OLTS – 1920 – JEEM 2020

FULL TEST - 5

Part – A : Physics

Section – A

1. A stone dropped from a building of height 'h' reaches the ground after't' seconds. From the same building if two stones are thrown (one upwards and the other downwards) with the same velocity 'u' and they reach the ground after t_1 and t_2 seconds respectively, then the time interval 't' is

(A) $t = t_1 - t_2$ (B) $t = \frac{t_1 + t_2}{2}$ (C) $t = \sqrt{t_1 t_2}$ (D) $t = \sqrt{t_1^2 + t_2^2}$

Ans. **C**

Sol. $h = \frac{1}{2}gt^2$ …(1)

$h = ut_2 + \frac{1}{2}gt_2^2$ …(2)

$h = -ut_1 + \frac{1}{2}gt_1^2$ …(3)

By solving (1), (2) and (3)

$t = \sqrt{t_1 t_2}$

2. A raindrop of radius 'r' falls from a certain height 'h' above the ground. The work done by the gravitational force is proportional to

(A) r (B) r^2 (C) r^3 (D) r^4

Ans. **C**

Sol. $M = \frac{4\pi}{3} r^3 \rho$

$W = mgh = \frac{4\pi}{3} r^3 \rho gh$

$W \propto r^3$

3. A long cylindrical tube is mounted vertically and contains water. The cylinder has radius 2.5 cm. A tuning fork of frequency 384 Hz is placed at the open end of the tube. Water is draining from the tube at a constant rate of 50 cm^3/s. If the speed of sound is 340 m/s, how much time passes between consecutive resonance as the water drains?

(A) 5.5 s (B) 8.7 s (C) 11.1 s (D) 17.4 s

Ans. **D**

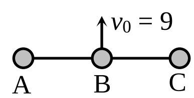
Sol. The wavelength of the sound is $v = f\lambda$

$\lambda = \frac{v}{f} = \frac{340 m/s}{384 Hz}$ = 88.5 cm

Resonances of the tube occur when the water level drops one-half wavelength. The flow rate out of the tube is $R = \frac{V}{t} = \frac{\pi r^2 L}{t} \Rightarrow t = \frac{\pi r^2 L}{R}$ where V is volume. Substituting gives

$t = \frac{\pi r^2 L}{R} = \frac{\pi 2.5 cm \times 44.25 cm}{50 cm^3/s}$ = 17.4 s

4. Three identical balls each of mass 5 kg are connected with each other as shown in figure, and rests over a smooth horizontal table. At moment *t* = 0 ball *B* is given velocity 9 m/sec then velocity of *A* in direction of velocity of *B* just before collision is

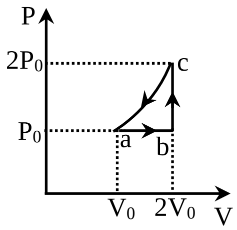


(A) 9 m/sec (B) zero (C) 3 m/sec (D) 6 m/sec

Ans. C

Sol. $P_i = P_F$
m(v) = 3m vl
m(9) = 3mv'
v' = 3

5. One mole of an ideal monatomic gas has initial temperature T_0, is made to go through the cycle *abca* shown in figure. If *U* denotes the internal energy, then choose the correct alternative

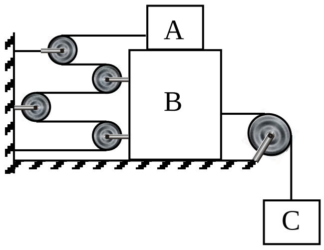


(A) $U_c > U_b > U_a$ (B) $U_c - U_b = 5RT_0$
(C) $U_c - U_a = \frac{10RT_0}{3}$ (D) $U_b - U_a = \frac{5RT_0}{2}$

Ans. A

Sol. as U ∝ T

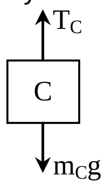
6. Given $m_A = m_B = m_C$ = 10 kg. The coefficient of friction between A and B and B and surface is 0.2. (g = 10 m/s^2)



(A) Friction force between A and B is 10 N
(B) Friction force between B and surface is 20 N
(C) Tension in string attached with C is 100N
(D) Tension in string attached with A is 12N

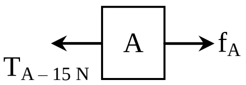
Ans. C

Sol. System will not move

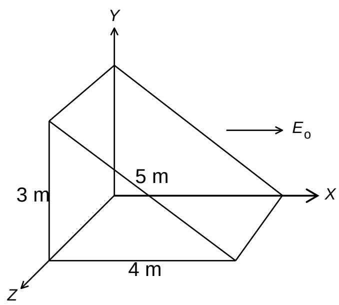


$T_C = m_C g$

= 10 × 10 = 100 N



7. The wedge-shaped surface in figure is in a region of uniform electric field E_0 along x axis. The net electric flux for the entire closed surface is

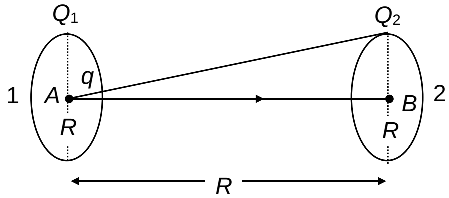


(A) 9 E_0 (B) 15 E_0
(C) 12 E_0 (D) zero

Ans. D

Sol. Since field is uniform, the net flux for the closed surface is zero.

8. Two identical thin rings, each of radius R metres are coaxially placed at a distance R metres apart. If Q_1 and Q_2 charges are spread uniformly on the two rings, the work done in moving a charge q from the centre of one ring to that of the other is



(A) zero

(B) $q(Q_1 - Q_2)(\sqrt{2}-1)/\sqrt{2}(4\pi\varepsilon_0 R)$

(C) $q\sqrt{2}(Q_1+Q_2)/(4\pi\varepsilon_0 R)$

(D) $q(Q_1+Q_2)(\sqrt{2}+1)/\sqrt{2}(4\pi\varepsilon_0 R)$

Ans. **B**

Sol. $V_B = \dfrac{KQ_2}{R}+\dfrac{KQ_1}{\sqrt{2}R}$, $\quad V_A = \dfrac{KQ_1}{R}+\dfrac{KQ_2}{\sqrt{2}R}$

$\therefore V_A - V_B = \dfrac{KQ_1}{R}\left(1-\dfrac{1}{\sqrt{2}}\right)+\dfrac{KQ_2}{R}\left(\dfrac{1}{\sqrt{2}}-1\right)$

$\therefore V_A - V_B = \dfrac{K}{R}\left(1-\dfrac{1}{\sqrt{2}}\right)(Q_1-Q_2)$, where $K=\dfrac{1}{4\pi\varepsilon_0}$

