
JEE Main Mock Test

Maximum Marks: 300

Time Allowed: 3 hours

General Instructions:

- The question Paper consists of 75 to attempt. The maximum marks are 300. There
- are three subjects in the question paper, Subject I, II and III consisting of Section- I (Physics), Section-II (Chemistry), Section-III (Mathematics), and having 25 questions in each part. Each Subject will have two sections. Section A will be of Multiple-Choice
- Questions (MCQs) and Section B will contain Questions whose answers are to be filled in as a numerical value. There will be a total of 20 MCQs and 5 Numerical Value Based Questions Each correct answer will give 4 marks while 1 Marks will be deducted for a wrong response.
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Q. No.	Questions	
Physics (Section A)		
1.	A block of mass m is placed on a rough inclined plane of angle θ . The coefficient of static friction is μ . The maximum value of θ for which the block will remain stationary is: (1) $\tan^{-1}(\mu s)$ (2) $\sin^{-1}(\mu s)$	4

	<p>(3) $\cos^{-1}(\frac{1}{2})$</p> <p>(4) $\tan^{-1}(\frac{1}{2})$</p>	
2.	<p>A particle of mass m is projected with velocity v_0 at an angle θ with the horizontal. The time of flight is given by:</p> <p>(1) $\frac{2v_0 \sin \theta}{g}$</p> <p>(2) $\frac{v_0 \cos \theta}{g}$</p> <p>(3) $\frac{v_0^2}{g}$</p> <p>(4) $\frac{2v_0}{g}$</p>	4
3.	<p>A thin rod of length L and mass M is pivoted at one end and allowed to swing freely in a vertical plane. Its time period for small oscillations is:</p> <p>(1) $2\pi \sqrt{\frac{L}{g}}$</p> <p>(2) $2\pi \sqrt{\frac{2L}{3g}}$</p> <p>(3) $2\pi \sqrt{\frac{3L}{g}}$</p> <p>(4) $2\pi \sqrt{\frac{L}{3g}}$</p>	4

4.	<p>A spherical shell has a uniform charge density ρ. The electric field inside the shell is:</p> <p>(1) Zero</p> <p>(2) Proportional to $\frac{1}{r^2}$</p> <p>(3) Proportional to r</p> <p>(4) Proportional to ρ</p>	4
5.	<p>A wire carries a current I in a circular loop of radius R. The magnetic field at the center of the loop is:</p> <p>(1) $\frac{\mu_0 I}{2R}$</p> <p>(2) $\frac{\mu_0 I}{4\pi R}$</p> <p>(3) $\frac{\mu_0 I^2}{R}$</p> <p>(4) $\frac{\mu_0 I}{4R}$</p>	4
6.	<p>A lens of focal length f is placed at a distance d from an object. The image formed is real and has a magnification m. The value of d is:</p> <p>(1) $f(1+m)$</p> <p>(2) $f(1-m)$</p>	

	<p>(3) $\frac{f(1+m)}{m}$</p> <p>(4) $\frac{f}{m}$</p>	
7.	<p>A car moving at a speed of v is brought to rest over a distance d. The average retardation experienced by the car is:</p> <p>(1) $\frac{v^2}{2d}$</p> <p>(2) $\frac{2d}{v^2}$</p> <p>(3) $\frac{d}{v}$</p> <p>(4) $\frac{v}{d}$</p>	4
8.	<p>A charged particle enters a uniform magnetic field at right angles to its direction of motion. The path of the particle will be:</p> <p>(1) Straight line</p> <p>(2) Circle</p> <p>(3) Ellipse</p> <p>(4) Parabola</p>	4
9.	<p>A capacitor of capacitance C is charged to a potential V. The energy stored in the capacitor is:</p>	4

	<p>(1) $\frac{CV^2}{2}$</p> <p>(2) $\frac{C2V}{2}$</p> <p>(3) $\frac{CV}{2}$</p> <p>(4) $\frac{C}{2}$</p>	
10.	<p>A simple pendulum has a time period T. If its length is reduced to one-fourth, the new time period will be:</p> <p>(1) $\frac{T}{2}$</p> <p>(2) $\frac{T}{\sqrt{2}}$</p> <p>(3) $\frac{T}{4}$</p> <p>(4) $T\sqrt{2}$</p>	4
11.	<p>A mass m is attached to a spring of constant k and is undergoing SHM. The total energy of the system is proportional to:</p> <p>(1) m</p> <p>(2) k</p> <p>(3) A^2</p>	4

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

12. The refractive index of a medium is μ . The critical angle for total internal reflection is:

(1) $\sin^{-1} \frac{1}{\mu}$

(2) $\cos^{-1} \frac{1}{\mu}$

(3) $\tan^{-1} \frac{1}{\mu}$

(4) $\frac{1}{\sin \mu}$

13. A wave has a frequency f and wavelength λ . The speed of the wave is: 4

(1) $f + \lambda$

(2) $f - \lambda$

(3) $f \lambda$

(4) $\frac{f}{\lambda}$

14. A body of mass m is rotated in a horizontal circle of radius r with a constant speed v . The centripetal force acting on the body is:

	<p>(1) $\frac{mv^2}{r}$</p> <p>(2) $\frac{v^2}{r}$</p> <p>(3) $\frac{mr}{v^2}$</p> <p>(4) $\frac{r}{mv^2}$</p>	
15.	<p>Two resistors R_1 and R_2 are connected in parallel. The equivalent resistance is given by:</p> <p>(1) $R_1 + R_2$</p> <p>(2) $\frac{R_1 R_2}{R_1 + R_2}$</p> <p>(3) $\frac{1}{R_1 + R_2}$</p> <p>(4) $\frac{R_1 + R_2}{R_1 R_2}$</p>	4
16.	<p>The escape velocity on a planet is v_e. If the mass of the planet doubles while the radius remains the same, the escape velocity becomes:</p> <p>(1) $v_e \sqrt{2}$</p> <p>(2) $\frac{v_e}{\sqrt{2}}$</p>	4

	<p>(3) $2v_e$</p> <p>(4) $\frac{v_e}{2}$</p>	
17.	<p>A Carnot engine operates between temperature T_1 and T_2. The efficiency of the engine is:</p> <p>(1) $\frac{T_1}{T_2}$</p> <p>(2) $1 - \frac{T_2}{T_1}$</p> <p>(3) $\frac{T_2}{T_1}$</p> <p>(4) $\frac{T_1 + T_2}{T_1}$</p>	4
18.	<p>A sound wave of frequency f propagates through air at a speed v. The wavelength of the wave is:</p> <p>(1) $v - f$</p> <p>(2) $v + f$</p> <p>(3) v/f</p> <p>(4) vf</p>	
19.	<p>A gas expands adiabatically. The process is governed by the equation:</p>	4

	<p>(1) $PV = \text{constant}$</p> <p>(2) $P^2V = \text{constant}$</p> <p>(3) $PV^\gamma = \text{constant}$</p> <p>(4) $PV^{\frac{1}{\gamma}} = \text{constant}$</p>	
20.	<p>A body falls freely under gravity. The distance covered by it in the n^{th} second is:</p> <p>(1) $u + \frac{1}{2}g(n^2 - (n-1)^2)$</p> <p>(2) $\frac{1}{2}gn^2$</p> <p>(3) $\frac{1}{2}g(2n-1)$</p> <p>(4) $g(n-1)$</p>	4
Physics (Section B)		
21.	<p>A uniform rod of length 2m and mass 10kg is hinged at one end. Find its moment of inertia about the hinge. (in $\text{kg}\cdot\text{m}^2$)</p>	4
22.	<p>A capacitor of $10\mu\text{F}$ is connected to a 100V battery. Find the energy stored in the capacitor. (in mJ)</p>	4

23.	A body is projected upward with a velocity of 50 m/s. Find the maximum height reached. (in m)	4
24.	A metallic wire of resistance $10\ \Omega$ has a length of 1m. If its length is doubled, find its new resistance. (in Ω)	4
25.	A bullet of mass 10g strikes a stationary wooden block of mass 990g. If the combined system moves with a velocity of 2m/s, find the initial velocity of the bullet. (in m/s)	4
Chemistry (Section A)		
26.	When N_2 is converted into NH_3 , the equivalent weight of nitrogen will be: (1) 1.6 (2) 2.67 (3) 3.67 (4) 4.67 .	4
27.	0.30g of an organic compound containing C, H and O on combustion yields 0.44g CO_2 and 0.18g H_2O . If one mole of the compound weighs 60, then the molecular formula of the compound is: (1) C_3H_8O (2) $C_2H_4O_2$ (3) CH_2O	4

	(4) C_4H_8O	
28.	<p>10g of $MgCO_3$ decomposes on heating to produce 0.1 mole CO_2 and 4g MgO. 4</p> <p>The percentage purity of $MgCO_3$ is:</p> <p>(1) 24%</p> <p>(2) 44%</p> <p>(3) 54%</p> <p>(4) 84%</p>	
29.	<p>The work function of a metal is 5eV. What is the kinetic energy of the 4 photoelectron ejected from the metal surface if the energy of the incident radiation is 6.2eV? ($1eV=1.6 \times 10^{-19}J$)</p> <p>(1) $6.626 \times 10^{-19}J$</p> <p>(2) $8.01 \times 10^{-19}J$</p> <p>(3) $1.92 \times 10^{-19}J$</p> <p>(4) $8.010 \times 10^{-18}J$</p>	
30.	<p>Which of the following rules could explain the presence of three unpaired electrons in N-atom?</p> <p>(1) Hund's rule</p> <p>(2) Aufbau's principle</p>	4

	<p>(3) Heisenberg's uncertainty principle</p> <p>(4) Pauli's exclusion principle</p>	
31.	<p>Be^{3+} and a proton are accelerated by the same potential. Their de-Broglie wavelengths have the ratio (assume mass of proton = mass of neutron):</p> <p>(1) 1:2</p> <p>(2) 1:4</p> <p>(3) 1:1</p> <p>(4) $1:\sqrt{3}$</p>	
32.	<p>2-Butyne and 1-Butyne show resemblance in all except:</p> <p>(1) Both decolourise alkaline $KMnO_4$</p> <p>(2) Both turn bromine water colourless</p> <p>(3) Both undergo addition reaction</p> <p>(4) Both form white precipitate with Tollen's reagent</p>	4
33.	<p>For BF_3 molecule, which of the following is true?</p> <p>(1) B-atom is sp^2 hybridized.</p> <p>(2) There is $p\pi-p\pi$ back bonding in this molecule.</p> <p>(3) Observed B-F bond length is found to be less than the expected bond length.</p>	4

	(4) All of these.	
34.	At identical temperature and pressure, the rate of diffusion of hydrogen gas is $3\sqrt{3}$ times that of a hydrocarbon having molecular formula C_nH_{2n} . What is the value of n ?	4
	(1) 1 (2) 4 (3) 3 (4) 8	
35.	An ideal gas is taken around the cycle ABCA as shown in the $P-V$ diagram. The net work done by the gas during the cycle is equal to:	4
	(1) $12P_1V_1$ (2) $6P_1V_1$ (3) $5P_1V_1$ (4) P_1V_1	
36.	The equilibrium constant, K_p , for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is 4.0 atm^{-1} at 1000K . What would be the partial pressure of O_2 if at equilibrium the moles of SO_2 and SO_3 are the same?	4
	(1) 16.0 atm (2) 0.25 atm	

	<p>(3) 1atm</p> <p>(4) 0.75atm</p>	
37.	<p>Which of the following cannot decompose on heating to give CO_2 in a dry test tube?</p> <p>(1) Li_2CO_3</p> <p>(2) Na_2CO_3</p> <p>(3) KHCO_3</p> <p>(4) BeCO_3</p>	4
38.	<p>Amorphous boron on burning in air forms:</p> <p>(1) B(OH)_3</p> <p>(2) Mixture of B_2O_3 and BN</p> <p>(3) Only B_2O_3</p> <p>(4) Only BN</p>	4
39.	<p>In which of the following reactions, H_2O_2 is acting as a reducing agent?</p> <p>(1) $\text{PbS} + 4\text{H}_2\text{O}_2 \rightarrow \text{PbSO}_4 + 4\text{H}_2\text{O}$</p> <p>(2) $2\text{KI} + \text{H}_2\text{O}_2 \rightarrow 2\text{KOH} + \text{I}_2$</p> <p>(3) $\text{H}_2\text{O}_2 + \text{SO}_2 \rightarrow \text{H}_2\text{SO}_4$</p>	4

	(4) $Ag_2O + H_2O_2 \rightarrow 2Ag + H_2O + O_2$	
40.	<p>Air pollutants that produce photochemical oxidants include:</p> <p>(1) CO_2, CO and SO_2</p> <p>(2) N_2O, NO and HNO_3</p> <p>(3) O_2, Cl_2 and HNO_3</p> <p>(4) O_3, Cl_2 and SO_2</p>	4
41.	<p>Select the basic strength order of the following molecules: (1) IV > I > III > IV (2) III > I > IV > II (3) II > I > III > IV (4) I > III > II > IV</p>	4
42.	<p>Find the order of K_a of the following compounds:</p> <p>(1) I < II < III < IV < V</p> <p>(2) IV < I < III < II < V</p> <p>(3) III < II < I < IV < V</p> <p>(4) II < I < III < IV < V</p>	4
43.	Which of the following groups show +M \square -I effect?	4

	<p>(1) $-F$</p> <p>(2) $-OCOR$</p> <p>(3) $-COOR$</p> <p>(4) $-COOH$</p>	
44.	<p>Which of the following anions is present in the simple single chain structure of silicate?</p> <p>(1) SiO_4^-</p> <p>(2) $Si_2O_6^-$</p> <p>(3) $(Si_2O_2)_n^-5$</p> <p>(4) $(SiO_2)_n^-2$</p>	4
45.	<p>For the reaction $2Fe(NO_3)_3 + 3Na_2CO_3 \rightarrow Fe_2(CO_3)_3 + 6NaNO_3$, initially, if 2.5 mole of $Fe(NO_3)_3$ and 3.6 mole of Na_2CO_3 are taken, and 6.3 mole of $NaNO_3$ is obtained, then the percentage yield of the given reaction is:</p> <p>(1) 50%</p> <p>(2) 84%</p> <p>(3) 87.50%</p> <p>(4) 100%</p>	4
Chemistry (Section B)		

46.	The equivalent weight of a metal is double that of oxygen. How many times is the weight of its oxide greater than the weight of the metal? (Report your answer by multiplying by 10).	4
47.	An element has atomic number 29. It belongs to x period and y group. Given value of $2x+y$.	4
48.	Find the total number of σ bonds in the following xenon compounds: $XeOF_2$, XeO_2F_4 , XeO_3 , XeO_4 , XeO_3F_2 , $XeOF_4$, XeO_2F_2	4
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50.	One mole of a non-ideal gas undergoes a change of state (1.0atm,3.0L,200K) \rightarrow (4.0atm,5.0L,250K) with a change in internal energy $\Delta U = 40L\text{-atm}$. The change in enthalpy of the process (inL-atm).	4
Mathematics (Section A)		
51.	If $f(x) = e^{x^2}$ and $g(x) = \int_0^x f(t)dt$, then $g'(x)$ is: (1) e^{x^2} (2) $2xe^{x^2}$ (3) e^{2x^2} (4) $\int_0^x e^{t^2} dt$	4

52.	<p>The area enclosed by the parabola $y^2 = 4x$ and the line $x = 4$ is:</p> <p>(1) 16</p> <p>(2) 8</p> <p>(3) 32</p> <p>(4) 4</p>	4
53.	<p>If the roots of the quadratic equation $x^2 - px + q = 0$ are α and β, and $\alpha^2 + \beta^2 = 40$, then $p^2 - 2q$ is:</p> <p>(1) 20</p> <p>(2) 40</p> <p>(3) 80</p> <p>(4) 60</p>	4
54.	<p>The equation of the circle passing through (1, 1) and (2, 2) and having its center on the line $x + y = 4$ is:</p> <p>(1) $(x-3)^2 + (y-1)^2 = 4$</p> <p>(2) $(x-2)^2 + (y-2)^2 = 1$</p> <p>(3) $(x-3)^2 + (y-3)^2 = 2$</p> <p>(4) $(x-1)^2 + (y-3)^2 = 5$</p>	4

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55.	<p>If the sum of the coefficients in the expansion of $(1+x)^{10}$ is equal to 1024, then the sum of the coefficients in $(1-x)^{10}$ is:</p> <p>(1) 0 (2) 512 (3) 1024 (4) 2048</p>	4
56.	<p>The distance between the planes $2x + y - z + 5 = 0$ and $4x + 2y - 2z + 15 = 0$ is:</p> <p>(1) 5 (2) 10 (3) $\frac{5}{\sqrt{3}}$ (4) $\frac{10}{\sqrt{3}}$</p>	4
57.	<p>The function $f(x) = x^3 - 6x^2 + 9x$ has a local minimum at:</p> <p>(1) $x = 2$ (2) $x = 3$ (3) $x = 0$ (4) None of these</p>	4

58.	<p>If the sum of an infinite geometric progression S and the sum of the squares of its terms is 12, then the first term is:</p> <p>(1) 2 (2) 3</p> <p>(3) $\sqrt{2}$</p> <p>(4) 1</p>	4
59.	<p>If $\log_{10} 2 = 0.3010$ and $\log_{10} 3 = 0.4771$ then $\log_{10} 36$ is:</p> <p>(1) 1.7781</p> <p>(2) 1.7782</p> <p>(3) 1.778</p> <p>(4) 1.4771</p>	4
60.	<p>The value of $\int_0^{\pi/4} \tan x dx$ is:</p> <p>(1) $\ln 2$</p> <p>(2) $\frac{\pi}{4}$</p> <p>(3) $\ln(\sec x)$</p> <p>(4) None of these</p>	4
61.	<p>If $\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$ and $\vec{b} = 3\hat{i} + 4\hat{j} - \hat{k}$, then $\vec{a} \cdot \vec{b}$ is:</p>	4

	<p>(1) 1</p> <p>(2) 2</p> <p>(3) 6</p> <p>(4) 7</p>	
62.	<p>The eccentricity of the hyperbola $\frac{x^2}{16} - \frac{y^2}{9} = 1$ is:</p> <p>(1) $\frac{5}{4}$</p> <p>(2) $\sqrt{2}$</p> <p>(3) $\frac{\sqrt{5}}{4}$</p> <p>(4) $\sqrt{\frac{25}{16}}$</p>	4
63.	<p>The coefficient of x^5 in the expansion of $(1+x)^8$ is:</p> <p>(1) 28</p> <p>(2) 56</p> <p>(3) 70</p> <p>(4) 84</p>	4

64.	<p>The point of intersection of the tangents to the parabola $y^2 = 4x$ at (1, 2) and (4, 4) is:</p> <p>(1) (3, 3)</p> <p>(2) (2,1)</p> <p>(3) (1,2)</p> <p>(4) None of these</p>	4
65.	<p>The sum of all solutions of $\cos 2x = \sin x$ in $[0, 2\pi]$ is:</p> <p>(1) 2π</p> <p>(2) $\frac{3\pi}{2}$</p> <p>(3) π</p> <p>(4) None of these</p>	4
66.	<p>If $x+y = 5$ and $xy = 6$, then the value of $x^3 + y^3$ is:</p> <p>(1) 65</p> <p>(2) 125</p> <p>(3) 55</p> <p>(4) 35</p>	4
67.	<p>The length of the tangent drawn to the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ from (5, 0) is:</p>	4

	<p>(1) $\sqrt{5}$</p> <p>(2) 5</p> <p>(3) $\sqrt{10}$</p> <p>(4) 10</p>	
68.	<p>Let $f(x) = \int_0^x t^2 dt$. The value of $f'(x)$ is:</p> <p>(1) x^2</p> <p>(2) $\int_0^x t^2 dt$</p> <p>(3) $2x$</p> <p>(4) None of these</p>	4
69.	<p>The number of 3-digit numbers divisible by 7 is:</p> <p>(1) 128 (2) 143 (3) 142 (4) 144</p>	4
70.	<p>If a, b, c are in GP and $a^2 + b^2 + c^2 = 14$ and $abc = 8$, then $a + b + c$ is:</p> <p>(1) 6</p> <p>(2) 8</p>	4

(3) 4

(4) 10

Mathematics(Section B)

71.	Find the value of $\int_1^4 \frac{1}{n^2}$. (Answer up to two decimal places.)	4
72.	If $\int_0^a x^3 dx = 16$, find the value of a .	4
73.	A triangle has sides $a = 6$, $b = 8$, and $c = 10$. Find its area.	4
74.	Find the smallest positive integer m such that $7^m \equiv 1 \pmod{10}$.	4
75.	Evaluate $\int_0^{\pi/2} x \sin x dx$. (Answer up to two decimal places.)	4

Answer Keys

Physics(Section A)

1.

Answer: (1)

Solution: For the block to remain stationary on an inclined plane, the component of gravitational force down the plane, $mg\sin\theta$, must be balanced by the maximum static friction force, $\mu smg\cos\theta$. Solving $\tan\theta = \mu^s$, we get $\theta = \tan^{-1}(\mu^s)$.

2.

Answer: (1)

Solution: The time of flight for a projectile is given by $T = \frac{2u\sin\theta}{g}$.

3.

Answer: (2)

Solution: The time period of a rod pivoted at one end and swinging in a vertical plane is $T = 2\pi\sqrt{\frac{2L}{3g}}$, where L is the length of the rod.

4.

Answer: (1)

Solution: The electric field inside a uniformly charged spherical shell is zero because all the charges on the shell cancel out due to symmetry.

5.

Answer: (1)

Solution: The magnetic field at the center of a current-carrying loop is given by $\frac{\mu_0 I}{2R}$, where I is the current and R is the radius of the loop.

6.

Answer: (3)

Solution: For a lens, the magnification is related to the distances by the lens formula. Solving gives $d = \frac{f(1+m)}{m}$.

7.

Answer: (1)

Solution: The average retardation for uniform deceleration is $\frac{v^2}{2d}$, derived from $v^2 = u^2 + 2as$.

8.

Answer: (2)

Solution: A charged particle in a uniform magnetic field moves in a circular path due to the Lorentz force.

9.

Answer: (1)

Solution: The energy stored in a capacitor is $U = \frac{1}{2}CV^2$.

10.

Answer: (1)

Solution: Time period of a pendulum is $T = 2\pi \sqrt{\frac{L}{g}}$. When L is reduced to $\frac{L}{4}$, the new time period becomes $\frac{T}{2}$.

11

Answer: (3)

Solution: Total energy in SHM is proportional to the square of the amplitude $E \propto A^2$.

12.

Answer: (1)

Solution: Critical angle is given by $\sin C = \frac{1}{\mu}$.

13.

Answer: (3)

Solution: Wave speed is $v = f\lambda$.

14.

Answer: (1)

Solution: Centripetal force is $F = \frac{mv^2}{r}$.

15.

Answer: (2)

Solution: For resistors in parallel, $R = \frac{R_1 R_2}{R_1 + R_2}$.

16.

Answer: (1)

Solution: Escape velocity is proportional to $\sqrt{M/R}$. If the mass doubles, v_e becomes $v_e\sqrt{2}$.

17.

Answer: (2)

Solution: Efficiency of a Carnot engine is $\eta = 1 - \frac{T_2}{T_1}$.

18.

Answer: (3)

Solution: Wavelength is $\lambda = \frac{v}{f}$.

19.

Answer: (3)

Solution: For adiabatic processes, $PV^\gamma = \text{constant}$.

20.

Answer: (3)

Solution: The distance covered in the n th second is $s_n = u + \frac{1}{2}g(2n-1)$.

Physics (Section B)

21. Moment of inertia of a rod hinged at one end is $I = \frac{1}{3}ML^2 = \frac{1}{3}(10)(22) = 13.33 \text{ kg}\cdot\text{m}^2$

Answer: 13.33

22. Energy stored in the capacitor is $U = \frac{1}{2}CV^2 = \frac{1}{2}(10 \times 10^{-6})(100)^2 = 50 \text{ mJ}$.

Answer: 50

23. Maximum height is $H = \frac{u^2}{2g} = \frac{50^2}{2(9.8)} = 127.55 \text{ m}$

Answer: 127.55

24. Resistance is proportional to length. If the length is doubled $R \propto 2R = 20 \Omega$.

Answer: 20

25.

