JEE (Main)-2025 (Online) Session-2

Memory Based Question with & Solutions

(Physics, Chemistry and Mathematics)

3rd April 2025 (Shift-2)

Time: 3 hrs. **M.M.: 300**

IMPORTANT INSTRUCTIONS:

(1) The test is of 3 hours duration.

(2) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.

(3) This question paper contains Three Parts. Part-A is Physics, Part-B is Chemistry and Part-C is Mathematics. Each part has only two sections: Section-A and Section-B.

(4) Section - A : Attempt all questions.

(5) Section - B : Attempt all questions.

(6) Section - A (01 - 20) contains 20 multiple choice questions which have only one correct answer. Each question carries +4 marks for correct answer and -1 mark for wrong answer.

(7) Section - B (21 – 25) contains 5 Numerical value based questions. The answer to each question should be rounded off to the nearest integer. Each question carries +4 marks for correct answer and -1 mark for wrong answer.

MEMORY BASED QUESTIONS JEE–MAIN EXAMINATION – APRIL, 2025

(Held On Thursday 3rd April, 2025) TIME : 3 : 00 PM to 6 : 00 PM

PHYSICS

SECTION-A

1. The ratio of intensities of two coherent sources is 1 : 9. The ratio of the maximum to minimum intensities is:

(1) 3 : 1 (2) 25 : 1

(3) 4 : 1 (4) 16 : 1

Ans. **(3)**

Sol. $\frac{I_1}{I_2} = \frac{1}{9}$

$I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = (1+3)^2 = 16$

$I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2 = (1-3)^2 = 4$

$\frac{I_{max}}{I_{min}} = \frac{16}{4} = \frac{4}{1}$

2. Excess pressure inside bubble A is half of that of bubble B. Find ratio of volume of bubble A to bubble B (surface tension is same in both cases).

(1) 5 (2) 2

(3) 9 (4) 8

Ans. **(4)**

Sol. $\Delta P_A = \frac{4S}{R_1}$ $\Delta P_B = \frac{4S}{R_2}$

$\Delta P_A = \frac{\Delta P_B}{2}$

$2R_2 = R_1 \Rightarrow \frac{R_1}{R_2} = 2$

$\frac{V_1}{V_2} = \frac{\frac{4\pi}{3}R_1^3}{\frac{4\pi}{3}R_2^3} = \frac{8}{1}$

3. In a resonance tube experiment at one end, resonance is obtained at two consecutive lengths $\ell_1 = 100$ cm and $\ell_2 = 140$ cm. If the frequency of the sound is 400 Hz, the velocity of sound is:

(1) 400 m/s (2) 420 m/s

(3) 300 m/s (4) 320 m/s

Ans. **(4)**

Sol. $e + \ell_1 = \frac{\lambda}{4}$

$e + \ell_2 = \frac{3\lambda}{4}$

$\ell_2 - \ell_1 = \frac{\lambda}{2}$

$\ell_2 - \ell_1 = \frac{v}{f_2}$

$f = \frac{v}{2(\ell_2 - \ell_1)}$

$v = 2f(\ell_2 - \ell_1)$

$v = \frac{2 \times 400 \times 40}{100}$

$v = 8 \times 40$

$= 320\ m/sec$

4. A magnetic dipole experiences a torque of $80\sqrt{3}$ Nm when placed in uniform magnetic field in such a way that dipole moment makes an angle of 60° with magnetic field. The potential energy of the dipole is :-

(1) 100 J (2) 120 J

(3) – 80 J (4) 90 J

Ans. **(3)**

Sol. $\tau = MB\sin\theta$

$80\sqrt{3} = MB\sin\theta$ ...(1)

$U = -MB\cos\theta$ ...(2)

$\frac{80\sqrt{3}}{U} = -\tan 60°$ $[\theta = 60°]$

$U = -80J$

5. In the resonance experiment, two air column's closed at one end of 100 cm and 120 cm along, give 15 beats per second when each one is sounding in the respective fundamental nodes. The velocity of sound in the air column is:

(1) 320 m/s (2) 360 m/s

(3) 380 m/s (4) 350 m/s

Ans. **(2)**

Sol. $15=\left[\frac{V}{4\times 100}-\frac{V}{4\times 120}\right]\times 100$

$15=\frac{V}{4}\left(1-\frac{10}{12}\right)=\frac{V}{4}\left(1-\frac{5}{6}\right)$

$V=15\times 24=360\ m/s$

6. A block of mass 1 kg, moving along x axis with speed $v_i = 10\ m/s$ enters a rough region ranging from x = 0.1 m to x = 1.9 m. The retarding fore acting on the block in this range is $F_r = -kx\ N$, with k = 10 N/m. Then the final speed of the block as it crosses rough region is:

(1) 8 m/s (2) 6 m/s

(3) 5 m/s (4) 7 m/s

Ans. **(1)**

Sol. $\frac{1}{2}mv^2-\frac{1}{2}k\Delta x^2=\frac{1}{2}mv_f^2$

$\frac{1}{2}\times 1\times 100-\frac{1}{2}10\left[(1.9)^2-(0.1)^2\right]=\frac{1}{2}\times 1\times V_f^2$

$50-5[1.8]\times[2]=\frac{V_f^2}{2}$

$(50-18)\times 2$

$64=V_f^2$

$V_f=8\,m/sec$

7. In a medium of refractive index 2, the frequency of light is 5×10^{14}Hz, the wavelength of the light is

(1) 600 nm (2) 400 nm

(3) 300 nm (4) 200 nm

Ans. **(3)**

Sol. $\mu=\frac{c}{v}=\frac{c}{f\lambda}$

$2=\frac{3\times 10^8}{\lambda\times 5\times 10^{14}}$

$\lambda=\frac{3\times 10^8}{10^{15}}$

$\lambda=3\times 10^{-7}$

$\lambda=300\times 10^{-9}$

$\lambda=300\ nm$

8. Physical quantity S is given as $S=\frac{pq}{r^3\sqrt{t}}$. Find to percentage change in S if percentage change in p, q, r and t are 1, 1, 3 and 2 respectively.

