# ⫴ AIEEE-2009 QUESTION PAPER ⫴

## PART-A : PHYSICS

1. This question contains statement-1 and statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.

   **Statement-1 :** For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q.

   **Statement-2 :** The net work done by a conservative force on an object moving a closed loop is zero

   1) Statement -1 is is true, statement -2 is false

   2) Statement -1 is true, statement-2 is true; statement -2 is the correct explanation of statement-1.

   3) Statement-1 is true, statement-2 is true; statement-2 is not the correct explanation of statement-1

   4) Statement-1 is false, statement-2 is ture

2. The above is a plot of binding energy per nucleon $E_b$, against the nuclear mass M; A, B, C, D, E, F correspond to different nuclei. Consider four reactions:

   i) $A + B \rightarrow C + \varepsilon$

   ii) $C \rightarrow A + B + \varepsilon$

   iii) $D + E \rightarrow F + \varepsilon$

   iv) $F \rightarrow D + E + \varepsilon$
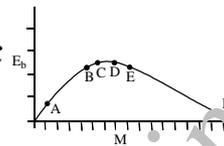
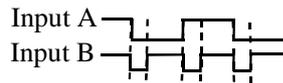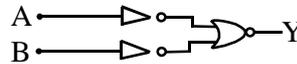   where $\varepsilon$ is the energy released? In which reactions is $\varepsilon$ positive ?

   1) (i) and (iv)      2) (i) and (iii)

   3) (ii) and (iv)     4) (ii) and (iii)

3. A p-n junction (D) shown in the figure can act as a rectifier. An alternating current source (V) is connected in the circuit. Output across R is
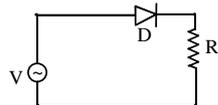
   1)      2)

   3)      4)

4. The logic circuit shown below has the input waveforms 'A' and 'B' as shown. Pick out the correct output waveform.

   1)

   2)

   3)

   4)

*5. If u, V and a denote the displacement, the velocity and the acceleration of a particle executing simple harmonic motion of time period T, then, which of the following does not change with time?

   1) $a^2T^2 + 4\pi v^2$      2) $\dfrac{aT}{x}$

   3) $aT + 2\pi v$      4) $\dfrac{aT}{v}$

6. In an optics experiment, with the position of the object fixed, a student varies the position of a convex lens and for each position, the screen is adjusted to get a clear image of the object. A graph between the object distance u and the image distance v, from the lens, is plotted using the same scale for the two axes. A straight line passing through the origin and making an angle of 45° with the x-axis meets the experimental curve at P. The coordinates of P will be

   1) (2f, 2f)      2) $\left(\dfrac{f}{2}, \dfrac{f}{2}\right)$

   3) (f, f)      4) (4f, 4f)

*7. A thin uniform rod of length l and mass m is swinging freely about a horizontal axis passing through its end. Its maximum angular speed is $\omega$. Its centre of mass rises to maximum height of

1) $\dfrac{1}{3}\dfrac{l^2\omega^2}{g}$
2) $\dfrac{1}{6}\dfrac{l\omega}{g}$

3) $\dfrac{1}{2}\dfrac{l^2\omega^2}{g}$
4) $\dfrac{1}{6}\dfrac{l^2\omega^2}{g}$

8. Let $\rho(r) = \dfrac{Q}{\pi R^4}r$ be the charge density distribution for a solid sphere of radius R and total charge Q. for a point 'p' inside the sphere at distance $r_1$ from the centre of the sphere, the magnitude of electric field is

1) 0
2) $\dfrac{Q}{4\pi\varepsilon_0 r_1^2}$

3) $\dfrac{Qr_1^2}{4\pi\varepsilon_0 R^4}$
4) $\dfrac{Qr_1^2}{3\pi\varepsilon_0 R^4}$

9. The transition from state n = 4 to n = 3 in a hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from
1) $2 \to 1$   2) $3 \to 2$   3) $4 \to 2$   4) $5 \to 4$

*10. One kg of a diatomic gas is at a pressure of $8 \times 10^4$ N/m². The density of the gas is 4 kg/m³. What is the energy of the gas due to its thermal motion ?
1) $3\times10^4$ J
2) $5\times10^4$ J
3) $6\times10^4$ J
4) $7\times10^4$ J

11. This question contains Statement-1 and Statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.

   **Statement-1:** The temperature dependence of resistance is usually given as $R = R_0(1 + \alpha\Delta t)$. The resistance of a wire changes from 100 $\Omega$ to 150 $\Omega$ when its temperature is increases from 27°C to 227°C. This implies that $\alpha = 2.5\times10^{-3}$/°C.

   **Statement 2 :** $R = R_i (1 + \alpha\Delta T)$ is valid only when the change in the temperature $\Delta T$ is small and $\Delta R = (R - R_0) << R_0$.

1) Statement -1 is true, statement-2 is false
2) Statement -1 is true, statement-2 is true: statement- 2 is the correct explanationof statement-1.
3) Statement -1 is true, statement-2 is ture; statement-2 is not the correct explanation of statement-1
4) Statement-1 is false, statement-2 is true

Directions: Question numbers 12 and 13 are based on the following paragraph.

A current loop ABCD is held fixed on the plane of the paper as shown in the figure. The arcs BC (radius = b) and DA (radius = a ) of the loop are joined by two straight wires AB and CD. A steady current | is flowing in the loop. Angle made by AB and CD at the origin O is 30°. Another straight thin wire with steady current $|_1$ flowing out of the plane of the paper is kept at the origin
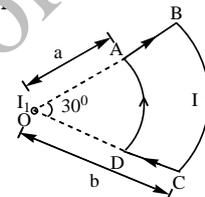


12. The magnitude of the magnetic field (B) due to loop ABCD at the origin (O) is

1) zero
2) $\dfrac{\mu_0(b-a)}{24ab}$

3) $\dfrac{\mu_0 |}{4\pi}\left[\dfrac{b-a}{ab}\right]$

4) $\dfrac{\mu_0 |}{4\pi}\left[a(b-a)+\dfrac{\pi}{3}(a+b)\right]$

13. Due to the presence of the current $|_1$ at the origin

1) The forces on AB and DC are zero

2) The forces on AD and BC are zero

3) The magnitude of the net force on the loop is given by $\dfrac{\mu_0 |\,|_1}{4\pi}\left[2(b-a)+\dfrac{\pi}{3}(a+b)\right]$

4) The magnitude of the net force on the loop is given by $\dfrac{\mu_0 |\,|_1}{24ab}(b-a)$

14. A mixture of light, consisting of wavelength 590 nm and an unknown wavelength, illumnates Young's double slit and gives rise to two overlapping interference patterns on the screen. The central maximum of both lights coincide. Further, it is observed that the third bright fringe of known light coincides with the 4th bright fringe of the unknown light. From this data, the wavelength of the unknown light is

1) 393.4nm
2) 885.0nm
3) 442.5nm
4) 776.8nm

15. Two points P and Q are maintained at the potentials of 10V and –4V respectively. The work done in moving 100 electrons from P to Q is

1) $-19 \times 10^{-17}$ J
2) $9.60 \times 10^{-17}$ J
3) $-2.24 \times 10^{-16}$ J
4) $2.24 \times 10^{-16}$ J

16. The surface of a metal is illuminated with the light of 400 nm. The kinetic energy of the ejected photoelectrons was found to be 1.68 eV. The work function of the metal is
(hc = 1240 eV nm)

1) 3.09eV
2) 1.41eV
3) 151eV
4) 1.68eV

*17. A particle has an initial velocity $3\hat{i} + 4\hat{j}$ and an acceleration of $0.4\hat{i} + 0.3\hat{j}$. Its speed after 10s is

1) 10 units
2) $7\sqrt{2}$ units
3) 7 units
4) 8.5 units

*18. A motor cycle starts from rest and accelerates along a straight path at 2 m/s². At the starting point of the motor cycle there is a stationary electric siren. How far has the motor cycle gone when the driver hears the frequency of the siren at 94% of its value when the motor cycel was at rest? (spped of sound = 330 ms⁻¹).

1) 49 m
2) 98 m
3) 147 m
4) 196 m

*19. Consider a rubber ball freely falling from a height h = 4.9 m onto a horizontal elastic plate. Assume that the duration of collision is negligible and the collision with the plate is totally elastic. Then the velocity as a function of time the height as function of time will be
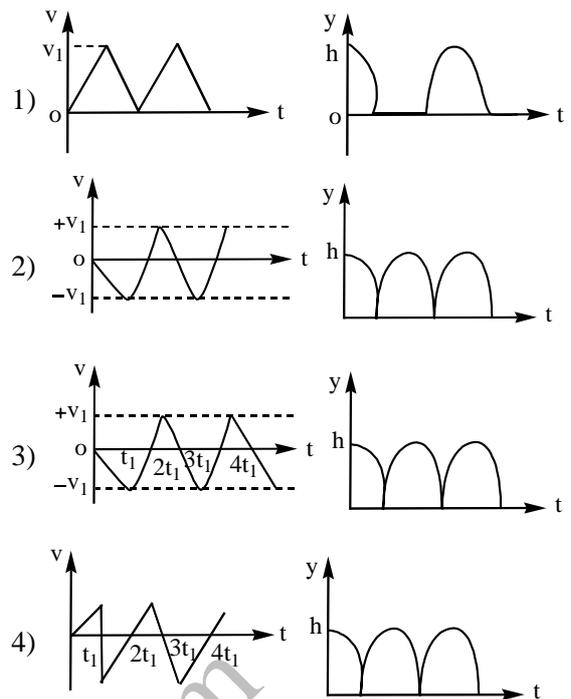


