ALL INDIA TEST SERIES

TEST - 8

JEE (Advanced)

Time Allotted: 3 Hours **Maximum Marks: 198**

General Instructions:

- The test consists of total **54** questions.
- Each subject (PCM) has **18** questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Three Sections**: **Section-A, Section – B & Section-C.**

Section-A (01 – 06, 19 – 24, 37– 42) *this section contains* ***18 multiple*** *choice questions.*
Each question has FOUR options. ***ONE OR MORE THAN ONE*** *of these four option(s) is (are) correct answer(s).*
For each question, choose the option(s) corresponding to (all) the correct answer(s)
Answer to each question will be evaluated according to the following marking scheme:

Full Marks **: +4** If only (all) the correct option(s) is (are) chosen:
Partial Marks **: +3** If all the four options are correct but ONLY three options are chosen;
Partial Marks **: +2** If three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks **: +1** If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks **: 0** If none of the options is chosen (i. e. the question is unanswered);
Negative Marks **: –2** In all other cases

Section-B (07 – 12, 25 – 30, 43– 48) *contains* ***18 Numerical*** *based questions with* ***Single digit integer*** *as answer, ranging from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-C (13 – 18, 31 – 36, 49– 54) *contains* ***18 Numerical*** *answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***0 marks*** *for wrong answer.*

Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **06** multiple choice questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A gas of mass 1.5kg undergoes a quasi-static expansion which follows a relationship $p=a+bV$ where a and b are constants. The initial and final pressure are $10^3\,\text{kPa}$ and $200\,\text{kPa}$ and corresponding volumes are $0.2\,\text{m}^3$ and $1.2\,\text{m}^3$. The specific internal energy of the gas is given by $U=1.5\,pV\text{-}85\text{kJ/kg}$ (where P is in kPa and V in m^3/kg):
   (A) Work done by gas during process is 600kJ
   (B) Change in internal energy of the gas is 90 kJ
   (C) Maximum internal energy during process is approximately 500 kJ
   (D) Maximum internal energy during process is approximately 300 kJ

2. A non-conducting solid sphere of radius 30 cm and relative permittivity 1 has the volume charge density $\rho=\left(\frac{5}{2\pi}\mu C/m^3\right)\left(1-\frac{r}{30cm}\right)$, where r (in cm) is the radial distance of any point in the space from the centre of the sphere. Then choose the correct statement(s):
   (A) Density of electric field lines is maximum at r = 25 cm
   (B) Density of electric field line sis maximum at r = 20 cm
   (C) Electrical energy stored in the space r = 30 cm to $r\to\infty$, is same as that of a solid non conducting sphere carrying charge of 0.0225 μC and radii 30 cm having uniform volume charge density in the same space r = 30 cm to $r\to\infty$.
   (D) Variation of magnitude of electric field due to the sphere with respect to radial distance r is rectangular hyperbola in the region r = 30 cm to $r\to\infty$.

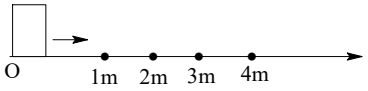
3. A satellite of mass m is orbiting a planet of mass M at a radial distance r_0 from the centre of the planet. The satellite expels a small mass in a direction opposite to its orbital velocity. The immediate recoil velocity of the satellite exceeds the initial orbital velocity by Δv for which the satellite remains within the gravitational field of the planet is:
   (A) $\sqrt{\frac{2GM}{r_0}}$
   (B) $\sqrt{\frac{GM}{2r_0}}$
   (C) $\left(\sqrt{2}-1\right)\sqrt{\frac{GM}{r_0}}$
   (D) None of the above

4. A real object is kept in front of a lens in air. The object is a linear extended object with its length perpendicular to the optical axis of lens. With reference to different cases of image formation by lens, choose the correct options:
   (A) If the image has a magnification -2.5 then Image is real and power of lens is positive.
   (B) If the magnification of the image is $+0.5$ then Image is virtual and power of lens is negative.

(C) If length of image is the same as that of object then Image is real and power of lens is positive.

(D) If length of image is the same as that of object then Image is virtual and power of lens is negative.

5. A block of mass 2kg is given velocity 5 m/s along the horizontal surface which is alternatively smooth and rough $\left(\mu = \frac{1}{8}\right)$.



Consider first 1 meter is smooth. Then:

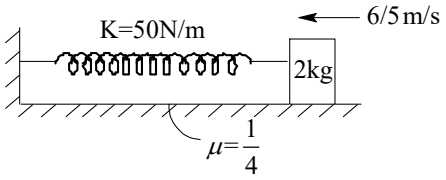
(A) Speed of block when it crosses 2m point is 3 m/s

(B) Speed of block when it crosses 2m point is $2\sqrt{5}$ m/s

(C) Total distance travelled by block before it stops is 10 m

(D) Total distance travelled by block before it stops is 20 m

6. A block is given velocity when the spring was in natural length. Then (g=10 m/s^2)



(A) Distance travelled by the block before it stops for the first time is 32 cm

(B) Distance travelled by the block before it stops for the first time is 64 cm

(C) Acceleration of block when it stops for the first time is $5.5\,m/s^2$

(D) Speed of block when the spring is in natural length again is $\frac{2\sqrt{6}}{5} m/s$

SECTION – B
(Single Digit Integer Type)

This section contains **06** questions. The answer to each question is a **Single Digit integer** ranging from **0** to **9**, both inclusive.

