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Question Paper

Solutions

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PHYSICS

1. The plot that depicts the behavior of the mean free time $\tau$ (time between two successive collisions) for the molecules of an ideal gas, as a function of temperature ($T$), qualitatively, is: (Graphs are schematic and not drawn to scale)

   1) \[
   \begin{align*}
   \tau & \sim \frac{1}{\sqrt{T}} \\
   \frac{1}{T} & \sim \frac{1}{\sqrt{T}} \\
   \tau & \sim T \\
   \tau & \sim \sqrt{T}
   \end{align*}
   \]

   Ans: 1

2. Consider two solid spheres of radii $R_1 = 1m, R_2 = 2m$ and masses $M_1$ and $M_2$, respectively. The gravitational field due to sphere 1 and 2 are shown. The value of $\frac{M_1}{M_2}$ is:

   1) $\frac{1}{2}$
   2) $\frac{2}{3}$
   3) $\frac{1}{6}$
   4) $\frac{1}{3}$

   Ans: 3
3. When photon of energy 4.0eV strikes the surface of a metal A, the ejected photoelectrons have maximum kinetic energy \( T_A \) eV and de-Broglie wavelength \( \lambda_A \). The maximum kinetic energy of photoelectrons liberated from another metal B by photon of energy 4.50eV is \( T_B = (T_A - 1.5)eV \). If the de-Broglie wavelength of these photoelectrons \( \lambda_B = 2\lambda_A \), then the work function of metal B is:

1) 1.5 eV  
2) 4eV  
3) 2eV  
4) 3eV

Ans: 2

4. The coordinates of centre of mass of a uniform flag shaped lamina (thin flat plate) of mass 4 kg. (The coordinates of the same are shown in figure) are:

1) (1.25m, 1.50m)  
2) (0.75m, 0.75m)  
3) (0.75m, 1.75m)  
4) (1m, 1.75m)

Ans: 3

5. A thermodynamic cycle xyzx is shown on a V-T diagram
The P-V diagram that best describes this cycle is: (Diagrams are schematic and not to scale)

1) 2) 3) 4)

Ans: 3

6. A particle of mass m is fixed to one end of a light spring having force constant k and unstretched length l. The other end is fixed. The system is given an angular speed ω about the fixed end of the spring such that it rotates in a circle in gravity free space. Then the stretch in the spring is:

1) \( \frac{ml\omega^2}{k + m\omega} \)
2) \( \frac{ml\omega^2}{k - m\omega} \)
3) \( \frac{ml\omega^2}{k + m\omega^2} \)
4) \( \frac{ml\omega^2}{k - m\omega^2} \)

Ans: 4

7. At time t=0 magnetic field of 1000 Gauss is passing perpendicularly through the area defined by the closed loop shown in the figure. If the magnetic field reduces linearly to 500 Gauss, in the next 5s, then induced EMF in the loop is:

1) 36μV
2) 56μV
3) 48μV
4) 28μV

Ans: 2
8. Three charged particles A, B and C with charges \(-4q, 2q\) and \(-2q\) are present on the circumference of a circle of radius \(d\). The charged particles A, C and centre O of the circle formed an equilateral triangle as shown in figure, Electric field at O along x-direction is:

\[
\begin{align*}
1) & \quad \frac{2\sqrt{3}q}{\pi \varepsilon_0 d^2} \\
2) & \quad \frac{\sqrt{3}q}{\pi \varepsilon_0 d^2} \\
3) & \quad \frac{3\sqrt{3}q}{4\pi \varepsilon_0 d^2} \\
4) & \quad \frac{\sqrt{3}q}{4\pi \varepsilon_0 d^2}
\end{align*}
\]

Ans: 2

9. The critical angle of a medium for a specific wavelength, if the medium has relative permittivity 3 and relative permeability \(\frac{4}{3}\) for this wavelength, will be:

\[
\begin{align*}
1) & \quad 45^\circ \\
2) & \quad 15^\circ \\
3) & \quad 60^\circ \\
4) & \quad 30^\circ
\end{align*}
\]