$\therefore W = q(V_A - V_B)$

$\therefore$ (b)

9. A cell sends a current through a resistance R_1 for time t and next the same cell sends a current through another resistance R_2 for the same time t. If same quantity of heat is developed in both the resistances, then the internal resistance of the cell is

(A) $\dfrac{R_1+R_2}{2}$ (B) $\dfrac{R_1-R_2}{2}$ (C) $\sqrt{R_1R_2}$ (D) $\dfrac{\sqrt{R_1R_2}}{2}$

Ans. **C**

Sol. $i_1 = \dfrac{E}{R_1+r};\, i_2 = \dfrac{E}{R_2+r}$

$H = i_1^2R_1t = i_2^2R_2t$

$\left(\dfrac{E}{R_1+r}\right)^2 R_1t = \left(\dfrac{E}{R_2+r}\right)^2 R_2t$, $\quad \dfrac{R_2+r}{R_1+r}=\sqrt{\dfrac{R_2}{R_1}}$

$\dfrac{R_2-R_1}{R_1+r} = \dfrac{\sqrt{R_2}-\sqrt{R_1}}{\sqrt{R_1}}$

$R_1+r = \sqrt{R_1}\dfrac{(R_2-R_1)}{\sqrt{R_2}-\sqrt{R_1}} = \sqrt{R_1}\left(\sqrt{R_2}+\sqrt{R_1}\right)$

$R_1+r = \sqrt{R_1R_2}+R_1$

$r = \sqrt{R_1R_2}$

$\therefore$ (c)

10. Two coherent sources produce waves of different intensities which interfere. After interference, the ratio of the maximum intensity to the minimum intensity is 16. The intensity of the waves are in the ratio:

(A) 4 : 1 (B) 25 : 9 (C) 16 : 9 (D) 5 : 3

Ans. **B**

Sol. $\dfrac{I_{max}}{I_{min}} = 16$

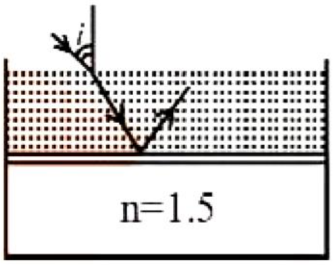
$\Rightarrow \frac{A_{max}}{A_{min}} = 4$

$\Rightarrow \frac{A_1 + A_2}{A_1 - A_2} = \frac{4}{1}$

Using componendo & dividendo

$\frac{A_1}{A_2} = \frac{5}{3} \Rightarrow \frac{I_1}{I_2} = \left(\frac{5}{3}\right)^2 = \frac{25}{9}$

11. Consider a tank made of glass(reiractive index 1.5) with a thick bottom. It is filled with a liquid of refractive index μ,. A student finds that, irrespective of what the incident angle i (see figure) is for a beam of light entering the liquid, the light reflected from the liquid glass interface is never completely polarized. For this to happen, the minimum value of μ is



(A) $\frac{3}{\sqrt{5}}$ (B) $\frac{5}{\sqrt{3}}$

(C) $\sqrt{\frac{5}{3}}$ (D) $\frac{4}{3}$

Ans. A

Sol. $C < i_b$

Here i_b is "brewester angle"
and c is critical angle

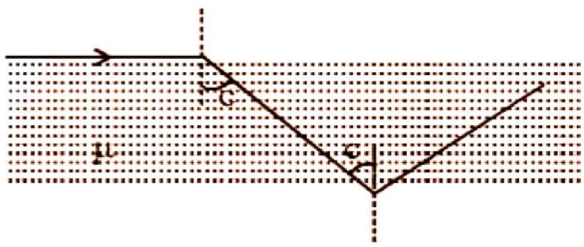
$\sin_c < \sin i_b$ since $\tan i_b = \mu_{0_{bl}} = \frac{1.5}{\mu}$

$\frac{1}{\mu} < \frac{1.5}{\sqrt{\mu^2 + (1.5)^2}}$ $\therefore \sin i_b = \frac{1.5}{\sqrt{\mu^2 + (1.5)^2}}$

$\sqrt{\mu^2 \times (1.5)^2} < 1.5 \times \mu$

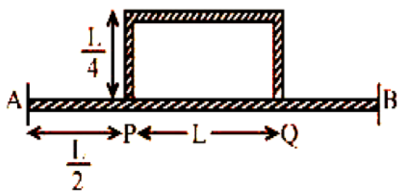
$\mu^2 + (1.5)^2 < (\mu \times 1.5)^2$

$\mu < \frac{3}{\sqrt{5}}$



slab μ = 1.5

12. Temperature difference of 120°C is maintained between two ends of a uniform rod AB of length 2L.Another bent rod PQ, of same cross section as AB and length $\frac{3L}{2}$, is connected across AB (See figure). In steady state, temperature difference between P and Q will be close to

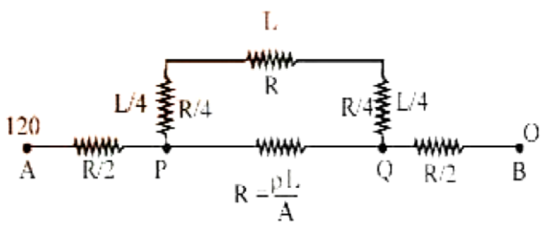


(A) 60^0C (B) 75^0C

(C) 35^0C (D) 45^0C

Ans. D

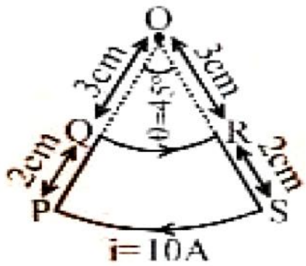
Sol.



$$\frac{\Delta T}{R_{eq.}} = 1 = \frac{(120)^5}{8R} = \frac{120\times 5}{8R}$$

$$\Delta T_{PQ} = \frac{120\times 5}{8R}\times\frac{3}{5}R = \frac{360}{8} = 45^0 C$$

13. A current loop, having two circular arcs joined by two radial lines is shown in the figure. It carries a current of 10 A. The magnetic field at point O will be close to

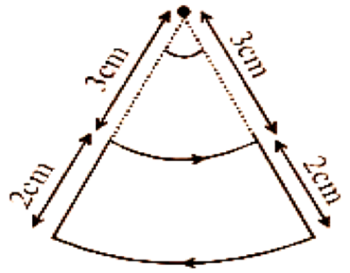


(A) $1.0\times10^{-5}T$ (B) $1.5\times10^{-5}T$

(C) $1.0\times10^{-7}T$ (D) $1.0\times10^{-7}T$

Ans. **A**

Sol.



