MENIIT

NEET | IIT-JEE | FOUNDATION

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JEE MAINS-2019

09-01-2019 Online (Evening)

IMPORTANT INSTRUCTIONS

1. The test is of 3 hours duration.
2. This Test Paper consists of **90 questions**. The maximum marks are 360.
3. There are three parts in the question paper A, B, C consisting of **Physics, Mathematics and Chemistry** having 30 questions in each part of equal weightage. Each question is allotted 4 (four) marks for correct response.
4. Out of the four options given for each question, only one option is the correct answer.
5. For each incorrect response 1 mark i.e. ¼ (one-fourth) marks of the total marks allotted to the question will be deducted from the total score. No deduction from the total score, however, will be made if no response is indicated for an item in the Answer Box.
6. Candidates will be awarded marks as stated above in instruction No.3 for correct response of each question. One mark will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer box.
7. There is only one correct response for each question. Marked up more than one response in any question will be treated as wrong response and marked up for wrong response will be deducted accordingly as per instruction 6 above..

PART-A-PHYSICS

1. A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the rope at some point, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is ($g = 10\ ms^{-2}$)

(1) 200 N (2*) 100 N (3) 70 N (4) 140 N

Sol. $T \cos 45° = mg$

$T \sin 45° = F$

$\Rightarrow F = mg = 100$ N.

2. Two point charges $q_1(\sqrt{10}\,\mu C)$ and $q_2(-25\mu C)$ are placed on the x-axis at x = 1m and x = 4m respectively. The electric field (in V/m) at a point y = 3m on y-axis is [take $\frac{1}{4\pi \epsilon_0} = 9 \times 10^9\ Nm^2C^{-2}$]

(1*) $(63\hat{i} - 27\hat{j}) \times 10^2$ (2) $(-63\hat{i} + 27\hat{j}) \times 10^2$ (3) $(81\hat{i} - 81\hat{j}) \times 10^2$ (4) $(-81\hat{i} + 81\hat{j}) \times 10^2$

Sol. $\vec{E} = \frac{kq_1}{e_1^3}\vec{r}_1 + \frac{kq_2}{r_2^3}\vec{r}_2 = k \times 10^{-6}\left[\frac{\sqrt{10}}{10\sqrt{10}}\left(-\hat{i} + 3\hat{j}\right) + \frac{(-25)}{125}\left(-4\hat{i} + 3\hat{j}\right)\right]$

$= \left(3 \times 10^3\right)\left[\frac{1}{10}\left(-\hat{i} + 3\hat{j}\right) - \frac{1}{5}\left(-4\hat{i} + 3\hat{j}\right)\right]$

$= \left(9 \times 10^3\right)\left[\left(-\frac{1}{10} + \frac{4}{2}\right)\hat{i} + \left(\frac{3}{10} - \frac{3}{5}\right)\hat{i}\right] = 9000\left(\frac{7}{10}\hat{i} - \frac{3}{10}\hat{j}\right)$

$= \left(63\hat{i} - 27\hat{j}\right)(100)$

3. At a given instant, say t = 0, two radioactive substances A and B have equal activities. The ratio $\frac{R_B}{R_A}$ of their activities after time t itself decays with time t as e^{-3t}. If the half-life of A is $ln2$, the half-life of B is

(1*) $\frac{\ell n2}{4}$ (2) $4ln2$ (3) $2ln2$ (4) $\frac{\ell n2}{4}$

Sol. $R = R_O e^{-kt}$

$\therefore \quad \frac{R_B}{R_A} = \frac{R_o e^{-\lambda_B t}}{R_o e^{-\lambda_B t}} = e^{-(\lambda_B - \lambda_A)t} = e^{-3t}$

$\Rightarrow \quad \lambda_B - \lambda_A = 3$

$\Rightarrow \quad \frac{\ell n^2}{T_B} - \frac{\ell n2}{\ell n2} = 3.$

$\Rightarrow \quad T_B = \frac{\ell n2}{4}$

4. A particle is executing simple harmonic motion (SHM) of amplitude A, along the x-axis, about x = 0. When its potential energy (PE) equals kinetic energy (KE), the position of the particle will be:

(1) $\frac{A}{2\sqrt{2}}$ (2*) $\frac{A}{\sqrt{2}}$ (3) A (4) $\frac{A}{2}$

Sol. PE = KE

$$\Rightarrow \quad \frac{1}{2}m\omega^2\left(A^2 - x^2\right) = \frac{1}{2}m\omega^2x^2$$

$$\Rightarrow \quad x = \frac{A}{\sqrt{2}}$$

5. A musician using an open flute of length 50 cm produces second harmonic sound waves. A person runs towards the musician from another end of a hall at a speed of 10 km/h. If the wave speed is 330 m/s, the frequency heard by the running person shall be close to:

(1) 500 Hz (2) 333 Hz (3*) 666 Hz (4) 753 Hz

Sol. $f = \frac{2}{2\ell}v_s = \frac{330}{0.5} = 660\text{Hz}$

$$\therefore \quad f' = f\left(\frac{v_s + v}{v_s}\right) = (660)\left(\frac{330 + \frac{50}{18}}{330}\right) = 660\left(1 + \frac{50}{18 \times 330}\right)$$

= 666 Hz.

6. Expression for time in terms of G (universal gravitational constant), h (Planck constant) and c (speed of light) is proportional to:

(1) $\sqrt{\frac{Gh}{c^3}}$ (2) $\sqrt{\frac{c^3}{Gh}}$ (3*) $\sqrt{\frac{Gh}{c^5}}$ (4) $\sqrt{\frac{hc^5}{G}}$

Sol. $t = G^a h^b c^c$

$\Rightarrow \quad M^o L^o T' = (M^{-1} L^3 T^{-2})^a (ML^2T^{-1})^b (LT^{-1})^c$

$\Rightarrow -a + b = 0 \Rightarrow a = b$

$\Rightarrow 3a + 2b + c = 0$

$\Rightarrow c = -5a$

$\Rightarrow -2a - b - c = 1$

$$\Rightarrow \quad a = \frac{1}{2}\ ;\ b = \frac{1}{2}\ ;\ c = -\frac{5}{2}$$

7. A rod of mass 'M' and length '2L' is suspended at its middle by a wire. It exhibits torsional oscillations; If two masses each of 'm' are attached at distance 'L/2' from its centre on both sides, it reduces the oscillation frequency by 20%. The value of ratio m/M is close to:

(1) 0.57 (2) 0.77 (3*) 0.37 (4) 0.17

Sol. $f = \frac{1}{2\pi}\sqrt{\frac{C}{\left(\frac{ML^2}{3}\right)}}$ & $0.8\,f = \frac{1}{2\pi}\sqrt{\frac{C}{\left(\frac{ML^2}{3}+\frac{mL^2}{2}\right)}}$

$\Rightarrow \frac{25}{16} = \frac{\frac{ML^2}{3}+\frac{mL^2}{2}}{\frac{ML^2}{3}}$

$\Rightarrow \frac{25}{16} = 1 + \frac{3m}{2M}$

$\Rightarrow \frac{9}{16} = \frac{3m}{2M}$

$\Rightarrow \frac{m}{M} = \frac{3}{8} = 0.37$

8. The top of a water tank is open to air and its water level is maintained. It is giving out 0.74 m^3 water per minute through a circular opening of 2 cm radius in its wall. The depth of the centre of the opening from the level of water in the tank is close to:

(1) 6.0 m (2) 2.9 m (3*) 4.8 m (4) 9.6 m

Sol. $\frac{dV}{dt} = Av \Rightarrow \frac{dV}{dt} = A\sqrt{2gh}$

$\Rightarrow \frac{0.74}{60} = (3.14)\left(\frac{2}{100}\right)^2 \sqrt{2(9.8)h}$

$\Rightarrow$ h = 4.92 m

9. Two Carnot engines A and B are operated in series. The first one, A, receives heat at T_1(= 600 K) and rejects to a reservoir at temperature T_2. The second engine B receives heat rejected by the first engine and, in turn, rejects to a heat reservoir at T_3(= 400 K). Calculate the temperature T_2 if the work outputs of the two engines are equal:

(1) 300 K (2*) 500 K (3) 600 K (4) 400 K

Sol. $W_1 = W_2$

$\Rightarrow 600 - T_2 = T_2 - 400$

$\Rightarrow T_2 = 500$ K

10. In a car race on straight road, car A takes a time t less than car B at the finish and passes finishing point with a speed 'v' more than that of car B. Both the cars start from rest and travel with constant acceleration a_1 and a_2 respectively. Then 'v' is equal to:

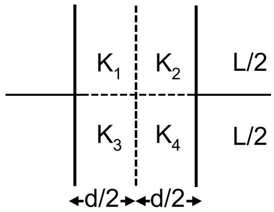
(1*) $\sqrt{a_1a_2}\,t$ (2) $\frac{2a_1a_2}{a_1+a_2}t$ (3) $\frac{a_1+a_2}{2}t$ (4) $\sqrt{2a_1a_2}\,t$

Sol. $\sqrt{\frac{2\ell}{a_2}} - \sqrt{\frac{2\ell}{a_1}} = t \quad \Rightarrow \quad \frac{\sqrt{2\ell}}{t} = \frac{\sqrt{a_1 a_2}}{\sqrt{a_1} - \sqrt{a_2}}$

