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JEE (Main)

PAPER-1 (B.E./B. TECH.)

2021

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 25 July, 2021 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)

SUBJECT: PHYSICS

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PART : PHYSICS

1. A body of mass 2 kg and linear velocity 4 m/s collides elastically head on with another body at rest. After collision body of mass 2 kg starts moving with velocity 1 m/s then what will the velocity of center of mass of system ?

(1) 1.5 m/s (2) 0.5 m/s (3) 3.5 m/s (4) 2.5 m/s

Ans. (4)

Sol. From linear momentum conservation

$2 \times 4 + 0 = 2 \times 1 + m_2v_2$

From the definition of elastic collision

$v_2 - v_1 = e(u_1 - u_2)$

$v_2 - 1 = 1(4 - 0)$

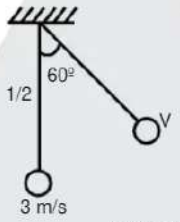
$v_2 = 5$

$8 = 2 + m_2 \times 5$

$m_2 = 6/5$

$$V_{cm} = \frac{m_1v_1 + m_2v_2}{m_1 + v_2} = \frac{2\times 4 + 0}{2 + \frac{6}{5}} = 2.5 \text{ m/s}$$

What will be the speed of pendulum mass, when string of pendulum makes an angle of 60º with vertical ?



(1) 2 m/s (2) 4 m/s (3) 6 m/s (4) 8 m/s

Ans. (1)

Sol. $\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg\ell(1-\cos 60°)$

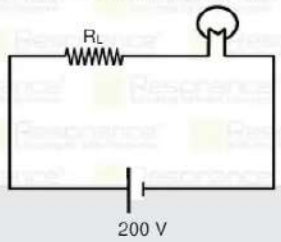
$u^2 = v^2 + 2g\ell(1-\cos 60°)$

$9 = v^2 + 20 \times 1/2 \times 1/2$

$9 = v^2 + 5$

$v = 2$ m/s

3. A bulb has rated power 200 W and rated voltage 100 V. This bulb is connected in circuit as shown in figure. What should be value of load resistance R_L so that bulb works at rated voltage ?



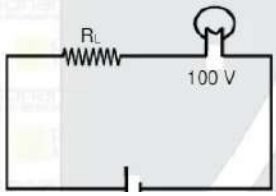
(1) 25Ω (2) 50Ω (3) 75Ω (4) 100Ω

Ans. (2)

Sol. $P = \frac{V^2}{R}$

$200 = \frac{(100)^2}{R}$

$R = 50\ \Omega$



200 V

Current through bulb

$i = \frac{100}{50} \Rightarrow 2A$

$V_L = 100$

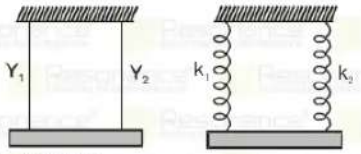
$R_L = \frac{100}{2} = 50\ \Omega$

4. Two geometrical identical wires have young modules Y_1 and Y_2 then find equivalent young modules :

(1) $Y_1 + Y_2$ (2) $\frac{Y_1 + Y_2}{2}$ (3) $\frac{Y_1 Y_2}{Y_1 + Y_2}$ (4) $\sqrt{Y_1 Y_2}$

Ans. **(2)**

Sol.



$K_{eq} = K_1 + K_2$

$\frac{Y2A}{\ell} = \frac{Y_1 A}{\ell} + \frac{Y_2 A}{\ell}$

$Y = \frac{Y_1 + Y_2}{2}$

5. Battery is connected to a resistor and a inductor for a long time as shown in figure, then battery is removed & short circuited. Find the current in the circuit after 1 ms after battery get removed :

(1) 1.32A (2) 0.44A (3) 0.65A (4) 0.74A

Ans. **(4)**

Sol. $i_0 = \frac{20}{10} = 2A$

$i = i_0 e^{-Rt/L}$

$= 2 \times e^{\frac{10 \times 10^{-3}}{10 \times 10^{-3}}} = \frac{2}{e} = 0.74A$

6. A particle of mass 4m at rest splits into two particle of mass 3 m and m. If both the masses have different velocities then find ratio of their De-Broglie wavelength ?

(1) 1 : 1 (2) 1 : 2 (3) 2 : 1 (4) 1 : 3

Ans. **(1)**

Sol. $\lambda = \frac{h}{P}$

here momentum is same for both

$\lambda_{2m} \quad 1$

7. An electron, a proton and an alpha particle are get accelerated by giving same K.E., then which of the following is correct about De-Broglie wavelength.

(1) $\lambda_e < \lambda_p < \lambda_\alpha$ (2) $\lambda_e > \lambda_p > \lambda_\alpha$ (3) $\lambda_e = \lambda_p < \lambda_\alpha$ (4) $\lambda_e = \lambda_p > \lambda_\alpha$

Ans. **(2)**

$\frac{h}{\quad} \quad 1$

Sol. $\lambda = \frac{h}{\sqrt{2m\,KE.}} \Rightarrow \lambda \propto \frac{1}{\sqrt{m}}$

$m_\alpha > m_p > m_e$

so $\lambda_e > \lambda_p > \lambda_\alpha$

8. A ball of mass m is thrown towards wall in two different situations,
(i) Ball strikes perpendicular to wall (ii) Ball strikes at an angle of 45° to wall
What will be ratio of impulse in two cases ?
(1) 2 : 1 (2) 1 : 1 (3) 1 : 2 (4) 3 : 1

Ans. (2)

Sol.

During elastic collision with vertical wall, velocity in vertical direction remains constant and component velocity along horizontal direction become opposite after collision.
So, change in momentum,

So, $\frac{\Delta P_1}{\Delta P_2} = \frac{2mu\cos\theta}{2mu\cos\theta} = 1 : 1$

9. Photons of wavelength 400nm strikes on a material with energy 1000J in 10 sec. what will be no. of electron leaving the material in one second ?
(1) 5×10^9 (2) 5×10^{18} (3) 5×10^{13} (4) 5×10^{10}

Ans. (2)

Sol. $\text{Energy} = N \times \frac{hc}{\lambda}$

$1000 = \frac{12400}{4000} \times N \times 1.6 \times 10^{-19}$

$N = \frac{1000 \times 4}{12400 \times 1.6 \times 10^{-19}}$

So, number of electron leaving from material in 1 sec $= \frac{N}{10} = 5 \times 10^{18}$

10. A radioactive nuclei of initial number of active nuclei N_0. Decays $N_0/4$ active nuclei in time t_1 and decays to $N_0/2$ active nuclei in time t_2. Find the ratio between t_1 and t_2 ?

Ans. (1)

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

$\frac{3N_0}{4} = N_0 e^{-\lambda t_1}$

$t_1 = \frac{\ell n \frac{4}{3}}{\lambda}$; $t_2 = \frac{\ell n 2}{\lambda}$

$\frac{t_1}{t_2} = \frac{\ell n \frac{4}{3}}{\ell n 2} = \frac{2\ell n 2 - \ell n 3}{\ell n 2} = 2 - \frac{1.098}{0.693} = 2 - 1.58 = 0.42$

11. For an ideal gas, C_v is the specific heat at constant volume and C_p is the Specific heat at constant pressure. if at some temperature T_P, they are related as $C_p - C_v = R$ and for some other temperature T_Q They are related as $C_p - C_v = 1.1R$, then which is correct

(1) $T_P > T_Q$ (2) $T_Q > T_P$ (3) $T_P = T_Q$ (4) can't say

Ans. (1)

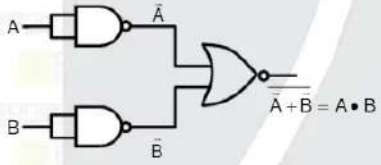
Sol. At high temperature gas behaves has ideal gas.

12. Find equivalent circuit

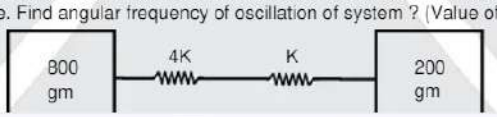
(1) NOR (2) OR (3) AND (4) NAND

Ans. (3)

Sol.