Ans: 4

10. Consider a uniform rod of mass \(M = 4m\) and length \(l\) pivoted about its centre. A mass \(m\) moving with velocity \(v\) making angle \(\theta = \frac{\pi}{4}\) to the rod’s long axis collides with one end of the rod and sticks to it. The angular speed of the rod-mass system just after the collision is:

\[
\begin{align*}
1) & \quad \frac{3\sqrt{2} v}{7 \ell} \\
2) & \quad \frac{3 v}{7 \ell} \\
3) & \quad \frac{3 v}{7\sqrt{2} \ell} \\
4) & \quad \frac{4 v}{7 \ell}
\end{align*}
\]

Ans: 1

11. The length of a potentiometer wire is 1200cm and it carries a current of 60mA. For a cell of emf 5V and internal resistance of 20\(\Omega\), the null point on it is found to be at 1000cm. the resistance of whole wire is:

\[
\begin{align*}
1) & \quad 80\Omega \\
2) & \quad 120\Omega \\
3) & \quad 60\Omega \\
4) & \quad 100\Omega
\end{align*}
\]

Ans: 4
12. Consider a solid sphere of radius R and mass density \( \rho(r) = \rho_0 \left(1 - \frac{r^2}{R^2}\right), \ 0 < r \leq R \). The minimum density of a liquid in which it will float is:

1) \( \frac{2\rho_0}{5} \)  
2) \( \frac{2\rho_0}{3} \)  
3) \( \frac{\rho_0}{5} \)  
4) \( \frac{\rho_0}{3} \)

Ans: 1

13. In finding the electric field using Gauss law the formula \( \overline{E} = \frac{q_{enc}}{\varepsilon_0 A} \) is applicable. In the formula \( \varepsilon_0 \) is permittivity of free space, A is the area of Gaussian surface and \( q_{enc} \) is charge enclosed by the Gaussian surface. This equation can be used in which of the following situation?

1) Only when the Gaussian surface is an equipotential surface
2) Only when the Gaussian surface is an equipotential surface and \( \overline{E} \) is constant on the surface
3) Only when \( \overline{E} \) = constant on the surface
4) For any choice of Gaussian surface

Ans: 2

14. Effective capacitance of parallel combination of two capacitors \( C_1 \) and \( C_2 \) is 10 \( \mu \)F. When these capacitors are individually connected to a voltage source of 1 V, the energy stored in the capacitor \( C_2 \) is 4 times that of \( C_1 \). If these capacitors are connected in series, their effective capacitance will be:

1) 1.6 \( \mu \)F  
2) 3.2 \( \mu \)F  
3) 8.4 \( \mu \)F  
4) 4.2 \( \mu \)F

Ans: 1

15. A leak proof cylinder of length 1m, made of a metal which has very low coefficient of expansion is floating, vertically in water at 0\(^{\circ}\)C such that its height above the water surface is 20cm. When the temperature of water is increased to 4\(^{\circ}\)C, the height of the cylinder above the water surface becomes 21cm. The density of water at \( T = 4^{\circ}\)C, relative to the density at \( T = 0^{\circ}\)C is close to:

1) 1.01  
2) 1.03  
3) 1.04  
4) 1.26

Ans: 1
16. The magnifying power of a telescope with tube length 60cm is 5. What is the focal length of its eye piece?
   1) 20cm  2) 10cm  3) 30cm  4) 40cm
   Ans: 2

17. Boolean relation at the output stage-Y for the following circuit is:

   ![Circuit Diagram]

   1) \( \overline{A} \overline{B} \)  2) \( A \overline{B} \)  3) \( A+B \)  4) \( \overline{A} + \overline{B} \)
   Ans: 1

18. The dimension of stopping potential \( V_0 \) in photoelectric effect in units of Planck's constant \( h \), speed of light \( c \) and gravitational constant \( G \) and ampere \( A \) is:

   1) \( h^{1/3} G^{2/3} C^{4/3} A^{-1} \)  2) \( h^{2/3} C^{5/3} G^{1/3} A^{-1} \)
   3) \( h^{-2/3} C^{-1/3} G^{4/3} A^{-1} \)  4) \( h^{2} G^{3/2} c^{1/3} A^{-1} \)
   Ans: 2

19. Proton with kinetic energy of 1 MeV moves from south to north. It gets an acceleration of \( 10^{12} \text{ m/s}^2 \) by an applied magnetic field (west to east). The value of magnetic field: (Rest mass of proton is \( 1.6 \times 10^{-27} \text{ kg} \))