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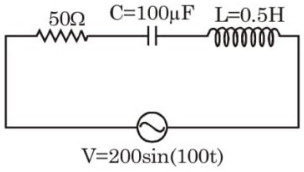
7. In the given LCR AC circuit, the effective current (in ampere) flowing through the circuit is:

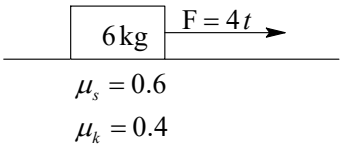


8. The side wall of a wide vertical cylindrical vessel of height h=75cm has a narrow vertical slit running all the way down to the bottom of the vessel. The length of the slit is l = 50cm and the width b = 1mm. With the slit closed, the vessel is filled with water. The resultant force of reaction of water flowing out of the vessel immediately after the slit is opened is (in N)

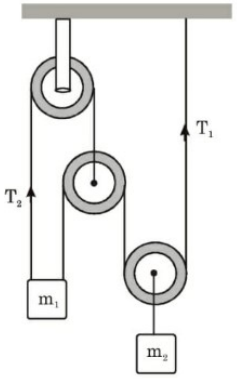
9. A block of mass M = 1kg lies on a smooth horizontal floor. A bullet of mass 0.1kg is fired horizontally with a velocity *u* = 110m/s and gets embedded in the block. The combined mass is set into motion and encounters a rough inclined plane of inclination 37°and length *l=1.8m* in its path. It starts moving up the inclined plane ($\mu_k = 0.5$), reaches the topmost point and finally lands on the horizontal floor. Assuming that the mass is not jerked when it starts up on the inclined plane, the horizontal distance covered by the combined mass while it is not in contact with the horizontal floor is (approximately in m)

10. A point moves according to the law $x = at, y = at(1-\alpha t)$ where $a \text{ and } \alpha$ positive constants are and t is time. If the moment at which angle between velocity vector and acceleration vector is $\frac{\pi}{4}$ is given by $\frac{A}{\alpha}$ is given by $\frac{A}{\alpha}$. Find the value of A.

11. A 6 kg block is moving with a speed of 10 m/s over a rough surface with coefficients of friction $\mu_s = 0.6$ and $\mu_k = 0.4$ as shown in figure. A time varying force $F = 4t$ (f in newton and t in second) is applied on the block as shown. Find the acceleration of block at $t = 5\,\text{sec}$. (Take $g = 10\,m/s^2$)



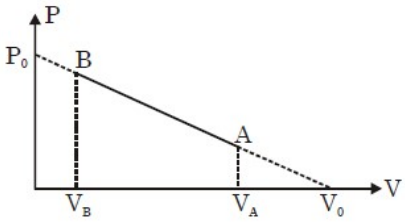
12. Two blocks of masses $m_1 = 5kg$ and $m_2 = 2kg$ are connected by threads which pass over the pulleys as shown in the figure. The threads are massless and the pulleys are massless and smooth. The blocks can move only along the vertical direction. If the acceleration of m_1, if expressed in simplest from, is equal to $\left(\frac{2n}{n-1}\right) m/\sec^2$, calculate '$n$'. (Take g = 10 m/s²)



SECTION – C
(Numerical Answer Type)

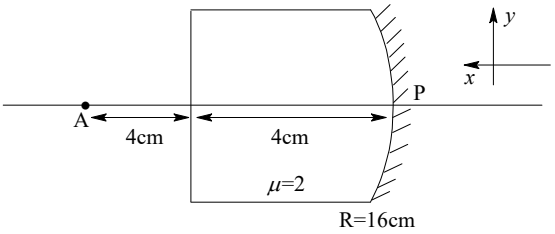
This section contains **06 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **SECOND DECIMAL PLACE**; e.g. XXXXX. XX).

13. The diagram shows the PV diagram of a process carried out with a certain quantity of oxygen $\left(\gamma = \frac{7}{5}\right)$. If $V_A = \frac{2}{3}V_0$ and $V_B = \frac{5}{12}V_0$, find the volume till the gas absorbs heat. If this volume is NV_0, the find N.

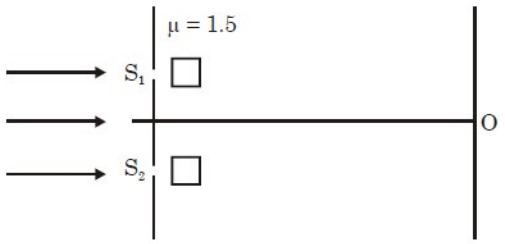


14. A string of length 1m fixed at both ends is vibrating in 3rd overtone. Tension in string is 200 N and linear mass density is 5 gm/m. Find the frequency of these vibrations in Hz.

15. A curved thick glass surface is silvered at curved face & not silvered on plane surface. Object is placed at A as shown in figure. Considering P (pole of the silvered surface) as origin. If x – co – ordinate of final image is 'n' cm then find n.