20. A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then the Q/q equals

1) $-2\sqrt{2}$
2) –1
3) 1
4) $-\dfrac{1}{\sqrt{2}}$

*21. A long metallic bar is carrying heat from one of its ends to the other end under steady-state. The variation of temperature $\theta$ alogn the length× of the bar from its hot end is best described by which of the following figure.
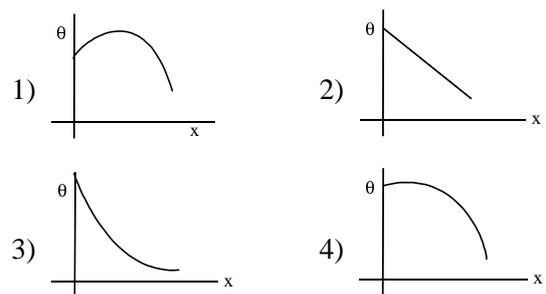


22. A transparent solid cylindrical rod has a refractive index of $\dfrac{2}{\sqrt{3}}$. It is surrounded by air. A light ray is incident at the mid point of one end of the rod as shown in the figure.
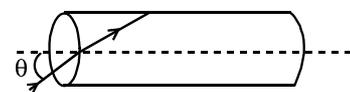
The incident angle $\theta$ for which the light ray grazes along the wall of the rod is

1) $\sin^{-1}\left(\dfrac{1}{2}\right)$　　2) $\sin^{-1}\left(\dfrac{\sqrt{3}}{2}\right)$

3) $\sin^{-1}\left(\dfrac{2}{\sqrt{3}}\right)$　　4) $\sin^{-1}\left(\dfrac{1}{\sqrt{3}}\right)$

*23. Three sound waves of equal amplitudes have frequencies $(v-1)$, $v$, $(v+1)$. They superpose to give beats. The number of beats per second will be

　　1) 4　　　2) 3　　　3) 2　　　4) 1

*24. The height at which the cceleration due to gravity becomes $\dfrac{g}{9}$ (where g = the acceleration due to gravity on the surface of the earth) in terms of R, the radius of the earth is

　　1) 2R　　2) $\dfrac{R}{\sqrt{2}}$　　3) $\dfrac{R}{2}$　　3) $\sqrt{2}R$

*25. Two wires are made of the same material and have the same volume. However wire 1 has cross-sectional area A and wire-2 has cross-sectional area 3A. If the length of wire 1 increases by $\Delta x$ on applying force F, how much force is needed to stretch wire 2 by the same amount?

　　1) F　　2) 4F　　3) 6F　　4) 9F

*26. In an experiment the angles are required to be measured using an instrument. 29 divisions of the main scale exactly coincide with the 30 divisions of hte vernier scale. If the smallest division of the main scale is half-a-degree (=0.5°), then the least count of the instrument is

　　1) one minute　　　2) half minute
　　3) one degree　　　4) half degree

27. An inductor of inductance L = 400 mH and resistors of resistances $R_1 = 2\,\Omega$ and $R_2\ 2\,\Omega$ are connected to a battery of emf 12V as shown in the figure. The internal resistance of the battery is negligible. the switch S is closed at t = 0. The potential drop across L as a function of time is

　　1) $6e^{-5t}V$

　　2) $\dfrac{12}{t}e^{-3t}V$

　　3) $6(1-e^{-t/0.2})V$

　　4) $12e^{-5t}V$
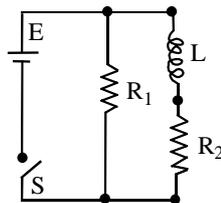
**Directions :** Question numbers 28, 29 and 30 are based on the following paragraph.

Two moles of helium gas are taken over the cycle ABCDA, as shown in the P – T diagram.
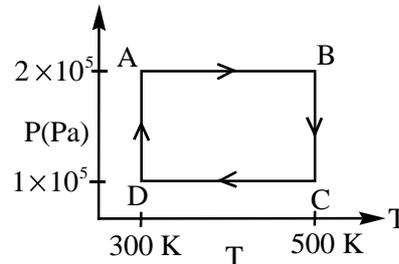


*28. Assuming the gas to be ideal the work done on the gas in taking it from A to B is

　　1) 200 R　　　　2) 300 R
　　3) 400 R　　　　4) 500 R

*29. The work done on the gas in taking it from D to A is

　　1) – 414 R　　　2) + 414 R
　　3) – 690 R　　　4) + 690 R

*30. The net work doen on the gas in the cycle ABCDA is

　　1) zero　　　　2) 276 R
　　3) 1076 R　　　4) 1904 R

### PART-B : CHEMISTRY

31. Knowing that the chemistry of lanthanoids (Ln) is dominated by its + 3 oxidation state, which of the following statements in incorrect ?

　　1) Because of the large size of the Ln(III) ions the bonding in its compounds is predominantly ionic in character

　　2) The ionic sizes of Ln(III) decreases in general with increasing atomic number

　　3) Ln(III) compounds are generally colourless

　　4) Ln(III) hydroxides are mainly basic in character

32. A liquid was mixed with ethanol and a drop of concentrated $H_2SO_4$ was added. A compound with a fruity smell was formed. The liquid was:

　　1) $CH_3OH$　　　　2) HCHO
　　3) $CH_3COCH_3$　　4) $CH_3COOH$

33. Arrange the carbanions,

    $(CH_3)_3 \overline{C}, \overline{C}Cl_3, (CH_3)_2 \overline{C}H, C_6H_5 \overline{C}H_2$, in order of their decreasing stability :

    1) $C_6H_5 \overline{C}H_2 > \overline{C}Cl_3 > (CH_3)_3 \overline{C} > (CH_3)_2 \overline{C}H$

    2) $(CH_3)_2 \overline{C}H > \overline{C}Cl_3 > C_6H_5 \overline{C}H_2 > (CH_3)_3 \overline{C}$

    3) $\overline{C}Cl_3 > C_6H_5 \overline{C}H_2 > (CH_3)_2 \overline{C}H > (CH_3)_3 \overline{C}$

    4) $(CH_3)_3 \overline{C} > (CH_3)_2 \overline{C}H > C_6H_5 \overline{C}H_2 > \overline{C}Cl_3$

34. The alkene that exhibits geometrical isomerism is:

    1) propene  2) 2 – methyl propene

    3) 2-butene  4) 2-methyl -2-butene

35. In which of the following arrangements, the sequence is not strictly according to the property written against it ?

    1) $CO_2 < SiO_2 < SnO_2 < PbO_2$ : increasing oxidising power

    2) $HF < HCl < HBr < HI$ : increasing acid strength

    3) $NH_3 < PH_3 AsH_3 < SbH_3$ : increasing basic strength

    4) $B < C < O < N$ : increasing first ionization enthalpy

36. The major product obtained on interaction of phenol with sodium hydroxide and carbon dioxide is :

    1) benzoic acid        2) salicylaldehyde

    3) salicylic acid       4) phthalic acid

37. Which of the following statements is incorrect regarding physissorptions ?

    1) It occurs because of vander Waal's forces

    2) More easily liquefiable gases are absorbed readily

    3) Under high pressure it results into multi molecular layer on absorbent surface.

    4) Enthalpy of adsorption $(\Delta H_{adsorption})$ is low and positive

38. Which of the following on heating with aqueous KOH, produces acetaldehyde ?

    1) $CH_3 COCl$        2) $CH_3 CH_2 Cl$

    3) $CH_2 Cl\ CH_2 Cl$       4) $CH_3 CHCl_2$

39. In an atom, an electron is moving with a speed of 600 m/.s with an accuracy of 0.05%. Certainity with which the position of the electron can be located is (h = $6.6 \times 10^{-34}$ kgm²s⁻¹, mass of electron, $e_m = 9.1 \times 10^{-31}$ kg)

    1) $1.52 \times 10^{-4}$m        2) $5.10 \times 10^{-3}$m

    3) $1.92 \times 10^{-3}$ m       4) $3.84 \times 10^{-3}$ m

40. In a fuel cell methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is

    $CH_3OH_{(\ell)} + \frac{3}{2}O_{2(g)} \rightarrow CO_{2(g)} + 2H_{2(\ell)}$. At 298K standard Gibb's energies of formation for $CH_3OH_{(\ell)}, H_2O_{(\ell)}$ and $CO_{2(g)}$ are $-166.2, -237.2$ and $-394.4$ kJ mol⁻¹ respectively. If standard enthalpy of combustion of methanol is $-726$kJ mol⁻¹, efficiency of the fuel cell will be

    1) 80%     2) 87%     3) 90%     4) 97%

41. Two liquids X and Y form an ideal solution. At 300 K, vapour pressure of the solution containing 1 mol of X and 3 mol of Y is 550 mm Hg. At the same temperature, if 1 mol of Y is further added to this solution, vapour pressure of the solution increases by 10 mm Hg. Vapour pressure (in mm Hg) of X and Y in their pure states will be, respectively :

    1) 200 and 300        2) 300 and 400

    3) 400 and 600        4) 500 and 600

42. The half life period of a first order chemical reaction is 6.93 minutes. The time required for the completion of 99% of the chemical reaction will be (log 2 = 0.301) :

    1) 230.3 minutes      2) 23.03 minutes

    3) 46.06 minutes      4) 460.6 minutes

43. Given $E^0_{Fe^{3+}/Fe} = -0.036V$, $E^0_{Fe^{2+}/Fe} = -0.439V$. The value of standard electrode potential for the change, $Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)}$ will be :

    1) $-0.072$ V        2) 0.385 V

    3) 0.770 V           4) $-0.270$

44. On the basis of the following thermochemical data:

    $(\Delta fG^0 H^+_{(aq)} = 0)$

    $H_2O_{(\ell)} \rightarrow H^+_{(aq)} + OH^-_{(aq)}; \Delta H = 57.32$kJ

    $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(\ell)}; \Delta H = -286.20$kJ

The value of enthalpy of formation of $OH^-$ ion at $25^0C$ is :

1) $-22.88$ kJ      2) $-228.88$ kJ

3) $+228.88$ kJ      4) $-343.52$ kJ

45. Copper crystallizes in fcc with a unit cell length of 361 pm. What is the radius of copper atom ?

1) 108pm   2) 127pm   3) 157pm   4) 181pm

46. Which of the following has an optical isomer ?

1) $[CO(NH_3)_3Cl]^+$      2) $[CO(en)(NH_3)_2]^{2+}$

3) $[CO(H_2O)_4(en)]^{3+}$      4) $[CO(en)_2(NH_3)_2]^{3+}$

47. Solid $Ba(NO_3)_2$ is gradually dissolved in a $1.0 \times 10^{-4}M$ $Na_2CO_3$ solution. At what concentration of $Ba^{2+}$ will a precipitate begin to form ? ($K_{sp}$ for $BaCO_3 = 5.1 \times 10^{-9}$).