(1) 12% (2) 11%

(3) 5% (4) 3%

Ans. **(1)**

Sol. $s=\frac{pq}{r^3\sqrt{t}}$

$\frac{\Delta S}{S}=\frac{\Delta P}{P}+\frac{\Delta q}{q}+\frac{3\Delta r}{r}+\frac{1}{2}\frac{\Delta t}{t}$

$=1+1+3\times 3+\frac{1}{2}\times 2$

$=1+1+9+1$

$=12\ \%$

9. A capacitor $C_1 = 100pF$ is connected to a 60 V cell then disconnected. C_1 is now connected to an unchanged capacitor C_2 such that the final potential across C_1 becomes 20 V. Find C_2.

(1) 100 pF (2) 200 pF

(3) 400 pF (4) 500 pF

Ans. **(2)**

Sol. $C_1V_1=(C_1+V_2)V_{common}$

$100\times 60=(100+C_2)\times 20$

$C_2=200PF$

10. A bulb rated 100 W, 220 V connected to an ac supply of 220 V. Calculate peak current in the bulb.

(1) 2 A (2) 8 A

(3) 3.2 A (4) 0.64 A

Ans. **(4)**

Sol. $P=V_{rms}\ I_{rms}\cos\phi\ (\phi=0°)$

$100=220\,I_{rms}$

$I_{rms}=\frac{100}{220}$

$I_{peak}=\sqrt{2}\ I_{rms}=\sqrt{2}\times\frac{100}{220}=\frac{5\sqrt{2}}{11}=0.64$

11. The pressure of an ideal gas is increased by 0.4% keeping the volume constant. Find the initial temperature of the gas if there is a 1°C rise in temperature.

(1) 2500 K (2) 300 K

(3) 250 K (4) 1500 K

Ans. **(3)**

Sol. $PV = nRT$

$P = KT$

$$\frac{\Delta P}{P} = \frac{\Delta T}{T}$$

$$\frac{0.4}{100} = \frac{1}{T}$$

$$T = \frac{1000}{4} = 250\ K$$

12. Statement-I : O^{2-} and H^{+} are projected in a magnetic field perpendicular to the field with same speed. The radius of curvature of O^{2-} will be less than H^{+} . Statement-II : e^{-} and p^{+} are projected in a magnetic field perpendicular to the field with same speed. The radius of curvature of e^{-} will be more the proton.

(1) Statement-I is correct, statement-II is incorrect

(2) Both statement-I and statement-II are correct

(3) Both statement-I and statement-II are incorrect

(4) Statement-I is incorrect and statement-II is correct.

Ans. **(3)**

Sol. Statement I $\quad \dfrac{r_{O^{2-}}}{r_{H^+}} = \dfrac{\frac{mv}{qB}}{\frac{mv}{qB}} = \dfrac{\frac{16}{2}}{\frac{1}{1}}$

$$\frac{r_{O^{2-}}}{r_{H^+}} = 8$$

Statement II $\quad r = \dfrac{mv}{9B}$

$$r_p > r_e$$

q of electron = q of proton

$$m_e < m_p$$

13. Match the list-I with list-II

List-I	**List-II**
(A) Planck's constant	(I) ML^2T^{-1}
(B) Coefficient of viscosity	(II) $MLT^{-3}K^{-1}$
(C) Boltzmann constant	(III) $ML^2T^{-2}K^{-1}$
(D) Thermal conductivity	(IV) $ML^{-1}T^{-1}$

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(2) (A)-(I), (B)-(IV), (C)-(III), (D)-(II)

(3) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

(4) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

Ans. **(2)**

Sol. Plank Constant

$E = h\nu$

$ML^2T^{-2} = hT^{-1}$

$h = ML^2T^{-1}$

Coefficient of viscosity

$$F = \eta A \frac{dN}{dy}$$

$$MLT^{-2}\eta = L^2\frac{LT^{-1}}{L}$$

$MLT^{-2} = \eta L^2T^{-1}$

$\eta = ML^{-1}T^{-1}$

Boltzmann constant

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

$ML^2T^{-2} = [K][\theta]$

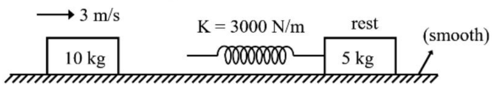
$K = [ML^2T^{-2}k^{-1]}$

Thermal conductivity

$$ML^2T^{-3} = KL^2\frac{K}{L}$$

$MLT^{-3}k^{-1} = k$

14. A block of mass 10 kg is moving with speed 3 m/s collides with a spring connected to another block of mass 5 kg initially at rest. Find the compression in spring when both move with same speed.



(1) 0.1 cm (2) 0.1 m

(3) 1 m (4) None

Ans. **(1)**

Sol. $\frac{1}{2}M_1V^2 = \frac{1}{2}kx^2 + \frac{1}{2}(M_1 + M_2)V_{com}^2$

$$\frac{1}{2}\times 10\times 3^2 = \frac{1}{2}3000x^2 + \frac{1}{2}15\times 2^2$$

$M_1V = (M_1 + M_2)V_{com}$

$30 = 15V_{com}$

$V_{com} = 2m/sec$

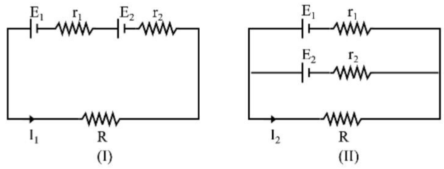
$45 = 1500x^2 + 30$

$$\frac{15}{1500} = x^2$$

$$\frac{1}{100}\times 2x^2$$

$$x = \frac{1}{10} = 0.1\ m$$

15. In two situation given in figures (I) and (II) current through R is I_1 and I_2 respectively. If $E_1 = 2V$, $r_1 = 1$ W, $E_2 = 1$ V, $r_2 = 2$ W, R = 6 W then find $\frac{I_1}{I_2}$.