13. Two block of mass 800 gm and 200gm are attached by two springs of spring constant 4 K and K in series as shown in figure. Find angular frequency of oscillation of system ? (Value of K = 20 N/m)



Ans. (1)

Sol. $T = 2\pi\sqrt{\frac{\mu}{k_{eq}}}$

$\mu = \frac{m_1 m_2}{m_1 + m_2} \Rightarrow \frac{200 \times 800}{200 + 800} = 160g = 0.16kg$

$K_{eq} = \frac{k_1 k_2}{k_1 + k_2} = \frac{4k \times k}{4k + k} = \frac{4}{5}k = \frac{4}{5} \times 20 = 16\frac{N}{m}$

$T = 2\pi\sqrt{\frac{0.16}{16}}$; $T = \pi/5$ sec.

$\omega = \frac{2\pi}{T} = 10$ rad/s

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14. A conducting loop of radius 0.1 m has a time variable magnetic field $B(t) = \frac{4}{100}\left[1 - \frac{t}{100}\right]$. Find energy dissipated till magnetic field becomes zero if resistance of loop is 0.01Ω.

(1) 16×10^{-7} J (2) 8×10^{-7} J (3) 4×10^{-7} J (4) 2×10^{-7} J

Ans. (1)

Sol. $\varepsilon = \left|-A\frac{dB}{dt}\right|$

$\varepsilon = \pi(0.1)^2 \times \frac{4}{100} \times \frac{1}{100}$

$\varepsilon = 4\pi \times 10^{-6}$ v

Energy = $\frac{}{R} \times t = \frac{}{10^{-2}} \times 100 = 16\pi^2 \times 10^{-9} = 16 \times 10^{-9}$ J

15. An Electric field of a wave propagating as $E = E_0 \cos(kz - 5.6 \times 10^3 t)$ reflecting from mirror at z = a, then
(1) $\lambda = 5.6$ m
(2) $f = 5.6 \times 10^3$ Hz
(3) Equation of reflecting wave $E = E_0 \cos(kz - 5.6 \times 10^3 t)$
(4) Equation of reflecting wave $E = -E_0 \cos(kz + 5.6 \times 10^3 t)$

Ans. **(4)**

Sol. $w = 5.6 \times 10^3$

$2\pi f = 5.6 \times 10^3$

$$f = \frac{5.6\times10^3}{2\pi} = \frac{5.6\times10^3}{2\times3.14} = 891.7\text{Hz}$$

$C = f\lambda$

$$\lambda = \frac{c}{f} = \frac{3\times10^8}{891.7} = 3.36\times10^5\text{ m}$$

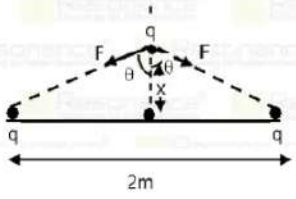
Reflecting wave

$E = E_0 \cos(-kz - 5.6 \times 10^3 + \pi)$

16. Two similar charge of magnitude q are fixed at distance of 2m. And another opposite charge of same magnitude is brought at center point between two charges and given a slight displacement along equatorial direction and released then angular frequency of oscillations of opposite charge will be? (Value of $q^2 = 10$ C^2) (Mass of opposite charge 0.2 gram)
(1) 3×10^7 rad/s (2) 3×10^5 rad/s (3) 3×10^{-5} rad/s (4) 3×10^6 rad/s

Ans. **(1)**

Sol.



Net force on charge is

$F_{net} = 2F\cos\theta$ Here $F = \frac{kq^2}{(1+x^2)}$

$$F_{net} = \frac{2kq^2}{(1+x^2)} \cdot \frac{X}{\sqrt{1+X^2}}$$

$F_{net} = \frac{2kq^2x}{}$ $\because x << 1$, so $x^2 <<< 1$

$ma = 2kq^2 x$

$$a = \frac{2kq^2x}{m}$$

$$\omega = \sqrt{\frac{2kq^2}{m}} = \sqrt{\frac{2\times9\times10^9\times10}{2\times10^{-4}}} = 3\times10^7\text{ rad/sec.}$$

17. Water drops are falling from a tap in regular interval of time. A drop falls from the tap and after 4 second of falling, the drop is 34.3m away from next drop. Then drops are falling at rate of (Use g = 9.8 m/s^2)
(1) 1 drop in 1 sec (2) 1 drop in 7 sec (3) 1 drop in 5 sec (4) 1 drop in 6 sec

Ans. **(1)**

Sol. Let next drop after t sec distance travelled by Ist drop in 4 sec. is $S_1 = \frac{1}{2}at^2 = 78.4$ m (t should be less then 4 sec) distance travelled by succeeding drop in 4 – t sec

$S_2 = \frac{1}{2}a(4-t)^2$

$(4-t)^2 = 9$

$4 - t = 3$

$t = 1$ sec

18. In YDSE, distance between the slits are varied as $d = a + b \sin \omega t$. What will be difference between maximum and minimum fringe width?

(1) $\frac{2bD\lambda}{a^2-b^2}$ (2) $\frac{4bD\lambda}{a^2-b^2}$ (3) $\frac{3bD\lambda}{a^2+b^2}$ (4) $\frac{5bD\lambda}{a^2+b^2}$

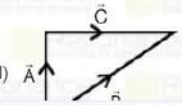
Ans. (1)

Sol. Fringe width $= \frac{D\lambda}{d}$

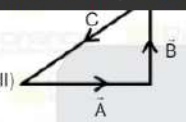
$$\beta = \frac{D\lambda}{(a+b\sin wt)}$$

$$\beta_{max} - \beta_{min} \Rightarrow \frac{D\lambda}{a-b} - \frac{D\lambda}{a+b} \Rightarrow D\lambda\left[\frac{a+b-a+b}{a^2+b^2}\right] = \frac{2bD\lambda}{a^2-b^2}$$

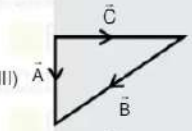
19. Match the following column.

(I) 

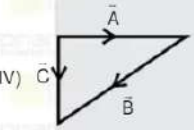
(a) $\vec{C} - \vec{A} - \vec{B} = 0$

(II) 

(b) $\vec{A} - \vec{C} - \vec{B} = 0$

(III) 

(c) $\vec{B} - \vec{A} - \vec{C} = 0$

(IV) 

(d) $\vec{A} + \vec{B} + \vec{C} = 0$

(1) (I) c ; (II) d ; (III) b ; (IV) a
(2) (I) d ; (II) c ; (III) b ; (IV) a
(3) (I) c ; (II) d ; (III) a ; (IV) b
(4) (I) b ; (II) d ; (III) a ; (IV) c

(II) $\vec{A} + \vec{B} + \vec{C} = 0$

(III) $\vec{A} - \vec{B} - \vec{C} = 0$

(IV) $\vec{A} + \vec{B} - \vec{C} = 0$

20. In a parallel plate capacitor distance between the plates is 'd'. If dielectric of variable permeability is filled as :

$\varepsilon(x) = \varepsilon_0 + kx \quad ; \quad 0 < x \le d/2$

$\varepsilon(x) = \varepsilon_0 + k(d - x) \quad ; \quad d/2 < x \le d$

Find capacitance ?