16. In young's double slit experiment, the coherent sources are separated by a small distance and screen is placed at a large distance. Thin strips are placed infront of slits S_1 and S_2 as shown. The strip which is placed in front of S_1 has width 4 mm and has refractive index 1.5. The strip which is placed infront of S_2 has a variable refractive index $\mu = 1 + Cx$ where x is distance from left end of strip and $C = 1\,\text{mm}^{-1}$.



If central maxima is obtained at O {symmetrical with respect to O}, then find width of strip (in mm) placed in front of S_2.

17. For an equilateral prism, it is observed that when a ray strikes grazingly at one face and it emerges grazingly at the other. Its refractive index will be:

18. A and B are two points on horizontal ground separated by a distance of 300 m. A point source of sound is situated at point A. If velocity of sound in still air is 260 m/s and air flows with speed 100 m/s horizontally and perpendicular to AB then find time taken (in sec) by sound travel from A to B:

Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **06** multiple choice questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Which of the following information(s) is/are incorrect regarding the voids formed in three dimensional HCP of identical spheres?
    (A) A tetrahedral void is formed when a sphere of the second layer is present above the triangular void of the first layer.
    (B) All the triangular voids are not covered by the spheres of the second layer.
    (C) Tetrahedral voids are formed when the triangular voids in the second layer lie above the triangular voids in the first layer and the triangular voids in the first layer and the triangular shapes of these voids do not overlap.
    (D) Octahedral voids are formed when the triangular voids in the second layer exactly overlap with similar voids in the first layer.

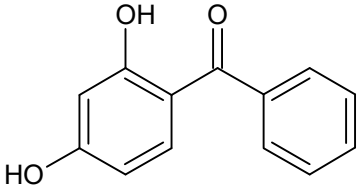
20. Consider 0.1molal aqueous solutions of two solutes X and Y. The solute X behaves as a univalent electrolyte, while the solute Y dimerizes in solution. Which of the following statement(s) is/are correct regarding these solutions?
    (A) The boiling point of the solution of X will be higher than that of Y.
    (B) The osmotic pressure of the solution of X will be higher than that of Y.
    (C) The freezing point of the solution of X will be higher than that of Y.
    (D) The relative lowering of vapour pressure of both the solution will be the same.

21. Select the correct statement:
    (A) Chelation effect is maximum for five and six membered rings
    (B) Greater the charge on the central metal cation, greater the value of $\Delta\left(\mathrm{CFSE}\right)$
    (C) In complex ion $\left[\mathrm{CoF_6}\right]^{3-}$, $\mathrm{F^-}$ is a weak field ligand, so that $\Delta_{oct} < P$ (Pairing energy) and it is low spin complex.
    (D) $\left[\mathrm{CoCl_2\left(NH_3\right)_2\left(en\right)}\right]^{+}$ complex ion will have four different isomers

22. Roasting of copper pyrites is done:
    (A) to remove moisture
    (B) to oxidise free sulphur
    (C) to decompose pyrite into $\mathrm{Cu_2S}$ and FeS
    (D) to remove volatile organic impurities

23. Select the incorrect statement(s):
    (A) $\mathrm{Cs^+}$ is more hydrated than the other alkali metal ions
    (B) Among the alkali metals Li, Na, K and Rb, lithium has the highest melting point
    (C) Ionic mobility of Li^+ is maximum among alkali metal cations
    (D) Ionisation potential of Li is lower than that of Na.

24. A sunburn prevention agent must be non-toxic, non-staining, non-volatile, reasonably water soluble. It should filter of the burning rays of sunlight. Given structure is one such compound:



which method/s for synthesis of above compound starting from m-dimethoxybenzene:

(A) (i) Ph-COCl, (ii) dil. NaOH

(B) (i) Conc. HI (ii) Ph-COCl, $AlCl_3$

(C) (i) Ph-COCl, $AlCl_3$ (ii) conc. HI

(D) All of these

SECTION – B
(Single Digit Integer Type)

This section contains **06** questions. The answer to each question is a **Single Digit integer** ranging from **0** to **9**, both inclusive.

25. If four atoms of same radius are placed at the alternate corner of a cube touching each other, than the length of body diagonal of the cube is equal to $\sqrt{x} \times R$, where R is the radius of atom. Find the value of x?

26. A certain buffer solution contains equal concentration of X^- and HX. The K_b for X^- is 10^{-10}. Find the pH of this buffer solution?

27. Co forms dinuclear complex with a sigma bond within two Co atoms. Consider that metal carbonyls follows EAN rule. The complex can be written as $Co_2(CO)_x$. Find the value of x?

28. Diethyl $\beta, \beta'-$dimethyl glutarate $(ester)$ is condensed with diethyl oxalate in presence of sodium ethoxide and ethanol to form a major product (P), which on acidic hydrolysis followed by heating gives another product (Q). Calculate total number of C=O bonds in (P) and (Q) compounds?

29. At 298 K, if ΔG_f° of $HCl_{(g)}$ is $1.72\, kJ\, mol^{-1}$, then calculate K_p for the following reversible reaction: $2HCl_{(g)} \rightleftharpoons H_{2(g)} + Cl_{2(g)}$

(Use: at $298\, K : 2.303\, RT = 5700\, J\, mol^{-1}$ *and* $\log 2 = 0.30$)

30. Total no of lone pairs in XeO_3F_2 is $2x$. Find the value of x.

SECTION – C
(Numerical Answer Type)

This section contains **06 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **SECOND DECIMAL PLACE**; e.g. XXXXX. XX).

