MENIIT

NEET | IIT-JEE | FOUNDATION

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JEE MAIN-2021

COMPUTER BASED TEST (CBT)

DATE : 26-08-2021 (MORNING SHIFT) | TIME : (9.00 am to 12.00 pm)

Duration 3 Hours | Max. Marks : 300

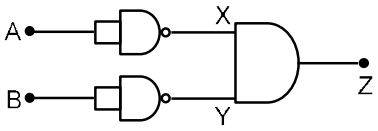
QUESTION & SOLUTIONS

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.

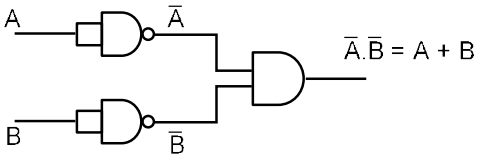
1. Identify the logic operation carried out by the given circuit



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

Ans. (1)

Sol.



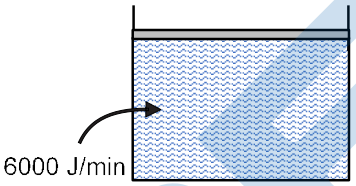
NOR GATE

2. An electric appliance supplies 6000J/min heat to the system. If the system delivers a power of 90 W. How long it would take to increase the internal energy by 2.5 × 103J ?

(1) 4.1×10^1 s (2) 2.4×10^3 s (3) 2.5×10^2 s (4) 2.5×10^1 s

Ans. (3)

Sol.



$= \frac{6000}{60} J/s = 100 J/s$

$\Delta U = Q - w$

$2500 = 100t - 90t$

$t = 250$ s

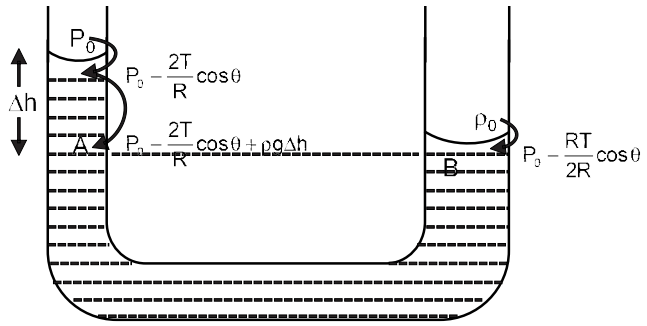
3. Two narrow bores of diameter 5.0 mm and 8.0 mm are joined together to form a U-shaped tube open at both ends. If this U-tube contains water, what is the difference in level of two limbs of the tube?

[Take surface tension of water T = 7.3×10^{-2} Nm^{-1}, angle of contact = 0, g = 10 ms^{-2} and density of water = 1.0×10^3 kg m^{-3}]

(1) 4.97 mm (2) 2.19 mm (3) 5.34 mm (4) 3.62 mm

Ans. (2)

Sol.



$$P_0 \quad \frac{2T}{R_1} \quad h_1 \; g \quad P_0 \quad \frac{2T}{R_2} \quad h_2 \; g$$

$$(h_1 \quad h_2) \; g \quad 2T \; \frac{1}{\frac{5}{2} \quad 10^{\;3}} \quad \frac{1}{\frac{8}{2} \quad 10^{\;3}} \; ; h_1 \quad h_2 \quad \frac{2 \quad 7.3 \quad 10^{\;2}}{1000 \quad 10 \quad 10^{\;3}} \quad \frac{3}{20} \quad 2.19\text{mm}$$

4. In a Screw Gauge, fifth division of the circular scale coincides with the reference line when the ratchet is closed. There are 50 divisions on the circular scale, and the main scale moves by 0.5 mm on a complete rotation. For a particular observation the reading on the main scale is 5 mm and the 20th division of the circular scale coincides with reference line. Calculate the true reading.

(1) 5.00 mm (2) 5.20 mm (3) 5.25 mm (4) 5.15 mm

Ans. (4)

Sol. L.C. of screw Gauge = $\frac{0.5}{50}$ = 0.01mm

Zero error of screw Gauge = 5 × L.C. = 5 × 0.01 = 0.05 mm

Reading of screw gauge = main scale reading + circular scale reading × L.C. – Zero error

= 5 + 20 × 0.01 – 0.05 = 5.15 mm

5. Car B overtakes another car A at relative speed of 40 ms^{-1}. How fast will the image of car B appear to move in the mirror of focal length 10 cm fitted in car A, when the car B is 1.9 m away from car A?