$\sqrt{2a_1\ell} - \sqrt{2a_2\ell} = \nu \quad \Rightarrow \quad \frac{\sqrt{2\ell}}{\nu} = \frac{1}{\sqrt{a_1} - \sqrt{a_2}}$

$\Rightarrow \frac{\nu}{r} = \sqrt{a_1 a_2} \quad \Rightarrow \quad \nu = \left(\sqrt{a_1 a_2}\right)t$

11. A parallel plate capacitor with square plates is filled with four dielectrics of dielectric constants K_1, K_2, K_3, K_4 arranged as shown in the figure. The effective dielectric constant K will be:



(1) $K = \frac{(K_1+K_2)(K_3+K_4)}{2(K_1+K_2+K_3+K_4)}$

(2) $K = \frac{(K_1+K_2)(K_3+K_4)}{K_1+K_2+K_3+K_4}$

(3) $K = \frac{(K_1+K_4)(K_2+K_3)}{2(K_1+K_2+K_3+K_4)}$

(4*) $K = \frac{(K_1+K_3)(K_2+K_4)}{K_1+K_2+K_3+K_4}$

Sol. $C_1 = \frac{\varepsilon_0 K_1 \frac{L^2}{2}}{\frac{d}{2}} + \frac{\varepsilon_0 K_3 \frac{L^2}{2}}{\left(\frac{d}{2}\right)} = \frac{\varepsilon_0 L^2}{d}(K_1 + K_3)$

$C_2 = \frac{\varepsilon_0 K_2 \frac{L^2}{2}}{\frac{d}{2}} + \frac{\varepsilon_0 K_4 \frac{L^2}{2}}{\left(\frac{d}{2}\right)} = \frac{\varepsilon_0 L^2}{d}(K_2 + K_4)$

$\therefore \frac{1}{c} = \frac{1}{c_1} + \frac{1}{c_2}$

$\Rightarrow \frac{d}{\varepsilon_0 K L^2} = \frac{d}{\varepsilon_0 L^2 (K_1 + K_3)} + \frac{d}{\varepsilon_0 L^2 (K_2 + K_4)}$

12. A particle having the same charge as of electron moves in a circular path of radius 0.5 cm under the influence of a magnetic field of 0.5T. If an electric field of 100 V/m makes it to move in a straight path, then the mass of the particle is (Given charge of electron = 1.6×10^{-19} C)

(1) 1.6×10^{-19} kg (2) 1.6×10^{-27} kg (3) 9.1×10^{-31} kg (4*) 2.0×10^{-24} kg

Sol. eE = evB

$\Rightarrow E = \left(\frac{eBr}{m}\right)B$

$\Rightarrow\ E = \frac{eB^2r}{E}$

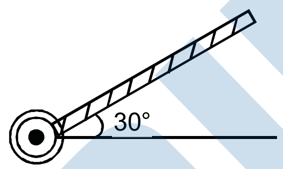
$\Rightarrow\ \frac{(1.6\times10^{-19})(0.5\times10^{-2})}{100} = 2\times10^{-24}\text{kg.}$

13. A series AC circuit containing an inductor (20 mH), a capacitor (120 μF) and a resistor (60Ω) is driven by an AC source of 24V/50Hz. The energy dissipated in the circuit in 60 s is:

(1) 3.39×10^3 J (2) 5.65×10^2 J (3*) 5.17×10^2 J (4) 2.26×10^3 J

Sol. $E = Pt = \frac{E^2}{Z^2}Rt = \frac{(24)^2}{60^2 + (8.33\pi - 2\pi)^2}(60)(60) = 518\text{J.}$

14. A rod of length 50 cm is pivoted at one end. It is raised such that if makes an angle of 30° from the horizontal as shown and released from rest. Its angular speed when it passes through the horizontal (in rad s^{-1}) will be (g = 10 ms^{-2})



(1) $\sqrt{\frac{30}{2}}$ (2) $\frac{\sqrt{30}}{2}$ (3) $\frac{\sqrt{20}}{3}$ (4*) $\sqrt{30}$

Sol. $mg\frac{\ell}{2}\left(\frac{1}{2}\right) = \frac{1}{2}\left(\frac{m\ell^2}{3}\right)\omega^2$

$\Rightarrow\ \omega = \sqrt{\frac{3g}{2\ell}} = \sqrt{30}$

15. In a Young's double slit experiment, the slits are placed 0.320 mm apart. Light of wavelength λ = 500 nm is incident on the slits. The total number of bright fringes that are observed in the angular range $-30° \le \theta \le 30°$ is:

(1) 320 (2) 640 (3) 321 (4*) 641

Sol. ΔX_{max} = d sin θ = 0.32 sin 30 = 0.16 mm

$\therefore\ n = \frac{\Delta X_{max}}{\lambda} = \frac{0.16\times10^{-3}}{500\times10^{-9}} = \frac{0.16\times10^6}{500} = \frac{1600}{5} = 320$

$\therefore$ Number of Bfs = (2n + 1) = 641

16. The energy required to take a satellite to a height 'h' above Earth surface (radius of Earth = 6.4×10^3 km) is E_1 and kinetic energy required for the satellite to be in a circular orbit at this height is E_2. The value of h for which E_1 and E_2 are equal, is:

(1) 6.4×10^3 km (2) 1.28×10^4 km (3) 1.6×10^3 km (4*) 3.2×10^3 km

Sol. $E_1 = -\frac{GMm}{R+h} - \left(-\frac{GMm}{R}\right)$

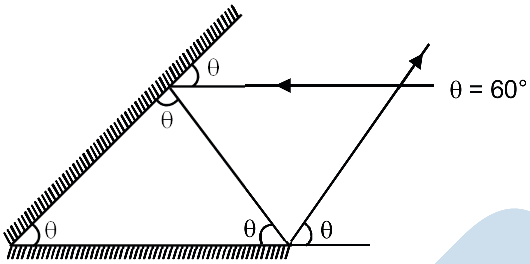
$$E_2 = \frac{1}{2}m\left(\sqrt{\frac{GM}{R+h}}\right)^2 = \frac{GMm}{2(R+h)}$$

$$E_1 = E_2 \;\; ; \;\; h = \frac{R}{2}$$

17. Two plane mirrors are inclined to each other such that a ray of light incident on the first mirror (M_1) and parallel to the second mirror (M_2) is finally reflected from the second mirror (M_2) parallel to the first mirror (M_1). The angle between the two mirrors will be:

(1) 75° (2*) 60° (3) 90° (4) 45°

Sol.



18. A force acts on a 2 kg object so that its position is given as a function of time as $x = 3t^2 + 5$. What is the work done by this force in first 5 seconds?

(1) 875 J (2) 950 J (3) 850 J (4*) 900 J

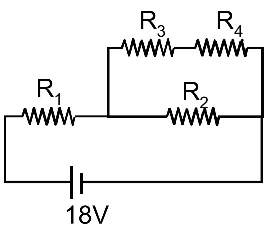
Sol. $x = 3t^2 + 5$

$\Rightarrow \quad v = 6t$

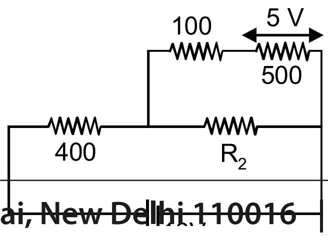
$\Rightarrow \quad \Delta W = \Delta k$

$$= \frac{1}{2}(2)(30^2) - \frac{1}{2}2(0)^2 = 900 \text{ J}$$

19. In the given circuit the internal resistance of the 18V cell is negligible. If $R_1 = 400\ \Omega$, $R_3 = 100\Omega$ and $R_4 = 500\Omega$ and the reading of an ideal voltmeter across R_4 is 5V, then the value of R_2 will be:



(1) 550 Ω (2) 230 Ω (3*) 300 Ω (4) 450 Ω



Sol. $\dfrac{12}{400}=\dfrac{6}{600}+\dfrac{6}{R_2}$

$\Rightarrow \dfrac{1}{200}=\dfrac{1}{600}+\dfrac{1}{R_2}$

$\Rightarrow R_2 = 300\ \Omega$

20. The position co-ordinates of a particle moving in a 3-D coordinate system is given

by $x = a\cos\omega t$

$y = a\sin\omega t$

and $z = a\omega t$

The speed of the particle is:

(1) $\sqrt{3}\,a\omega$ (2) $a\omega$ (3) $2a\omega$ (4*) $\sqrt{2}a\omega$

Sol. $v_x=\dfrac{dx}{dt}=-a\omega\sin\omega t$

$v_y=\dfrac{dy}{dt}=a\omega\cos\omega t$

$v_z=\dfrac{dz}{dt}=a\omega\cos\omega t$

$\therefore\ v=\sqrt{v_x^2+v_y^2+v_z^2}=\sqrt{2}a\omega$

21. A carbon resistance has a following colour code. What is the value of the resistance?

(1*) 530 kΩ ± 5% (2) 6.4 MΩ ± 5% (3) 64 kΩ ± 10% (4) 5.3 MΩ ± 5%

Sol. R = 530 kΩ ±5%

22. A power transmission line feeds input power at 2300 V to a step down transformer with its primary windings having 4000 turns. The output power is delivered at 230 V by the transformer. If the current in the primary of the transformer is 5A and its efficiency is 90%, the output current would be:

(1) 25A (2*) 45A (3) 50A (4) 35A

Sol. $P_s=\eta P_P$

$\Rightarrow E_s i_s = \eta E_i i_p$

$\Rightarrow i_s=\dfrac{(0.9)(2300)(5)}{(230)}=45\,A.$

23. One of the two identical conducting wires of length L is bent in the form of a circular loop and the other one into a circular coil of N identical turns. If the same current is passed in both, the ratio of the magnetic field at the central of the loop (B_L) to that at the centre of the coil (B_C), i.e. $\frac{B_L}{B_C}$ will be:

(1) $\frac{1}{N}$ (2*) $\frac{1}{N^2}$ (3) N^2 (4) N

Sol. $B_L = \frac{\mu_o i}{2R}$

$B_C = \frac{\mu_o N i}{2(R/N)}$

$\therefore \frac{B_L}{B_C} = \frac{1}{N^2}$

24. A 15 g mass of nitrogen gas is enclosed in a vessel at a temperature 27°C. Amount of heat transferred to the gas, so that rms velocity of molecules is doubled, is abou: [Take R = 8.3 J/K mole]

(1) 6 kJ (2*) 10 kJ (3) 14 kJ (4) 0.9 kJ

Sol. $\Delta Q = \frac{f}{2} nR\Delta T$

$= \frac{5}{2}\left(\frac{15}{28}\right)(8.3)(1200-300) = 10000 \text{ J.}$

25. In a communication system operating at wavelength 800 nm, only one percent of source frequency is available as signal bandwidth. The number of channels accommodated for transmitting TV signals of band width 6 MHz are (Take velocity of light c = 3 × 10^8 m/s, h = 6.6 × 10^{-34} J-s)

(1*) 6.25 × 10^5 (2) 3.75 × 10^6 (3) 3.86 × 10^6 (4) 4.87 × 10^5

Sol. $f = \frac{c}{\lambda} = \frac{3\times10^8}{8\times10^{-7}} = \frac{3}{8}\times10^{15}\text{Hz}$

$\therefore \quad n = \frac{(0.01)f}{6\times10^6} = \frac{\frac{3}{8}\times10^{13}}{6\times10^6}$

$= \frac{1}{16}\times10^7 = 6.25\times10^5$

26. Charge is distributed within a sphere of radius R with a volume charge density $\rho(r) = \frac{A}{r^2}e^{-2r/a}$, where A and *a* are constants. If Q is the total charge of this charge distribution, the radius R is:

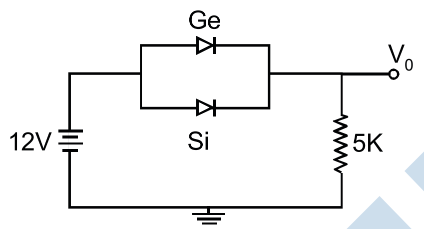
(1) $\frac{a}{2}\log\left(1-\frac{Q}{2\pi aA}\right)$ (2) $a\log\left(\frac{1}{1-\frac{Q}{2\pi aA}}\right)$ (3) $a\log\left(1-\frac{Q}{2\pi aA}\right)$ (4*) $\frac{a}{2}\log\left(\frac{1}{1-\frac{Q}{2\pi aA}}\right)$

Sol. $Q = \int \rho 4\pi^2 dr = \int_0^R \left(\frac{A}{r^2} e^{-\frac{2r}{a}}\right)(4\pi r^2) dr$

$= 4\pi A \frac{a}{2}\left(1 - e^{\frac{-2R}{a}}\right)$

$\Rightarrow \quad R = \frac{-a}{2} \log\left(1 - \frac{Q}{2\pi A a}\right)$

27. Ge and Si diodes start conducting at 0.3 V and 0.7 V respectively. In the following figure if Ge diode connection are reversed, the value of V_0 changes by: (assume that the Ge diode has large breakdown voltage)



(1) 0.8 V (2) 0.6 V (3) 0.2 V (4*) 0.4 V

Sol. $V_{o_i} = 12 - 0.3 = 11.7$ V

$V_{o_f} = 12 - 0.7 = 11.3$ V

$\Rightarrow \quad \Delta V_o = -0.4$ V

28. The energy associated with electric field is (U_E) and with magnetic field is (U_B) for an electromagnetic wave in free space. Then:

(1) $U_E < U_B$ (2) $U_E > U_B$ (3*) $U_E = U_B$ (4) $U_E = \frac{U_B}{2}$

Sol. $B = \frac{E}{C}$

$\Rightarrow \quad U_E = \frac{1}{2}\varepsilon_o E^2$

$U_B = \frac{B^2}{2\mu_o} = \frac{E^2}{2\mu_o C^2} = \frac{E^2}{2\mu_o}(\mu_o \varepsilon_o) = U_E$

29. The pitch and the number of divisions, on the circular scale, for a given screw gauge are 0.5 mm and 100 respectively. When the screw gauge is fully tightened without any object, the zero of its circular scale lies 3 divisions below the mean line.

The readings of the main scale and the circular scale, for a thin sheet, are 5.5 mm and 48 respectively, the thickness of this sheet is:

(1) 5.950 mm (2*) 5.725 mm (3) 5.755 mm (4) 5.740 mm

Sol. Zero error $= +3 \times \frac{0.5 \text{ mm}}{100} = 0.015$ mm

$MSR = 5.5 + 48 \times \frac{0.5}{100}$

= 5.74 mm.

$\therefore$ Thickness = 5.74 – 0.015 = 5.725 mm

30. The magnetic field associated with a light wave is given, at the origin, by

$B = B_0$ [sin (3.14 × 10^7)ct + sin (6.28 × 10^7) ct]. If this light falls on a silver plate having a work function of 4.7 eV, what will be the maximum kinetic energy of the photo electrons?

(c = 3 × 10^8 ms^{-1}, h = 6.6 × 10^{-34} J-s)

(1) 12.5 eV (2) 8.52 eV (3) 6.82 eV (4*) 7.72 eV

Sol. $KE_{max} = h\nu_{max} - \phi$

$$= \frac{(6.6 \times 10^{-34})(6.28 \times 10^7)(3 \times 10^8)}{1.6 \times 10^{-19} \times 2 \times 3.14} - 4.7$$

= 12.37 – 4.7 = 7.67 eV

PART-B-MATHEMATICS

31. The coefficient of t^4 in the expansion of $\left(\frac{1-t^6}{1-t}\right)^3$ is

(1) 12 (2) 10 (3*) 15 (4) 14

Sol. $(1-t^6)^3 (1-t)^{-3}$

$(1-t^{18} - 3t^6 + 3t^{12})(1-t)^{-3}$

$\Rightarrow$ coefficient of t^4 in $(1-t)^{-3}$ is ${}^{3+4-1}C_4 = {}^6C_2 = 15$

32. If $f(x) = \int \frac{5x^8 + 7x^6}{(x^2+1+2x^7)^2} dx$, $(x \geq 0)$, and $f(0) = 0$, then the value of $f(1)$ is

(1) $-\frac{1}{2}$ (2) $\frac{1}{2}$ (3) $\frac{1}{4}$ (4) $-\frac{1}{4}$

Sol. $\int \frac{5x^8 + 7x^6}{(x^2+1+2x^7)} dx$

$\int \frac{5x^{-6} + 7x^{-8}}{\left(\frac{1}{x^7} + \frac{1}{x^5} + 2\right)^2} dx = \frac{1}{2 + \frac{1}{x^5} + \frac{1}{x^7}} + C$

As $f(0) = 0$, $f(x) = \frac{x^7}{2x^7 + x^2 + 1}$

$f(1) = \frac{1}{4}$

33. A hyperbola has its centre at the origin, passes through the point (4, 2) and has transverse axis of length 4 along the x-axis. Then the eccentricity of the hyperbola is

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

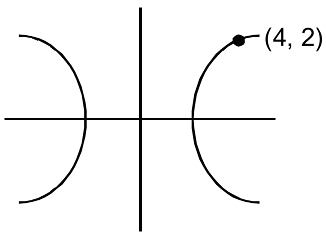
Sol. Given hyperbola is

$\frac{x^2}{4} - \frac{y^2}{b^2} = 1$

Satisfying the point (4,2)

$\Rightarrow b^2 = \frac{4}{3}$

$\Rightarrow e = \frac{2}{\sqrt{3}}$



34. If the system of linear equations

$x - 4y + 7z = g$

$3y - 5z = h$

$-2x + 5y - 9z = k$

of linear equations

(1) $g + h + 2k = 0$ (2) $g + 2h + k = 0$ (3) $2g + h + k = 0$ (4) $g + h + k = 0$

Sol. $P_1 = x - 4y + 7z - g = 0$

$P_2 = 3x - 5y - h = 0$

$P_3 = -2x + 5y - 9z - k = 0$

Here $\Delta = 0$

$2P_1 + P_2 + P_3 = 0$ when $2g + h + k = 0$

35. A data consists of n observations:

$x_1, x_2, ..., x_n$. If $\sum_{i=1}^{n}(x_i+1)^2 = 9n$ and $\sum_{i=1}^{n}(x_i-1)^2 = 5n$, then the standard deviation of this data is :

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

Sol. $\Sigma(x_i+1)^2 = 9n$ ....(1)

$\Sigma(x_i - 1)^2 = 5n$ ....(2)

(1) + (2) $\Rightarrow \Sigma(x_i^2 + 1) = 7n$

$\Rightarrow \frac{\sum x_i^2}{n} = 6$

(1) . (2) $\Rightarrow 4\Sigma x_i = 4n$

$\Rightarrow \Sigma x_i = n$

$\Rightarrow \frac{\sum x_i}{n} = 1$

$\Rightarrow$ variance = 6 – 1 = 5

$\Rightarrow$ standard deviation $= \sqrt{5}$

36. Let a, b and c be the $7^{th,}$ 11^{th} and 13^{th} terms respectively of a non-constant A.P. If these are also the three consecutive terms of a G.P., then $\frac{a}{c}$ is equal to

(1) 2 (2) $\frac{1}{2}$ (3) $\frac{7}{13}$ (4*) 4

Sol. $a = A + 6d$

$b = A + 10d$

$c = A + 12d$

a, b, c are in G.P.

