. A Carnot engine operates between two reservoirs of temperatures 900 K and 300 K. The engine performs 1200 J of work per cycle. The heat energy (in J) delivered by the engine to the low temperature reservoir, in a cycle, is_____.
22. A non-isotropic solid metal cube has coefficients of linear expansion as: $5 \times 10^{-5} / ^\circ C$ along the x -axis and $5 \times 10^{-6} / ^\circ C$ along the y and z -axis. If the coefficient of volume expansion of the solid is $C \times 10^{-6} / ^\circ C$ then the value of C is_____.
23. A particle ($m = 1$ kg) slides down a frictionless track (AOC) starting from rest at a point A (height $2m$). After reaching C, the particle continues to move freely in air as a projectile. When it reaching its highest point P(height 1 m), the kinetic energy of the particle (in J) is: (Figure drawn is schematic and not to scale; take $g = 10 \text{ ms}^{-2}$)_____.



24. A loop ABCDEFA of straight edges has six corner points $A(0, 0, 0)$, $B(5, 0, 0)$, $C(5, 5, 0)$, $D(0, 5, 0)$, $E(0, 5, 5)$ and $F(0, 0, 5)$. The magnetic field in this region is $\vec{B} = (3\hat{i} + 4\hat{k})T$. The quantity of flux through the loop ABCDEFA (in Wb) is_____.
25. A beam of electromagnetic radiation of intensity $6.4 \times 10^{-5} \text{ W/cm}^2$ is comprised of wavelength, $\lambda = 310 \text{ nm}$. It falls normally on a metal (work function $\phi = 2 \text{ eV}$) of surface area of 1 cm^2 . If one in 10^3 photons ejects an electron, total number of electrons ejected in 1 s is 10^x . ($hc = 1240 \text{ eVnm}$, $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$), then x is_____.

SECTION 1

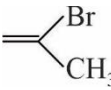
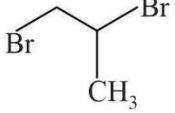

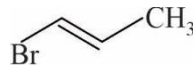
This section contains 20 Multiple Choice Questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE CHOICE is correct.

- Amongst the following statements, that which was not proposed by Dalton was:
 - Matter consists of indivisible atoms
 - When gases combine or reproduced in a chemical reaction they do so in a simple ratio by volume provided all gases are at same T & P
 - Chemical reactions involve reorganization of atoms. These are neither created nor destroyed in a chemical reaction
 - All the atoms of a given element have identical properties including identical mass. Atoms of different elements differ in mass
- At 35°C, the vapour pressure of CS₂ is 512 mm Hg and that of acetone is 344 mm Hg. A solution of CS₂ in acetone has a total vapour pressure of 600 mm Hg. The false statement amongst the following is:
 - Raoult's law is not obeyed by this system
 - CS₂ and acetone are less attracted to each other than to themselves
 - Heat must be absorbed in order to produce the solution at 35°C
 - A mixture of 100 mL CS₂ and 100 mL acetone has a volume < 200 mL
- Given that the standard potentials (E°) of Cu²⁺ / Cu and Cu⁺ / Cu are 0.34 V and 0.522 V respectively, the E° of Cu²⁺ / Cu⁺ is:

(1) +0.158 V	(2) -0.182 V	(3) -0.158 V	(4) 0.182 V
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- Match the following

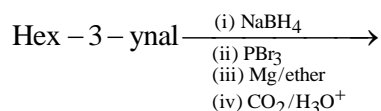
(i) Riboflavin	(a) Beriberi
(ii) Thiamine	(b) Scurvy
(iii) Pyridoxine	(c) Cheilosis
(iv) Ascorbic acid	(d) Convulsions

(1) (i) – (a), (ii) – (d), (iii) – (c), (iv) – (b)	(2) (i) – (c), (ii) – (a), (iii) – (d), (iv) – (b)
(3) (i) – (d), (ii) – (b), (iii) – (a), (iv) – (c)	(4) (i) – (c), (ii) – (d), (iii) – (a), (iv) – (b)
- The IUPAC name of the complex [Pt(NH₃)₂Cl(NH₂CH₃)]Cl is:
 - Diammine (methanamine) chlorido platinum (II) chloride
 - Diamminechlorido (methanamine) platinum (II) chloride
 - Diamminechlorido (aminomethane) platinum (II) chloride
 - Bisamine (methanamine) chlorido platinum (II) chloride
- 1-methyl ethylene oxide when treated with an excess of HBr produces:

(1) 	(2) 	(3) 	(4) 
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7. A solution of m-chloroaniline, m-chlorophenol and m-chlorobenzoic acid in ethyl acetate was extracted initially with a saturated solution of NaHCO_3 to give fraction A. The left over organic phase was extracted with dilute NaOH solution to give fraction B. The final organic layer was labelled as fraction C, Fractions A, B and C, contain respectively:
- (1) m-chlorobenzoic acid, m-chlorophenol and m-chloroaniline
 - (2) m-chlorophenol, m-chlorobenzoic acid and m-chloroaniline
 - (3) m-chlorobenzoic acid, m-chloroaniline and m-chlorophenol, m-chloroaniline
 - (4) m-chlorobenzoic acid and m-chlorophenol
8. The number of orbitals associated with quantum numbers $n = 5, m_s = +\frac{1}{2}$ is:
- (1) 15
 - (2) 50
 - (3) 11
 - (4) 25
9. Oxidation number of potassium in $\text{K}_2\text{O}, \text{K}_2\text{O}_2$ and KO_2 , respectively, is:
- (1) +1, +4 and +2
 - (2) +2, +1 and $+\frac{1}{2}$
 - (3) +1, +2 and +4
 - (4) +1, +1 and +1
10. Consider the following reactions:
- (a) $(\text{CH}_3)_3\text{CCH}(\text{OH})\text{CH}_3 \xrightarrow{\text{conc. H}_2\text{SO}_4}$
 - (b) $(\text{CH}_3)_2\text{CHCH}(\text{Br})\text{CH}_3 \xrightarrow{\text{alc. KOH}}$
 - (c) $(\text{CH}_3)_2\text{CHCH}(\text{Br})\text{CH}_3 \xrightarrow{(\text{CH}_3)_3\text{O}^\ominus \text{K}^\oplus}$
 - (d) $(\text{CH}_3)_2\underset{\text{OH}}{\text{C}}-\text{CH}_2-\text{CHO} \xrightarrow{\Delta}$
- Which of these reactions will not produce Saytzeff product?
- (1) (a), (c) and (d)
 - (2) (d) only
 - (3) (c) only
 - (4) (b) and (d)
11. The atomic radius of Ag is closest to:
- (1) Au
 - (2) Hg
 - (3) Cu
 - (4) Ni
12. In comparison to the zeolite process for the removal of permanent hardness, the synthetic resins method is:
- (1) more efficient as it can exchange only cations
 - (2) more efficient as it can exchange both cations as well as anions
 - (3) less efficient as it exchanges only anions
 - (4) less efficient as the resins cannot be regenerated
13. The purest form of commercial irons is:
- (1) Scrap iron and pig iron
 - (2) Wrought iron
 - (3) Pig iron
 - (4) Cast iron
14. The dipole moments of $\text{CCl}_4, \text{CHCl}_3$ and CH_4 are in the order:
- (1) $\text{CH}_4 < \text{CCl}_4 < \text{CHCl}_3$
 - (2) $\text{CHCl}_3 < \text{CH}_4 = \text{CCl}_4$
 - (3) $\text{CCl}_4 < \text{CH}_4 < \text{CHCl}_3$
 - (4) $\text{CH}_4 = \text{CCl}_4 < \text{CHCl}_3$
15. The electron gain enthalpy (in kJ/mol) of fluorine, chlorine, bromine and iodine, respectively are:
- (1) -349, -333, -325 and -296
 - (2) -333, -325, -349 and -296
 - (3) -296, -325, -333 and -349
 - (4) -333, -349, -325 and -296

16. What is the product of the following reaction?

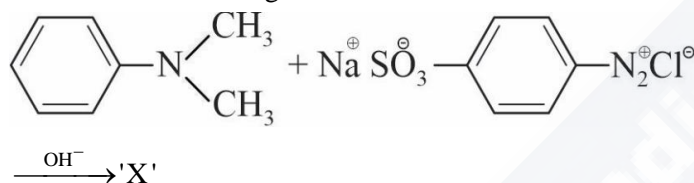


- (1)  (2) 
 (3)  (4) 

17. The relative strength of interionic/intermolecular forces in decreasing order is:

- (1) ion-dipole > ion-ion > dipole-dipole (2) ion-ion > ion-dipole > dipole-dipole
 (3) dipole-dipole > ion-dipole > ion-ion (4) ion-dipole > dipole-dipole > ion-ion

18. Consider the following reaction

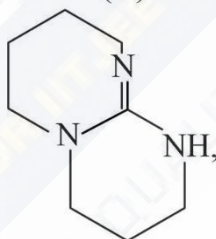


The product 'X' is used:

- (1) In laboratory test for phenols
 (2) In acid base titration as an indicator
 (3) As food grade colourant
 (4) In protein estimation as an alternative to ninhydrin
19. The increasing order of pK_b for the following compounds will be:



(A)



(B)



(C)

- (1) (C) < (A) < (B) (2) (A) < (B) < (C) (3) (B) < (C) < (A) (4) (B) < (A) < (C)

20. The theory that can completely/properly explained the nature of bonding in $[\text{Ni}(\text{CO})_4]$

- (1) Valence bond theory (2) Werner's theory
 (3) Crystal field theory (4) Molecular orbital theory

SECTION 2

This section has FIVE (05) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places.