(1) 0.2 ms^{-1} (2) 40 ms^{-1} (3) 0.1 ms^{-1} (4) 4 ms^{-1}

Ans. (3)

Sol. u = – 1.9 m

f = 10 cm

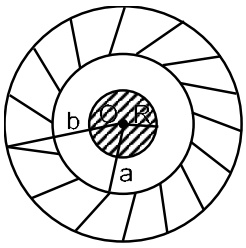
$$m \quad \frac{f}{f \quad u} \quad \frac{10}{10 \quad (\ 190)}$$

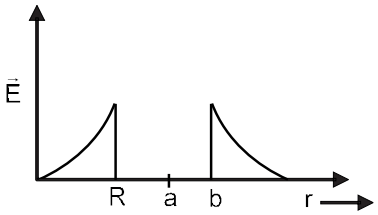
$$m \quad \frac{10}{200} \quad \frac{1}{20}$$

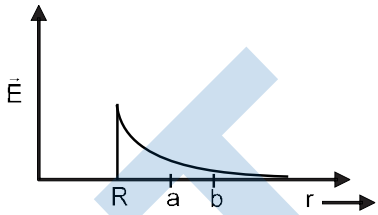
$$V_I \quad m^2 V_0 \quad \frac{1}{20}^{\;2} \quad 40$$

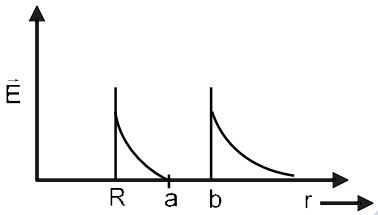
V_I = – 0.1 m/s

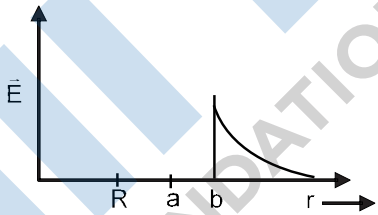
6. A solid metal sphere of radius R having charge q is enclosed inside the concentric spherical shell of inner radius a and outer radius b as shown in figure. The approximate variation electric field $\vec{E}$ as a function of distance r from centre O is given by:



(1)


(2)


(3)


(4)


Ans. (3)

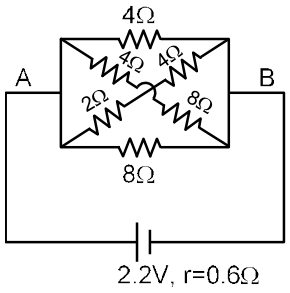
Sol. $0 < r < R$ $\quad E = 0$

$R \le r \le a$ $\quad E \dfrac{KQ}{r^2}$

$a < r \le b$ $\quad E = 0$

$r > b$ $\quad E \dfrac{kQ}{r^2}$

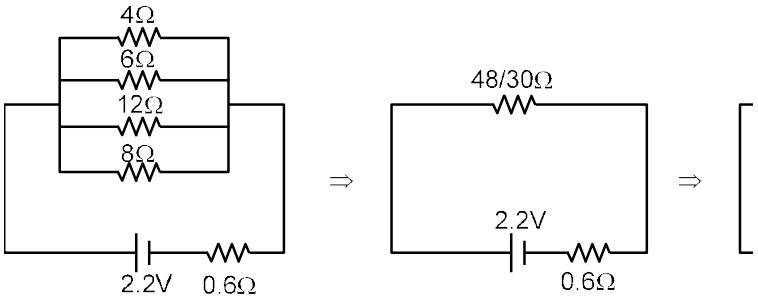
7. In the given figure, the emf of the cell is 2.2 V and if internal resistance is 0.6 Ω. Calculate the power dissipated in the whole circuit :



(1) 0.65 W (2) 4.4 W (3) 1.32 W (4) 2.2 W

Ans. (4)

Sol.