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31. An optically active substance, A, decomposes into optically active substances 'B' and 'C' as:

$$A \xrightarrow{K=0.001\ \text{min}^{-1}} 2B + C$$

The specific rotations of A, B and C are +40°, +10° and $-30°$ per mole, respectively. If initially A and C were present in $4:3$ mole ratio, the time (in min), after which the sample becomes optically inactive, is (ln 2=0.7, ln 5=1.6, ln 7=2.0, ln 13=2.5)

32. A hydrogenation reaction is carried out at 500K. If the same reaction is carried out in the presence of a catalyst at the same rate, the temperature required is 400 K. The activation energy of reaction (in kJ/mol), if the catalyst lowers the activation energy by 20 kJ/mol, is:

33. A volume of 100 ml of a liquid contained in an isolated container at a pressure of 1 bar. The pressure is steeply increases to 100 bar by which the volume of liquid is decreased by 1 ml. The change in enthalpy, $\Delta H,$ of the liquid (in bar mL)

34. The boiling point of a solution of 5g sulphur in 100g of CS_2 is $0.5\ ^0C$ above that of pure solvent. If the K_b of CS_2 is 2.56 $Kg\,K\,mol^{-1}$. Find the atomicity of sulphur in this solvent.

35. Which of the following statements is/are correct?
(i) Sulphur solution is an example of macro molecular colloid.
(ii) Adsorbent used in gas masks is activated charcoal
(iii) AgI is used for producing artificial rain by seeding.
(iv) Alums purify muddy water by coagulation of colloidal sized clay & sand.
(v) It occurs because of van der Waals forces. (for physisorption)
(vi) More easily liquefiable gases are adsorbed readily. (for physisorption)
(vii) Under high pressure it results into multimolecular layer on adsorbent surface. (for physisorption)
(viii) Enthalpy of adsorption ($\Delta\text{H}_{\text{adsorption}}$) is low and positive. (for physisorption)

36. Pressure over 1000 ml of a liquid is gradually increased from 1 bar to 1001 bar under adiabatic conditions. If the final volume of the liquid is 990 ml and there is linear variation of volume with pressure, the value of ΔU of the process is (Answer as 'abcd', where a = 1, if ΔU is +ve and a = 2, if ΔU is –ve , and 'bcd' is the magnitude of ΔU , in J):

Mathematics

PART – III

SECTION – A
(One or More than one correct type)

This section contains **06** multiple choice questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If in a ΔABC, a, b, c are in A.P. and P_1, P_2, P_3 are the altitudes from the vertices A, B and C respectively, then
(A) P_1, P_2, P_3 are in A.P.
(B) P_1, P_2, P_3 are in H.P.
(C) $P_1 + P_2 + P_3 \le \frac{3R}{\Delta}$
(D) $\frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3} \le \frac{3R}{\Delta}$

38. Given three non – zero, non – coplanar vectors, and $\vec{a}, \vec{b}$ and $\vec{c}$ and $\vec{r}_1 = p\vec{a} + q\vec{b} + \vec{c}$ and $\vec{r}_2 = \vec{a} + p\vec{b} + q\vec{c}$ if the vectors $\vec{r}_1 + 2\vec{r}_2$ and $2\vec{r}_1 + \vec{r}_2$ are collinear then (p, q) is
(A) (0, 0)
(B) (1, –1)
(C) (–1, 1)
(D) (1, 1)

39. Each of 2010 boxes in a line contains one red marble and for $1 \le k \le 2010,$ the box is the k^{th} position also contain k white marbles. A child begins at the fist box and successively drawn a single marble at random from each box in order. The stops when be fist draws a red marble. Let $p(n)$ be the probability that he stops after drawing exactly n marbles. The possible value(s) of n for which $p(n) < \frac{1}{2010}$ is:
(A) 44
(B) 45
(C) 46
(D) 47

40. If α, β, γ are roots of $x^3 + 2x^2 - 3x + 1 = 0$, then value of $\frac{\alpha\beta}{\alpha+\beta} + \frac{\alpha\gamma}{\alpha+\gamma} + \frac{\beta\gamma}{\beta+\gamma}$ is less than
(A) 2
(B) 3
(C) 4
(D) 5

41. The solution of differential equation $3\frac{dx}{dy} = \frac{x}{x^3 - y}$ is $x^{\ell} = mx^n y + c$, then which of the following is/are **CORRECT**? {c is any arbitrary constant}
(A) $\ell + m + n = 11$
(B) $\ell + n = 9$
(C) $\ell + 2m = 10$
(D) $m+n=4$

42. Three are 5 boxes numbered from 1 to 5. There is 1 Red and 2k black balls in k^{th} box, $k = 1,2,3,4,5$. From each box either one red ball is taken or one or more than one black balls are taken. But from each box both coloured balls are never taken (ball of same coloure are all alike). Now which of the following holds good?

(A) Total number of ways selecting odd number of red balls is 4725
(B) Total number of ways of selecting even number of red balls is 5670
(C) Total number of ways selecting odd number of red balls is 5670
(D) Total number of ways of selecting even number of red balls is 4725

SECTION – B
(Single Digit Integer Type)

This section contains **06** questions. The answer to each question is a **Single Digit integer** ranging from **0** to **9**, both inclusive.