(1) $\frac{1}{Ak} \times \ell n \frac{\varepsilon_0 + \frac{kd}{2}}{\varepsilon_0}$ (2) $\frac{1}{Ak} \times 2\ell n \frac{\varepsilon_0 + \frac{kd}{2}}{\varepsilon_0}$ (3) $\frac{1}{Ak} \times \ell n \frac{\varepsilon_0 - \frac{kd}{2}}{\varepsilon_0}$ (4) $\frac{1}{Ak} \times 2\ell n \frac{\varepsilon_0 - \frac{kd}{2}}{\varepsilon_0}$

Ans. (2)

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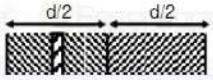
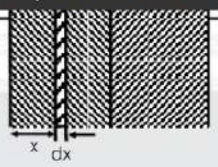
Sol.





$$\frac{1}{C_{eq}} \Rightarrow \int \frac{dx}{A\varepsilon}$$

$$\Rightarrow \int_0^{d/2} \frac{dx}{A(\varepsilon_0 + kx)} + \int_{d/2}^{d} \frac{dx}{A[\varepsilon_0 + k(d-x)]}$$

$$\Rightarrow \frac{1}{A}\left\{\frac{1}{k}\left[\ell n(\varepsilon_0 + kx)\right]_0^{d/2} + \frac{1}{k}\left[\ell n(\varepsilon_0 + k(d-x))\right]_{d/2}^{d}\right\}$$

$$\Rightarrow \frac{1}{Ak} \times 2\ell n \frac{\varepsilon_0 + \frac{kd}{2}}{\varepsilon_0}$$

21. The position of an object varies as $\vec{R} = 10\lambda\beta t^2\hat{i} + 5\beta(t-5)\hat{j}$. Find time at which angular momentum

(1) 10 sec (2) 12 sec (3) 15 sec (4) 17 sec

Ans. (1)

Sol. $\vec{R} = 10\lambda\beta t^2\hat{i} + 5\beta(t-5)\hat{j}$

$\vec{v} = 20\lambda\beta t\hat{i} + 5\beta\hat{j}$

$\vec{L} = m(\vec{r} \times \vec{v})$

$\vec{L} = m\left(10\lambda\beta t^2\hat{i} + 5\beta(t-5)\hat{j}\right) \times \left(20\lambda\beta t\hat{i} + 5\beta\hat{j}\right)$

at $t = 0$, $\vec{L} = 0$

At any time t

$\vec{L} = m\left(50\lambda\beta^2 t\hat{k} - 100\lambda\beta^2(t-5)\hat{k}\right)$

$0 = 50\ m\ \lambda\beta^2\ [t - 2\ (t-5))\ \hat{k}$

$\Rightarrow t - 2t + 10 = 0$

$\Rightarrow t = 10$ sec

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22. A message signal $x_m = 10 \sin (2\pi \times 10^5 t)$ is amplitude modulated with carrier signal $x_c = 20 \sin (2\pi \times 10^7 t)$ then find the half of band width.

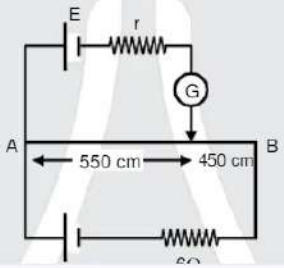
Sol. Band width = $2f_m$

$\therefore$ Half of bandwidth = f_m

$= 10^5$ Hz

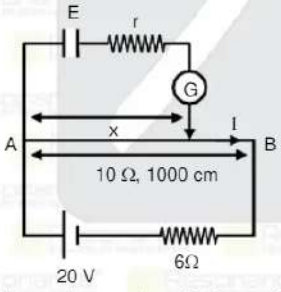
= 100 KHz

23. Circuit shown is in the balanced state in which galvanometer shows non-deflection. Given that wire AB has 0.01 Ω/cm of resistance. Find maximum possible value of voltage that can be measured by this set up.



Ans. (2)

Sol. At zero deflection

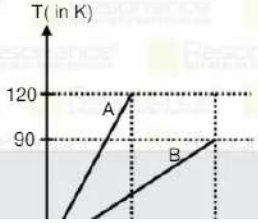


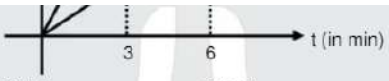
The maximum value of E that can be measured = V_{AB}

$$V_{AB} = \frac{20}{10+6} \times 10 = 12.5V$$

24. The temperature vs time graph for two different gases A and B having same number of moles is as shown

both the gases ?





(1) 3/8 (2) 5/8 (3) 7/8 (4) 9/8

Ans. (1)

Sol. $Q = nC\Delta T$

$$\frac{dQ}{dt} = nC\frac{dT}{dt}$$

Rate of heat is same for both gases

$$\left(\frac{dT}{dt}\right)_1 = \left(\frac{dT}{dt}\right)_2$$

$$\frac{C_1}{C_2} = \frac{\left(\frac{dT}{dt}\right)_2}{\left(\frac{dT}{dt}\right)_1} = \frac{\frac{90}{6}}{\frac{120}{3}} = \frac{90\times 3}{120\times 6} = \frac{3}{8}$$

25. For a magnetic material, the relative change in magnetic susceptibility is equal to 2.2×10^{-4}. Find the percentage change in magnetic field ?

(1) 0.012 (2) 0.025 (3) 0.022 (4) 0.028

Ans. (3)

Sol. $\mu_r = 1 + \chi$

$\Delta\mu_r = \Delta\chi$

also $B \propto \mu_r$

$B = k\mu_r$ (k = constant)

$$\% \text{ change} = \frac{\Delta B}{B}\times 100 = \frac{k(\Delta\mu_r)}{k\mu_r}\times 100$$

$$= \frac{2.2\times 10^{-4}}{\cdot}\times 100 = 0.022\ \%$$

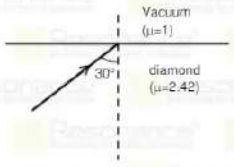
26. A ray incident at an angle 30° on the interface of diamond and vacuum from the diamond side then which of following is correct (given $\mu_{diamond} = 2.42$)

(1) The incident of ray will not get refracted (2) The ray will not get refracted if incident at 53°

(3) The ray will get refracted if incident at 22° (4) There is always TIR for angle greater then 30°

Ans. (1)

Sol.



Critical angle $C = \sin^{-1}\left(\frac{1}{2.42}\right) = 24.4°$

Given Incident angle 30° > C

So there is TIR at interface

27. A monoatomic gas filled in a piston cylinder arrangement, its temperature changes from T_1 to T_2 and length of gas column changes from L_1 to L_2, against atmosphere. Then the ratio of T_1/T_2 :

(1) $\left(\frac{L_2}{L_1}\right)^{2/3}$ (2) $\left(\frac{L_1}{L_2}\right)^{2/3}$ (3) $\left(\frac{L_2}{L_1}\right)$ (4) $\left(\frac{L_1}{L_2}\right)$

at constant atmospheric pressure

$$\frac{T_1}{T_2} = \frac{v_1}{v_2}$$

$$\frac{T_1}{T_2} = \frac{AL_1}{AL_2}$$

$$\frac{T_1}{T_2} = \frac{L_1}{L_2}$$

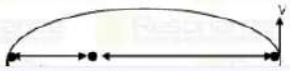
$T_2 \quad L_2$

28. A particle is revolving around a planet with maximum distance x and minimum distance y. If maximum velocity of particle is v_0 then find minimum velocity of particle :

(1) $\frac{v_0 x}{y}$ (2) $\frac{v_0 y}{x}$ (3) $\frac{v_0 x^2}{y^2}$ (4) $\frac{v_0 y^2}{x^2}$

Ans. (2)

Sol.



By angular momentum conservation

$mv_0 y = mvx$

$v = \frac{v_0 y}{x}$

29. A radioactive material of mass number 198 decays with half-life of 3 days. If initial amount of radioactive material is 2 mg, then its initial activity will be ?

(1) 1626×10^5 dps (2) 1626×10^{10} dps (3) 1626×10^8 dps (4) 1626×10^6 dps

Ans. (2)

Sol. No. of Nuclei = $\frac{m}{M}.N_A = \frac{2\times10^{-3}}{198} \times 6.02 \times 10^{23}$

$A_0 = \lambda N_0 = \frac{0.693}{3\times24\times60\times60} \times \frac{2\times10^{-3}}{198} \times 6.02 \times 10^{23}$

$1625 \times 10^{-8} \times 10^{18}$

1626×10^{10} dps

30. Based on given statement choose the correct option

Statement I : For a disc situated in x–y plane. The radius of gyration is same for x-axis, y-axis and z-axis.