21. The number of chiral carbons in chloramphenicol is_____.
22. Two solutions, A and B, each of 100 L was made by dissolving 4g of NaOH and 9.8 g of H₂SO₄ in water, respectively. The pH of the resultant solution obtained from mixing 40 L of solution A and 10 L of solution B is_____.
23. During the nuclear explosion, one of the products is ⁹⁰Sr with half-life of 6.93 years. If 1μg of ⁹⁰Sr was absorbed in the bones of a newly born baby in place of Ca, how much time, in years, is required to reduce it by 90% if it is not lost metabolically_____.
24. For reaction; A(l) → 2B(g)
ΔU = 2.1 kcal, ΔS = 20 cal K⁻¹ at 300 K . Hence ΔG in kcal is_____.
25. Chlorine reacts with hot and concentrated NaOH and produces compounds (X) and (Y). Compound (X) gives white precipitate with silver nitrate solution. The average bond order between Cl and O atoms in (Y) is_____.

SECTION 1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE CHOICE is correct.

- If $y = y(x)$ is the solution of the differential equation, $e^y \left(\frac{dy}{dx} - 1 \right) = e^x$ such that $y(0) = 0$, then $y(1)$ is equal to:
 (1) $1 + \log_e 2$ (2) $\log_e 2$ (3) $2e$ (4) $2 + \log_e 2$
- Let P be a plane passing through the points $(2, 1, 0)$, $(4, 1, 1)$ and $(5, 0, 1)$ and R be any point $(2, 1, 6)$. Then the image of R in the plane P is:
 (1) $(3, 4, -2)$ (2) $(6, 5, 2)$ (3) $(4, 3, 2)$ (4) $(6, 5, -2)$
- An unbiased coin is tossed 5 times. Suppose that a variable X is assigned the value k when k consecutive heads are obtained for $k = 3, 4, 5$, otherwise X takes the value -1 . Then the expected value of X, is:
 (1) $-\frac{3}{16}$ (2) $-\frac{1}{8}$ (3) $\frac{3}{16}$ (4) $\frac{1}{8}$
- If $y = mx + 4$ is a tangent to both the parabolas, $y^2 = 4x$ and $x^2 = 2by$, then b is equal to:
 (1) -64 (2) -32 (3) 128 (4) -128
- The greatest positive integer k , for which $49^k + 1$ is factor of the sum $49^{125} + 49^{124} + \dots + 49^2 + 49 + 1$, is:
 (1) 60 (2) 63 (3) 65 (4) 32
- Total number of 6-digit numbers in which only and all the five digits 1, 3, 5, 7 and 9 appear, is:
 (1) $6!$ (2) 5^6 (3) $\frac{1}{2}(6!)$ (4) $\frac{5}{2}(6!)$
- Let $x^k + y^k = a^k$, $(a, k > 0)$ and $\frac{dy}{dx} + \left(\frac{y}{x} \right)^{\frac{1}{3}} = 0$, then k is:
 (1) $\frac{3}{2}$ (2) $\frac{1}{3}$ (3) $\frac{2}{3}$ (4) $\frac{4}{3}$
- Let α and β be two real roots of the equation $(k+1)\tan^2 x - \sqrt{2} \cdot \lambda \tan x = (1-k)$, where $k (\neq -1)$ and λ are real numbers. If $\tan^2(\alpha + \beta) = 50$, then a value of λ is:
 (1) $5\sqrt{2}$ (2) $10\sqrt{2}$ (3) 10 (4) 5
- Let α be a root of the equation $x^2 + x + 1 = 0$ and the matrix $A = \frac{1}{\sqrt{3}} \begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha^4 \end{bmatrix}$, then the matrix A^{31} is equal to:
 (1) A (2) A^3 (3) I_3 (4) A^2