   1) 0.71mT  2) 0.071mT  3) 71mT  4) 7.1mT
   Ans: 1
20. The graph which depicts the results of Rutherford gold foil experiment with 
\( \alpha \) - particles is:
\( \theta \): Scattering angle
\( Y \): Number of scattered \( \alpha \)-particles detected
(Plots are schematic and not to scale)

![Graphs showing scattering angles and particle counts]

1) ![Graph 1]
2) ![Graph 2]
3) ![Graph 3]
4) ![Graph 4]

Ans: 2

21. A point object in air is in front of the curved surface of a plano-convex lens. The radius of curvature of the curved surface is 30cm and the refractive index of the lens material is 1.5, then the focal length of the lens (in cm) is ________

Ans: 60.00

22. A body A, of mass \( m = 0.1 \)kg has an initial velocity of \( 3\hat{i} \text{ ms}^{-1} \). It collides elastically with another body, B of the same mass which has an initial velocity of \( 5\hat{j} \text{ ms}^{-1} \). After collision, A moves with a velocity \( \vec{v} = 4(\hat{i} + \hat{j}) \). The energy of B after collision is written as \( \frac{x}{10} \) J. The value of x is ________

Ans: 16.00
23. Four resistances of 15Ω, 12Ω, 4Ω and 10Ω respectively in cyclic order to form Wheatstone’s network. The resistance that is to be connected in parallel with the resistance of 10Ω to balance the network is __________ Ω.

Ans: 10.00

24. A one metre long (both ends open) organ pipe is kept in a gas that has double the density of air at STP. Assuming the speed of sound in air at STP is 300 m/s, the frequency difference between the fundamental and second harmonic of this pipe is ______ Hz

Ans: 106.00

25. A particle is moving along the x-axis with its co-ordinate with time ‘t’ given by

\[ x(t) = 10 + 8t - 3t^2 \]. Another particle is moving along the y-axis with its coordinate as a function of time given by \( y(t) = 5 - 8t^3 \). At \( t=1 \) s, the speed of the second particle as measured in the frame of the first particle is given as \( \sqrt{v} \). Then \( v \) in m/s) is ______

Ans: 13.00
CHEMISTRY

1. The number of bonds between sulphur and oxygen atoms in $S_2O_8^{2-}$ and the number of bonds between sulphur and sulphur atoms in rhombic sulphur, respectively, are:

1) 8 & 8  
2) 4 & 6  
3) 8 & 6  
4) 4 & 8

Ans: 1

2. A graph of vapour pressure and temperature for three different liquids X, Y and Z is shown below:

![Graph of vapour pressure and temperature for three different liquids X, Y and Z]

The following inferences are made:

A) X has higher intermolecular interactions compared to Y
B) X has lower intermolecular interaction compared to Y
C) Z has lower intermolecular interactions compared to Y

The correct inference(s) is/are:

1) C  
2) A  
3) B  
4) A & C

Ans: 3

3. The complex that can show fac- and mer- isomers is:

1) $[\text{CoCl}_2(\text{en})_2]$  
2) $[\text{Co(NH}_3)_4\text{Cl}_2]^+$  
3) $[\text{Co(NH}_3)_3(\text{NO}_2)_3]$  
4) $[\text{Pt(NH}_3)_2\text{Cl}_2]$

Ans: 3
4. Arrange the following compounds in increasing order of C – OH bond length:
   Methanol, Phenol, p-ethoxyphenol
   1) methanol < phenol < p-ethoxyphenol
   2) Phenol < methanol < p-ethoxyphenol
   3) methanol < p-ethoxyphenol < phenol
   4) Phenol < p-ethoxyphenol < methanol
   Ans: 4

5. For the Balmer series in the spectrum of H atom, \( \bar{v} = R_H \left( \frac{1}{n_1} - \frac{1}{n_2} \right) \), the correct statements among (I) to (IV) are:
   (I) As wavelength decreases, the lines in the series converge
   (II) The integer \( n_1 \) is equal to 2
   (III) The lines of longest wavelength corresponds to \( n_2 = 3 \)
   (IV) The ionization energy of hydrogen can be calculated from wave number of these lines
   1) (II), (III), (IV)  2) (I), (II), (III)  3) (I), (II), (IV)  4) (I), (III), (IV)
   Ans: 2

6. The major product of the following reaction is:
7. The decreasing order of reactivity towards dehydrohalogenation ($E_1$) reaction of the following compounds is:

1) B>A>D>C
2) B>D>A>C
3) D>B>C>A
4) B>D>C>A

Ans: 3

8. The predominant intermolecular forces present in ethyl acetate, a liquid, are:

1) London dispersion, dipole-dipole and hydrogen bonding
2) Dipole-dipole and hydrogen bonding
3) Hydrogen bonding and London dispersion
4) London dispersion and dipole-dipole

Ans: 4
9. Which of the following statement is not true for glucose?