1) $4.1 \times 10^{-5}M$      2) $5.1 \times 10^{-5}M$

3) $8.1 \times 10^{-8}$ M      4) $8.1 \times 10^{-7}$ M

48. Which one of the following reactions of Xenon compounds is not feasible ?

1) $XeO_3 + 6HF \rightarrow XeF_6 + 3H_2O$

2) $3XeF_4 + 6H_2O \rightarrow 2Xe + XeO_3 + 12 HF + 1.5O_2$

3) $2XeF_2 + 2H_2O \rightarrow 2Xe + 4HF + O_2$

4) $XeF_6 + RbF \rightarrow Rb(XeF_7)$

49. Using MO theory predict which of the following species has the shortest bond length ?

1) $O_2^{2+}$     2) $O_2^+$     3) $O_2^-$     4) $O_2^{2-}$

50. In context with the transition elements, which of the following statements is incorrect ?

1) In addition to the normal oxidation states, the zero oxidation state is also shown by these elements in complexes

2) In the highest oxidation states, the transition metal show basic character and form cationic complexes.

3) In the highest oxidation states of the first five transition elements (Sc to Mn), all the 4s and 3d electrons are used for bonding.

4) Once the $d^5$ configuration is exceeded, the tendency to involve all the 3d electrons in bonding decreases.

51. Calculate the wavelength (in nanometer) associated with a proton moving at $1.0 \times 10^3ms^{-1}$ (Mass of proton $= 1.67 \times 10^{-27}kg$ and $h = 6.63 \times 10^{-34}$ Js) :

1) 0.032 nm      2) 0.40 nm

3) 2.5 nm      4) 14.0 nm

52. A binary liquid solution is prepared by mixing n-heptane and ethanol. Which one of the following statements is correct regarding the behaviour of the solution ?

1) The solution formed is an ideal solution

2) The solution is non-ideal, showing +ve deviation from Raoult's law.

3) The solution is non-ideal, showing –ve deviation from Raoult's law.

4) n-heptane shows +ve deviation while ethanol show – ve deviation from Raoult's law

53. The number of stereoisomers possible for a compound of the molecular formula $CH_3-CH=CH-CH(OH)-Me$ is :

1) 3      2) 2      3) 4      4) 6

54. The IUPAC name of neopentane is

1) 2-methylbutane      2) 2, 2-dimethylpropane

3) 2-methylpropane      4) 2, 2-dimethylbutane

55. The set representing the correct order of ionic radius is :

1) $Li^+ > Be^{2+} > Na^+ > Mg^{2+}$

2) $Na^+ > Li^+ > Mg^{2+} > Be^{2+}$

3) $Li^+ > Na^+ > Mg^{2+} > Be^{2+}$

4) $Mg^{2+} > Be^{2+} > Li^+ > Na^+$

56. The two functional groups present in a typical carbohydrate are :

1) –OH and – COOH      2) –CHO and – COOH

3) $> C = O$ and – OH      4) –OH and – CHO

57. The bond dissociation energy of B – F in $BF_3$ is 646 kJ $mol^{-1}$ where as that of C – F in $CF_4$ is 515 kJ $mol^{-1}$. The correct reason for higher B–F bond dissociation energy as compared to that of C – F is :

1) smaller size of B-atom as compared to that of C -atom

2) stronger $\sigma$ bond between B and F is $BF_3$ as compared to that between C and F in $CF_4$

3) significant $p\pi - p\pi$ interaction between B and F in $BF_3$ where as there is no possibility of such interaction between C and F in $CF_4$.

4) lower degree of $p\pi - p\pi$ interaction between B and F in $BF_3$ than that between C and F in $CF_4$.

58. In Cannizzaro reaction given below

    $2PhCHO \xrightarrow{:\overset{(-)}{OH}} PhCH_2OH + PhC\overset{..}{\underset{}{O}}{}_2^{(-)}$

    the slowest step is :
    1) the attack of : $OH^-$ at the carboxyl group
    2) the transfer of hydride to the carbonyl group
    3) the abstraction of proton from the carboxylic group
    4) the deprotonation of $Ph\ CH_2OH$

59. Which of the following pairs represents linkage isomers ?
    1) $\left[Cu(NH_3)_4\right]\left[PtCl_4\right]$ and $\left[Pt(NH_3)_4\right]\left[CuCl_4\right]$
    2) $\left[Pd(P\ Ph_3)_2(NCS)_2\right]$ and $\left[Pd(P\ Ph_3)_2(SCN)_2\right]$
    3) $\left[CO(NH_3)_5\ NO_3\right]SO_4$ and $\left[CO(NH_3)_5\ SO_4\right]NO_3$
    4) $\left[PtCl_2(NH_3)_4\right]Br_2$ and $\left[PtBr_2(NH_3)_4\right]Cl_2$

60. Buna- N synthetic rubber is a copolymer of :

    1) $H_2C = CH–\overset{Cl}{\underset{}{C}} = CH_2$ and $H_2C = CH–CH = CH_2$
    2) $H_2C = CH – CH = CH_2$ and $H_5C_6 – CH = CH_2$
    3) $H_2C = CH – CN$ and $H_2C = CH – CH = CH_2$
    4) $H_2C = CH – CN$ and $H_2C = CH – \underset{CH_3}{\overset{}{C}} = CH_2$

**PART-C : MATHEMATICS**

61. Let $a, b, c$ be such that $b(a+c) \ne 0$. If

    $\begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix} + \begin{vmatrix} a+1 & b+1 & c-1 \\ a-1 & b-1 & c+1 \\ (-1)^{n+2}a & (-1)^{n+1}b & (-1)^n c \end{vmatrix} = 0,$

    then the value of '$n$' is
    1) zero
    2) any even integer
    3) any odd integer
    4) any integer

62. If the mean deviation of number $1, 1+d, 1 + 2d,..., 1 + 100d$ from their mean is 255, then the $d$ is equal to
    1) 10.0      2) 20.0      3) 10.1      4) 20.2

63. If the roots of the equation $bx^2 + cx + a = 0$ be imaginary, then for all real values of $x$, the expression $3b^2x^2 + 6bcx + 2c^2$ is
    1) greater than $4ab$      2) less than $4ab$
    3) greater than $-4ab$     4) less than $-4ab$

64. Let $A$ and $B$ denote the statements
    $A : \cos\alpha + \cos\beta + \cos\gamma = 0$
    $B : \sin\alpha + \sin\beta + \sin\gamma = 0$
    If $\cos(\beta-\gamma) + \cos(\gamma-\alpha) + \cos(\alpha-\beta) = -\dfrac{3}{2}$, then
    1) A is true and B is false
    2) A is false and B is true
    3) both A and B are true
    4) both A and B are false

65. The lines
    $p(p^2 + 1)x – y + q = 0$ and $(p^2+1)^2x + (p^2+ 1)y + 2q = 0$
    are perpendicular to a common line for
    1) no value of $p$
    2) exactly one value of $p$
    3) exactly two values of $p$
    4) more than two values of $p$

66. If A, B and C are three sets such that $A \cap B = A \cap C$ and $A \cup B = A \cup C$, then
    1) $A = B$                2) $A = C$
    3) $B = C$                4) $A \cap B = \phi$

67. If $\vec{u}, \vec{v}, \vec{w}$ are non-coplanar vectors and $p, q$ are real numbers, then the equality
    $[3\vec{u}\ p\vec{v}\ p\vec{w}] - [p\vec{v}\ \vec{w}\ q\vec{u}] - [2\vec{w}\ p\vec{v}\ q\vec{u}] = 0$ holds for
    1) exactly one value of $(p, q)$
    2) exactly two values of $(p, q)$
    3) more than two but not all values of $(p, q)$
    4) all values of $(p, q)$

68. Let the line $\dfrac{x-2}{3} = \dfrac{y-1}{-5} = \dfrac{z+2}{2}$ lies in the plane
    $x + 3y - \alpha z + \beta = 0$. Then $(\alpha, \beta)$ equals
    1) (6, –17)               2) (–6, 7)
    3) (5, –15)               4) (–5, 15)

69. From 6 different novels and 3 different dictionaries, 4 novels and dictionary are to be selected and arranged in a row on the shelf so that the dictionary is always in the middle. Then the number of such arrangements is
    1) less than 500
    2) at least 500 but less than 750
    3) at least 750 but less than 1000
    4) at least 1000

70. $\int_{0}^{\pi}[\cot x]dx, [\bullet]$ denotes the greatest integer function, is equal to

1) $\frac{\pi}{2}$   2) 1   3) –1   4) $-\frac{\pi}{2}$

71. For real $x$, let $f(x) = x^3 + 5x + 1$, then
   1) $f$ is one-one but not onto $R$
   2) $f$ is onto $R$ but not one-one
   3) $f$ is one-one and onto $R$
   4) $f$ is neither one-one nor onto $R$

72. In a binomial distribution $B\left(n, p=\frac{1}{4}\right)$, if the probability of at least one success is greater than or equal to $\frac{9}{10}$, then n is greater than

1) $\frac{1}{\log_{10}^{4} - \log_{10}^{3}}$   2) $\frac{1}{\log_{10}^{4} + \log_{10}^{3}}$

3) $\frac{9}{\log_{10}^{4} - \log_{10}^{3}}$   4) $\frac{4}{\log_{10}^{4} - \log_{10}^{3}}$