10. If the system of linear equations
 $2x + 2ay + az = 0$
 $2x + 3by + bz = 0$
 $2x + 4cy + cz = 0,$
 Where $a, b, c \in R$ are non-zero and distinct; has a non-zero solution, then:
 (1) $a + b + c = 0$ (2) a, b, c are in G.P.
 (3) $\frac{1}{a}, \frac{1}{b}, \frac{1}{c}$ are in A.P. (4) a, b, c are in A. P.
11. The logical statement $(p \Rightarrow q) \wedge (q \Rightarrow \sim p)$ is equivalent to:
 (1) q (2) $\sim p$ (3) $\sim q$ (4) p
12. If $y(\alpha) = \sqrt{2 \left(\frac{\tan \alpha + \cot \alpha}{1 + \tan^2 \alpha} \right) + \frac{1}{\sin^2 \alpha}}, \alpha \in \left(\frac{3\pi}{4}, \pi \right)$, then $\frac{dy}{dx}$ at $\alpha = \frac{5\pi}{6}$ is:
 (1) $\frac{4}{3}$ (2) -4 (3) 4 (4) $-\frac{1}{4}$
13. If $\operatorname{Re} \left(\frac{z-1}{2z+i} \right) = 1$, where $z = x + iy$, then the point (x, y) lies on a:
 (1) Circle whose centre is at $\left(-\frac{1}{2}, -\frac{3}{2} \right)$ (2) Straight line whose slope is $-\frac{2}{3}$
 (3) Circle whose diameter is $\frac{\sqrt{5}}{2}$ (4) Straight line whose slope is $\frac{3}{2}$
14. Let the function, $f: [-7, 0] \rightarrow R$ be continuous on $[-7, 0]$ and differentiable on $(-7, 0)$. If $f(-7) = -3$ and $f'(x) \leq 2$, for all $x \in (-7, 0)$, then for all such functions $f, f(-1) + f(0)$ lies in the interval:
 (1) $(-\infty, 20]$ (2) $[-3, 11]$ (3) $[-6, 20]$ (4) $(-\infty, 11]$
15. The area of the region, enclosed by the circle $x^2 + y^2 = 2$ which is not common to the region bounded by the parabola $y^2 = x$ and the straight line $y = x$, is:
 (1) $\frac{1}{3}(12\pi - 1)$ (2) $\frac{1}{6}(12\pi - 1)$ (3) $\frac{1}{6}(24\pi - 1)$ (4) $\frac{1}{3}(6\pi - 1)$
16. If the distance between the foci of an ellipse is 6 and the distance between its directrices is 12, then the length of its latus rectum is:
 (1) $2\sqrt{3}$ (2) $\frac{3}{\sqrt{2}}$ (3) $\sqrt{3}$ (4) $3\sqrt{2}$
17. Five numbers are in A.P., whose sum is 25 and product is 2520. If one of these five numbers is $-\frac{1}{2}$, then the greatest number amongst them is:
 (1) $\frac{21}{2}$ (2) 7 (3) 27 (4) 16
18. If $g(x) = x^2 + x - 1$ and $(g \circ f)(x) = 4x^2 - 10x + 5$, then $f\left(\frac{5}{4}\right)$ is equal to:
 (1) $-\frac{1}{2}$ (2) $\frac{1}{2}$ (3) $-\frac{3}{2}$ (4) $\frac{3}{2}$

19. If $f(a+b+1-x)=f(x)$, for all x , where a and b are fixed positive real numbers, then

$\frac{1}{a+b} \int_a^b x(f(x) + f(x+1))dx$ is equal to:

(1) $\int_{a+1}^{b+1} f(x)dx$ (2) $\int_{a+1}^{b+1} f(x+1)dx$ (3) $\int_{a-1}^{b-1} f(x+1)dx$ (4) $\int_{a-1}^{b-1} f(x)dx$

20. A vector $\vec{a} = \alpha\hat{i} + 2\hat{j} + \beta\hat{k}$ ($\alpha, \beta \in R$) lies in the plane of the vectors, $\vec{b} = \hat{i} + \hat{j}$ and $\vec{c} = \hat{i} - \hat{j} + 4\hat{k}$. If \vec{a} bisects the angle between \vec{b} and \vec{c} , then:

(1) $\vec{a} \cdot \hat{k} + 4 = 0$ (2) $\vec{a} \cdot \hat{k} + 2 = 0$ (3) $\vec{a} \cdot \hat{i} + 3 = 0$ (4) $\vec{a} \cdot \hat{i} + 1 = 0$

SECTION 2

This section has FIVE (05) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places.

21. $\lim_{x \rightarrow 2} \frac{3^x + 3^{3-x} - 12}{3^{-x/2} - 3^{1-x}}$ is equal to _____.

22. If the sum of the coefficients of all even powers of x in the product $(1+x+x^2+\dots+x^{2n})(1-x+x^2-x^3+\dots+x^{2n})$ is 61, then n is equal to _____.

23. If the variance of the first n natural numbers is 10 and the variance of the first m even natural numbers is 16, then $m+n$ is equal to _____.

24. Let $A(1, 0)$, $B(6, 2)$ and $C\left(\frac{3}{2}, 6\right)$ be the vertices of a triangle ABC. If P is a point inside the triangle ABC such that the triangle APC, APB and BPC have equal areas, then the length of the line segment PQ, where Q is the point $\left(-\frac{7}{6}, -\frac{1}{3}\right)$, is _____.

25. Let S be the set of points where the function, $f(x) = |2 - |x - 3||$, $x \in R$, is not differentiable. Then

$\sum_{x \in S} f(f(x))$ is equal to _____.