$$\vec{B} = \frac{\mu_0 i}{4\pi}\theta\left[\frac{1}{r_1}-\frac{1}{r_2}\right]\hat{k}$$

$$r_1 = 3cm = 3\times10^2 m$$

$$r_2 = 5cm = 5\times10^{-2} m$$

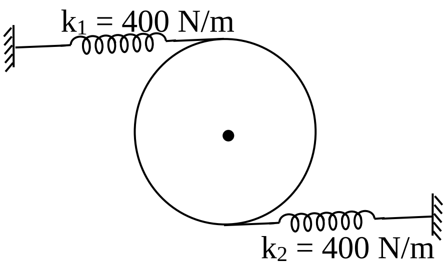
$$\theta = \frac{\pi}{4}, i = 10A$$

$$\Rightarrow \vec{B} = \frac{4\pi\times10^{-7}}{16}\times10\left[\frac{1}{3\times10^2}-\frac{1}{5\times10^2}\right]\hat{k}$$

$$\Rightarrow \left|\vec{B}\right| = \frac{\pi}{3}\times10^{-5}T$$

$$\approx 1\times10^5 T$$

14. A disc of radius 0.1m and mass 4kg is connected as shown in figure. Find frequency of SHM.



(A) 1.59 Hz (B) 3.18 Hz

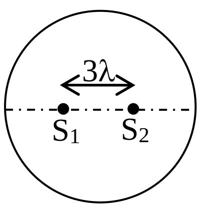
(C) 4.78 Hz (D) 6.30 Hz

Ans. **B**

Sol. $\tau = -2kR^2\theta$

$$= \alpha = -\left(\frac{4k}{m}\right)\theta$$

$$f = \frac{10}{\pi} = 3.18Hz$$



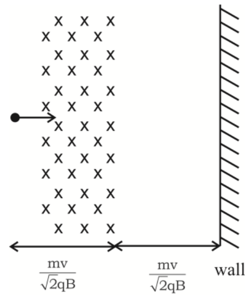
15. Two coherent sources are placed at a distance '3λ' from each other symmetric to the centre of circle shown in the figure. Then number of fringe(s) shown on the screen placed along the circumference is

(A) 16 (B) 12
(C) 8 (D) 4

Ans. B

Sol. Fro constructive interference path difference = nλ
∴ 12 fringers will be formed

16. A particle of mass m and charge q enters a region of magnetic field (as shown) with speed v. There is a region in which the magnetic field is absent, as shown. The particle after entering the region collides elastically with a rigid wall. Time after which the velocity of particle becomes anti parallel to its initial velocity is



(A) $\frac{m}{2qB}(\pi+4)$ (B) $\frac{m}{qB}(\pi+2)$
(C) $\frac{m}{4qB}(\pi+2)$ (D) $\frac{m}{4qB}(2\pi+3)$

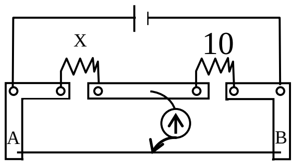
Ans. A

Sol. Total time = time in field + time in fee region

$$= \frac{T}{v} + \left(\frac{mv}{\sqrt{2}qB}\sqrt{2}/v\right)$$

$$= \frac{m}{2qB}(\pi+v)$$

17. A meter bridge is set up as shown, to determine an unknown resistance 'X' using a standard 10 ohm resistor. The galvanometer shows null point when tapping-key is at 52 cm mark. The end-corrections are 1 cm and 2 cm respectively for the ends A and B. The determined value of 'X' is

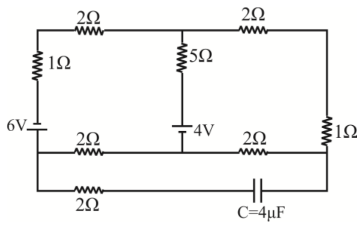


(A) 10.2 ohm (B) 10.6 ohm
(C) 10.8 ohm (D) 11.1 ohm

Ans. B

Sol. $\frac{X}{53} = \frac{10}{50}$

18. Find charge on capacitor in steady state in given circuit



(A) 9.6 μC (B) 7.2μC
(C) 4.8μC (D) 2.4μC

Ans. A

Sol. at steady state capacitor will behave as open circuit

19. In YDSE, the intensity at the bright fringe is $4I_0$, when two identical slits or used. One of the slits is now covered. The new intensity at any point on the screen is

(A) I_0 (B) 2 I_0 (C) $\frac{I_0}{2}$ (D) $\frac{I_0}{\sqrt{2}}$

Ans. A

Sol. $\left(I_1 + I_1\right)^2 = 4I_0$

$I_1 = I_0$

20. A resistance R draws P power when connected to an AC source. If an inductance is now placed in series with the resistance, such that the impedance of the circuit becomes z, the power drawn will be

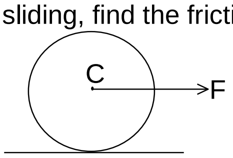
(A) $P\left(\frac{R}{Z}\right)^2$ (B) $P\left(\frac{R}{Z}\right)$ (C) $P\sqrt{\frac{R}{Z}}$ (D) P

Ans. A

Sol. $P = \frac{V^2}{R}, P' = VI\cos\phi = V.\frac{V}{2}.\frac{R}{2} = P\left(\frac{R}{2}\right)^2$

Section – B

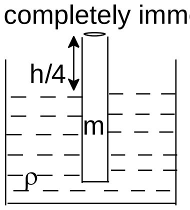
21. A horizontal force F = 14 N acts at the centre of mass of a sphere of mass m = 1 kg. If the sphere rolls without sliding, find the frictional force (in N)



Ans. 4

Sol. $\frac{F-f}{m} = R.\frac{5f}{2mR} \Rightarrow f = \frac{2}{7}F = 4N$

22. A solid cylinder of height h and mass m is floating in a liquid of density ρ as shown in the figure. Find the acceleration of the vessel (in m/s^2) containing liquid for which the relative downward acceleration of the completely immersed cylinder w.r.t. vessel becomes equal to one-third of that of the vessel. (Take g = 10 m/s^2)



Ans. 5

Sol. Let the volume of the cylinder be V. when the cylinder is floating, upthrust = weight. Hence,

$\rho\left(\frac{3}{4}V\right)g = mg \Rightarrow V = \frac{4m}{3\rho}$

Let the acceleration of the particle vessel be A (upwards). In the reference frame of the vessel, the acceleration of the cylinder is A/3.