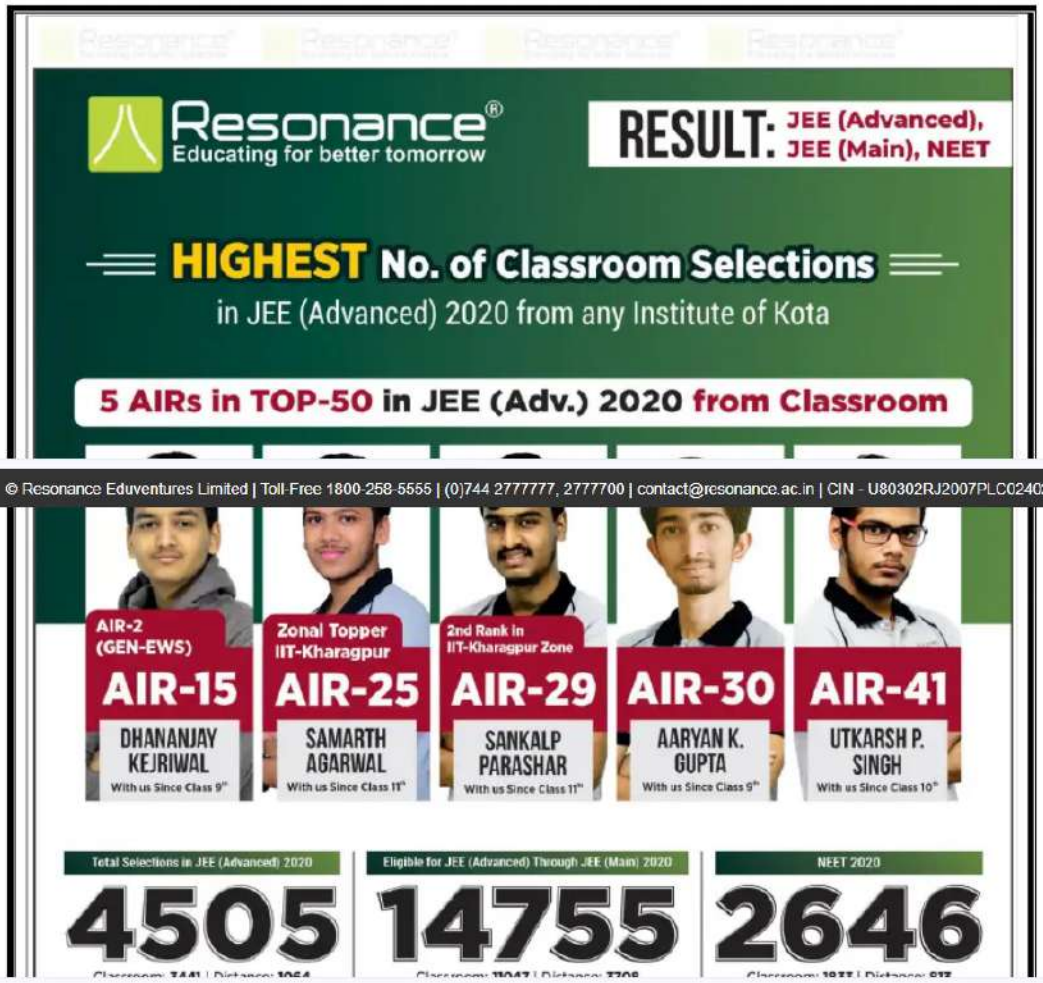
Statement II : In case of rigid body motion there is no change in shape and mass.

(1) Statement 1 & 2 both are true

(3) Statement-1 is false Statement-2 is true

(4) Statement-2 is true Statement-1 is false.

Ans. (3)



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SUBJECT: CHEMISTRY

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PART : CHEMISTRY

1. In the combustion of butane 72gm of H_2O is produced. The amount of butane taken initially is $[X] \times 10^{-1}$. The value of 'X' is

Ans. 464

Sol. $C_4H_{10} + \frac{13}{2} O_2 \rightarrow 4CO_2 + 5H_2O$

$C_nH_{2n-2} + \left(\frac{3n+1}{2}\right)O_2 \rightarrow n\,CO_2 + (n+1)\,H_2O$

$\because$ 1 mole C_4H10 produces 5 mole H_2O.

5 mole $(5 \times 18) = 90$ gm.

90 gm $\rightarrow$ 58 gm

2. $A+B \rightleftharpoons 2C$.

Initially 1 mole each of A, B and C are taken in 1 litre vessel. Equilibrium constant is 100. The concentration of C at equilibrium in $[X] \times 10^{-1}$. The value of 'X' is

Ans. (25)

Sol. $A + B \rightleftharpoons 2C \quad K_C = 100$

$t = 0 \quad 1 \quad 1 \quad 1$

$t = t_{eq.} \; 1-x \quad 1-x \quad 1+2x$

$$K_c = \frac{(1+2x)^2}{(1-x)^2}$$

$$100 = \frac{(1+2x)^2}{(1-x)^2} \text{ of [C]}$$

$$10 \quad (1+2x)$$

$$X = \frac{3}{4}$$

concentration of [C] = $1 + 2\left(\frac{3}{4}\right) = 25 \times 10^{-1}$

3. In the leaching of Bauxite, which Oxide is leached out using NaOH.

(1) Fe_2O_3 (2) Al_2O_3 (3) TiO_2 (4) SiO_2

Ans. (2)

Sol. $Al_2O_3 .xH_2O + NaOH \longrightarrow NaAlO_2$

$\downarrow H_2O$

$Al(OH)_3 + NaOH$

$Al(OH)_3 \xrightarrow{1200K} Al_2O_3$ (pure)

4. Among the given oxides

(i) CrO_3 (ii) V_2O_5 (iii) Fe_2O_3 (iv) MnO_2

(1) (i) < (ii) < (iii) < (iv) (2) (ii) < (iii) < (i) < (iv) (3) (iii) < (iv) < (i) < (ii) (4) (iii) < (iv) < (ii) < (i)

Ans. (4)

Sol.

	Compound	Oxidation state of metal
(i)	CrO_3	+6
(ii)	V_2O_5	+5
(iii)	Fe_2O_3	+3
(iv)	MnO_2	+4

5. Find the concentration of Fe^{2+} (10 ml) required to reduce 15 ml of 0.1M $K_2Cr_2O_7$ Solution is:

Ans. 0.9

Sol. $Cr_2O_7^{2-} + Fe^{2+} \rightarrow Fe^{3+} + Cr^{3+}$

15 ml 10 ml

$N_1V_1 = N_2V_2$

$15 \times 0.1 \times 6 = 10 \times M \times 1$

M = 0.9 Molar

6. Arrange the following ions in the increasing order of size, Na^+, K^+, Mg^{+2}, Al^{+3}.

(1) $Al^{+3} < Mg^{2+} < Na^+ < K^+$ (2) $K^+ < Na^+ < Al^{+3} < Mg^{2+}$

(3) $Al^{+3} < Mg^{2+} < K^+ < Na^+$ (4) $Mg^{2+} < Al^{+3} < K^+ < Na^+$

Ans. (1)

Sol. $K^+ > Na^+$ {moving down the group size increases}

$Na^+ > Mg^{+2} > Al^{+3}$ {Isoelectronic species}

Z	11	12	13
E	10	10	10

7. Henry's law constant for CO_2 in water in $0.835 \times 2 \times 10^3$ bar. How many milimoles of CO_2 would dissolve

Ans. 25

Sol. $P_{CO_2} = K_H X_{CO_2}$

$$X_{CO_2} = \frac{P_{CO_2}}{K_H} = \frac{0.835}{0.835 \times 2 \times 10^3}$$

$X_{CO_2} = 0.5 \times 10^{-3}$

Number of moles of water $= \frac{900}{18} = 50$

$$\frac{n_{CO_2}}{n_{CO_2} + nH_2O} = 0.5 \times 10^{-3}$$

(n_{CO_2} in denominator is neglected as it is << 50)

$n_{CO_2} = 0.5 \times 10^{-3} \times 50 = 25 \times 10^{-3}$ moles

= 25 milimoles

(1) SiF_6^{2-} (2) $SiCl_6^{2-}$ (3) $GeCl_6^{2-}$ (4) $Sn(OH)_6^{2-}$

Ans. (2)

Sol. The main reasons are :

(i) six large chloride ions cannot be accommodated around Si^{4+} due to limitation of its size.