$P \quad \frac{V^2}{R}, P \quad \frac{(2.2)^2}{2.2} \quad 2.2W$

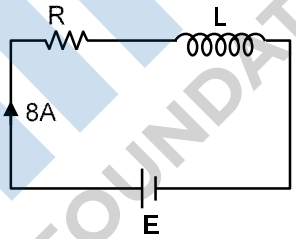
8. An inductor coil stores 64 J of magnetic field energy and dissipates energy at the rate of 640 W when a current of 8 A is passed through it. If this coil is joined across an ideal battery, find the time constant of the circuit in seconds :

(1) 0.8 (2) 0.125 (3) 0.4 (4) 0.2

Ans. (4)

Sol. $U \quad \frac{1}{2}LI^2$

$64 \quad \frac{1}{2}.L.(8)^2 \quad L \quad 2H$



and $P = I^2R$

$640 = (8)^2.R \Rightarrow R = 10\Omega$

time constant

$\frac{L}{R} \quad \frac{2}{10} \quad 0.2$

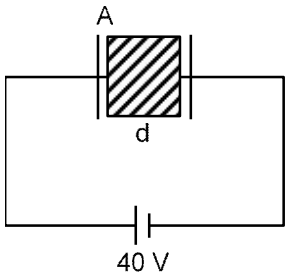
9. The material filled between the plates of a parallel plate capacitor has resistivity 200 Ωm. The value of capacitance of the capacitor is 2pF. If a potential difference of 40 V is applied across the plates of the capacitor, then the value of leakage current following out of the capacitor is: (given the value of relative permittivity of material is 50)

(1) 9.0 μA (2) 9.0 mA (3) 0.9 mA (4) 0.9 μA

Ans. (3)

Sol. $\rho = 200\ \Omega m$

$K = 50$



$C \quad \frac{_0 KA}{d} \quad 2 \quad 10^{-12} f$

$R \quad \frac{d}{A}$

$I \quad \frac{V}{R} \quad \frac{AV}{d} \quad \frac{V}{} \quad \frac{C}{_0 K} \quad \frac{40}{200} \quad \frac{2 \quad 10^{-12}}{8.85 \quad 10^{-12} \quad 50} \quad 0.9mA$

10. In a photoelectric experiment ultraviolet light of wavelength 280 nm used with lithium cathode having work function ϕ = 2.5 eV. If the wavelength of incident light is switched to 400 nm, find out the change in the stopping potential. (h = 6.63 × 10^{-34} Js, c = 3 × 108 ms^{-1})

(1) 0.6 V (2) 1.1 V (3) 1.3 V (4) 1.9 V

Ans. (3)

Sol. $eV_0 \quad \frac{hc}{}$

$eV_1 \quad \frac{hc}{280nm}$

$eV_2 \quad \frac{hc}{400nm}$

$e(V_1 \quad V_2) \quad 1240 \quad \frac{120}{280 \quad 400} \quad 1.3eV$

11. The initial mass of a rocket is 1000 kg. Calculate at what rate the fuel should be burnt so that rocket is given an acceleration of 20 ms^{-2}. The gases come out at a relative speed of 500 ms^{-1} with respect to he rocket: [Use g = 10 m/s^2]

(1) 6.0 × 10^2 kg s^{-1} (2) 500 kg s^{-1} (3) 10 kg s^{-1} (4) 60 kg s^{-1}

Ans. (4)

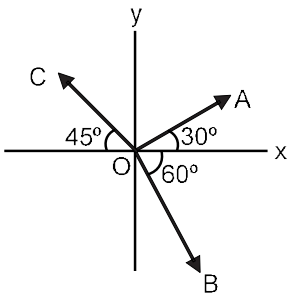
Sol. f_T mg = ma

$\frac{dm}{dt}v_r \quad mg \quad ma$

$\frac{dm}{dt}500 \quad 1000(10 \quad 20)$

$\frac{dm}{dt} \quad 60Kg/s$

12. The magnitude of vector $\overrightarrow{OA}, \overrightarrow{OB}$ and $\overrightarrow{OC}$ in the given figure are equal. The direction of $\overrightarrow{OA} \quad \overrightarrow{OB} \quad \overrightarrow{OC}$ with x-axis will be:



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

Ans. (2)

Sol. $\overrightarrow{OA}$ R cos30° î sin30° ĵ

$\overrightarrow{OB}$ R cos60° î (sin60°)ĵ

$\overrightarrow{OC}$ R cos45° î sin45° ĵ

$\overrightarrow{OA}$ $\overrightarrow{OB}$ $\overrightarrow{OC}$ R $\frac{1}{2}$ $\frac{\sqrt{3}}{2}$ $\frac{1}{\sqrt{2}}$ î R $\frac{1}{2}$ $\frac{\sqrt{3}}{2}$ $\frac{1}{\sqrt{2}}$ ĵ

angle with the x-axis

$$\tan \frac{\frac{1}{2} \quad \frac{\sqrt{3}}{2} \quad \frac{1}{\sqrt{2}}}{\frac{1}{2} \quad \frac{\sqrt{3}}{2} \quad \frac{1}{\sqrt{2}}} \quad \frac{1 \quad \sqrt{3} \quad \sqrt{2}}{1 \quad \sqrt{3} \quad \sqrt{2}}$$

$$\tan^{1} \frac{1 \quad \sqrt{3} \quad \sqrt{2}}{1 \quad \sqrt{3} \quad \sqrt{2}}$$