73. If $P$ and $Q$ are the points of intersection of the circles $x^2 + y^2 + 3x + 7y + 2p - 5 = 0$ and $x^2 + y^2 + 2x + 2y - p^2 = 0$, then there is a circle passing through $P, Q$ and (1, 1) for
   1) all values of $p$
   2) all except one value of $p$
   3) all except two values of $p$
   4) exactly one value of $p$

74. The projections of a vector on the three coordinate axis are 6, –3, 2 respectively. The direction cosines of the vector are

1) 6, –3, 2   2) $\frac{6}{5}, -\frac{3}{5}, \frac{2}{5}$

3) $\frac{6}{7}, -\frac{3}{7}, \frac{2}{7}$   4) $-\frac{6}{7}, -\frac{3}{7}, \frac{2}{7}$

75. If $\left|Z - \frac{4}{Z}\right| = 2$, then the maximum value of $|Z|$ is equal to
   1) $\sqrt{3}+1$   2) $\sqrt{5}+1$   3) 2   4) $2+\sqrt{2}$

76. Three distinct points $A, B$ and $C$ are given in the 2–dimensional coordinate plane such that the ratio of the distance of any one of them from the point (1,0) to the distance from the point (–1, 0) is equal to $\frac{1}{3}$. Then the circumcentre of the triangle $ABC$ is at the point

1) (0, 0)   2) $\left(\frac{5}{4}, 0\right)$

3) $\left(\frac{5}{2}, 0\right)$   4) $\left(\frac{5}{3}, 0\right)$

77. The remainder left out when $8^{2n} - (62)^{2n+1}$ is divided by 9 is
   1) 0   2) 2   3) 7   4) 8

78. The ellipse $x^2 + 4y^2 = 4$ is inscribed in a rectangle aligned with the coordinate axes, which in turn in inscribed in another ellipse that passes through the point (4, 0). Then the equation of the ellipse is
   1) $x^2 + 16y^2 = 16$   2) $x^2 + 12y^2 = 16$
   3) $4x^2 + 48y^2 = 48$   4) $4x^2 + 64y^2 = 48$

79. The sum to the infinity of the series
   $1 + \frac{2}{3} + \frac{6}{3^2} + \frac{10}{3^3} + \frac{14}{3^4} + ....$ is
   1) 2   2) 3   3) 4   4) 6

80. The differential equation which represents the family of curves $y = c_1 e^{c_2 x}$, where $c_1$ and $c_2$ are arbitrary constants is
   1) $y' = y^2$   2) $y'' = y'y$
   3) $yy'' = y'$   4) $yy'' = (y')^2$

81. One ticket is selected at random from 50 tickets numbered 00, 01, 02,......, 49. Then the probability that the sum of the digits on the selected ticket is 8, given that the product of these digits is zero, equals

1) $\frac{1}{14}$   2) $\frac{1}{7}$   3) $\frac{5}{14}$   4) $\frac{1}{50}$

82. Let $y$ be an implicit function of $x$ defined by $x^{2x} - 2x^x \cot y - 1 = 0$. Then $y'(1)$ equals
   1) –1   2) 1   3) log2   4) –log2

83. The area of the region bounded by the parabola $(y-2)^2 = x - 1$, the tangent to the parabola at the point (2, 3) and the $x$-axis is
   1) 3       2) 6       3) 9       4) 12

84. Given $P(x) = x^4 + ax^3 + bx^2 + cx + d$ such that $x=0$ is the only real root of $P'(x) = 0$. If $P(-1)<P(1)$, then in the interval $[-1, 1]$
   1) $P(-1)$ is the minimum and $P(1)$ is the maximum of $P$
   2) $P(-1)$ is not minimum but $P(1)$ is the maximum of $P$
   3) $P(-1)$ is the minimum and $P(1)$ is not the maximum of $P$
   4) Neither $P(-1)$ is the minimum nor $P(1)$ is the maximum of $P$

85. The shortest distance between the line $y - x = 1$ and the curve $x = y^2$ is
   1) $\dfrac{3\sqrt{2}}{8}$     2) $\dfrac{2\sqrt{3}}{8}$     3) $\dfrac{3\sqrt{2}}{5}$     4) $\dfrac{\sqrt{3}}{4}$

86. Let $f(x) = (x +1)^2 -1,\ x \geq -1$
   Statement-1 : The set $\{x : f(x) = f^{-1}(x)\} = \{0, -1\}$
   Statement-2 : f is a bijection
   1) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1
   2) Statement-1 is true, Statement-2 is true; Statement-2 is not correct explanation for Statement-1
   3) Statement-1 is true, Statement-2 is false
   4) Statement-1 is false, Statement-2 is true

87. Let $f(x) = x|x|$ and $g(x) = \sin x$
   **Statement-1 :** gof is differentiable at $x = 0$ and its derivative is continuous at that point.
   **Statement-2 :** gof is twice differentiable at x=0.
   1) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1
   2) Statement-1 is true, Statement-2 is true; Statement-2 is not correct explanation for Statement-1
   3) Statement-1 is true, Statement-2 is false
   4) Statement-1 is false, Statement-2 is true

88. **Statement-1 :** The variance of first $n$ even natural numbers is $\dfrac{n^2 - 1}{4}$
   **Statement-2 :** The sum of first $n$ natural numbers is $\dfrac{n(n+1)}{2}$ and the sum of squares of first $n$ natural numbers is $\dfrac{n(n+1)(2n+1)}{6}$
   1) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1
   2) Statement-1 is true, Statement-2 is true; Statement-2 is not correct explanation for Statement-1
   3) Statement-1 is true, Statement-2 is false
   4) Statement-1 is false, Statement-2 is true

89. **Statement-1 :** $\sim(p \leftrightarrow \sim q)$ is equivalent to $p \leftrightarrow q$
   **Statement-2 :** $\sim(p \leftrightarrow \sim q)$ is a tautology.
   1) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1
   2) Statement-1 is true, Statement-2 is true; Statement-2 is not correct explanation for Statement-1
   3) Statement-1 is true, Statement-2 is false
   4) Statement-1 is false, Statement-2 is true

90. Let $A$ be a $2 \times 2$ matrix
   Statement-1 : adj(adj A) = A
   Statement-2 : |adj A| = |A|
   1) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1
   2) Statement-1 is true, Statement-2 is true; Statement-2 is not correct explanation for Statement-1
   3) Statement-1 is true, Statement-2 is false
   4) Statement-1 is false, Statement-2 is true

## AIEEE 2009 ANSWERS

### PART-A : PHYSICS

| | | | | |
|---|---|---|---|---|
| 1) **2** | 2) **1** | 3) **3** | 4) **1** | 5) **2** |
| 6) **1** | 7) **4** | 8) **3** | 9) **4** | 10) **2** |
| 11) **1** | 12) **2** | 13) **2** | 14) **3** | 15) **4** |
| 16) **2** | 17) **2** | 18) **2** | 19) **3** | 20) **1** |
| 21) **2** | 22) **4** | 23) **3** | 24) **1** | 25) **4** |
| 26) **1** | 27) **4** | 28) **3** | 29) **1** | 30) **2** |

### PART-B : CHEMISTRY

| | | | | |
|---|---|---|---|---|
| 31) **3** | 32) **4** | 33) **3** | 34) **3** | 35) **3** |
| 36) **3** | 37) **4** | 38) **4** | 39) **3** | 40) **4** |
| 41) **3** | 42) **3** | 43) **3** | 44) **2** | 45) **2** |

| | | | | |
|---|---|---|---|---|
| 46) **4** | 47) **2** | 48) **1** | 49) **1** | 50) **2** |
| 51) **2** | 52) **2** | 53) **3** | 54) **2** | 55) **2** |
| 56) **3** | 57) **3** | 58) **2** | 59) **2** | 60) **3** |

### PART-C : MATHEMATICS

| | | | | |
|---|---|---|---|---|
| 61) **3** | 62) **3** | 63) **3** | 64) **3** | 65) **2** |
| 66) **3** | 67) **1** | 68) **2** | 69) **4** | 70) **4** |
| 71) **3** | 72) **1** | 73) **1** | 74) **3** | 75) **2** |
| 76) **2** | 77) **2** | 78) **2** | 79) **2** | 80) **4** |
| 81) **1** | 82) **1** | 83) **3** | 84) **2** | 85) **1** |
| 86) **3** | 87) **3** | 88) **4** | 89) **3** | 90) **2** |

## AIEEE 2009 HINTS AND SOLUTIONS
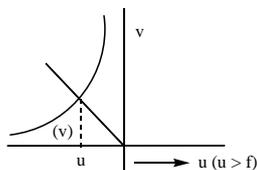
### PART-A : PHYSICS

1. **(2)** Work done by conservative force does not depend on the path. Electrostatic force is a conservative force.

2. **(1)** 1st reaction is fusion and 4th reaction is fission.

3. **(3)** Given figure is half wave rectifier.

4. **(1)** Truth Table

| A | B | Y |
|---|---|---|
| 1 | 1 | 1 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 0 | 0 | 0 |
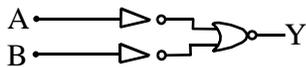
*5. **(2)** $\frac{aT}{x} = \frac{\omega^2 \times T}{x} = \frac{4\pi^2}{T^2} \times T = \frac{4\pi^2}{T}$ = constant.

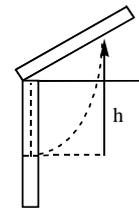6. **(1)** It is possible when object kept at centre of curvature.
$u = v$
$u = 2f, v = 2f$.

*7. **(4)** $T.E._i = T.E._f$
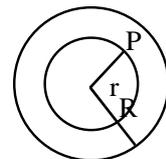$\frac{1}{2}I\omega^2 = mgh$
$\frac{1}{2} \times \frac{1}{3}ml^2\omega^2 = mgh$
$\Rightarrow h = \frac{1}{6}\frac{l^2\omega^2}{g}$

8. **(3)** $E4\pi r_1^2 = \frac{\int_0^{r_1}\frac{Q}{\pi R^4}r4\pi r^2 dr}{\varepsilon_0}$
$\Rightarrow E = \frac{Qr_1^2}{4\pi\varepsilon_0 R^4}$

9. **(4)** IR corresponds to least value of $\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$
i.e. from paschen, Bracket and Pfund series. Thus the transition corresponds to $5 \rightarrow 4$.