(ii) interaction between lone pair of chloride ion and Si^{4+} is not very strong.

The species like, SiF_6^{2-}, $[GeCl_6]^{2-}$, $[Sn(OH)_6]^{2-}$ exist where the hybridisation of the central atom is sp^3d^2.

9. Which of the following complex is active in magnetic field.

(1) $[Fe(H_2O)_6]^{3+}$ (2) $[Co(CN)_6]^{3-}$ (3) $[Ni(Co)_4]$ (4) $[Ni(CN)_4]^{2-}$

Ans. (1)

Sol. Fe^{3+}: $3d^5$

If will contain 5 unpaired electrons.

Thus it is paramagnetic and attracted in external magnetic field.

10. Empirical formula of a given octahedral complex is $CrCl_3.3NH_3.3H_2O$. It precipitates 3 moles of AgCl. What is the secondary valency of central atom.

Ans. (4)

Sol. $[Cr(NH_3)_3(H_2O)]Cl_3 + AgNO_3 \longrightarrow 3AgCl\downarrow$

White ppt.

11. For a process ΔH_{fuson} = 2.4 l.Cal mol^{-1} and $DH_{vaporistion}$ = 98.6 k.Cal mol^{-1}. Then $\Delta H_{Sublimation}$ (on Kcal mol^{-1}) :

Ans. 101 K.Cal mol^{-1}

Sol. $\Delta H_{Sublimation} = \Delta H_{vap} + \Delta H_{fusion}$

$= 98.6 + 2.4$

$= 101$ K.Cal mol^{-1}

12. Which of the following statement is correct :

(1) H–H bond strength is equal to D–D bond strength.

(2) H–H bond strength is half of D–D bond strength.

(3) H–H bond strength is double the D–D bond.

(4) H–H bond strength is less than D–D bond strength

Sol. H–H bond denunciation energy 435 KJ/mol

D–D bond denunciation energy 450 KJ/mol

13. Which of the following about micelle formation is correct for sodium stearate $[C_{14}H_{35}COO^-Na^+]$

(1) Micelles formed are spherical with hydrocarbon part towards the centre of sphere

(2) Micelles formed are spherical with hydrocarbon part lying outside

(3) Micelles formed are Non spherical with hydrocarbon part towards the centre of sphere

(4) Micelles formed are Non-spherical with hydrocarbon part lying outside

Ans. (1)

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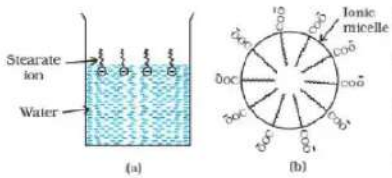
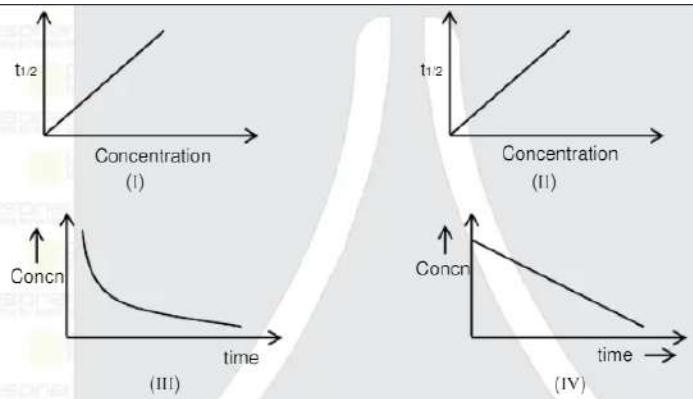
Sol.





(1) I, III – First order ; II, IV – Zero order

(2) I, IV – zero order ; II, III – First order

Ans. (2)

Sol. $A_t = (A)_0 - Kt$. : Zero Oder

$$t_{1/2} = \left(\frac{A_0}{2K}\right)$$

$A = A_0e^{-Kt}$; First oder

$$t_{1/2} = \frac{\ell n 2}{K}$$

15. Which of the following protein is soluble in water?

(1) Albumin (2) Fibrin (3) myosin (4) Collagen

Ans. (1)

Sol. It is globular protein (water soluble)

16. Which of the following is not used for drying agent?

Ans. (1)

17. CH_3MgBr react which of the following to give methane gas?

(1) H_2S (2) H_2O (3) NH_3 (4) All of these

Ans. (4)

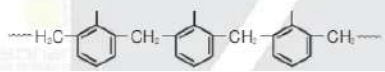
Sol. Grignard reagent act as strong base.

18. Number of σ bonds

$CH_3–CH=CH–C\equiv CH$

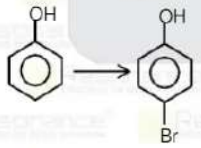
Ans. (10)

19. Given structure is



Sol. Novolac is linear polymer.

20.



(i) Br_2/H_2O (ii) $Br_2/FeBr_3$ (iii) Br_2/CS_2 (iv) $Br_2/CHCl_3$

(1) (i) & (ii) (2) (ii) & (iii) (3) (iii) & (iv) (4) (i) & (iv)

Ans. (3)

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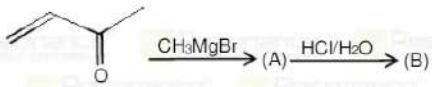
21.



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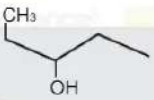
(3)

(4)

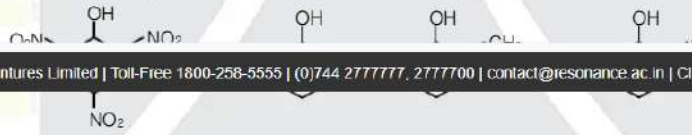


Ans. (2)

22. **Assertion:** Primary aromatic amine can't be prepared by gabrial-thalamide method.
Reason: Aryl halide cannot be undergo nucleophilic substitution reaction.
(1) Assertion-1 is True, Reason-2 is True; Reason-2 is a correct explanation for Assertion-1.
(2) Assertion-1 is True, Reason-2 is True; Reason-2 is NOT a correct explanation for Assertion-1.
(3) Assertion-1 is True, Reason-2 is False.
(4) Assertion-1 is False, Reason-2 is True.

Ans. (1)

23. Which of the following react with $NaHCO_3$ and evolved CO_2 gas.



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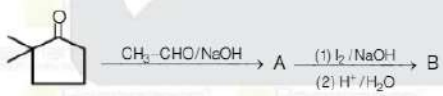
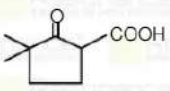
Ans. (1)

24.



(1)



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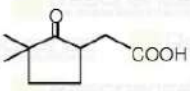
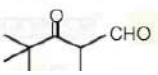


(3)

(4)



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Ans. (1)

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SUBJECT: MATHEMATICS

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PART : MATHEMATICS

1 If the ratio of coefficient of middle term in the expansion of $(1 + x)^{20}$ and sum of coefficients of middle terms in the expansion of $(1 + x)^{19}$ is λ, then λ is :

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

Ans. **(2)**

Sol. $\dfrac{{}^{20}C_{10}}{{}^{19}C_{9} + {}^{19}C_{10}} = \dfrac{{}^{20}C_{10}}{{}^{20}C_{10}} = 1$

2. If $f(x) = \begin{cases} \dfrac{\lambda\,|x^2 - 5x + 6|}{\mu\,(5x - 6 - x^2)} & ; x < 2 \\ \mu & ; x = 2 \\ e^{\frac{\tan(x-2)}{x - [x]}} & ; x > 2 \end{cases}$, is continuous at $x = 2$. Then the sum of λ and μ is:

Sol. $RHL = \lim\limits_{x \to 2^+} e^{\frac{\tan(x-2)}{x - [x]}} = \lim\limits_{x \to 2^+} e^{\frac{\tan(x-2)}{(x-2)}} = e$

$LHL = \lim\limits_{x \to 2^-} \dfrac{\lambda\,|x^2 - 5x + 6|}{\mu\,(5x - 6 - x^2)}$