Given Data:

Mass of the bullet, $m_1 = 10\text{g} = 0.01\text{kg}$

Mass of the wooden block, $m_2 = 990\text{g} = 0.99\text{kg}$

Combined velocity after collision, $v = 2\text{m/s}$

Initial velocity of the block, $u_2 = 0\text{m/s}$

Initial velocity of the bullet, $u_1 = ?$

Using the Law of Conservation of Momentum:

$$m_1 u_1 + m_2 u_2 = (m_1 + m_2) v$$

Substituting the values:

$$(0.01)u_1 + (0.99)(0) = (0.01 + 0.99)(2)$$

$$0.01u_1 = 2$$

$$0.01u_1 = 2$$

$$u_1 = \frac{2}{0.01}$$

$$u_1 = 200\text{m/s}$$

Answer: The initial velocity of the bullet is 200 m/s.

Chemistry (Section A)

26. Answer: (3) 3.67

Solution: Equivalent weight = $\frac{\text{Molecular weight}}{\text{Number of equivalents}}$ For N_2 converting to NH_3 ,
 $N_2 + 3H_2 \rightarrow 2NH_3$. Thus, equivalent weight = $\frac{14}{4} = 3.67$.

27. Answer: (2) $C_2H_4O_2$

Solution: Moles of C = $\frac{0.44}{44} = 0.01$, moles of H = $\frac{0.18}{18} = 0.01$. The empirical formula is CH_2O .
. Since molecular weight is 60, the molecular formula is $C_2H_4O_2$.

28. Answer: (4) 84%

Solution: $MgCO_3 \rightarrow MgO + CO_2$. Theoretical mass of $MgCO_3$ for 0.1 mole is $0.1 \times 84 = 8.4$ g.
Purity = $\frac{8.4}{10} \times 100 = 84\%$.

29. Answer: (3) $1.92 \times 10^{19} \text{ J}$

Solution: Kinetic energy = $E_{\text{photon}} - \phi = 6.2 - 5 = 1.2 \text{ eV}$. Converting to joules:
 $1.2 \times 1.6 \times 10^{19} = 1.92 \times 10^{19} \text{ J}$.

30. Answer: (1) Hund's rule

Solution: Hund's rule states that electrons occupy degenerate orbitals singly before pairing, explaining three unpaired electrons in W ($1s^2 2s^2 2p^3$).

31. Answer: (2) 1:4

Solution: Wavelength $\propto \frac{1}{\sqrt{m}}$. Ratio of masses is 1:4, so the ratio of wavelengths is 1:4.

32. Answer: (4) Both form white precipitate with Tollen's reagent.

Solution: Both compounds can react with bromine (Br_2) in an addition reaction, decolourising bromine water.

33. Answer: (4) All of these

Solution: B is sp^2 hybridized, $p\pi-p\pi$ back bonding occurs, and bond length is shorter than expected due to resonance.

34. Answer: (2) 4

Solution: Rate $\propto \frac{1}{\sqrt{\text{Molar mass}}}$. Molar mass of C_nH_{2n} = 54. Solving for n : $12n + (2n - 2) = 54$, $n = 4$.

35. Answer: (1) $12P_1V_1$

Solution: Work done = Area of the cycle. Using the geometry of the $P-V$ diagram, $W = 12P_1V_1$.

36. Answer: (2) 0.25 atm

Solution: Using $K_p = \frac{[SO_3]^2}{[SO_2][O_2]}$, solve for p_{O_2} .

37. Answer: (2) Na_2CO_3

Solution: Na_2CO_3 does not decompose under normal heating conditions, unlike the others.

38. Answer: (3) Only B_2O_3

Solution: Amorphous boron burns to form boron trioxide B_2O_3 .

39. Answer: (2) $2KI + H_2O_2 \rightarrow 2KOH + I_2$

Solution: In this reaction, H_2O_2 acts as a reducing agent by reducing I_2 .

40. Answer: (4) O_3 , Cl_2 , SO_2

Solution: These gases produce photochemical oxidants under UV light.

41. Answer: (4) I > III > II > IV

Solution: Basic strength is determined by the ability of the compound to donate a lone pair, depending on substituents.

42. Answer: (4) II < I < III < IV < V

Solution: Compare the acidity of the given compounds based on the inductive and resonance effects.

43. Answer: (2) $-OCOR$

Solution: $-OCOR$ group has a strong +M effect due to resonance.

44. Answer: (4) $(SiO_2-3)n$

Solution: The single chain structure of silicates corresponds to the repeating anion $(SiO_2-3)n$.

45. Answer: (3) 87.5%

Solution: Based on stoichiometry, 6.3 moles of $NaNQ$ correspond to an 87.5% yield.

Chemistry (Section B)

46. Answer: 20

Solution: Ratio of weights is calculated from equivalent weights of the oxide and the metal. Multiply by 10.

47. Answer: 16

Solution: Period $x = 4$, group $y = 12$. $2x + y = 8 + 12 = 16$.

48. Answer: 10

Solution: Count π bonds in all given xenon compounds and sum.

49. Answer: 30

Solution: Use the formula $v_{rms} = \sqrt{\frac{3P}{\rho}}$. Substitute $P = 1.2 \times 10^5$, $\rho = 4$. Report answer divided by 10.

50. Answer: 60

Solution: Use the relation $\Delta H = \Delta U + P\Delta V$. Calculate ΔV , then solve.

Mathematics(Section A)

51. Answer: (1)

Solution: Analyze all products for chirality. Three products are optically active.

Given $f(x) = e^x$ and $g(x) = \int f(t) dt$.

By the Fundamental Theorem of Calculus, $g'(x) = f(x) = e^x$.

52. Answer: (3)

The area enclosed by $y^2 = 4x$ and $x = 4$ is calculated as:

$$\text{Area} = \int_0^4 2\sqrt{x} dx = 2 \left[\frac{2}{3} x^{3/2} \right]_0^4 = \frac{16}{3}.$$

53. Answer: (3)

For roots α and β , $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta = p^2 - 2q$. Given $\alpha^2 + \beta^2 = 40$, $p^2 - 2q = 40$.

54. Answer: (3)

Substituting the points (1, 1) and (2, 2) into the general circle equation and solving for the center on $x + y = 4$, we find:

$$\text{Equation: } (x - 3)^2 + (y - 3)^2 = 2.$$

55. Answer: (1)

The sum of coefficients in $(1-x)^{10}$ is $(1+(-1))^{10} = 0$.

56. Answer: (4)

The distance between planes $ax+by+cz+d_1=0$ and $ax+by+cz+d_2=0$ is:

$$\text{Distance} = \frac{|d_2 - d_1|}{\sqrt{a^2 + b^2 + c^2}} = \frac{10}{3}$$

57. Answer: (2)

Finding critical points by $f'(x) = 3x^2 - 12x + 9 = 3(x-1)(x-3)$, $x = 3$ is a local minimum.

58. Answer: (1)

Let a be the first term and r the common ratio. From $S = \frac{a}{1-r} = 6$ and $\frac{a^2}{1-r^2} = 12$, solving gives $a = 2$.

59. Answer: (2)

Using $\log_{10} 36 = \log_{10}(2^2 \cdot 3^2) = 2\log_{10} 2 + 2\log_{10} 3$, we get:

$$\log_{10} 36 = 2(0.3010) + 2(0.4771) = 1.7782.$$

60. Answer: (1)

Using the identity $\int \tan x = \ln |\sec x|$, we evaluate:

$$\int_0^{\pi/4} \tan x dx = \ln(\sec \pi/4) - \ln(\sec 0) = \ln 2.$$

61. Answer: (1)

$$a \cdot b = (2)(3) + (1)(4) + (1)(-1) = 6 + 4 - 1 = 9.$$

62. Answer: (1)

The eccentricity e of $\frac{x^2}{16} - \frac{y^2}{9} = 1$ is:

$$e = \sqrt{1 + \frac{b^2}{a^2}} = \sqrt{1 + \frac{9}{16}} = \sqrt{\frac{25}{16}} = \frac{5}{4}.$$

63. Answer: (2)

The coefficient of x^5 in $(1+x)^8$ is $\binom{8}{5} = 56$.

64. Answer: (1)

Solving the tangents for $y = 2x - 1$ and $y = x - 1$, their intersection is at (2, 3).

65. Answer: (3)

Solving $\cos 2x = \sin x$ in $[0, 2\pi]$, we find roots summing to π .

66. Answer: (4)

Using $x^3 + y^3 = (x + y)(x^2 - xy + y^2)$ and substituting $x + y = 5$, $xy = 6$:

$$x^3 + y^3 = 5(5^2 - 3(6)) = 125 - 90 = 35.$$

67. Answer: (4)

The length of the tangent to $\frac{x^2}{9} + \frac{y^2}{4} = 1$ from $(5, 0)$ is:

$$\sqrt{\frac{x^2}{a^2} - 1} = \sqrt{\frac{5^2}{9} - 1} = \sqrt{\frac{16}{9}} = \frac{4}{3}.$$

68. Answer: (1)

By the Fundamental Theorem of Calculus, $f'(x) = x^2$.

69. Answer: (3)

Solving $100 \leq 7n \leq 999$ gives 142 numbers.

70. Answer: (1)

Using $a^2 + b^2 + c^2 = 14$, $abc = 8$, solving yields $a + b + c = 6$.

Mathematics (Section B)

71. Answer: 1.64

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6} \approx 1.64493.$$

72.

Solving $\int_0^a x^3 dx = \frac{a^4}{4} = 16$ gives $a = 4$.

Answer: 4

73. Using Heron's formula, $\Delta = \sqrt{s(s-a)(s-b)(s-c)}$, $s = 12$, $\Delta = 24$.

Answer: 24

74. Solving $7^n \equiv 1 \pmod{100}$, $n = 20$.

Answer: 20

75. $\int_0^{\pi/2} x \sin x dx = \frac{\pi}{2} - 1.$

Answer: 0.57

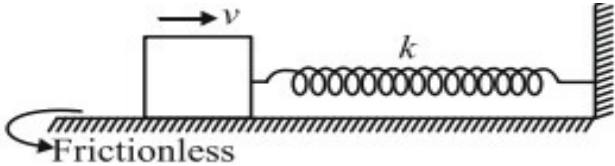
JEE Main Mock Test – Set 2

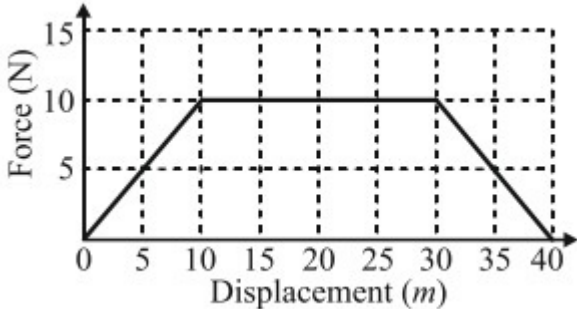
Maximum Marks: 300

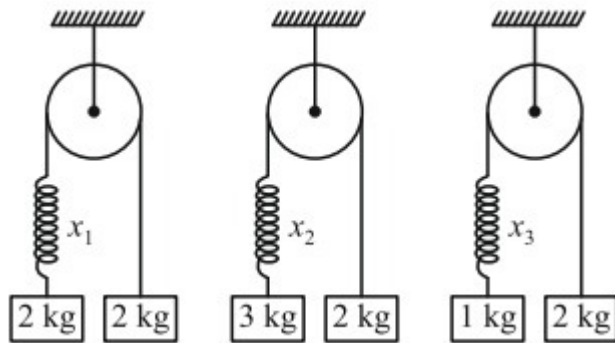
Time Allowed: 3 hours

General Instructions:

- The question Paper consists of 75 to attempt. The maximum marks are 300. There are
- three subjects in the question paper, Subject I, II and III consisting of Section- I (Physics), Section-II (Chemistry), Section-III (Mathematics), and having 25 questions in each part. Each Subject will have two sections. Section A will be of Multiple-Choice
- Questions (MCQs) and Section B will contain Questions whose answers are to be filled in as a numerical value. There will be a total of 20 MCQs and 5 Numerical Value Based Questions Each correct answer will give 4 marks while 1 Marks will be deducted for a wrong response.
-

Q. No.	Questions	
Physics (Section A)		
1.	<p>A block of mass m is given a speed v when spring is in its natural length 4 as shown in the figure. If the block comes to rest momentarily at the maximum compression of the spring, the percentage loss of energy is:</p>  <p>The diagram shows a rectangular block on a horizontal surface. An arrow above the block points to the right and is labeled with the variable v. To the right of the block is a coiled spring. The spring is attached to a vertical wall on the far right. The spring is labeled with the variable k. Below the surface, there is a curved arrow pointing to the left, labeled "Frictionless".</p>	

	<p>(1) 25%</p> <p>(2) 50%</p> <p>(3) 75%</p> <p>(4) Any value less than 50%</p>	
<p>2.</p>	<p>Adjacent figure shows the force-displacement graph of a moving body. The work done in displacing the body from $x = 0$ to $x = 35$ is equal to:</p>  <p>(1) 50J</p> <p>(2) 287.5J</p> <p>(3) 25J</p> <p>(4) 0</p>	
<p>3.</p>	<p>Same spring is attached with 2kg, 3kg, and 1kg blocks in three different cases as shown in the figure. If x_1, x_2, and x_3 are the extensions in the spring in these three cases:</p>	<p>4</p>



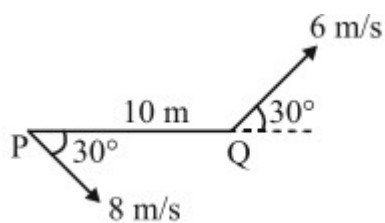
(1) $x_1 = 0, x_3 \neq x_2$

(2) $x_1 \neq x_2 \neq x_3$

(3) $x_1 \neq x_2 \neq x_3$

(4) $x_2 \neq x_1 \neq x_3$

4. Two moving particles P and Q are 10m apart at a certain instant. The velocity of P is 8m/s making an angle 30° with the line joining P and Q , and the velocity of Q is 6m/s making an angle 30° with PQ as shown in the figure. The rate of change of distance of P with respect to Q is:



(1) Zero

(2) 0.1rad/s

(3) 0.4 rad/s

(4) 0.7rad/s

5. Two bodies are thrown up at angles of 45° and 60° with the same velocity. If both bodies reach the same height, then the ratio of velocities with which they are thrown is:

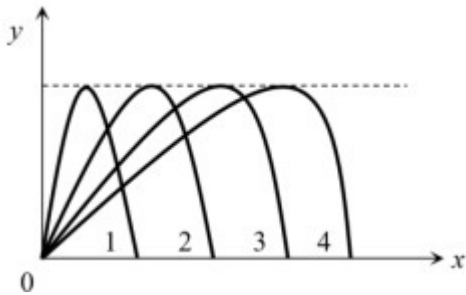
(1) $\sqrt{\frac{2}{3}}$

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

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

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

6. Figure shows four paths for a kicked football. Ignoring the effects of air on the flight, rank the paths according to the initial horizontal velocity component, highest first:



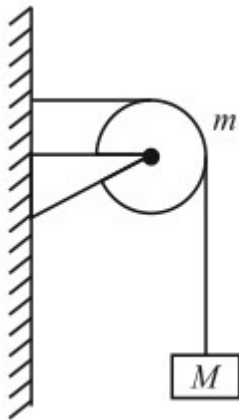
(1) 1, 2, 3, 4

(2) 3, 4, 2, 1

(3) 3, 4, 1, 2

(4) 4, 3, 2, 1

7. A string of negligible mass going over a clamped pulley of mass m supports a block of mass M as shown in the figure. The force on the pulley by the clamp is given by



(1) $\sqrt{2}Mg$

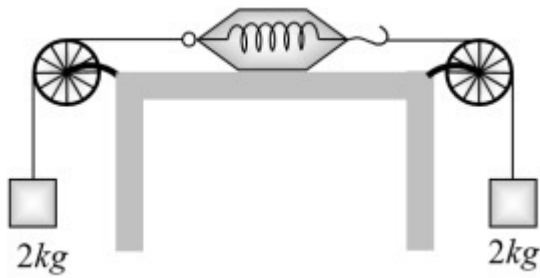
(2) $\sqrt{2}mg$

(3) $\sqrt{(M+m)^2 + m^2}g$

(4) $\sqrt{(M+m)^2 + M^2}g$

8. As shown in the figure, two equal masses each of 2kg are suspended from a spring balance. The reading of the spring balance will be:

4

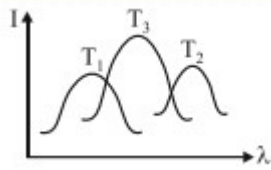


- (1) Zero
- (2) 2kg
- (3) 4kg
- (4) Between zero and 2kg

9. The coefficient of linear expansion of crystal in one direction is α_1 and α_2 that in every direction perpendicular to it is α_2 . The coefficient of cubical expansion is:

- (1) $\alpha_1 + 2\alpha_2$
- (2) $2\alpha_1 + \alpha_2^2$
- (3) $3\alpha_2^2$
- (4) none of these

10. The plots of intensity radiation versus wavelength of three black bodies at temperatures T_1 , T_2 , and T_3 are shown:



(1) $T_3 > T_2 > T_1$

(2) $T_1 > T_2 > T_3$

(3) $T_2 > T_3 > T^1$

(4) $T_3 > T_1 > T^2$

11. Assuming the sun to be a spherical body of radius R at a temperature T , write the total radiant power, incident on the Earth, at a distance r from the Sun:

(1) $\frac{R^2 T^4}{r^2}$

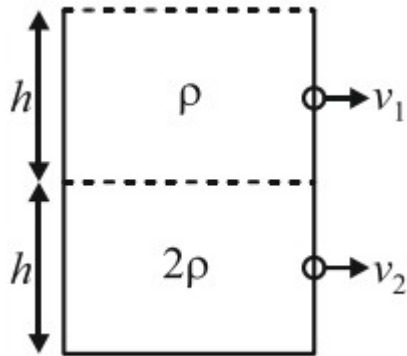
(2) $\frac{4\pi r^2 R^2 T^4}{r^2}$

(3) $\frac{4\pi R^2 T^4}{r^2}$

(4) $\frac{r^2 T^4}{4\pi R^2}$

12. Equal volume of two immiscible liquids of densities ρ_1 and ρ_2 are filled in a vessel as shown in the figure. Two small holes are punched at depths

$\frac{h}{2}$ and $\frac{3h}{2}$ from the surface of the lighter liquid. If v_1 and v_2 are the velocities of efflux at these two holes, then $\frac{v_1}{v_2}$:



(1) $\frac{v_1}{v_2} = \frac{1}{4}$

(2) $\frac{v_1}{v_2} = \frac{1}{2}$

(3) $\frac{v_1}{v_2} = \frac{1}{\sqrt{2}}$

(4) $\frac{v_1}{v_2} = \frac{1}{2\sqrt{2}}$

13. Two soap bubbles with radii r_1 and r_2 come in contact. Their common surface has a radius of curvature r

(1) $r = \frac{r_1 + r_2}{2}$

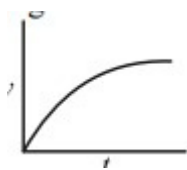
$$(2) r = \frac{r_1 r_2}{r_2 - r_1}$$

$$(3) r = \frac{r_1 r_2}{r_2 + r_1}$$

$$(4) r = \sqrt{r_1 r_2}$$

14. A piece of cork starts from rest at the bottom of a lake and floats up. Its velocity v is plotted against time. Which of the following best represents the resulting curve?

(1)



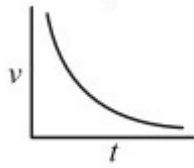
(2)



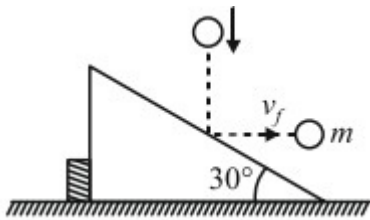
(3)



(4)



15. As shown in the figure, a body of mass m moving vertically with speed $4\sqrt{3}\text{ m/s}$ hits a smooth fixed inclined plane and rebounds with a velocity v in the horizontal direction. If the angle of the plane with horizontal is 30° , the velocity v will be:



- (1) 3 m/s
 (2) $\sqrt{3}\text{ m/s}$
 (3) $\frac{1}{\sqrt{3}}\text{ m/s}$
 (4) 2 m/s

16. A spring, which is initially in its unstretched condition, is first stretched by a length x and then again by a further length x . The work done in the first case is W_1 , and in the second case is W_2 . Then,

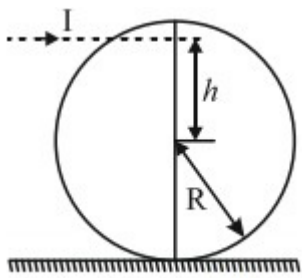
- (1) $W_2 = W_1$
 (2) $W_2 = 2W_1$

4

(3) $W_2 = 3W_1$

(4) $W_2 = 4W_1$

17. A solid sphere rests on a horizontal surface. A horizontal impulse is applied at height h from the center. The sphere starts rolling just after the application of impulse. The ratio h/R will be:



(1) $\frac{1}{2}$

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

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

(4) $\frac{2}{3}$

18. A sound wave of frequency 245 Hz travels with the speed of 300 m/s along the positive x -axis. Each particle in the medium executes SHM of amplitude 2mm. Which of the following is a mathematical expression of this traveling wave?

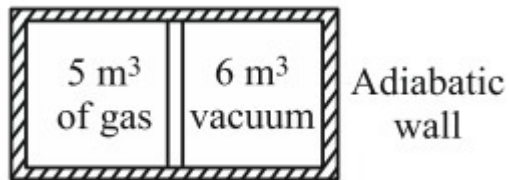
(1) $Y(x, t) = 0.006[\sin 0.8x - (0.5 \times 10^3)t]$

(2) $Y(x,t) = 0.003[\sin 5.1x - (1.5 \times 10^3)t]$

(3) $Y(x,t) = 0.003[\sin 5.1x - (0.2 \times 10^3)t]$

(4) $Y(x,t) = 0.06[\sin 5.1x - (1.5 \times 10^3)t]$

19. A movable piston separates a sample of gas from vacuum. In this state, the pressure of gas is P , then final pressure after piston is released is:



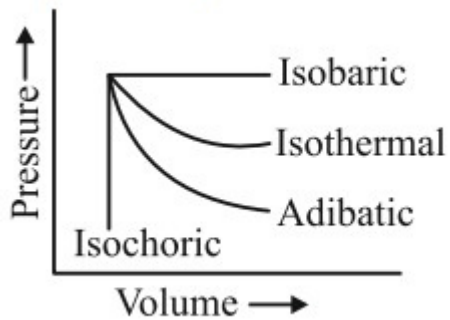
(1) P

(2) $6P$

(3) $\frac{5P}{11}$

(4) Pressure is not defined because it is a free expansion.

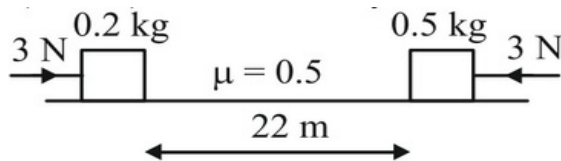
20. The amount of work done (in P - V diagram) by the gas during expansion 4 is greatest for:



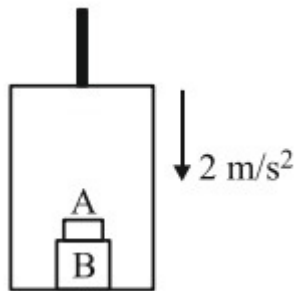
- (1) Isobaric process
- (2) Isothermal process
- (3) Adiabatic process
- (4) Same in each process

Physics (Section B)

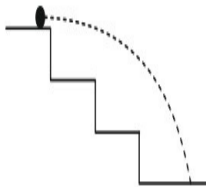
21. Two blocks of mass 0.2kg and 0.5kg, which are placed 22m apart on a 40° inclined plane. Two forces of magnitude 3 N each as shown in figure at time $t = 0$. Then, find the time t (in sec) at which they collide each other.



22. The elevator shown in figure is descending with an acceleration of 2 m/s^2 . The mass of the block A is 0.5kg. What force is exerted by the block A on the block B?



23. A staircase contains three steps each 10cm high and 20cm wide (figure). What should be the minimum horizontal velocity of a ball rolling off the uppermost place so as to hit directly the lowest plane?