$\Rightarrow (A + 10d)^2 = (A + 6d)(a + 12d)$

$\Rightarrow \frac{A}{d} = -14$

$\frac{a}{c} = \frac{A+6d}{A+12d} = \frac{6+\frac{A}{d}}{12+\frac{A}{d}} = \frac{6-14}{12-14} = 4$

37. The number of all possible positive integral values of α for which the roots of the quadratic equation $6x^2 - 11x + \alpha = 0$ are rational numbers is

(1) 2 (2*) 3 (3) 4 (4) 5

Sol. D must be perfect square

$\Rightarrow 121 - 24\alpha = \lambda^2$

$\Rightarrow$ maximum value of α is 5

$\alpha = 1 \Rightarrow \lambda \notin I$

$\alpha = 2 \Rightarrow \lambda \notin I$

$\alpha = 3 \Rightarrow \lambda \in I$ $\Rightarrow$ 3 integral values

$\alpha = 4 \Rightarrow \lambda \in I$

$\alpha = 5 \Rightarrow \lambda \in I$

38. If $\int_0^{\frac{\pi}{3}} \frac{\tan\theta}{\sqrt{2k\sec\theta}} d\theta = 1 - \frac{1}{\sqrt{2}}$, (k > 0), then the value of k is:

(1) $\frac{1}{2}$ (2*) 2 (3) 4 (4) 1

Sol. $\frac{1}{\sqrt{2k}} \int_0^{\pi/3} \frac{\tan\theta}{\sqrt{\sec\theta}} d\theta = \frac{1}{\sqrt{2k}} \int_0^{\pi/3} \frac{\sin\theta}{\sqrt{\cos\theta}} d\theta$

$= -\frac{1}{\sqrt{2k}} 2\sqrt{\cos\theta}\Big|_0^{\pi/3} = -\frac{\sqrt{2}}{\sqrt{k}}\left(\frac{1}{\sqrt{2}} - 1\right)$

$\Rightarrow$ k = 2

39. If $0 \le x < \frac{\pi}{2}$, then the number of values of x for which sin x – sin 2x + sin 3x = 0, is

(1*) 2 (2) 4 (3) 1 (4) 3

Sol. sin x – sin2x + sin3x = 0

$\Rightarrow$(sin x + sin3x) – sin2x = 0

$\Rightarrow$ 2sin x. cos x – sin2x = 0

$\Rightarrow$sin2x (2cos x – 1) = 0

$\Rightarrow$ sin 2x = 0 or $\cos x = \frac{1}{2} \Rightarrow x = 0, \frac{\pi}{3}$

40. If the circle $x^2 + y^2 - 16x - 20y + 164 = r^2$ and $(x-4)^2 + (y-7)^2 = 36$ intersect at two distinct points, then

(1) $r = 11$ (2*) $1 < r < 11$ (3) $r > 11$ (4) $0 < r < 1$

Sol. $x^2 + y^2 - 16x - 20y + 164 = r^2$

$A(8,10), R_1 = r$

$(x-4)^2 + (y-7)^2 = 36$

$B(4, 7), R_2 = 6$

$|R_1 - R_2| < AB < R_1 + R_2$

$\Rightarrow 1 < r < 11$

41. The sum of following series $1+6+\frac{9(1^2+2^2+3^2)}{7}+\frac{12(1^2+2^2+3^2+4^2)}{9}+\frac{15(1^2+2^2+...+5^2)}{11}+...$

up to 15 terms, is

(1) 7510 (2) 7520 (3) 7830 (4*) 7820

Sol. $T_n = \frac{(3+(n+1)\times 3)(1^2+2^2+......+n^2)}{(2n+1)}$

$$T_n = \frac{3.\frac{n^2(n+1)(2n+1)}{6}}{2n+1} = \frac{n^2(n+1)}{2}$$

$$S_{15} = \frac{1}{2}\sum_{n=1}^{15}(n^3+n^2) = \frac{1}{2}\left[\left(\frac{15(15+1)}{2}\right)^2 + \frac{15\times 16\times 31}{6}\right]$$

$= 7820$

42. If $A = \begin{bmatrix} e^t & e^{-t}\cos t & e^{-t}\sin t \\ e^t & -e^{-t}\cos t - e^{-t}\sin t & -e^{-t}\sin t + e^{-t}\cos t \\ e^t & 2e^{-t}\sin t & -2e^{-t}\cos t \end{bmatrix}$, then A is

(1) not invertible for any $t \in R$. (2*) invertible for all $t \in R$

(3) invertible only if $t = \frac{\pi}{2}$ (4) invertible only if $t = \pi$.

Sol. $|A| = e^{-t}\begin{vmatrix} 1 & \cos t & \sin t \\ 1 & -\cos t - \sin t & -\sin t + \cos t \\ 1 & 2\sin t & -2\cos t \end{vmatrix}$

$= e^{-t}[5\cos^2 t + 5\sin^2 t]\ \forall t \in R$

$= 5e^{-t} \neq 0\ \forall t \in R$

43. The logical statement $[\sim(\sim p \wedge q) \vee (p \wedge r)] \wedge (\sim q \wedge r)$ is equivalent to

(1) $(p \wedge \sim q) \vee r$ (2) $\sim p \vee r$ (3*) $(p \wedge r) \wedge \sim q$ (4) $(\sim p \wedge \sim q) \wedge r$

Sol. $[\sim(\sim p \vee q) \wedge (p \wedge r)] \cap (\sim q \wedge r)$

$= [(p \wedge \sim q) \vee (p \wedge r)] \wedge (\sim q \wedge r)$

$= [p \wedge (\sim q \vee r)] \wedge (\sim q \wedge r)$

$= p \wedge (\sim q \wedge r)$

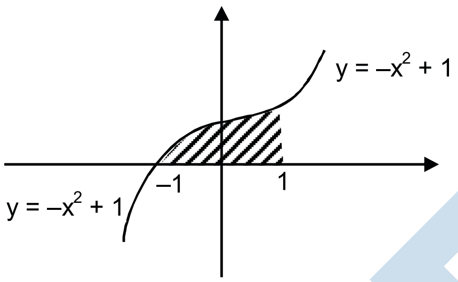
$= (p \wedge r) \sim q$

44. The area of the region A = {(x, y) : $0 \leq y \leq x\,|\,x\,| + 1$ and $-1 \leq x \leq 1$} in sq. units, is

(1) $\frac{1}{3}$ (2) $\frac{2}{3}$ (3*) 2 (4) $\frac{4}{3}$

Sol. The graph is a follows

$$\int_{-1}^{0}(-x^2+1)dx + \int_{0}^{1}(x^2+1)dx = 2$$



45. An urn contains 5 red and 2 green balls. A ball is drawn at random from the urn. If the drawn ball is green, then a red ball is added to the urn and if the drawn ball is red, then a green ball is added to the urn; the original ball is not returned to the urn. Now, a second ball is drawn at random from it. The probability that the second ball is red, is:

(1) $\frac{26}{49}$ (2) $\frac{27}{49}$ (3) $\frac{21}{49}$ (4*) $\frac{32}{49}$

Sol. E_1 : Event of drawing a Red ball and placing a green ball in the bag

E_2 : Event of drawing a green ball and placing a red ball in the bag

E : Event of drawing a red ball in second draw $P(E) = P(E_1) \times P\left(\frac{E}{E_1}\right) + P(E_2) \times P\left(\frac{E}{E_2}\right)$

$$= \frac{5}{7} \times \frac{4}{7} + \frac{2}{7} \times \frac{6}{7} = \frac{32}{49}$$

46. Let f : [0, 1] $\rightarrow$ R be such that f (xy) = f (x) · f (y), for all x, y $\in$ [0, 1] and f (0) $\neq$ 0. If y = y(x) satisfies the differential equation, $\frac{dy}{dx} = f(x)$ with y (0) = 1, then $y\left(\frac{1}{4}\right) + y\left(\frac{3}{4}\right)$ is equal to

(1) 5 (2) 4 (3) 2 (4*) 3

Sol. f(xy) = f(x) . f(y)

f(0) = 1 as f (0) $\neq$ 0

$\Rightarrow$ f (x) = 1

$\frac{dy}{dx} = f(x) = 1$

$\Rightarrow$ y = x + c

At, x = 0, y = 1 $\Rightarrow$ c = 1

y = x + 1

$\Rightarrow y\left(\frac{1}{4}\right) + y\left(\frac{3}{4}\right) = \frac{1}{4} + 1 + \frac{3}{4} + 1 = 3$

