MENIIT
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JEE MAIN-2021

COMPUTER BASED TEST (CBT)

DATE : 26-08-2021 (EVENING SHIFT) | TIME : (3.00 pm to 6.00 pm)

Duration 3 Hours | Max. Marks : 300

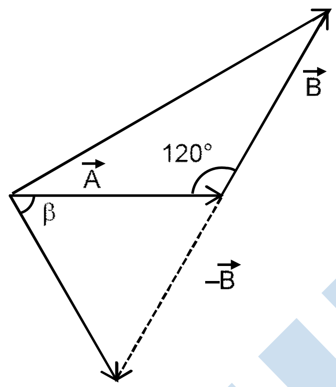
QUESTION & SOLUTIONS

PART A : PHYSICS

Single Choice Type

This section contains **20 Single choice questions**. Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

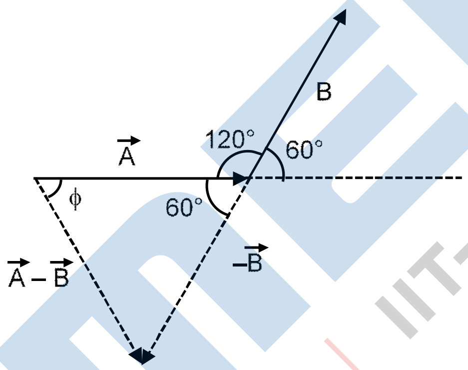
1. The angle between vector $\vec{A}$ and $\vec{A}$ $\vec{B}$ is :



(1) $\tan^{1}\frac{A}{0.7B}$ (2) $\tan^{1}\frac{\frac{B}{2}}{A\quad B\frac{\sqrt{3}}{2}}$ (3) $\tan^{1}\frac{\sqrt{3}B}{2A\quad B}$ (4) $\tan^{1}\frac{B\cos}{A\quad B\sin}$

Ans. (3)

Sol.



$$\tan \quad \frac{B\sin 60}{A \quad B\cos 60}$$

$$\tan^{1}\frac{B\sin 60}{A \quad B\cos 60} \qquad \tan \quad \frac{\sqrt{3}B}{2A \quad B}$$

2. The temperature of equal masses of three different liquids x, y and z are 10ºC, 20ºC and 30ºC respectively. The temperature of mixture when x is mixed with y is 16°C and that when y is mixed with z is 26ºC. The temperature of mixture when x and z are mixed will be :

(1) 20.28ºC (2) 25.62ºC (3) 23.84ºC (4) 28.32ºC

Ans. (3)

Sol. When A & B are mixed

$m_1 S_1 (16 - 10) = m_2 S_2 (20 - 16)$

$6m_1 S_1 = 4m_2 S_2$ ....(1)

When B & C are mixed

$m_2 S_2 (26 - 20) = m_3 S_3 (30 - 26)$

$6m_2 S_2 = 4m_3 S_3$ ....(2)

From equation (1) and (2)

$9m_1 S_1 = 4m_3 S_3$

When A & C are mixed

$m_1 S_1 (T - 10) = m_3 S_3 (30 - T)$

$$T \quad \frac{30m_3S_3 \quad 10m_1S_1}{m_1S_1 \quad m_3S_3}$$

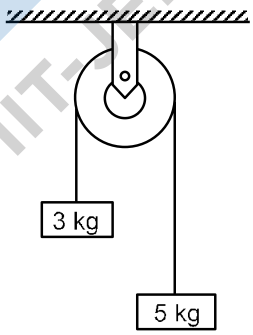
$$T \quad \frac{10(3m_3S_3 \quad m_1S_1)}{m_3S_3 \quad m_1S_1}$$

$$T \quad \frac{10(3m_3S_3 \quad \frac{4}{9}m_3S_3)}{m_3S_3 \quad \frac{4}{9}m_3S_3}$$

$$T \quad \frac{10 \quad 31}{13}$$

$= 23.84°C$

3. Two blocks of masses 3 kg are connected by a metal wire going over a smooth pulley. The breaking stress of the metal is $\frac{24}{\ }$ 10^2 Nm ^{2}. What is the minimum radius of the wire ? (take g = 10 ms^{-2})



(1) 1250 cm (2) 1.25 cm (3) 125 cm (4) 12.5 cm

Ans. (4)

Sol. Tension in the string $\frac{2m_1m_2}{(m_1 \quad m_2)}g$

$$\frac{2 \quad 3 \quad 5 \quad 10}{8} \quad \frac{75}{2}$$

Stress $\frac{T}{A}$

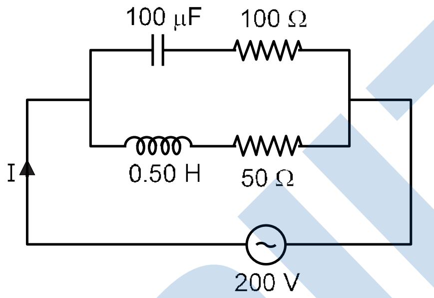
$\frac{24}{}\ 10^{\ 2}\ \frac{75}{2(\ r^2)}$

$r^2\ \frac{75}{48}\ 100$

$r^2\ \frac{25}{2}^{\ 2}$

R = 12.5

4. In the given circuit the AC source has ω = 100 rad s^{-1}. Considering the inductor and capacitor to be ideal, what will be the current I flowing through the circuit ?



(1) 0.94 A (2) 5.9 A (3) 4.24 A (4) 6 A

Ans. (Bonus) NTA given answer is (3)

Sol. $Z_C\ \sqrt{\frac{1}{\ C}^{\ 2}\ R^2}$

$\sqrt{\frac{1}{100\ \ 100\ \ 10^{\ 6}}^{\ 2}\ 100^2}$

$\sqrt{100^2\ \ 100^2}$

$100\sqrt{2}$

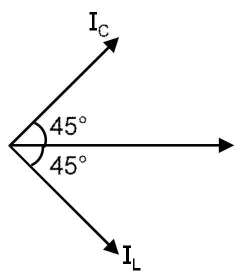
$Z_L\ \ \sqrt{(\ L)^2\ \ R^2}\ \ \sqrt{(100\ \ 0.5)^2\ \ 50^2}\ \ 50\sqrt{2}$

$i_L\ \ \frac{200}{Z_L}\ \ \frac{200}{50\sqrt{2}}\ \ \frac{4}{\sqrt{2}}\ 2\sqrt{2}$

$i_C\ \ \frac{200}{Z_C}\ \ \frac{200}{100\sqrt{2}}\ \ \sqrt{2}$

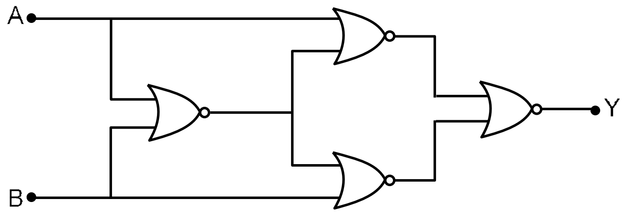
$\cos\ _1\ \ \frac{100}{100\sqrt{2}}\ \ \frac{1}{\sqrt{2}},\ \ _1\ \ 45$

$\cos\ _2\ \ \frac{50}{50\sqrt{2}}\ \ \frac{1}{\sqrt{2}},\ \ _2\ \ 45$



$I\ \ \sqrt{I_C^2\ \ I_L^2}\ ;\quad I\ \ \sqrt{8\ \ 2}\ ;\quad I\ \ \sqrt{10}\ A$

5. Four NOR gates are connected as shown in figure. The truth table for the given figure is :



(1)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

(2)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

(3)

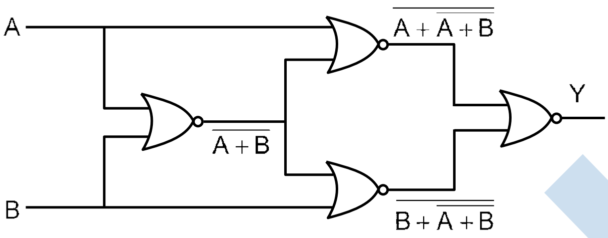
A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

(4)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

Ans. (1)

Sol.

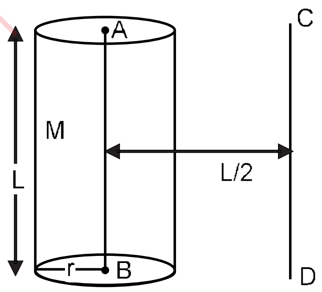


$y \quad \overline{\overline{(A \quad \overline{A \quad B})} \quad \overline{(B \quad \overline{A \quad B})}}$

$y \quad (A \quad \overline{A \quad B})\ (B \quad \overline{A \quad B})$

A	B	Y
0	0	1
1	1	1
0	1	0
1	0	0

6. The solid cylinder of length 80 cm and mass M has a radius of 20 cm. Calculate the density of the material used if the moment of inertia of the cylinder about an axis CD parallel of AB as shown in figure is 2.7 kg m^2.



(1) 7.5×10^2 kg/m^3 (2) 7.5×10^1 kg/m^3 (3) 14.9 kg/m^3 (4) 1.49×10^2 kg/m^3

Ans. (4)

Sol. $I \quad \frac{Mr^2}{2} \quad MI^2 \quad \frac{(\ r^2)\ell r^2}{2} \qquad r^2\ell\ \frac{\ell^2}{4}$

$r^2\ell\ \frac{r^2}{2}\ \ \frac{\ell^2}{4}$

$\frac{I}{r^2\ell\ \frac{r^2}{2}\ \ \frac{\ell^2}{4}}$

On putting the values $\rho = 1.49 \times 10^2$ Kg/m^3.

7. light beam is described by E = 800 sin $\ t\ \ \frac{x}{c}$. An electron is allowed to move normal to the propagation of light beam with a speed of 3×10^7. What is the maximum magnetic force exerted on the electron ?

(1) 1.28×10^{-21} N (2) 1.28×10^{-18} N (3) 12.8×10^{-18} N (4) 12.8×10^{-17} N

Ans. (3)

Sol. $E_0 = 800$

$B_0 \quad \frac{E_0}{C} \quad \frac{800\,V/m}{3 \quad 10^8}$

$F_m \quad q\ B_0 \quad \frac{1.6 \quad 10^{\ 19} \quad 3 \quad 10^7 \quad 800}{3 \quad 10^8}$

$= 12.8 \times 10^{-18}$ Newton

8. Match List – I with List – II :

List – I	List – II
(a) Magnetic Induction	(i) $ML^2T^{-2}A^{-1}$
(b) Magnetic Flux	(ii) $M^0L^{-1}A$
(c) Magnetic Permeability	(iii) $MT^{-2}A^{-1}$
(d) Magnetization	(iv) $MLT^{-2}A^{-2}$

Choose the most appropriate answer form the options given below :

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

Ans. (2)

9. A cylindrical container of volume 4.0×10^{-3} m^3 contains one mole of hydrogen and two moles of carbon dioxide. Assume the temperature of the mixture is 400 K. The pressure of the mixture of gases is :

[Take gas constant as 8.3 J mol^{-1} K^{-1}]

(1) 249×10^1 Pa (2) 24.9 Pa (3) 24.9×10^5 Pa (4) 24.9×10^3 Pa

Ans. (3)