$mg + mA - uptrust = m\left(\frac{A}{3}\right)$

$mg + mA - \rho Vg' = m\left(\frac{A}{3}\right)$

Where g' = g + A = effective value of g for upthrust.

$\therefore mg + mA - \rho V\left(g + A\right) = m\left(\frac{A}{3}\right)$

$\Rightarrow mg - \frac{4}{3}m\left(g + A\right) = -m\frac{2}{3}A$

$A = \left(-\frac{g}{2}\right) upwards$

The acceleration of the vessel should be $\frac{g}{2} = \frac{10}{2} = 5ms^{-2}\left(downwards\right)$

Section – C

23. The activity of a freshly prepared radioactive sample is 10^{10} disintegrations per second, whose mean life is 10^9 s. The mass of an atom of this radioisotope is 10^{-25} kg. The mass (in mg) of the radioactive sample is _____.

Ans. 00001.00

Sol. $N = N_0 e^{-\lambda t}$

$$\frac{dN}{dt} = 10^{10} = N_0(\lambda)e^{-10^{-9}t}$$

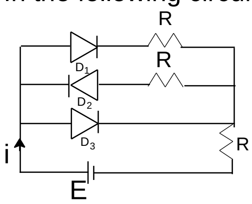
$$At\ t = 0, 10^{10} = N_0 10^{-9}$$

$$N_0 = 10^{19}$$

$$Mass\ of\ sample = N_0 \times (mass\ of\ atom)$$

$$= 10^{19} \times 10^{-25} kg = 10^{-6} kg = 1 mg$$

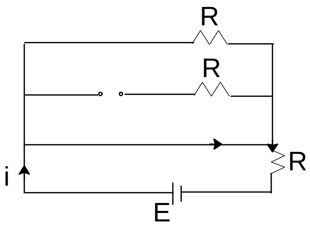
24. In the following circuit of pn junction diodes, D_1, D_2 and D_3 are ideal, then i is



(A) E/R (B) E/2R (C) 2E/3R (D) Zero

Ans. 00001.00

Sol. Diodes D_1 and D_3 are forward biased and D_2 is reverse biased so the circuit can be redrawn as follows:



$$\Rightarrow i = \frac{E}{R}$$

25. The focal length of a thin biconvex lens is 20 cm. When an object is moved from a distance of 25 cm in front of it to 50 cm, the magnification of its image changes from m_{25} to m_{50}. The ratio m_{25}/m_{50} is

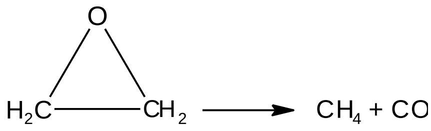
Ans. 6

Sol. $m = \dfrac{f}{f+u}$

Part – B : Chemistry

Section – A

26. The rate constant for First order decomposition of Ethylene oxide into CH_4 *and* CO is described by

$\log k\left(5^{-1}\right) = 14.34 - \frac{1.25\times10^5\,k}{T}$  The Activation energy of this Reaction is

(A) $2.39\times10^5\ KJ/mol$ (B) $2.39\times10^3\ KJ/mol$

(C) $4.78\times10^5\ KJ/mol$ (D) $4.73\times10^2\ KJ/mol$

Ans. B

Sol. $\log K = \log \mathrm{A} - \frac{E_a}{2.303\,RT}$

Equating with given equation

$E_a = 2.303\times8.314\times1.25\times10^5\ J/mol$

$= 2.39\times10^3\ KJ/mol$

27. Calculate Ecell of the reaction

$Mg(s) + 2\mathrm{A}g^{+}(0.0001M) \rightarrow Mg^{2+}(0.130M) + 2\mathrm{A}g(s)\ of\ E^{\circ}cell = 3.17v$

(A) – 2.96 v (B) +2.96 v (C) 3.38 v (D) -3.38 v

Ans. B

Sol. $Ecell = E^{\circ}cell - \frac{RT}{2F}\ell n\frac{[Mg]^{2+}}{\left[Ag^{+}\right]^{2}}$

$= 3.17 - 0.21 = 2.96v$

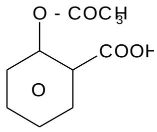
28. The value of X, Y and Z in the reaction are respectively

$XMnO_4^- + YH_2SO_4 \rightarrow 2Mn^{2+} + 5H_2O + 9O_2 + Ze^-$

(A) 2 ,5 , 6 (B) 5, 2, 9 (C) 3, 5, 5 (D) 2, 6, 6

Ans. A

Sol. $2MnO_4^- + 5H_2SO_4 \rightarrow 2Mn^{2+} + 5H_2O + 9O_2 + 6e^-$

29. 

Aspirin is a pain reliever with $Pka = 2$ Two tablet each containing 0.09 gm of aspirin are dissolved in 100 mL solution pH will be

(A) 0.5 (B) 1.0 (C) 0.0 (D) 2.0

Ans. D

Sol. Aspirin is a Weak Acid

$$M = \frac{0.09 \times 2 \times 1000}{180} = 10^{-2}$$

$$pH = \frac{1}{2}[pka - \log c] = \frac{1}{2} \times 4 = 2$$

30. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g),\ kp = 0.82\,atm,\ at\ 727^\circ C$

If 1 mole of $CaCO_3$ is placed in a closed container of 20 L and heated to this temperature. What amount of $CaCO_3$ would dissociate at equilibrium.

(A) 0.2 g (B) 80 g (C) 20 g (D) 50 g

Ans. **C**

Sol.

$$p_{CO_2} = kp = 0.82\ atm$$

$$n_{CO_2} = \frac{pv}{RT} = 0.2\ mol$$

So, Amount dissociated $= 0.2 \times 100 = 20\,g$

31. Calculate the resonance energy of $N_2O\left(\Delta f\ \overset{\circ}{H}\ of\ N_2O = 82\ KJ/mol\right)$

Bond energy of $N = O \rightarrow 607\ KJ/mol$

Bond energy of $O = O \rightarrow 498\ KJ/mol$

Bond energy of $N = N \rightarrow 418\ KJ/mol$

Bond energy of $N \equiv N \rightarrow 946\ KJ/mol$

(A) $82\ KJ/\text{mol}$ (B) $-88\ KJ/\text{mol}$ (C) $-82\ KJ/\text{mol}$ (D) $+88\ KJ/\text{mol}$

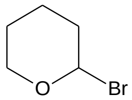
Ans. **B**

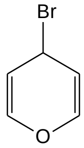
Sol. $N \equiv N(a) + \frac{1}{2}O \equiv O(g) \rightarrow N = N = O$