47. Let A = {x $\in$ R: x is not a positive integer}. Define a function f: A $\to$ R as f (x) = $\frac{2x}{x-1}$, then f is

(1*) injective but not surjective (2) not injective

(3) neither injective nor surjective (4) surjective but not injective

Sol. $f(x) = 2\left(1 + \frac{1}{x-1}\right)$

$f'(x) = \frac{2}{(x-1)^2}$

$\Rightarrow$ of is one – one but not onto

48. Let the equation of two sides of a triangle be 3x – 2y + 6 = 0 and 4x + 5y – 20 = 0. If the orthocentre of this triangle is at (1, 1), then the equation of its third side is:

(1) 26x + 61y + 1675 = 0 (2) 122y – 26x – 1675 = 0

(3) 122y + 26x + 1675 = 0 (4*) 26x – 122y – 1675 = 0

Sol. Equation of AB is 3x – 2y + 6 = 0

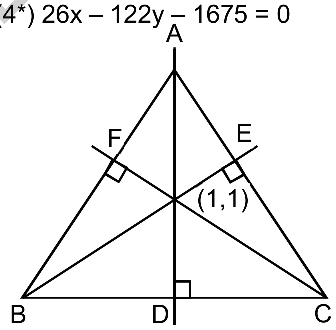
Equation of AC is 4x + 5y – 20 = 0 .

Equation of BE is 2x + 3y – 5 = 0

Equation of CF is 5x – 4y –1= 0

$\Rightarrow$ Equation of BC is

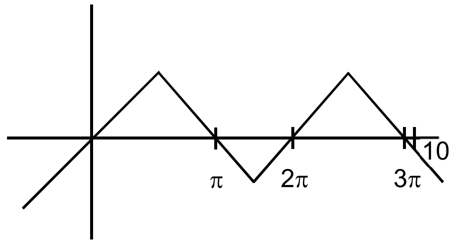
26x –122y = 1675



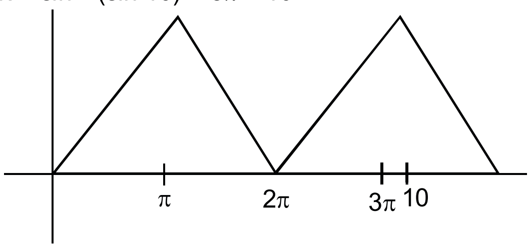
49. If x = $\sin^{-1}$ (sin10) and y = $\cos^{-1}$ (cos10), then y – x is equal to

(1*) π (2) 0 (3) 10 (4) 7π

Sol.



$x = \sin^{-1}(\sin 10) = 3\pi - 10$



$x = \sin^{-1}(\sin 10) = 3\pi - 10$
$y - x = \pi$

50. If both the roots of the equation $x^2 - mx + 4 = 0$ are real and distinct and they lie in the interval [1, 5], then m lies in the interval:

(1*) (4, 5) (2) (5, 6) (3) (3, 4) (4) (– 5, – 4)

Sol. $x^2 - mx + 4 = 0$

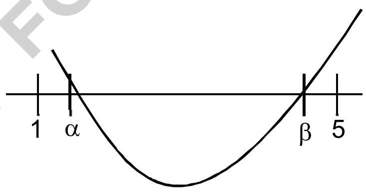
$\alpha, \beta \in [1,5]$

(1) $D > 0 \Rightarrow m^2 - 16 > 0$

$\Rightarrow \mu \in (-\infty, -4) \cup (4, \infty)$

(2) $f(1) \geq 0 \Rightarrow 5 - m \geq 0 \Rightarrow m \in (-\infty, 5)$

(3) $f(5) \geq 0 \Rightarrow 29 - 5m \geq 0 \Rightarrow m \in \left(-\infty, \frac{29}{5}\right)$



(4) $1 < \frac{-b}{2a} < 5 \Rightarrow 1 < \frac{m}{2} < 5 \Rightarrow m \in (2, 10)$

$\Rightarrow m \in (4, 5)$

No option correct : Bonus

* If we consider $\alpha, \beta \in (1, 5)$ then option (1) is correct.

51. If $x = 3 \tan t$ and $y = 3 \sec t$, then the value of at $t = \frac{d^2y}{dx^2}$, $\frac{\pi}{4}$ is

(1*) $\frac{1}{6\sqrt{2}}$ (2) $\frac{1}{3\sqrt{2}}$ (3) $\frac{1}{6}$ (4) $\frac{3}{2\sqrt{2}}$

Sol. $\frac{dx}{dt} = 3 \sec^3 t$

$\frac{dy}{dt} = 3 \sec t \tan t$

$$\frac{dy}{dx}=\frac{\tan t}{\sec t}=\sin t$$

$$=\frac{\cos t}{3\sec^2 t}=\frac{\cos^3 t}{3}=\frac{1}{3.2\sqrt{2}}=\frac{1}{6\sqrt{2}}$$

52. The number of natural numbers less than 7,000 which can be formed by using the digits 0, 1, 3, 7, 9 (repetition of digits allowed) is equal to

(1*) 374 (2) 250 (3) 375 (4) 372

53. If the lines x = ay + b, z = cy + d and x = a'z + b', y = c'z + d' are perpendicular, then

(1) bb' + cc' + 1 = 0 (2*) aa' + c + c' = 0 (3) ab' + bc' + 1 = 0 (4) cc' + a + a' = 0

Sol. Line x = ay + b, z = cy + d

$$\Rightarrow \frac{x-b}{a}=\frac{y}{1}=\frac{z-d}{c}$$

Line x =a' z + b', y = c' z + d'

$$\Rightarrow \frac{x-b'}{a'}=\frac{y-d'}{c'}=\frac{z}{c}$$

Given both the lines are perpendicular

$\Rightarrow$ aa' + C' + C = 0

54. For each x $\in$ R, let [x] be the greatest integer less than or equal to x. Then $\lim\limits_{x\to 0^-}\frac{x([x]+|x|)\sin[x]}{|x|}$ is equal to

(1) 1 (2) 0 (3*) – sin 1 (4) sin 1

Sol. $\lim\limits_{x\to\infty}\frac{x([x]+|x|)\sin[x]}{|x|}$

$X\to 0^-$

$$\left.\begin{matrix}[x]=-1\\ |x|=-x\end{matrix}\right\}\Rightarrow \lim_{x\to\infty}\frac{x(-x-1)\sin(-1)}{-x}=-\sin 1$$

55. Let f be a differentiable function from R to R such that $|f(x)-f(y)|\le 2|x-y|^{3/2}$, for all x, y $\in$ R.

If f (0) = 1 then $\int_0^1 f^2(x)dx$ is equal to

(1*) 1 (2) $\frac{1}{2}$ (3) 2 (4) 0

Sol. $|f(x) - f(y)|\,| \le 2|x - y|^{3/2}$

divide both side by |x – y|

$$\left|\frac{f(x)-f(y)}{x-y}\right| \le |2.|x-y|^{1/2}$$

Apply limit $x \to y$

$|f'(y) \le 0 \Rightarrow f'(y) = 0 \Rightarrow f(y) = c \Rightarrow f(x) = 1|$

$$\int_0^1 1.dx = 1$$

56. Let $\vec{a} = \hat{i} + \hat{j} + \sqrt{2}\hat{k}$, $\vec{b} = b_1\hat{i} + b_2\hat{j} + \sqrt{2}\hat{k}$ and $\vec{c} = 5\hat{i} + \hat{j} + \sqrt{2}\hat{k}$ be three vectors such that the projection vector of $\vec{b}$ on $\vec{a}$ is $\vec{a}$. If $\vec{a}+\vec{b}$ is perpendicular to $\vec{c}$, then $\left|\vec{b}\right|$ is equal to

(1) $\sqrt{22}$ (2*) 6 (3) $\sqrt{32}$ (4) 4

Sol. Projection of $\vec{b}$ on $\vec{a} = \frac{\vec{a}.\vec{b}}{|\vec{a}|} = |\vec{a}|$

$\Rightarrow b_1 + b_2 = 2$ ....(1)

and $\left(\vec{a}+\vec{b}\right) \perp \vec{c} \Rightarrow \left(\vec{a}+\vec{b}\right).\vec{c} = 0$

$\Rightarrow 5b_1 + b_2 = -10$ ....(2)

Form (1) and (2) $\Rightarrow b_1 = -3$ and $b_2 = 5$

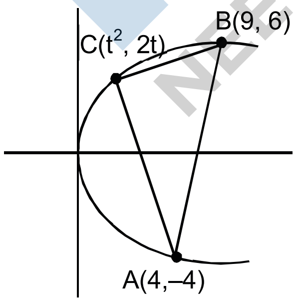
than $\left|\vec{b}\right| = \sqrt{b_1^2 + b_2^2 + 2} = 6$

57. Let A (4, – 4) and B (9, 6) be points on the parabola, $y^2 = 4x$. Let C be chosen on the arc AOB of the parabola, where O is the origin, such that the area of ΔACB is maximum. Then, the area (in sq. units) of ΔACB, is

(1) $31\frac{3}{4}$ (2) $30\frac{1}{4}$ (3*) $31\frac{1}{4}$ (4) 32

Sol. For maximum area, tangent at the point c must be parallel to chord BC.