Sol. For gas A

$P_AV = n_ART$

$P_A \quad \frac{(1)RT}{V}$

for gas B

$P_BV = n_BRT$

$P_B \quad \frac{(2)RT}{V}$

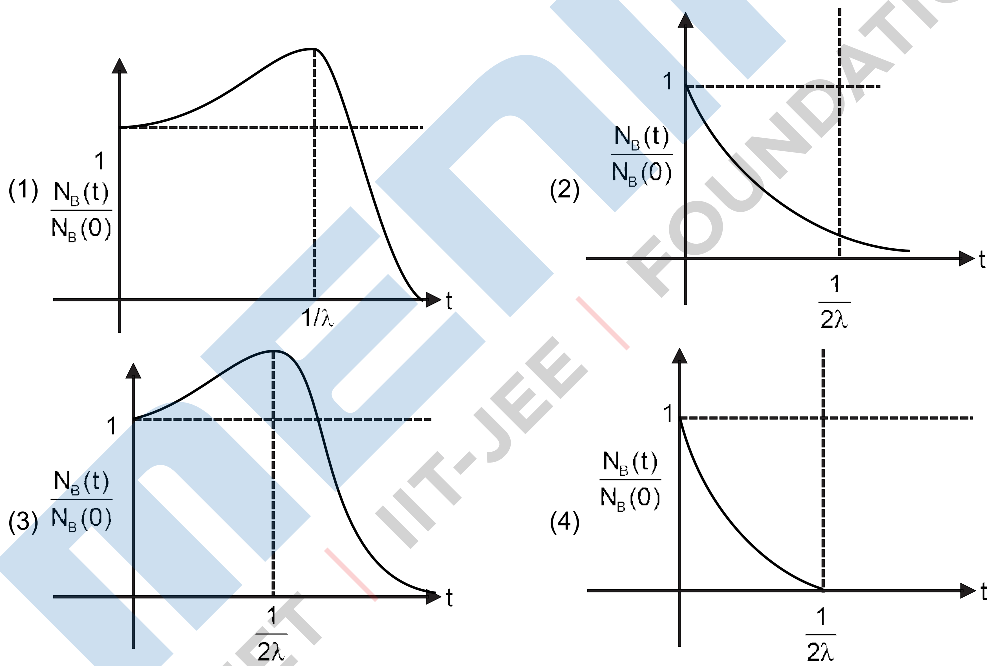
$P = P_A + P_B$

$\frac{3RT}{V} \quad \frac{3 \quad 8.314(400)}{4 \quad 10^{3}} \quad 24.9 \quad 10^{5}$ Pa

10. At time t = 0, material is composed of two radioactive atoms A and B, where $N_A(0) = 2N_B(0)$. The decay constant of both kind of radioactive atoms is λ. However, A disintegrates to B and B disintegrates to C. Which of the following figures represents the evolution of $N_B(t)/N_B(0)$ with respect to time t ?

$N_A(0)$ No. of A atom satt 0

$N_B(0)$ No. of B atom satt 0



Ans. (3)

Sol. Rate at which nucle of B is forming

$\frac{dN_B}{dt} \quad N_A \quad N_B \quad | \quad N_A \quad N_A^0 e^{\ t}$

$\frac{dN_B}{dt} \quad N_A^0 e^{\ t} \quad N_B$

$\frac{dN_B}{dt} \quad N_B \quad N_A^0 e^{\ t}$

$$\frac{dN_B}{dt} \quad N_A^0 e^{\ \ t} \quad XN_B$$

11. A bomb is dropped by a fighter plane flying horizontally. To an observer sitting in the plane, the trajectory of the bomb is a :

(1) hyperbola

(2) straight line vertically down the plane

(3) parabola in a direction opposite to the motion of plane

(4) parabola in the direction of motion of plane

Ans. (2)

Sol. Horizontal component of velocity of bomb & fighter jet are same

So, bomb will remains just below the jet, path is straight line w.r.t. pilot.

12. The de-Broglie wavelength of a particle having kinetic energy E is λ. How much extra energy must be given to this particle so that the de-Broglie wavelength reduces to 75% of the initial value ?

(1) E (2) $\frac{7}{9}E$ (3) $\frac{16}{9}E$ (4) $\frac{1}{9}E$

Ans. (2)

Sol. $E \quad \frac{1}{\ \ ^{2}}$

$E_0 \quad \frac{k}{\ \ ^{2}}$

$E_1 \quad \frac{16k}{9\ \ ^{2}}, \quad E \quad \frac{7}{9}E$

13. The two thin coaxial rings, each of radius 'a' and having charges +Q and –Q respectively are separated by a distance of 's'. The potential difference between the centres of the two ring is :

(1) $\frac{Q}{4\ \ _0}\ \frac{1}{a}\ \frac{1}{\sqrt{s^2\ \ a^2}}$ (2) $\frac{Q}{2\ \ _0}\ \frac{1}{a}\ \frac{1}{\sqrt{s^2\ \ a^2}}$

(3) $\frac{Q}{4\ \ _0}\ \frac{1}{a}\ \frac{1}{\sqrt{s^2\ \ a^2}}$ (4) $\frac{Q}{2\ \ _0}\ \frac{1}{a}\ \frac{1}{\sqrt{s^2\ \ a^2}}$

Ans. (2)

Sol. $V_1 \quad \frac{KQ}{a} \quad \frac{KQ}{\sqrt{s^2\ \ a^2}}$

$V_2 \quad \frac{KQ}{\sqrt{s^2\ \ a^2}} \quad \frac{KQ}{a}$

$V_1 \quad V_2 \quad \frac{Q}{2\ \ _0}\ \frac{1}{a}\ \frac{1}{\sqrt{s^2\ \ a^2}}$

14. A transmitting antenna at top of a tower has a height of 50 m and the height of receiving antenna is 80m. What is the range of communication for Lin of Sight (LoS) mode ?

[use radius of earth = 6400 km]

(1) 80.2 km (2) 57.28 km (3) 144.1 km (4) 45.5 km

Ans. (2)

Sol. Range $\sqrt{2Rh_1}$ $\sqrt{2Rh_2}$

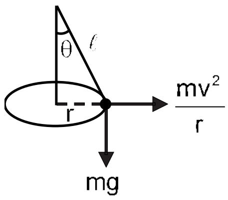
Putting values range = 57.28 km

15. particle of mass m is suspended from a celling through a string of length L. The particle moves in a horizontal circle of radius r such that r $\frac{L}{\sqrt{2}}$. The speed of particle will be :

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

Ans. (4)

Sol.



sin $\frac{1}{\sqrt{2}}$

$\theta = 45°$

tan $\frac{\frac{mv^2}{r}}{mg}$ $\frac{v^2}{Rg}$ 1

$v^2 = rg$

v $\sqrt{rg}$

16. If you are provided a set of resistances 2Ω, 4Ω, and 8Ω. Connect these resistances so as to obtain an equivalent resistance of $\frac{46}{3}$

(1) 2Ω and 4Ω are in parallel with 6Ω and 8Ω in series

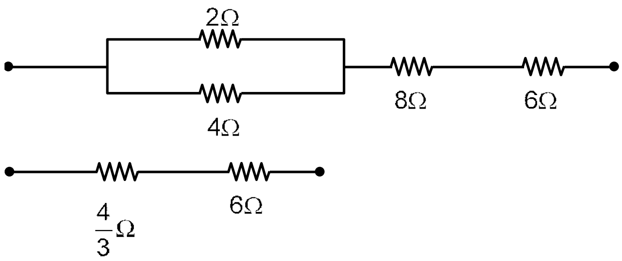
(2) 6Ω and 8Ω are in parallel with 2Ω and 4Ω in series

(3) 2Ω and 6Ω are in parallel with 4Ω and 8Ω in series

(4) 4Ω and 6Ω are in parallel with 2Ω and 8Ω in series

Ans. (1)

Sol.



$R_{eq}\quad \frac{4}{3}\quad 14\quad \frac{46}{3}$

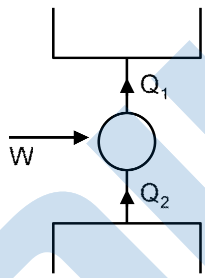
17. A refrigerator consumes an average 35 W power to operate between temperatures – 10ºC to 25ºC. If there is no loss of energy then how much average heat per second does it transfer?

(1) 263 J/s (2) 298 J/s (3) 350 J/s (4) 35 J/s

Ans. (1)

Sol. $W + Q_2 = Q_1$

$W = Q_1 - Q_2$



$\frac{Q_2}{W}\quad \frac{Q_2}{Q_1\quad Q_2}$

$\frac{Q_2}{W}\quad \frac{T_2}{T_1\quad T_2}$

$\frac{Q_2}{35}\quad \frac{263}{298\quad 263}$

$Q_2 = 263$ J/s

18. If the length of the pendulum in pendulum clock increases by 0.1%, then the error in time per day is :

(1) 43.2 s (2) 8.64 s (3) 4.32 s (4) 86.4 s

Ans. (1)

Sol. $T\quad 2\sqrt{\frac{\ell}{g}}$

$T \propto \ell_{1/2}$

$\frac{t}{t}\quad \frac{1}{2}\frac{\ell}{\ell}$

$\frac{t}{24\quad 3600}\quad \frac{1}{2}\frac{0.1}{100}$

$t\quad \frac{1}{2}\frac{0.1}{100}\quad 24\quad 3600$

$\Delta t = 43.2$ sec

19. An electric bulb of 500 watt at 100 volt is used in a circuit having a 200 V supply. Calculate the resistance R to be connected in series with the bulb so that the power delivered by the bulb is 500 W.

(1) 10 Ω (2) 5 Ω (3) 30 Ω (4) 20 Ω

Ans. (4)

Sol. Resistance of bulb

$$P \quad \frac{v^2}{r}$$

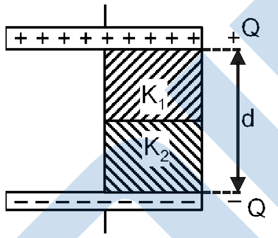
$$r \quad \frac{(100)^2}{500} \quad \frac{100 \quad 100}{500} \quad 20$$

$$i \quad \frac{P}{v} \quad \frac{500}{100} \quad 5\,A$$

ΔV in resistance R = 100 V

$$R \quad \frac{100}{5} \quad 20$$

20. A parallel-plate capacitor with plate area A has separation d between the plates. Two dielectric slabs of dielectric constant K_1 and K_2 of same area A/2 and thickness d/2 are inserted in the space between the plates. The capacitance of the capacitor will be given by :



(1) $\frac{{}_0A}{d} \quad \frac{1}{2} \quad \frac{2(K_1 \quad K_2)}{K_1K_2}$

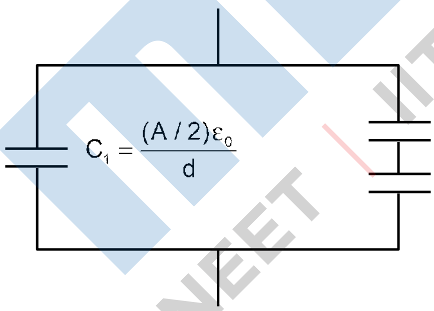
(2) $\frac{{}_0A}{d} \quad \frac{1}{2} \quad \frac{K_1 \quad K_2}{K_1K_2}$

(3) $\frac{{}_0A}{d} \quad \frac{1}{2} \quad \frac{K_1K_2}{K_1 \quad K_2}$

(4) $\frac{{}_0A}{d} \quad \frac{1}{2} \quad \frac{K_1K_2}{2(K_1 \quad K_2)}$

Ans. (3)

Sol.



$$C_2 = \frac{K_1(A/2)\varepsilon_0}{d/2} = \frac{k_1A\varepsilon_0}{d}$$

$$C_3 = \frac{K_2(A/2)\varepsilon_0}{d/2} = \frac{k_2A\varepsilon_0}{d}$$

$$C_{eq} \quad C_1 \quad \frac{C_2C_3}{C_2 \quad C_3}$$

$$C_{eq} \quad \frac{A \;\; {}_0}{2d} \quad \frac{\frac{K_1A \;\; {}_0}{d} \quad \frac{K_2A \;\; {}_3}{d}}{\frac{K_1A \;\; {}_0}{d} \quad \frac{K_2A \;\; {}_3}{d}}$$

$$C_{eq} \quad \frac{A \;\; {}_0}{2d} \quad \frac{A \;\; {}_0}{d} \quad \frac{K_1K_2}{K_1 \quad K_2} \qquad \frac{A \;\; {}_0}{d} \quad \frac{1}{2} \quad \frac{K_1K_2}{K_1 \quad K_2}$$

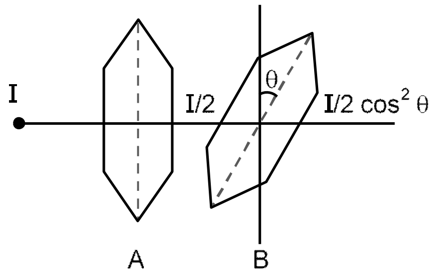
Numeric Value Type

This Section contains **10 Numeric Value Type question**, out of 10 only 5 have to be done.