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

(3) $\frac{3}{5}$ (4) $\frac{2}{5}$

Ans. **(1)**

Sol. $$I_1 = \frac{E_1 + E_2}{r_1 + r_2 + R} = \frac{3}{3+6} = \frac{3}{9} = \frac{1}{3}$$

$$E_q = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}} \qquad r_{eq} = \frac{r_1 r_2}{r_1 + r_2} = \frac{2}{3}$$

$$E_q = \frac{\frac{1}{2} + \frac{2}{1}}{\frac{1}{2} + 1} = \frac{5}{3}$$

$$I_2 = \frac{\frac{5}{3}}{\frac{20}{3}} = \frac{1}{4}$$

$$\frac{I_1}{I_2} = \frac{4}{3}$$

16. Two cylindrical vessels of equal cross sectional area of $2m^2$ contain water upto heights 10 m and 8 m, respectively. If the vessels are connected at their bottom then the work done by the force of gravity is (Density of water is $10^3\ kg/m^3$ and $g = 10\ m/s^2$):

(1) 25 kJ (2) 30 kJ

(3) 10 kJ (4) 20 kJ

Ans. **(4)**

Sol. $v_1 = 100\rho g \qquad v_2 = 64\rho g$

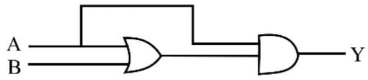
$$v_{initial} = 164\rho g$$

$$v_f = \rho \times g \times 2 \times g \times \frac{g}{2} \times 2$$

$$v_f = 162\rho g$$

$$\Delta U = 2\rho g = 20kJ$$

17. If Y = 1, then which of the following option is correct regarding A & B :-

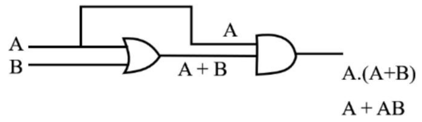


(1) A = 1, B = 1 (2) A = 0, B = 1

(3) A = 0, B = 0 (4) None

Ans. **(1)**

Sol.



A	B	AB	A+AB
0	0	0	0
0	1	0	0
1	0	0	1
1	1	1	1

18. A spherical ball of radius 1.8 mm & density 7825 kg/m^3 is dropped into a viscous fluid having density 925 kg/m^3. If it achieves terminal velocity of 245 m/s, then the coefficient of viscosity of the fluid is :-

(1) 2×10^{-4} Pa.s (2) 2×10^{-5} Pa.s

(3) 5×10^{-4} Pa.s (4) 5×10^{-5} Pa.s

Ans. **(1)**

Sol. $$\frac{2}{9}\frac{r^2 g}{\eta}(\rho_s - \rho_\ell) = V_T$$

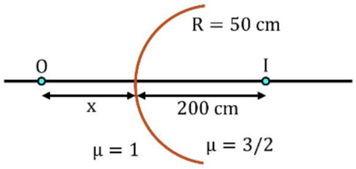
$$\frac{2}{9}\frac{\left(1.8 \times 10^{-3}\right)^2 \times 10}{\eta} \times 6900 = 245$$

$$\frac{2 \times 324 \times 10^{-8} \times 2300}{245 \times 3} = \eta$$

$$\eta = 2 \times 10^{-4}\ Pa.s$$

SECTION - B

1. Two media of R.I. $\mu = 1$ and $\mu = 3/2$ are separated by a spherical surface of radius 50 cm. Image of object O is formed at a distance of 200 cm form surface as shown in figure. Find x (in meter):



Ans. **(4 m)**

Sol. $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$

$$\frac{3}{2\times 200} - \frac{1}{-x} = \frac{\frac{3}{2}-1}{+50}$$

$$\frac{3}{400} + \frac{1}{x} = \frac{1}{100}$$

$$\frac{1}{x} = \frac{4}{400} - \frac{3}{400} = \frac{1}{400}$$

$$x = 400\text{ cm} = 4\text{ m}$$

2. If an electron in H atom jumps from 4^{th} excited state to n^{th} energy state, 2.86 eV photon is emitted. The value of 'n' will be :-

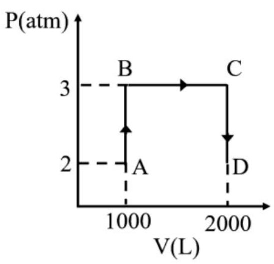
Ans. **(2)**

Sol. $2.86 = 13.6\left(\frac{1}{n^2} - \frac{1}{5^2}\right)$

$$0.21 = \frac{1}{n^2} - \frac{1}{25}$$

$$n = 2$$

3. Find out magnitude of work done in the process ABCD (in kJ) (1 atm. Lit = 101.3 J)



Ans. **(304)**

Sol. Area = (3 atm) (1000 ℓ)

$$= 3000\,\text{atm}\ell = 3\times 10^3 \times 101.3\text{J}$$

$$= 303.9\text{kJ} \simeq 304\text{kJ}$$

CHEMISTRY

SECTION-A

1.

List-I (Family)		List-II (Element)	
(a)	Pnitcogen	(i)	Mc
(b)	Chalcogen	(ii)	Ts
(c)	Halogen	(iii)	Og
(d)	Noble gas	(iv)	Lv

Correct match is :

(1) a – (i), b – (iv), c – (ii), d – (iii)

(2) a – (iv), b – (i), c – (iii), d – (ii)

(3) a – (i), b – (iv), c – (iii), d – (ii)

(4) a – (iv), b – (ii), c – (i), d – (iii)

Ans. **(1)**

Sol.

List-I (Family)			List-II (Element)
(a)	Pnitcogen	→	Mc
(b)	Chalcogen	→	Lv
(c)	Halogen	→	Ts
(d)	Noble gas	→	Og

2. **Statement-1:** Bohr model is applicable for hydrogen and hydrogen like species.

Statement-2: Bohr model does not consider electron-electron repulsion.

(1) Both Statements are correct.

(2) Both Statements are incorrect.

(3) Statement 1 is incorrect and statement 2 is correct.

(4) Statement 1 is correct and statement 2 is incorrect.

Ans. **(1)**

Sol. Bohr model is applicable for single e^- species and also do not consider electron-electron repulsion.

3. **Statement-1:** CrO_3 is stronger oxidizing agent than MoO_3

Statement-2: CrO_3 is more stable than MoO_3

(1) Both Statements are correct.

(2) Both Statements are incorrect.

(3) Statement 1 is incorrect and statement 2 is correct.

(4) Statement 1 is correct and statement 2 is incorrect.