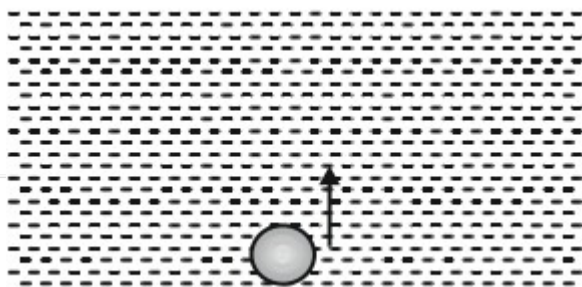


24. A physical quantity P is given by the relation:

$P = P_0 e^{-\lambda t} / T$ Here, T denotes the time. The dimensions of constant λ are:

4

25. An air bubble closes its radius on rising from the bottom of the water reservoir to the surface of water in it. If the atmospheric pressure is equal to 10m of water, the height (in meter) of water in the reservoir is:



Chemistry (Section A)

26. The rate constant of a reaction increases by 4 times when the temperature is raised from 300 K to 350 K. The activation energy (E_a) of the reaction is approximately:

- (1) 48 kJ/mol (2) 32 kJ/mol (3) 16 kJ/mol (4) 8 kJ/mol

27. The van't Hoff factor (i) for a 0.1 M solution of BaCl_2 is:

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

4

4

28.	<p>For a first-order reaction, the time taken for the concentration to reduce 4 to 25% of its initial value is:</p> <p>(1) Equal to $t_{1/2}$</p> <p>(2) Less than $t_{1/2}$</p> <p>(3) $2t_{1/2}$</p> <p>(4) $4t_{1/2}$</p>	
29.	<p>Which of the following has the highest entropy at standard conditions?</p> <p>(1) $H_2(g)$</p> <p>(2) H_2O</p> <p>(3) $C_6H_6(l)$</p> <p>(4) Diamond</p>	4
30.	<p>The critical temperature of a gas is the temperature above which:</p> <p>(1) It can be liquefied by pressure.</p> <p>(2) It cannot be liquefied by pressure.</p> <p>(3) Solidification occurs.</p> <p>(4) Gas decomposes.</p>	4
31.	The molar conductivity of a strong electrolyte:	4

	<p>(1) Increases with dilution.</p> <p>(2) Decreases with dilution.</p> <p>(3) Remains constant with dilution.</p> <p>(4) Becomes zero with dilution</p>	
32.	<p>The equilibrium constant for a reaction at 500 K is 10. If the reaction quotient (Q) is 5, then the reaction will:</p> <p>(1) Proceed forward.</p> <p>(2) Proceed backward.</p> <p>(3) Be at equilibrium.</p> <p>(4) Stop.</p>	
33.	<p>The pH of a 0.01M HCl solution is:</p> <p>(1) 2</p> <p>(2) 3</p> <p>(3) 4</p> <p>(4) 5</p>	4
34.	<p>The major product of the reaction $CH_3-CH_2-OH \xrightarrow{H_2SO_4}$ is:</p> <p>(1) CH_3-CH_3</p> <p>(2) $CH_2=CH_2$</p>	4

	<p>(3) CH_3-CHO</p> <p>(4) CH_3-O-CH_3</p>	
35.	<p>Which of the following does not give a positive Tollens' test?</p> <p>(1) Glucose</p> <p>(2) Sucrose</p> <p>(3) Formaldehyde</p> <p>(4) Benzaldehyde</p>	4
36.	<p>Which is the most reactive towards electrophilic aromatic substitution?</p> <p>(1) Benzene</p> <p>(2) Toluene</p> <p>(3) Nitrobenzene</p> <p>(4) Chlorobenzene</p>	4
37.	<p>The IUPAC name of $CH_3CH_2CHBrCH_3$ is:</p> <p>(1) 2-Bromo-2-methylpropane</p> <p>(2) 2-Bromo-3-methylbutane</p> <p>(3) 3-Bromobutane (4) 2-Bromobutane</p>	4

38.	The major product of $CH_3CH_2Br + KCN \rightarrow$ is: (1) CH_3CH_2CN (2) CH_3CH_2NC (3) CH_3CH_2COOH (4) CH_3CH_2OH	4
39.	Which of the following compounds will undergo a Cannizzaro reaction? 4 (1) Benzaldehyde (2) Acetaldehyde (3) Formaldehyde (4) Trimethylacetaldehyde	
40.	The reagent used for the conversion of alcohol to aldehyde is: (1) PCC (2) $KMnO_4$ (3) $NaBH_4$ (4) Grignard reagent	4
41.	Which of the following is a transition element? (1) Scandium	4

	<p>(2) Sodium</p> <p>(3) Magnesium</p> <p>(4) Calcium</p>	
42.	<p>The geometry of $[\text{Ni}(\text{CN})_4]^{2-}$ is:</p> <p>(1) Square planar</p> <p>(2) Tetrahedral</p> <p>(3) Octahedral</p> <p>(4) Linear</p>	4
43.	<p>The oxidation number of chromium in $\text{K}_2\text{Cr}_2\text{O}_7$ is:</p> <p>(1) +3</p> <p>(2) +5</p> <p>(3) +6</p> <p>(4) +7</p>	4
44.	<p>Which of the following has the highest ionization energy?</p> <p>(1) Na</p> <p>(2) Mg</p> <p>(3) Al</p> <p>(4) Si</p>	4

45.	The color of $[\text{Cu}(\text{NH}_3)_4]^{2+}$ complex is: (1) Blue (2) Green (3) Yellow (4) Red	4
Chemistry (Section B)		
46.	Calculate the pH of a 0.01M HCl solution.	4
47.	Determine the number of unpaired electrons in $[\text{Fe}(\text{CN})_6]^{4-}$ if Fe is in a low-spin state.	4
48.	Calculate the molality of a solution prepared by dissolving 5g of KCl (Molar mass = 74.5g/mol) in 200g of water.	4
49.	The vapor pressure of pure water at 300K is 23.8mmHg. Calculate the vapor pressure of a solution containing 10g of urea (molar mass = 60g/mol) in 100g of water.	4
50.	Find the equivalent weight of oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$) if it reacts completely with NaOH in an acid-base reaction.	4
Mathematics (Section A)		
51.	The roots of the quadratic equation $x^2 - 5x + 6 = 0$ are:	4

	<p>(1) 2, 3</p> <p>(2) -2, -3</p> <p>(3) 5, 6</p> <p>(4) -5, -6</p>	
52.	<p>The sum of the first 20 terms of the arithmetic progression 5, 8, 11, is:</p> <p>(1) 620</p> <p>(2) 640</p> <p>(3) 660</p> <p>(4) 700</p>	4
53.	<p>Find the sum of the infinite geometric series $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \dots$.</p> <p>(1) 1</p> <p>(2) 2</p> <p>(3) $\frac{1}{3}$</p> <p>(4) $\frac{3}{2}$</p>	4
54.	<p>If α and β are the roots of $x^2 - 7x + 10 = 0$, then $\alpha^2 + \beta^2$ is:</p> <p>(1) 29</p>	4

	<p>(2) 49</p> <p>(3) 39</p> <p>(4) 59</p>	
55.	<p>The sum of all three-digit numbers divisible by 5 is:</p> <p>(1) 99045 (2) 99500 (3) 100000 (4) 99000</p>	4
56.	<p>If $\tan A = \frac{3}{4}$, then $\sin A$ is:</p> <p>(1) $\frac{3}{5}$</p> <p>(2) $\frac{4}{5}$</p> <p>(3) $\frac{5}{4}$</p> <p>(4) $\frac{3}{4}$</p>	4
57.	<p>Solve for x: $2\cos 2x - 1 = 0$ for $0 \leq x \leq 2\pi$:</p> <p>(1) $\frac{\pi}{3}, \frac{5\pi}{3}$</p>	4

	<p>(2) $\frac{\pi}{4}, \frac{7\pi}{4}$</p> <p>(3) $\frac{\pi}{2}, \frac{3\pi}{2}$</p> <p>(4) $\pi, 0$</p>	
58.	<p>The value of $\sin^2 45^\circ + \cos^2 45^\circ$ is:</p> <p>(1) 1</p> <p>(2) $\frac{1}{2}$</p> <p>(3) 0</p> <p>(4) $\sqrt{2}$</p>	4
59.	<p>If $\sin \theta = \frac{5}{13}$ and θ is in the first quadrant, find $\cos \theta$:</p> <p>(1) $\frac{12}{13}$</p> <p>(2) $\frac{5}{13}$</p> <p>(3) $\frac{13}{12}$</p> <p>(4) $\frac{1}{13}$</p>	4
60.	<p>The general solution of $\cos x = 0$ is:</p>	4

	<p>(1) $x = n\pi$</p> <p>(2) $x = 2n\pi$</p> <p>(3) $x = (2n+1)\pi$</p> <p>(4) $x = n\pi + \frac{\pi}{2}$</p>	
61.	<p>Evaluate $\int_0^1 \sin x dx$:</p> <p>(1) 1</p> <p>(2) 2</p> <p>(3) -1</p> <p>(4) 0</p>	4
62.	<p>The derivative of $y = x^3 - 3x^2 + 5$ at $x = 2$ is:</p> <p>(1) 1</p> <p>(2) 2</p> <p>(3) 3</p> <p>(4) 5</p>	4
63.	<p>The value of $\lim_{x \rightarrow 0} \frac{\sin 2x}{x}$ is:</p> <p>(1) 2</p>	4

	<p>(2) 1</p> <p>(3) 0</p> <p>(4) 4</p>	
64.	<p>The slope of the tangent to the curve $y = x^2 + 3x$ at $x = 1$ is:</p> <p>(1) 5</p> <p>(2) 6</p> <p>(3) 7</p> <p>(4) 8</p>	4
65.	<p>The area bounded by the curve $y = x^2$ and the x-axis between $x = 0$ and $x = 2$ is:</p> <p>(1) $\frac{8}{3}$</p> <p>(2) 4</p> <p>(3) $\frac{7}{3}$</p> <p>(4) $\frac{5}{3}$</p>	4
66.	<p>The distance between the points (1, 2) and (4, 6) is:</p> <p>(1) 3</p>	4

	<p>(2) 5</p> <p>(3) 4</p> <p>(4) 6</p>	
67.	<p>The equation of the line passing through (3, 4) and (5,10) is:</p> <p>(1) $y=3x-5$</p> <p>(2) $y=2x-2$</p> <p>(3) $y=5x+3$</p> <p>(4) $y=2x+2$</p>	4
68.	<p>The eccentricity of the ellipse $\frac{x^2}{16} + \frac{y^2}{9} = 1$ is:</p> <p>(1) $\frac{5}{4}$</p> <p>(2) $\frac{4}{5}$</p> <p>(3) $\sqrt{7} / 4$</p> <p>(4) $\sqrt{7} / 5$</p>	4
69.	<p>The center of the circle $x^2 + y^2 - 4x + 6y - 12 = 0$ is:</p> <p>(1) (2, -3)</p>	4

	<p>(2) $(-2, 3)$</p> <p>(3) $(-2, -3)$</p> <p>(4) $(3, -2)$</p>	
70.	<p>The equation of the line parallel to $y = 2x + 3$ and passing through $(1, 1)$ is:</p> <p>(1) $y = 2x - 1$</p> <p>(2) $y = 2x + 1$</p> <p>(3) $y = 3x + 1$</p> <p>(4) $y = 2x + 2$</p>	4
Mathematics (Section B)		
71.	Calculate the sum of the first 50 natural numbers.	4
72.	Find the length of the latus rectum of the parabola $y^2 = 16x$.	4
73.	Determine the slope of the tangent to the curve $y = \ln x$ at $x = e$.	4
74.	Find the radius of the circle $x^2 + y^2 = 25$.	4
75.	If $\sin \theta = \frac{3}{5}$, find $\tan \theta$.	4

Answer Key

Physics (Section A)

1. Answer: (3)

$$\frac{1}{2}mv^2 = \frac{1}{2}kx^2_{\max} = \sqrt{\frac{mv^2}{k}}$$

Now, $k_t = k_1 + k_2$.

$$\frac{1}{2}mv^2 = \frac{1}{2}k_t \frac{x^2}{2} = \frac{3mv^2}{4} = \frac{1}{2}k_t x^2$$

$$k_t = \frac{4}{3}n\pi^2 \rho k t = \frac{4}{3}k$$

Then $KE=75\%$.

2. Answer: (3) W = total area under curved

3. Answer: (2) $T = \frac{2mR}{m\hbar + m}$ and $f = kx$

4. Answer: (4) $w = \frac{v_1}{r} = 0.7 \text{ rad/s}$

5. Answer: (3)

$$H_{\max} = u^2 \sin 2\theta$$

$$u = \frac{\sqrt{2u^2 \sin 2\theta}}{\sqrt{g}}$$

$$u = \frac{\sqrt{2} \cdot \frac{\sqrt{3}}{2}}{\sqrt{1/2}}$$

$$u = \frac{\sqrt{3}}{\sqrt{2}}$$

6. Answer: (3)

$$H_{\max} = u^2 \sin 2\theta \quad u = \frac{\sqrt{2u^2 \sin 2\theta}}{\sqrt{g}}$$

$$u = \frac{\sqrt{2} \cdot \frac{\sqrt{3}}{2}}{\sqrt{1/2}} \quad u = \frac{\sqrt{3}}{\sqrt{2}}$$

7. Answer:

(4) Force on the pulley by the clamp:

$$F_c = \sqrt{T^2 + [(M + m)g]^2}$$

$$F_c = \sqrt{(Mx)^2 + [(M + m)g]^2}$$

$$F_c = \sqrt{M^2x^2 + (M + m)^2 g^2}$$

$$F_c = \sqrt{M^2x^2 + (M + m)^2 g^2}$$

8. Answer: (2)

In this case, one 2 kg wt on the left will act as the support for the spring balance. Hence its reading will be 2 kg.

9. Answer: (3)

$$V = l_0(1 + \dots) \text{ or } l_2 = l_0(1 + \dots)^2 (1 + \dots)$$

$$l^2 = l_0^2(1 + 4\dots) \text{ Since } l_0^3 = l_0^2,$$

$$1 + \dots = (1 + \dots)(1 + \dots)$$

$$\dots = \dots 1 + 2\dots$$

10. Answer: (4)

According to Wien's law:

$\lambda_m T = \text{const}$ and from the figure:

$\lambda_1 m_1 = \lambda_2 m_2 = \lambda_3 m_3$ Therefore,

$$T_1 = T_3 = T_2.$$

11. Answer: (3)

Energy radiated per second by the sun:

$E = 4\pi R^2 \sigma T^4$ This energy falls uniformly on the inner surface of the sphere centered on the sun.

If r is the distance of the earth from the sun, then energy falling per second on unit area of the sphere of radius r :

$$\frac{4\pi R^2 \sigma T^4}{4\pi r^2} = \frac{R^2 \sigma T^4}{r^2} \text{ The radiant power incident on the earth is given by:}$$

$$\frac{\pi r^2 R^2 \sigma T^4}{r^2}$$

12. Answer: (3)

$$P + \rho gh + \frac{1}{2} \rho v^2 = c P_0 + \rho gh + \frac{1}{2} \rho v^2 = 0 + 0$$

$$\rho gh = \frac{1}{2} \rho v_1^2 \quad v_1 = \sqrt{2gh}, \quad v_2 = \sqrt{\frac{gh}{2}}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{2 \sqrt{2gh}}{\sqrt{gh}}} = \frac{1}{\sqrt{2}}$$

13. Answer: (2)

Let p_1 and p_2 be the pressures inside the two bubbles.

$$p_1 - p_0 = \frac{4S}{r_1}, \quad p_2 - p_0 = \frac{4S}{r_2} \quad p_1 - p_2 = \frac{4S}{r_1} - \frac{4S}{r_2}$$

Pressure difference across the common surface:

$$p_c - p_A = \frac{4S}{r_1} - \frac{4S}{r_2} \quad \text{Let } r \text{ be the radius of curvature of the common surface.}$$

$$p_c - p_A = \frac{4S}{r} \quad \square \quad \frac{4S}{r_1} - \frac{4S}{r_2} = \frac{4S}{r}$$

14. Answer:(1)

As the cork moves up, the force due to buoyancy remains constant. As its speed increases, the retarding force due to viscosity increases, being proportional to the speed. Thus, the acceleration gradually decreases.

The acceleration is variable, and hence the relation between velocity and time is not linear.

15. Answer: (2)

Velocity component along AB should remain unchanged.

$$v = 3 \sin 30^\circ = v \cos 30^\circ \quad v = 3 \tan 30^\circ = \sqrt{3} \text{ m/s}$$

16. Answer: (3)

Let k = force constant of the spring.

Potential energy of the spring after the first stretching:

$$E_1 = \frac{1}{2} kx^2$$

Potential energy of the spring after the second stretching:

$$E_2 = \frac{1}{2} k(2x)^2$$

$$W = E_2 - E_1$$

17. Answer: (2)

Rolling is rotation about the point of contact. Applying impulse momentum equation about P :

$$J(R+h) = I\omega \quad \text{and} \quad J = rm \cdot v$$

As the sphere rolls, $v = \omega R$, and

$$mR^2\omega = mR^2\omega + mR^2\omega = 2mR^2\omega$$

After solving, we get $h = \frac{2}{5}R$.

18. Answer: (2)

$$2A = 0.06 \quad \Rightarrow \quad A = 0.03$$

$$\omega = \frac{300}{245}, \quad k = \frac{2\omega}{300} \cdot 245 = 5.1$$

$\Delta = 1540$

So, option (2) matches.

19. Answer: (3)

For free expansion: $W = 0$

$\Delta Q = 0$ and $\Delta U = 0$

$P = \text{constant}$

$$\frac{V}{P} = \frac{5}{11} \Rightarrow P = \frac{5}{11} V$$

V

20. Answer: (1)

1 → isobaric

2 → isothermal

3 → adiabatic

4 → isochoric

Physics (Section B)

$$21. a_1 = \frac{F - f_1}{m_1} = \frac{F - \mu m_1 g}{m_1} = 10 \text{ m/s}^2 \quad a_2 = \frac{-F + \mu m_2 g}{m_2} = -1 \text{ m/s}^2$$

$$\Delta s = \frac{1}{2} a_{\text{real}} t^2 \quad 22 = \frac{1}{2} [10 - (1)] t^2 \Rightarrow t = 2 \text{ sec}$$

22.

$$0.5 \text{ g} - N = 0.5 \times 2 \text{ N} = 5 - 1 = 4$$

23. 2

24.

$P = P_0 e^{-\alpha t^2}$ The power of the exponent is dimensionless,

$$[\alpha t^2] = [M^0 L^0 T^0] = [T^{-2}]$$

25. 70m

Chemistry (Section A)

26. Answer: (2) 32 kJ/mol

Explanation: Using the Arrhenius equation, $\ln(k_2/k_1) = \frac{E_a}{R} \left[\frac{1}{T_1} - \frac{1}{T_2} \right]$, we calculate $E_a = 32 \text{ kJ/mol}$.

27. Answer: (3) 3

Explanation: BaCl_2 dissociates into Ba^{2+} and 2Cl^- . Hence, $i = 1 + 2 = 3$.

28. Answer: (3) $2t_{1/2}$

Explanation: For a first-order reaction, the concentration reduces to 25% in $2t_{1/2}$.

29. Answer: (1) $H_2(g)$

Explanation: Gases have the highest entropy compared to liquids and solids at standard conditions.

30. Answer: (2) It cannot be liquefied by pressure.

Explanation: Above the critical temperature, the kinetic energy is too high for condensation to occur.

31. Answer: (1) Increases with dilution.

Explanation: Molar conductivity increases as interionic attractions decrease with dilution.

32. Answer: (1) Proceed forward.

Explanation: Since $Q < K$, the reaction will proceed in the forward direction to reach equilibrium.

33. Answer: (1) 2

Explanation: $pH = -\log[H^+] = -\log(0.01) = 2$.

34. Answer: (2) $CH_2=CH_2$

Explanation: Dehydration of ethanol with concentrated H_2SO_4 produces ethene ($CH_2=CH_2$).

35. Answer: (2) Sucrose

Explanation: Sucrose does not have a free aldehyde or ketone group to give a positive Tollens' test.

36. Answer: (2) Toluene

Explanation: The methyl group in toluene activates the benzene ring toward electrophilic aromatic substitution.

37. Answer: (4) 2-Bromobutane

Explanation: The longest chain is butane, and the bromine is attached to the second carbon.

38. Answer: (1) CH_3CH_2CN

Explanation: Potassium cyanide reacts with ethyl bromide in a nucleophilic substitution reaction to form ethyl cyanide.

39. Answer: (1) Benzaldehyde

Explanation: Benzaldehyde undergoes Cannizzaro reaction as it lacks an α -hydrogen atom.

40. Answer: (1) PCC

Explanation: Pyridinium chlorochromate (PCC) selectively oxidizes alcohols to aldehydes without further oxidation to carboxylic acids.

41. Answer: (1) Scandium

Explanation: Scandium is a d-block element and thus a transition metal.

42. Answer: (1) Square planar

Explanation: $[Ni(CN)]_4^{2-}$ has a $d8$ configuration and forms a square planar geometry due to strong field ligands.

43. Answer: (3) +6

Explanation: In $K_2Cr_2O_7$, chromium has an oxidation state of +6.

44. Answer: (4) Si

Explanation: Silicon has the highest ionization energy due to its increased nuclear charge and smaller atomic size compared to Na, Mg, and Al.

45. Answer: (1) Blue

Explanation: The $[Cu(NH_3)_4]^{2+}$ complex is blue due to d-d transitions in the visible spectrum.

Chemistry (Section B)

46. Answer: 2

Explanation: For strong acids like HCl, $\text{pH} = -\log[H^+]$. Given $[H^+] = 0.01\text{M}$,

$$\text{pH} = -\log(0.01) = 2.$$

47. Answer: 0

Explanation: In $[\text{Fe}(\text{CN})_6]^{4-}$, Fe is in a +2 oxidation state. CN^- is a strong field ligand, leading to a low-spin configuration where all d electrons are paired.

48. Answer: 0.336 mol/kg

Explanation:

$$\text{Molality } m = \frac{\text{moles of solute}}{\text{mass of solvent in kg}}$$

$$\text{Moles of KCl} = \frac{5}{74.5} = 0.067 \text{ mol.}$$

$$\text{Mass of water} = 200\text{g} = 0.2 \text{ kg.}$$

$$\text{Molality } m = \frac{0.067}{0.2} = 0.336 \text{ mol/kg.}$$

49 Answer: 23.48mmHg

Explanation:

Use Raoult's law: $P_{\text{solution}} = P_{\text{solvent}} (1 - \chi_{\text{solute}})$.

Moles of urea = $\frac{10}{60} = 0.167\text{mol}$, moles of water = $\frac{100}{18} = 5.556\text{mol}$.

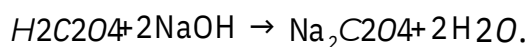
Mole fraction of solute $\chi_{\text{solute}} = \frac{0.167}{0.167 + 5.556} = 0.0298$.

$P_{\text{solution}} = 23.8 (1 - 0.0298) = 23.48\text{mmHg}$.

50. Answer: 63g/mol

Explanation:

Oxalic acid reacts with NaOH in a 1:2 ratio:



Equivalent weight = $\frac{\text{Molar mass}}{\text{n-factor}} = \frac{126}{2} = 63\text{g/mol}$.

Mathematics (Section A)

51. Answer: (1) 2, 3

Explanation: The roots of $x^2 - 5x + 6 = 0$ are the solutions of $(x-2)(x-3) = 0$, which are $x = 2$ and $x = 3$.

52. Answer: (2) 640

Explanation: Sum of n terms of an AP is $S_n = \frac{n}{2}[2a + (n-1)d]$. Here, $a=5$, $d=3$, $n=20$.

$$S_{20} = \frac{20}{2}[2(5) + 19(3)] = 640.$$

53. Answer: (1)

Explanation: The sum of an infinite geometric series is given by $S = \frac{a}{1-r}$, where a is the first term and r is the common ratio. Here,

$$a = \frac{1}{2}, r = \frac{1}{2}.$$

$$S = \frac{\frac{1}{2}}{1 - \frac{1}{2}}$$

$$= \frac{\frac{1}{2}}{\frac{1}{2}}$$

$$= 1.$$

54. Answer: (1) 29

Explanation: $\square + \square = 7$, $\square \square = 10$.

$$2 + 2 = (1 + 1) 2 - 2(1) = 7^2 - 2(10) = 29.$$

55. Answer: (1) 99045

Explanation: The first three-digit number divisible by 5 is 100, and the last is 995.

This forms an AP with $a = 100$, $d = 5$, $l = 995$.

$$n = \frac{l - a}{d} + 1 = \frac{995 - 100}{5} + 1 = 180.$$

$$\text{Sum } S_n = \frac{n}{2}(a + l) = \frac{180}{2}(100 + 995) = 99045.$$

56. Answer: (1) $\frac{3}{5}$

Explanation: $\tan A = \frac{\sin A}{\cos A} = \frac{3}{4}$. Using Pythagoras, $\sin A = \frac{3}{5}$ and $\cos A = \frac{4}{5}$.