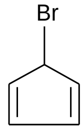
$$\Delta f\ \overset{\circ}{n} = \left[946 + \frac{1}{2}(498)\right] - [418 + 607] = 170\,KJ/mol$$

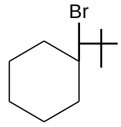
$$R.E = 82 - 170 \Rightarrow -88\,KJ/mol$$

32. Which of the following is most reactive towards $AgNO_3$

(A) 

(B) 

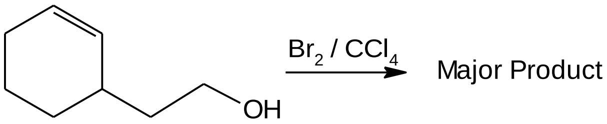
(C) 

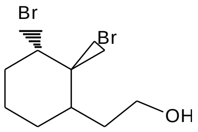
(D) 

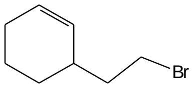
Ans. **B**

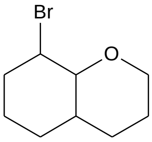
Sol. It will form Aromatic cation

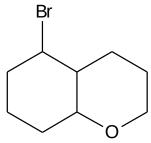
33. Give the major product of the following reaction



(A) 

(B) 

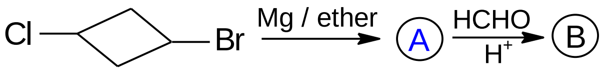
(C) 

(D) 

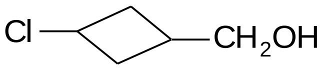
Ans. C

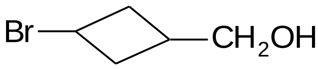
Sol. Intra molecular reaction will take place.

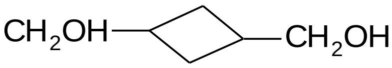
34.

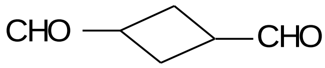


Product B is

(A) 

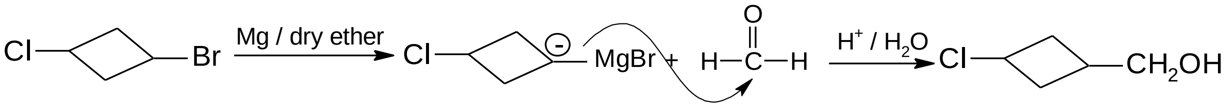
(B) 

(C) 

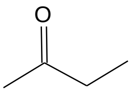
(D) 

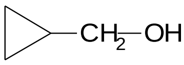
Ans. A

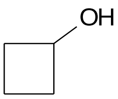
Sol.

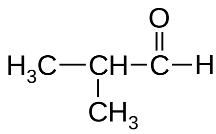


35. Compound X C_4H_8O which gives 2, 4 DNP derivative and negative Sodoform test is

(A) 

(B) 

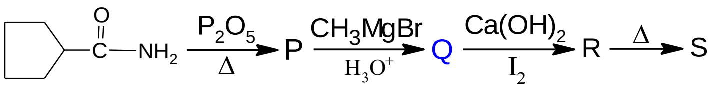
(C) 

(D) 

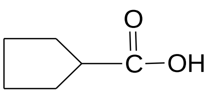
Ans. D

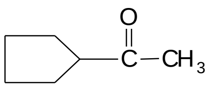
Sol. For 2, 4 DNP test compound should have Carbonyl group while for sodoform test compound should have Methyl Keto group.

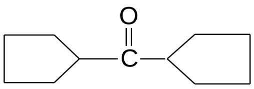
36.

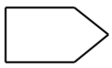


Find product S

(A) 

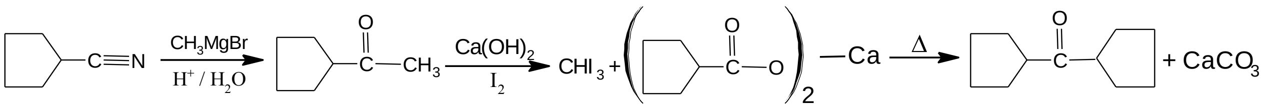
(B) 

(C) 

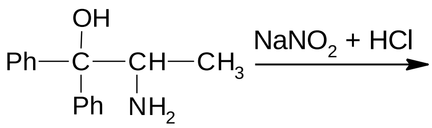
(D) 

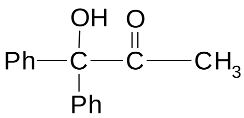
Ans. C

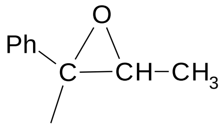
Sol.

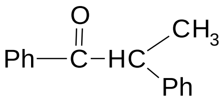


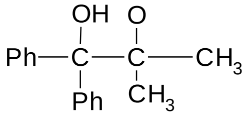
37. The major product of this reaction is



(A) 

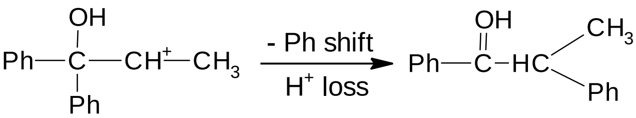
(B) 

(C) 

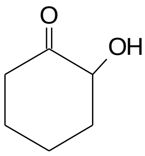
(D) 

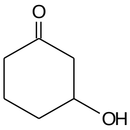
Ans. C

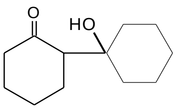
Sol.

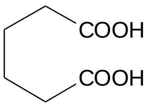


38. When Cyclo hexanone is treated with Na_2CO_3 solution we get

(A) 

(B) 

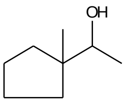
(C) 

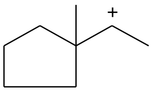
(D) 

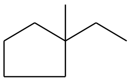
Ans. C

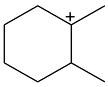
Sol. Aldol condensation

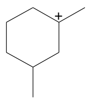
39. Which Carbo cation is more likely to formed in the dehydration of



(A) 

(B) 

(C) 

(D) 

Ans. C

Sol. Ring expansion and rearrangement if Carbo cation will take place

40. In an experiment, 200 ml of 0.5 M oxalic acid is shaken with 10 g of activated charcoal and filtered. The concentration of filtrate is reduced to 0.4 M. The amount of adsorption $\left(\frac{x}{m}\right)$ is-