Ans. **(4)**

Sol. $CrO_3 < MoO_3$ (Stability)

(Oxidising agent)

4. Find orbital angular momentum for 2s and 2p energy levels.

(1) $0, \frac{h}{(\sqrt{2})\pi}$ (2) $0, \frac{h}{\sqrt{2}\pi}$

(3) $\frac{h}{\pi}, \frac{h}{\pi}$ (4) $0, \frac{h}{2\pi}$

Ans. **(1)**

Sol. Angular momentum = $\sqrt{\ell(\ell+1)}\frac{h}{2\pi}$

For to 2s ($\ell = 0$)

$$\text{Angular momentum} = \sqrt{0(0+1)}\frac{h}{2\pi}$$

$$= 0$$

For to 2p ($\ell = 1$)

$$\text{Angular momentum} = \sqrt{1(1+1)}\frac{h}{2\pi}$$

$$= \frac{h}{\sqrt{2}\pi}$$

5. Which of the following is **CORRECT** order ?

(1) B < Ga < Al < In < Tl (atomic radius)

(2) B > Ga > Tl > In (First Ionisation enthalpy)

(3) Tl > In > Ga > B > Al (Density)

(4) B < Ga < Al < In < Tl (EN order)

Ans. **(1)**

Sol. (1) B < Ga < Al < In < Tl (atomic radius)

(2) B > Tl > Ga > In (First Ionisation enthalpy)

(3) Tl > In > Ga > Al > B (Density)

(4) B > Tl > In > Ga > Al (EN order)

6. Which of the following compound or complex ions is/are diamagnetic in nature

(a) CrO_3 (b) $[Fe(CN)_6]^{4-}$

(c) $[Co(H_2O)_3F_3]$ (d) $[Cr(NH_3)_6]^{3+}$

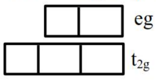
(1) a and b only (2) a, b and c only

(3) a, b, c and d (4) c and d only

Ans. **(2)**

Sol. (a) CrO_3

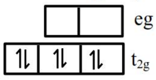
$Cr^{+6} \Rightarrow [Ar]3d^0 4s^0$



→Diamagnetic

(b) $[Fe(CN)_6]^{4-}$

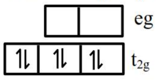
$Fe^{2+} \Rightarrow [Ar]3d^6 4s^0$



→Diamagnetic

(c) $[Co(H_2O)_3F_3]$

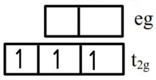
$Co^{+3} \Rightarrow [Ar]3d^6 4s^0$



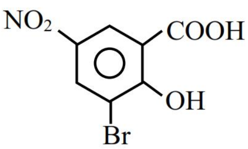
→Diamagnetic

(d) $[Cr(NH_3)_6]^{3+}$

$Cr^{3+} \Rightarrow [Ar]3d^3$



→Paramagnetic

7. 

What is the IUPAC nomenclature of the above compound.

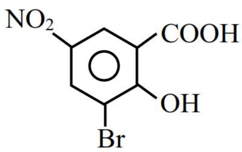
(1) 2-Bromo-3-Hydroxy-5-Nitrobenzoic acid

(2) 5-Bromo-6-Hydroxy-3-Nitrobenzoic acid

(3) 3-Bromo-2-Hydroxy-5-Nitrobenzoic acid

(4) None of these

Ans. **(3)**

Sol. 

3-Bromo-2-Hydroxy-5-Nitrobenzoic acid

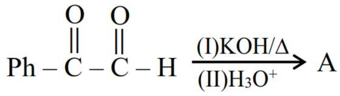
8. Fat soluble vitamin is

(1) Vitamin B_1 (2) Vitamin C

(3) Vitamin B_{12} (4) Vitamin K

Ans. **(4)**

Sol. Fat soluble vitamin are -K, E, D, A

9. 

The product of above reaction is :

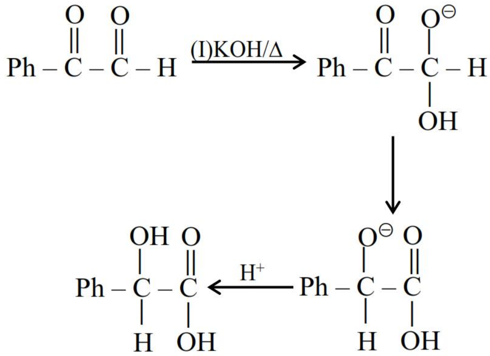
(1) Ph–C(=O)–CH_2–OH

(2) Ph–CH(OH)–C(=O)–OH

(3) Ph–CH(OH)–CH_2–OH

(4) Ph–C(=O)–C(=O)–OH

Ans. **(2)**

Sol. 

10. Statement I: Hyper conjugation is not a permanent effect

Statement II: In general, greater the number of Alkyl groups attached to a positively charged carbon atom greater is the Hyper conjugation interaction and stabilization of the cation.

(1) Statement I and Statement II both are correct.

(2) Statement I is correct but Statement II is incorrect.

(3) Statement I is incorrect but Statement II is correct.

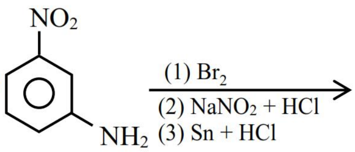
(4) Both Statement are incorrect.

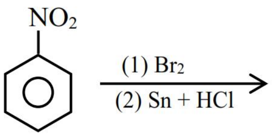
Ans. **(3)**

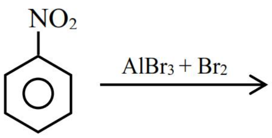
Sol. Hyperconjugation is permanent effect

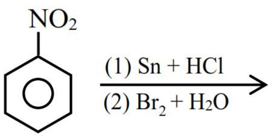
Hyperconjugation effect $\propto$ Number of α.H

11. Which of the following reagent is used to prepare tribromoaniline?

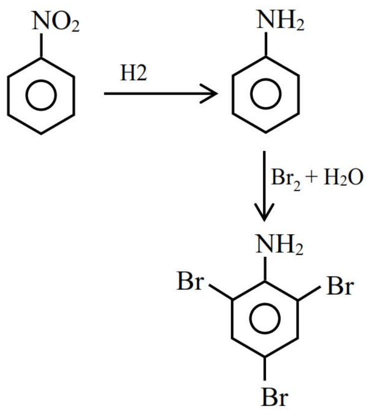
(1) 

(2) 

(3) 

(4) 

Ans. **(4)**

Sol. 

12. Statement I: Wet cotton cloths made up of cellulose based carbohydrate takes comparatively longer time to get dried than wet nylon based clothes.