For $x < 2$, $|x^2 - 5x + 6| = x^2 - 5x + 6$

$\therefore$ LHL $= \lim\limits_{x \to 2^-} \dfrac{\lambda\,|x^2 - 5x + 6|}{-\mu\,(x^2 - 5x + 6)} = \dfrac{-\lambda}{\mu}$

$\therefore$ LHL = $\lim_{x \to 2^-} \mu\left(5x-6-x^2\right) = \mu$

Also, f(2) = μ

For f(x) to be continuous at x = 2,

RHL = LHL = f(2)

$\therefore e = \frac{-\lambda}{\mu} = \mu$

$\Rightarrow \mu = e$ and $\lambda = -e^2$

$\therefore \lambda + \mu = e - e^2$

3. If $\sin x + \sin 2x + \sin 3x + \sin 4x = 0$, $x \in [0, 2\pi]$ then sum of values of x is

(1) 7π (2) 9π (3) 11π (4) 12π

Ans. (2)

Sol. $(\sin x + \sin 4x) + (\sin 2x + \sin 3x) = 0$

$\Rightarrow 2\sin\frac{5x}{2}\cos\frac{3x}{2} + 2\sin\frac{5x}{2}\cos\frac{x}{2} = 0$

$\Rightarrow 2\sin\frac{5x}{2}\left(\cos\frac{3x}{2} + \cos\frac{x}{2}\right) = 0$

$\Rightarrow 4\sin\frac{5x}{2}\cos x\cos\frac{x}{2} = 0$

$\Rightarrow \sin\frac{5x}{2} = 0$ or $\cos x = 0$ or $\cos\frac{x}{2} = 0$

$\Rightarrow \frac{5x}{2} = 0, \pi, 2\pi, 3\pi, 4\pi, 5\pi$ or $x = \frac{\pi}{2}, \frac{3\pi}{2}$ or $\frac{x}{2} = \frac{\pi}{2}$

$\Rightarrow x = 0, \frac{2\pi}{5}, \frac{4\pi}{5}, \frac{6\pi}{5}, \frac{8\pi}{5}, \frac{10\pi}{5}$ or $x = \frac{\pi}{2}, \frac{3\pi}{2}$ or $x = \pi$

$\Rightarrow x = 0, \frac{2\pi}{5}, \frac{4\pi}{5}, \frac{6\pi}{5}, \frac{8\pi}{5}, 2\pi, \frac{\pi}{2}, \frac{3\pi}{2}, \pi$

4. The number of real solutions of the equation $e^{5x} + e^{4x} + 2e^{3x} + 12e^{2x} + e^x - 1 = 0$

(1) 0 (2) 1 (3) 6 (4) 8

Ans. **(2)**

Sol. Since $f(x) = e^{5x} + e^{4x} + 2e^{3x} + 12e^{2x} + e^x - 1$

$\Rightarrow f'(x) = 6e^{6x} + 4e^{4x} + 6e^{3x} + 24e^{2x} + e^x > 0, \forall x \in R$

Hence f(x) is an increasing function

Now $\lim_{x \to -\infty} f(x) = -1$ and $f(0) = 1 + 1 + 2 + 12 + 1 - 1$

$\Rightarrow f(0) > 0$

Hence f(x) = 0 has a root in $(-\infty, 0)$

5. If $\frac{1}{a-b} + \frac{1}{a-2b} + \ldots\ldots\frac{1}{a-nb} = \alpha n + \beta n^2 + \gamma n^3$ where a is so large than b such that cube and higher powers of $\frac{b}{a}$ may be neglected then value of γ is :

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

Ans. **(1)**

Sol. $\frac{1}{a-b} + \frac{1}{a-2b} + \frac{1}{a-3b} + \ldots\ldots + \frac{1}{a-nb}$

$$=\frac{1}{a}\left[\left(1-\frac{b}{a}\right)^{-1}+\left(1-\frac{2b}{a}\right)^{-1}+\left(1-\frac{3b}{a}\right)^{-1}+.....+\left(1-\frac{nb}{a}\right)^{-1}\right]$$

$$=\frac{1}{a}\left[\left\{1+\left(\frac{b}{a}\right)+\left(\frac{b}{a}\right)^2+.....\right\}+\left\{1+\left(\frac{2b}{a}\right)+\left(\frac{2b}{a}\right)^2+.....\right\}+\left\{1+\left(\frac{nb}{a}\right)+\left(\frac{nb}{a}\right)^2+.....\right\}\right]$$

$$=\frac{1}{a}\left[n+\frac{b}{a}(1+2+.....+n)+\frac{b^2}{a^2}(1^2+2^2+.....n^2)\right]$$

$$=\frac{1}{a}\left[n+\frac{n(n+1)}{2}\frac{b}{a}+\frac{n(n+1)(2n+1)}{6}\frac{b^2}{a^2}\right]$$

$$=\frac{1}{a}\left[n+\frac{n^2}{2}\frac{b}{a}+\frac{n}{2}\frac{b}{a}+\frac{2n^3+3n^2+n}{6}\left(\frac{b^2}{a^2}\right)\right]$$

$$=n\left(\frac{1}{a}+\frac{b}{2a^2}+\frac{b^2}{6a^3}\right)+\left(\frac{b}{2a^2}+\frac{b^2}{2a^3}\right)n^2+\frac{b^2}{3a^3}n^3$$

we get $\gamma=\frac{b^2}{3a^3}$

6 In an A.P, if $S_{3n} = 3S_{2n}$, then ratio $\frac{S_{4n}}{S_{2n}}$ equals:

(1) 8 (2) 6 (3) 4 (4) 2

Ans. (2)

Sol. $\frac{S_{3n}}{S_{2n}}=\frac{\frac{3n}{2}[2a+(3n-1)d]}{\frac{2n}{2}[2a+(2n-1)d]}=3$

$\Rightarrow 2a+(3n-1)d = 2[2a + (2n-1)d]$

$\Rightarrow 2a+(n-1)d = 0$ .....(1)

Now $\frac{S_{4n}}{S_{2n}}=\frac{\frac{4n}{2}[2a+(4n-1)d]}{\frac{2n}{2}[2a+(2n-1)d]}$

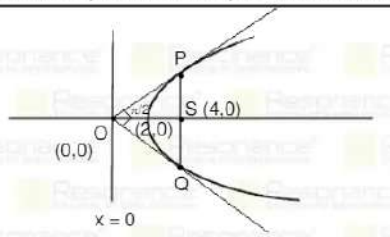
$=\frac{}{[2a+(2n-1)d]}$

Put, $2a = -(n-1)d$, we have, $\frac{S_{4n}}{S_{2n}}=\frac{2[3nd]}{nd}=6$

7. A parabola whose vertex is at 2 unit distance from origin on positive x-axis and distance between focus and origin is 4 unit. The tangent drawn from the origin to the parabola meet the parabola at P and Q, then the area of ΔOPQ is

Ans. **16 square unit**

Sol.



Equation of parabola
$(y-0)^2 = 4(2)(x-2)$
origin lie on directrix x = 0

$T = 0$
$x = 4$
It is latus rectum of parabola
so area of OPQ = $\frac{1}{2} \times 4 \times 8 = 16$ square unit

8. The term independent of x in expansion of $\left(\frac{x+1}{x^{2/3}-x^{1/3}+1} - \frac{x-1}{x-x^{1/2}}\right)^{10}$ is :

(1) 4 (2) 120 (3) 210 (4) 310

Sol. (3)

$\left((x^{1/3}+1) - \left(\frac{\sqrt{x}+1}{\sqrt{x}}\right)\right)^{10}$

$(x^{1/3} - x^{-1/2})^{10}$

$T_{r+1} = {}^{10}C_r (x^{1/3})^{10-r} (-x^{-1/2})^r$

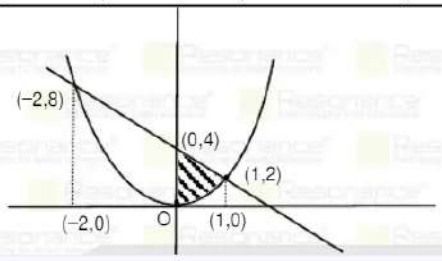
$\frac{10-r}{3} - \frac{r}{2} = 0 \Rightarrow 20 - 2r - 3r = 0$

$\Rightarrow r = 4$

$T_5 = {}^{10}C_4 = \frac{10 \times 9 \times 8 \times 7}{4 \times 3 \times 2 \times 1} = 210$

(1) $\frac{11}{12}$ (2) $\frac{7}{3}$ (3) $\frac{2}{3}$ (4) $\frac{5}{2}$

Ans. (2)
Sol.