(A) 0.18 (B) 0.9 (C) 1.8 (D) 0.09

Ans. A

Sol. Mass of O acid absorbed by 109 charcoal

$= 200 \times 10^{-3}\left[0.5 - 0.4\right] \times 90 = 1.8\,g$

$so,\ \frac{x}{m} = \frac{1.8}{10} = 0.18$

41. How many Nearest and 'Next Nearest' neighbours respectively, does Potassium have in bcc lattice.

(A) 8, 8 (B) 8, 6 (C) 6, 8 (D) 6, 6

Ans. B

Sol. 1st coordination number is 8, 2nd coordination number is 6

42. Correct order of ionic size of element

(A) $Mn^{+7} < Mn^{+4} < Mn^{+4}$ (B) $C^{+} < C < C^{-}$

(C) $Fe^{+3} < Fe^{+2} < Fe$ (D) All of the above

Ans. D

Sol. All are correct

43. Which of the following hydride is covalent and polymeric in nature?

(A) CaH_2 (B) BeH_2 (C) NaH (D) BaH_2

Ans. B

Sol. BeH_2

44. A perfect gas undergoes a reversible adiabatic expansion from $(300\,K,\ 200\ atm)\ to\ (90\,K, 10\ atm)$. Find atomicity of gas.

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

Ans. A

Sol. For reversible adiabatic process

$$P^{1-v}T^{v} = const. \quad \Rightarrow \frac{300}{90} = \left(\frac{10}{20}\right)^{\frac{1-v}{v}}$$

On solving this we get $v = 1.66 =$ atomicity of gas is 1.

45. The product of Blast furnace is known as

(A) Cast iron (B) Wrought iron (C) Pig iron (D) Steel

Ans. C

Sol. Pig iron

Section – B

46. Total number of species having fractional bond order among the following is/are

O_2^{+} CO B_2 O_2^{-} NO^{+} He_2^{+} C_2^{2+} CN^{-} N_2^{-}

Ans. 4

Sol. Use molecular orbital theory

47. Sum of oxidation state of Nitrogen atom in Hyponitrous acid, Nitric acid and Nitrous acid.

Ans. 9

Sol. $\Rightarrow 1+5+3=9$

Section – C

48. A 10 L box contains 41.4 g of a mixture of gases $C_xH_8\ and\ C_xH_{12}$. The total pressure at $44^{\circ}C$ in flask is 1.56 atm. Analysis revealed that the gas mixture has 87% total C and 13% total H find value of x.

Ans. 00005.00

Sol. $Total\ moles = \frac{\rho v}{R\pi} \Rightarrow \frac{1.56\times10}{0.082\times317} = 0.6\ mol$

Let C_xH_8 is a mole C_xH_2 is 0.6 –a mole

Total mass of C in mixture $= 12ax + 12x(0.6-a)g = 7.2x$

% C in mixture $= \frac{7.2x}{41.4}\times100 = 87\%$ $x = 5$

49. To stop the flow of Photoelectrons produced by electromagnetic radiation incident on certain metal a negative potential of 300 v is required. If the photoelectric threshold of metal is 1500 A. What is the frequency of incident radiation in terms of $10^6\ Hz.$

Ans. 00007.45

Sol. K.E. of Photo electron = $= 1.602\times10^{-19}\times300 \Rightarrow 4.806\times10^{-17}\ J$

$$K.E. = h(v-v_0) = 6.626\times10^{-34}\left(v - \frac{3\times10^8}{1500\times10^{-10}}\right)$$

$$v - 2\times10^{15} = \frac{4.806\times10^{-7}}{6.626\times10^{-34}} = 72.33\times10^{15}$$

$$v = 7.45\times10^{16} \Rightarrow 7.45$$

50. The sum of coordination number, oxidation number and number of d electron on metal (Co) in the complex $\left[CO(NH_3)_4CO_3\right]ClO_4^-$ is-

Ans. 00015.00

Sol. Here carbonate ion is working as bidentate ligand so coordination no. of CO is +6 O. No. 3

Part – C : Mathematics

Section – A

51. The number of solution of the equation $\sqrt{x^2} - \sqrt{(x-1)^2} + \sqrt{(x-2)^2} = \sqrt{5}$ is

(A) 0 (B) 1 (C) 2 (D) None of these

Ans. **C**

Sol.

$$C-I \quad x \geq 2 \quad \Rightarrow x = 1+\sqrt{5}$$
$$C-II \quad 1 \leq x < 2 \Rightarrow No\ solution$$
$$C-III \quad 0 \leq x < 1 \Rightarrow No\ solution$$
$$C-IV \quad x < 0 \quad \Rightarrow x = 1-\sqrt{5}$$

52. If $|z-25i| \leq 15$ *then* $|\text{maximum amp}(z) - \text{minimum amp}(z)| =$

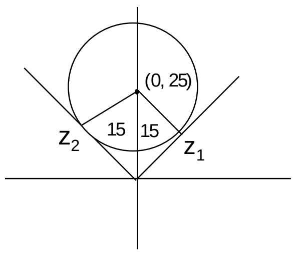
(A) $\cos^{-1}\left(\frac{3}{5}\right)$ (B) $\pi - 2\cos^{-1}\left(\frac{3}{5}\right)$

(C) $\frac{\pi}{\alpha} + \cos^{-1}\left(\frac{3}{5}\right)$ (D) $\sin^{-1}\left(\frac{3}{5}\right) - \cos^{-1}\left(\frac{3}{5}\right)$

Ans. **B**

Sol.

$$Max\ amp = \frac{\pi}{2} + \sin^{-1}\frac{3}{5}$$
$$Min\ amp = \cos^{-1}\frac{3}{5}$$



53. If $x = \sum_{n=0}^{\infty} a^n,\ y = \sum_{n=0}^{\infty} b^n,\ z = \sum_{n=0}^{\infty} (ab)^n$, *where* $a, b < 1$, then

(A) $xyz = x+y+z$ (B) $xz + yz = xy + z$ (C) $xy + yz = xz + y$ (D) $xy + xz = yz + x$

Ans. **B**

Sol.

$$a = \frac{x-1}{x}, \qquad b = \frac{y-1}{y}, \qquad ab = \frac{z-1}{z}$$
$$\frac{x-1}{x} \cdot \frac{y-1}{y} = \frac{z-1}{z}$$

54. For what value of $'a'$, $x^4 + 2ax^3 + x^2 + 2ax + 1 = 0$ has at least two distinct negative roots.

(A) $a < \frac{3}{4}$ (B) $0 < a < \frac{3}{4}$ (C) $a > \frac{3}{4}$ (D) $\frac{3}{4} < a < 2$

Ans. **C**

Sol. Divide by

x^2 & $assume\ x+\frac{1}{x}=t$

$t^2+2at-1=0\ where\ t<-2$

$f(2)<0 \Rightarrow a>\frac{3}{4}$

55. Maximum possible number of point of intersection of 8 straight lines and 4 circles is
(A) 32 (B) 64 (C) 76 (D) 104

Ans. D

Sol. $^{8}C_2 \times 1 + {}^{4}C_2 \times 2 + \left({}^{8}C_1 \times {}^{4}C_1\right) \times 2$

56. If the coefficient of $x^3\ and\ x^4$ in the expansion of $\left(1+ax+bx^2\right)(1-2x)^{18}$ in power of x are both zero then $a+3b$ equal to
(A) 288 (B) 284 (C) 267 (D) 265

Ans. A

Sol.