Statement II: Intermolecular hydrogen bonding with water molecule is more in nylon based clothes than in cotton clothes.

(1) Statement I and Statement II both are correct.

(2) Statement I is correct but Statement II is incorrect.

(3) Statement I is incorrect but Statement II is correct.

(4) Both Statement are incorrect.

Ans. **(2)**

Sol. Wet cotton cloths made up of cellulose based carbohydrate takes comparatively longer time to get dried than wet nylon based clothes because cotton based cloths has more intermolecular hydrogen bonding with water molecule is more than nylon based cloths

13. Which of the following statement is correct w.r.t. Arrhenius equation?

(1) Dimension of k and A are same

(2) k decreases with increase in temperature generally

(3) A decreases with increase in temperature always

(4) k increases as value of E_a increase

Ans. **(1)**

Sol. Arrhenius equation $\Rightarrow k = Ae^{-E_a/RT}$

$$\ln k = \ln A - \frac{E_a}{RT}$$

So $\Rightarrow$ Unit of k and A are same (True)

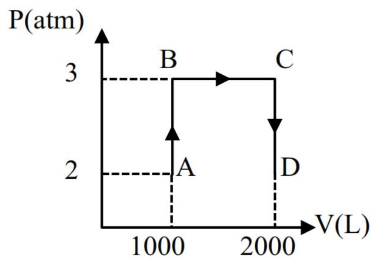
and or (T) ↑ (k) ↑

So only (1) follows and (2), (3), (4) False

SECTION-B

14. Find out magnitude of work done in the process ABCD (in kJ)

(1 atm. Lit = 101.3 J)



Ans. **(304)**

Sol. Work done = area under the curve

= 3 atm × 1000 L

= 3000 L atm

= 3000 ×101.3 J

= 303.9 kJ

≈ 304 kJ

15. Amount of magnesium (Mg) (in mg) required to liberate 224 mL of H_2 gas at STP, when reacted with HCl.

Ans. **(240)**

Sol. $Mg + 2HCl \longrightarrow MgCl_2 + H_{2(g)}$

$$n_{H_2} = \frac{224}{22400} = 10^{-2} \text{mol}$$

$$n_{Mg} = 10^{-2} \text{mol}$$

mass of Mg = $10^{-2} \times 24$ g

= $10^{-2} \times 24 \times 10^3$ mg

= 240 mg

16. Among Sc, Ti, Mn and Co, Calculate the spin only magnetic moment in +2 oxidation state of metal having highest heat of atomization.

Ans. **(3)**

Sol. Among Sc, Ti, Mn and Co highest enthalpy of atomisation is for Ti

as per ncert data

Element	Sc	Ti	Mn	Co
ΔH_a(kJ/mol)	326	473	281	425

$_{22}Ti \Rightarrow [Ar]\ 3d^2$

$3d^2$ | 1 | 1 | | | | n=2

Spin only magnetic moment $\mu = \sqrt{n(n+2)}$B.M.

For $Ti^{2\oplus}$ $\mu = \sqrt{2(2+2)}$

$= \sqrt{8}$

= 2.84 B.M.

≈ 3 B.M. (Round off)

17. Calculate the % N, if the pressure is 715 mm Hg, temperature 300 K having aqueous tension of 15 mm Hg occupying the volume of 60 mL having mass of compound 0.4 gm.

Ans. **(16)**

Sol. $P_{N_2} = 715 - 15$

= 700 mm Hg

$$P_{N_2} = \frac{PV}{RT} = \frac{\frac{700}{760} \times \frac{60}{1000}}{0.0821 \times 300}$$

$= 0.02243$

$P_{N_2} = 0.202243 \times 28$

$= 0.06282$

$$\%N = \frac{0.06282}{0.4} \times 100$$

$= 15.70$

$\approx 16\%$

18. In an 'H' like species if an electron jumps from 4^{th} excited state to n^{th} state the energy emits during the transition is 2.86 eV find the value of 'n'.

Ans. **(2)**

Sol. $$\Delta E = 13.6 Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$2.86 = 13.6 \times 1 \left(\frac{1}{n_1^2} - \frac{1}{25}\right) ;\ (Z = 1)$$

$$0.210 = \frac{1}{n_1^2} - \frac{1}{25}$$

$$\frac{1}{n_1^2} = 0.25$$

$\Rightarrow n_1^2 = 4$

$n_1 = 2$

19. Bomb calorimeter has heat capacity 5 kJ/K. Combustion of octane takes place in presence of excess O_2. Temperature rises by 5ºC. Find $\Delta H_{combustion}$ in kJ. (Nearest Integer)

Ans. **(25)**

Sol. C = 5 kJ/K

$\Delta H = nC\Delta T$

= 1 × 5 × 5

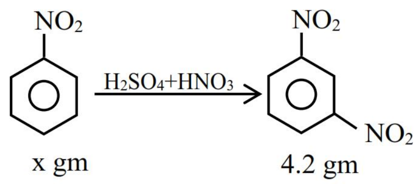
= 5 × 5

= 25

20. 'x' g of nitrobenzene gives 4.2 g of 1, 3-dinitrobenzene with 100% yield. Find the value of 'x'.

Ans. **(3)**

Sol.