$2x^2 = 4 - 2x$

$x^2 + x - 2 = 0$

$(x + 2)(x - 1) = 0$

$x = -2, x = 1$

Required area $= \frac{1}{2}(2+4)\times 1 - \int_0^1 2x^2 dx = 3 - \frac{2}{3} = \frac{7}{3}$ square units

10. An ellipse with eccentricity $\frac{1}{\sqrt{3}}$ passes through the point $\left(\sqrt{\frac{3}{2}}, 1\right)$. A circle is drawn whose centre is the focus of ellipse and its radius is $\frac{2}{\sqrt{3}}$. If circle cuts the ellipse at two different points P and Q then the value of PQ^2 is

(1) $\frac{8}{3}$ (2) $\frac{4}{3}$ (3) $\frac{16}{3}$ (4) $\frac{5}{3}$

Sol. Let equation of ellipse is $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \ (a > b)$

it passes through $\left(\sqrt{\frac{3}{2}}, 1\right) \Rightarrow \frac{3}{2a^2} + \frac{1}{b^2} = 1$ ....(1)

Given $e = \frac{1}{\sqrt{3}} \Rightarrow b^2 = a^2(1 - e^2) = \frac{2}{3}a^2$ .....(2)

Solve (1) & (2) we get $a^2 = 3, b^2 = 2$

$\therefore$ Ellipse is $\frac{x^2}{3} + \frac{y^2}{2} = 1$ ..... (3)

Focus $(\pm ae, 0) = \left(\pm\sqrt{3}.\frac{1}{\sqrt{3}}, 0\right) = (\pm 1, 0)$

Hence circle is $(x - 1)^2 + y^2 = \left(\frac{2}{\sqrt{3}}\right)^2 = \frac{4}{3}$ .....(4)

Solve (3) & (4)

$2x^2 + 3\left(\frac{4}{3} - (x-1)^2\right) = 6$

$2x^2 + 4 - 3(x^2 + 1 - 2x) = 6$

$x = 1, 5$

When $x = 1 \Rightarrow \frac{1}{3} + \frac{y^2}{2} = 1 \Rightarrow y^2 = \frac{4}{3} \Rightarrow y = \pm\frac{2}{\sqrt{3}}$

Hence $P\left(1, \frac{2}{\sqrt{3}}\right), Q\left(1, -\frac{2}{\sqrt{3}}\right) \Rightarrow PQ^2 = \frac{16}{3}$

When $x = 5 \Rightarrow \frac{y^2}{2} = 1 - \frac{25}{3} = -\frac{22}{3} \Rightarrow$ not possible

$PQ^2 = \frac{16}{3}$

11. The statement $(p \to q) \wedge (p \to \sim q)$ is logically equivalent to:

(1) p (2) q (3) $\sim$ p (4) $\sim$ q

Ans. **(3)**

Sol. $= (p \to q) \wedge (p \to \sim q)$

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

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

12. In class 10th, 11th and 12th of a school there are 5, 6 and 8 students respectively. The number of ways of selection of 10 students such that at least two students are selected from each of the classes and at most 5 students together can be selected from class 10th & 11th are k × 100 then the value of k is.

Ans. 238

Sol.

Total student	(5)	(6)	(8)		
Class	10^{th}	11^{th}	12^{th}		
	2	2	6	→	$5_{C_2} \times 6_{C_2} \times 8_{C_6}$
	2	3	5	→	$5_{C_2} \times 6_{C_3} \times 8_{C_5}$
	3	2	5	→	$5_{C_3} \times 6_{C_2} \times 8_{C_5}$

Total number of ways $= 5_{C_2} \times 8_{C_3}\left(6_{C_3} + 6_{C_2}\right) + 5_{C_2} \times 6_{C_2} \times 8_{C_6}$

$= 23800$

13. If $\left(1+\frac{2}{3}+\frac{6}{3^2}+\frac{10}{3^3}+.....+\infty\right)^{\log_{0.25}\left(\frac{1}{3}+\frac{1}{3^2}+\frac{1}{3^3}+...\right)}$ is ℓ then ℓ^2 is

Ans. (3)

Sol. $\left(1+\frac{2}{3}+\frac{6}{3^2}+\frac{10}{3^3}+.....\right)^{\log_{0.25}\left(\frac{1}{3}\left(\frac{1}{\left(\frac{2}{3}\right)}\right)\right)} = \ell$

$\left(1+\frac{2}{3}+\frac{6}{3^2}+\frac{10}{3^3}+.....\right)^{\log_{\frac{1}{4}}\frac{1}{2}} = \ell$

Let $1+\frac{2}{3}+\frac{6}{3^2}+\frac{10}{3^3}+..... = x$

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

$\frac{1}{3}(x-1) = \frac{2}{3^2}+\frac{6}{3^3}+.....$ .... (2)

From (1) – (2), we get

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

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

$\frac{2}{3}(x-1) = \frac{2}{3}+\frac{4}{3^2}\frac{3}{2}$,

$\frac{2}{3}(x-1) = \frac{2}{3}+\frac{2}{3}$

$x - 1 = 2$ & $x = 3$

$\log_{\frac{1}{2}}$

$3^2 = \ell$

$\ell^2 = 3$

14. A hyperbola with equation $\frac{(x-1)^2}{16}-\frac{(y+2)^2}{9} = 1$ is given. A triangle is formed with two vertices as the focus of the hyperbola and third vertex lies on hyperbola. The locus of centroid of the triangle is:

(1) $16(x-1)^2 - 9(y+2)^2 = 16$ (2) $9(x-1)^2 - 16(y+2)^2 = 16$

(3) $9(x-1)^2 + 16(y+2)^2 = 16$ (4) $16(x-1)^2 + 9(y+2)^2 = 16$

Ans. (2)

Sol. Given $\frac{(x-1)^2}{16}-\frac{(y+2)^2}{9} = 1$

Let $x - 1 = X$

$y + 2 = Y$

$$\frac{X^2}{16}-\frac{Y^2}{9}=1$$

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$b^2 = a^2(e^2-1) \Rightarrow \frac{9}{16} = e^2-1 \Rightarrow e = \frac{5}{4}$

Focus $(\pm ae, 0) \Rightarrow X = \pm ae, \quad Y = 0$

Hence focus S(–4, –2), S'(6, –2)

Let any point on hyperbola $x-1 = 4\sec\theta$, $y+2 = 3\tan\theta \Rightarrow P(1+4\sec\theta, -2+3\tan\theta)$

Hence centroid is $\equiv \left(\frac{-4+6+1+4\sec\theta}{3}, \frac{-2-2-2+3\tan\theta}{3}\right)$

$h = \frac{3+4\sec\theta}{3} \Rightarrow \sec\theta = \frac{3h-3}{4}$

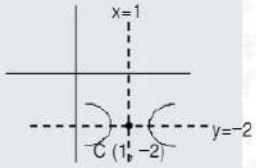
$k = \frac{-6+3\tan\theta}{3} \Rightarrow \tan\theta = k+2$

$\sec^2\theta - \tan^2\theta = 1$

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

Locus is $\frac{9(x-1)^2}{16} - \frac{(y+2)^2}{1} = 1$

$\Rightarrow 9(x-1)^2 - 16(y+2)^2 = 16$



15. Evaluate $\int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{dx}{1+\sqrt[3]{\tan 2x}}$:

(1) $\frac{\pi}{24}$ (2) $\frac{\pi}{4}$ (3) $\frac{\pi}{12}$ (4) $\frac{\pi}{6}$

Ans. (3)

Sol. $\int_a^b f(x)dx = \int_a^b f(a+b-x)dx$

$$I = \int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{dx}{1+\sqrt[3]{\tan 2x}} \quad .....(1)$$

By property

$$I = \int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{dx}{1+\sqrt[3]{\cot 2x}}$$

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$I = \int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \sqrt[3]{\tan 2x}\, dx$ .....(2)

By adding (1) & (2)

$$2I = \int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{(1+\sqrt[3]{\tan 2x})\, dx}{1+\sqrt[3]{\tan 2x}}$$

$$2I = \int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} dx = \frac{\pi}{6}$$

$\therefore I = \frac{\pi}{12}$

16. If a set of matrix $M = \left\{\begin{pmatrix} a & b \\ c & d \end{pmatrix} : a,b,c,d \in \{\pm 1, \pm 2, \pm 3\}\right\}$ and $A \in M$ then the number of such matrices A whose determinant value is 15.