$Coeff.\ of\ x^3 = {}^{18}C_3(-2)^3 + a\cdot(-2)^2\cdot{}^{18}C_2 + b(-2)\cdot{}^{18}C_1 = 0$

$Coeff.\ of\ x^4 = {}^{18}C_4(-2)^4 + a\cdot(-2)^3\cdot{}^{18}C_3 + b(-2)^2\cdot{}^{18}C_2 = 0$

57. Let M be 3 x 3 matrix satisfying

$M\begin{bmatrix}0\\1\\0\end{bmatrix}=\begin{bmatrix}-1\\2\\3\end{bmatrix},\ M\begin{bmatrix}1\\-1\\0\end{bmatrix}=\begin{bmatrix}1\\1\\-1\end{bmatrix}\ and\ M\begin{bmatrix}1\\1\\1\end{bmatrix}=\begin{bmatrix}0\\0\\12\end{bmatrix}$

then product of diagonal entries of M is

(A) 14 (B) 7 (C) 0 (D) - 14

Ans. C

Sol. $a_{11}=0,\ a_{22}=2,\ \mathrm{a}_{33}=7$

58. $\int\sqrt{1+\cos ec\,x}\,dx$ equal to

(A) $\cos^{-1}(1-2\sin x)+c$ (B) $\sqrt{2}\cos^{-1}\sqrt{\cos x}+c$

(C) $\mathrm{c}-2\sin^{-1}(1-2\sin x)$ (D) None of these

Ans. A

Sol. $\int\frac{1+\cos ec\,x}{\sqrt{1+\cos ec\,x}}dx=\cos^{-1}(1-2\sin x)+c$

59. The equation $x^2+2\sqrt{2}\,xy+2y^2+4x+4\sqrt{2}\,y+1=0$ represents a pair of lines. Then distance between them

(A) 4 (B) $\frac{4}{\sqrt{3}}$ (C) 2 (D) $\frac{2}{\sqrt{3}}$

Ans. C

Sol. Two lines are parallel if $af^2=bg^2$ & $n^2=ab$

60. If the circle $x^2+y^2=a^2$ cuts off a chord of length 2b from line $y=mx+c;$ then

(A) $(1-m^2)(a^2+b^2)=c^2$ (B) $(1+m^2)(a^2-b^2)=c^2$

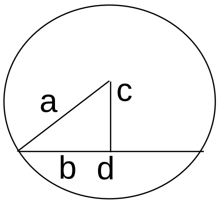
(C) $(1-m^2)(a^2-b^2)=c^2$ (D) None of these

Ans. B

Sol.

$$CD=\left|\frac{C}{\sqrt{1+m^2}}\right|$$

$$a^2-b^2=\frac{C^2}{1+m^2}$$



61. If PSQ is the focal chord of the Parabola $y^2=8x$ *such that* $SP=6$ then length SQ is

(A) 6 (B) 4 (C) 3 (D) None of these

Ans. C

Sol. $4=2\cdot\frac{(SP)(SQ)}{(SP+SQ)}$

62. Equation $\frac{1}{r}=\frac{1}{8}+\frac{3}{8}\cos\theta$ represents

(A) A rectangular hyperbola (B) A hyperbola

(C) An ellipse (D) A parabola

Ans. B

Sol. $\frac{8}{r}=1+3\cos\theta$

Which is form of $\frac{1}{r}=1+e\cos\theta$

$e=3>0$ so hyperbola

63. The value of a and b for which $\left|e^{|x-b|}-a\right|=2$ has four distinct solutions, are:

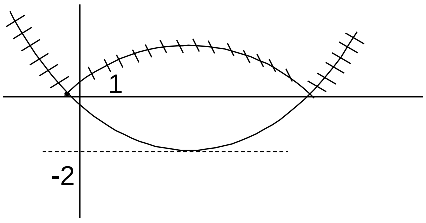
(A) $a\in(-3,\infty),\ b=0$ (B) $a\in(2,\infty),\ b=0$

(C) $a\in(3,\infty),\ b\in R$ (D) $a\in(2,\infty),\ b=a$

Ans. C

Sol.

$b \in R \quad \& \quad a > 3$



64. Let $\alpha = \underset{n\to\infty}{\ell t} \frac{\left(1^3 - 1^2\right) + \left(2^3 - 2^2\right) + ---- + \left(n^3 - n^2\right)}{n^4}$, then α equal to

(A) 1/3 (B) 1/4 (C) 1/2 (D) Not exist

Ans. B

Sol. $\underset{n\to\infty}{\ell t} \frac{\left(\frac{n(n+1)}{\alpha}\right)^2 - \frac{n(2n+1)(n+1)}{6}}{n^4} = \frac{1}{4}$

65. Number of points where

$$f(x) = \begin{cases} \max\left(\left|x^2 - x - 2\right|, \; x^2 - 3x\right) & : \quad x \ge 0 \\ \max\left(\ell n(-x), \; e^x\right) & : \quad x < 0 \end{cases}$$

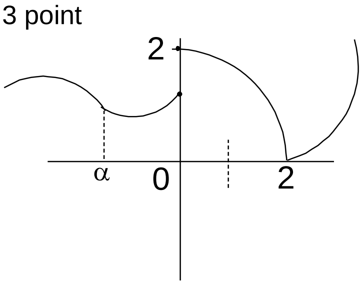
Is non differentiable will be:

(A) 1 (B) 2 (C) 3 (D) None of these

Ans. C

Sol.