$n_{1,3\text{- dinitrobenzene}} = n_{nitrobenzene}$

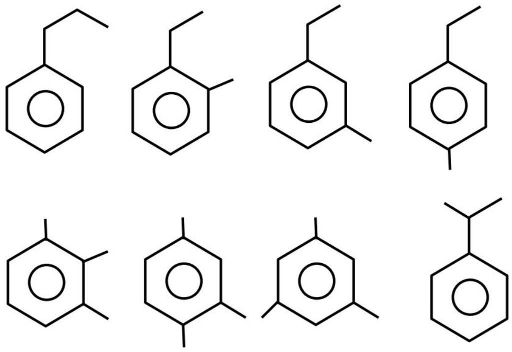
$$\frac{4.2}{1.68} = \frac{x}{123}$$

x = 3.075 ≃ 3

21. C_9H_{12} is a derivative of benzene, how many total structural isomers of the compounds are possible.

Ans. **(8)**

Sol. D.O.U. $= (9+1) - \frac{12}{2} = 4$



MATHEMATICS

1. If $\lim_{x\to 0}\left(\frac{\tan x}{x}\right)^{\frac{1}{x^2}} = p$, then $96\, ln\, p$ is equal to

Ans. **(32)**

Sol. $\left(1^{\infty} \text{ from}\right)$

$e^{\lim_{x\to 0}\frac{1}{x^2}\left(\frac{\tan x}{x}-1\right)}$

$= e^{\lim_{x\to 0}\left(\frac{1}{x^2}\frac{(\tan x - x)}{x}\right)}$

$= e^{\lim_{x\to 0}\frac{\tan x - x}{x^3}}$

Apply L'Hôpital method

$= e^{\lim_{x\to 0}\frac{\sec^2 x - 1}{3x^2}}$

$= e^{\lim_{x\to 0}\frac{(\tan^2 x)}{3x^2}}$

$p = e^{\frac{1}{3}}$

So, $96\ell n\left(e^{\frac{1}{3}}\right) = \frac{96}{3} = 32$

2. Let A ={-3,-2,-1,0,1,2,3}. A relation R is defined such that xRy iff $y = \max\{x, 1\}$. Number of elements required to make it reflexive is l, number of elements required to make it symmetric is m and number of elements in the relation R is n. Then value of $l + m + n$ is equal to

Ans. **(15)**

Sol. A = {–3, –2, –1, 0, 1, 2, 3}

y = max {x, 1}

R = {(0, 1), (–1, 1), (–2, 1), (–3, 1) (1, 1) (2, 2), (3, 3)}

ℓ for reflexive relations will be

(0, 0) (–1, –1), (–2, –2), (–3, –3)

m for symmetric relations will be

(1, 0), (1, –1), (1, –2), (1, –3)

So, ℓ + m + n = 4 + 4 + 7 = 15

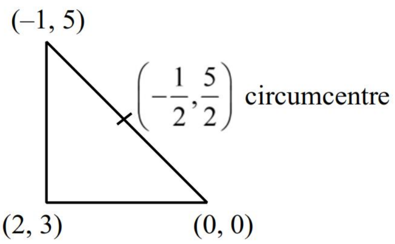
3. Let a circle C with radius r passes through four distinct points (0,0), $(k, 3k)$,(2,3) and (-1,5), such that $k \neq 0$, then $(10k + 2r^2)$ is equal to

(1) 35 (2) 34

(3) 27 (4) 32

Ans. **(3)**

Sol.



Radius of circle $r = \sqrt{\frac{1}{4} + \frac{25}{4}} = \sqrt{\frac{13}{2}}$

Equation of circle $\left(x + \frac{1}{2}\right)^2 + \left(y - \frac{5}{2}\right)^2 = \frac{13}{2}$

Passes (k, 3k)

$\left(k + \frac{1}{2}\right)^2 + \left(3k - \frac{5}{2}\right)^2 = \frac{13}{2}$

$k^2 + k + \frac{1}{4} + 9k^2 - 15k + \frac{25}{4} = \frac{13}{2}$

$10k^2 - 14k = 0$

$K = 0, \frac{7}{5}$

$10k + 2r^2 = 14 + 13 = 27$

4. $I = \int_0^{\pi} \frac{8x}{4\cos^2 x + \sin^2 x} dx$ is equal to

Ans. **($2\pi^2$)**

Sol. $I = \int_0^{\pi} \frac{8x dx}{4\cos^2 x + \sin^2 x}$ ….(i)

$I = \int_0^{\pi} \frac{8(\pi - x) dx}{4\cos^2 x + \sin^2 x}$ …(ii)

Adding (i) and (ii)

$2I = \int_0^{\pi} \frac{8\pi dx}{4\cos^2 x + \sin^2 x}$

$$I = 2\times\int_0^{\frac{\pi}{2}} \frac{4\pi dx\left(\sec^2 x\right)}{4+\tan^2 x}$$

Let tanx = t ⇒ dt = $\sec^2$x dx

$$\Rightarrow I = 2\times\int_0^{\infty}\frac{4\pi dt}{4+t^2} = 2\times 4\pi\cdot\frac{1}{2}\left(\tan^{-1}\frac{t}{2}\right)\Bigg|_0^{\infty}$$

$$\Rightarrow I = 8\pi\cdot\frac{1}{2}\left[\frac{\pi}{2}-0\right] = \frac{4\pi^2}{2} = 2\pi^2$$

5. The distance of the point (7,10,11) from the line $\frac{x-4}{1}=\frac{y-4}{0}=\frac{z-2}{3}$ along the line $\frac{x-9}{2}=\frac{y-13}{3}=\frac{z-17}{6}$ is

Ans. **(14)**

Sol. Equation of line passing through point P(7, 10, 11) along the line

$\frac{x-9}{2}=\frac{y-13}{3}=\frac{z-17}{6}$ is

$$\frac{x-7}{2}=\frac{y-10}{3}=\frac{z-11}{6}=\lambda$$

Let the point on the line is

Q(2λ + 7, 3λ + 10, 6λ + 11)

Point Q lie on line $\frac{x-4}{1}=\frac{y-4}{0}=\frac{z-2}{3}$

So, $\frac{(2\lambda+7-4)}{1}=\frac{(3\lambda+10-4)}{0}=\frac{(6\lambda+11-2)}{3}$

⇒ λ = –2

Point Q ≡ (3, 4, –1)

∴ PQ = 14

6. $S = 1+\frac{1+3}{1!}+\frac{1+3+5}{2!}+\ldots\ldots\infty$. The value of S is equal to

(1) 4e-2 (2) 4e

(3) 5e (4) 7e

Ans. **(3)**

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

$$T_n = \frac{(n+1)}{(n-2)!}+\frac{1}{(n-1)!}$$

$$T_n = \frac{(n-2)}{(n-2)!}+\frac{3}{(n-2)!}+\frac{1}{(n-1)!}$$

$$T_n = \frac{1}{(n-3)!}+\frac{3}{(n-2)!}+\frac{1}{(n-1)!}$$

$$S_n = \left[\frac{1}{0!}+\frac{1}{1!}+\frac{1}{2!}+\frac{1}{3!}+\ldots\ldots\right]+3\left[\frac{1}{0!}+\frac{1}{1!}+\frac{1}{2!}\ldots\ldots\right]+\left[\frac{1}{0!}+\frac{1}{1!}+\ldots\ldots\right]$$