13. The fractional change in the magnetic field intensity at distance 'r' from centre on the axis of current carrying coil of radius 'a' to the magnetic field intensity at centre of the same coil is : (Take r < a)

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

Ans. (2)

Sol. $B_{axis} \quad \frac{\mu_0 i R^2}{2(R^2 \quad x^2)^{3/2}}$

$B_{centre} \quad \frac{\mu_0 i}{2R}$

$B_{axis} \quad \frac{\mu_0 i a^2}{2(a^2 \quad r^2)^{3/2}}$

$\therefore$ fractional change in magnetic field $\frac{\frac{\mu_0 i}{2a} \quad \frac{\mu_0 i a^2}{2(a^2 \quad r^2)^{3/2}}}{\frac{\mu_0 i}{2a}} \quad 1 \quad \frac{1}{1 \quad \frac{r^2}{a^2}^{3/2}}$

$1 \quad 1 \frac{3}{2}\frac{r^2}{a^2} \quad \frac{3}{2}\frac{r^2}{a^2}$

14. What equal length of an iron wire a copper-nickel alloy wire, each of 2 mm diameter connected parallel to give an equivalent resistance of 3 Ω?

[Given resistivities of iron and copper-nickel alloy wire are 12 μΩ cm and 51 μΩ cm respectively]

(1) 82 m (2) 97 m (3) 110 m (4) 90 m

Ans. (2)

Sol. $\frac{R_1 R_2}{R_1 \quad R_2} \quad 3$

$\frac{1\ 2}{1\ \ 2}\ \frac{\ell}{A}\ 3\ ;\ell\ 3\ A\ \frac{(\ 1\ \ 2)}{1\ 2}\ \frac{3\ \ (10^{\ 3})^2\ \ 63\ \ 10^{\ 8}}{12\ \ 51\ \ 10^{\ 16}};\ell\ \ 97m$

15. A series LCR circuit driven by 300 V at frequency of 50 Hz contains a resistance R = 3 kΩ, an inductor of inductive reactance XL = 250 πΩ and an unknown capacitor. The value of capacitance to maximize the average power should be: (take $\pi^2 = 10$)

(1) 4 μF (2) 400 μF (3) 40 μF (4) 25 μF

Ans. (1)

Sol. At resonance $\omega = 2\pi f$

$X_C = X_L$ $= 2\pi \times 50$

$\frac{1}{C}\ \ L$ $= 100\ \pi$

$\frac{1}{C}\ \ 250$

$C\ \ \frac{1}{100\ \ \ 250}\ \ 4\mu F$

16. The rms speed of the molecules of Hydrogen, Oxygen and Carbon dioxide at the same temperature are V_H, V_O and V_C respectively then :

(1) $V_H > V_O > V_C$ (2) $V_H = V_O > V_C$ (3) $V_C > V_O > V_H$ (4) $V_H = V_O = V_C$

Ans. (1)

Sol. $V_{rms}\ \ \sqrt{\frac{3RT}{M}}\ \ \frac{1}{\sqrt{M}}$

$M_{H_2}\ \ M_{O_2}\ \ M_{CO_2}$

$V_{H_2}\ \ V_{O_2}\ \ V_{CO_2}$

17. A particular hydrogen like ion radiation of frequency 2.92×10^{15} Hz when it makes transition from n = 3 to n = 1. The frequency in Hz of radiation emitted in transition from n = 2 to n = 1 will be:

(1) 6.57×10^{15} (2) 2.46×10^{15} (3) 4.38×10^{15} (4) 0.44×10^{15}

Ans. (2)

Sol. $h\ \ E_0 z^2\ \frac{1}{n_1^2}\ \ \frac{1}{n_2^2}$

$\frac{1}{n_1^2}\ \ \frac{1}{n_2^2}$

$\frac{2.19\ \ 10^{15}}{\frac{1}{1}\ \ \frac{1}{4}}\ \ \frac{\frac{1}{1}\ \ \frac{1}{9}}{\frac{1}{1}\ \ \frac{1}{4}}$

$2.19 \quad 10^{15} \frac{3}{4} \quad \frac{9}{8}$

$\upsilon = 2.46 \times 10^{15}$ Hz

18. Inside a uniform spherical shell:

(a) The gravitation field is zero

(b) The gravitational potential is zero

(c) The gravitational field is same everywhere.