1. A source of light is placed in front of a screen. Intensity of light on the screen is I. Two Polaroids P_1 and P_2 are so placed in between the source of light and screen that the intensity of light on screen is I/2. P_2 should be rotated by an angle of ________ (degrees) so that the intensity of light on the screen becomes 3I/8.

Ans. (30)

Sol.

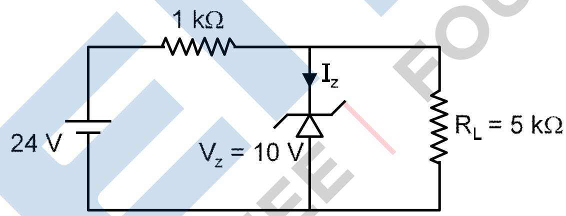


I' $\frac{I}{2}\cos^2$

$\frac{3I}{8}$ $\frac{I}{2}\cos^2$

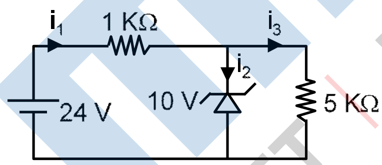
$\theta = 30°$

2. For the given circuit, the power across zener diode is ____________ mW.



Ans. (120)

Sol.



i_1 $\frac{14}{1}$ 14 mA

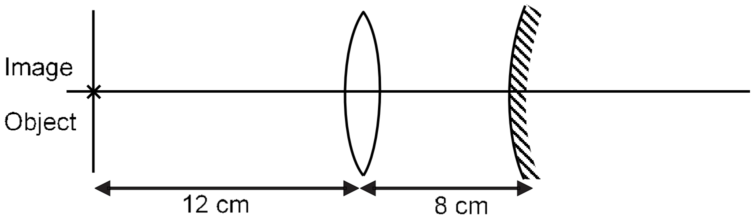
i_3 $\frac{10}{5}$ 2 mA

$i_2 = i_1 - i_3 = 12$ mA

Power consume in zerer diode

$= V \times i = 0.12$ W

3. An object Is placed at a distance of 12 cm from a convex lens. A convex mirror of focal length 15 cm is placed on other side of lens at 8 cm as shown in the figure. Image of object coincides with the object.



When the convex mirror is removed, a real and inverted image is formed at a position. The distance of the image from the object will be ___________ (cm).

Ans. (50)

Sol. Image object coincide

Image by lens must be on centre of curvature of mirror. Hence, distance between object and image after removing mirror = 12 + 8 + 30 = 50

4. A coil in the shape of an equilateral triangle of side 10 cm lies in a vertical place between the pole pieces of permanent magnet producing a horizontal magnetic field 20 mT. The torque acting on the coil when a current of 0.2 A is passed through it and its plane becomes parallel to the magnetic field will be $\sqrt{x} \quad 10^{5}$ Nm . The value of x is _________ .

Ans. (3)

Sol. $\quad \vec{M} \quad \vec{B}$

= IAB

$$0.2 \quad \frac{\sqrt{3}a^2}{4} \quad 2 \quad 10^{\ 2} \quad \frac{0.2 \quad \sqrt{3} \quad 10^{\ 2} \quad 2 \quad 10^{\ 2}}{4}$$

$$\sqrt{3} \quad 10^{\ 5}$$

5. Two simple harmonic motions are represented by the equations $x_1 \quad 5\sin\ 2\ t \quad \frac{}{4}$ and $x_2 \quad 5\sqrt{2}(\sin 2\ \ t \quad \cos 2\ \ t)$. The amplitude of second motion is __________ times the amplitude in first motion.

Ans. 2

Sol. $A_1 = 5$

$x_2 \quad 5\sqrt{2}[\sin 2\ \ t \quad \cos 2\ \ t]$

$x_2 \quad 10[\sin(2\ \ T \quad \frac{}{4})]$

$A_2 = 10$

$A_2 = 2A_1$

6. The acceleration due to gravity is found upto an accuracy of 4% on a planet. The energy supplied to a simple pendulum of known mass 'm to undertake oscillations of time period T is being estimated. If time period is measured to an accuracy of 3%, the accuracy to which E is known as __________ %.

Ans. 14

Sol. $T \quad 2 \sqrt{\frac{\ell}{g}}$

$\frac{g}{g} \quad \frac{2 \; T}{T} \quad \frac{L}{L}$

4 + 2 × 3 = 10%

$E \quad \frac{1}{2}m \quad {}^{2}A^{2} \quad \frac{1}{2}m\frac{g}{\ell}A^{2} \quad \frac{g}{g} \quad \frac{L}{L} \quad 4 \quad 10 \quad 14\%$

7. If the maximum value of acceleration potential provided by a radio frequency oscillator is 12 kV. The number of revolution made by a proton in cyclotron to achieve one sixth of the speed of light is ________.

[$m_p = 1.67 \times 10^{-27}$ kg, $e = 1.6 \times 10^{-19}$ C, Speed of light = 3×10^{8} m/s]

Ans. 543

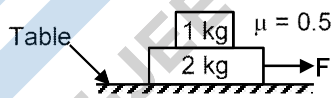
Sol. $2nev \quad \frac{1}{2}m \quad v^{2}$

$2n \quad 12 \quad 10^{3} \quad 1.6 \quad 10^{\;1} \quad \frac{1}{2} \quad 1.67 \quad 10^{\;27} \quad (5 \quad 10^{7})^{2}$

N = 543

8. The coefficient of static friction between two blocks is 0.5 and the table is smooth. The maximum horizontal force that can be applied to move the blocks together is __________ N.

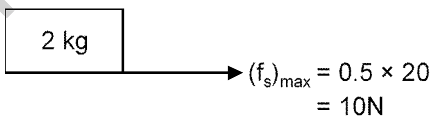
(take $g = 10\ ms^{-2}$)



Ans. 15

Sol. For Fmax with relative rest, f_s between

2 kg & 1 kg must be maximum.



$a_{comman} \leq a_{max}$

$\frac{F}{3} \quad \frac{10}{2}$

$F \leq 15$

9. A circular coil of radius 8.0 cm and 20 turns is rotated about its vertical diameter with an angular speed of 50 rad s^{-1} in a uniform horizontal field of 3.0×10^{-2} T. The maximum emf induced the coil will be ___________ $\times 10^{-2}$ volt

Ans. 60

Sol. Emf = BωNAsinωt

$Emf_{max} = B\omega NA = B\omega N(\pi R^2)$

$3 \quad 10^{\ 2} \quad 5 \quad 20 \quad \frac{64}{10^4} \quad 60 \quad 10^{\ 2}$ Volt

10. Two waves are simultaneously passing through a string and their equations are : $y_1 = A_1 \sin k(x - vt)$, $y_2 = A_2 \sin(x - vt + x_0)$. Given amplitudes A_1 = 12 mm and A_2 = 5 mm, x_0 = 3.5 cm and wave number k = 6.28 cm^{-1}. The amplitude of resulting, wave will be ____________ mm.

Ans. 7

Sol. $kx_0 \quad \frac{2}{\ } x_0 \quad 2 \quad 3.5 \qquad \frac{2}{k} \quad 1$

$2 \quad \frac{35}{10} \quad 7$

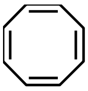
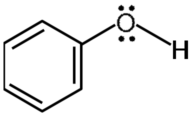
$A_R \quad \sqrt{12^2 \quad 5^2 \quad 2 \quad 12 \quad 5 \quad \cos(7 \quad)} \quad \sqrt{(12 \quad 5)^2} \quad 7$

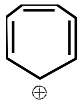
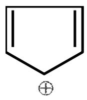
PART B : CHEMISTRY

Single Choice Type

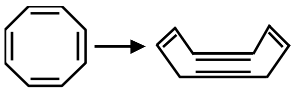
This section contains **20 Single choice questions**. Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

1. Which one of the following compounds is not aromatic?

(1) 
(2) 

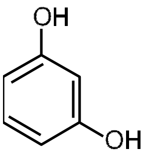
(3) 
(4) 

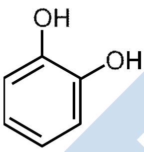
Ans. (1)

Sol. 

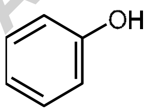
It exists as non-planar tab-shaped so it is non aromatic.

2. Which one of the following phenols does not give colour when condensed with phthalic anhydride in presence of conc. H_2SO_4?

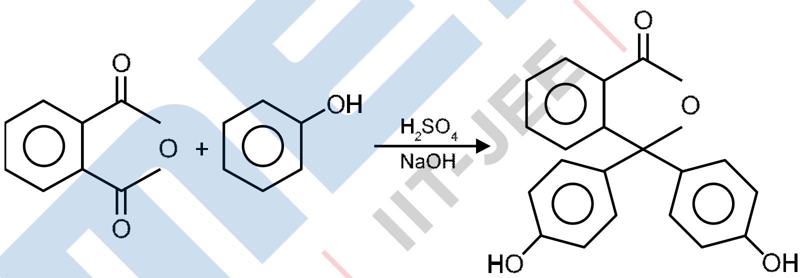
(1) 

(2) 

(3) 

(4) 

Ans. (3)

Sol. 

Pink colour
(derivative of phenolphthalein)

Phenol and its derivatives react at para position with phthalic anhydride. In p-cresol para position is blocked. So reaction not possible.

3. Chalcogen group elements are:

(1) O, Ti and Po (2) Se, Te and Po (3) Se, Tb and Pu (4) S, Te and Pm

Ans. (2)

Sol. Oxygen family also called as chalcogen family So, O, S, Se, Te, Po are chalcogen family member

4. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : Heavy water is used for the study of reaction mechanism.

Reason (R) : The rate of reaction for the cleavage of O-H bonds is slower than that of O–D bond.

Choose the most appropriate answer from the options given below:

(1) Both (A) and (R) are true but (R) is not the true explanation of (A).

(2) (A) is false but (R) is true.

(3) (A) is true but (R) is false.

(4) Both (A) and (R) are true and (R) is the true explanation of (A).

Ans. (3)

Sol. **Statement-1 :** D_2O is used as a moderator in nuclear reactor and in exchange reactions for the study of reaction mechanisms

Statement-2 : Bond energy of O–H < Bond energy of O–D.

So rate of reaction of cleavage of O-H bond is faster than that of O-D bond.

5. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : Sucrose is a disaccharide and a non-reducing sugar.

Reason (R) : Sucrose involves glycosidic linkage between C_1 of β-glucose and C_2 of α-fructose.

Choose the most appropriate answer from the options given below:

(1) (A) is true but (R) is false.

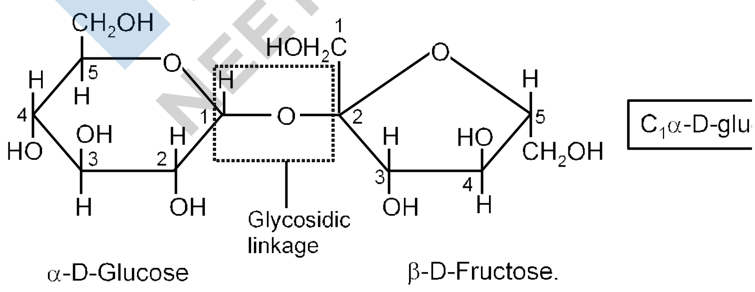
(2) Both (A) and (R) are true but (R) is not the true explanation of (A).

(3) (A) is false but (R) is true.

(4) Both (A) and (R) are true and (R) is the true explanation of (A).