⇒ S_n = e + 3e + e = 5e

7. Let $y = f(x)$ be the solution of the differential equation $\frac{dy}{dx}+3y\tan^2 x+3y=\sec^2 x$ such that $f(0)=\frac{e^3}{3}+1$, then $f\left(\frac{\pi}{4}\right)$ is equal to

(1) $(1+e^{-3})$ (2) $\frac{2}{3}(1+e^{-3})$

(3) $\frac{1}{3}(1-e^{-3})$ (4) $\frac{1}{3}(1+e^{-3})$

Ans. **(2)**

Sol. $\frac{dy}{dx}+y\left(3\tan^2 x+3\right)=\sec^2 x$

I.F. = $e^{\int\left(3\tan x^2 x+3\right)dx} = e^{3\tan x}$

$$y\cdot e^{3\tan x} = \int \sec^2 x\cdot e^{3\tan x}dx$$

$\tan x = t$

$\sec^2 x dx = dt$

$= \int e^{3t}dt$

$$y\cdot e^{3\tan x} = \frac{e^{3\tan x}}{3}+c$$

$$y = \frac{1}{3}+c\cdot e^{-3\tan x}$$

$$\frac{e^3}{3}+1 = \frac{1}{3}+c$$

$$c = \frac{e^3}{3}+\frac{2}{3}$$

So, $f\left(\frac{\pi}{4}\right)=\frac{1}{3}+\left(\frac{e^3}{3}+\frac{2}{3}\right)e^{-3}$

$$=\frac{2}{3}+\frac{2}{3}e^3$$

$$=\frac{2}{3}\left(1+\frac{1}{e^3}\right)$$

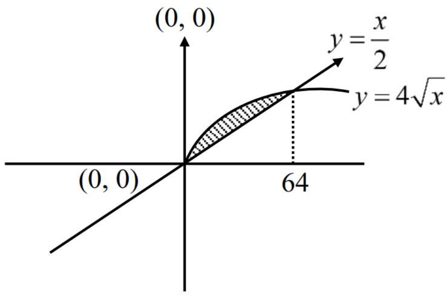
8. Area bounded by $|x-y|\le y\le 4\sqrt{x}$ is equal to (in square units)

(1) $\frac{2048}{3}$ (2) $\frac{1024}{3}$

(3) $\frac{512}{3}$ (4) $\frac{128}{3}$

Ans. **(2)**

Sol.



$$|x-y| \le y \le 4\sqrt{x}$$

$$y=|x-y|$$

$$y^2=(x-y)^2$$

$$(x-y)^2-y^2=0$$

$$(x-y+y)(x-2y)=0$$

$$x(x-2y)=0$$

$$x=0,\ y=\frac{x}{2}$$

$$\frac{x}{2}=4\sqrt{x}$$

$$\frac{x^2}{4}=16x$$

$$x \ne 0,\ x=6y$$

$$\int_6^{64}\left(4\sqrt{x}-\frac{x}{2}\right)dx$$

$$\Rightarrow 4\left[\frac{2x^{3/2}}{3}\right]_0^{64}-\frac{1}{2}\left[\frac{x^2}{2}\right]_0^{64}$$

$$4\left[\frac{2}{3}\times 8^3\right]-\frac{1}{4}\left[(64)^2\right]$$

$$\Rightarrow \frac{8^4}{3}-\frac{8^4}{4}=8^4\left[\frac{4-3}{12}\right]$$

$$=\frac{8\times8\times8\times8}{12-3}=\frac{64\times16}{3}=\frac{1024}{3}$$

9. If the probability that the random variable X takes the value x is given by $P(X=x)=k(x+1)3^{-x},\ x=0,1,2,3\ldots$ where k is a constant then $P(x\ge 3)$ is equal to

(1) $\frac{7}{27}$ (2) $\frac{8}{27}$

(3) $\frac{4}{9}$ (4) $\frac{1}{9}$

Ans. **(4)**

Sol. $s=\frac{k}{3^0}+\frac{2k}{3}+\frac{3k}{3^2}+\ldots\ldots$

$$\frac{s}{3}=\frac{k}{3}+\frac{2k}{3^2}+\ldots\ldots..$$

$$s-\frac{s}{3}=k+\frac{k}{3}+\frac{k}{3^2}+\ldots\ldots..$$

$$\frac{2s}{3}=k\left(1+\frac{1}{3}+\frac{1}{3^2}+\ldots\ldots\right)$$

$$\frac{2s}{3}=k\times\frac{1}{1-\frac{1}{3}}\Rightarrow\frac{3k}{2}$$

$$s=\frac{9k}{4}=1 \text{ (Total probability)}$$

$$k=\frac{4}{9}$$

$P(x \ge 3) = 1 - (P(x = 0) + P.(x = 1) + P(x = 2))$

$$\Rightarrow 1-\left(k+\frac{2k}{3}+\frac{3k}{3^2}\right)$$

$$\Rightarrow 1-2k$$

$$\Rightarrow 1-2\times\frac{4}{9}=\frac{1}{9}$$

10. If the domain of the function $f(x)=\log_7(1-\log_4(x^2-9x+18))$ is $(\alpha,\beta)\cup(\gamma,\delta)$ then $\alpha+\beta+\gamma+\delta$ is equal to

(1) 18 (2) 16

(3) 15 (4) 17

Ans. **(1)**

Sol. $f(x)=\log_7\left(1-\log_4\left(x^2-9x+18\right)\right)$

For domain $1-\log_4\left(x^2-9x+18\right)>0$

$$\log_4\left(x^2-9x+18\right)<1$$

$$x^2-9x+18<4$$

$$x^2-9x+14<0$$

$$(x-7)(x-2)<0 \qquad x\in(2,7)$$

Also, $x^2-9x+18>0$

$$(x-6)(x-3)>0$$

$$(-\infty,3)\cup(6,\infty)$$

Intersection of both is Domain $(2,3)\cup(6,7)$

$$\alpha+\beta+\gamma+\delta=2+3+6+7=18$$

11. The number of solutions of the equation $(4-\sqrt{3})\sin x - 2\sqrt{3}\cos^2 x = \frac{-4}{1+\sqrt{3}}$, $x \epsilon \left[-2\pi, \frac{5\pi}{2}\right]$