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43. If the polynomial $f(x) = 4x^4 - ax^3 + bx^2 - cx + 5$ where $a, b, c \in R$ has four positive real roots say r_1, r_2, r_3 and r_4, such that $\frac{r_1}{2} + \frac{r_2}{4} + \frac{r_3}{5} + \frac{r_4}{8} = 1$. Find the value of (a-10).

44. All the three vertices of an equilateral triangle lie on the parabola $y = x^2$, and one of its sides has a slope of 2. The x-coordinates of the three vertices have a sum equal to $\frac{p}{q}$ where p and q are relatively prime positive integers. Find the value of (q-p)

45. $f(x) = \max|2\sin y - x|$ where $y \in R$ then minimum value of $f(x)$ is:

46. Let $f(x)(x > 1)$ be a differentiable function satisfying $f(x) = (\ln x)^2 - \int_1^e \frac{f(t)}{t} dt$. Then if Area bounded by tangent line of $y = f(x)$ at $(e, f(e))$, then curve $y = f(x)$ and $x = 1$ is A then $[A]$ is ($[.]$ is G. I. F)

47. If the equation on reflection of $\frac{(x-4)^2}{16} + \frac{(y-3)^2}{9} = 1$ about the line $x - y - 2 = 0$ is $16x^2 + 9y^2 + k_1x - 36y + k_2 = 0$ then $\frac{k_1 + k_2}{22}$ is

48. A and B are two square matrices such that $A^2B = BA$ and if $(AB)^{10} = A^kB^{10}$ then the value of $k - 1020$ is....

SECTION – C
(Numerical Answer Type)

This section contains **06 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **SECOND DECIMAL PLACE**; e.g. XXXXX. XX).

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49. If two points P and Q on $9x^2 - 5y^2 = 1$ (whose centre is C) be such that CP is perpendicular to CQ then value of $\frac{1}{CP^2} + \frac{1}{CQ^2}$ is…..

50. Let z_1, z_2 and z_3 be complex numbers such that $|z_1| = |z_2| = |z_3| = |z_1 + z_2 + z_3| = 2$. If $|z_1 - z_2| = |z_1 - z_3|$ *and* $z_2 \neq z_3$. Then find the value of $|z_1 + z_2||z_1 + z_3|$.

51. If $\lim_{x \to 1} \frac{100}{1 - x^{100}} - \frac{50}{1 - x^{50}} = 5A$; find the value of A.

52. Let $H_n = 1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n}$ and $T_n = \frac{1}{(n+1)H_n H_{n+1}}$, then the value of $(T_1 + T_2 + T_3 + ... + \infty)$ is:

53. There are 4 bowlers, 4 batsman and 1 all-rounder (who is bowler as well as batsman). Randomly a team of 4 players consisting of at least two bowlers and at least two batsman is formed. If the probability that all-rounder has been selected in team is $\frac{4}{p}$, then p is equal to:

54. Suppose $\int \frac{1 - 7\cos^2 x}{\sin^7 x \cos^2 x} dx = \frac{g(x)}{\sin^7 x} + C$, where C is an arbitrary constant of integration. Then the value of $g'(0) + g''\left(\frac{\pi}{4}\right)$.

ALL INDIA TEST SERIES

TEST - 8

JEE (Advanced)

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. AC

2. BC

Sol. $$E_{inside}\,4\pi r^2 = \frac{\int_0^x \left(\frac{5}{2\pi}\right)\left(1-\frac{r}{30}\right)4\pi r^2 dr}{\varepsilon_0}$$

$$\frac{dE_{inside}}{dx} = 0$$

3. C

Sol. $$v_e = \sqrt{2}\sqrt{\frac{GM}{r_0}}$$

$$\therefore \Delta v = v_e - v_0 = \left(\sqrt{2}-1\right)\sqrt{\frac{GM}{r_0}}$$

4. ABC

Sol. Positive power lens (convex lens in rare medium) can from enlarged (or of same size) real, inverted image.
Positive power lens (convex lens in rare medium) can form virtual, erect, diminished image.

5. BD

Sol. $-\mu mgx = \frac{1}{2}mv^2 - \frac{1}{2}mv^2$

$\Rightarrow -\frac{1}{8}(20)(1) = \frac{1}{2}(2)v^2 - \frac{1}{2}(2)5^2$

$\Rightarrow v = \frac{3}{2}\sqrt{5} m/s$

$-\mu mgx = 0 - \frac{1}{2}mv^2$

$x = 10m$

Total distance $= 20m$

6. ACD

Sol. $-\frac{1}{4}\times 20\times x - \left(\frac{1}{2}50x^2\right) = 0 - \frac{1}{2}2(6/5)^2$

$\Rightarrow x = \frac{8}{25}m = 32cm$

$a = \frac{kx - f_s}{m} = \frac{16-5}{2} = 5.5 m/s^2$

$\& \; -\frac{1}{4}(20)(8/25) - \left(-\frac{1}{2}50\times\frac{64}{625}\right) = \frac{1}{2}(2)v^2$