Ans. (1)

Sol. In sucrose two monosaccharides are joined together by an oxide linkage formed by loss of water molecule. Such linkage through oxygen atom is called glycosidic linkage. In sucrose linkage in between C_1 of α-glucose and C_2 of β-fructose. Since the reducing group of glucose & fructose are involved in glycosidic bond formation, sucrose is non reducing sugar.



6. The bond order and magnetic behavior of O_2 ion are, respectively:

(1) 2 and diamagnetic.
(2) 1.5 and paramagnetic.
(3) 1 and paramagnetic.
(4) 1.5 and diamagnetic.

Ans. (2)

Sol. O_2 (Total electron = 17) {Bond order = 1.5, Paramagnetic}

$1s^2, \; *1s^2, \; 2s^2, \; *2s^2, \; 2P_z^2, \; 2P_z^2 \quad 2P_y^1, \; *2P_x^2 \quad *2P_y^1, \; *2P_z^0$

Number of unpaired electron = 1

so it is paramagnetic

Bond order $\frac{n_b \quad n_a}{2} \quad \frac{10 \quad 7}{2} \quad 1.5$ b

7. Given below are two statements:

Statements I : Sphalerite is a sulphide ore of zinc and copper glance is a sulphide ore of copper.

Statements II : It is possible to separate two sulphide ores by adjusting proportion of oil to water or by using 'depressants' in a froth flotation method.

Choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are true
(2) Statement I is true but Statement II is false.
(3) Statement I is false but Statement II is true.
(4) Both Statement I and Statement II are false.

Ans. (1)

Sol. Sphelarite ZnS

Copper glance Cu_2S

it is possible to separate two sulphide ores by adjusting proportion of oil to water or by using ‘depressants’. For example, in case of an ore containing ZnS and PbS, the depressant used is NaCN. It selectively prevents ZnS from coming to the froth but allows PbS to come with the froth.

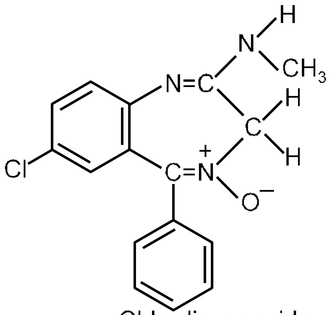
8. The interaction energy of London forces between two particles is proportional to r^x, where r is the distance between the particles. The value of x is:

(1) 6
(2) –6
(3) –3
(4) 3

Ans. (2)

Sol. In London force interaction energy is inversely proportional the sixth power of the distance between two interacting particles $\frac{1}{r^6}$

9.



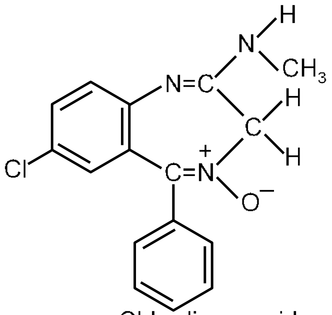
Chlordiazepoxide

The class of drug to which chlordiazepoxide with above structure belongs is:

(1) Analgesic (2) Tranquilizer (3) Antibiotic (4) Antacid

Ans. (2)

Sol.



Chlordiazepoxide

Belongs to tranquilizer drug.

10. Arrange the following Cobalt complexes in the order of increasing Crystal Field Stabilization Energy (CFSE) value.

Complexes : $\underset{A}{[CoF_6]^3}$,$\underset{B}{[Co(H_2O)_6]^2}$,$\underset{C}{[Co(NH_3)_6]^3}$ and $\underset{D}{[Co(en)_6]^3}$

Choose the correct option:

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

Ans. (4)

Sol. CFSE $\propto$ strength of ligand

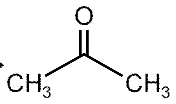
en > NH_3 > H_2O > F^-

CFSE $\propto$ oxidation number of central metal.

$\therefore$ Order of CFSE $[\overset{2}{Co}(H_2O)_6]^2$ $[\overset{3}{Co}F_6]^3$ $[\overset{3}{Co}(NH_3)_6]^3$ $[\overset{3}{Co}(en)_6]^3$

11. Match List-I with List-II.

List-I		List-II	
(Chemical Reaction)		(Reagent used)	
(a)	$CH_3COOCH_2CH_3 \longrightarrow CH_3CH_2OH$	(i)	CH_3MgBr/H_3O+ (1 equivalent)
(b)	$CH_3COOCH_3 \longrightarrow CH_3CHO$	(ii)	H_2SO_4/H_2O
(c)	$CH_3 \equiv N \longrightarrow CH_3CHO$	(iii)	$DI^*BAL\text{-}H/H_2O$

(d)	$CH_3C\equiv N \longrightarrow$ 	(iv)	$SnCl_2$, HCl/H_2O

Choose the most appropriate match.

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

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

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

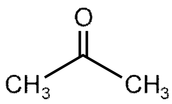
(4) (a) – (ii), (b) – (iv), (c) – (iii), (d)- (i)

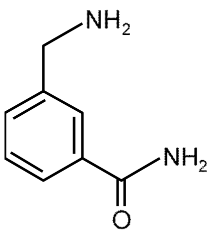
Ans. (2)

Sol. (a) $CH_3COOCH_2CH_3$ $\quad {}^{H_2SO_4/H_2O}\quad$ CH_3CH_2OH (Hydrolysis of ester)

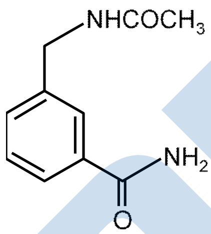
(b) CH_3COOCH_3 $\quad {}^{DI^{*}BAL\ \ H}\quad$ CH_3CHO (Reduction of ester)

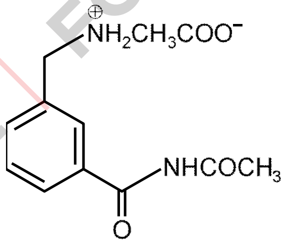
(c) CH_3 N $\quad {}^{SnCl_2,HCl/H_2O}\quad$ CH_3CHO (Reduction followed by hydrolysis)

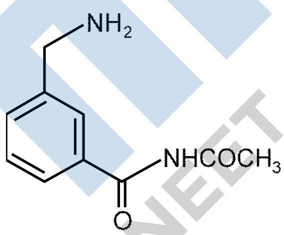
(d) $CH_3C\equiv N \xrightarrow{CH_3MgBr\ /\ H_3O^+}$  (Nucleophillic addition reaction)

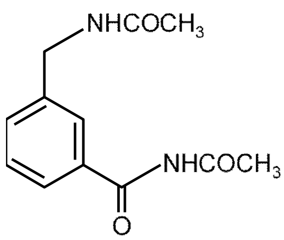
12.  $\xrightarrow{(CH_3CO)_2O}$ P (Major Product)

The major product in the above reaction is:

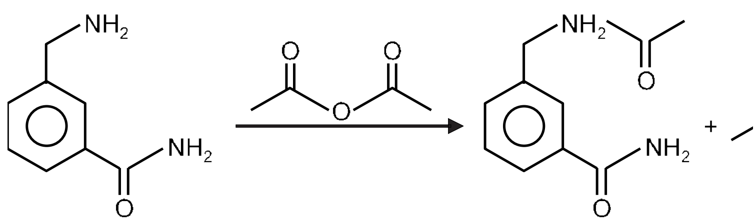
(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. 

since $-CH_2-NH_2$ is more r

13. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : Barium carbonate is insoluble in water and is highly stable.

Reason (R) : The thermal stability of the carbonates increases with cationic size.

Choose the most appropriate answer from the options given below:

(1) Both (A) and (R) are true but (R) is the true explanation of (A).

(2) Both (A) and (R) are true and (R) is not the true explanation of (A).

(3) (A) is false but (R) is true.

(4) (A) is true but (R) is false.

Ans. (1)

Sol. $BeCO_3$ $MgCO_3$ $CaCO_3$ $SrCO_3$ $BaCO_3$

(i) Stability ↑ as size of cation ↑, ionic character ↑

(ii) Solubility in water ↓

14. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : Photochemical smog causes cracking of rubber.

Reason (R) : Presence of ozone, nitric oxide, acrolein, formaldehyde and peroxyacetyl nitrate in photochemical smog makes it oxidizing.

Choose the most appropriate answer from the options given below:

(1) (A) is false but (R) is true.

(2) Both (A) and (R) are true but (R) is not the true explanation of (A).

(3) (A) is true but (R) is false.

(4) Both (A) and (R) are true and (R) is the true explanation of (A).

Ans. (4)

Sol. Photochemical smog has high concentration of oxidising agents and is, therefore, called as oxidising smog.

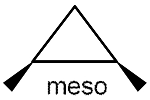
The common components of photochemical smog are ozone, nitric oxide, acrolein, formaldehyde and peroxyacetyl nitrate (PAN). Photochemical smog causes serious health problems. Both ozone and PAN act as powerful eye irritants. Ozone and nitric oxide irritate the nose and throat and their high concentration causes headache, chest pain, dryness of the throat, cough and difficulty in breathing.

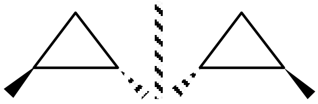
Photochemical smog leads to cracking of rubber and extensive damage to plant life. It also causes corrosion of metals, stones, building materials, rubber and painted surfaces.

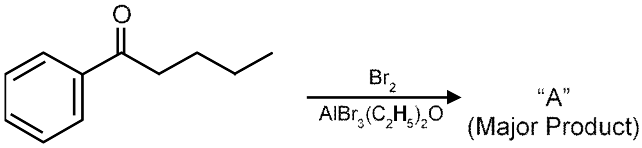
15. The number of stereoisomers possible for 1,2-dimethyl cyclopropane is:

(1) Three (2) Two (3) Four (4) One

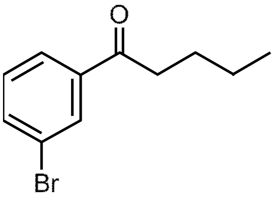
Ans. (1)

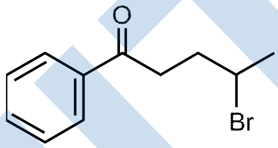
Sol. (i) 

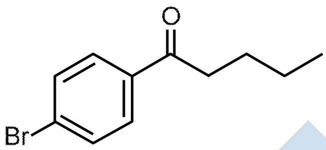
(ii) 

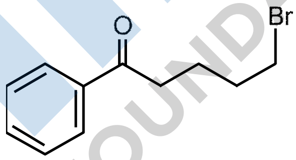
16. 

Consider the given reaction the product A is:

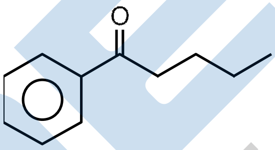
(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. Halogenation of 

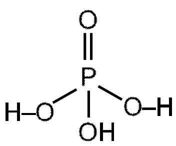
by electrophilic substitution reaction mechanism in presence of Lewis acid take place at meta position.

17. The number of non-ionisable hydrogen atoms present in the final product obtained from the hydrolysis of PCl_5 is:

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

Ans. (4)

Sol. $PCl_5 \xrightarrow{H_2O} POCl_3 \xrightarrow{H_2O} H_3PO_4$



18. Indicate the complex/complex ion with did not show any geometrical isomerism:

(1) $[Co(NH_3)_4Cl_2]^+$ (2) $[CoCl_2(en)_2]$ (3) $[Co(NH_3)_3(NO_2)_3]$ (4) $[Co(CN)_5(NC)]^{3+}$

Ans. (4)

Sol. (1) $[Co(NH_3)_4Cl_2]^+$ show cis-trans isomerism.

(2) $[CoCl_2(en)_2]$ show cis-trans isomerism.

(3) $[Co(NH_3)_3(NO_2)_3]$ show fac-mer isomerism.

(4) $[Co(CN)_5(NC)]^{3+}$ can't show geometrical isomerism due to the presence of plane of symmetry.