(d) the gravitational potential is same everywhere.

(e) all of the above

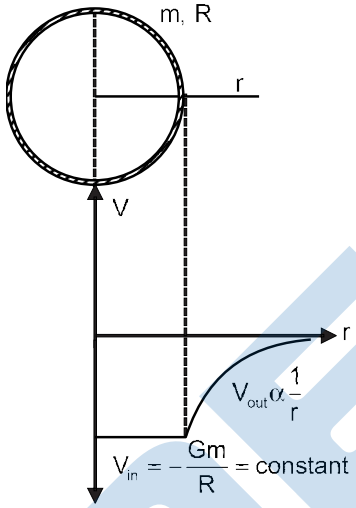
Choose the most appropriate answer from the options given below:

(1) (b), (c), and (d) only (2) (e) only

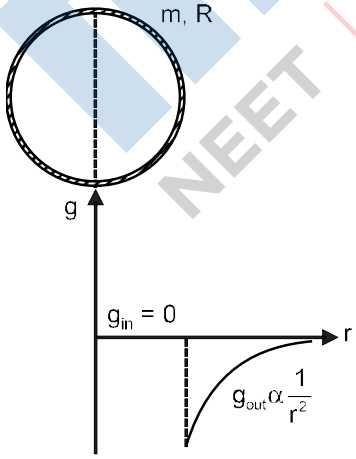
(3) (a), (c) and (d) only (4) (a), (b) and (c) only

Ans. (3)

Sol. Gravitational potential due to uniform spherical shell



Gravitational field due to uniform spherical shell



19. If E, L, M and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimension of P in the formula $P = EL^2M^{-5}G^{-2}$ are:

(1) $[M^1L^1T^{-2}]$ (2) $[M^{-1}L^{-1}T^2]$ (3) $[M^0L^1T^0]$ (4) $[M^0L^0T^0]$

Ans. (4)

Sol. $P = EL^2M^{-5}G^{-2}$

$P = [ML^2T^{-2}]\,[ML^2T^{-1}]^2\,[M^{-5}]\,[M^{-1}L^3T^{-2}]^{-2}$

$P = [M^0L^0T^0]$

20. **Statement-I :** By doping semiconductor with pentavalent material, the density increases.

Statement-II : The n-type semiconductor has net negative charge.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are false. (2) Both Statement I and Statement II are true.

(3) Statement I is false but Statement II is true. (4) Statement I is true but Statement II is false.

Ans. (4)

Sol. Pentavalent material have excess free e^- So e^- density increases but overall semiconductor is neutral.

Numeric Value Type

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

1. A source and a detector move away from each other in absence of wind with a speed of 20 m/s with respect to the ground. If the detector detects a frequency of 1800 Hz of the sound coming from the source, then the original frequency of source considering speed of sound in air 340 m/s will be_____Hz.

Ans. (2025)

Sol. $f' \quad f \frac{v \quad v_0}{v \quad v_s}$

$1800 \quad f \frac{340 \quad 20}{340 \quad 20}$

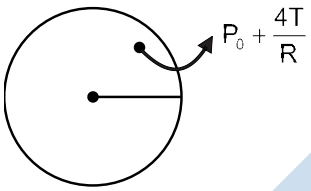
$f \quad \frac{1800 \quad 360}{320}$

$f = 2050$ Hz

2. A soap bubble of radius 3 cm is formed inside the another soap bubble of radius 6 cm. The radius of an equivalent soap bubble which has the same excess pressure as inside the smaller bubble with respect to the atmospheric pressure is____cm.

Ans. (2)

Sol.



$P_0 \quad \frac{4T}{6} \quad \frac{4T}{3} \quad P_0 \quad \frac{4T}{R}$

$\frac{1}{6} \quad \frac{1}{3} \quad \frac{1}{R}$

$R = 2$ cm

3. An amplitude modulated wave is represented by $C_m(t) = 10\ (1 + 0.2 \cos 12560t) \sin (111 \times 10^4 t)$ volts. The modulating frequency in kHz will be_____.