57. Answer: (3) $\frac{\pi}{2}, \frac{3\pi}{2}$

Explanation: $2\cos 2x - 1 = 0 \Rightarrow \cos 2x = \frac{1}{2}$.

$\cos x = \pm \frac{1}{\sqrt{2}}$, which gives $x = \frac{\pi}{2}, \frac{3\pi}{2}$ in the given interval.

58. Answer: (1) 1

Explanation: $\sin^2 45^\circ + \cos^2 45^\circ = 1$, as per the Pythagorean identity.

59. Answer: (1) $\frac{12}{13}$

Explanation: $\sin \theta = \frac{5}{13}$. Using $\sin^2 \theta + \cos^2 \theta = 1$,

$$\cos^2 \theta = 1 - \frac{5^2}{13^2} = \frac{144}{169} \quad \cos \theta = \frac{12}{13}$$

60. Answer: (4) $x = n\pi + \frac{\pi}{2}$

Explanation: $\cos x = 0$ when $x = n\pi + \frac{\pi}{2}$, where $n \in \mathbb{Z}$.

61. Answer: (2) 2

Explanation: $\int_0^{\pi} \sin x \, dx = [-\cos x]_0^{\pi} = -\cos \pi + \cos 0 = -(-1) + 1 = 2$.

62. Answer: (3) 3

Explanation: $\frac{d}{dx} (3x^2 - 6x) = 6x - 6$. At $x = 2$, $\frac{d}{dx} (3(2)^2 - 6(2)) = 6(2) - 6 = 6$.

63. Answer: (1) 2

Explanation: $\lim_{x \rightarrow 0} \frac{\sin 2x}{x} = \lim_{x \rightarrow 0} 2 \frac{\sin 2x}{2x} = 2.$

64. Answer: (1) 5

Explanation: $\frac{d}{dy} = 2x + 3$. At $x=1$, $\frac{d}{dy} = 2(1) + 3 = 5$.

65. Answer: (1) $\frac{8}{3}$

Explanation: $\int_0^2 2x dx = \left[\frac{x^2}{1} \right]_0^2 = \frac{2^2}{1} - 0 = \frac{4}{1} = 4$.

66. Answer: (2) 5

Explanation: Distance formula: $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} = \sqrt{(4 - 1)^2 + (6 - 2)^2} = 5.$

67. Answer: (2) $y=2x-2$

Explanation: Slope $m = \frac{10 - 4}{5 - 3} = 3$. Using point-slope form: $y - 4 = 3(x - 3)$ gives $y = 2x - 2$.

68 Answer: (4) $\sqrt{7}/5$

Explanation: Eccentricity $e = \frac{b}{a} = \frac{\sqrt{16}}{2} = \frac{4}{2} = 2$.
 $e = \sqrt{1 - \frac{b^2}{a^2}} = \sqrt{1 - \frac{9}{16}} = \sqrt{\frac{7}{16}} = \frac{\sqrt{7}}{4}$.

69. Answer: (1) (2, -3)

Explanation: Rewrite $x^2 + y^2 - 4x + 6y - 12 = 0$ as $(x-2)^2 + (y+3)^2 = 25$. Center is (2, -3).

70. Answer: (1) $y = 2x - 1$

Explanation: Parallel lines have the same slope. Equation passing through (1, 1) with slope $m = 2$ is $y - 1 = 2(x - 1)$, which simplifies to $y = 2x - 1$.

Mathematics (Section B)

71. Answer: 1275

Explanation: Sum of the first 50 natural numbers: $S_n = \frac{n(n+1)}{2} = \frac{50(51)}{2} = 1275$.

72. Answer: 4

Explanation: Length of the latus rectum of $y^2 = 16x$ is 4.

73. Answer: 1

Explanation: Slope of the tangent to $y = \ln x$ at $x = e$ is $\frac{d}{dx}(\ln x) = \frac{1}{x}$. At $x = e$, slope = 1.

74. Answer: 5

Explanation: The equation $x^2 + y^2 = 25$ represents a circle with radius $\sqrt{25} = 5$.

75. Answer: $\frac{3}{4}$

Explanation: $\tan \theta = \frac{\sin \theta}{\cos \theta} = \frac{\frac{3}{5}}{\frac{4}{5}} = \frac{3}{4}$.

JEE Main Mock Test – Set 3

Maximum Marks: 300

Time Allowed: 3 hours

General Instructions:

- The question Paper consists of 75 to attempt. The maximum marks are 300. There are
- three subjects in the question paper, Subject I, II and III consisting of Section- I (Physics), Section-II (Chemistry), Section-III (Mathematics), and having 25 questions in each part. Each Subject will have two sections. Section A will be of Multiple-Choice
- Questions (MCQs) and Section B will contain Questions whose answers are to be filled in as a numerical value. There will be a total of 20 MCQs and 5 Numerical Value Based Questions Each correct answer will give 4 marks while 1 Marks will be deducted for a wrong response.
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Q. No.	Questions	
Physics (Section A)		
1.	A body of mass 5 kg is moving with a velocity of 2 m/s. What is its momentum? (A) 1 kg m/s (B) 5 kg m/s (C) 2.5 kg m/s (D) 10 kg m/s	4

2.	<p>he work done by a variable force $F(x) = 2x + 3$ N over a displacement 4 from $x=0$ to $x=2$ meters is:</p> <p>(A) 8 J</p> <p>(B) 6 J</p> <p>(C) 5 J</p> <p>(D) 4 J</p>	
3.	<p>A stone is thrown vertically upwards with a velocity of 10 m/s. How 4 high will it rise before coming to rest?</p> <p>(A) 10 m (B) 5 m (C) 20 m (D) 15 m</p>	
4.	<p>A bullet of mass 10 g is fired from a gun of mass 1.5 kg with a velocity 4 of 100 m/s. What is the velocity of the gun?</p> <p>(A) 0.67 m/s (B) 1.67 m/s (C) 0.5 m/s (D) 0.33 m/s</p>	
5.	<p>A 4 kg block is moving on a frictionless surface with velocity 5 m/s. 4 The total kinetic energy is:</p>	

	<p>(A) 50 J</p> <p>(B) 100 J</p> <p>(C) 25 J</p> <p>(D) 200 J</p>	
6.	<p>The period of oscillation of a simple pendulum is 2 seconds. What is its length? (Take $g=9.8\text{m/s}^2$)</p> <p>(A) 0.5 m</p> <p>(B) 1 m (C)</p> <p>2 m (D)</p> <p>0.25 m</p>	
7.	<p>A coil of 50 turns, each of radius 5 cm, carries a current of 2 A. The magnetic field at the center of the coil is:</p> <p>(A) $1.6 \times 10^{-5}\text{T}$</p> <p>(B) $3.2 \times 10^{-5}\text{T}$</p> <p>(C) $6.4 \times 10^{-5}\text{T}$</p> <p>(D) $2.5 \times 10^{-5}\text{T}$</p>	
8.	<p>The radius of the Earth is 6400 km. If a satellite is moving in an orbit 200 km above the Earth's surface, the gravitational potential energy of the satellite is:</p>	4

	<p>(A) Negative</p> <p>(B) Zero</p> <p>(C) Positive</p> <p>(D) Depends on the orbit radius</p>	
9.	<p>A parallel-plate capacitor has a plate area of 2 m^2 and plate separation of 1 mm. What is the capacitance if the dielectric constant is 4?</p> <p>(A) $8 \times 10^{-12} \text{ F}$</p> <p>(B) $4 \times 10^{-12} \text{ F}$</p> <p>(C) $1 \times 10^{-12} \text{ F}$</p> <p>(D) $2 \times 10^{-12} \text{ F}$</p>	4
10.	<p>A body is thrown with an initial velocity of 10 m/s at an angle of 30°. The time of flight is:</p> <p>(A) 2 s (B) 1.5 s (C) 3 s (D) 4 s</p>	4
11.	<p>The electric field due to a uniformly charged infinite sheet is:</p> <p>(A) Zero</p>	4

	<p>(B) $\frac{\square}{2}_0$</p> <p>(C) $\frac{\square}{0}$</p> <p>(D) $\frac{\square}{4}_0$</p>	
12.	<p>A car is moving at a speed of 20 m/s. What is its kinetic energy? (Mass of the car = 1000 kg)</p> <p>(A) 10000 J (B) 20000 J (C) 30000 J (D) 5000 J</p>	4
13.	<p>The focal length of a lens is 15 cm. An object is placed 20 cm from the lens. The image distance is:</p> <p>(A) 60 cm (B) 30 cm (C) 10 cm (D) 50 cm</p>	4
14.	<p>A photon of energy 2 eV is absorbed by an electron. The velocity of the electron is:</p>	4

	<p>(A) 3×10^5 m/s</p> <p>(B) 1.5×10^6 m/s</p> <p>(C) 5×10^5 m/s</p> <p>(D) 2×10^6 m/s</p>	
15.	<p>In an ideal gas, the internal energy is proportional to:</p> <p>(A) $\frac{1}{T}$</p> <p>(B) T</p> <p>(C) $\frac{T}{2}$</p> <p>(D) T^2</p>	4
16.	<p>A metal rod is heated, and its length increases by 1 cm. If the original length is 2 m, the coefficient of linear expansion is:</p> <p>(A) $5 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$</p> <p>(B) $1 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$</p> <p>(C) $2 \times 10^{-5} \text{ } ^\circ\text{C}^{-1}$</p> <p>(D) $2.5 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$</p>	4
17.	<p>A current of 5 A flows through a wire of resistance 2 ohms. The power dissipated in the wire is:</p>	4

	<p>(A) 25 W</p> <p>(B) 10 W</p> <p>(C) 15 W</p> <p>(D) 5 W</p>	
18.	<p>A block of mass 5 kg is sliding on a rough surface with an initial velocity of 4 m/s. The coefficient of friction is 0.2. The distance travelled by the block before coming to rest is:</p> <p>(A) 10 m (B) 5 m (C) 20 m</p> <p>(D) 15 m</p>	
19.	<p>A tuning fork produces sound at 512 Hz. If the speed of sound is 340 m/s, the wavelength of the sound is:</p> <p>(A) 0.6 m (B) 0.4 m (C) 1 m (D) 1.5 m</p>	
20.	<p>The time period of a simple harmonic oscillator is 0.5 s. What is its frequency?</p> <p>(A) 0.25 Hz</p>	

	(B) 2 Hz (C) 1 Hz (D) 0.5 Hz	
Physics (Section B)		
21.	A body is moving with a velocity of 6 m/s. Calculate its momentum.	4
22.	A block of mass 3 kg is displaced by a force of 15 N. What is the work done by the force?	4
23.	The intensity of a wave is 50 W/m ² . What is the energy passing through 1 m ² in 10 seconds?	4
24.	A spring has a spring constant of 250 N/m and is stretched by 0.2 m. Calculate the potential energy stored in the spring.	4
25.	A gas expands from 2 L to 4 L against a constant pressure of 5 atm. Calculate the work done during the expansion.	4
Chemistry (Section II)		
26.	What is the pH of a 0.1 M NaOH solution? (A) 12 (B) 13 (C) 14	4

	(D) 15	
27.	<p>The equilibrium constant for a reaction is 2. What happens to the 4 reaction when the temperature is increased?</p> <p>(A) Shifts to the left</p> <p>(B) Shifts to the right</p> <p>(C) Stays unchanged</p> <p>(D) None of the above</p>	
28.	<p>The enthalpy of formation of CO₂ is:</p> <p>(A) -393.5 kJ/mol</p> <p>(B) +393.5 kJ/mol</p> <p>(C) -285.5 kJ/mol</p> <p>(D) +285.5 kJ/mol</p>	4
29.	<p>Which of the following is the correct IUPAC name for CH₃-CH₂-4 CH=CH₂?</p> <p>(A) But-1-ene (B) But-2-ene (C) Propene (D) Ethene</p>	4

30.	<p>What is the molar mass of a gas that occupies 22.4 L at STP, given that the gas is oxygen (O₂)?</p> <p>(A) 16 g/mol</p> <p>(B) 32 g/mol</p> <p>(C) 64 g/mol</p> <p>(D) 44 g/mol</p>	4
31.	<p>The molecular mass of oxygen is:</p> <p>(A) 32 g/mol (B) 16 g/mol (C) 8 g/mol (D) 18 g/mol</p>	4
32.	<p>What is the number of moles in 18 g of water?</p> <p>(A) 1 mol (B) 2 mol (C) 3 mol (D) 0.5 mol</p>	4
33.	<p>The boiling point of water increases with the addition of:</p> <p>(A) A non-volatile solute</p>	4

	<p>(B) A volatile solute</p> <p>(C) A solvent</p> <p>(D) A gas</p>	
34.	<p>What is the formula of calcium chloride?</p> <p>(A) CaCl (B) CaCl₂ (C) Ca₂Cl (D) Ca₂Cl₂</p>	4
35.	<p>The electron configuration of chlorine (Cl) is:</p> <p>(A) [Ne]3s²3p⁵</p> <p>(B) [Ne]3s²3p⁶</p> <p>(C) [Ne]3s¹3p⁵</p> <p>(D) [Ne]3s²3p³</p>	4
36.	<p>Which of the following statements about the enthalpy of formation of 4 O₂(g) is correct?</p> <p>(A) It is zero because O₂ is an elemental form.</p> <p>(B) It is equal to 0.5 times the enthalpy of formation of O₃(g).</p> <p>(C) It is negative because oxygen molecules are formed from atoms.</p>	

	(D) It cannot be defined because the molecule does not exist in the elemental form.	
37.	The molar solubility of AgCl in a solution that is 0.1 M in NaCl is: (A) 1.0×10^{-6} M (B) 1.0×10^{-3} M (C) 1.0×10^{-4} M (D) 1.0×10^{-5} M	4
38.	In the reaction: $2\text{Na}(s) + 2\text{H}_2\text{O}(l) \rightarrow 2\text{NaOH}(aq) + \text{H}_2(g),$ <p>which of the following is true about the standard electrode potentials of Na^+/Na and $\text{H}_2\text{O}/\text{H}_2$?</p> <p>(A) The standard electrode potential of Na^+/Na is higher than that of $\text{H}_2\text{O}/\text{H}_2$.</p> <p>(B) The standard electrode potential of Na^+/Na is lower than that of $\text{H}_2\text{O}/\text{H}_2$.</p> <p>(C) Both electrode potentials are equal.</p> <p>(D) This reaction does not depend on the electrode potentials.</p>	4
39.	Which of the following compounds exhibits optical isomerism? <p>(A) $[\text{Ni}(\text{CO})_4]$ (B) $[\text{Cr}(\text{CO})_6]$</p>	4

	(C) $[\text{Cu}(\text{NH}_3)_4]^{2+}$ (D) $[\text{CoCl}_3(\text{NH}_3)_3]$	
40.	The rate of a chemical reaction is 1st order with respect to both A and 4 B. If the concentrations of A and B are doubled, the rate of the reaction will (A) Quadruple (B) Double (C) Remain unchanged (D) Increase by a factor of eight	
41.	Which of the following is the correct order of acid strength for the 4 given compounds? (A) $\text{HNO}_3 > \text{H}_2\text{SO}_4 > \text{HClO}_4$ (B) $\text{HClO}_4 > \text{HNO}_3 > \text{H}_2\text{SO}_4$ (C) $\text{HNO}_3 > \text{HClO}_4 > \text{H}_2\text{SO}_4$ (D) $\text{H}_2\text{SO}_4 > \text{HClO}_4 > \text{HNO}_3$	
42.	Which of the following compounds has the highest oxidation state for 4 the central atom? (A) Na_2O_2 (B) $\text{K}_2\text{Cr}_2\text{O}_7$ (C) KMnO_4	

	(D) H ₂ O ₂	
43.	<p>In the reaction between hydrogen and oxygen:</p> $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l}),$ <p>which of the following types of reaction is this?</p> <p>(A) Redox reaction</p> <p>(B) Combination reaction</p> <p>(C) Decomposition reaction</p> <p>(D) Displacement reaction</p>	4
44.	<p>The standard enthalpy change for the reaction:</p> $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$ <p>is -393.5 kJ/mol. What is the enthalpy change for the reverse reaction?</p> <p>(A) +393.5 kJ/mol</p> <p>(B) -393.5 kJ/mol</p> <p>(C) +787 kJ/mol</p> <p>(D) -787 kJ/mol</p>	4
45.	<p>The bond order of nitrogen in the molecule N₂ is:</p> <p>(A) 2 (B) 3</p>	4

	(C) 4 (D) 1	
Chemistry (Section B)		
46.	The solubility product of AgCl is 1.8×10^{-10} . What is the solubility of AgCl in a 0.1 M NaCl solution?	
47.	What is the molar mass of a gas if 2.5 moles of it occupy 56.8 L at 4 STP?	
48.	The rate constant for a first-order reaction is $2 \times 10^{-3} \text{ mol s}^{-1}$. What is the half-life of the reaction when the initial concentration of the reactant is 0.1 M?	
49.	A 0.1 M solution of HCl has a pH of 1. Calculate the concentration of H_3O^+ ions.	
50.	The equilibrium constant for the reaction: $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ is $K_c = 1.0 \times 10^4$. If 1 mole of N_2 and 3 moles of H_2 are mixed in a 2 L container, what will be the equilibrium concentrations of the gases?	4
Mathematics (Section A)		
51.	If the equation of the tangent to the curve $y = \log(1 + x^2)$ at $x = 1$ is:	4

	<p>(A) $y = 1 + \frac{1}{2}x$</p> <p>(B) $y = 1 + x$</p> <p>(C) $y = \frac{1}{2} + x$</p> <p>(D) $y = \frac{3}{2} + x$</p>	
52.	<p>If $f(x) = \sin(x) + \cos(x)$, find the second derivative of $f(x)$.</p> <p>(A) $f''(x) = \sin(x) - \cos(x)$</p> <p>(B) $f''(x) = -\sin(x) + \cos(x)$</p> <p>(C) $f''(x) = -\cos(x) - \sin(x)$</p> <p>(D) $f''(x) = \cos(x) - \sin(x)$</p>	4
53.	<p>The sum of the series: $\sum_{n=1}^{\infty} \frac{1}{3^n}$</p> <p>(A) $\frac{3}{4}$</p> <p>(B) $\frac{2}{3}$</p> <p>(C) $\frac{4}{3}$</p> <p>(D) $\frac{1}{2}$</p>	4

54.	<p>If the roots of the quadratic equation $ax^2+bx+c=0$ are real and distinct, then the discriminant Δ satisfies:</p> <p>(A) $\Delta > 0$</p> <p>(B) $\Delta = 0$</p> <p>(C) $\Delta < 0$</p> <p>(D) $\Delta \geq 0$</p>	4
55.	<p>The equation of the circle passing through the origin with center (2, 3) is:</p> <p>(A) $(x-2)^2+(y-3)^2=13$</p> <p>(B) $(x-2)^2+(y-3)^2=9$</p> <p>(C) $x^2+y^2-4x-6y=0$</p> <p>(D) $x^2+y^2-4x+6y=0$</p>	4
56.	<p>The solution to the differential equation $y' = 2x + y$ is:</p> <p>(A) $y=2x+C$</p> <p>(B) $y=e^x+C$</p> <p>(C) $y = e^x+2x+C$</p> <p>(D) $y=e^{-x}+2x+C$</p>	4

57.	<p>If $f(x) = x^2 \sin x$, the value of $f'(x)$ at $x = \frac{\pi}{2}$ is:</p> <p>(A) $\frac{\pi}{2}$</p> <p>(B) π</p> <p>(C) 0</p> <p>(D) $\frac{\pi}{4}$</p>	4
58.	<p>The area of the region enclosed by the curve $y = x^2$ and the x-axis between $x=1$ and $x=3$ is:</p> <p>(A) 8</p> <p>(B) 12</p> <p>(C) 10</p> <p>(D) 9</p>	4
59.	<p>If $\lim_{x \rightarrow 0} \frac{\sin 3x}{x}$ exists, its value is:</p> <p>(A) 3</p> <p>(B) 1</p> <p>(C) 0</p> <p>(D) 2</p>	4

60.	<p>The number of real solutions to the equation $\cos x = x$ in the interval $[0, \pi]$ is</p> <p>(A) 1</p> <p>(B) 2</p> <p>(C) 3</p> <p>(D) 4</p>	4
61.	<p>If the sum of the series $1 + 2 + 3 + \dots + n$ is 210, then n is.</p> <p>(A) 10</p> <p>(B) 15</p> <p>(C) 20</p> <p>(D) 25</p>	4
62.	<p>The value of the integral $\int_0^{\pi} 2^x dx$ is.</p> <p>(A) $\frac{\pi}{4}$</p> <p>(B) $\frac{\pi}{2}$</p> <p>(C) $\frac{\pi}{8}$</p> <p>(D) $\frac{\pi}{6}$</p>	4

63.	<p>The value of $\tan^{-1}(1) + \cot^{-1}(1)$ is.</p> <p>(A) $\frac{\pi}{4}$</p> <p>(B) $\frac{\pi}{2}$</p> <p>(C) $\frac{\pi}{3}$</p> <p>(D) π</p>	4
64.	<p>If $f(x) = e^x \sin x$, the second derivative $f''(x)$ is.</p> <p>(A) $e^x \sin x$</p> <p>(B) $e^x(\sin x + \cos x)$</p> <p>(C) $e^x(\sin x - \cos x)$</p> <p>(D) $e^x \cos x$</p>	4
65.	<p>The roots of the equation $x^3 - 3x^2 + 4x - 2 = 0$ are.</p> <p>(A) $x=1,2,3$</p> <p>(B) $x=-1,2,3$</p> <p>(C) $x=1,-2,3$</p> <p>(D) $x=1,1,-2$</p>	4

66.	<p>If $a + b + c = 0$, the value of $a^3 + b^3 + c^3 - 3abc$ is.</p> <p>(A) 0</p> <p>(B) 1</p> <p>(C) 2</p> <p>(D) $a + b + c$</p>	4
67.	<p>The value of the integral $\int_0^1 (1 - x^2) dx$ is.</p> <p>(A) $\frac{2}{3}$</p> <p>(B) $\frac{1}{3}$</p> <p>(C) $\frac{1}{2}$</p> <p>(D) 1</p>	4
68.	<p>The length of the curve $y = x^3$ from $x = 0$ to $x = 1$ is.</p> <p>(A) $\frac{3}{2}$</p> <p>(B) $\frac{2}{3}$</p> <p>(C) $\frac{5}{2}$</p> <p>(D) 1</p>	4

69.	<p>If the sequence $a_n = \frac{1}{n^2}$ is converging, the sum of the first 100 terms is approximately.</p> <p>(A) 1 (B) 0.5 (C) 0.25 (D) 0.33</p>	4
70.	<p>The solution to the differential equation $y' = y^3$ with the initial condition $y(0)=2$ is.</p> <p>(A) $y=2e^{3x}$ (B) $y=2e^{-3x}$ (C) $y=e^{3x}$ (D) $y=e^{-3x}$</p>	
Mathematics (Section B)		
71.	<p>The value of $\int_0^1 20e^{-3x} dx$ is:</p>	4
72.	<p>If the differential equation $y' = \frac{2x}{y}$ holds, find $y(x)$.</p>	4

73.	The sum of the first 10 terms of the arithmetic progression 5,10,15} is:	4
74.	Find the equation of the line passing through the point (2, 3) with slope 4.	4
75.	The volume of a sphere of radius 3 cm is.	4

Answer Keys

Physics(Section A)

1. (D) 10 kg m/s

Solution

$$\text{Momentum } p = mv = 5\text{kg} \times 2\text{m/s} = 10\text{kg m/s}$$

2. (B) 6 J

Solution

$$\text{Work done } W = \int_0^6 (2x + 3) dx = \left[x^2 + 3x \right]_0^6 = 0(4+6) - (0+0) = 6\text{J}$$

3. (B) 5 m

Solution

$$\text{Using } v^2 = u^2 - 2gh,$$

$$\text{where } u = 10\text{m/s}, v = 0, \text{ and } g = 9.8\text{m/s}^2$$

$$0 = (10)^2 - 2 \times 9.8 \times h$$

$$\text{Solving for } h, \text{ we get } h = 5\text{m}$$

4. (A) 0.67 m/s

Solution

By conservation of momentum:

$$m_{\text{bullet}}v_{\text{bullet}} = m_{\text{gun}}v_{\text{gun}}$$

$$(0.01) \times 100 = (1.5) \times v_{\text{gun}}$$

Solving for v_{gun} , we get $v_{\text{gun}} = 0.67 \text{ m/s}$

5. (B) 100 J

Solution

$$\text{Kinetic energy } KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 4 \times (5)^2 = 100 \text{ J}$$

6. (B) 1 m

Solution

$$\text{Period } T = 2\pi \sqrt{\frac{L}{g}}$$

Given $T = 2$ seconds, $g = 9.8 \text{ m/s}^2$, solve for L ,

$$2 = 2\pi \sqrt{\frac{L}{9.8}}$$

$$L = 1\text{m}$$

7. (B) $3.2 \times 10^{-5}\text{T}$

Solution

The magnetic field at the center of a coil is given by:

$$B = \frac{\mu_0 IN}{2R}$$

Where $\mu_0 = 4\pi \times 10^{-7}\text{T}\cdot\text{m/A}$, $I = 2\text{A}$, $N = 50$, and $R = 0.05\text{m}$.