$\Rightarrow v^2 = 24/25 \Rightarrow U = \frac{2\sqrt{6}}{5} m/s$

SECTION – B

7. 2

Sol. $R = 50\Omega$

$X_L = \omega L = 50\Omega$

$X_L = \frac{1}{\omega C} = 100\Omega$

$\Rightarrow Z = \sqrt{R^2 + (X_L - X_C)^2}$

$Z = 50\sqrt{2}\Omega$

$\mathrm{I}_{\mathrm{ram}} = \frac{V_{rms}}{Z} = \frac{200/\sqrt{2}}{50\sqrt{2}} = 2A$

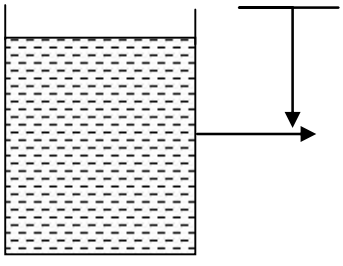
8. 5

Sol. $V = \sqrt{2gy}$

$\Rightarrow dF = \left(1\times 10^{-3}\right)\left(\sqrt{2gy}\, dy\sqrt{2gy}\times\rho\right)$

$dF = 1\times 10^{-3}\times 2\times 10\times y\times 10^3\, dy = 40\, ydy$

$\Rightarrow F = \frac{20}{2}\int ydy = \frac{40}{2}\left(0.75^2 - 0.25^2\right) = 20\times 0.5 = 5$



9. 9

10. 1

Sol. $\frac{dx}{dt} = a \Rightarrow \frac{d^2x}{dt^2} = 0$

$\frac{dy}{dt} = a - 2a\alpha t \Rightarrow \frac{d^2y}{dt^2} = -2a\alpha$

Velocity vector $\vec{v} = a\hat{i} + (a - 2a\alpha t)\hat{j}$

$\vec{a} = -2a\alpha\hat{j}$

$\vec{v}.\vec{a} = va\cos\frac{\pi}{4}$

$t = \frac{1}{\alpha} \Rightarrow A = 1$

11. 0

Sol. Block start when $\mu_s mg = 4t$

$t = 9\,\text{sec}$

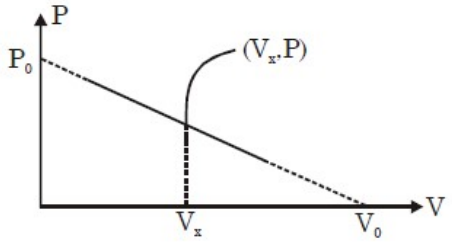
At $t = 5s$ block was at rest so answer = 0

12. 4

SECTION – C

13. 00000.58

Sol. $\frac{P}{V_0 - V_x} = \frac{7}{5}\frac{P}{V_X}$



$5V_x = 7V_0 - 7V_x$

$V_x = \frac{7V_0}{12}$

14. 00400.00

Sol. IIIrd overtone

$f = \frac{4V}{2L} = \frac{2V}{L} = \frac{2}{1}\sqrt{\frac{200}{(5/1000)}} = 2(200)$

$f = 400Hz$

15. 00014.00

Sol. $u=-\left(4+\frac{4}{2}\right)\times 2=-12\,cm$

$\frac{1}{v}+\frac{1}{-12}=\frac{1}{-8} \quad \Rightarrow v=-24\,cm$

For final image (refraction through plane surface) we can write.

$24=2\left(\frac{x}{1}+\frac{4}{2}\right)\Rightarrow \quad 24=2x+4$

$x=10\,cm$

So distance from P is $14\,\text{cm}$

16. 00002.00

Sol. Let width of second strip is ℓ

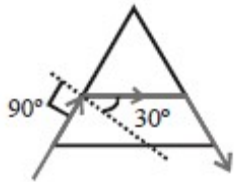
$\left(S_1O-4\right)+1.5\left(4\right)=\left(S_2O\text{-}\ell\right)+\left(\ell+\frac{\ell^2}{2}\right)$