Ans. 2

Sol. $C_m \quad A_C \ 1 \ \frac{A_m}{A_C} \sin 2 \ f_m t$

$2\pi f_m = 12560$

$f_m = 2000$ Hz $= 2$KHz

4. The electric field in a plane electromagnetic wave is given by

$\vec{E}$ 200 cos $\frac{0.5 \quad 10^3}{m}$ x 1.5 $10^{11}\frac{rad}{s}$ t $\frac{v}{m}\hat{j}$. If this wave falls normally on a perfectly reflecting surface having an area of 100 cm^2. If the radiation pressure exerted by the E. M. wave on the surface during a 10 minute exposure is $\frac{x}{10^9}\frac{N}{m^2}$. Find the value of x.

Ans. 354

Sol. $E_0 = 200$

I $\frac{1}{2}\ {}_0E_0^2.C$

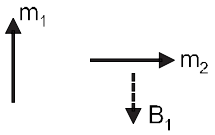
Radiation pressure

P $\frac{2I}{C}$ $\frac{2}{C}$ $\frac{1}{2}\ {}_0E_0^2C$ ${}_0E_0^2$ 8.85 $10^{\ 12}$ 200^2 8.85 $10^{\ 8}$ 4 $\frac{354}{10^9}$

5. Two short magnetic dipoles m_1 and m_2 each having magnetic moment of 1 Am^2 are placed at point O and P respectively. The distance between OP is 1 meter. The torque experienced by the magnetic dipole m^2 due to the presence of m1 is _____× 10^{-7} Nm.

Ans. 1

Sol.



$\vec{M}_2$ $\vec{B}_1$

$M_2B_1 \sin 90° \quad 1 \quad \frac{\mu_0}{4}\frac{M}{(1)^3}1 \quad 10^{\ 7}$N.m

6. Two spherical balls having equal masses with radius of 5 cm each are thrown upwards along the same vertical direction at an interval of 3s with the same initial velocity of 35 m/s, then these balls collide at a height of _____m. (take g = 10 m/s^2)

Ans. 50

Sol. $S_1 = S_2$

35t $\frac{1}{2}(\ g)t^2$ 35(t 3) $\frac{1}{2}(\ g)(t \quad 3)^2$

35t $\frac{1}{2}gt^2$ 35t 35 $3\frac{1}{2}g(t^2$ 6t 9)

35 × 3 + 45 = 30 t

t $\frac{150}{30}$ 5

height h 35 5 $\frac{1}{2}$ 10 5^2

h = 175 – 125 = 50 m

7. White light is passed through a double slit and interference is observed on a screen 1.5 m away. The separation between the slits is 0.3 mm. The first violet and red fringes are formed 2.0 mm and 3.5 mm away from the central white fringes. The difference in wavelength of red and violet light is____nm.

Ans. 300

Sol. $y_1 \quad \frac{{}_1D}{d}$

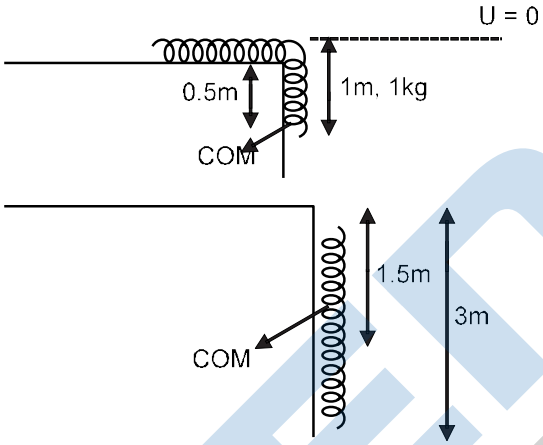
$y_2 \quad \frac{{}_vD}{d}$

$_r \quad _v \quad (y_1 \quad y_2)\frac{d}{D} \quad (3.5 \quad 2)mm \quad \frac{0.3mm}{1.5m} \quad 300nm$

8. A uniform chain of length 3 meter and mass 3 kg overhangs a smooth table with 2 meter laying on the table. If k is the kinetic energy of the chain in joule as it completely slips off the table, then the value of is ____.

Ans. 40

Sol.