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



58. Let S be the set of all triangles in the xy-plane, each having one vertex at the origin and the other two vertices lie on coordinate axes with integral coordinates. If each triangle in S has area 50 sq. units, then the number of elements in the set S is

(1*) 36 (2) 32 (3) 18 (4) 9

Sol. Let A $(\alpha,0)$ and B$(0, \beta)$ be the vectors of the given triangle AOB

$\Rightarrow |\alpha\beta| = 100$

$\Rightarrow$ Number of triangles

= 4 × (number of divisors of 100)

= 4 × 9 = 36

59. Let z_0 be a root of the quadratic equation, $x^2 + x + 1 = 0$. If $z = 3 + 6i\ z_0^{81} - 31\ z_0^{93}$, then arg z is equal to

(1*) $\frac{\pi}{4}$ (2) $\frac{\pi}{3}$ (3) $\frac{\pi}{6}$ (4) 0

Sol. $z = \omega$ or ω^2 (where ω is a non – real cube root of unity)

$z = 3 + 6i(\omega)^{81} - 3i(\omega)^{93}$

$z = 3 + 3i$

$\Rightarrow \arg z = \frac{\pi}{4}$

60. The equation of the plane containing the straight line $\frac{x}{2} = \frac{y}{3} = \frac{z}{4}$ and perpendicular to the plane containing the straight lines $\frac{x}{3} = \frac{y}{4} = \frac{z}{2}$ and $\frac{x}{4} = \frac{y}{2} = \frac{z}{3}$ is

(1) $5x + 2y - 4z = 0$ (2) $3x + 2y - 3z = 0$ (3) $x - 2y + z = 0$ (4) $x + 2y - 2z = 0$

Sol. Vector along the normal to the plane containing the lines

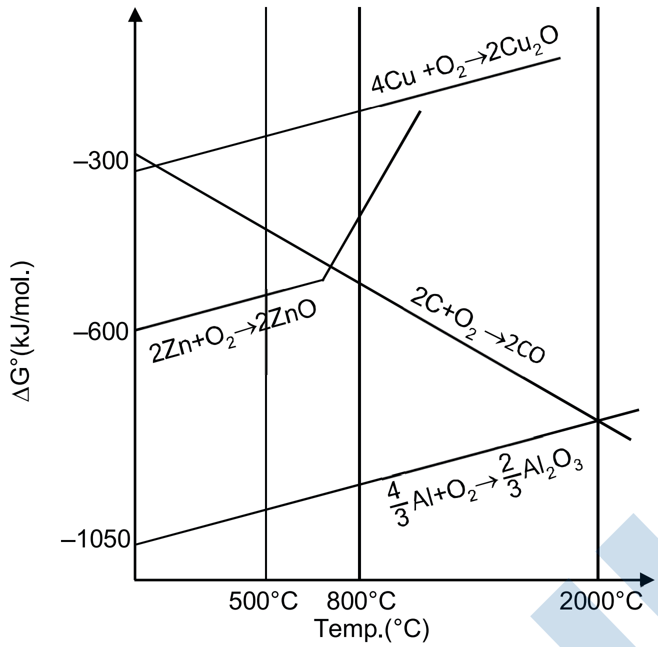
$\frac{x}{3} = \frac{y}{4} = \frac{z}{2}$ and $\frac{x}{4} = \frac{y}{2} = \frac{z}{3}$ is $\left(8\hat{i} - \hat{j} - 10\hat{k}\right)$.

Vector perpendicular to the vectors $2\hat{i} + 3\hat{j} + 4\hat{k}$ and $8\hat{i} - \hat{j} - 10\hat{k} - 52\hat{j} + 26\hat{k}$

So, required plane is $26x - 52y + 26z + 0 \Rightarrow x - 2y + z = 0$

PART-C-CHEMISTRY

61. The correct statement regarding the given Ellingham diagram is:



(1) At 800°C, Cu can be used for the extraction of Zn from ZnO.

(2) At 500°C, coke can be used for the extraction of Zn from ZnO.

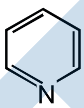
(3*) At 1400°C, Al can be used for the extraction of Zn from ZnO.

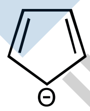
(4) Coke cannot be used for the extraction of Cu from Cu_2O.

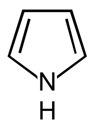
Sol. $4Al + 6ZnO \longrightarrow 2Al\ O + 6Zn$

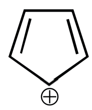
ΔH for the above reaction is –ve.

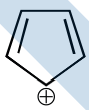
62. Which of the following compounds is not aromatic?

(1) 

(2) 

(3) 

(4*) 

Sol. 

Is anti aromatic

63. The transition element that has lowest enthalpy of atomisation, is -

(1) Fe (2) Zn (3) V (4*) Cu

Sol. Due to weak metallic bonding.

64. For the following reaction, the mass of water produced from 445 g of $C_{57}H_{110}O_6$ is:

$2C_{57}H_{110}O_6(s) + 163\ O_2(g) \rightarrow 114CO_2(g) + 110H_2O(l)$

(1) 890 g (2*) 495 g (3) 445 g (4) 490 g

Sol. $2C_{57}H_{110}O_6(s) + 163O_2(g) \longrightarrow 114\,CO_2(g) + 110H_2O(I)$

$$\frac{\text{Moles of } C_{57}H_{110}O_6}{2} = \frac{\text{Moles of } H_2O}{110}$$

$$\frac{\frac{445}{890}}{2} = \frac{\frac{\text{mass of } H_2O}{18}}{110}$$

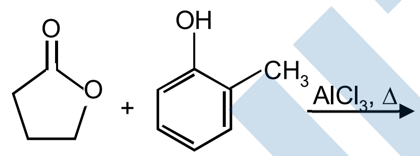
Mass of H_2O = 495 g

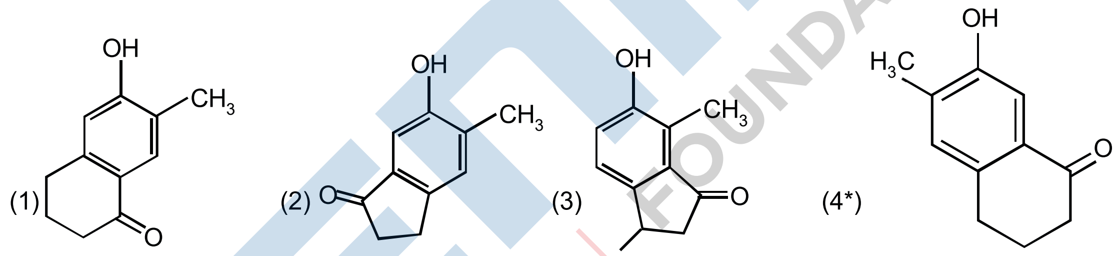
65. For coagulation of arsenious sulphide sol, which one of the following salt solution will be most effective?

(1) NaCl (2) Na_3PO_4 (3)* $AlCl_3$ (4) $BaCl_2$

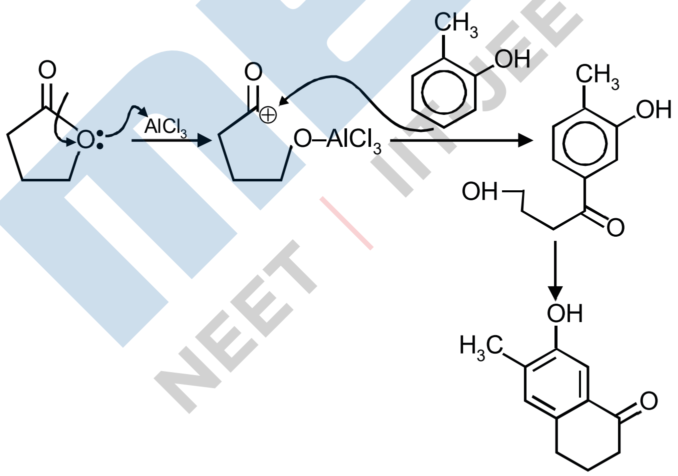
Sol. As_2S_3 is a negatively charged sol. so $AlCl_3$ will be most effective.

66. The major product of the following reaction is





Sol.



67. For the reaction, 2A + B → products, when the concentration of A and B both were doubled, the rate of the reaction increased from 0.3 mol $L^{-1}\ s^{-1}$ to 2.4 mol $L^{-1}\ s^{-1}$. When the concentration of A alone is doubled, the rate increased from 0.3 mol L^{-1} s^{-1} to 0.6 L^{-1} s^{-1}. Which one of the following statements is correct?

(1) Order of the reaction with respect to A is 2.

(2) Total order of the reaction is 4.

(3) Order of the reaction with respect to B is 1.

(4*) Order of the reaction with respect to B is 2.

Sol. $2A + B \longrightarrow$ products

Rate = $K[A]^x[B]^y$

$r = K[A]^x[B]^y$ - - - - (i)

$0.3 = K[A]^x[B]^y$ - - - - (1)

$2.4 = K[2A]^x[2B]^y$ - - - - (2)

$0.6 = K[2A]^x[B]^y$ - - - - (3)

From (1), (2) & (3)

x = 1, y = 2

Overall order = 2 + 1 = 3

Order w.r.t A = 1

Order w.r.t B = 2

68. The complex that has highest crystal field splitting energy (Δ), is:

(1) $[Co(NH_3)_5Cl]Cl_2$ (2) $[Co(NH_3)_5(H_2O)]Cl_3$

(3*) $K_3[Co(CN)_6]$ (4) $K_2[CoCl_4]$

Sol. As CN^- is a strong field ligand. $K_3[Co(CN)_6]$ will have maximum 'Δ'.