$\left(1.5-1\right)\left(4\right)=\frac{\ell^2}{2}$

$\ell=2mm$

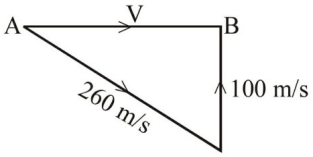
17. 00002.00

Sol. $\mu=\frac{\sin 90^\circ}{\sin 30^\circ}=2$



18. 00001.25

Sol. Speed of sound in direction of AB $V=\sqrt{260^2-100^2}=240\,m/s$



$\therefore t=\frac{300}{240}=1.25$

Chemistry PART – II

SECTION – A

19. CD

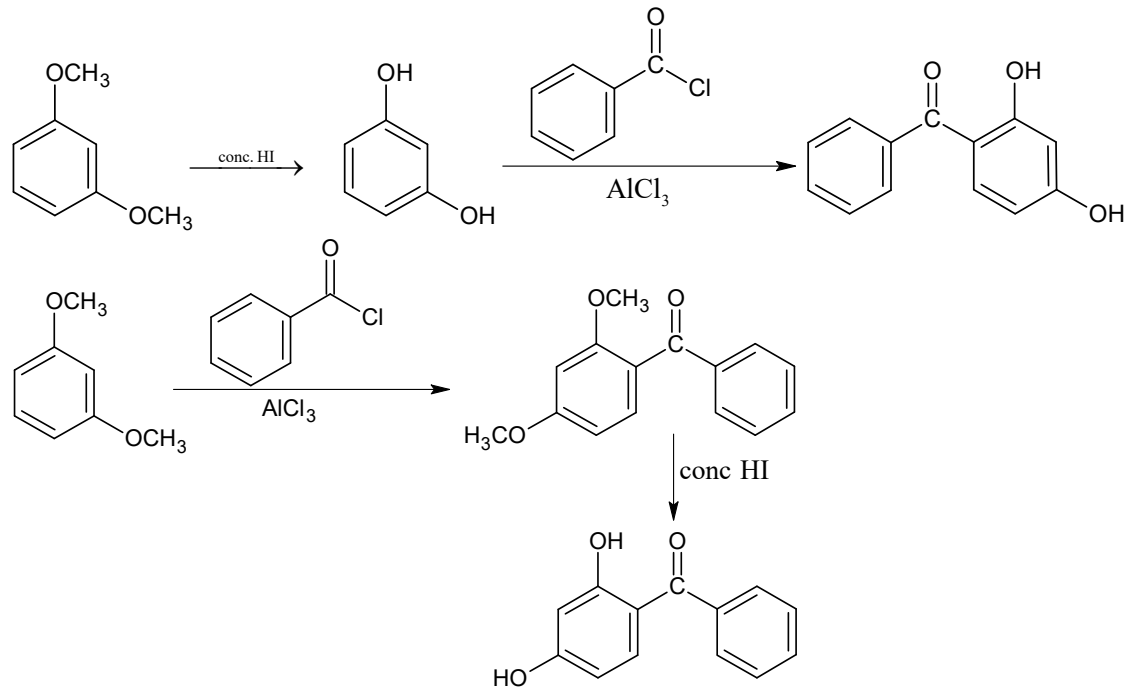
20. AB
Sol. Solute X will dissociate into the solution so i>1.

21. ABD
Sol. $\left[CoF_6\right]^{3-}$ is a high spin complex.

22. ABCD

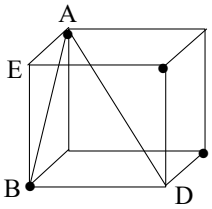
23. ACD
Sol. Due to the more cohesive energy in Li, it has highest melting point among alkali metals.

24. BC
Sol.



SECTION – B

25. 6
Sol.



Face diagonal of cube $(AB)=2R$

Edge length of cube $(\mathrm{BE})=\dfrac{2\mathrm{R}}{\sqrt{2}}$

Body diagonal of cube $(\mathrm{AD})=\sqrt{3}\times\dfrac{2\mathrm{R}}{\sqrt{2}}$

$=\sqrt{6}\times R$

26. 4

Sol. $pKa\ of\ HX=14-10=4$

$pH=pK_a+\log\dfrac{1}{1}=4$

27. 8

Sol. $(CO)_{x/2}\,Co-Co(CO)_{x/2}$

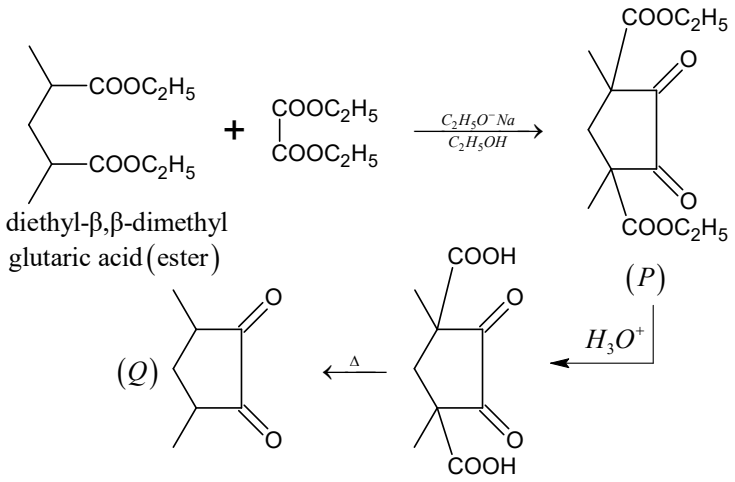
$EAN(=36)=27+1+2\times\dfrac{x}{2}$

$\Rightarrow 28+x=36$

$x=8$

28. 6

Sol.



29. 4

Sol. $\dfrac{1}{2}H_2(g)+\dfrac{1}{2}Cl_2(g)\rightleftharpoons HCl(g)\,\Delta G^\circ=1.72\,kJ\,mol^{-1}$

ΔG° for $2HCl(g)\rightleftharpoons H_2(g)+Cl_2(g)$ is $\left[2\times(-1.72)\right]kJ$

$\Delta G^\circ=-2.303RT\log K_p$

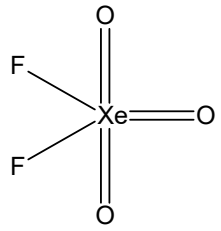
$-3.44\times10^3=-5700\log K_p$

$\log K_p=0.6$

$K_p=4$

30. 6

Sol.