*10. **(2)** Thermal energy corresponds to internal energy
Mass = 1kg
density = 8 kg/m$^3$
$\Rightarrow$ Volume = $\frac{mass}{density} = \frac{1}{8}$ m$^3$

Pressure $= 8 \times 10^4$ N/m$^2$

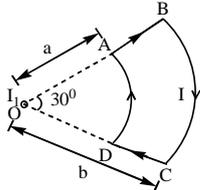$\therefore$ Internal Energy $= \dfrac{5}{2} P \times V = 5 \times 10^4$ J

11. **(1)**

12. **(2)** Net magnetic field due to loop ABCD at O is

$B = B_{AB} + B_{BC} + B_{CD} + B_{DA}$

$= 0 + \dfrac{\mu_0 I}{4\pi a} \times \dfrac{\pi}{6} + 0 - \dfrac{\mu_0 I}{4\pi b} \times \dfrac{\pi}{6}$

$= \dfrac{\mu_0 I}{24a} - \dfrac{\mu_0 I}{24b} = \dfrac{\mu_0 I}{24ab}(b - a)$

13. **(2)** The forces on AD and BC are zero because magnetic field due to a straight wire on AD and BC is parallel to elementary length of the loop.

14. **(3)** $3\lambda_1 = 4\lambda_2$

$\Rightarrow \lambda_2 = \dfrac{3}{4}\lambda_1 = \dfrac{3}{4} \times 590 = \dfrac{1770}{4} = 442.5$nm

15. **(4)** W=QdV=Q($V_q$-$V_p$)=

$\qquad 100 \times (1.6 \times 10^{-19}) \times (-4 - 10)$

$= + 100 \times 1.6 \times 10^{-19} \times 14 = +2.24\ 10^{-16}$J.

16. **(2)** $\dfrac{1}{2}mv^2 = eV_0 = 1.68$eV $\Rightarrow$

$h\nu = \dfrac{hc}{\lambda} = \dfrac{1240\text{evnm}}{400\text{nm}} = 3.1$eV $\Rightarrow$

$3.1$eV $= W_0 + 1.6$eV

$\therefore W_0 = 1.42$eV

*17. **(2)** $\vec{u} = 3\hat{i} + 4\hat{j}$; $\vec{a} = 0.4\hat{i} + 0.3\hat{j}$

$\vec{u} = \vec{u} + \vec{a}t$

$= 3\hat{i} + 4\hat{j} + (0.4\hat{i} + 0.3\hat{j})10 = 3\hat{i} + \hat{j} + 4\hat{i} + 3\hat{j} = 7\hat{i} + 7\hat{j}$

Speed is $\sqrt{7^2 + 7^2} = 7\sqrt{2}$ units

*18. **(2)** Motor cycle, u = 0, a = 2 m/s$^2$

Observer is in motion and source is at rest.

$\Rightarrow n' = n\dfrac{v - v_0}{v + v_s} \Rightarrow \dfrac{94}{100}n = n\dfrac{330 - v_0}{330} \Rightarrow$

$330 - v_0 = \dfrac{330 \times 94}{100}$

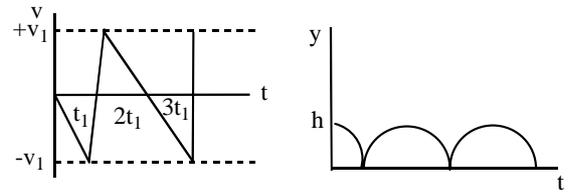$\Rightarrow v_0 = 330 - \dfrac{94 \times 33}{10} = \dfrac{33 \times 6}{10}$ m/s

$s = \dfrac{v^2 - u^2}{2a} = \dfrac{9 \times 33 \times 33}{100} = \dfrac{9 \times 1089}{100} \approx 98$m

*19. **(3)** $h = \dfrac{1}{2}gt^2$

v = –gt and after the collision, v = gt.
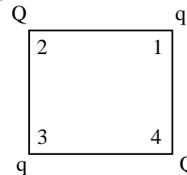(parabolic)                 (straight line)

Collision is perfectly elastic then ball reaches to same height again and again with same velocity.

20. **(1)** Three forces $F_{41}$, $F_{42}$ and $f_{43}$ acting on Q are shown

Resultant of $F_{41} + F_{43} = \sqrt{2} F_{each} = \sqrt{2}\dfrac{1}{4\pi\varepsilon_0}\dfrac{Qq}{d^2}$

Resultant on Q becomes zero only when 'q' charges are of negative nature.

$F_{4,2} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{Q \times Q}{\left(\sqrt{2}d\right)^2}$ $\Rightarrow \sqrt{2}\dfrac{dQ}{d^2} = \dfrac{Q \times Q}{2d^2}$

$\Rightarrow \sqrt{2} \times q = \dfrac{Q \times Q}{2}$ $\therefore q = -\dfrac{Q}{2\sqrt{2}}$ or $\dfrac{Q}{q} = -2\sqrt{2}$

*21. **(2)** We know that $\dfrac{dQ}{dt} = KA\dfrac{d\theta}{dx}$

In steady state flow of heat

$d\theta = \dfrac{dQ}{dt} \cdot \dfrac{1}{kA} \cdot dx$

$\Rightarrow \theta_H - \theta = k'x \Rightarrow \theta = \theta_H - k'x$

Equation $\theta - \theta_H - k'x$ represents a straight line.

22. **(4)** $\sin C = \dfrac{\sqrt{3}}{2}$ .................. (1)

$\sin r = \sin (90 - C) = \cos C = \dfrac{1}{2}$

$$\frac{\sin\theta}{\sin r} = \frac{\mu_2}{\mu_1}$$

$$\sin\theta = \frac{2}{\sqrt{3}} \times \frac{1}{2}$$

$$\theta = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$$

*23. **(3)** Maximum number of beats = $v + 1 - (v - 1) = 2$

$$y_1 + y_2 + y_3 = (a \sin 2\pi vt + a \sin 2\pi 2vt + a \sin 2\pi 3vt) \text{ and proceed.}$$

*24. **(1)** $g' = \dfrac{GM}{(R+h)^2}$, acceleration due to gravity at height h

$$\Rightarrow \frac{g}{9} = \frac{GM}{R^2} \cdot \frac{R^2}{(R+h)^2} = g\left(\frac{R}{R+h}\right)^2$$

$$\Rightarrow \frac{1}{9} = \left(\frac{R}{R+h}\right)^2 \Rightarrow \frac{R}{R+h} = \frac{1}{3}$$

$$\Rightarrow 3R = R + h \Rightarrow 2R = h$$

*25. **(4)** $A_1 l_1 = A_2 l_2 \Rightarrow l_2 = \dfrac{A_1 l_1}{A_2}$

$$= \frac{A \times l_1}{3A} = \frac{l_1}{3} \Rightarrow \frac{l_1}{l_2} = 3$$

$$\Delta x_1 = \frac{F_1}{A\gamma} \times l_1 \qquad \text{.......... (i)}$$

$$\Delta x_2 = \frac{F_2}{3A\gamma} l_2 \qquad \text{.......... (ii)}$$

Here $\Delta x_1 = \Delta x_2$

$$\frac{F_2}{3A\gamma} l_2 = \frac{F_1}{A\gamma} l_1 \quad F_2 = 3F_1 \times \frac{l_1}{l_2} = 3F_1 \times 3 = 9F$$
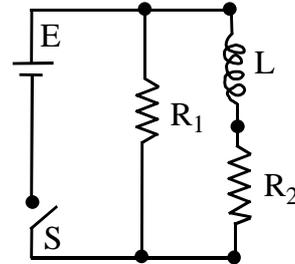
*26. **(1)** Least count $= \dfrac{\text{value of main scale division}}{\text{No of divisions on vernier scale}}$

$$= \frac{1}{30} MSD = \frac{1}{30} \times \frac{1°}{2} = \frac{1°}{60} = 1 \text{ minute}$$

27. **(4)** $I_1 = \dfrac{F}{R_1} = \dfrac{12}{2} = 6A \qquad E = L\dfrac{d I_2}{dt} + R_2 \times I_2$

$$I_2 = I_o(1 - e^{-t/t_0}) \Rightarrow I_o = \frac{E}{R_2} = \frac{12}{2} = 6A$$
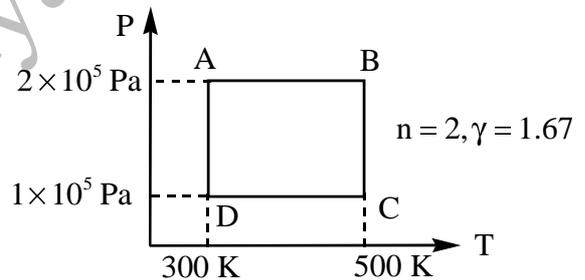
$$t_o = \frac{L}{R} = \frac{400 \times 10^{-3}}{2} = 0.2$$



$$I_2 = 6(1 - e^{-t/0.2})$$

Potential drop across L = $E - R_2 I_2 =$

$$12 - 2 \times 6 (1 - e^{-bt}) = 12 e^{-5t}$$

*28. **(3)** $W_{AB} = \Delta Q - \Delta U = nC_p dT - nC_v dT$

(at constant pressure)



$$= n(C_p - C_v)dt$$

$$= nRdT = 2 \times R \times (500 - 300) = 400 R$$

*29. **(1)** At constant temperature (isothermal process)

$$W_{DA} = nRT \ln\left(\frac{P_1}{P_2}\right) = 2.303 \times 2R \times 300 \log\left(\frac{10^5}{2 \times 10^5}\right)$$

$$= 2.303 \times 600R \log\left(\frac{1}{2}\right) = 0.693 \times 600R = 414R .$$

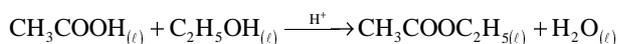*30. **(2)** Net work done in a cycle = $W_{AB} + W_{CB} + W_{BA}$

$$= 400 R + 2 \times 2.303 \times 500R \ln 2 - 400R - 414 R$$

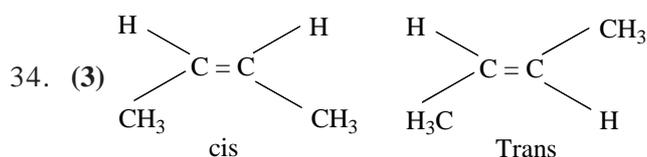$$= 1000 R \times \ln 2 - 600R \times \ln 2$$

$$= 400R \times \ln 2 = 276R$$

## PART-B : CHEMISTRY

31. **(3)** $Ln^{+3}$ compounds are mostly coloured.