1) Glucose reacts with hydroxylamine to form oxime
2) Glucose gives Schiff’s test for aldehyde
3) Glucose exists in two crystalline forms \( \alpha \) and \( \beta \)
4) The pentaacetate of glucose does not react with hydroxylamine to give oxime

Ans: 2

10. When gypsum is heated to 393 K, it forms:

1) Dead burnt plaster
2) \( \text{CaSO}_4 \cdot 0.5 \text{H}_2\text{O} \)
3) Anhydrous \( \text{CaSO}_4 \)
4) \( \text{CaSO}_4 \cdot 5\text{H}_2\text{O} \)

Ans: 2

11. The strength of an aqueous NaOH solution is most accurately determined by titrating:

(Note: consider that an appropriate indicator is used)

1) Aq. NaOH in a burette and aq. Oxalic acid in a conical flask
2) Aq. NaOH in a volumetric flask and conc. H\(_2\)SO\(_4\) in a conical flask
3) Aq. NaOH in a pipette and aqueous oxalic acid in a burette
4) Aq. NaOH in a burette and conc. H\(_2\)SO\(_4\) in a conical flask

Ans: 1

12. The most suitable reagent for the given conversion is:

\[
\begin{align*}
\text{CONH}_2 & \quad \text{CH}_3 \\
\text{C=O} & \\
\text{HO}_2\text{C} & \quad \text{CN}
\end{align*}
\]

\[
\begin{align*}
\text{CONH}_2 & \quad \text{COCH}_3 \\
\text{HO}_2\text{C} & \quad \text{CN}
\end{align*}
\]

1) LiAlH\(_4\) 2) B\(_2\)H\(_6\) 3) H\(_2\)/Pd 4) NaBH\(_4\)

Ans: 2
13. The first ionization energy (in kJ/mol) of Na, Mg, Al and Si respectively, are:

1) 496, 577, 737, 786  
2) 786, 737, 577, 496  
3) 496, 737, 577, 786  
4) 496, 577, 786, 737  

Ans: 3

14. The rate of a certain biochemical reaction at physiological temperature (T) occurs $10^6$ times faster with enzyme than without. The change in the activation energy upon adding enzyme is:

1) $+6(2.303)RT$  
2) $+6RT$  
3) $-6(2.303)RT$  
4) $-6RT$  

Ans: 3

15. Among the gases (a) – (e), the gases that cause greenhouse effect are:

(a) CO$_2$  
(b) H$_2$O  
(c) CFCs  
(d) O$_2$  
(e) O$_3$

1) a & d  
2) a, b, c & e  
3) a, c, d & e  
4) a, b, c & d  

Ans: 2

16. A flask contains a mixture of isohexane and 3-methylpentane. One of the liquids boils at 63°C while the other boils at 60°C. What is the best way to separate the two liquids and which one will be distilled out first?

1) Simple distillation, 3-methylpentane

2) Fractional distillation, isohexane

3) Fractional distillation, 3-methylpentane

4) Simple distillation, isohexane

Ans: 2
17. The stoichiometry and solubility product of a salt with the solubility curve given below is, respectively:

$$\begin{align*}
1) & \quad XY_2, 1 \times 10^{-9} \text{ M}^3 \\
2) & \quad XY, 2 \times 10^{-6} \text{ M}^3 \\
3) & \quad X_2Y, 2 \times 10^{-9} \text{ M}^3 \\
4) & \quad XY_2, 4 \times 10^{-9} \text{ M}^3
\end{align*}$$