69. The correct match between **Item-I** and **Item-II** is -

	Item-I	**Item-II**
(A)	Benzaldehyde	(P) Mobile phase
(B)	Alumina	(Q) Adsorbent
(C)	Acetonitrile	(R) Adsorbate

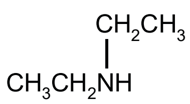
(1) (A) $\rightarrow$ (Q); (B) $\rightarrow$ (P);(C) $\rightarrow$ (R) (2) (A) $\rightarrow$ (P); (B) $\rightarrow$ (R);(C) $\rightarrow$ (Q)

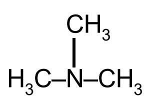
(3) (A) $\rightarrow$ (Q); (B) $\rightarrow$ (R);(C) $\rightarrow$ (P) (4*) (A) $\rightarrow$ (R); (B) $\rightarrow$ (Q);(C) $\rightarrow$ (P)

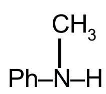
Sol. Acetonitrile is used as mobile phase for most of the reverse chromatography. Benzaldehyde is adsorbed on alumina.

70. The increasing basicity order of the following compounds is:

(A) $CH_3CH_2NH_2$

(B) 

(C) 

(D) 

(1) (A) < (B) < (D) < (C) (2*) (D) < (C) < (A) < (B)

(3) (A) < (B) < (C) < (D) (4) (D) < (C) < (B) < (A)

Sol. Correct order of basic strength is

$NH_2(Et)_2 > EtNH_2 > NMC_3 > Ph - NH - CH_3$

71. Which of the following combination of statements is true regarding the interpretation of the atomic orbitals?

(a*) An electron in an orbital of high angular momentum stays away from the nucleus than an electron in the orbital of lower angular momentum.

(b) For a given value of the principal quantum number, the size of the orbit is inversely proportional to the azimuthal quantum number.

(c) According to wave mechanics, the ground state angular momentum is equal to $h/2\pi$.

(d) The plot of Ψ vs r for various azimuthal quantum numbers, shows peak shifting towards higher r value.

(1) (a), (c) (2) (b), (c) (3) (a), (d) (4) (a), (b)

Sol. Refer Theory

72. The pH of rain water, is approximately:

(1*) 5.6 (2) 6.5 (3) 7.0 (4) 7.5

Sol. Fact based.

73. The metal that forms nitride by reacting directly with N_2 of air, is :

(1) Rb (2*) Li (3) Cs (4) K

Sol. The only alkali metal which forms nitride by reacting directly with N_2 is 'Li'.

74. At 100°C, copper (Cu) has FCC unit cell structure with cell edge length of x Å. What is the approximate density of Cu (in g cm^{-3}) at this temperature? [Atomic mass of Cu = 63.55 u]

(1) $\frac{205}{x^3}$ (2*) $\frac{422}{x^3}$ (3) $\frac{105}{x^3}$ (4) $\frac{211}{x^3}$

Sol. $d = \frac{ZM}{N_a a^3}$

75. If the standard electrode potential for a cell is 2V at 300K, the equilibrium constant (K) for the reaction:

$Zn(s) + Cu^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Cu(s)$

At 300K is approximately. [R = 8 JK^{-1} mol^{-1}, F = 96000 C mol^{-1})

(1) e^{320} (2) e^{-160} (3) e^{-80} (4*) e^{160}

Sol. $Zn(s) + Cu^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Cu(s)$

$-nFE_{cell} = -RT\ell nk$

$$\ell nK = \frac{2 \times 96500 \times 2}{8 \times 300} = 160.83$$

$K = e^{160}$

76. Homoleptic octahedral complexes of a metal ion M^{3+} with three monodentate ligands L_1, L_2 and L_3 absorb wavelengths in the region of green, blue and red respectively. The increasing order of the ligand strength is:

(1*) $L_3 < L_1 < L_2$ (2) $L_2 < L_1 < L_3$ (3) $L_3 < L_2 < L_1$ (4) $L_1 < L_2 < L_3$

Sol. L_1 L_2 L_3

Green Blue Red absorbed wave length

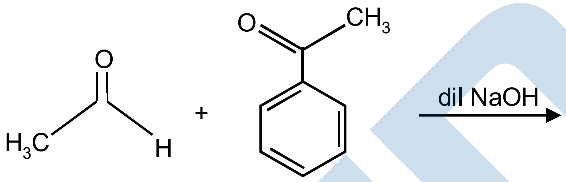
Order of λ Red > Green > Blue

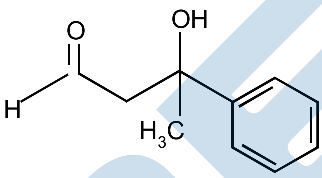
$L_3 > L_1 > L_2$

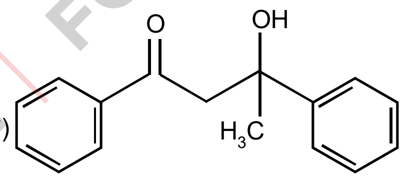
$\therefore$ Strength of ligand $\alpha\ \Delta\ \alpha\ 1/\lambda$

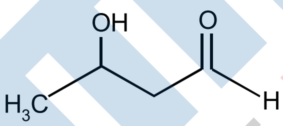
$\therefore$ Strength of ligand $L_2 > L_1 > L_3$

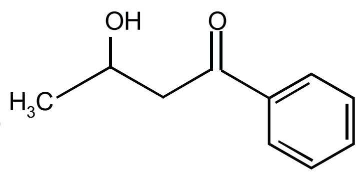
77. The major product formed in the following reaction is:

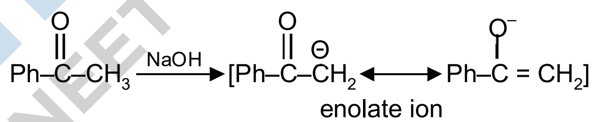


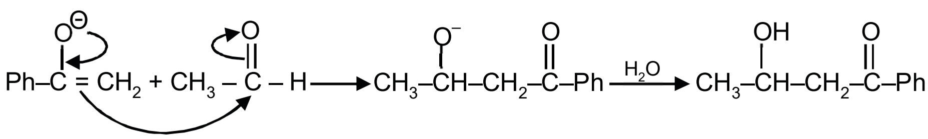
(1) 

(2*) 

(3) 

(4) 



Sol. 

78. Consider the following reversible chemical reactions:

$A_2(g) + B_2(g) \overset{K_1}{\rightleftharpoons} 2AB(g)$ .....(1)

$6AB(g) \overset{K_2}{\rightleftharpoons} 3A_2(g) + 2B_2(g)$ .....(2)

The relation between K_1 and K_2 is :

(1) $K_2 = K_1^3$ (2) $K_1K_2 = 3$ (3*) $K_2 = K_1^{-3}$ (4) $K_1K_2 = \frac{1}{3}$

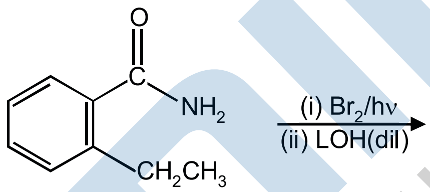
Sol. $A_2(g) + B_2(g) \overset{K_1}{\rightleftharpoons} 2AB(g)$ .....(1)

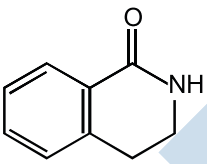
$6AB(g) \overset{K_2}{\rightleftharpoons} 3A_2(g) + 2B_2(g)$ .....(2)

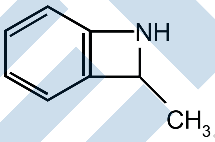
Reaction (2) = –3 × reaction (1)

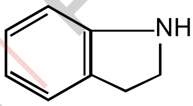
$\therefore K_2 = \left(\frac{1}{K_1}\right) \Rightarrow K_2 = K_1^{-3}$

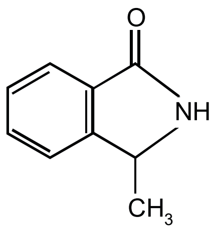
79. The major product of the following reaction is:

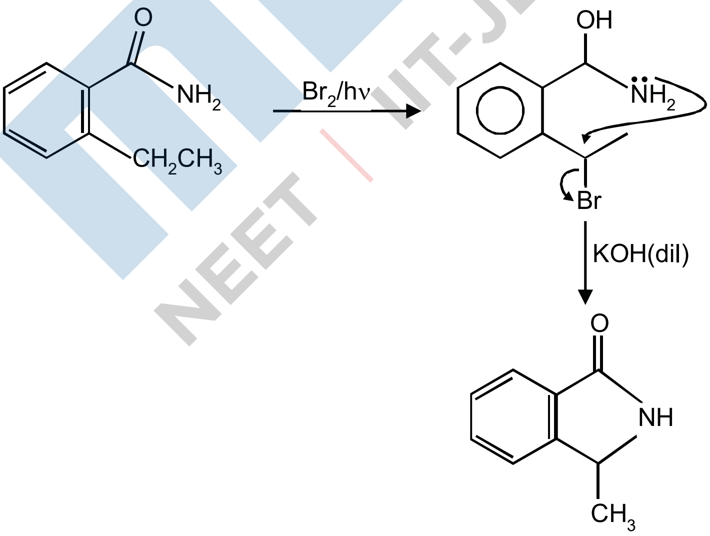


(1) 

(2) 

(3) 

(4) 

Sol. 