Ans. **(16)**

Case – I $ad = 9$ & $bc = -6$

$ad = (3,3)$ or $(-3,-3)$ $bc = (2,-3), (-2,3), (-3,2), (3,-2)$

Total $= 2 \times 4 = 8$ matrix

Case – II $ad = 6$ and $bc = -9$

Similarly, Total $= 4 \times 2 = 8$ matrix

Total such matrix $= 8 + 8 = 16$ matrix

17. If $\frac{dy}{dx} = 1 + xe^{y-x}$, $-\sqrt{2} < x < \sqrt{2}$ and $y(0) = 0$ then minimum value of y is

(1) $(1-\sqrt{3}) - \ell n(\sqrt{3}-1)$ (2) $(1+\sqrt{3}) - \ell n(\sqrt{3}-1)$

(3) $(1-\sqrt{3}) - \ell n(\sqrt{3}+1)$ (4) $(1+\sqrt{3}) - \ell n(\sqrt{3}+1)$

Ans. (1)

Sol. $\frac{dy}{dx} = 1 + xe^{y-x}$ .....(1)

$e^{-y}\frac{dy}{dx} = e^{-y} + xe^{-x}$

Put $e^{-y} = t \Rightarrow e^{-y}\frac{dy}{dx} = -\frac{dt}{dx}$

$= t + x$

I.F. $= e^{\int 1.dx} = e^x$

Solution of equation (2) is

$te^x = \int (-xe^{-x}).e^x dx + c$

$te^x = -\frac{x^2}{2} + c$

$e^{x-y} = -\frac{x^2}{2} + c$ .....(3)

$\therefore$ $y(0) = 0 \Rightarrow 1 = c \Rightarrow e^{x-y} = \left(\frac{2-x^2}{2}\right)$

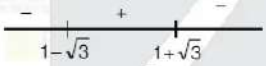
$x - y = \ell n\left(\frac{2-x^2}{2}\right)$

$y = x - \ell n\left(\frac{2-x^2}{2}\right)$

Now, $\frac{dy}{dx} = 1 + x\left(\frac{2}{2-x^2}\right)$

$\Rightarrow -\left(\frac{x^2-2x-2}{2-x^2}\right) = 0$

$x = 1 \pm \sqrt{3}$



$\Rightarrow y_{min}$ at $x = 1 - \sqrt{3}$ $\Rightarrow y_{min} = (1-\sqrt{3}) - \ell n(\sqrt{3}-1)$

18. A balloon with radius 16 cm is at a certain height above the ground such that the angle of elevation of its centre is 75° from a point on the ground. if the balloon subtends an angle of 60° at that point, then the height of its topmost point from the ground is:

(1) $8\left(\sqrt{6}-\sqrt{2}+2\right)$ (2) $8\left(\sqrt{6}-2\sqrt{2}+2\right)$

(3) $8\left(\sqrt{6}+\sqrt{2}+2\right)$ (4) $8\left(\sqrt{6}-2\sqrt{2}+2\right)$

Ans. (3)

Sol. In triangle EOD

$ED = \frac{16}{\tan 30^\circ} = 16\sqrt{3}$

$DF = 16\sqrt{3}$

Now in Δ DFC'

$C'F = 16\sqrt{3}.\sin 45^\circ$

$= 16\sqrt{3}.\frac{1}{\sqrt{2}} = 8\sqrt{6}$

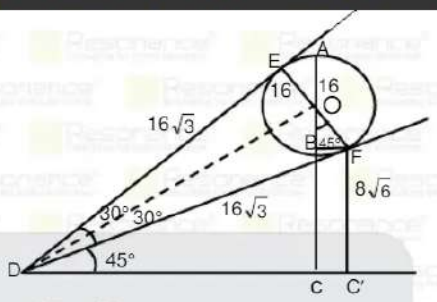
$CB = 8\sqrt{6}$

In Δ^{le} OBF

$OB = 16\sin 45^\circ$

$= \frac{16}{\sqrt{2}} = 8\sqrt{2}$

Height of top most point $= 8\sqrt{6} + 8\sqrt{2} + 16 = 8\left(\sqrt{6}+\sqrt{2}+2\right)$



19. If $S = \{n : n \in N \text{ and } 1 \le n \le 100, \begin{bmatrix} 1 & 0 \\ i & 0 \end{bmatrix} \begin{bmatrix} a & b \\ c & d \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \forall\ a,b,c,d \in R\}$ then the number of 2 digit numbers in S is

(1) 25 (2) 22 (3) 24 (4) 20

Ans. (2)

Sol. Let $A = \begin{bmatrix} 0 & i \end{bmatrix}^n$ and $B = \begin{bmatrix} a & b \end{bmatrix}$

Sol. Let $A = \begin{bmatrix} i & 0 \end{bmatrix}$ and $B = \begin{bmatrix} c & d \end{bmatrix}$

$AB = IB$

$(A - I)B = 0$

$A = I$

$\begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}^n = I$

$A^4 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

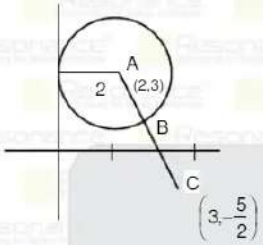
20. If $|z - (3i + 2)| < 2$ then the min value of $|2z - 6 + 5i|$ is

(1) $(5\sqrt{5} - 2)$ (2) $(5\sqrt{5} - 4)$ (3) $(5\sqrt{5} + 2)$ (4) $\left(\frac{5\sqrt{5}}{2} + 2\right)$

Ans. (2)

Sol. $|(x - 2) + (y - 3)i| < 2$

Point A (2,3) and radius = 2



$|(2x - 6) + (2y + 5)i|$

$x = 3$

5

point C $\left(3, -\frac{5}{2}\right)$

$AC = \sqrt{(3-2)^2 + \left(-\frac{5}{2} - 3\right)^2}$

$= \sqrt{1 + \frac{121}{4}}$

$= \sqrt{\frac{125}{4}}$

Min distance $2BC = 2\left(\frac{5\sqrt{5}}{2} - 2\right) = (5\sqrt{5} - 4)$

21. Let $\vec{p}=(3\hat{i}+2\hat{j}+\hat{k})$, $\vec{q}=(2\hat{i}+\hat{j}+\hat{k})$ and $\vec{r}$ is perpendicular to both $\vec{p}+\vec{q}$ and $\vec{p}-\vec{q}$ such that $|\vec{r}|=\sqrt{3}$. If $\vec{r}=(a\hat{i}+b\hat{j}+c\hat{k})$, then the value of $|a|+|b|+|c|$ is :

(1) 0 (2) 1 (3) 3 (4) 6

Ans. **(3)**

Sol. $(\vec{p}+\vec{q})\times(\vec{p}-\vec{q})=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\5&3&2\\1&1&0\end{vmatrix}=-2\hat{i}+2\hat{j}+2\hat{k}$

$$\vec{r}=\pm\sqrt{3}\frac{((\vec{p}+\vec{q})\times(\vec{p}-\vec{q}))}{|(\vec{p}+\vec{q})\times(\vec{p}-\vec{q})|}$$

$$=\pm(-\hat{i}+\hat{j}+\hat{k})$$

$|a|+|b|+|c|=3$