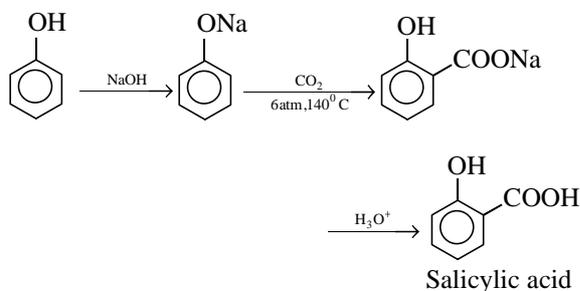32. **(4)** Esterification reaction is involved

$$CH_3COOH_{(\ell)} + C_2H_5OH_{(\ell)} \xrightarrow{H^+} CH_3COOC_2H_{5(\ell)} + H_2O_{(\ell)}$$

33. **(3)** $2^0$ carbanion is more stable than $3^0$. Chlorine causes –I effect.

34. **(3)**



35. **(3)** correct basic strength is :
$$NH_3 > PH_3 > AsH_3 > BiH_3$$

36. **(3)** Kolbe – Schmidt reaction is



Salicylic acid

37. **(4)** Enthalpy of adsorption regarding physissorption is not positive and it is negative.

38. **(4)**

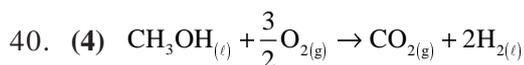$$CH_3CHCl_2 \xrightarrow{aq.KOH} CH_3CH \xrightarrow{-H_2O} CH_3CHO$$
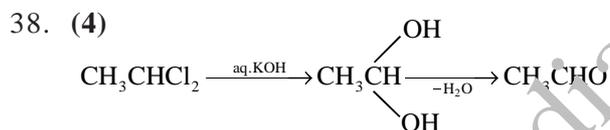
39. **(3)** $\Delta x.m\Delta v = \dfrac{h}{4\pi}$

$$\Delta x = \dfrac{h}{4\pi\, m\Delta v}$$

$$\Delta v = 600 \times \dfrac{0.005}{100} = 0.03$$

$$\Rightarrow \Delta x = \dfrac{6.625 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 0.03} = 1.92 \times 10^{-3}\,m$$

40. **(4)** $CH_3OH_{(\ell)} + \dfrac{3}{2}O_{2(g)} \rightarrow CO_{2(g)} + 2H_{2(\ell)}$

$\Delta H = -726$ kJ $mol^{-1}$

Also $\Delta G^0_f CH_3OH_{(\ell)} = -1662.kJmol^{-1}$

$\Delta G^0_f H_2O_{(\ell)} = -237.2 kJmol^{-1}$

$\Delta G^0_f CO_{2(\ell)} = -394.4 kJmol^{-1}$

$\because \Delta G = \sum \Delta G^0_r \text{products} - \sum \Delta G^0_r \text{ reactants}$

$= -394.4 - 2(237.2) + 166.2 = -702.6$ kJ $mol^{-1}$

Now efficiency of fuel cell $= \dfrac{\Delta G}{\Delta H} \times 100$

$$= \dfrac{702.6}{726} \times 100 = 97\%$$

41. **(3)** $P_T = P^0_x X_x + P^0_Y X_Y$

$X_x$ = mol fraction of X

$X_y$ = mol fraction of Y

$$\therefore 550 = P^0_x \left(\dfrac{1}{1+3}\right) + P^0_Y\left(\dfrac{3}{1+3}\right) = \dfrac{P^0_x}{4} + \dfrac{3P^0_Y}{4}$$

$$\therefore 550(4) = P^0_x + 3P^0_Y \quad .........(1)$$

Further 1 mol of Y is added and total pressure increases by 10 mm Hg.

$$\therefore 550 + 10 = P^0_x\left(\dfrac{1}{1+4}\right) + P^0_Y\left(\dfrac{4}{1+4}\right)$$

$$\therefore 560(5) = P^0_x + 4P^0_Y \quad ............. (2)$$

By solving (1) and (2)

We get $P^0_x = 400$ mm Hg

$P^0_Y = 600$ mm Hg

42. **(3)** $\because \lambda = \dfrac{0.6932}{t_{1/2}} = \dfrac{0.6392}{6.93} min^{-1}$

Also $t = \dfrac{2.303}{\lambda} \log \dfrac{[A_0]}{[A]}$

$[A_0]$ = initial concentration (amount)

$[A]$ = final concentration (amount)

$$\therefore t = \dfrac{2.303 \times 6.93}{0.6932} \log \dfrac{100}{1} = 46.06 \text{ minutes}$$

43. **(3)** $\because Fe^{3+} + 3e^- \rightarrow Fe ; E^0 = -0.036V$

$\therefore \Delta G^0_1 = -nFE^0 = -3F(-0.036) = +0.108F$

Also $Fe^{2+} + 2e^- \rightarrow Fe$ ; $E^0 = -0.439$ V

$\therefore \Delta G^0_2 = -nFE^0 = -2F(-0.439) = 0.878$ F
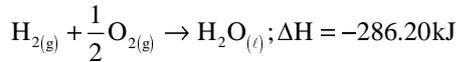
To find $E^0$ for $Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)}$

$\Delta G^0 = -nFE^0 = -1FE^0$

$\because G^0 = G^0_1 - G^0_2$

$\therefore G^0 = 0.108F - 0.878$ F

$\therefore E^0 = 0.878 - 0.108 = 0.77$ V

44. **(2)** By adding the two given equations, we have

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(\ell)}; \Delta H = -286.20 kJ$$

Here $\Delta H_f^0$ of $H_{(aq)}^+ = 0$

$\therefore \Delta H_f^0$ of $OH^- = -228.88$ kJ

45. **(2)** for FCC,

$\sqrt{2}a = 4r$ (the atoms touches each other along the face - diagonal)

$$r = \frac{\sqrt{2}a}{4} = \frac{\sqrt{2} \times 361}{4} = 127 \text{ pm}$$

46. **(4)** It is an octahedral complex of the type $[M(AA)_2X_2]$ where AA is bidentate ligand.

47. **(2)** $Ba(NO_3)_2 + CaCO_3 \rightarrow BaCO_3 + 2NaNO_3$

Here $\left[CO_3^{-2}\right] = [Na_2CO_3] = 10^{-4}M$

$K_{sp} = [Ba^{+2}]\left[CO_3^{-2}\right] \Rightarrow 5.1 \times 10^{-9} = [Ba^{2+}](10^{-4})$

$\Rightarrow [Ba^{2+}] = 5.1 \times 10^{-5}$

At this value, just precipitation starts.

48. **(1)** Remaining reactions are feasible

49. **(1)** Bond length $\alpha \dfrac{1}{\text{bond order}}$

Bond order $= \dfrac{\text{no.of bonding } \bar{e} - \text{no.of antibonding } \bar{e}}{2}$

Bond orders of $O_2^+$, $O_2^-$, $O_2^{-2}$ and $O_2^{+2}$ are respectively : 2.5, 1.51, 1 and 3.

50. **(2)** In higher oxidation states transition elements show acidic nature

51. **(2)** $\lambda = \dfrac{h}{mv} = \dfrac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 10^3} \equiv 0.40 \text{nm}$

52. **(2)** The interactions between n-heptane and ethanol are weaker than that in pure components.

53. **(3)** About the double bond, two geometrical isomers are possible and the compound is having one chiral carbon.

54. **(2)** Neopentane is $H_2C - \overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}} - CH_3$
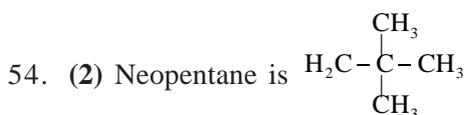
55. **(2)** Follow the periodic trends of ionic radii)

56. **(3)** Carbohydrates are polyhydroxy carbonyl compounds.

57. **(3)** Given option itself is the reason

58. **(2)** Hydride transfer is the slowest step.

59. **(2)** $NCS^-$ is ambidentate ligand and it can be linked through N (or) S

60. **(3)** Acxilonitrile and 1, 3–butdiene are momers of Buna-N.

## PART-C : MATHEMATICS

61. **(3)**

Sol. $\begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix} + (-1)^n \begin{vmatrix} a+1 & b+1 & c-1 \\ a-1 & b-1 & c+1 \\ a & -b & c \end{vmatrix} =$

$\begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & c-1 \\ c & c-1 & c+1 \end{vmatrix} + (-1)^n \begin{vmatrix} a+1 & a-1 & a \\ b+1 & b-1 & -b \\ c-1 & c+1 & c \end{vmatrix}$

$= \begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix} + (-1)^{n+1} \begin{vmatrix} a+1 & a & a-1 \\ b+1 & -b & b-1 \\ c-1 & c & c+1 \end{vmatrix}$

$= \begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix} + (-1)^{n+2} \begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix}$

This is equal to zero only if $n + 2$ is odd i.e. $n$ is odd integer.