SECTION – C

31. 00500.00

32. 00100.00

Sol. $K = Ae^{-Ea/RT}$

33. 09900.00

Sol. $\Delta U = q\ tw$

For adiabatic process $q = 0$

$\Delta U = w$

$\Delta U = P\Delta V = -P\left(V_2 - V_1\right)$

$\Delta U = -100\left(99 - 100\right) = 100\,\text{bar mL}$

Now $\Delta H = \Delta U + \Delta\left(PV\right)$

$\Delta H = 100 + \left[100 \times 99 - 1 \times 100\right]$

$\Delta H = 9900\,\text{bar mL}$

34. 00008.00

35. 00006.00

36. 01501.00

SECTION – A

37. BD

38. D

39. BCD

Sol. $p(n)$ = Probability that child stops after drawing exactly n marbles

$$p(n)=\frac{1}{2}.\frac{2}{3}.\frac{3}{4}.....\left(\frac{n-1}{n}\right)\left(\frac{1}{n+1}\right)=\frac{1}{n(n+1)}$$

40. ABCD

Sol. $x^3+2x^2-3x+1=0\begin{cases}\alpha\\ \beta\\ \gamma\end{cases}$

$$x^3-3x^2-2x+1=0\begin{cases}1/\alpha\\ 1/\beta\\ 1/\gamma\end{cases}$$

Given expression $\frac{1}{3-\frac{1}{\alpha}}+\frac{1}{3-\frac{1}{\beta}}+\frac{1}{3-\frac{1}{\gamma}}$

$$=\frac{\sum\left(3-\frac{1}{\alpha}\right)\left(3-\frac{1}{\beta}\right)}{\left(3-\frac{1}{\alpha}\right)\left(3-\frac{1}{\beta}\right)\left(3-\frac{1}{\gamma}\right)}=\frac{27-6\sum\left[\frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma}\right]+\frac{1}{\alpha\beta}+\frac{1}{\beta\gamma}+\frac{1}{\gamma\alpha}}{\left(3-\frac{1}{\alpha}\right)\left(3-\frac{1}{\beta}\right)\left(3-\frac{1}{\gamma}\right)}=\frac{11}{7}$$

41. ABC

Sol. $3x^2\frac{dx}{dy}=\frac{x^3}{x^3-y}\qquad x^3=t$

$$\Rightarrow\frac{dt}{dy}=\frac{t}{t-y}\quad\Rightarrow(t-y)dt=t\,dy$$

$$\Rightarrow t\,dt=y\,dt+t\,dt\Rightarrow\frac{t^2}{2}=t.y+\frac{c}{2}$$

$$\Rightarrow x^6=2x^3y+c$$

42. AD

Sol. Let

x: Total No of ways of selecting even number of red balls

even number of red balls

y: Total No of ways of selecting

odd numbers of red balls

$(2-1)(4-1)(6-1)(8-1)(10-1)=x-y$ $(2+1)(4+1)(6+1)(8+1)(10+1)=x+y$

SECTION – B

43. 9

Sol. A.M.=G.M.

$$\frac{r_1}{2}=\frac{r_2}{4}=\frac{r_3}{5}=\frac{r_4}{8}=k$$

44. 8

Sol. $t_1+t_2=2$

$$\frac{2-m_2}{1+2m_2}=\sqrt{3}$$

$$\text{and}\frac{m_3-2}{1+2m_3}=\sqrt{3}$$

$$t_1+t_2+t_3=\frac{p}{q}=\frac{3}{11}$$

45. 2

46. 0

47. 6

48. 3

SECTION – C

49. 00004.00

50. 00008.00

Sol. The triangle has circumcentre at origin and its orthocentre laying on the circumcircle.

51. 00005.00

Sol. $$\lim_{y\to1}\frac{100y^{100}}{y^{100}-1}-\frac{50.y^{50}}{y^{50}-1}$$

$$\lim_{y\to1}100-50-\left(\frac{100}{1-y^{100}}-\frac{50}{1-y^{50}}\right)$$

$$L=50-L\ \therefore L=\frac{50}{2}=25$$

52. 00001.00

Sol. $$T_n=\frac{H_{n+1}-H_n}{H_nH_{n+1}}$$

As $H_{n+1}-H_n=\frac{1}{n+1}$

$\Rightarrow T_n=\frac{1}{H_n}-\frac{1}{H_{n+1}}$

$\Rightarrow T_1=\frac{1}{H_1}-\frac{1}{H_2}$

$T_2=\frac{1}{H_2}-\frac{1}{H_3}$

$\vdots \quad \vdots \quad \vdots$

$T_n=\frac{1}{H_n}-\frac{1}{H_{n+1}}$

$T_1+T_2+...+T_n=\frac{1}{H_1}-\frac{1}{H_{n+1}}$

$\text{As } n\to\infty, \quad T_1+T_2+...+0=1$

53. 00007.00

Sol. Clearly a team of 4 with two batsman and two bowler can be formed as

Case-I: 2 bowler+2batsman

Number of ways= ${}^4C_2\times{}^4C_2=36$

Case-II: 2 bowler+1 batsman +1 all-rounder

${}^4C_2\times{}^4C_1\times{}^1C_1=24$

Case-III: 1bowler +2 batsman +1 all-rounder

${}^4C_1\times{}^4C_2\times{}^1C_1=24$

$\therefore$ Probability that all-rounder is selected= $\frac{24+24}{36+24+24}=\frac{4}{7}$

$\therefore \quad p=7$

54. 00005.00