3 point



66. Let $f(x) = \sin^{-1}\left(\frac{2g(x)}{1 + \left(g(x)\right)^2}\right)$, then which are correct.

(i) $f(x)$ is decreasing if $g(x)$ is increasing and $\left|g(x)\right| > 1$

(ii) $f(x)$ is an increasing if $g(x)$ is increasing and $\left|g(x)\right| \le 1$

(iii) $f(x)$ is decreasing function if $g(x)$ is decreasing and $\left|g(x)\right| > 1$

(A) (i) *and* (iii) (B) (i) *and* (ii) (C) $(i),(ii)$ *and* (iii) (D) (iii)

Ans. B

Sol.

$$f(x) = 2\tan^{-1}(g(x) \quad |g(x) \le 1$$

$$= \pi - 2\tan^{-1}(g(x) \quad g(x) > 1$$

$$= -\pi - 2\tan^{-1}(g(x) \quad g(x) < -1$$

$$f'(x) = \frac{2g'(x)}{1+(g(x))^2} \qquad |(g(x))| < 1$$

$$= -\frac{2g'(x)}{1+(g(x))^2} \qquad |g(x)| > 1$$

67. Let $f:(0, 1) \to (0, 1)$ be a differentiable function such that

$f'(x) \neq 0$ *for all* $x \in (0, 1)$ *and* $f\left(\frac{1}{2}\right) = \frac{\sqrt{3}}{2}$, suppose for all x,

$$\underset{t\to x}{\ell t}\left[\frac{\int_0^t \sqrt{1-(f(s))^2}\,ds - \int_0^x \sqrt{1-(f(s))^2}\,ds}{f(t) - f(x)}\right] = f(x)$$

Then the value of $f\left(\frac{1}{4}\right)$ belongs to

(A) $\left(\frac{\sqrt{7}}{4}, \frac{\sqrt{15}}{4}\right)$ (B) $\left(\frac{\sqrt{7}}{3}, \frac{\sqrt{15}}{3}\right)$ (C) $\left(\frac{\sqrt{7}}{2}, \frac{\sqrt{15}}{2}\right)$ (D) $\left(\sqrt{7}, \sqrt{15}\right)$

Ans. A

Sol. Let

$$g(x) = \int_0^x \sqrt{1-(f(x))^2}\,ds$$

$$\underset{t\to x}{\ell t}\frac{g(t) - g(x)}{f(t) - f(x)} = f(x)$$

$$\sqrt{1-y^2} = 1 - x,\ f\left(\frac{1}{2}\right) = \frac{\sqrt{3}}{2}$$

68. Let $f(x) = x^3 - 3x^2 + 3x + 1$ and g be the inverse of it, then area bounded by the curve $y = g(x)$ with x-axis between $x = 1$ *to* $x = 2$ is

(A) 1/2 (B) 1/4 (C) 3/4 (D) 1

Ans. B

Sol.

$$\int_1^2 g(x)dx$$

$$Let\ x = f(t) \Rightarrow dx = f'(t)dt$$

$$\int_0^1 t(3t^2 - 6t + 3)dt = \frac{1}{4}$$

69. The solution of the equation $\frac{dy}{dx}+\frac{1}{x}\tan y=\frac{1}{x^2}(\tan y)(\sin y)$ is

(A) $2y=\sin y\left(1-2cx^2\right)$

(B) $2x=\cot y\left(1+2cx^2\right)$

(C) $2x=\sin y\left(1-2cx^2\right)$

(D) $2x\sin y=\left(1-2cx^2\right)$

Ans. **C**

Sol. Let $\operatorname{cosec} y=t$

$\Rightarrow -\cos ec\, y\cot y\, dy=dt$

$\frac{dt}{dx}-\frac{t}{x}=\frac{-1}{x^2}\ (LDE)$

70. Find the locus of a point whose distances from x-axis is twice the distances from the point $(1, -1, 2)$

(A) $y^2+2x-2y-4z+6=0$

(B) $x^2+2x-2y-4z+6=0$

(C) $x^2-2x+2y-4z+6=0$

(D) $z^2-2x+2y-4z+6=0$

Ans. **C**

Sol. Let $P=\left(x_p,\ y_p,\ z_p\right)$

Distance as point from x-axis is $\sqrt{{y_p}^2+{z_p}^2}$

$\sqrt{\left(x_{p-1}\right)^2+\left(y_{p-1}\right)^2+\left(z_{p-2}\right)^2}=\sqrt{{y_p}^2+{z_p}^2}$

$x^2-2x+2y-4z+6=0$

Section – B

71. A fair coin is tossed 10 times. If the probability that heads never occur on consecutive tosses be $\frac{m}{n}$ (where m, n are coprime and $m,\ n\in N$) then value of $(n-7m)$ equal to

Ans. **1**

Sol. $P=\frac{{}^6C_5+{}^7C_4+{}^8C_3+{}^9C_2+{}^{10}C_1+1}{2^{10}}=\frac{9}{64}$

72. Let $f(x)=\int_0^x e^{x-y}f'(y)dy-\left(x^2-x+1\right)e^x$ find the number of roots of the equation $f(x)=0$

Ans. **1**

Sol. $f(x)=0\Rightarrow\int_0^x e^{-y}f'(y)dy=x^2$

$\Rightarrow f(x)=(2x-3)e^x$

Section – C

73. Let $f(x)=ax+\cos 2x+\sin x+\cos x$ is defined $\forall x\in R$ *and* $a\in R$ is strictly increasing function. If the range of a is $\left[\frac{m}{n},\ \infty\right)$, then find the minimum value of $(m-n)$.

Ans. 00009.00

Sol.

$$f'(x)=a-2\sin^2 x+\cos x-\sin x$$
$$g(x)=-2\sin^2 x+\cos x-\sin x$$
$$=-2\left[(\cos x-\sin x)^2-1\right]+\cos x-\sin x$$
$$Let\ \cos x-\sin x=t$$
$$=-2t^2+t+2\cdot\forall t\in\left[-\sqrt{2},\ \sqrt{2}\right]$$
$$\boxed{a\geq\frac{17}{8}}$$

74. Find the number of solution of the equation $2\sin^2 x+\sin^2 2x=2;\ \sin 2x+\cos 2x=\tan x$ in $[0,\ 4\pi]$ satisfying the condition $2\cos^2 x+\sin x\leq 2$

Ans. 00008.00

Sol.

$$2\sin^2 x+4\sin^2 x\cos^2 x=2 \qquad \Rightarrow \sin x=\pm\frac{1}{\sqrt{2}},\ \pm1$$
$$\sin 2x+\cos 2x=\tan x$$
$$\tan^3 x+\tan^2 x-\tan-1=0 \qquad \Rightarrow \sin x(2\sin x-1)\geq 0$$

75. A straight line L intersect perpendicularly both the lines:
$$\frac{x+2}{3}=\frac{y+6}{3}=\frac{z-34}{-10}\ and\ \frac{x+6}{4}=\frac{y-7}{-3}=\frac{z-7}{-2}$$
Then the square of perpendicular distances of origin from L is

Ans. 00005.00

Sol. Distance is 5