Substitute these values to get B.

8. (A) Negative

Solution:

The gravitational potential energy is negative because work done against the gravitational force requires energy.

9: (B) $4 \times 10^{-12}\text{F}$

Solution:

$$\text{Capacitance } C = \frac{\epsilon_0 A}{d},$$

where $A = 2\text{m}^2$, $d = 1\text{mm} = 1 \times 10^{-3}\text{m}$, and $\epsilon_0 = 8.85 \times 10^{-12}\text{F/m}$.

Substituting the values, we get $C = 4 \times 10^{-12} \text{ F}$.

10. (B) 1.5 s

Solution

Time of flight for projectile motion:

$$T = \frac{2u \sin \theta}{g},$$

where $u = 10 \text{ m/s}$, $\theta = 30^\circ$, and $g = 9.8 \text{ m/s}^2$

$$\text{Thus, } T = \frac{2 \times 10 \times \sin 30^\circ}{9.8} = 1.5 \text{ seconds}$$

11. (B) $\frac{\sigma}{2\epsilon_0}$

Solution

The electric field due to an infinite sheet of charge is constant and given by $E = \frac{\sigma}{2\epsilon_0}$, where σ is the surface charge density.

12. (B) 20000 J

Solution

Kinetic energy $KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 1000 \times (20)^2 = 20000 \text{ J}$

13. (B) 30 cm

Solution

Using the lens formula:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u},$$

where $f = 15 \text{ cm}$, $u = -20 \text{ cm}$, solving for v , we get $v = 30 \text{ cm}$.

14. (B) $1.5 \times 10^6 \text{ m/s}$

Solution

Using the energy equation:

$$E = \frac{1}{2}mv^2,$$

where $E = 2 \text{ eV} = 3.2 \times 10^{-19} \text{ J}$, and $m = 9.11 \times 10^{-31} \text{ kg}$, solving for v , we get $v = 1.5 \times 10^6 \text{ m/s}$

15. (B) T

Solution:

For an ideal gas, the internal energy is proportional to the temperature T , given by $U = nC_vT$, where n is the number of moles and C_v is the molar heat capacity at constant volume.

16. (A) $5 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$

Solution

The change in length is given by $\Delta L = \alpha L_0 \Delta T$,

where $L_0 = 2\text{m}$, $\Delta L = 1\text{cm} = 0.01\text{m}$, and ΔT is the temperature change.

Solving for α , we get $\alpha = 5 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$.

17. (A) 25 W

Solution

Power dissipated in a resistor is given by $P = I^2 R$,

where $I = 5\text{A}$ and $R = 2\Omega$.

Substituting the values, we get $P = (5)^2 \times 2 = 25\text{W}$.

18. (B) 5 m

Solution

Using the work-energy principle, the work done by friction is equal to the loss in kinetic energy.

$$W = F_{\text{friction}} d = \mu mgd,$$

where $\mu = 0.2$, $m = 5\text{kg}$, and $v = 4\text{m/s}$.

$$\text{The work done is } W = \frac{1}{2}mv^2 = \mu mgd.$$

Solving for d , we get $d = 5\text{m}$.

19. (B) 0.4 m

Solution

$$\text{The wavelength } \lambda = \frac{v}{f},$$

where $v = 340\text{m/s}$ is the speed of sound and $f = 512\text{Hz}$ is the frequency.

$$\text{Substituting the values, we get } \lambda = \frac{340}{512} = 0.4\text{m}.$$

Physics (Section A)

20. (B) 2 Hz

Solution

$$\text{Frequency } f = \frac{1}{T},$$

where $T = 0.5\text{s}$ is the time period.

$$\text{Thus, } f = \frac{1}{0.5} = 2\text{Hz}.$$

21. 30 kg m/s

Solution

$$\text{Momentum } p = mv = 5\text{kg} \times 6\text{m/s} = 30\text{kg m/s}$$

22. 45 Joules

Solution

$$\text{Work done } W = F \times d = 15\text{N} \times 3\text{m} = 45\text{J}$$

23. 500 J

Solution

$$\text{Energy } E = \text{Intensity} \times \text{Area} \times \text{Time} = 50 \times 1 \times 10 = 500 \text{ J}$$

24. 5 Joules

Solution

$$\text{Potential energy } PE = \frac{1}{2} kx^2 = \frac{1}{2} \times 250 \times (0.2)^2 = 5 \text{ J}$$

25. 1013 J

Solution

$$\text{Work done } W = P \Delta V = 5 \text{ atm} \times (4 - 2) \text{ L}$$

$$W = 10 \text{ atm} \times \text{L}$$

$$\text{Using } 1 \text{ atm} \times \text{L} = 101.3 \text{ J},$$

$$W = 10 \times 101.3 = 1013 \text{ J}$$

Chemistry (Section A)

26. (C) 14

Solution

For NaOH, $\text{pOH} = -\log[\text{OH}^-] = -\log(0.1) = 1$.

Since $\text{pH} + \text{pOH} = 14$, $\text{pH} = 14 - 1 = 13$.

27. (B) Shifts to the right

Solution

For an exothermic reaction, increasing the temperature will shift the equilibrium to the left, and for an endothermic reaction, it will shift to the right.

28. (A) -393.5 kJ/mol

Solution

The standard enthalpy of formation of CO_2 is a well-known value, -393.5 kJ/mol.

29. (B) But-2-ene

Solution

The longest chain is 4 carbon atoms with a double bond at position 2.

30. (B) 32 g/mol

Solution

At STP, 1 mole of gas occupies 22.4 L. Hence, 2 moles occupy 44.8 L, and the molar mass of the gas is 32g/mol (oxygen).

31. (A) 32 g/mol

Solution

The molecular mass of oxygen (O₂) is 32 g/mol.

32. 1 mol

Solution

Given 18 g of water (H₂O), using the molar mass of water 18g/mol, the number of moles is

$$\frac{18}{18} = 1 \text{ mol.}$$

1
8

33. (A) A non-volatile solute

Solution

The addition of a non-volatile solute increases the boiling point of a solvent (Boiling Point Elevation).

34. (B) CaCl_2

Solution

The correct formula for calcium chloride is CaCl_2 .

35. (A) $[\text{Ne}]3s^23p^5$

Solution

The electron configuration of chlorine (Cl) is $[\text{Ne}]3s^23p^5$.

36. (A) It is zero because O_2 is an elemental form.

Solution.

The enthalpy of formation of an element in its standard state is defined as zero. Since O_2 is the standard state of oxygen, its enthalpy of formation is zero.

37. (C) $1.0 \times 10^{-4} \text{ M}$

Solution.

The common ion effect reduces the solubility of AgCl .

The solubility product of AgCl is $K_{sp} = [\text{Ag}^+][\text{Cl}^-]$.

In a 0.1 M NaCl solution, the concentration of Cl^- is already 0.1 M.

Thus, the solubility of AgCl is reduced, and the final molar solubility is $1.0 \times 10^{-4} \text{ M}$.

38. (B) The standard electrode potential of Na^+/Na is lower than that of $\text{H}_2\text{O}/\text{H}_2$. Solution.

Sodium (Na) is a highly reactive metal, and its standard electrode potential is negative. For the hydrogen ion (H^+) to be reduced to H_2 , the standard electrode potential is positive. Thus, Na has a lower electrode potential than $\text{H}_2\text{O}/\text{H}_2$.

39. (D) $[\text{CoCl}_3(\text{NH}_3)_3]$ Solution. Optical isomerism occurs in compounds with a chiral center. The

compound $[\text{CoCl}_3(\text{NH}_3)_3]$

has a non-superimposable mirror image due to its asymmetric octahedral geometry, making it optically active.

40. (A) Quadruple Solution. Since the reaction is first-order with respect to both reactants, the

rate law can be written as

$\text{Rate} = k[\text{A}][\text{B}]$. If the concentrations of both A and B are doubled, the rate increases by a factor

of $2 \times 2 = 4$, so the rate will quadruple.

41. (B) $\text{HClO}_4 > \text{HNO}_3 > \text{H}_2\text{SO}_4$ Solution. In the series of strong acids, the strongest acid is typically HClO_4 , followed by HNO_3 , and then H_2SO_4 . This is because HClO_4 has a higher tendency to donate protons compared to HNO_3 and H_2SO_4 .

42. (C) KMnO_4

Solution.

The compound KMnO_4 contains Mn in the highest oxidation state of +7, which is the highest oxidation state for the central atom among the given options.

43. (A) Redox reaction

Solution.

This is a redox reaction because it involves the reduction of oxygen (from O_2 to H_2O) and the oxidation of hydrogen (from H_2 to H^+).

44. (A) +393.5 kJ/mol Solution. For the reverse reaction, the enthalpy change will be the opposite sign of the forward reaction, which has an enthalpy change of -393.5 kJ/mol. Hence, the enthalpy change for the reverse reaction is +393.5 kJ/mol.

Q53

Solution.

The bond order of nitrogen in the N₂ molecule is determined by molecular orbital theory. Since N₂ has a total of 10 electrons in bonding orbitals and 4 in anti-bonding orbitals, the bond order is given by:

$$\text{Bond order} = \frac{(8 - 4)}{2} = 2$$

Chemistry (Section B)

46.

Solution.

Let the solubility of AgCl in water be S, and in the NaCl solution, the concentration of Cl⁻ is 0.1 M.

From the solubility product, we have:

$$K_{sp} = [\text{Ag}^+][\text{Cl}^-] = S(0.1 + S) \approx S \cdot 0.1$$

$$\text{Thus, } S = \frac{K_{sp}}{0.1} = \frac{1.8 \times 10^{-10}}{0.1} = 1.8 \times 10^{-9} \text{ mol/L.}$$

47.

Solution.

At STP, 1 mole of an ideal gas occupies 22.4 L.

Thus, the molar mass of the gas is:

$$\text{Molar mass} = \frac{\text{Mass}}{\text{Moles}} = \frac{56.8\text{L}}{22.4\text{ L/mol}} \times 2.5\text{mol} = 6.33\text{g/mol.}$$

48.

Solution.

For a first-order reaction, the half-life is given by:

$$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{2 \times 10^{-3}} = 346.5\text{seconds.}$$

49.

Solution.

Since $\text{pH} = -\log[\text{H}_3\text{O}^+]$,

$$[\text{H}_3\text{O}^+] = 10^{-\text{pH}} = 10^{-1} = 0.1\text{M.}$$

50.

Solution.

Let the change in the concentration of N_2 be $-x$. The change for H_2 will be $-3x$, and for NH_3 it will be $+2x$.

At equilibrium, the concentrations will be:

$$[N_2] = \frac{1-x}{2}, \quad [H_2] = \frac{3-3x}{2}, \quad [NH_3] = \frac{2x}{2}.$$

Using the equilibrium expression:

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{\left(\frac{2x}{2}\right)^2}{\left(\frac{1-x}{2}\right)\left(\frac{3-3x}{2}\right)^3} = 1.0 \times 10^4.$$

Solving for x , we get the equilibrium concentrations.

Mathematics(Section A)

51. (A) $y = 1 + \frac{1}{2}x$

Solution.

The slope of the tangent at $x=1$ is the derivative of $y = \log(1+x^2)$, which is $\frac{2x}{1+x^2}$.

At $x=1$, the slope is $\frac{2 \times 1}{1+1^2} = \frac{1}{2}$.

Using the point-slope form of the equation of a line, the equation of the tangent is

$$y - \log(2) = \frac{1}{2}(x - 1).$$

Thus, the correct tangent equation is $y = 1 + \frac{1}{2}x$.

52. (C) $f''(x) = -\cos(x) - \sin(x)$

Solution.

The first derivative of $f(x) = \sin(x) + \cos(x)$ is $f'(x) = \cos(x) - \sin(x)$.

Differentiating again, we get $f''(x) = -\sin(x) - \cos(x)$.

53. (B) $\frac{2}{3}$

Solution.

The sum of the series $\sum_{n=1}^{\infty} \frac{1}{3^n}$ can be computed using the formula for the sum of a series.

The sum is $\frac{2}{3}$.

54. (A) $\Delta > 0$

Solution.

For real and distinct roots, the discriminant of the quadratic equation $ax^2+bx+c=0$ must be greater than zero, i.e., $\Delta=b^2-4ac>0$.

55. (A) $(x-2)^2+(y-3)^2=13$

Solution.

The equation of the circle with center (2,3) is $(x-2)^2+(y-3)^2=r^2$.

Since it passes through the origin, substitute $(x,y)=(0,0)$ to find the radius.

Thus, $r^2=13$, so the equation is $(x-2)^2+(y-3)^2=13$.

56. (C) $y=ex+2x+C$

Solution.

To solve $y' = 2x + y$, rewrite as $y' - y = 2x$.

The solution to this linear differential equation is $y=ex+2x+C$.

57. (B) $\frac{1}{2}$

Solution.

The first derivative of $f(x) = x^2 \sin x$ is $f'(x) = 2x \sin x + x^2 \cos x$.

At $x = \frac{1}{2}$, $f'(x) = \frac{1}{2}$.

58. (B) 12

Solution.

The area between the curve $y = x^2$ and the x-axis from $x = 1$ to $x = 3$ is calculated by the integral:

$$\int_1^3 x^2 dx = \left[\frac{x^3}{3} \right]_1^3 = \frac{27}{3} - \frac{1}{3} = 12.$$

59. (A) 3

Solution.

The limit $\lim_{x \rightarrow 0} \frac{\sin 3x}{x} = 3$ by applying L'Hopital's Rule or using the known result that $\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$.

60. (A) 1 Solution. The equation $\cos x = x$ has one real solution

in the interval

numerical methods or graphical methods.

$[0, \frac{\pi}{2}]$, which can be found using

61. (B) 15

Solution.

The sum of the first n natural numbers is $S_n = \frac{n(n+1)}{2}$.

Substituting $S_n = 210$, we solve $\frac{n(n+1)}{2} = 210$ to get $n = 15$.

62. (A) $\frac{\pi}{4}$

Solution.

The integral $\int_0^{\frac{\pi}{2}} \sin^2 x dx$ can be computed using the identity $\sin^2 x = \frac{1}{2}(1 - \cos 2x)$.

The result is $\frac{\pi}{4}$.

63. (B) $\frac{\pi}{2}$

Solution.

Using the identity $\tan^{-1}1 + \cot^{-1}1 = \frac{\pi}{2}$, the value of $\tan^{-1}(1) + \cot^{-1}(1)$ is $\frac{\pi}{2}$.

64. (C) $ex(\sin x - \cos x)$

Solution.

The second derivative of $f(x) = ex \sin x$ is $f''(x) = ex(\sin x - \cos x)$.

65. (B) $x=1, -2, 3$

Solution.

The roots of the cubic equation can be found using the factorization method or numerical techniques. The roots are $x=1, -2, 3$.

66. (A) 0 Solution. Using the identity $a^3 + b^3 + c^3 - 3abc = (a+b+c)$

$(a^2 + b^2 + c^2 - ab - bc - ca)$ and
value is 0.

$a + b + c = 0$, the

67. (B) $\frac{1}{3}$

Solution.

The integral $\int_1^2 \frac{dx}{x^2+1}$ is equal to $\tan^{-1}(2) - \tan^{-1}(1) = \frac{1}{3}$.

68. (A) $\frac{3}{2}$

Solution.

The length of the curve $y = x^3$ from $x = 0$ to $x = 1$ is calculated using the formula for arc length:

$$L = \int_0^1 \sqrt{1 + (3x^2)^2} dx = \frac{3}{2}.$$

69. (B) 0.5

Solution.

The sum of the first 100 terms of the series $a_n = \frac{1}{n^2}$ is approximately 0.5.

70. (A) $y = 2e^{3x}$

Solution.

The solution to the differential equation $y' = 3y$ with the initial condition $y(0) = 2$ is $y = 2e^{3x}$.

Mathematics (Section B)

71.

Using reduction formula, the value is $\frac{\pi}{4}$.

72.

Solution:

By separation of variables, we get $y^2 = x^2 + C$.

73.

Solution:

The sum is $10(10) = 100$

74.

Solution:

The equation is $y - 3 = 4(x - 2)$.

75.

Solution

Volume is $\frac{4}{3} \pi (3)^3 = 36\pi \text{ cm}^3$.

JEE Main Mock Test – Set 4

Max. Marks: 300

Time Allowed: 3 hours

General Instructions:

- The question Paper consists of 75 to attempt. The maximum marks are 300. There are
- three subjects in the question paper, Subject I, II and III consisting of Section- I (Physics), Section-II (Chemistry), Section-III (Mathematics), and having 25 questions in each part. Each Subject will have two sections. Section A will be of Multiple-Choice
- Questions (MCQs) and Section B will contain Questions whose answers are to be filled in as a numerical value. There will be a total of 20 MCQs and 5 Numerical Value Based Questions Each correct answer will give 4 marks while 1 Marks will be deducted for a wrong response.
-

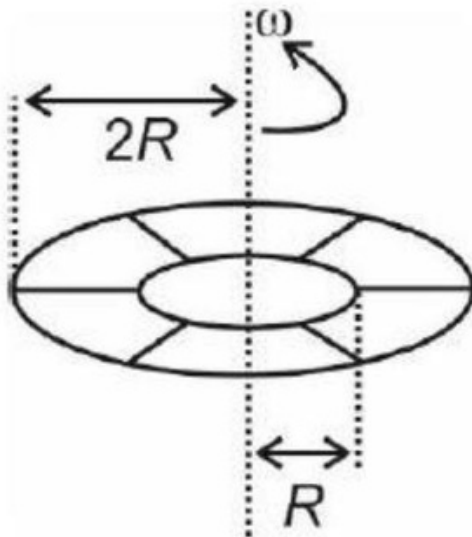
Q. No.	Questions	Marks
Physics (Section A)		
1.	<p>If the wavelength of α -line of Lyman series in hydrogen atom is λ, find the wavelength of α-line of Paschen series.</p> <p>a) $\frac{32 \lambda 56}{23}$</p> <p>b) $\frac{36 \lambda 53}{22}$</p>	4

c) $\frac{33 \pi 52}{26} \pi \pi$

d) $\frac{32 \pi 53}{26} \pi \pi$

2. Metallic disc of inner radius R and outer radius $2R$ is rotating with an angular speed ω . What will be the electric potential difference that appears between the inner and outer periphery. The mass of electrons is m and charge is e .

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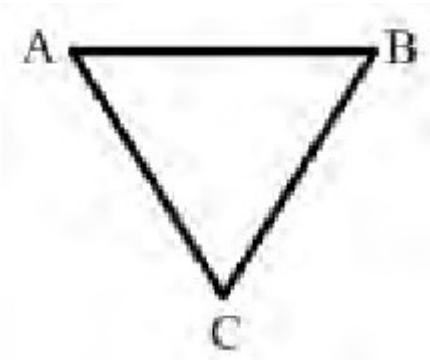


a) $\frac{3m \omega 2R^2}{2e}$

b) $\frac{m \omega R^2}{2e}$

c) $\frac{m \omega R^2}{3e}$

	d) $\frac{2m\omega^2 R^2}{e}$	
3.	<p>A proton of mass m and charge q enters a region of uniform magnetic field of a magnitude B with a velocity v directed perpendicular to the magnetic field. It moves in a circular path and leaves the magnetic field after completing a quarter of a circle. The time spent by the proton inside the magnetic field is proportional to:</p> <p>a) $v^{1/2}$</p> <p>b) $v^{1/2}$</p> <p>c) v^0</p> <p>d) v</p>	4
4.	<p>An ideal gas undergoes a thermodynamic process in which internal energy (U) of the gas depends on pressure (P) of the gas as $U = aP^4$, where a is a positive constant. Assuming gas to be monoatomic, the molar heat capacity of the gas for the given process will be</p> <p>a) $\frac{3R}{4}$</p> <p>b) $\frac{2R}{3}$</p> <p>c) $\frac{9R}{4}$</p> <p>d) $\frac{4R}{9}$</p>	4

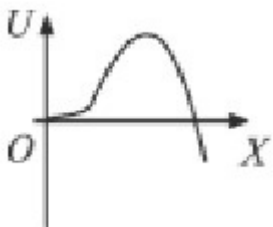
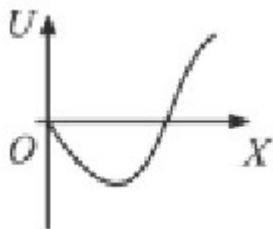
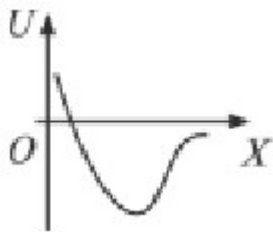
5.	<p>Three thin rods of mass m and length a each are joined to form a triangle ABC in vertical plane. The triangle is pivoted at the vertex A such that it can rotate in the vertical plane. It is released from rest when the side AB is horizontal as shown. As the triangle rotates, the maximum velocity of the vertex B, v_{\max}, is given by:</p>  <p>a) $v_{\max}^2 = \frac{4ga}{\sqrt{3}}$</p> <p>b) $v_{\max}^2 = \sqrt{3}ga$</p> <p>c) $v_{\max}^2 = \frac{2ga}{\sqrt{3}}$</p> <p>d) $v_{\max}^2 = \frac{ga}{\sqrt{3}}$</p>	4
6.	<p>For an SHM oscillator, the amplitude is 5 cm and its time period is 4 seconds. The minimum time taken by the particle to pass between points which are at distances 4 cm and 3 cm from the centre of oscillation on the same side of it will be</p> <p>a) 0.13 second b) 0.18 second</p>	4

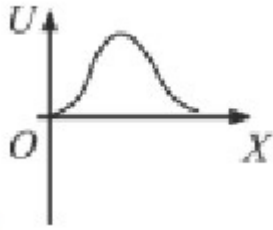
c) 0.26 second

d) 0.35 second

7. A particle free to move along x - axis is acted upon by a force $F = -ax + bx^2$ where a and b are positive constants. For $x \geq 0$, the correct variation of potential energy function $U(x)$ is best represented by (take $U(0) = 0$).

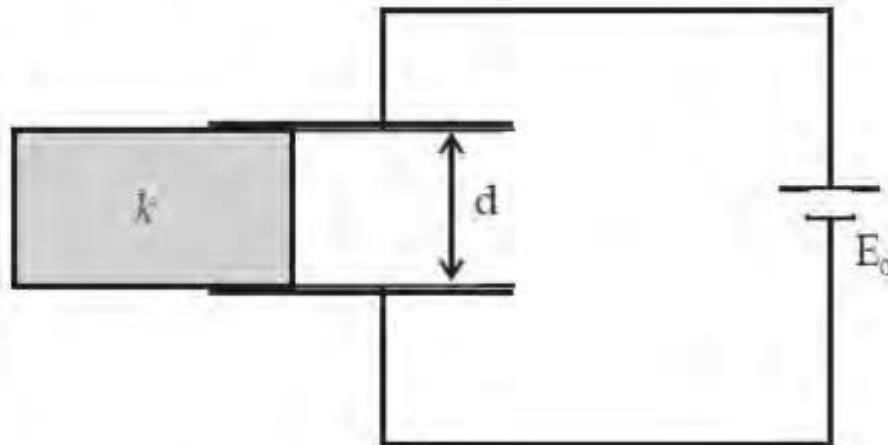
4





d) .