Ans: 4

18. As per Hardy-Schulze formulation, the flocculation values of the following for ferric hydroxide sol are in the order:

$$\begin{align*}
1) & \quad K_3[Fe(CN)_6] < K_2CrO_4 < AlCl_3 < KBr < KNO_3 \\
2) & \quad K_3[Fe(CN)_6] > AlCl_3 > K_2CrO_4 > KBr > KNO_3 \\
3) & \quad AlCl_3 > K_3[Fe(CN)_6] > K_2CrO_4 > KBr = KNO_3 \\
4) & \quad K_3[Fe(CN)_6] < K_2CrO_4 < KBr = KNO_3 = AlCl_3
\end{align*}$$

Ans: 4

19. The major products A and B in the following reactions are:
20. The third ionization enthalpy is minimum for:

1) Fe  
2) Mn  
3) Ni  
4) Co

Ans: 1

21. Ferrous sulphate heptahydrate is used to fortify foods with iron. The amount (in grams) of the salt required to achieve 10 ppm of iron in 100 kg of wheat is_____.

Atomic weight : Fe = 55.85; S = 32.00; O = 16.00

Ans: 4.95 to 4.97

22. What would be the electrode potential for the given half cell reaction at pH=5?

\[ 2H_2O \rightarrow O_2 + 4H^\circ + 4e^- ; E_{\text{red}}^0 = 1.23 \text{V} \]

(R=8.314 J mol\(^{-1}\) K\(^{-1}\); Temp = 298 K; oxygen under std. atm. Pressure of 1 bar)

Ans: 1.52 to 1.53

23. The number of chiral centres in pencillin is_____.

Ans: 3.00
24. The volume (in mL) of 0.125 M AgNO₃ required to quantitatively precipitate chloride ions in 0.3 g of [Co(NH₃)₆]Cl₃ is______.

\[ M \left[ \text{Co} \left( \text{NH}_3 \right)_6 \right] \text{Cl}_3 = 267.46 \text{ g/mol} \]

\[ M \text{AgNO}_3 = 169.87 \text{ g/mol} \]

Ans: 26.80 to 27.00

25. The magnitude of work done by a gas that undergoes a reversible expansion along the path ABC shown in the figure is______.

![Diagram of pressure-volume graph with points A, B, and C]
MATHEMATICS

Q.ID: 4050361520

1. If the equation, \( x^2 + bx + 45 = 0 \), \((b \in \mathbb{R})\) has conjugate complex roots and they satisfy \( |z + 1| = 2\sqrt{10} \), then:

   1) \( b^2 + b = 12 \)  
   2) \( b^2 - b = 30 \)  
   3) \( b^2 + b = 72 \)  
   4) \( b^2 - b = 42 \)

   Ans: 2

2. If \( a, b \) and \( c \) are the greatest values of \( {}^{19}C_p, {}^{20}C_q \) and \( {}^{21}C_r \), respectively, then:

   1) \( \frac{a}{11} = \frac{b}{22} = \frac{c}{21} \)  
   2) \( \frac{a}{11} = \frac{b}{22} = \frac{c}{42} \)  
   3) \( \frac{a}{10} = \frac{b}{11} = \frac{c}{42} \)  
   4) \( \frac{a - b}{10} = \frac{c}{21} \)

   Ans: 2

3. Let the line \( y = mx \) and the ellipse \( 2x^2 + y^2 = 1 \) intersect at a point \( P \) in the first quadrant. If the normal to this ellipse at \( P \) meets the co–ordinate axes at \( \left( \frac{-1}{3\sqrt{2}} , 0 \right) \) and \( (0, \beta) \), then \( \beta \) is equal to:

   1) \( \frac{2\sqrt{2}}{3} \)  
   2) \( \frac{2}{3} \)  
   3) \( \frac{\sqrt{2}}{3} \)  
   4) \( \frac{2}{\sqrt{3}} \)

   Ans: 3

4. The locus of a point which divides the line segment joining the point \( (0, -1) \) and a point on the parabola, \( x^2 = 4y \), internally in the ratio 1:2 is:

   1) \( 4x^2 - 3y = 2 \)  
   2) \( x^2 - 3y = 2 \)  
   3) \( 9x^2 - 3y = 2 \)  
   4) \( 9x^2 - 12y = 8 \)