80. Which of the following conditions in drinking water causes methemoglobinemia?

(1) > 50 ppm of chloride (2) > 50 ppm of lead

(3) > 100 ppm of sulphate (4*) > 50 ppm of nitrate

Sol. Fact based

81. When the first electron gain enthalpy ($\Delta_{eg}H$) of oxygen is – 141 kJ/mol, its second electron gain enthalpy is:

(1) a more negative value than the first (2) negative, but less negative than the first

(3*) a positive value (4) almost the same as that of the first.

Sol. 2^{nd} electron gain enthalpy of oxygen is positive.

82. Good reducing nature of H_3PO_2 is attributed to the presence of:

(1) Two P–OH bonds (2*) Two P–H bonds (3) One P–OH bond (4) One P–H bond

Sol. Refer theory

83. The entropy change associated with the conversion of 1 kg of ice at 273 K to water vapours at 383 K is : (Specific heat of water liquid and water vapour are 4.2 kJ K^{-1} kg^{-1} and 2.0 kJ K^{-1} kg^{-1}; heat of liquid fusion and vapourisation of water are 334 kJ kg^{-1} and 2491 kJ kg^{-1} , respectively).

(log 273 = 2.436, log 373 = 2.572, log 383 = 2.583)

(1) 8.49 kJ kg^{-1} K^{-1} (2) 7.90 kJ kg^{-1} K^{-1} (3*) 9.26 kJ kg^{-1} K^{-1} (4) 2.64 kJ kg^{-1} K^{-1}

Sol. $H_2O(s) \longrightarrow H_2O(\ell) \longrightarrow H_2O(\ell) \longrightarrow H_2O(g) \longrightarrow H_2O(g)$

1 kg 1 kg 1 kg

at 273 K at 273 K at 373 K at 373 K at 383 K

$\Delta S = \Delta S_1 + \Delta S_2 + \Delta S_3 + \Delta S_4$

$$= \frac{334}{273} + 4.2\ell n\frac{373}{273} + \frac{2491}{373} + 2\ell n\frac{383}{373} = 9.267 \text{ KJ Kg}^{-1}\text{ K}^{-1}$$

84. The temporary hardness of water is due to:

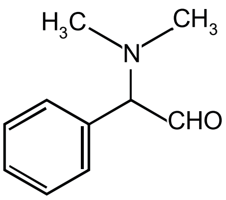
(1) Na_2SO_4 (2) $CaCl_2$ (3) NaCl (4*) $Ca(HCO_3)_2$

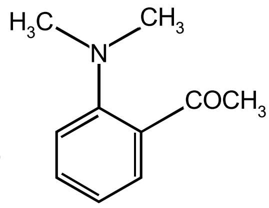
Sol. Fact based.

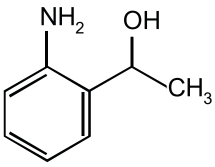
85. The tests performed on compound X and their inferences are:

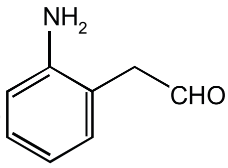
Test	Inference
(a) 2,4-DNP test	Coloured precipitate
(b) Iodoform test	Yellow precipitate
(c) Azo-dye test	No dye formation

Compound 'X' is:

(1*) 

(2) 

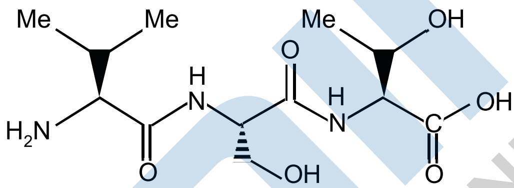
(3) 

(4) 

Sol. ∵ $-COCH_3$ is present it will show both 2, 4-DNP & iodoform test.

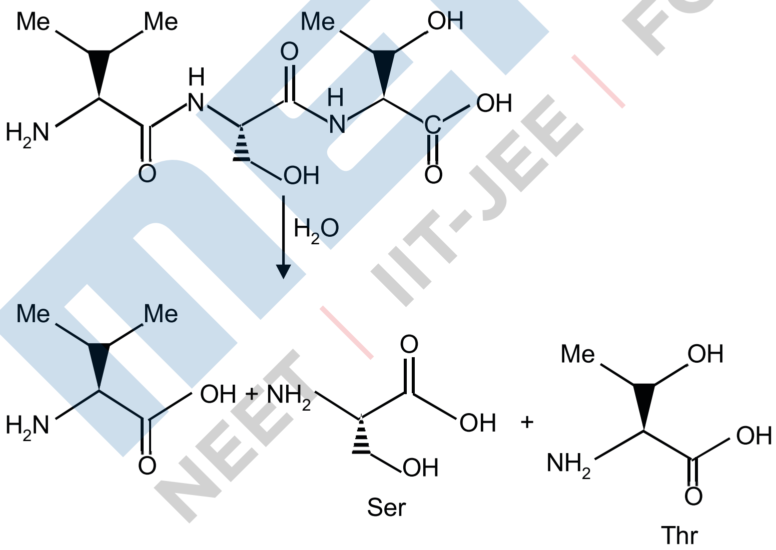
Due to steric inhibition of resonance. l.P of 'N' is not involved in delocalization so coupling reaction will not take place.

86. The correct sequence of amino acids present in the tripeptide given below is:



(1) Thr-Ser-Val (2) Leu-Ser-Thr (3*) Val-Ser-Thr (4) Thr-Ser-Leu

Sol.



87. A solution containing 62 g ethylene glycol in 250 g water is cooled to – 10°C. If K_f for water is 1.86 K kg mol^{-1}, the amount of water (in g) separated as ice is:

(1*) 64 (2) 16 (3) 32 (4) 48

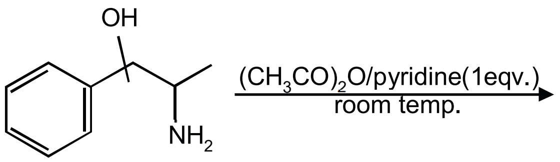
Sol. Let moles of H_2O separated as ice = x gm

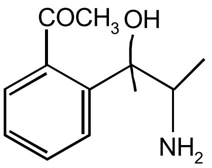
$\Delta T_f = iK_f m$

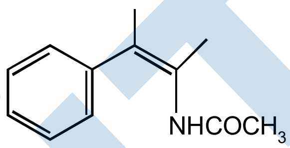
$$10 = 1 \times 1.86 \frac{\frac{62}{62}}{\frac{250-x}{1000}}$$

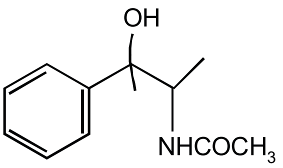
X = 64 gm

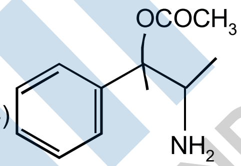
88. The major product obtained in the following reaction is:



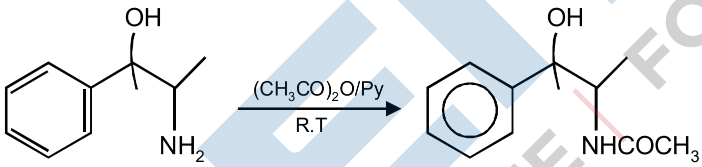
(1) 

(2) 

(3*) 

(4) 

Sol. Nucleophilicity of NH_2 > OH



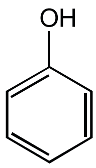
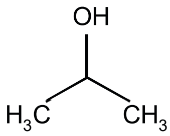
89. In which of the following processes, the bond order has increased and paramagnetic character has changed to diamagnetic?

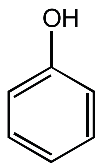
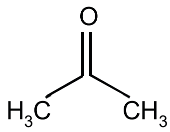
(1) $O_2 \rightarrow O_2^{2-}$ (2) $O_2 \rightarrow O_2^+$ (3) $N_2 \rightarrow N_2^+$ (4*) $NO \rightarrow NO^+$

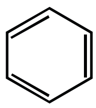
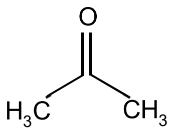
Sol.

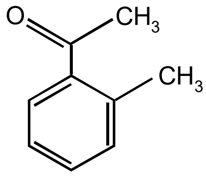
	$NO \longrightarrow$	NO^+		$N_2 \longrightarrow$	N_2^+
B.O	0.5	3	B.O	3	2.5
	Para	Dia		Dia	Para
	$O_2 \longrightarrow$	N_2^+		$O_2 \longrightarrow$	N_2^{2-}
B.O	2	2.5	B.O	2	1
	Para	Para		Para	Dia

90. The products formed in the reaction of cumene with O_2 followed by treatment with dil. HCl are:

(1)  and 

(2*)  and 

(3)  and 

(4)  and $CH_3 - OH$

Sol.