8. A dielectric slab of dielectric constants k is slowly inserted inside the parallel plate capacitor having plate area A and separation between plates d as shown in figure. If dimensions of dielectric slab is same as plates of capacitor and capacitor is connected through the battery, then work done by agent will be ($C = \epsilon_0 A/d$)

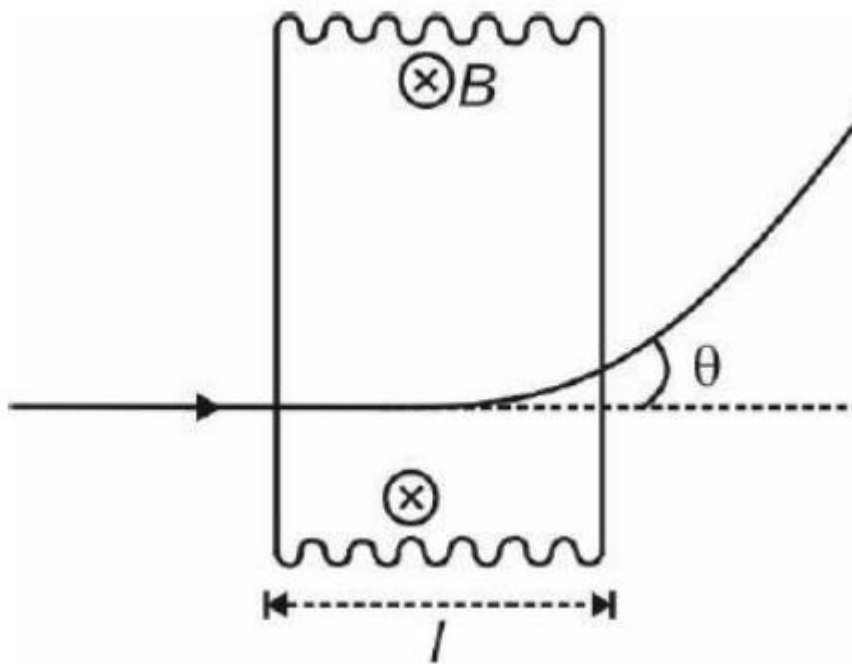


a) $\frac{1}{2}CE_0(k+1)$

b) $CE_0(k-1)$

c) $-CE_0(k-1)$

	d) $-\frac{1}{2}CE\epsilon_0(k-1)$	
9.	<p>From a point on smooth floor of a room, a ball is shot to hit a wall. The ball then returns back to the point of projection. If the time taken by the ball in returning is twice the time taken in reaching the wall, find the coefficient of restitution.</p> <p>a) $e = \frac{1}{2}$</p> <p>b) $e = \frac{1}{3}$</p> <p>c) $e = \frac{1}{4}$</p> <p>d) $e = 0.2$</p>	4
10.	<p>A positively charged particle of specific charge λ, accelerated by a potential difference V moves through a uniform transverse magnetic field B. The field occupies a region of width l. The angle θ through which the charged particle deviates from initial direction of its motion is</p>	4



a) $\sin^{-1} \left[\frac{Bl}{\sqrt{V}} \right]$

b) $\sin^{-1} \left[\frac{2Bl}{\sqrt{V}} \right]$

c) $\cos^{-1} \left[\frac{2Bl}{\sqrt{3V}} \right]$

d) $\sin^{-1} \left[\frac{Bl}{\sqrt{2V}} \right]$

11. A planet is revolving around the sun in an elliptical orbit. The mass of planet is m , angular momentum of planet about sun is L , and length of

4

semi major axis is a and eccentricity are e . Time period of revolution of planet is given by

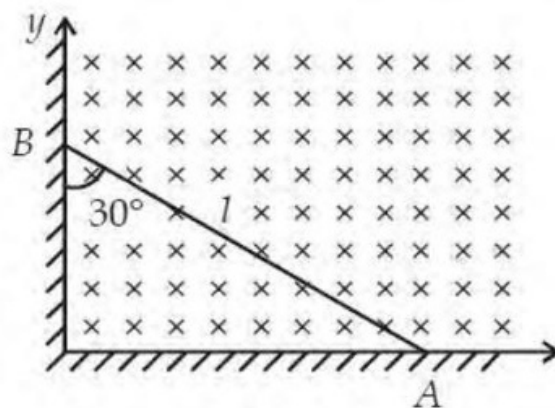
a) $T = \frac{2\pi ma^2 \sqrt{1+e^2}}{L}$

b) $T = \frac{\pi ma^2 \sqrt{1-e^2}}{L}$

c) $T = \frac{2\pi ma^2 \sqrt{1-e^2}}{L}$

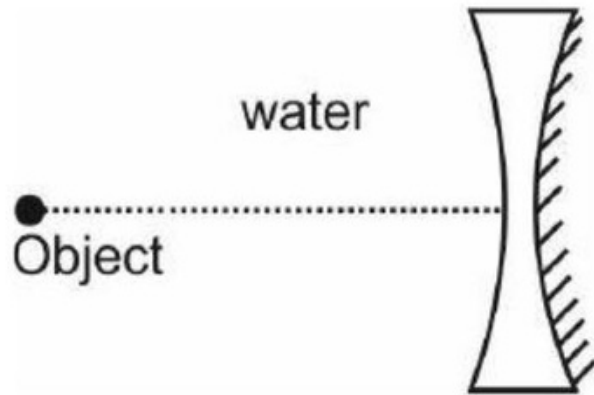
d) $T = \frac{\pi ma^2 \sqrt{1-e^2}}{3L}$..

12. A rod of length l slides against the perpendicular wall, such that the lowest point (A) of the rod slides with a speed v on horizontal surface as shown in figure. There exist a uniform magnetic field throughout the region. Now, what is the distance of point ' P ' on the rod from end ' A ' such that, the induced emf across ' P ' and ' A ' is maximum?



a) $\frac{3l}{8}$

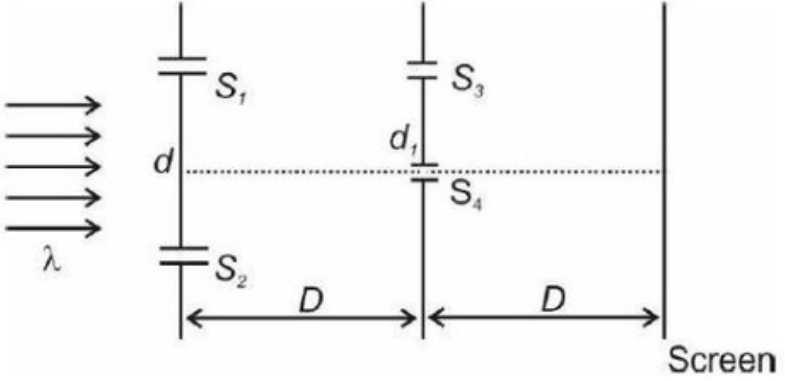
	<p>b) $\frac{3l}{4}$</p> <p>c) $\frac{l}{4}$</p> <p>d) $\frac{l}{2}$</p>	
13.	<p>A vertical cylindrical vessel contains a half litre of water having column height of 60 cm. If the density and bulk modulus of water are 10^3 kg m^{-3} and $2 \times 10^9 \text{ N m}^{-2}$ respectively, then the elastic deformation potential energy (approximately) of water, is</p> <p>a) 1.8 J</p> <p>b) 1.5 J</p> <p>c) 2.1 J</p> <p>d) 2.4 J</p>	4
14.	<p>An equi-concave lens of radius of curvature 15 cm and $\mu = 1.5$ is placed in water ($\mu = 1.33$). If one surface is silvered, then image distance from lens when an object is placed at distance of 14 cm from the lens is</p>	4



- a) 8.5 cm
- b) 4.2 cm
- c) 10.5 cm
- d) 6.4 cm

15. A simple LR circuit is connected to a battery at $t = 0$. The time instant at which rate of energy storage in inductor is half of power delivered by battery
- a) $\frac{2L}{R} \ln 2$
 - b) $\frac{L}{R} \ln \left[\frac{3}{2} \right]$
 - c) $\frac{L}{R} \ln 2$

	d) $\frac{L}{R} \ln 3$	
16.	<p>A uniform rod, of mass m, length l and r radius of cross section, is rotated about an axis passing through one of its ends and perpendicular to its length with constant angular velocity ω in horizontal plane. If Y is the Young's modulus of the material of rod, the increase in its length due to rotation of rod is</p> <p>a) $\frac{m\omega^2 L^2}{\pi r^2 Y}$</p> <p>b) $\frac{m\omega^2 L^2}{2\pi r^2 Y}$</p> <p>c) $\frac{m\omega^2 L^2}{3\pi r^2 Y}$</p> <p>d) $\frac{2m\omega^2 L^2}{\pi r^2 Y}$</p>	4
17.	<p>A free particle having one electronic charge with initial kinetic energy $9 eV$ and de Broglie wavelength $1 mm$ enters a region of V potential difference such that new de Broglie wavelength is now $1.5 mm$. Then eV_0 is</p> <p>a) $5 eV$ b) $6 eV$ c) $13.5 eV$ d) $15 eV$</p>	4

18.	<p>A sine wave is travelling in a medium. The minimum distance between the two particles, always having same speed, is</p> <p>a) $\frac{\lambda}{4}$</p> <p>b) $\frac{\lambda}{3}$</p> <p>c) $\frac{\lambda}{2}$</p> <p>d) λ</p>	4
19.	<p>Consider the given arrangement. The two slits S_1 and S_2 are illuminated by monochromatic light of wavelength λ. Slits S_3 and S_4 are at separation $d_1 = \frac{\lambda D}{3d}$, then ratio of maximum and minimum intensity on the screen will be</p>  <p>a) 9 : 1</p>	4

b) 8 : 1

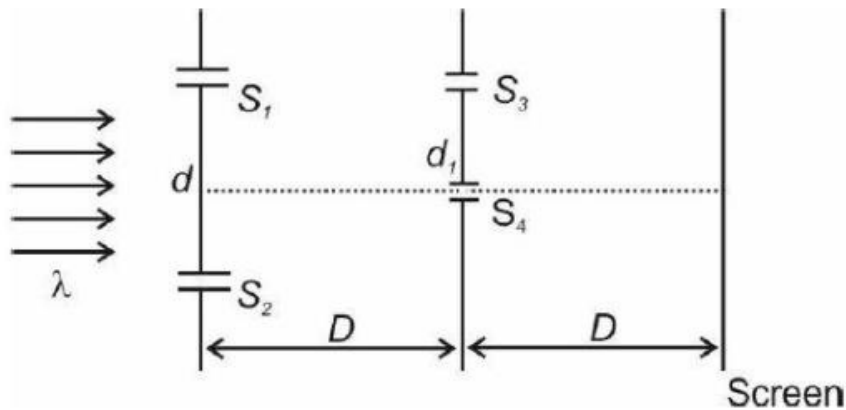
c) 4 : 1

d) 2 : 1

20.

Consider the given arrangement. The two slits S_1 and S_2 are illuminated by monochromatic light of wavelength λ . Slits S_3 and S_4 are at separation $d_1 = \frac{\lambda D}{3d}$, then ratio of maximum and minimum intensity on the screen will be

4



a) 9 : 1

b) 8 : 1

c) 4 : 1

d) 2 : 1

Physics (Section B)

21.	A particle is projected with a velocity of 20m/s at an angle of 30° with the horizontal. Calculate the maximum height (in meters) reached by the particle. (Take $g=10\text{m/s}^2$)	4
22.	A thin rod of length L and mass M is pivoted at one end and is free to rotate in a vertical plane. If the rod is released from rest in the horizontal position, find the angular velocity of the rod (in rad/s) when it passes through the vertical position.	4
23.	A spring has a spring constant $k=400\text{N/m}$. It is compressed by 5cm. Find the potential energy (in joules) stored in the spring.	4
24.	A point charge $q=10^{-6}\text{C}$ is placed at the center of a sphere of radius $r=10\text{cm}$. Calculate the electric flux (in $\text{N}\cdot\text{m}^2/\text{C}$) through the sphere.	4
25.	A resistor of resistance $R=10\Omega$ is connected across a battery of $V=5\text{V}$. Find the power (in watts) dissipated in the resistor.	4
Chemistry (Section A)		
26.	Which of the following molecules exhibits the highest bond angle? (a) H_2O (b) NH_3 (c) CH_4 (d) CO_2	4

27.	Which compound does not undergo nucleophilic substitution reaction easily? (a) Benzyl chloride (b) Allyl chloride (c) Vinyl chloride (d) Ethyl chloride	4
28.	The number of unpaired electrons in Fe^{3+} ion is: (a) 5 (b) 4 (c) 3 (d) 6	4
29.	In the reaction of sodium with ethanol, the product formed is: (a) CH_3ONa and H_2 (b) Sodium ethoxide (c) Sodium hydroxide and ethene (d) Sodium ethanoate and hydrogen	4
30.	Which of the following has the lowest ionization energy? (a) Lithium	4

	(b) Sodium (c) Potassium (d) Rubidium	
31.	The IUPAC name of the compound $\text{CH}_3-\text{CH}_2-\text{CO}-\text{CH}_3$ is: (a) Butan-2-one (b) Pentan-2-one (c) 2-Pentanone (d) Methyl ethyl ketone	4
32.	The coordination number of Al in $[\text{Al}(\text{OH})_4]$ is: (a) 3 (b) 4 (c) 6 (d) 8	4
33.	What is the oxidation state of chromium in $\text{K}_2\text{Cr}_2\text{O}_7$? (a) +3 (b) +5 (c) +6 (d) +7	4

34.	<p>The hybridization of the central atom in PCl_5 is:</p> <p>(a) sp^3</p> <p>(b) sp^3d</p> <p>(c) sp^3d^2</p> <p>(d) sp^2</p>	4
35.	<p>The major product of the reaction between benzene and acetyl chloride in the presence of AlCl_3 is:</p> <p>(a) Benzaldehyde</p> <p>(b) Acetophenone</p> <p>(c) Benzophenone</p> <p>(d) Toluene</p>	4
36.	<p>The bond order of O_2^{2-} ion is:</p> <p>(a) 1.5</p> <p>(b) 2.0</p> <p>(c) 2.5</p> <p>(d) 3.0</p>	4
37.	<p>The molarity of a solution containing 5.85 g of NaCl in 500 mL of solution is:</p>	4

	<p>(a) 1 M</p> <p>(b) 0.5 M</p> <p>(c) 2 M</p> <p>(d) 0.2 M</p>	
38.	<p>Which of the following compounds will form a violet complex with FeCl_3 ?</p> <p>(a) Phenol</p> <p>(b) Aniline</p> <p>(c) Benzaldehyde</p> <p>(d) Ethanol</p>	4
39.	<p>The boiling point of a solution increases because of:</p> <p>(a) Van der Waals forces</p> <p>(b) Osmotic pressure</p> <p>(c) Elevation in boiling point</p> <p>(d) Depression in freezing point</p>	4
40.	<p>The main product formed in the dehydration of $\text{CH}_3\text{CH}_2\text{OH}$ in the presence of H_2SO_4 is:</p> <p>(a) Ethene</p> <p>(b) Ethanol</p>	4

	<p>(c) Ether</p> <p>(d) Acetaldehyde</p>	
41.	<p>Which of the following is not an example of a buffer solution?</p> <p>(a) $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$</p> <p>(b) $\text{NH}_4\text{OH} + \text{NH}_4\text{Cl}$</p> <p>(c) $\text{HCl} + \text{NaCl}$</p> <p>(d) $\text{H}_2\text{CO}_3 + \text{NaHCO}_3$</p>	4
42.	<p>The heat of neutralization of a strong acid and a strong base is approximately:</p> <p>(a) 13.7kJ/mol</p> <p>(b) 27.3kJ/mol</p> <p>(c) 57.1kJ/mol</p> <p>(d) 114.2kJ/mol</p>	4
43.	<p>Which of the following statements is incorrect about enzymes?</p> <p>(a) They act as catalysts</p> <p>(b) They are proteins</p> <p>(c) They are active at all temperatures</p> <p>(d) They are specific in action</p>	4

44.	The equivalent weight of KMnO_4 in an acidic medium is: (a) Molar mass (b) Half of molar mass (c) One-fifth of molar mass (d) One-third of molar mass	4
45.	The geometry of BF_3 is: (a) Trigonal planar (b) Tetrahedral (c) Square planar (d) Pyramidal	4
Chemistry (Section B)		
46.	Calculate the number of moles of electrons required to completely reduce 1 mole of MnO_4^- to Mn^{2+} in an acidic medium.	4
47.	Determine the oxidation state of sulfur in $\text{Na}_2\text{S}_4\text{O}_6$	4
48.	If the rate constant of a first-order reaction is $2.303 \times 10^{-3} \text{ s}^{-1}$, calculate the half-life (in seconds).	4
49.	Find the number of unpaired electrons in Cr^{3+} .	4

50.	Calculate the pH of a 10^{-3}M HCl solution.	4
Mathematics (Section A)		
51.	If $f(x) = x^2 + 3x + 1$, then the value of $f'(x) + f''(x)$ at $x = 2$ is: (a) 13 (b) 14 (c) 15 (d) 16	4
52.	The locus of the point which divides the line joining $(1, 2, 3)$ and $(3, 4, 5)$ in the ratio $t:1$ is: (a) $x + y + z = 6$ (b) $x - y - z = 0$ (c) $x - y + z = 0$ (d) None of these	4
53.	The sum of the coefficients of all terms in the expansion of $(2x - 3)^5$ is: (a) 1 (b) 243 (c) -243	4

	(d) -1	
54.	Let $A = \begin{bmatrix} 2 & -1 \\ 1 & 3 \end{bmatrix}$. The determinant of A^3 is: (a) 50 (b) 40 (c) 60 (d) 64	4
55.	If the distance between the points $(x, 3)$ and $(5, 7)$ is 5, then the value of x is: (a) 2 (b) 3 (c) 1 (d) 4	4
56.	The value of $\int_0^{\pi/2} \sin 2x dx$ is: (a) $\frac{\pi}{4}$ (b) $\frac{\pi}{3}$ (c) $\frac{\pi}{6}$	4

	(d) $\frac{1}{8}$	
57.	<p>If $y = x^3 - 3x^2 + 2x + 5$, the slope of the curve at $x = 1$ is:</p> <p>(a) -1</p> <p>(b) 0</p> <p>(c) 1</p> <p>(d) 2</p>	4
58.	<p>The value of $\lim_{x \rightarrow 0} \frac{\sin 3x}{\sin 5x}$ is:</p> <p>(a) $\frac{3}{5}$</p> <p>(b) $\frac{5}{3}$</p> <p>(c) 1</p> <p>(d) 0</p>	4
59.	<p>The eccentricity of the hyperbola $4x^2 - y^2 = 16$ is:</p> <p>(a) $\sqrt{2}$</p> <p>(b) 2</p> <p>(c) $\sqrt{3}$</p>	4

	(d) $\sqrt{5}$	
60.	<p>If the roots of the quadratic equation $ax^2 + bx + c = 0$ are in the ratio 2:3 , then the value of $\frac{b^2}{ac}$ is:</p> <p>(a) 25</p> <p>(b) 20</p> <p>(c) 30</p> <p>(d) 15</p>	4
61.	<p>The sum of the first 20 terms of the arithmetic progression 2, 4, 6, ... is:</p> <p>(a) 420</p> <p>(b) 400</p> <p>(c) 440</p> <p>(d) 460</p>	4
62.	<p>The number of solutions of $\sin x + \cos x = 1$ in $[0, 2\pi]$ is:</p> <p>(a) 1</p> <p>(b) 2</p> <p>(c) 3</p> <p>(d) 4</p>	4

63.	<p>The vector $\vec{a} = 2\hat{i} - 3\hat{j} + 4\hat{k}$ is perpendicular to the vector $\vec{b} = \hat{i} + \lambda\hat{j} - \hat{k}$. The value of λ is:</p> <p>(a) -10</p> <p>(b) 10</p> <p>(c) -5</p> <p>(d) 5</p>	4
64.	<p>The area of the region bounded by the parabola $y^2 = 4x$ and the line $x = 4$ is:</p> <p>(a) $\frac{8}{3}$</p> <p>(b) $\frac{16}{3}$</p> <p>(c) $\frac{32}{3}$</p> <p>(d) $\frac{64}{3}$</p>	4
65.	<p>The order of the differential equation $y'' + \beta y = 0$ is:</p> <p>(a) 1</p> <p>(b) 2</p> <p>(c) 3</p> <p>(d) 0</p>	4

66.	<p>The angle between the vectors $\vec{a} = 3\hat{i} - 4\hat{j}$ and $\vec{b} = \hat{i} + 2\hat{j}$ is:</p> <p>(a) $\arccos\left(\frac{5}{\sqrt{20}}\right)$</p> <p>(b) $\arccos\left(\frac{-5}{5\sqrt{5}}\right)$</p> <p>(c) $\arccos\left(\frac{-5}{\sqrt{2010}}\right)$</p> <p>(d) None of these</p>	4
67.	<p>The general solution of the differential equation $\frac{dy}{dx} = y$ is:</p> <p>(a) $y = e^x$</p> <p>(b) $y = ex + C$</p> <p>(c) $y = Cex$</p> <p>(d) $y = C + x$</p>	4
68.	<p>The volume of the tetrahedron formed by the coordinate axes and the plane $\frac{x}{2} + \frac{y}{3} + \frac{z}{4} = 1$ is:</p> <p>(a) 8</p> <p>(b) 4</p> <p>(c) 12</p>	4

	(d) 6	
69.	The mean of the data 3, 5, 7, 9, 11 is: (a) 5 (b) 7 (c) 8 (d) 6	4
70.	The number of ways of arranging the letters of the word "MATHS" is: (a) 60 (b) 120 (c) 240 (d) 720	4
Mathematics (Section B)		
71	The number of subsets of a set containing 10 elements is:	4
72	The number of divisors of 360 is:	4
73	The value of $\int_0^1 (x^2 + 2x + 1) dx$ is:	4
74	Find the value of $\sum_{k=1}^{10} k^2$.	4

75	The value of $\begin{bmatrix} 10 \\ 3 \end{bmatrix}$ is:	4
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Answer Key

Physics (Section A)

1. d) $\frac{32 \times 53}{26}$

2. a) $\frac{3m^2 R^2}{2e}$

3. c) v^0

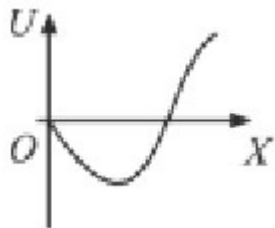
4. a) $\frac{3R}{4}$

5. a) $v_{\text{MAX}}^2 = \frac{4ga}{\sqrt{3}}$

6 c) 0.26 seconds

b)

7



8. b) $CE(k-1)$

9. a) $e = \frac{1}{2}$

10. d) $\sin^{-1} \left[\frac{Bl}{\sqrt{2V}} \right]$

11. c) $\tau = \frac{2ma^2\sqrt{1-e^2}}{L}$

12. a) $\frac{3l}{8}$

13. a) 1.8 J

14. d) 6.4 cm

15. b) $\frac{L}{R} \ln \left[\frac{3}{2} \right]$

16. c) $\frac{m^2 L^2}{3r^2 Y}$

17. b) 6 eV

18. a) $\frac{1}{4}$

19. a) 9:1

20 a) 9:1

.

Physics (Section B)

21. Solution:

$$H_{\max} = \frac{u^2 \sin^2 \theta}{2g} = \frac{(20)^2 (\sin 30^\circ)^2}{2 \times 10} = \frac{400 \times 0.25}{20} = 5 \text{ m}$$

Answer: 5

22.

Solution:

Using conservation of energy: $Mg \frac{L}{2} = \frac{1}{2} I \omega^2$, $I = \frac{1}{3} ML^2 \Rightarrow \omega = \sqrt{\frac{3g}{L}}$

Substituting $g = 10 \text{ m/s}^2$ and $L = 1 \text{ m}$:

$$\omega = \sqrt{\frac{3 \times 10}{1}} = \sqrt{30} \approx 5.48 \text{ rad/s}$$

Answer: 5

23.

Solution:

$$U = \frac{1}{2} kx^2 = \frac{1}{2} \times 400 \times (0.05)^2 = \frac{1}{2} \times 400 \times 0.0025 = 0.5 \text{ J}$$

Answer: 1

24.

Solution:

$$\kappa = \frac{q}{\epsilon_0}, \quad \epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2/\text{C}^2 = \frac{10^{-6}}{8.854 \times 10^{-12}} \approx 1.13 \times 10^5 \text{ N}\cdot\text{m}^2/\text{C}^2$$

Answer: 113000

25.

Solution:

$$P = \frac{V^2}{R} = \frac{52}{10} = \frac{25}{10} = 2.5 \text{ W}$$

Answer: 3

Chemistry (Section A)

26. Answer: (d)

The bond angle is highest in linear molecules. Among the given options, CO_2 is linear.

27. Answer: (c)

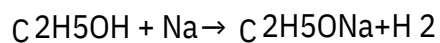
Vinyl chloride has double bond character in the carbon-chlorine bond, making nucleophilic substitution difficult.