   Ans: 2

5. The inverse function of \( f(x) = \frac{8^{2x} - 8^{-2x}}{8^{2x} + 8^{-2x}}, x \in (-1,1) \), is

   1) \( \frac{1}{4} \log_e \left( \frac{1+x}{1-x} \right) \)  
   2) \( \frac{1}{4} \log_e \left( \frac{1-x}{1+x} \right) \)  
   3) \( \frac{1}{4} (\log_e 8) \log_e \left( \frac{1-x}{1+x} \right) \)  
   4) \( \frac{1}{4} (\log_e 8) \log_e \left( \frac{1+x}{1-x} \right) \)

   Ans: 4
6. Let the volume of a parallelepiped whose coterminous edges are given by
\[ \vec{u} = \hat{i} + \hat{j} + \lambda \hat{k}, \quad \vec{v} = \hat{i} + 3 \hat{j} + \hat{k}, \quad \text{and} \quad \vec{w} = 2 \hat{i} + \hat{j} + \hat{k}, \]
be 1 cu. unit. If \( \theta \) be the angle between the edges \( \vec{u} \) and \( \vec{w} \), the \( \cos \theta \) can be:

1) \( \frac{7}{6\sqrt{3}} \)
2) \( \frac{7}{6\sqrt{6}} \)
3) \( \frac{5}{7} \)
4) \( \frac{5}{3\sqrt{3}} \)

Ans: 1

7. Let, then \( f(x) = x \cos^{-1}(-\sin|x|), x \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right] \) which of the following is true?

1) \( f'(0) = -\frac{\pi}{2} \)
2) \( f \) is not differentiable at \( x = 0 \)
3) \( f' \) is increasing in \( \left(-\frac{\pi}{2}, 0\right) \) and decreasing in \( \left(0, \frac{\pi}{2}\right) \)
4) \( f' \) is decreasing in \( \left(-\frac{\pi}{2}, 0\right) \) and increasing in \( \left(0, \frac{\pi}{2}\right) \)

Ans: 4

8. Let \( f: \mathbb{R} \rightarrow \mathbb{R} \) be such that for all \( x \in \mathbb{R} \left(2^{x} + 2^{-x}\right), f(x) \) and \( (3^x + 3^{-x}) \) are in A.P., then the minimum value of \( f(x) \) is:

1) 2
2) 3
3) 4
4) 0

Ans: 2

9. Let \( f(x) = \left(\sin(\tan^{-1} x) + \sin(\cot^{-1} x)\right)^2 - 1 \mid x \mid > 1 \). If \( \frac{dy}{dx} = \frac{1}{2} \left(\sin^{-1}(f(x))\right) \) and \( y\left(\sqrt{3}\right) = \frac{\pi}{6} \) then \( y\left(-\sqrt{3}\right) \) is equal to:

1) \( -\frac{\pi}{6} \)
2) \( \frac{5\pi}{6} \)
3) \( \frac{\pi}{3} \)
4) \( \frac{2\pi}{3} \)

Ans: 2

10. The mean and the standard deviation (s.d.) of 10 observations are 20 and 2 respectively. Each of these 10 observations is multiplied by \( p \) and then reduced by \( q \), where \( p \neq 0 \) and
q ≠ 0. If the new mean and new s.d. become half of their original values, then q is equal to:

1) 10  2) −10  3) −20  4) −5

Ans: 3

11. \[ \lim_{{x \to 0}} \left( \frac{3x^2 + 2}{7x^2 + 2} \right)^{\frac{1}{x^2}} \]

is equal to:

1) \( \frac{1}{e} \)  2) \( e^2 \)  3) \( \frac{1}{e^2} \)  4) e

Ans: 3

12. For \( a > 0 \), let the curves \( C_1 : y^2 = ax \) and \( C_2 : x^2 = ay \) intersect at origin O and a point P. Let the line \( x = b \ (0 < b < a) \) intersect the chord OP and the x-axis at points Q and R, respectively. If the line \( x = b \) bisects the area bounded by the curves, \( C_1 \) and \( C_2 \) and the area \( \Delta OQR = \frac{1}{2} \), then ‘a’ satisfies the equation:

1) \( x^6 + 6x^3 - 4 = 0 \)  2) \( x^6 - 12x^3 + 4 = 0 \)
3) \( x^6 - 12x^3 - 4 = 0 \)  4) \( x^6 - 6x^3 + 4 = 0 \)

Ans: 2

13. The shortest distance between the lines

\[ \frac{x - 3}{3} = \frac{y - 8}{-1} = \frac{z - 3}{1} \quad \text{and} \quad \frac{x + 3}{2} = \frac{y + 7}{4} = \frac{z - 6}{4} \]

is:

1) \( \frac{7}{2} \sqrt{30} \)  2) 3  3) \( 2 \sqrt{30} \)  4) \( 3 \sqrt{30} \)

Ans: 4

14. If c is a point at which Rolle’s theorem holds for the function, \( f(x) = \log_e \left( \frac{x^2 + \alpha}{7x} \right) \) in the interval \( [3, 4] \), where \( \alpha \in \mathbb{R} \), then \( f''(c) \) is equal to:

1) \( \frac{\sqrt{3}}{7} \)  2) \( -\frac{1}{12} \)  3) \( -\frac{1}{24} \)  4) \( \frac{1}{12} \)

Ans: 4
15. If \( \int \frac{\cos x \, dx}{\sin^3 x (1 + \sin^6 x)^{2/3}} = f(x) \left(1 + \sin^6 x \right)^{1/3} + c \) where \( c \) is a constant of integration, then \( \lambda \cdot f\left(\frac{\pi}{3}\right) \) is equal to:

1) \(-\frac{9}{8}\)  
2) \(-2\)  
3) \(2\)  
4) \(\frac{9}{8}\)

Ans: \(2\)

16. Which one of the following is a tautology?

1) \(P \lor (P \land Q)\)  
2) \(Q \land \neg (P \lor Q)\)  
3) \(P \land (P \lor Q)\)  
4) \(P \land (P \lor Q) \lor Q\)

Ans: \(4\)

17. For which of the following ordered pairs \((\mu, \delta)\), the system of linear equations is inconsistent?

\[
\begin{align*}
x + 2y + 3z &= 1 \\
3x + 4y + 5z &= \mu \\
4x + 4y + 4z &= \delta
\end{align*}
\]

1) \((4,6)\)  
2) \((1,0)\)  
3) \((3,4)\)  
4) \((4,3)\)

Ans: \(4\)

18. Let two points be \(A(1,-1)\) and \(B(0,2)\). If a point \(P(x',y')\) be such that the area of \(\Delta PAB = 5\) sq.units and it lies on the line, \(3x+y-4\lambda = 0\), then a value of \(\lambda\) is:

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

Ans: \(2\)

19. Let \(A\) and \(B\) be two independent events such that \(P(A) = \frac{1}{3}\) and \(P(B) = \frac{1}{6}\). Then, which of the following is TRUE?

1) \(P(A/B) = \frac{1}{3}\)  
2) \(P(A/B) = \frac{2}{3}\)  
3) \(P(A \lor B) = \frac{1}{3}\)  
4) \(P(A/(A \lor B)) = \frac{1}{4}\)

Ans: \(1\)

20. Let \(y = y(x)\) be a solution of the differential equation, \(\sqrt{1-x^2} \frac{dy}{dx} + \sqrt{1-y^2} = 0, |x| < 1\). If \(y\left(\frac{1}{2}\right) = \frac{\sqrt{3}}{2}\), then \(y\left(\frac{-1}{\sqrt{2}}\right)\) is equal to:
1) \(-\frac{1}{\sqrt{2}}\)  
2) \(\frac{\sqrt{3}}{2}\)  
3) \(-\frac{\sqrt{3}}{2}\)  
4) \(\frac{1}{\sqrt{2}}\)

Ans: 4

21. The least positive value of ‘a’ for which the equation, \(2x^2 + (a - 10)x + \frac{33}{2} = 2a\) has real roots is _____________

Ans: 8

22. The number of all \(3 \times 3\) matrices A, with entries from the set \{-1, 0, 1\} such that the sum of the diagonal elements of \(AA^T\) is 3, is ___________

Ans: 672

23. An urn contains 5 red marbles, 4 black marbles and 3 white marbles. Then the number of ways in which 4 marbles can be drawn so that at the most three of them are red is ______

Ans: 490

24. The sum \(\sum_{k=1}^{20}(1+2+3+\ldots+k)\) is

Ans: 1540

25. Let the normal at a point P on the curve \(y^2 - 3x^2 + y + 10 = 0\) intersect the y-axis at \(\left(0, \frac{3}{2}\right)\). If \(m\) is the slope of the tangent at P to the curve, then \(|m|\) is equal to

Ans: 4

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