62. **(3)**

$\text{Mean}(\bar{x}) = \dfrac{\text{sum of quantities}}{n} = \dfrac{\frac{n}{2}(a+1)}{n}$

$= \dfrac{1}{2}[1 + 1 + 100d] = 1 + 50d$

$M.D = \dfrac{1}{n}\Sigma|x_i - \bar{x}|$

$\Rightarrow 255 = \dfrac{1}{101}[50d + 49d + ....d + 0 + d + .... + 50d]$

$= \dfrac{2d}{101}\left[\dfrac{50 \times 51}{2}\right]$

$\Rightarrow d = \dfrac{255 \times 101}{50 \times 51} = 10.1$

63. **(3)** $bx^2 + cx + a = 0$

Roots are imaginary

$\Rightarrow c^2 - 4ab < 0 \Rightarrow c^2 < 4ab \Rightarrow -c^2 > -4ab$

$3b^2x^2 + 6bcx + 2c^2$

since $3b^2 > 0$

Given expression has minimum value

Minimum value $= \dfrac{4(3b^2)(2c^2) - 36b^2c^2}{4(3b^2)}$

$= -\dfrac{12b^2c^2}{12b^2} = -c^2 > -4ab$

64. **(3)** $\cos(\beta - \gamma) + \cos(\gamma - \alpha) + \cos(\alpha - \beta) = -\dfrac{3}{2}$

$\Rightarrow 2\left[\cos(\beta - \gamma) + \cos(\gamma - \alpha) + \cos(\alpha - \beta)\right] + 3 = 0$

$\Rightarrow 2\left[\cos(\beta - \gamma) + \cos(\gamma - \alpha) + \cos(\alpha - \beta)\right] +$

$\sin^2\alpha + \cos^2\alpha + \sin^2\beta + \cos^2\beta + \sin^2\gamma + \cos^2\gamma = 0$

$\Rightarrow (\sin\alpha + \sin\beta + \sin\gamma)^2 + (\cos\alpha + \cos\beta + \cos\gamma)^2 = 0$

65. **(2)** Lines must be parallel, therefore slopes are equal

$\Rightarrow p(p^2 + 1) = -(p^2 + 1) \Rightarrow p = -1$

66. **(3)** $A \cap B - A \cap C = 0 \ \& \ A \cup B - A \cup C = 0$

$A \cap (B - C) = 0 \ \& \ A \cup (B - C) = 0$

Both possible if $\boxed{B = C}$

67. **(1)** $\left(3p^2 - pq + 2q^2\right)\left[\vec{u}\ \vec{v}\ \vec{w}\right] = 0$

But $\left[\vec{u}\ \vec{v}\ \vec{w}\right] \neq 0$

$3p^2 - pq + 2q^2 = 0$

$2p^2 + p^2 - pq + \left(\dfrac{q}{2}\right)^2 + \dfrac{7q^2}{4} = 0$

$\Rightarrow 2p^2 + \left(p - \dfrac{q}{2}\right)^2 + \dfrac{7}{4}q^2 = 0$

$\Rightarrow p = 0, \ q = 0, \ p = \dfrac{q}{2}$

This possible only when $p = 0$, $q = 0$ exactly one value of $(p, q)$

68. **(2)** Dr's of line $= (3, -5, 2)$

Dr's of normal to the plane $= (1, 3, -\alpha)$

Line is perpendicular to normal

$\Rightarrow 3(1) - 5(3) + 2(-\alpha) = 0 \Rightarrow 3 - 15 - 2\alpha = 0$

$\Rightarrow 2\alpha = -12 \Rightarrow \alpha = -6$

Also $(2, 1, -2)$ lies on the plane

$2 + 3 + 6(-2) + \beta = 0 \Rightarrow \beta = 7 \quad \therefore (\alpha, \beta) = (-6, 7)$

69. **(4)** 4 novels can be selected from 6 novels in $^6C_4$ ways. 1 dictionary can be selected from 3 dictionaries in $^3C_1$ ways. As the dictionary selected is fixed in the middle, the remaining 4 novels can be arranged in 4! ways.

$\therefore$ The required number of ways of arrangement

$= {}^6C_4 \times {}^3C_1 \times 4! = 1080$

70. **(4)** Let $I = \displaystyle\int_0^\pi [\cot x] dx$     ....(1)

$I = \displaystyle\int_0^\pi [\cot(\pi - x)] dx = \int_0^\pi [-\cot x] dx$     ....(2)

Adding (1) and (2)

$2I = \displaystyle\int_0^\pi [\cot x] dx + \int_0^\pi [-\cot x] dx = \int_0^\pi [-1] dx$

$\left[\because [x] + [-x] = -1 \text{ if } x \notin Z \atop \qquad\qquad\quad = 0 \text{ if } x \in Z\right]$

$= [-x]_0^\pi = -\pi \quad \therefore I = -\dfrac{\pi}{2}$

71. **(3)** Given $f(x) = x^3 + 5x + 1$

Now $f'(x) = 3x^2 + 5 > 0, \ \forall x \in R$

$\therefore$ $f(x)$ is strictly increasing function

$\therefore$ It is one-one

Clearly, $f(x)$ is a continuous function and also increasing on $R$,

$\underset{x \to -\infty}{lt} f(x) = -\infty$ and $\underset{x \to \infty}{lt} f(x) = \infty$

$\therefore$ $f(x)$ takes every value between $-\infty$ and $\infty$

Thus, $f(x)$ is onto function.

72. **(1)** $1 - q^n \geq \dfrac{9}{10} \Rightarrow \left(\dfrac{3}{4}\right)^n \leq \dfrac{1}{10}$

$\Rightarrow n \geq -\log_{3/4} 10 \Rightarrow n \geq \dfrac{1}{\log_{10}^4 - \log_{10} 3}$

73. **(1)** Given circles

$S = x^2 + y^2 + 3x + 7y + 2p - 5 \ 0$

$S' = x^2 + y^2 + 2x + 2y - p^2 = 0$

Equation of required circle is $S + \lambda S' = 0$

As it passes through (1, 1) the value of

$$\lambda = \frac{-(7+2p)}{(6-p^2)}$$

If $7 + 2p = 0$, it becomes the second circle

∴ it is true for all values of $p$

74. **(3)** Projection of a vector on coordinate axis are
$x_2 - x_1, y_2 - y_1, z_2 - z_1$
$x_2 - x_1 = 6, y_2 - y_1 = -3, z_2 - z_1 = 2$

$$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2} =$$

$$\sqrt{36+9+4} = 7$$

The D.C's of the vector are $\frac{6}{7}, -\frac{3}{7}, \frac{2}{7}$

75. **(2)** $|Z|\left|\left(Z - \frac{4}{Z}\right) + \frac{4}{Z}\right| \Rightarrow |Z| = \left|Z - \frac{4}{Z} + \frac{4}{Z}\right|$

$$\Rightarrow |Z| \le \left|Z - \frac{4}{Z}\right| + \frac{4}{|Z|} \Rightarrow |Z| \le 2 + \frac{4}{|Z|}$$

$$\Rightarrow |Z|^2 - 2|Z| - 4 \le 0$$

$$\left(|Z| - (\sqrt{5} + 1)\right)\left(|Z| - (1 - \sqrt{5})\right) \le 0$$

$$\Rightarrow 1 - \sqrt{5} \le |Z| \le \sqrt{5} + 1$$

76. **(2)** $P = (1, 0); Q (-1, 0)$
Let $A = (x, y)$

$$\frac{AP}{AQ} = \frac{BP}{BQ} = \frac{CP}{CQ} = \frac{1}{3} \qquad ....(1)$$

$$\Rightarrow 3AP = AQ \Rightarrow 9AP^2 = AQ^2$$

$$\Rightarrow 9(x-1)^2 + 9y^2 = (x+1)^2 + y^2$$

$$\Rightarrow 9x^2 - 18x + 9 + 9y^2 = x^2 + 2x + 1 + y^2$$

$$\Rightarrow 8x^2 - 20x + 8y^2 + 8 = 0$$

$$\Rightarrow x^2 + y^2 - \frac{5}{2}x + 1 = 0 \qquad ....(2)$$

∴ $A$ lies on the circle
Similarly $B, C$ are also lies on the same circle
∴ Circumcentre of $ABC$ =

Centre of Circle(1) = $\left(\frac{5}{4}, 0\right)$

77. **(2)** $8^{2n} - (62)^{2n+1} = (1+63)^n - (63-1)^{2n+1}$

$$(1+63)^n + (1-63)^{2n+1} =$$

$$\left(1 + {}^nC_1 63 + {}^nC_2(63)^2 + ... + (63)^n\right) +$$

$$\left(1 - {}^{(2n+1)}C_1 63 + {}^{(2n+1)}C_2(63)^2 + ... + (-1)(63)^{(2n+1)}\right)$$

$$= 2 + 63\left({}^nC_1 + {}^nC_2(63) + ..... + (63)^{n-1} - \right.$$

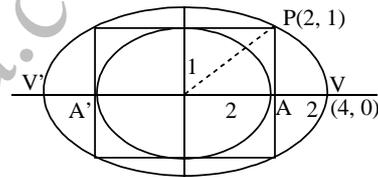$$\left. {}^{(2n+1)}C_1 + {}^{(2n+1)}C_2(63) + ... - (63)^{(2n)}\right)$$

∴ Reminder is 2

78. **(2)** $x^2 + 4y^2 = 4 \Rightarrow \frac{x^2}{4} + \frac{y^2}{1} = 1$

$$\Rightarrow a = 2, b = 1 \Rightarrow P = (2, 1)$$

Required Ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \Rightarrow \frac{x^2}{4^2} + \frac{y^2}{b^2} = 1$

(2, 1) lies on it



$$\Rightarrow \frac{4}{16} + \frac{1}{b^2} = 1 \Rightarrow \frac{1}{b^2} = 1 - \frac{1}{4} = \frac{3}{4} \Rightarrow b^2 = \frac{4}{3}$$

$$\therefore \frac{x^2}{16} + \frac{y^2}{\left(\frac{4}{3}\right)} = 1 \Rightarrow \frac{x^2}{16} + \frac{3y^2}{4} = 1 \Rightarrow x^2 + 12y^2 = 16$$