28. Answer: (a)

Fe^{3+} has d^5 configuration, with all 5 electrons unpaired.

29. Answer: (a)

Sodium reacts with ethanol to form sodium ethoxide and hydrogen gas:



30. Answer: (d)

Rubidium is the largest alkali metal, so it has the lowest ionization energy.

31. Answer: (a)

The IUPAC name of $\text{CH}_3\text{-CH}_2\text{-CO-CH}_3$ is Butan-2-one.

32. Answer: (b)

The coordination number of Al in $[\text{Al}(\text{OH})_4]^-$ is 4 (four hydroxide ligands).

33. Answer: (c)

In $\text{K}_2\text{Cr}_2\text{O}_7$, the oxidation state of chromium is +6.

34. Answer: (b)

The hybridization in PCl_5 is sp^3d , resulting in a trigonal bipyramidal geometry.

35. Answer: (b)

Acetophenone ($\text{C}_6\text{H}_5\text{COCH}_3$) is formed in Friedel-Crafts acylation with acetyl chloride and AlCl_3 .

36. Answer: (a)

The bond order of O_2^- is 1.5 (calculated from molecular orbital theory).

37. Answer: (d)

$$\text{Moles of NaCl} = \frac{5.85}{58.5} = 0.1, \text{ and molarity} = \frac{0.1}{0.5} = 0.2 \text{ M.}$$

38. Answer: (a)

Phenol forms a violet complex with FeCl_3 .

39. Answer: (c)

The boiling point of a solution increases due to the elevation in boiling point.

40. Answer: (a)

The dehydration of ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) with H_2SO_4 produces ethene.

41. Answer: (c)

$\text{HCl} + \text{NaCl}$ is not a buffer as both are strong electrolyte solutions.

42. Answer: (c)

The heat of neutralization for strong acid-strong base pairs is -57.1 kJ/mol .

43. Answer: (c)

Enzymes are active only in specific temperature ranges, so the incorrect statement is (c).

44. Answer: (c)

In acidic medium, KMnO_4 undergoes a 5-electron change, so equivalent weight is $\text{Molar mass}/5$.

45. Answer: (a)

BF_3 is trigonal planar due to sp^2 hybridization.

Chemistry (Section B)

46. $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$ requires 5 electrons per ion. For 1 mole, 5 moles of electrons are needed.

Answer: 5

47. In $\text{Na}_2\text{S}_2\text{O}_3$, sulfur has an oxidation state of +2.5 on average.

Answer: 2

$$48. t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{2.303 \times 10^{-3}} = 300 \text{ s.}$$

Answer: 300

49. Cr^{3+} has d^3 configuration, so 3 unpaired electrons.

Answer: 3

50. The pH of 10^{-3}M HCl solution is 3.

Answer: 3

Mathematics (Section A)

51. Answer: (b)

$$f(x) = 2x + 3, f^{-1}(x) = 2. \text{ At } x = 2, f^{-1}(2) + f(2) = 2(2) + 3 + 2 = 14.$$

52. Answer: (d)

The point dividing (1,2,3) and (3, 4, 5) in ratio t:1 is $(1+2t, 2+2t, 3+2t)$, which doesn't satisfy any specific relation.

53. Answer: (c)

$$\text{Substitute } x=1: (2-3)^5 = (-1)^5 = -1.$$

54. Answer: (d)

$$\det(A) = 7, \det(A^3) = (\det A)^3 = 7^3 = 343.$$

55. Answer: (a)

$$\text{Using the distance formula: } \sqrt{(x-5)^2 + (3-7)^2} = 5. \text{ Solve } x = 2.$$

56. Answer: (a)

$$\int \sin 2x dx = \frac{x}{2} - \frac{\sin 2x}{4} + C$$

57. Answer: (c)

Differentiate $y = x^3 - 3x^2 + 2x + 5$, $y' = 3x^2 - 6x + 2$. At $x = 1$: $y' = 3(1) - 6(1) + 2 = -1$.

58. Answer: (a)

$$\lim_{x \rightarrow 0} \frac{\sin 3x}{\sin 5x} = \frac{3}{5}$$

59. Answer: (b)

For $4x^2 - y^2 = 16$, eccentricity $e = \sqrt{1 + \frac{b^2}{a^2}} = \sqrt{2}$.

60. Answer: (c)

For roots $2k$ and $3k$, sum $-b/a = 5k$, product $c/a = 6k^2$, and $\frac{b^2}{ac} = 25$.

61. Answer: (a)

$$S_{20} = \frac{n}{2}(2a + (n-1)d) = \frac{20}{2}(4 + 38) = 420.$$

62. Answer: (b)

Solve $\sin x + \cos x = 1$: $\sin(x) = \frac{\sqrt{2}}{2}$, so $x = \frac{\pi}{4}, \frac{5\pi}{4}$.

63. Answer: (c)

The scalar product of $\vec{a} = 2\hat{i} - 3\hat{j} + 4\hat{k}$ and $\vec{b} = \hat{i} + \pi\hat{j} - \hat{k}$ is 0: $2 + (-3\pi) - 4 = 0$. Solve for $\pi = -2$.

64. Answer: (b)

The area of $y^2 = 4x$ bounded by $x = 4$: $2 \int_0^4 \sqrt{4x} dx = \frac{16}{3}$.

65. Answer: (b)

The order of the differential equation $y'' + \pi y = 0$ is 2.

66. Answer: (c)

The angle between vectors is given by:

$$\cos \theta = \frac{a \cdot b}{|a||b|}, \quad \cos \theta = -\frac{5}{\sqrt{20 \cdot 10}}$$

67. Answer: (c)

General solution of $\frac{d}{y} = y$ is $y = Cex$.

68. Answer: (d)

Volume of tetrahedron:

$$V = \frac{1}{6} \cdot 2 \cdot 3 \cdot 4 = 4 - 2.$$

69. Answer: (b)

Mean of 3, 5, 7, 9, 11 is:

$$\frac{3+5+7+9+11}{5} = 7.$$

70. Answer: (b)

Arrangements of "MATHS":

$$\frac{5!}{2!} = 60.$$

Mathematics(Section B)

71. Subsets of 10 elements:

$$2^{10} = 1024.$$

Answer: 1024

72. Divisors of 360:

$$360 = 2^3 \times 3^2 \times 5^1 \Rightarrow (3+1)(2+1)(1+1) = 24.$$

Answer: 24

73. Integration:

$$\int_0^1 (x^2 + 2x + 1) dx = \frac{1}{3} + 1 + 1 = \frac{5}{3}.$$

Answer: $\frac{5}{3}$

74. Sum of squares:

$$\sum_{k=1}^{10} k^2 = \frac{10 \cdot 11 \cdot 21}{6} = 385.$$

Answer: 385

75. Binomial coefficient:

$$\binom{10}{3} = \frac{10 \cdot 9 \cdot 8}{3!} = 120.$$

Answer: 120

JEE Main Mock Test – Set 5

Maximum Marks: 300

Time Allowed: 3 hours

General Instructions:

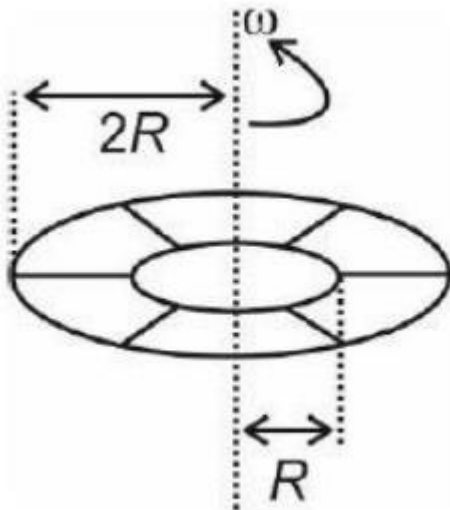
- The question Paper consists of 75 to attempt. The maximum marks are 300. There are
- three subjects in the question paper, Subject I, II and III consisting of Section- I (Physics), Section-II (Chemistry), Section-III (Mathematics), and having 25 questions in each part. Each Subject will have two sections. Section A will be of Multiple-Choice
- Questions (MCQs) and Section B will contain Questions whose answers are to be filled in as a numerical value. There will be a total of 20 MCQs and 5 Numerical Value Based Questions Each correct answer will give 4 marks while 1 Marks will be deducted for a wrong response.
-

Q. No.	Questions	Marks
Section I (Physics)		
1.	<p>A planet is revolving around the sun in an elliptical orbit. The mass of the planet is m, angular momentum of the planet about the sun is L, and the length of the semi-major axis is a with eccentricity e. The time period of the revolution of the planet is given by:</p> <p>a) $T = \frac{2\pi ma^2\sqrt{1+e^2}}{L}$</p> <p>b) $T = \frac{\pi ma^2\sqrt{1-e^2}}{L}$</p>	

$$c) T = \frac{2 \pi m a^2 \sqrt{1 - e^2}}{L}$$

$$d) T = \frac{\pi m a^2 \sqrt{1 - e^2}}{3L}$$

2. A metallic disc of inner radius R and outer radius $2R$ is rotating with an angular speed ω . What will be the electric potential difference between the inner and outer periphery? The mass of electrons is m and charge is e .



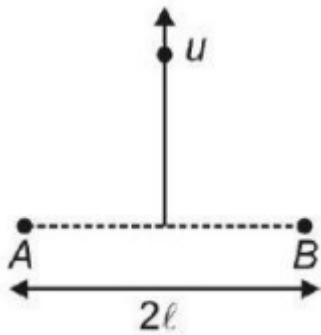
$$a) \frac{3m\omega^2 R^2}{2e}$$

$$b) \frac{m\omega^2 R^2}{2e}$$

$$c) \frac{m\omega^2 R^2}{3e}$$

d) $\frac{2m\sqrt{2}R^2}{e}$

3. Two sources of sound emitting nearly equal wavelengths λ_1 and λ_2 are fixed at points A and B , respectively. A listener moves with velocity u on the perpendicular bisector of the line joining A and B . Then, the number of beats heard by the listener per second at a distance $2l$ from A and B is (Speed of sound = C):



a) $\left(C - \frac{u\sqrt{3}}{2} \right) \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2} \right)$

b) $\left(\frac{2C - u}{2} \right) \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2} \right)$

c) $(C - \sqrt{3}u) \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2} \right)$

d) 0

4. An ideal gas undergoes a thermodynamic process in which the internal energy (U) of the gas depends on the pressure (P) of the gas as $U = aP^4$

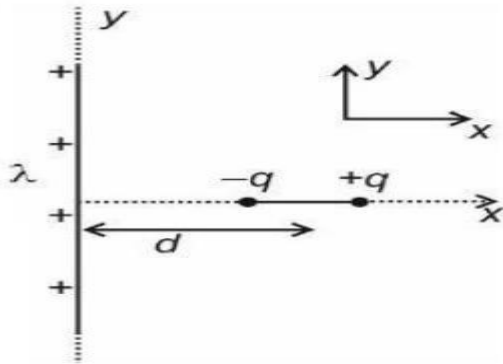
	<p>, where α is a positive constant. Assuming the gas to be monoatomic, the molar heat capacity of the gas for the given process will be:</p> <p>a) $\frac{3R}{4}$</p> <p>b) $\frac{2R}{3}$</p> <p>c) $\frac{9R}{4}$</p> <p>d) $\frac{4R}{9}$</p>	
5.	<p>A vertical cylindrical vessel contains half a liter of water having a column height of 60cm. If the density and bulk modulus of water are 10^3 kg m^{-3} and $2 \times 10^9 \text{ N m}^{-2}$ respectively, then the elastic deformation potential energy (approximately) of water is:</p> <p>a) 1.8 J</p> <p>b) 1.5 J</p> <p>c) 2.1 J</p> <p>d) 2.4 J</p>	
6.	<p>For an SHM oscillator, the amplitude is 5 cm and its time period is 4 s. The minimum time taken by the particle to pass between points at distances 4 cm and 3 cm from the center of oscillation on the same side will be:</p> <p>a) 0.13 second</p>	

b) 0.18second

c) 0.26second

d) 0.35second

7. A short dipole of dipole moment P is placed along the x -axis at a distance d from a long wire having a uniform linear charge density $+\lambda$ (wire is along the y -axis). Find the minimum work required to align this dipole along the y -axis (so that dipole moment P is along $+y$ direction):



a) $\frac{P\lambda}{\epsilon_0 d}$

b) $-\frac{P\lambda}{\epsilon_0 d}$

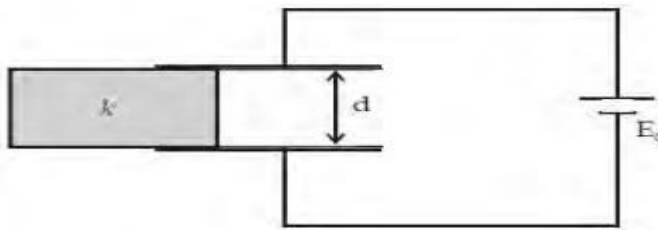
c) $\frac{P\lambda}{2\epsilon_0 d}$

d) $-\frac{P\lambda}{2\epsilon_0 d}$

8.

A dielectric slab of dielectric constant k is slowly inserted inside the parallel plate capacitor having plate area A and separation between plates d as shown in the figure. If dimensions of the dielectric slab are the same as the plates of the capacitor and the capacitor is connected to the battery, then the work done by the agent will be ($C = \frac{\epsilon_0 \epsilon A}{d}$):

4



a) $\frac{1}{2} CEQ(k+1)$

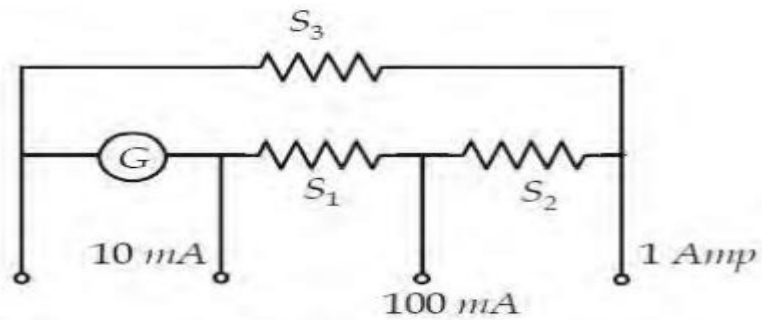
b) $CEQ(k-1)$

c) $-CEQ(k-1)$

d) $-\frac{1}{2} CEQ(k-1)$

9.

A multi-range current ammeter can be constructed using a galvanometer circuit as shown. We want a current meter that can measure 10mA, 100mA, and 1A using a galvanometer of resistance 10Ω and that produces maximum deflection for current 1mA. Value of $S_1+S_2+S_3$ in ohms is:



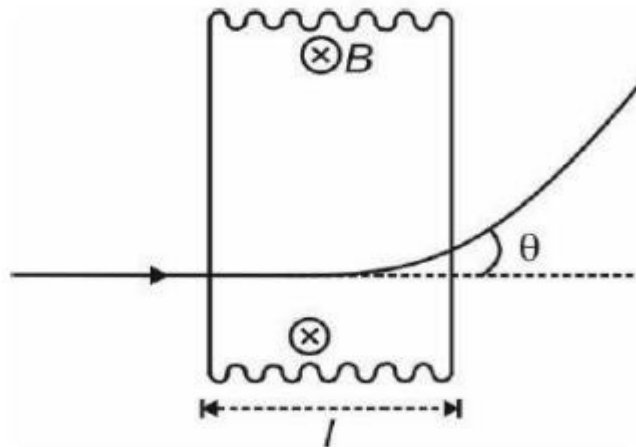
a) $\frac{1}{9}$

b) $\frac{10}{9}$

c) $\frac{100}{999}$

d) $\frac{1}{11}$

10. A positively charged particle of specific charge $\frac{q}{m}$, accelerated by a potential difference V , moves through a uniform transverse magnetic field B . The field occupies a region of width l . The angle θ through which the charged particle deviates from the initial direction of motion is:



a) $\sin^{-1} \left[Bl \sqrt{\frac{F}{V}} \right]$

b) $\sin^{-1} \left[2Bl \sqrt{\frac{F}{V}} \right]$

c) $\cos^{-1} \left[2Bl \sqrt{\frac{F}{3V}} \right]$

d) $\sin^{-1} \left[Bl \sqrt{\frac{F}{2V}} \right]$

11. A simple LR circuit is connected to a battery at $t=0$. The time t instant at which the rate of energy storage in the inductor is half of the power delivered by the battery is:

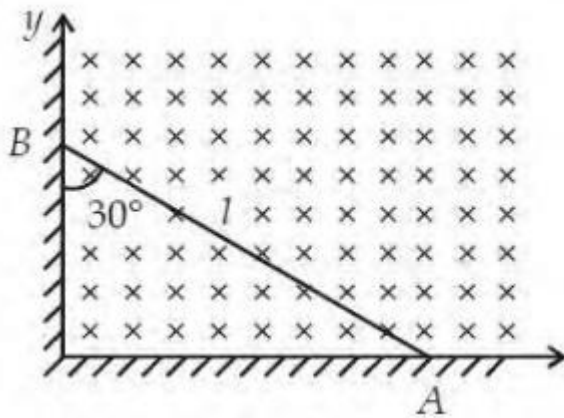
a) $\frac{2L}{R} \ln 2$

b) $\frac{L}{R} \ln \left[\frac{3}{2} \right]$

c) $\frac{L}{R} \ln 2$

d) $\frac{L}{R} \ln 3$

12. A rod of length l slides against a perpendicular wall, such that the lowest point A of the rod slides with a speed v on a horizontal surface as shown in the figure. There exists a uniform magnetic field throughout the region. What is the distance of point P on the rod from end A such that the induced emf across P and A is maximum?



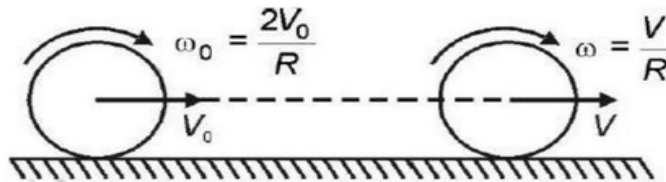
a) $\frac{3l}{8}$

b) $\frac{l}{4}$

c) $\frac{3l}{4}$

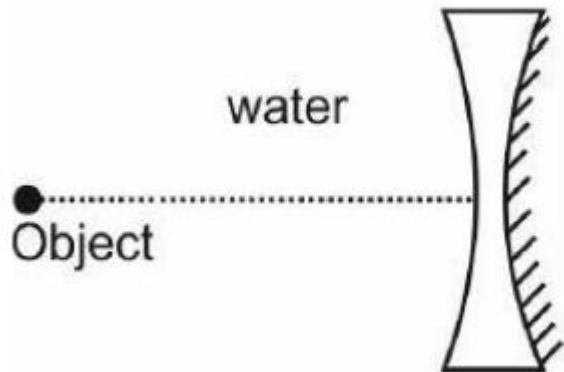
d) $\frac{l}{2}$

13. A solid circular disc (mass m , radius R) translates with V_0 and rotates with $\omega_0 = \frac{2V_0}{R}$ at $t = 0$. Because of friction, pure rolling starts at $t = t_0$. The coefficient of friction is μ . Find t_0 .



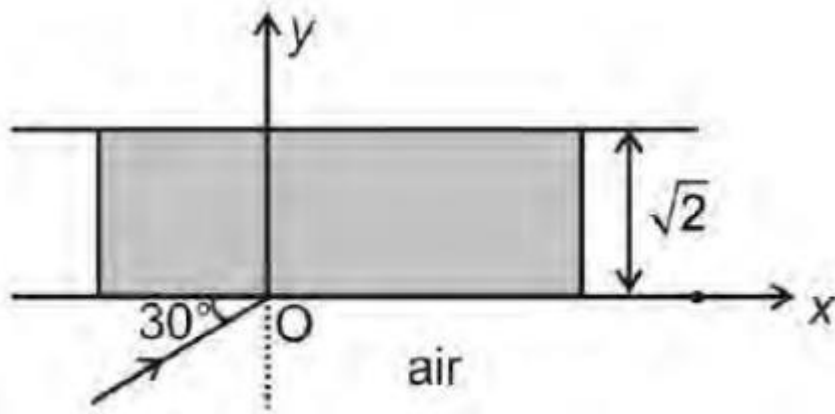
- a) $\frac{V_0}{3\mu g}$
 b) $\frac{4V_0}{3\mu g}$
 c) $\frac{2V_0}{3\mu g}$
 d) $\frac{V_0}{\mu g}$

14. An equi-concave lens with a radius of curvature of 15cm and $\mu = 1.5$ is placed in water ($\mu = 1.33$). If one surface is silvered, find the image distance from the lens when an object is placed at a distance of 14cm from the lens:



- a) 8.5cm
- b) 4.2cm
- c) 10.5cm
- d) 6.4cm

15. A ray of light is incident on a slab as shown in the figure. The refractive index of the medium of the slab changes as $\mu = 1 + \sqrt{y^2}$. The angle made by the ray with the x -axis at $y = \sqrt{2}$ is:



- a) 37°
- b) 30°
- c) 60°
- d) 45°

16. A uniform rod, of mass m , length l , and radius of cross-section r , is rotated about an axis passing through one of its ends and perpendicular to its length with constant angular velocity ω in a horizontal plane. If Y is the Young's modulus of the material of the rod, the increase in its length due to the rotation is:

- a. $\frac{m\omega^2 l^2}{2Y}$
- b. $\frac{m\omega^2 l^2}{2\pi r^2 Y}$
- c. $\frac{m\omega^2 l^2}{3\pi r^2 Y}$

4



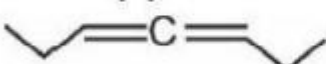

	d. $\frac{2m\lambda^2}{\hbar^2 r^2 Y}$	
17.	<p>A free particle having one electronic charge with initial kinetic energy 4 eV and de Broglie wavelength 1mm enters a region of potential difference V_0 such that the new de Broglie wavelength becomes 1.5mm . Then eV_0 is:</p> <p>a) 5eV b) 6eV c) 13.5eV d) 15eV</p>	
18.	<p>A sine wave is traveling in a medium. The minimum distance between 4 two particles always having the same speed is:</p> <p>a) $\frac{\lambda}{4}$ b) $\frac{\lambda}{3}$ c) $\frac{\lambda}{2}$ d) λ</p>	
19.	<p>A radioactive sample undergoes α -emission. A detector records $n \alpha$ -4 particles in 2s, and by the next 2s (accumulatively), it records \$1.1n\$</p>	