19. The sol given below with negatively charged colloidal particles is:

(1) $FeCl_3$ added to hot water
(2) $AgNO_3$ added to KI solution
(3) KI added to $AgNO_3$ solution
(4) $AL_2O_3 \cdot xH_2O$ in water

Ans. (2)

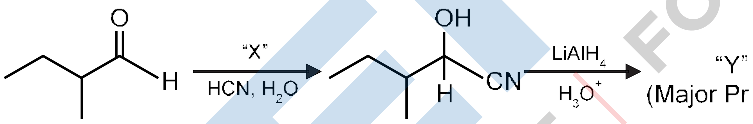
Sol. (1) FeCl3 added to hot water, $FeCl_3 \xrightarrow{\text{Hot } H_2O} Fe(OH)_3 | Fe$
Positively charge

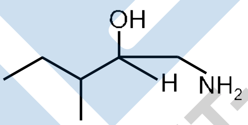
(2) When AgNO3 is added to KI, $KI \xrightarrow{AgNO_3} AgI\downarrow \xrightarrow{KI} AgI | I$
Negatively charge

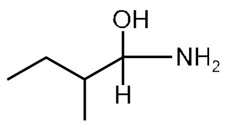
(3) When KI is added to AgNO3, $AgNO_3 \xrightarrow{KI} AgI\downarrow \xrightarrow{AgNO_3} AgI | I$
Positively charge

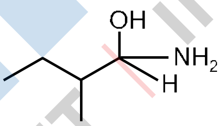
(4) $Al_2O_3 \cdot 2H_2O$ in water $Al(OH)_3 | Al$
Positively charge

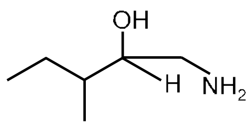
20. Consider the given reaction, identify 'X' and 'Y'



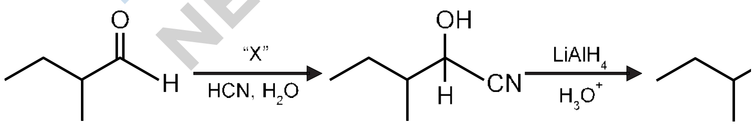
(1) X – HNO_3 Y – 

(2) X – HNO_3 Y – 

(3) X – NaOH Y – 

(4) X – NaOH Y – 

Ans. (4)

Sol. 

Major

Numeric Value Type

This Section contains **10 Numeric Value Type question**, out of 10 only 5 have to be done.

1. The equilibrium constant K_C at 298 K for the reaction $A + B \rightleftharpoons C + D$ is 100. Starting with an equimolar solution with concentrations of A, B, C and D all equal to 1 M, the equilibrium concentration of D is____________ $\times 10^{-2}$ M.

Ans. (182)

Sol.

	A	+	B	$\rightleftharpoons$	C	+	D	$K_C = 100$
Initially	1		1		1		1	
At eq.	(1 – x)		(1 – x)		(1 + x)		(1 + x)	

$$K_C \quad \left(\frac{1 \quad x}{1 \quad x}\right)^2 \quad 100$$

$$\frac{1 \quad x}{1 \quad x} \quad 10$$

= 1 + x = 10 – 10x

11x = 9

$$x \quad \frac{9}{11}$$

$$[D] \quad 1 \quad \frac{9}{11} \quad \frac{20}{11} = 1.818 = 1.82 \text{ (approx.)} \Rightarrow 182 \times 10^{-2}$$

Ans. 182

2. 83 g of ethylene glycol dissolved in 625 g of water. The freezing point of the solution is ______K.

[Use : Molal freezing point depression constant of water = 1.86 K kg mol^{-1}]

Freezing point of water = 273 K

Atomic masses : C : 12.0 u, O : 16.0 u, H : 1.0 u]

Ans. 269

Sol. $\Delta T_f = iK_f \times m$

$$1 \quad 1.86 \quad \frac{83 \quad 1000}{62 \quad 625}$$

$\Delta T_f = 3.98$

So, freezing point of solution = 273 – 3.98 = 269.02 = 269 K

3. 100 mL of Na_3PO_4 solution contains 3.45 g of sodium. The molarity of the solution is ________ $\times 10^{-2}$ mol L^{-1}.

[Atomic Masses – Na : 23.0 u, O : 16.0 u, P : 31.0 u]

Ans. 50

Sol. Number of mole of Na^{+} ion $\frac{3.45}{23}$

So number of mole of Na_3PO_4 $\frac{3.45}{3 \quad 23}$ 0.050

Molarity $\frac{0.050}{100}$ 1000 0.50 50 $10^{\;2}$ M

Ans. 50

4. The reaction rate for the reaction

$[PtCl_2]^{2-} + H_2O \rightleftharpoons [Pt(H_2O)Cl_3]^{-} + Cl^{-}$

Was measured as a function of concentrations of different species. It was observed that

$$\frac{d \;\; PtCl_4 \;\; ^{2}}{dt} \quad 4.8 \quad 10^{\;5} \quad PtCl_4 \;\; ^{2} \quad 2.4 \quad 10^{\;3} \quad Pt(H_2O)Cl_3 \quad Cr$$

where square brackets are used to denote molar concentration. The equilibrium constant K_C = ______.

Ans. (50)

Sol. $K_C \quad \frac{K_f}{K_b} \quad \frac{4.8 \quad 10^{\;5}}{2.4 \quad 10^{\;3}} \quad 2 \quad 10^{\;2}$

Note : NTA ans. is 50, but Zigyan ans. is 2×10^{-2}.

5. For the galvanic cell,

$Zn(s) + Cu^{2+}$ (0.02M) $\rightarrow$ Zn^{2+} (0.04M) + Cu(s)

E_{cell} = ____________ $\times 10^{-2}$ V.

[Use : $E^0_{Cu/Cu^2} \quad 0.34\,V, E^0_{Zn/Zn^2} \quad 0.76\,V, \frac{2.303\,RT}{F} \quad 0.059\,V$]

Ans. 109

Sol. Cell reaction

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

0.02M 0.04M

$E^0_{cell} \quad \left| E^0_{Cu^2\;/Cu} \quad E^0_{Zn/Zn^2} \right|$

= 0.34 – (–0.75) = 1.1V

$$E_{cell} \quad E^0_{cell} \quad \frac{0.059}{2} \log \frac{[Zn^2\;\;]}{[Cu^2\;\;]}$$

$$1.1 \quad \frac{0.059}{2} \log \frac{0.04}{0.02}$$

= 1.1 – 0.03 log 2 = 1.1 – 0.03 × 0.30

= 1. 0915 = 1.09V = 109×10^{-2} V

Ans = 109

6. A chloro compound "A"

(i) forms aldehydes on ozonolysis followed by the hydrolysis.

(ii) when vaporized completely 1.53 g of A, given 448 mL of vapour at STP.

The number of carbon atoms in a molecules of compound A is_________.

Ans. 3

Sol. 448 mL of A gives 1.53 g of A

22400 mL gives $\frac{1.53}{448}$ 22400 g of A = 76.5 g

CH_3 CH CH Cl $\xrightarrow[Zn/H_2O]{O_3}$ CH_3CHO (aldehyde)

$CH_3 - CH = CH - Cl$ has 3-carbon atoms and molecular mass = 76.5.

7. In the sulphur estimation 0.471 g of an organic compound gave 1.44 g of barium sulfate. The percentage of sulphur in the compound is ________%.

(Atomic Mass of Ba = 137 u)

Ans. 42%

Sol. 233 g of $BaSO_4$ contains 32 g sulphur.

Amount of S in 1.44 g of $BaSO_4$ $\frac{32}{233}$ 1.44

So percentage of S in 0.471 of organic compound $\frac{32}{233}$ $\frac{1.44}{0.471}$ 100 42%

8. A metal surface is exposed to 500 nm radiation. The threshold frequency of the metal for photoelectric current is 4.3×10^{14} Hz. The velocity of ejected electron is ___________$\times 10^5$ ms^{-1}.

[Use : h = 6.63×10^{-34} Js, me = 9.0×10^{-31} Kg]

Ans. 5

Sol. 500 nm $\frac{C}{}$ $\frac{3 \quad 10^8}{500 \quad 10^{9}}$ 6 10^{14} Hz

$\nu = 4.3 \times 10^{14}$ Hz

For PEE, $h\nu = h\nu_0 + K_\varepsilon$

$KE = h\nu - h\nu_0 = h(\nu - \nu_0) = 6.6 \times 10^{-34} (6 \times 10^{14} - 4.3 \times 10^{14})$

$= 6.6 \times 1.7 \times 10^{-20}$ J

K.E. $\frac{1}{2}mv^2$; v $\sqrt{\frac{2 \quad K.E.}{m}}$

V $\sqrt{\frac{2 \quad 6.6 \quad 1.7 \quad 10^{20}}{9.1 \quad 10^{31}}}$ $\sqrt{24.65 \quad 10^{10}}$ 5 10^5 m / s

9. The overall stability constant of the complex ion $[Cu(NH3)4]^{2+}$ is 2.1×10^{13}. The overall dissociation constant is $y \times 10^{-14}$. Then y is __________.

Given: 1

Ans. 5

Sol. Dissociation constant $\frac{1}{\text{stability constant}} \quad \frac{1}{2.1 \quad 10^{13}} \quad \frac{100 \quad 10^{14}}{21}$

$= 4.7 \times 10^{-14}$

$\approx 5 \times 10^{-11}$

Ans. 5

10. For water Δ_{vap} H = 41 kJ mol^{-1} at 373 K and 1 bar pressure. Assuming that water vapour is an ideal gas that occupies a much larger volume than liquid water, the internal energy changing during evaporation of water is ____________ kJ mol^{-1}.

[Use : R = 8.3] mol^{-1} K^{-1}]

Ans. 38

Sol. $H_2O(\ell) \rightleftharpoons H_2O(g)$; $\Delta H_{vap.}$ = 41 kJ/mol

$\Delta H = \Delta U + \Delta n_g RT$

$41 \quad U \quad (1)\frac{8.3}{1000} \quad 373$

$\Delta U = 41 - 3.0959$

ΔU = 38 kJ/mol.

PART C : MATHEMATICS

Single Choice Type

This section contains **20 Single choice questions.** Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

1. If $\sqrt{3} \quad i^{100} \quad 2^{99} \quad p \quad iq$ then p and q are roots of the equation :

(1) $x^2 \quad \sqrt{3} \quad 1\,x \quad \sqrt{3} \quad 0$

(2) $x^2 \quad \sqrt{3} \quad 1\,x \quad \sqrt{3} \quad 0$

(3) $x^2 \quad \sqrt{3} \quad 1\,x \quad \sqrt{3} \quad 0$

(4) $x^2 \quad \sqrt{3} \quad 1\,x \quad \sqrt{3} \quad 0$

Ans. (4)

Sol. $\sqrt{3} \quad i^{100} \quad 2^{99} \quad p \quad iq$

$2^{100} \quad \cos\frac{}{6} \quad i\sin\frac{}{6}^{100} \quad 2^{99}(p \quad iq)$

$2^{100} e^{i\frac{50}{3}} \quad 2^{99}(p \quad iq)$

$2 \quad \cos\frac{50}{3} \quad i\sin\frac{50}{3} \quad p \quad iq$

$2 \quad \frac{1}{2} \quad \frac{i\sqrt{3}}{2} \quad p \quad iq$

$p = -1$ & $q \quad \sqrt{3}$

p and q Roots of the equation

$x^2 \quad \sqrt{3} \quad 1\,x \quad \sqrt{3} \quad 0$

2. If $\sum_{r\ 1}^{50} \tan^{\ 1}\frac{1}{2r^2} \quad p$, then the value of tan p is :

(1) $\frac{101}{102}$

(2) $\frac{50}{51}$

(3) 100

(4) $\frac{51}{50}$

Ans. (2)