(1) 4 (2) 6

(3) 5 (4) 3

Ans. **(3)**

Sol. $\left(4-\sqrt{3}\right)\sin x - 2\sqrt{3}\cos^2 x = \frac{-4}{1+\sqrt{3}}$

$2\sqrt{3}\sin^2 x + 4\sin x - \sqrt{3}\sin x - 2 = 0$

$2\sin x\left(\sqrt{3}\sin x + 2\right) - 1\left(\sqrt{3}\sin x + 2\right) = 0$

$\sin x = \frac{1}{2}$, $\sin x = \frac{-2}{\sqrt{3}}$ (Rejected)

number of solutions in $\left[-2\pi, \frac{5\pi}{2}\right] = 5$

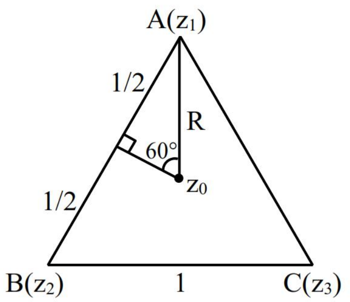
12. Let $A(z_1)$, $B(z_2)$ and $C(z_3)$ are the vertices of an equilateral trinagle. If z_0 is the centroid of triangle ABC and $|z_1 - z_2| = 1$, then the value of $\sum_{i=1}^{3} |z_i - z_0|^2$ is equal to

(1) 1 (2) 2

(3) 3 (4) 9

Ans. **(1)**

Sol.



$\sin 60° = \frac{1}{2R} = \frac{\sqrt{3}}{2}$

$\Rightarrow R = \frac{1}{\sqrt{3}}$

$\sum_{i=1}^{3} |z_i - z_0|^2 = R^2 + R^2 + R^2$

$= 3R^2$

$= 1$

13. If $f(x) = ||x+2| - 2|x||$, then number of points of local maxima and local minima is

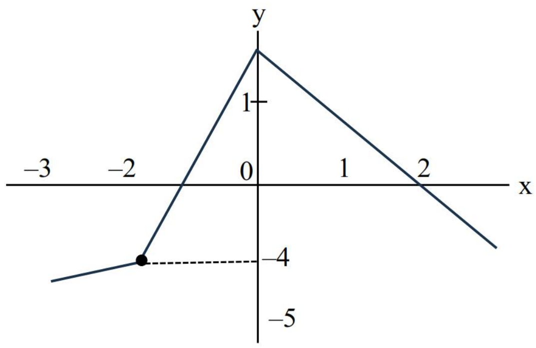
(1) 5 (2) 3

(3) 2 (4) 7

Ans. **(2)**

Sol. $y = \left\| x+2 \right| - 2\left| x \right\|$

Plotting graph |x + 2 | – 2 |x|



Number of points of local extremum will be = 3

14. $x(x-2)(12-k) = 2$ has both roots same. The distance of $\left(k, \frac{k}{2}\right)$ from the line $3x + 4y + 5 = 0$ is

(1) 24 (2) 14

(3) 15 (4) 20

Ans. **(3)**

Sol. $(12 - x)x^2 - 2x(12 - x) - 2 = 0$

$D = 0$

$4(12 - x)^2 + 4(12 - x) \times 2 = 0$

$(12 - x)(12 - x + 2) = 0$

k = 12 (rejected), k = 14

Point (14, 7)

$3x + 4y + 5 = 0$

$d = \left|\frac{42+28+5}{5}\right| = 15$

15. The shortest distance between the parabola $y^2 = 8x$ and the circle $x^2 + y^2 + 12y + 35 = 0$ is

(1) $\left(2\sqrt{2} - 1\right)$ units (2) $\left(\sqrt{2} - 1\right)$ units

(3) $\left(2\sqrt{2} + 1\right)$ units (4) $\left(\sqrt{2} + 1\right)$ units

Ans. **(1)**

Sol. Equation of normal

$y = mx - 2am - am^3$

since a = 2

y = mx – 4m – 2m^3 ....(i)

centre of circle C(0, –6), $r=\sqrt{36-35}=1$

$\therefore$ –6 = –4m – 2m^3

$\Rightarrow$ m^3 + 2m = 3

$\therefore$ m = 1

$P\left(am_1^2-2am\right)=P(2,-4)$

$\therefore\ CP=\sqrt{2^2+2^2}=2\sqrt{2}$

Minimum distance = $2\sqrt{2}-1$

16. Let f be a function such that

$f(x)+3f\left(\frac{24}{x}\right)=4x,\ x\neq 0.$

Then $f(3)+f(8)$ is equal to

(1) 12 (2) 10

(3) 13 (4) 11

Ans. **(4)**

Sol. Put x = 3 f(3) + 3f(8) = 12 ...(i)

x = 8 f(8) + 3f(3) = 32 ...(ii)

(i) + (ii) 4(f(3) + f(8)) = 44

$\therefore$ f(3) + f(8) = 11.

17. If the coordinates of foci of a hyperbola $3x^2-y^2-\alpha x+\beta y+\gamma=0$ are (4,2) and (8,2). Then $(\alpha+\beta+\gamma)$ is equal to

(1) 81 (2) 137

(3) 121 (4) 141

Ans. **(4)**

Sol. So, $3x^2-y^2-36x+4y+r=0$

$3\left(x^2-12x+36-36\right)-\left(y^2-4y+4-4\right)+r=0$

$3(x-6)^2-108-(y-2)^2+4+r=0$

$3(x-6)^2-(y-2)^2=108-4-r$

$\frac{(x-6)^2}{\frac{104-r}{3}}-\frac{(y-2)^2}{104-r}=1$

ae = 2

$\Rightarrow$ a^2 + b^2 = 4

$\Rightarrow \frac{104-r}{3}+104-r=4$

$\Rightarrow r=101$

$\frac{\delta f}{\delta x}=0\Rightarrow 6x-\alpha=0$

$\Rightarrow x=\frac{\alpha}{6}=\frac{4+8}{2}$

$\Rightarrow \alpha=36$

& $\frac{\delta f}{\delta y}=0\Rightarrow -2y+\beta=0$

$\Rightarrow y=\frac{\beta}{2}=\frac{2+2}{2}$

$\Rightarrow \beta=4$

So, finally

$\alpha+\beta+\gamma=36+4+101=141$