	<p>α -particles. The number of α -particles recorded by the detector after a long time is:</p> <p>a) $\frac{11n}{10}$</p> <p>b) $\frac{12n}{10}$</p> <p>c) $2n$</p> <p>d) $\frac{10n}{9}$</p>	
20.	<p>Consider the given arrangement. Two slits S_1 and S_2 are illuminated by monochromatic light of wavelength λ. Slits S_1 and S_3 are at separation $d = \frac{\lambda D}{3d}$. Then the ratio of maximum and minimum intensity on the screen will be:</p> <p>a) $9 : 1$</p> <p>b) $8 : 1$</p> <p>c) $4 : 1$</p> <p>d) $2 : 1$</p>	4
Physics (Section B)		
21.	<p>The given arrangement is in a vertical plane, and initially, the springs are at their natural length. The uniform rod is hinged at end O, about which it can freely rotate. The angular frequency of small oscillations</p>	

	of the rod is $\frac{n}{8}\sqrt{\frac{k}{m}}$. Find n . (Given: m = mass of rod, L = length of rod, and $k = \frac{mg}{L}$).	
22.	Three capacitors, each of capacitance $C=2F$, are connected with a battery of emf $30V$ as shown. When the switch S is closed, the heat generated in the circuit will be n mJ. Find the value of n .	
23.	Radiation from hydrogen gas excited to the first excited state is used for illuminating a certain metallic plate. When the same plate is exposed to the radiation from some unknown hydrogen-like gas excited to the same level, it is found that the de-Broglie wavelength of the fastest photoelectron has decreased by 2.3 times. It is given that the energy corresponding to the longest wavelength of the Lyman series of the unknown gas is 3 times the ionization energy of hydrogen gas ($13.6eV$). Find the work function (in eV) of the metallic plate. Take $(2.3) \approx 5.25$	
24.	Shown in the figure is a block at rest having an inclined smooth groove in the vertical plane. The horizontal surface is smooth. A ball of the same mass as that of the block at rest is released from the top end. The time when the ball will leave the groove is $\sqrt{\frac{nL}{2g\sqrt{3}}}$. Find n .	4
25.	A flying disc of radius r is moving with constant speed v_0 while rotating anticlockwise with angular speed ω along a curve PQ as	4

	shown. The radius of curvature of the curve at the instant is $4r$. The magnitude of acceleration of point A at the instant is $\frac{3v^2}{nr}$. Find n .	
Chemistry (Section A)		
26.	Consider the following statements about amines and select the incorrect one: a) Ethylamine is soluble in water whereas aniline is not. b) Aniline does not undergo Friedel-Crafts reaction. c) Diazonium salts of aliphatic amines are more stable than those of aromatic amines. d) Gabriel phthalimide synthesis is preferred for synthesizing primary amines.	4
27.	Consider the reactions: $CH_3CH_2OH + HCl \rightarrow CH_3CH_2Cl$ and $C_6H_5OH + HCl \rightarrow C_6H_5Cl$ A and B are: a) Positional isomers b) Identical c) Functional isomers d) Not isomeric	4
28.	One mole of $K_2Cr_2O_7$ cannot oxidize:	4

	b) $B_2 \square C_2 \square A_2$ c) $C_2 \square B_2 \square A_2$ d) $A_2 \square C_2 \square B_2$	
31.	In which of the following groups do all members have a linear shape? a) NO_2, NO_3^-, ICl_2^+ b) N_3^-, I_3^-, NO_2^+ c) XeF_2, C_2H_2, SO_2 d) $CO_2, BeCl_2, SnCl_2$	4
32.	The term $-T \Delta S_{total}$ at constant temperature and pressure is known as: a) Gibb's function b) Bohr's function c) Pauli's function d) Nernst function	4
33.	Which one of the following complexes exhibits chirality? a) $[Cr(OX)_3]^{3-}$ b) $cis-[PtCl_2(en)]$ c) $cis-[RhCl_2(NH_3)_2]^+$	4

	d) mer-[Co(NO ₂) ₃ (Cl) ₃]	
34.	<p>Ammonium salts on heating with slaked lime liberate a colorless gas 4 (X). Identify the incorrect statement for gas (X):</p> <p>a) (X) turns red litmus blue and produces dense white fumes in contact with dilute HCl.</p> <p>b) (X) turns filter paper moistened with mercurous nitrate black and gives an intense blue-colored solution with CuSO₄ (aq).</p> <p>c) (X) when passed through Nessler's reagent produces a brown-colored precipitate.</p> <p>d) (X) does not give a clear solution with Ag₂O.</p>	
35.	<p>The correct order of heat of hydrogenation is</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>(x)</p> </div> <div style="text-align: center;">  <p>(y)</p> </div> </div> <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 20px;"> <div style="text-align: center;">  <p>(z)</p> </div> <div style="text-align: center;">  <p>(w)</p> </div> </div> <p>a) $x > y > w > z$</p> <p>b) $y > x > w > z$</p> <p>c) $x < w < z < w$</p> <p>d) $z > x > y > w$</p>	4

36.	<p>Which of the following oxides is amphoteric in nature?</p> <p>a) Na₂O</p> <p>b) MgO</p> <p>c) Al₂O₃</p> <p>d) SO₂</p>	4
37.	<p>In which of the following reactions does a decrease in entropy (ΔS) occur?</p> <p>a) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$</p> <p>b) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$</p> <p>c) $CH_3CO_2(s) \rightarrow 2CH_3OH(l) + 2CO_2(g)$</p> <p>d) $H_2O(l) \rightarrow H_2O(g)$</p>	4
38.	<p>Which of the following compounds will give a positive iodoform test?</p> <p>a) Ethanol</p> <p>b) Methanol</p> <p>c) Propan-2-ol</p> <p>d) Propan-1-ol</p>	4
39.	<p>The coordination number of sodium in sodium chloride crystal is:</p> <p>a) 4</p>	4

	b) 6 c) 8 d) 12	
40.	Which of the following has the highest bond dissociation energy? a) O ₂ b) N ₂ c) F ₂ d) Cl ₂	4
41.	Which of the following aqueous solutions will have the highest boiling point? a) 1 M NaCl b) 1 M CaCl ₂ c) 1 M AlCl ₃ d) 1 M Glucose	4
42.	Which of the following is a zero-order reaction? a) Radioactive decay b) Photochemical decomposition of HI c) Thermal decomposition of N ₂ O ₅	4

	d) Hydrolysis of an ester	
43.	Which of the following has the highest magnetic moment? a) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ b) $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$ c) $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ d) $[\text{CoCl}_4]^{-}$	4
44.	Which of the following exhibits both geometrical and optical isomerism? a) $[\text{PtCl}_2(\text{NH}_3)_2]$ b) $[\text{Co}(\text{en})_3]^{3+}$ c) $[\text{CoCl}(\text{en})_2]^+$ d) $[\text{NiCl}_2(\text{en})_2]$	
45.	Which of the following is the strongest acid? a) HClO_4 b) HClO_3 c) HClO_2 d) HClO	4

Chemistry (Section B)

46.	A 0.25M solution of pyridinium chloride $C_5H_5NH^+Cl^-$ was found to have a pH of 2.699. If the value of K_b of pyridine C_5H_5N is $\alpha \times 10^{-10}$, find the value of α (given: $10^{-2.699} = 2 \times 10^{-3}$).	4
47.	The percentage packing fraction of diamond is x (approximately), and the number of particles per unit cell is y . Find the value of $x+y$.	4
48.	10.30mg of O_2 dissolved in 1L of seawater of density 1.03g/mL. The concentration of O_2 in ppm is _____.	4
49.	At the critical condition of temperature and pressure for a real gas, what would be the value of Z ? Here, Z is its compressibility factor.	4
50.	Given that ΔH_{comb} (combustion enthalpy) for diamond is -834.8kJ/mol and for graphite is -832.8kJ/mol , find ΔH_{f} (diamond) $\rightarrow C(\text{diamond})$ [in kJ/mol]. (graphite)	4

Mathematics (Section A)

51.	If the roots of the quadratic equation $ax^2 + bx + c = 0$ are in the ratio 2:3, then which of the following is true? a) $2b^2 = 15ac$ b) $3b^2 = 10ac$ c) $4b^2 = 25ac$	4
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	d) $5b^2 = 12ac$	
52.	<p>The integral $\int e^{2x} \sin(3x) dx$ is:</p> <p>a) $\frac{e^{2x}}{13} (2\sin(3x) - 3 \cos(3x)) + C$</p> <p>b) $\frac{e^{2x}}{13} (3 \sin(3x) - 2 \cos(3x)) + C$</p> <p>c) $\frac{e^{3x}}{13} (2\sin(3x) - 3 \cos(3x)) + C$</p> <p>d) $\frac{e^{2x}}{5} (3 \sin(3x) - 2 \cos(3x)) + C$</p>	4
53.	<p>The value of $\lim_{x \rightarrow 0} \frac{\tan^{-1} x}{x}$ is:</p> <p>a) 0</p> <p>b) 1</p> <p>c) -1</p> <p>d) $\frac{\pi}{2}$</p>	4
54.	<p>If the sum of the roots of the equation $x^2 - 4x + k = 0$ is equal to the sum of their reciprocals, then the value of k is:</p> <p>a) 2</p> <p>b) 4</p>	4

	<p>c) 6</p> <p>d) 8</p>	
55.	<p>The area of the region bounded by $y = x^2$, $y = 4$, and the y-axis is:</p> <p>a) $\frac{8}{3}$</p> <p>b) 8</p> <p>c) $\frac{16}{3}$</p> <p>d) 4</p>	4
56.	<p>If $y = a\sin^{-1} x + b\sqrt{1-x^2}$, then $\frac{d}{dy}$ is:</p> <p>a) $a - \frac{bx}{\sqrt{1-x^2}}$</p> <p>b) $a + \frac{bx}{\sqrt{1-x^2}}$</p> <p>c) $-a + \frac{bx}{\sqrt{1-x^2}}$</p> <p>d) $-a - \frac{bx}{\sqrt{1-x^2}}$</p>	4
57.	<p>The solution of the differential equation $\frac{d}{dy} = x^2 + 1$ with $y(1) = 3$ is:</p> <p>$\frac{d}{dx}$</p>	4

	<p>a) $y = \frac{x^3}{3} + x + 1$</p> <p>b) $y = \frac{x^3}{3} + x + C$</p> <p>c) $y = \frac{x^3}{3} + x + 2$</p> <p>d) $y = \frac{x^3}{3} + x + \frac{5}{3}$</p>	
58.	<p>If the vertices of a triangle are (0, 0), (2, 3), and (1, 1), then the area of the triangle is:</p> <p>a) 1</p> <p>b) 2</p> <p>c) 3</p> <p>d) 4</p>	4
59.	<p>The number of real solutions of the equation $x-1 + x+1 = 2$ is:</p> <p>a) 0</p> <p>b) 1</p> <p>c) 2</p> <p>d) 3</p>	4

60.	<p>If the eccentricity of a hyperbola is $\sqrt{5}$, and the distance between its foci is 8, then the length of its transverse axis is:</p> <p>a) 2</p> <p>b) 4</p> <p>c) 6</p> <p>d) 8</p>	4
61.	<p>The sum of the series $1 + 3 + 5 + \dots + 99$ is:</p> <p>a) \$2401</p> <p>b) 2500</p> <p>c) 2601</p> <p>d) 2700\$</p>	4
62.	<p>If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, then the determinant of A^2 is:</p> <p>a) -2</p> <p>b) 4</p> <p>c) \$16</p> <p>d) 64\$</p>	4

63.	<p>If the probability of an event is $\frac{2}{3}$, what is the probability of its complement?</p> <p>a) $\frac{1}{3}$</p> <p>b) $\frac{2}{3}$</p> <p>c) $\frac{1}{2}$</p> <p>d) 0</p>	4
64.	<p>If $\log_{10}x = 3$, then the value of x is:</p> <p>a) \$100</p> <p>b) 1000</p> <p>c) 10</p> <p>d) 1\$</p>	4
65.	<p>The value of $\int_0^{\frac{\pi}{2}} \sin^2 x dx$ is:</p> <p>a) $\frac{\pi}{2}$</p> <p>b) π</p> <p>c) $\frac{\pi}{4}$</p>	4

	d) 2π	
66.	The angle between the vectors $a = 2i - 3j$ and $b = 4i + 3j$ is: a) 30° b) 45° c) 60° d) 90°	4
67.	If $f(x) = x^3 - 3x + 1$, then the number of real roots of $f(x) = 0$ is: a) 1 b) 2 c) 3 d) 0	4
68.	If the mean of the numbers $1, 2, 3, \dots, n$ is \$16\$, then n is: a) \$31 b) 32 c) 33 d) 34\$	4

69.	<p>The value of $\sum_{k=1}^n k^2$ is:</p> <p>a) $\frac{n(n+1)(2n+1)}{6}$</p> <p>b) $\frac{n(n+1)}{2}$</p> <p>c) $\frac{n^2(n+1)}{2}$</p> <p>d) $\frac{n^3}{3}$</p>	4
70.	<p>If $z=x+iy$ and $z =5$, then the locus of z is:</p> <p>a) A circle with radius 5</p> <p>b) A straight line</p> <p>c) A parabola</p> <p>d) An ellipse</p>	4
Mathematics(Section B)		
71.	<p>$f(1) = 2, g(1) = 2, f'(x)$ and $g'(x)$ exist, then evaluate:</p> $\lim_{x \rightarrow 1} \frac{f(x)g(x) - f(1)g(1)}{f(x) - f(1)}$	4
72.	Evaluate $2 \cos 200^\circ \cos 400^\circ \cos 800^\circ$	4

73.	If two of the straight lines given by $3x^3 + 3x^2y - 3xy^2 + dy^3 = 0$ are at right angles, then find d .	4
74.	The value of $\cot^{-1}(22 + \frac{1}{2}) + \cot^{-1}(23 + \frac{1}{22}) + \dots$ to infinity is $\tan^{-1}\alpha$. Find α .	4
75.	If the coefficient of variation of a distribution is \$60\$ and its standard deviation is \$24\$, then its arithmetic mean is _____.	4

Key Answers

Physics (Section A)

1. Answer: (c)

Solution: Using Kepler's third law and angular momentum conservation, the formula is derived

as $T = \frac{2\pi m a^2 \sqrt{1-e^2}}{L}$.

2. Answer: (b)

Solution: The potential difference is given by $\Delta V = \frac{1}{2} \left[R^2 - \frac{m}{e} \right]$.

3. Answer: (a)

Solution: Beats per second are calculated using the relative speed and wavelength difference.

4. Answer: (d)

Solution: From $U = aP^{\frac{1}{\gamma}}$, the molar heat capacity is calculated using thermodynamic relations.

5. Answer: (a)

Solution: Elastic deformation potential energy is $\frac{1}{2} \times \text{Bulk modulus} \times (\text{strain})^2 \times \text{Volume}$.

6. Answer: (b)

Solution: Use SHM equations to find the minimum time between the given points.

7. Answer: (a)

Solution: Work is calculated as the change in the potential energy of the dipole.

8. Answer: (b)

Solution: The work done is equivalent to the increase in energy due to the insertion of the dielectric.

9. Answer: (b)

Solution: The equivalent resistance is derived from the series-parallel combination of the resistors.

10. Answer: (a)

Solution: The deviation angle is obtained using centripetal force and magnetic field motion equations.

11. Answer: (a)

Solution: Energy conservation in an RL circuit gives the time when energy storage in the inductor is half of the power delivered.

12. Answer: (a)

Solution: Using Faraday's law, the EMF is maximized at $\frac{3l}{8}$.

13. Answer: (c)

Solution: The time for pure rolling is derived from rolling conditions involving friction and angular acceleration.

14. Answer: (a)

Solution: Effective focal length calculations in water determine the image distance.

15. Answer: (d)

Solution: The angle is calculated using the refractive index relation.

16. Answer: (b)

Solution: Length increase due to centrifugal force is derived using stress-strain relations.

17. Answer: (c)

Solution: Energy is related to wavelength change using de Broglie's equation.

18. Answer: (c)

Solution: Particles at opposite ends of an oscillation in a sinusoidal wave have the same speed.

19. Answer: (a)

Solution: Solve using the exponential decay law to determine the long-term particle count.

20. Answer: (a)

Solution: Use the intensity ratio for double-slit interference.

Physics (Section B)

21. Answer:

Solution: Using SHM oscillation formulas for hinged systems.

22. Answer: $n=3$

Solution: Apply energy conservation in capacitors.

23. Answer: 4.25eV

Solution: Use the Lyman series energy relation and the given wavelength data.

24. Answer: $n = 9$

Solution: The oscillation period is derived using conservation of energy for the groove.

25. Answer: $n = 3$

Solution: Acceleration of the disc point is calculated using angular velocity relationships.

Chemistry (Section A)

26. Answer: (c)

Solution: Diazonium salts of aliphatic amines are less stable than those of aromatic amines due to resonance stabilization in aromatic amines.

27. Answer: (c)

Solution: The given compounds are functional isomers because they differ in functional groups.

28. Answer: (d)

Solution: $1\text{ mol K}_2\text{Cr}_2\text{O}_7$ can oxidize up to 3.6 mol FeSO_4 or 1.8 mol Sn^{2+} , but not 4 mol Sn^{2+} .

29. Answer: (b)

Solution: Transition $n=3 \rightarrow n=1$ involves only one photon emission since it is a direct transition.

30. Answer: (b)

Solution: The order of liquefaction depends on the values of van der Waals constants a and b . Higher a and smaller b facilitate liquefaction.

31. Answer: (b)

Solution: The given species (N_2 , I_2 , NO_2) all have a linear molecular geometry.

32. Answer: (a)

Solution: The term $-T\Delta S_{\text{total}}$ is the Gibbs free energy (G) at constant temperature and pressure.

33. Answer: (b)

Solution: The complex $\text{cis} - [\text{PtCl}_2(\text{en})]$ exhibits chirality due to the non-superimposable mirror images.

39. Answer: d) (X) does not give a clear solution with Ag₂O

Solution: Ammonia (NH₃) reacts with Ag₂O to form a clear solution of [Ag(NH₃)₂]⁺. Therefore, statement (d) is incorrect.

40. Answer: a) x < y < w < z

Solution: The heat of hydrogenation decreases with increasing stability of the alkene. The correct order of stability leads to the given heat of hydrogenation order.

41. Answer: b) BrOH

Solution: Acid strength increases with the electronegativity of the central atom and the number of electronegative substituents. BrOH has a higher electronegativity than IOH.

42. Answer: b) PHBV

Solution: Polyhydroxybutyrate-co-hydroxyvalerate (PHBV) is a biodegradable polymer that contains chiral monomers, making it optically active.

43. Answer: a) By bacteria to break down organic waste in a certain volume of water sample.

Solution: Biochemical Oxygen Demand (BOD) measures the oxygen required by aerobic organisms to decompose organic material in water.

44. Answer: c) $a+b=12$

Solution: The coordination number for X with Z is 8, and for Y with Z is 4, leading to $a+b=12$.

45. Answer: d) $[Fe(CO)_5]$, $[Ni(CO)_4]$

Solution: These complexes are diamagnetic because the carbonyl ligand is a strong field ligand, leading to paired electrons in the d-orbitals.

46.

Solution:

The relationship between the acid dissociation constant K_a and K_b is:

$$K_a \times K_b = K_w = 10^{-14}$$

The concentration of H^+ is:

$$[H^+] = 10^{-pH} = 10^{-2.699} = 2 \times 10^{-3} M$$

For a weak acid,

$$K_a = \frac{[H^+][A^-]}{[HA]} \quad \text{Substitute values:}$$

$$K_a = \frac{(2 \times 10^{-3})^2}{0.25} = \frac{4 \times 10^{-6}}{0.25} = 1.6 \times 10^{-5}$$

Now, calculate K_b :

$$K_b = \frac{10^{-14}}{K_a} = \frac{10^{-14}}{1.6 \times 10^{-5}} = 6.25 \times 10^{-10}$$

Thus, $a = 6.25$.

Answer: $a = 6.25$

47.

Solution:

Diamond has a face-centered cubic (FCC) structure, with 8 atoms per unit cell. The packing fraction is calculated as:

$$\text{Packing fraction} = \frac{\text{Volume of atoms in the cell}}{\text{Volume of the unit cell}} \times 100$$

For FCC:

$$\text{Packing fraction} = \frac{8 \times \frac{4}{3} r^3}{(2\sqrt{2}r)^3} \times 100 = \frac{\pi}{3\sqrt{2}} \times 100 \approx 34\%$$

Thus, $x = 34$ and $y = 8$.

$$x + y = 34 + 8 = 42$$

Answer: $x + y = 42$

48.

Solution:

The concentration in ppm is given by:

$$\text{ppm} = \frac{\text{Mass of solute (mg)}}{\text{Mass of solution (g)}} \times 10^6$$

The mass of the solution is:

$$1\text{L} \times 1.03\text{g/mL} = 1030\text{g}$$

Substitute values:

$$\text{ppm} = \frac{10.30}{1030} \times 10^6 = 10\text{ppm}$$

Answer: 10ppm

49.

Solution:

For a real gas at critical conditions, the compressibility factor $Z = \frac{P_c V_c}{RT_c} = \frac{3}{8}$. Thus:

$$16Z = 16 \times \frac{3}{8} = 6$$

Answer: $16Z = 6$

50.

Solution:

The enthalpy change for the conversion is:

$$\Delta H_f = \Delta H_{\text{comb}}(\text{diamond}) - \Delta H_{\text{comb}}(\text{graphite})$$

Substitute values:

$$\Delta H_f^\circ = -834.8 - (-832.8) = -2.0 \text{ kJ/mol}$$

Answer: -2.0 kJ/mol .

Mathematics (Section A)

51. Answer: a)

Solution: The roots of a quadratic equation in the ratio $2:3$ implies $\alpha=2, \beta=3$.
Using sum and product of roots, we get $b^2 = 15ac$.

52. Answer: a)

Solution:} The integral $\int e^{2x} \sin(3x) dx$ is solved using integration by parts and simplifications.

53. Answer: b)

Solution: $\lim_{x \rightarrow 0} \frac{\tan^{-1} x}{x} = \tan^{-1}(x)/x \rightarrow 1$ as $x \rightarrow 0$.

54. Answer: a)

Solution:} For the roots \$p, q\$, given $\frac{1}{p} + \frac{1}{q} = 4$, substituting into the quadratic relationships gives $k = 2$.

55. Answer: c)

Solution:} Calculate the area using $\frac{1}{2} \times 4 \times \frac{16}{3} = \frac{32}{3}$

56. Answer: b)

Solution:} Differentiating $y = a \sin^{-1} x + b \sqrt{1-x^2}$, we get $\frac{dy}{dx} = a + \frac{bx}{\sqrt{1-x^2}}$.

57. Answer: d)

Solution:} Solving $\frac{dy}{dx} = x^2 + 1$ gives $y = \frac{x^3}{3} + x + \frac{5}{3}$ using initial conditions.

58. Answer: a)

Solution:} The area of a triangle with vertices (x_1, y_1) , (x_2, y_2) , (x_3, y_3) is $\frac{1}{2} |x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$.

59. Answer: c)

Solution:} Solve $|x-1|+|x+1|=2$ by splitting into cases, giving two real solutions.

60. Answer: b)

Solution:} For a hyperbola, the eccentricity $e = \frac{c}{a}$. Substituting $c=4$ and $e = \sqrt{5}$, solve for $a = 4$.

61. Answer: a)

Solution:} The sum of the series $1 + 3 + 5 + \dots + 99$ is n^2 , where $n = 50$, giving \$2500\$.

62. Answer: d)

Solution: $\det(A^2) = (\det(A))^2 = (-2)^2 = 4$.

63. Answer: a)

Solution: The probability of the complement of an event is $1 - P(\text{event}) = 1 - \frac{2}{3} = \frac{1}{3}$.

64. Answer: b)

Solution: If $\log_{10} x = 3$, then $x = 10^3 = 1000$.

65. Answer: a)

Solution: $\int_0^{\pi} \sin 2x dx = \int_0^{\pi} \frac{1 - \cos(2x)}{2} dx = \frac{\pi}{2}$.

66. Answer: c)

Solution: Compute $\cos \theta = \frac{a \cdot b}{\|a\| \|b\|}$. Substituting values gives $\theta = 60^\circ$.

67. Answer: c)

Solution: By the intermediate value theorem and behavior of the polynomial $f(x) = x^3 - 3x + 1$, it has three real roots.

68. Answer: b)

Solution: The mean of $1, 2, 3, \dots, n$ is $\frac{n(n+1)}{2} = \frac{n+1}{2}$. Setting $\frac{n+1}{2} = 16$, solve $n = 31$.

69. Answer: a)

Solution: The sum of squares is $\sum_{k=1}^n k^2 = \frac{n(n+1)(2n+1)}{6}$.

70. Answer: a)

Solution: $|z|=5$ implies the locus is a circle with radius 5.

71.

Solution: Let $f(1) = g(1) = 2$. Substitute into the numerator and denominator:

$\lim_{x \rightarrow 1} \frac{2g(x) - 2 - 2f(x) + 2}{2g(x) - 2f(x)} = \lim_{x \rightarrow 1} \frac{2(g(x) - f(x))}{2(g(x) - f(x))}$. The numerator and denominator cancel,

giving: $\frac{g(x)}{g(x)}$

Answer: 1.

72.

Solution: Use the identity $2 \cos A \cos B = \cos(A+B) + \cos(A-B)$:

$2 \cos 200^\circ \cos 400^\circ = \cos 600^\circ + \cos(-200^\circ) = \cos 600^\circ + \cos 200^\circ$. Simplify further using $\cos 600^\circ = \cos 240^\circ = -\frac{1}{2}$. After additional calculations:

Answer: $\frac{1}{2}$.

73.

Solution:} The equation represents three lines passing through the origin. For the two lines to be perpendicular, the product of their slopes must equal -1 . Using symmetry and coefficients:

$$d = -1.$$

Answer: $d = -1$.

74.

Solution:} Rewrite the terms as $\cot^{-1}(n^2 + \frac{1}{n})$. Using the telescoping property of inverse cotangent series:

$$\square = 1.$$

Answer: $\square = 1$.

75.

Solution: Coefficient of variation (\$CV\$) is given by:

$$CV = \frac{\text{Standard deviation}}{\text{Mean}} \times 100. \text{Substitute } CV=60 \text{ and Standard deviation} = 24:$$

$$60 = \frac{24}{\text{Mean}} \times 100 \implies \text{Mean} = \frac{24 \times 100}{60} = 40.$$

Answer: 40.