Sol. $\tan^{\ 1}\frac{1}{2r^2} \quad \tan^{\ 1}\frac{2}{4r^2}$

$\tan^{\ 1}\frac{2}{1 \quad 4r^2 \quad 1}$

$\tan^{\ 1}\frac{2}{1 \quad (2r \quad 1)(2r \quad 1)}$

$\tan^{\ 1}\frac{(2r \quad 1) \quad (2r \quad 1)}{1 \quad (2r \quad 1)(2r \quad 1)}$

$= \tan^{-1}(2r+1) - \tan^{-1}(2r-1)$

So, $\sum_{r=1}^{50} \tan^{-1}\frac{1}{2r^2}$ $= \tan^{-1}(3) - \tan^{-1}(1)$

$+ \tan^{-1}(5) - \tan^{-1}(3)$

$+ \tan^{-1}(7) - \tan^{-1}(5)$

$\vdots$

$+ \tan^{-1}(101) - \tan^{-1}(99)$

$\tan^{-1}(101) - \tan^{-1}(1)$

$\tan^{-1}\frac{101-1}{1+101}$

$\tan^{-1}\frac{100}{102} = P$

So, $\tan P = \frac{100}{102} = \frac{50}{51}$

3. If y (x) be the solution of the differential equation $2x^2dy + (e^y - 2x)dx = 0$, $x > 0$. If y(e) = 1, then y(1) is equal to :

(1) $\log_e 2$ (2) 0 (3) $\log_e(2e)$ (4) 2

Ans. (1)

Sol. $\frac{dy}{dx} = -\frac{e^y}{2x^2} + \frac{1}{x}$

$\frac{e^{-y}dy}{dx} = \frac{e^{-y}}{x} - \frac{1}{2x^2}$

Let $e^{-y} = t$ ……………….(1)

$e^{-y}(-1)\frac{dy}{dx} = \frac{dt}{dx}$

$\frac{dt}{dx} + \frac{t}{x} = \frac{1}{2x^2}$

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

$tx = \int \frac{1}{2x^2} x\,dx + C$

Using equation (1)

$e^{-y}x = \frac{1}{2}\ell nx + C$

$e^{-1}e = \frac{1}{2} + C \Rightarrow C = \frac{1}{2}$

$e^{\ y}x \quad \frac{1}{2}(1 \quad \ell nx)$

Put x = 1 then y is ⇒ y = ℓn2

4. The value of $\int_{\frac{\ }{2}}^{\frac{\ }{2}} \frac{1 \quad \sin^2 x}{1 \quad ^{\sin x}} \, dx$ is :

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

Ans. (4)

Sol. $I \quad \int_a^b f(x)dx$

f(a + b – x) = f(x)

$I \quad \int_{\frac{\ }{2}}^{\frac{\ }{2}} \frac{1 \quad \sin^2 x}{1 \quad ^{\sin x}} dx$ ....(i)

$I \quad \int_{\frac{\ }{2}}^{\frac{\ }{2}} \frac{1 \quad \sin^2 x}{1 \quad ^{\sin x}} dx$ ....(ii)

Add equation (i) and (ii)

$2I \quad \int_{\frac{\ }{2}}^{\frac{\ }{2}} 1 \quad \sin^2 x \ dx$

$2I \quad \frac{1}{2} \int_{\frac{\ }{2}}^{\frac{\ }{2}} 1 \quad \cos 2x \ dx$

$2I \quad \frac{1}{2} \ x \quad \frac{\sin 2x}{2} \Big|_{\frac{\ }{2}}^{\frac{\ }{2}}$

$2I \quad \frac{1}{2} \quad \frac{3}{2}$

$I \quad \frac{3}{4}$

5. Let [t] denote the greatest integer less than or equal to t.

Let f(x) = x – [x], g(x) = 1 – x + [x], and h(x) = min {f(x), g(x)}, ∈ [– 2, 2]. Then h is.

(1) continuous in [– 2, 2] but not differentiable at more than four points in (– 2, 2)

(2) continuous in [– 2, 2] but not differentiable at exactly three points in (– 2, 2)

(3) not continuous at exactly four points in [– 2, 2]

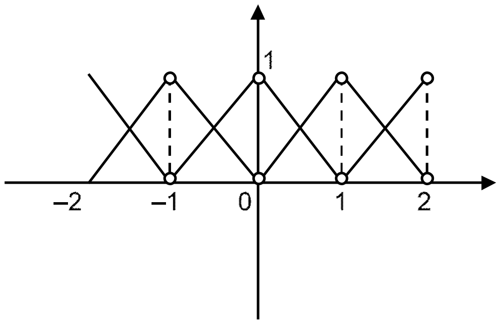
(4) not continuous at exactly three points in [– 2, 2]

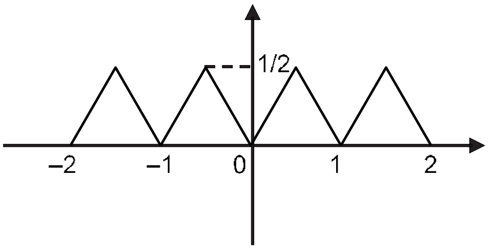
Ans. (1)

Sol. f(x) = x – [x] = {x}

9(x) = 1 – x + [x] = 1 – {x}

Now, Graph of min {f(x), 9(x)}





Clearly graph is continuous in [–2, 2] but non differentiable at 7 points (i.e. greater than 4) in (–2, 2)

6. A fair die is tossed until six is obtained on it. Let X be the number required tosses, then the conditional probability P(X ≥ 5| x > 2) is :

(1) $\frac{5}{6}$ (2) $\frac{125}{216}$ (3) $\frac{25}{36}$ (4) $\frac{11}{36}$

Ans. (3)

Sol. $P\ \frac{x \quad 5}{x \quad 2} \quad \frac{P(x \quad 5 \quad x \quad 2)}{P(x \quad 2)}$

$\frac{P(x \quad 5) \quad P(x \quad 6) \quad P(x \quad 7) \quad .....}{P(x \quad 3) \quad P(x \quad 4) \quad P(x \quad 5) \quad .....}$

$\frac{\frac{5}{6}^{4} \frac{1}{6} \quad \frac{5}{6}^{5} \frac{1}{6} \quad .....}{\frac{5}{6}^{2} \frac{1}{6} \quad \frac{5}{6}^{3} \frac{1}{6} \quad .....}$

$\frac{\dfrac{\frac{5}{6}^{4} \quad \frac{1}{6}}{1 \quad \frac{5}{6}}}{\dfrac{\frac{5}{6}^{2} \quad \frac{1}{6}}{1 \quad \frac{5}{6}}} \quad \frac{5}{6}^{2} \quad \frac{25}{36}$

7. The domain of the function cosec ^{1} $\frac{1 \quad x}{x}$ is :

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

Ans. (2)

Sol. $\frac{1 \quad x}{x} \quad 1$ or $\frac{1 \quad x}{x} \quad 1$

$\frac{1 \quad x \quad x}{x} \quad 0$ or $\frac{1 \quad x \quad x}{x} \quad 0$

$\frac{2x \quad 1}{x} \quad 0$ or $\frac{1}{x} \quad 0$

+ – + (number line: −1/2, 0) or – + (number line: 0)

$x \quad \frac{1}{2}, 0$ or $x \in (0, \infty)$

$x \quad \frac{1}{2}, \quad \{0\}$

8. The local maximum value of the function

$f(x) \quad \frac{2}{x}^{x^2}$, $x > 0$, is :

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

Ans. (1)

Sol. $f'(x) = 0$ for maximum value

Let $y \quad \frac{2}{x}^{x^2}$

$\ell ny \quad x^2 \ell n\frac{2}{x}$

$\frac{1}{y}y' \quad 2x\ell n\frac{2}{x} \quad x^2 \frac{1}{\frac{2}{x}} \quad \frac{2}{x^2}$

$y' \quad (xy)(2\ell n\frac{2}{x} \quad 1)$

$y' \quad \frac{2}{x}^{x^2} (x)(2\ell n\frac{2}{x} \quad 1)$

$2\ell n\frac{2}{x} \quad 1$

$\frac{2}{x} \quad e^{\frac{1}{2}}$

$x \quad 2e^{\frac{1}{2}}$

Then maximum value will be

$f(2e^{\frac{1}{2}}) \quad \frac{2}{2e^{\frac{1}{2}}}^{4e^{1}} \quad e^{2e^{1}}$

9. The locus of the mid points of the chords of the hyperbola $x^2 - y^2 = 4$, which touch the parabola $y^2 = 8x$, is :

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

Ans. (2)

Sol. Tangent to $y^2 = 8x$ is $y \quad mx \quad \frac{2}{m}$

$y \quad \frac{xh}{k} \quad \frac{k^2 \quad h^2}{k}$ is the equation of chord with mid-point (h, k)

Comparing the above equations we get,

$m \quad \frac{h}{k}$ and $\frac{2}{m} \quad \frac{k^2 \quad h^2}{k}$

$\frac{2k}{h} \quad \frac{k^2 \quad h^2}{k}$

$\Rightarrow h^3 + 2k^2 - k^2 h = 0$

$\therefore$ Equation of locus is $x^3 + 2y^2 - y^2x = 0$

10. Two fair dice are thrown. The numbers on them are taken as λ and μ, and a system of linear equations

$x + y + z = 5$

$x + 2y + 3z = \mu$

$x + 3y + \lambda z = 1$

is constructed. If p is the probability that the system has a unique solution and q is the probability that the system has no solution, then :

(1) $p \quad \frac{1}{6}$ and $q \quad \frac{5}{36}$ (2) $p \quad \frac{5}{6}$ and $q \quad \frac{1}{36}$ (3) $p \quad \frac{1}{6}$ and $q \quad \frac{1}{36}$ (4) $p \quad \frac{5}{6}$ and $q \quad \frac{5}{36}$

Ans. (4)

Sol.
$$\begin{matrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 3 & \end{matrix} \quad 5$$

$$_1 \quad \begin{matrix} 1 & 1 & 5 \\ 2 & 3 & \\ 3 & & 1 \end{matrix} \quad 10 \quad 3 \quad 44$$

$$_2 \quad \begin{matrix} 1 & 1 & 5 \\ 1 & 3 & \\ 1 & & 1 \end{matrix} \quad 5 \quad 13$$

$$_3 \quad \begin{matrix} 1 & 1 & 5 \\ 1 & 2 & \\ 1 & 3 & 1 \end{matrix} \quad 2 \quad 6$$

For unique solution

$\lambda \neq 5, \mu \in \{1, 2, 3, 4, 5, 6\}$

$p \quad \frac{5}{6} \quad 1 \quad \frac{5}{6}$

For No Solution

$\lambda = 5, \mu \neq 3$

$q \quad \frac{1}{6} \quad \frac{5}{6} \quad \frac{5}{36}$

11. Consider the two statements

(S1) : $(p \to q) \vee (\sim q \to p)$ is a tautology.

(S2) : $(p \wedge \sim q) \wedge (\sim p \vee q)$ is a fallacy.

Then :

(1) only (S2) is true

(2) only (S1) is true.

(3) both (S1) and (S2) are false.

(4) both (S1) and (S2) are true.

Ans. 4)

Sol.

p	**q**	**$\sim p$**	**$\sim q$**	**$p \to q$**	**$\sim q \to p$**	**$(p \to q) \vee (\sim q \to p)$**	**$p \wedge \sim q$**	**$\sim p \vee q$**	**$(p \wedge \sim q) \wedge (\sim p \vee q)$**
T	T	F	F	T	T	T	F	T	F
T	F	F	T	F	T	T	T	F	F
F	T	T	F	T	T	T	F	T	F
F	F	T	T	T	F	T	F	T	F

From table

$(p \to q) \vee (\sim q \to p)$ is tautology

and $(p \wedge \sim q) \wedge (\sim p \vee q)$ is fallacy

12. The point P$(\sqrt{6}, \sqrt{3})$ lies on the hyperbola $\frac{x^2}{a^2} \quad \frac{y^2}{b^2} \quad 1$ having eccentricity $\frac{\sqrt{5}}{2}$. If the tangent and normal at P to the hyperbola intersect its conjugate axis at the points Q and R respectively, the QR is equal to :

(1) 6

(2) $4\sqrt{3}$

(3) $3\sqrt{6}$

(4) $6\sqrt{3}$

Ans. (4)

Sol. As point P$(\sqrt{6}, \sqrt{3})$ lies on hyperbola.