79. **(2)** Let $S = 1 + \frac{2}{3} + \frac{6}{3^2} + \frac{10}{3^3} + \frac{14}{3^4} + ...$  ....(1)

$$\frac{1}{3}S = \frac{1}{3} + \frac{2}{3^2} + \frac{6}{3^3} + \frac{10}{3^4} + ...  ....(2)$$

Dividing (1) & (2)

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

$$\frac{2}{3}S = \frac{4}{3} + \frac{4}{3^2}\left(1 + \frac{1}{3} + \frac{1}{3^2} + ...\right) \Rightarrow \frac{2}{3}S = \frac{4}{3} + \frac{4}{3^2}\left(\frac{1}{1 - \frac{1}{3}}\right)$$

$$= \frac{4}{3} + \frac{4}{3^2} \cdot \frac{3}{2} = \frac{4}{3} + \frac{2}{3} = \frac{6}{3} \Rightarrow \frac{2}{3}S = \frac{6}{3} \Rightarrow S = 3$$

80. **(4)** $y = c_1 e^{c_2 x}$ .....(1)

$y' = c_2 c_1 e^{c_2 x}$

$y' = c_2 y$ .....(2)

$y'' = c_2 y'$

From (2)

$c_2 = \dfrac{y'}{y}$

So, $y'' = \dfrac{(y')^2}{y} \Rightarrow y y'' = (y')^2$

81. **(1)** $S = \{00, 01, 02, ...., 49\}$

Let $A$ be the even that sum of the digits on the selected ticket is 8 then

$A = \{08, 17, 26, 35, 44\}$

Let $B$ be the event that the product of the digits is zero.

$B = \{00, 01, 02, 03,..., 09, 10, 20, 30, 40)$

$A \cap B = \{8\}$

Required probability =

$$P\left(\dfrac{A}{B}\right) = \dfrac{P(A \cap B)}{P(B)} = \dfrac{\dfrac{1}{50}}{\dfrac{14}{50}} = \dfrac{1}{14}$$

82. **(1)** $x^{2x} - 2x^x \cot y - 1 = 0$ ......(1)

Now $x = 1$,

$1 - 2\cot y - 1 = 0 \Rightarrow \cot y = 0 \Rightarrow y = \dfrac{\pi}{2}$

Now differentiating eq. (1) w.r.t. 'y'

$2x^{2x}(1 + \log x) -$

$2\left[ x^x\left(-\text{cosec}^2 y\right)\dfrac{dy}{dx} + \cot y x^x (1 + \log x)\right] = 0$

Now at $\left(1, \dfrac{\pi}{2}\right)$

$2(1 + \log 1) - 2\left( 1(-1)\left(\dfrac{dy}{dx}\right)_{\left(1, \frac{\pi}{2}\right)} + 0 \right) = 0$

$\Rightarrow 2 + 2\left(\dfrac{dy}{dx}\right)_{\left(1, \frac{\pi}{2}\right)} = 0 \Rightarrow \left(\dfrac{dy}{dx}\right)_{\left(1, \frac{\pi}{2}\right)} = -1$

83. **(3)** Equation of tangent at (2, 3) to $(y-2)^2 = x-1$ is $S_1 = 0$

$\Rightarrow x - 2y + 4 = 0$

Required Area = Area of $\triangle OCB$ + Area of $OAPD$ – Area of $\triangle PCD$

$= \dfrac{1}{2}(4 \times 2) + \int_0^3 \left(y^2 - 4y + 5\right)dy - \dfrac{1}{2}(1 \times 2)$

$= 4 + \left[\dfrac{y^3}{3} - 2y^2 + 5y\right]_0^3 - 1 = 4 - 9 - 18 + 15 - 1$
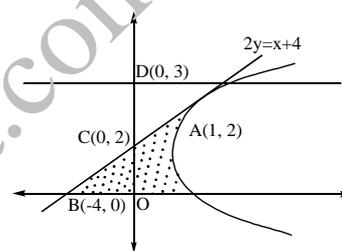
$= 28 - 19 = 9 \text{ sq.units}$

Area =

$\int_0^3 (2y - 4 - y^2 + 4y - 5)dy = \int_0^3 (-y^2 + 6y - 5)dy =$

$-\int_0^3 (3 - y)^2 dy = \left[\dfrac{(y-3)^3}{3}\right]_0^3 = \dfrac{27}{3} = 9 \text{ sq.units}$

84. **(2)** $P(x) = x^4 + ax^3 + bx^2 + cx + d$

$P'(x) = 4x^3 + 3ax^2 + 2bx + c$

$\because x = 0$ is a solution for $P'(x) = 0, \Rightarrow c = 0$



$\therefore P(x) = x^4 + ax^3 + bx^2 + d$ ....(1)

Also, we have $P(-1) < P(1)$

$\Rightarrow 1 - a + b + d < 1 + a + b + d \Rightarrow a > 0$

$\because P'(x) = 0$, only when $x = 0$ and $P(x)$ is differentiable in $(-1, 1)$, we should have the maximum and minimum at the points $x = -1, 0$ and 1 only

Also, we have $P(-1) < P(1)$

$\therefore$ Max. of $P(x) = $ Max. $\{P(0), P(1)\}$ & Min. of $P(x) = $ Min.$\{P(-1), P(0)\}$

In the interval [0, 1]

$P'(x) = 4x^3 + 3ax^2 + 2bx = x(4x^2 + 3ax + 2b)$

$\because P'(x)$ has only one root $x = 0$, $4x^2 + 3ax + 2b = 0$ has no real roots

$\therefore (3a)^2 - 32b < 0 \Rightarrow \dfrac{3a^2}{32} < b \qquad \therefore b > 0$

Thus, we have $a > 0$ and $b > 0$

$\therefore P'(x) = 4x^3 + 3ax^2 + 2bx > 0, \forall x \in (0,1)$

Hence $P(x)$ is increasing in $[0, 1]$

$\therefore$ Max. of $P(x) = P(1)$

Similarly, $P(x)$ is decreasing in $[-1, 0]$

Therefore Min$P(x)$ does not occur at $x = -1$

85. **(1)** $x - y + 1 = 0$ ....(1)

$x = y^2$

$1 = 2y \dfrac{dy}{dx} \Rightarrow \dfrac{dy}{dx} = \dfrac{1}{2y} = $ Slope of given line (1)

$\dfrac{1}{2y} = 1 \Rightarrow y = \dfrac{1}{2} \Rightarrow y = \dfrac{1}{2}$

$\Rightarrow x = \left(\dfrac{1}{2}\right)^2 = \dfrac{1}{4} \Rightarrow (x, y) = \left(\dfrac{1}{4}, \dfrac{1}{2}\right)$

$\therefore$ The shortest distance is

$\dfrac{\left|\dfrac{1}{4} - \dfrac{1}{2} + 1\right|}{\sqrt{1+1}} = \dfrac{3}{4\sqrt{2}} = \dfrac{3\sqrt{2}}{8}$

Directions :Question number 86 to 90 are Assertion-Reason type questions. Each of these questions contains two statements.

Statement-1 (Assertion) and Statement-2(Reason)

Each of these questions also have four alternative choices, only one of which is the correct answer. You have to select the correct choice.

86. **(3)** There is no information about co-domain therefore $f(x)$ is not necessarily onto.

87. **(3)** $f(x) = x|x|$ and $g(x) = \sin x$

$gof(x) = \sin\left(x|x|\right) = \begin{cases} -\sin x^2 & , \quad x < 0 \\ \sin x^2 & , \quad x \geq 0 \end{cases}$

$\therefore (gof)'(x) = \begin{cases} 2x\cos x^2 & , \quad x < 0 \\ 2x\cos x^2 & , \quad x \geq 0 \end{cases}$

Clearly, L(gof)'(0) = 0 R(gof)'(0)

$\therefore$ gof is differentiable at $x = 0$ and also its derivative is continuous at $x = 0$

Now, $(gof)''(x) = \begin{cases} -2\cos x^2 + 4x^2 \sin x^2 & , \quad x < 0 \\ 2\cos x^2 - 4x^2 \sin x^2 & , \quad x \geq 0 \end{cases}$

$\therefore$ L(gof)''(0) = –2 and R(gof)''(0) = 2

$\therefore$ L(gof)''(0) $\neq$ R(gof)''(0)

$\therefore$ gof(x) is not twice differentiable at $x = 0$.

88. **(4)** Statement-2 is true

**Statement-1 :**

Sum of n even natural numbers = $n(n + 1)$

$\text{Mean}(\bar{x}) = \dfrac{n(n+1)}{n} = n + 1$

Variance =

$\left[\dfrac{1}{n}\sum(x_i)^2\right] - (\bar{x})^2 = \dfrac{1}{n}\left[2^2 + 4^2 + .... + (2n)^2\right] - (n+1)^2$

$= \dfrac{1}{n}2^2[1^2 + 2^2 + ..... + n^2] - (n+1)^2$

$= \dfrac{4}{n}\dfrac{n(n+1)(2n+1)}{6} - (n+1)^2$
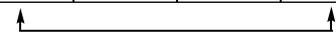
$= \dfrac{(n+1)[2(2n+1) - 3(n+1)]}{3}$

$= \dfrac{(n+1)[4n + 2 - 3n - 3]}{3}$

$= \dfrac{(n+1)(n-1)}{3} = \dfrac{n^2 - 1}{3}$

$\therefore$ Statement 1 is false.

89. **(3)**

| p | q | $p \leftrightarrow q$ | $\sim q$ | $p \leftrightarrow \sim q$ | $\sim(p \leftrightarrow \sim q)$ |
|---|---|---|---|---|---|
| T | T | T | F | F | T |
| T | F | F | T | T | F |
| F | T | F | F | T | F |
| F | F | T | T | F | T |

90. **(2)** $|\text{adj } A| = |A|^{n-1} = |A|^{2-1} = |A|$

adj(adj A) = $|A|^{n-2} A = |A|^0 A = A$