$\frac{24}{a^2} \quad \frac{3}{b^2} \quad 1$ ....(1)

$e^2 \quad \frac{5}{4}$

$\frac{a^2 \quad b^2}{a^2} \quad \frac{5}{4}$

$a^2 = 4b^2$ ____ putting in (1)

$\frac{6}{b^2} \quad \frac{3}{b^2} \quad 1$

$b^2 = 3$ & $a^2 = 12$

Hyperbola $\frac{x^2}{12} \quad \frac{y^2}{3} \quad 1$

$\frac{2x}{12} \quad \frac{2y\ y'}{3} \quad 0$

$y'|_{(2\sqrt{6},\sqrt{3})} \quad \frac{1}{\sqrt{2}}$

equation of tangent $(y \quad \sqrt{3}) \quad \frac{1}{\sqrt{2}}(x \quad 2\sqrt{6})$

at $x = 0,\ y \quad \sqrt{3},\ Q \quad \sqrt{2}(x \quad 2\sqrt{6})$

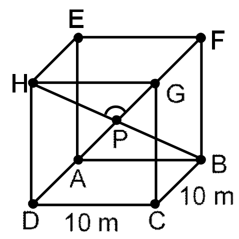
equation of normal $(y \quad \sqrt{3}) \quad \sqrt{2}(x \quad 2\sqrt{6})$

at $x = 0,\ y \quad 5\sqrt{3}$

$R(0, 5\sqrt{3})$

$QR \quad 6\sqrt{3}$

13. A hall has a square floor of dimension 10 m × 10 m (see the figure) and vertical walls. If the angle GPH between the diagonals AG and BH is $\cos^{1}\frac{1}{5}$, then the height of the hall (in meters) is :



(1) $5\sqrt{3}$

(2) $5\sqrt{2}$

(3) $2\sqrt{10}$

(4) 5

Ans. (2)

Sol. $\overrightarrow{AG} \quad 10\hat{i} \quad h\hat{j} \quad 10\hat{k}$

$\overrightarrow{BH} \quad 10\hat{i} \quad h\hat{j} \quad 10\hat{k}$

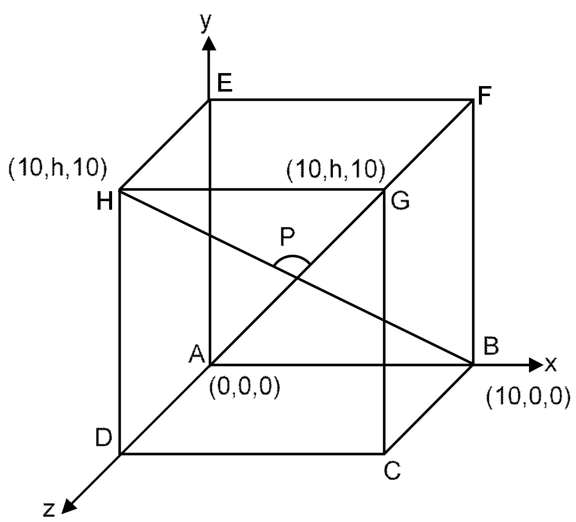
$\cos \quad \frac{100 \quad h^2 \quad 100}{(\sqrt{200 \quad h^2})^2}$

$\frac{1}{5} \quad \frac{h^2}{200 \quad h^2}$

$200 = 4h^2$

$h^2 = 50$

$h \quad 5\sqrt{2}$



14. Let P be the plane passing through the point (1,2, 3) and the line of intersection of the planes $\vec{r}\ \ \hat{i}\ \ \hat{j}\ \ 4\hat{k}\ \ \ 16$ and $\vec{r}\ \ \ \hat{i}\ \ \hat{j}\ \ \hat{k}\ \ \ 1.$

Then which of the following points does NOT lie on P?

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

Ans. (1)

Sol. Equation of the plane

$(x + y + 4z - 16) + \lambda(-x + y + z - 6) = 0$

it passes through the point (1,2,3)

$(1 + 2 + 12 - 16) + \lambda(-1 + 2 + 3 - 6) = 0$

$\Rightarrow -1 - 2\lambda = 0 \qquad \frac{1}{2}$

Plane P ; $(1 - \lambda)x + (1 + \lambda)y + (4 + \lambda)z = 16 + 6\lambda$

$\frac{3}{2}x \quad \frac{1}{2}y \quad \frac{7}{2}z \quad 13$

$\Rightarrow 3x + y + 7z = 26$

15. If the value of the integral $^{5}_{0}\frac{x\ \ [x]}{e^{x\ \ [x]}}dx \quad e^{\ 1}$, where $\alpha, \beta \in R$, $5\alpha + 6\beta = 0$, and [x] denotes the greatest integer less than or equal to x, then the value of $(\alpha + \beta)^2$ is equal to :

(1) 25 (2) 36 (3) 16 (4) 100

Ans. (1)

Sol. $^{5}_{0}\frac{x\ \ [x]}{e^{x\ \ [x]}}dx \quad e^{\ 1}$

$^{1}_{0}\frac{x}{e^{x}}dx \quad ^{2}_{1}\frac{x\ \ 1}{e^{x\ \ 1}}dx \quad ^{3}_{2}\frac{x\ \ 2}{e^{x\ \ 2}}dx \quad ^{4}_{3}\frac{x\ \ 3}{e^{x\ \ 3}}dx \quad ^{5}_{4}\frac{x\ \ 4}{e^{x\ \ 4}}dx$

$x = p + 1 \quad x = q + 2 \quad x = r + 3 \quad x = w + 4$

$^{1}_{0}\frac{x}{e^{x}}dx \quad ^{1}_{0}\frac{p\ \ 2}{e^{p}}dp \quad ^{1}_{0}\frac{q\ \ 4}{e^{q}} \quad ^{1}_{0}\frac{r\ \ 6}{e^{r}} \quad ^{1}_{0}\frac{w\ \ 8}{p^{w}}dw$

$^{1}_{0}\frac{5x\ \ 20}{e^{x}}dx \quad 5\ ^{1}_{0}\frac{x\ \ 4}{e^{x}}dx$

$5\ \ (x\ \ \ 4)\frac{e^{\ x}}{1}\Big|_{0}^{1} \quad ^{1}_{0}\frac{e^{\ x}}{1}dx$

$= 5\,[-5e^{-1} + 4 + (-e^{-1} + 1)]$

$= 5(-6e^{-1} + 5) = -30\,e^{-1} + 25 = -30\,e^{-1} + 25$

$\alpha = -30,\ \beta = 25$

$(\alpha + \beta)^2 = 25$

16. Let $A \quad \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \end{matrix}$. Then $A^{2025} - A^{2020}$ is equal to :

(1) A^6 (2) $A^6 - A$ (3) $A^5 - A$ (4) A^5

Ans. (2)

Sol. $A \quad \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \end{matrix}$

$A^2 \quad \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \end{matrix} \quad \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \end{matrix} \quad \begin{matrix} 1 & 0 & 0 \\ 1 & 1 & 1 \\ 1 & 0 & 0 \end{matrix}$

$A^3 \quad \begin{matrix} 1 & 0 & 0 \\ 1 & 1 & 1 \\ 1 & 0 & 0 \end{matrix} \quad \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 0 \end{matrix} \quad \begin{matrix} 1 & 0 & 0 \\ 2 & 1 & 1 \\ 1 & 0 & 0 \end{matrix}$

$A^4 \quad \begin{matrix} 1 & 0 & 0 \\ 3 & 1 & 1 \\ 1 & 0 & 0 \end{matrix}$

$A^n \quad \begin{matrix} 1 & 0 & 0 \\ n \; 1 & 1 & 1 \\ 1 & 0 & 0 \end{matrix}$

$A^{2025} \quad A^{2020} \quad \begin{matrix} 1 & 0 & 0 \\ 2024 & 1 & 1 \\ 1 & 0 & 0 \end{matrix} \quad \begin{matrix} 1 & 0 & 0 \\ 2019 & 1 & 1 \\ 1 & 0 & 0 \end{matrix}$

$\begin{matrix} 0 & 0 & 0 \\ 5 & 0 & 0 \\ 0 & 0 & 0 \end{matrix} \quad A^6 \quad A$

17. The value of

$2\sin\frac{}{8} \; \sin\frac{2}{8} \; \sin\frac{3}{8} \; \sin\frac{5}{8} \; \sin\frac{6}{8} \; \sin\frac{7}{8}$ is :

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

Ans. (1)

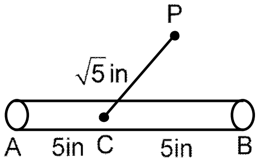
Sol. $2\sin\frac{}{8} \; \sin\frac{2}{8} \; \sin\frac{3}{8} \; ......\sin\frac{7}{8} \quad 2\sin\frac{}{8} \; \sin\frac{2}{8} \; \sin\frac{3}{8} \; ......\sin \quad \frac{2}{8} \; \sin \quad \frac{}{8}$

$2\sin^2\frac{}{8} \; \sin^2\frac{2}{8} \; \sin^2\frac{3}{8} \; \sin\frac{}{2}$

$\sin^2\frac{}{8}\sin^2 \; \frac{}{2} \; \frac{}{8} \quad \sin^2\frac{}{8}\cos^2\frac{}{8} \quad \frac{1}{4}\sin^2\frac{}{4} \quad \frac{1}{8}$

18. A 10 inches long pencil AB which mid point C and a small eraser P are placed on the horizontal top of a table such that PC $\sqrt{5}$ inches and $\angle PCB = \tan^{-1}(2)$.

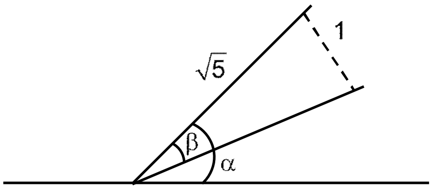
The acute through which the pencil must be rotated about C so that the perpendicular distance between eraser and pencil becomes exactly 1 inch is :



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

Ans. (3)

Sol.



sin $\frac{1}{\sqrt{5}}$ tan $\frac{1}{2}$

$\tan\alpha = 2$

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

tan ^{1} $\frac{3}{4}$

19. A circle C touches the line x = 2y at the point (2, 1) and intersects the circle $C_1 : x^2 + y^2 + 2y - 5 = 0$ at two points P and Q such that PQ is a diameter of C_1.Then the diameter of C is :

(1) $4\sqrt{15}$ (2) $7\sqrt{5}$ (3) 15 (4) $\sqrt{245}$

Ans. (4)

Sol. Family of circle touching line 2y = x at point (2,1)

$(x-2)^2 + (y-1)^2 + \lambda(x-2y) = 0$ ……(1)

common chord PQ is

$(x-2)^2 + (y-1)^2 + \lambda(x-2y) - x^2 - y^2 - 2y + 5 = 0$

(diameter of C_1 passes through (0, –1))

$4 + 4 + 2\lambda - 1 + 2 + 5 = 0$

$\lambda = -7$ put in (1)

$(x-2)^2 + (y-1)^2 - 7(x-2y) = 0$

$x^2 + y^2 - 11x + 12y + 5 = 0$

$r = \sqrt{\frac{121}{4} + 36 - 5} = \sqrt{\frac{121 + 124}{4}} = \sqrt{\frac{245}{4}} = \frac{\sqrt{245}}{2} \Rightarrow$ diameter $= \sqrt{245}$

20. $\lim_{x \to 2} \sum_{n=1}^{9} \frac{x}{n(n+1)x^2 + 2(2n+1)x + 4}$ is equal to :

(1) $\frac{5}{24}$ (2) $\frac{1}{5}$ (3) $\frac{9}{44}$ (4) $\frac{7}{36}$

Ans. (3)

Sol. $\lim_{x \to 2} \sum_{n=1}^{9} \frac{x}{n(n+1)x^2 + 2(2n+1)x + 2}$

$\lim_{x \to 2} \sum_{n=1}^{9} \frac{x}{(nx+2)x^2 + ((n+1)x+2)}$

$\lim_{x \to 2} \sum_{n=1}^{9} \left(\frac{1}{(nx+2)} - \frac{1}{((n+1)x+2)}\right)$

$\frac{1}{x+2} - \frac{1}{2x+2}$

$\frac{1}{2x+2} - \frac{1}{3x+2}$

$\vdots$

$\frac{1}{9x+2} - \frac{1}{10x+2}$

$\frac{1}{x+2} - \frac{1}{10x+2}$

$\lim_{x \to 2} \frac{1}{x+2} - \frac{1}{10x+2} = \frac{9}{44}$

Numeric Value Type

This Section contains **10 Numeric Value Type question**, out of 10 only 5 have to be done.

1. If the projection of the vector $\lambda\hat{i} + 2\hat{j} + \hat{k}$ on the sum of two vectors $2\hat{i} + 4\hat{j} - 5\hat{k}$ and $-\lambda\hat{i} + 2\hat{j} + 3\hat{k}$ is 1, then λ is equal to __________.

Ans. (5)

Sol. Sum of two vectors $= 2\hat{i} + 4\hat{j} - 5\hat{k} + (-\lambda\hat{i} + 2\hat{j} + 3\hat{k}) = (2-\lambda)\hat{i} + 6\hat{j} - 2\hat{k}$

Projection = 1 $\Rightarrow \dfrac{\lambda(2-\lambda) + 2(6) + 1(-2)}{\sqrt{(2-\lambda)^2 + 6^2 + 2^2}} = 1$

$\Rightarrow \dfrac{12 - \lambda}{\sqrt{\lambda^2 - 4\lambda + 44}} = 1$

$\Rightarrow (12 - \lambda)^2 = \lambda^2 - 4\lambda + 44$

$\Rightarrow 144 + \lambda^2 - 24\lambda = \lambda^2 - 4\lambda + 44$

$\Rightarrow 100 = 20\lambda$

$\Rightarrow \lambda = 5$

2. The least positive integer n such that $\dfrac{(2i)^n}{(1-i)^{n-2}}, i = \sqrt{-1}$, is a positive integer, is _______.

Ans. (6)

Sol. $\dfrac{(2i)^n}{(1-i)^{n-2}} = \dfrac{(2i)^{\frac{n+2}{2}}}{(-1)^{\frac{n-2}{2}}}$ is positive integer

Clearly n must be even n = 2, 4 rejected

So for n = 6

3. Let a and b respectively be the points of local maximum and local minimum of the function $f(x) = 2x^3 - 3x^2 - 12x$.

If A is the total area of the region bounded by y = f(x), the x-axis and the lines x = a and x = b, then 4 A is equal to _______.

Ans. (114)

Sol. $f'(x) = 6x^2 - 6x - 12 = 6(x^2 - x - 2)$

$= 6(x - 2)(x + 1)$

+   –   +
–1   2

–1 = a   2 = b

$A = \int_{-1}^{0}\left(2x^3 - 3x^2 - 12x\right)dx + \int_{0}^{2}\left|2x^3 - 3x^2 - 12x\right|dx$

$$\frac{x^4}{2} \quad x^3 \quad 6x^3 \Big|_{1}^{0} \quad \frac{x^4}{2} \quad x^3 \quad 6x^3 \Big|_{0}^{2}$$

$$\frac{1}{2} \quad 1 \quad 6 \qquad 8 \quad 8 \quad 24$$

$$\frac{9}{2} \quad 24 \quad \frac{57}{2} \qquad 4A \quad 114$$

4. Let the mean and variance of four numbers 3, 7, x and y (x > y) be 5 and 10 respectively. Then the mean of four numbers 3 + 2x, 7 + 2y, x + y and x – y is ________.

Ans. (12.00)

Sol. Mean = 5, Variance = 10

$$\frac{3 \quad 7 \quad x \quad y}{4} \quad 5, 10 \quad \frac{x_i^2}{4} \qquad \bar{x}^{\,2}$$

$$10 + x + y = 20, \; 10 \quad \frac{x_i^2}{4} \quad 25$$

$x + y = 10$

$y = 10 - x, \qquad 40 \qquad x_i^2 \quad 100$

$140 \qquad x_i^2$

$140 = 9 + 49 + x^2 + y^2$

$140 = 58 + x^2 + y^2$

$x^2 + y^2 = 82$

$(x^2 + y^2) = x^2 + y^2 + 2xy$

$100 - 82 = 2xy$

$18 = 2xy$

$xy = 9$

$x(10 - x) = 9$

$\Rightarrow x^2 - 10x + 9 = 0$

$= x = 1, 9$

$y = 9, 1$

As $x > y$ So, $x = 9$, $y = 1$

$$\bar{x} \quad \frac{3 \quad 2x \quad 7 \quad 2y \quad x \quad y \quad x \quad y}{4}$$

$$\frac{10 \quad 4x \quad 2y}{4}$$

$$\frac{5 \quad 2x \quad y}{2}$$

$\frac{5 \quad 18 \quad 1}{2} \quad \frac{24}{2} \quad 12$

5. The sum of all 3-digit numbers less than or equal to 500, that are formed without using the digit "1" and they all are multiple of 11, is _________.

Ans. (7744)

Sol. S = (209 + 220 + 231.....495) – (231 + 319 + 418 + 341 + 451)

$S \quad \frac{27}{2}(704) \quad (1760)$

S = 9504 – 1760 = 7744

6. Let A be a 3 × 3 real matrix. If det (2 Adj(2 Adj(Adj (2A)))) = 241, then value of det (A^2) equals _____.

Ans. (04.00)

Sol. $\therefore$ |KA| = K^n |A|, If A is n × n matrics

|Adj A| = |A|n–1 If A is n × n matrics

$|2Adj\ (2\ Adj\ (Adj(2A)))| = 2^{41}$

$\Rightarrow 2^3\ |\ Adj\ (2\ Adj\ (Adj(2A)))| = 2^{41}$

$\Rightarrow |Adj\ (2\ Adj\ (Adj(2A)))| = 2^{38}$

$\Rightarrow (|2\ Adj\ (Adj(2A))|)^2 = 2^{38}$

$\Rightarrow |2\ Adj\ (Adj(2A))| = 2^{19}$

$\Rightarrow 2^3|Adj\ (Adj(2A))| = 2^{19}$

$\Rightarrow |Adj\ (Adj(2A))| = 2^{16}$

$\Rightarrow (|Adj(2A)|)^2 = 2^{16}$

$\Rightarrow |Adj(2A)| = 2^8$

$\Rightarrow |(2A)|^2 = 2^8$

$\Rightarrow |(2A)| = 2^4$

$\Rightarrow 2^3|A| = 2^4$

$\Rightarrow |A| = 2$

So, $|A^2| = 4$

7. Let $\frac{n}{k}$ denote ${}^nC_k$ and

$$\begin{matrix} n \\ k \end{matrix} \quad \begin{matrix} \begin{matrix} n \\ k \end{matrix}, & \text{if} 0 \quad k \quad n \\ 0, & \text{otherwise.} \end{matrix}$$

if $A_k \quad \sum_{i\,0}^{9} \begin{matrix} 9 \\ i \end{matrix} \begin{matrix} 12 \\ 12 \quad k \quad i \end{matrix} \quad \sum_{i\,0}^{8} \begin{matrix} 8 \\ i \end{matrix} \begin{matrix} 13 \\ 13 \quad k \quad i \end{matrix}$ and $A_4 – A_3$ = 190 p, then p is equal to _______.

Ans. (49)

Sol. $A_4 \quad \overset{9}{\underset{i\ 0}{}} \ 9_{C_i} \ 12_{C_{8\ i}} \quad \overset{8}{\underset{i\ 0}{}} \ 8_{C_i} \ 13_{C_{9\ i}}$

$\quad {}^{21}C_4 \quad {}^{21}C_4 \quad 2({}^{21}C_4)$

$A_3 \quad {}^{21}C_3 \quad {}^{21}C_3 \quad 2({}^{21}C_3)$

$A_4 \quad A_3 \quad 2 \quad {}^{21}C_4 \quad {}^{21}C_3 \quad 190P$

$\Rightarrow \quad P = 49$

8. Let $a_1, a_2, \ldots\ldots, a_{10}$ be an AP with common difference –3 and $b_1, b_2, \ldots\ldots\ b_{10}$ be a GP with common ratio 2. Let $c_k = a_k + b_k$, k = 1, 2, ... 10. If $c_2 = 12$ and $c_3 = 13$, then $\overset{10}{\underset{k\ 1}{}} c_k$

Ans. (2021)

Sol. $c_k = a_k + b_k$

where $a_k = a_1 + (k-1)(-3)$

and $b_k = b_1\, 2^{k-1}$

$c_k = a_1 + (k-1)(-3) + b_1\, 2^{k-1}$

$\overset{10}{\underset{k\ 1}{}} c_k \quad \overset{10}{\underset{k\ 1}{}} a_k \quad \overset{10}{\underset{k\ 1}{}} b_k$

$c_2 = a_1 - 3 + b_1(2) = 12$

$c_3 = a_1 - 6 + 4b_1 = 13$

by solving

$2b_1 - 3 = 1 \Rightarrow b_1 = 2$ and $a_1 = 11$

$\overset{10}{\underset{k\ 1}{}} c_k \quad \frac{10}{2}(22 \quad 9(\ \ 3)) \quad 2(2^{10} \quad 1)$

$= -25 + 2046 = 2021$

9. Let $\lambda \neq 0$ be in R. If α and β are the roots of the equation $x^2 - x + 2\lambda = 0$, and a and γ are the roots of the equation $3x^2 - 10x + 27\gamma = 0$, then —

Ans. (18)

Sol. $\alpha + \beta = 1$ ....(i)

$\alpha\beta = 2\lambda$ ....(ii)

$\frac{10}{3}$ ....(iii)

$\alpha\gamma = 9\lambda$ ....(iv)

from (iv)/(ii)

$-\ \frac{9}{2}$ ....(v)

from (iii) – (i)

$$\frac{10}{3} \quad 1 \quad \frac{7}{3} \qquad ....(vi)$$

from (v) and (vi)

$$\frac{2}{3}, \quad 3$$

from (i) $\quad 1 \quad 1 \quad \frac{2}{3} \quad \frac{1}{3}$

from (ii) $\quad \frac{}{2} \quad \frac{\frac{1}{3} \quad \frac{2}{3}}{2} \quad \frac{1}{9}$

So $\frac{}{} \quad \frac{\frac{2}{3} \quad 3}{\frac{1}{9}} \quad 18$

10. Let Q be the foot of the perpendicular from the point P(7, –2, 13) on the plane containing the lines $\frac{x \quad 1}{6} \quad \frac{y \quad 1}{7} \quad \frac{z \quad 3}{8}$ and $\frac{x \quad 1}{3} \quad \frac{y \quad 2}{5} \quad \frac{z \quad 3}{7}$.

Then $(PQ)^2$, is equal to ________.

Ans. 96.00

Sol. Equation of the plane

$$A(x + 1) + B(y – 1) + C(z – 3) = 0$$

where 6A + 7B + 8C = 0 and 3A + 5B + 7C = 0

$$\frac{A}{1} \quad \frac{B}{2} \quad \frac{C}{1}$$

$\Rightarrow$ 1(x + 1) – 2(y – 1) + 1(z – 3) = 0 $\Rightarrow$ x – 2y + z = 0

Let Q(α, β, γ)

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

Q(α, β, γ) $\equiv$ (3, 6, 9)

$(PQ)^2 = 16 + 64 + 16$

$(PQ)^2 = 96$