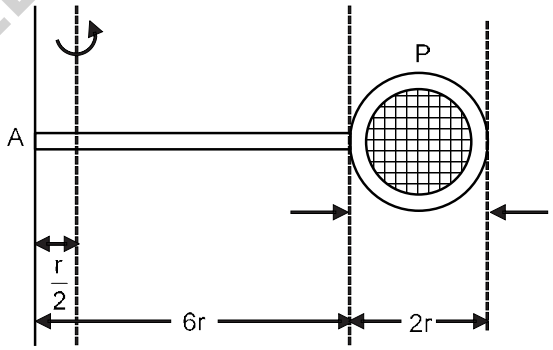
Apply conservation of energy $U_i + K_i = U_f + K_f$

$1 \quad 10 \quad \frac{1}{2} \quad 0 \quad 3 \quad 10 \quad 1.5 \quad KE$

K.E. = 45 – 5

K.E. = 40J

9. Consider a badminton racket with length scales as shown in the figure.



If the mass of the linear and circular portions of the badminton racket are same (M) and the mass of the threads are negligible, the moment of inertia of the racket about an axis perpendicular to the handle and in the plane of the ring at, $\frac{r}{2}$ distance from the end A of the handle will be_____Mr^2.

Ans. 52

Sol. $I_A \quad \frac{Mr^2}{2} \quad M\ 7r\ \frac{r}{2}^{\ 2} \quad \frac{M(6r)^2}{12} \quad M\ 3r\ \frac{1}{2}^{\ 2}$

$\frac{Mr^2}{2} \quad M\frac{(169)r^2}{4} \quad M3r^2 \quad \frac{M25r^2}{4} \quad \frac{171Mr^2}{4} \quad \frac{37Mr^2}{4} \quad \frac{208}{4}Mr^2 \quad 52Mr^2$

10. Two travelling waves produces a standing wave represented by equation. $y = 1.0\ mm\ \cos(1.57\ cm^{-1})x\ \sin(78.5\ s^{-1})t$. The node closest to the origin in the region $x > 0$ will be at x =_____cm.

Ans. 1

Sol. At Node

$y = 0$

$1\cos(1.57x)\sin(178.5)t = 0$

$\cos(1.57x) = 0$

$1.57x \quad \frac{}{2}$

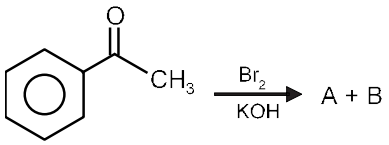
$x = 1\ cm$

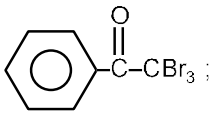
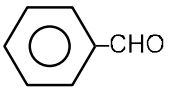
PART B : CHEMISTRY

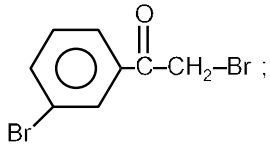
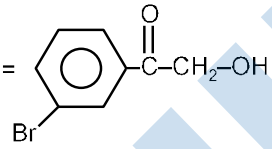
Single Choice Type

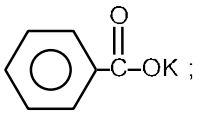
This section contains **20 Single choice questions**. Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

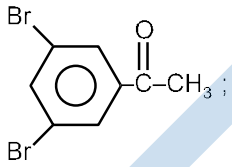
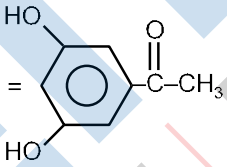
1. The major products formed in the following reaction sequence A and B are :



(1) A =  ; B = 

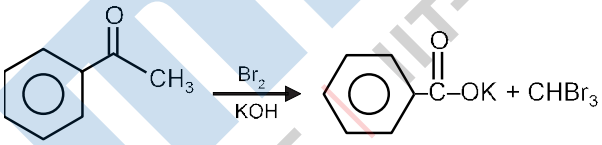
(2) A =  ; B = 

(3) A =  ; B = $CHBr_3$

(4) A =  ; B = 

Ans. (3)

Sol. It is Haloform reaction.



2. Given below are two statements.

Statement-I : The choice of reducing agents for metals extraction can be made by using Ellingham diagram, a plot of ΔG vs temperature.

Statement-II : The value of ΔS increases from left to right in Ellingham diagram.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement-I is false but Statement-II is true.

(2) Both Statement-I and Statement-II are false.

(3) Statement-I is true but Statement-II is false.

(4) Both Statement-I and Statement-II are true.

Ans. (3)

Sol. Ellingham diagram is used to check which metal oxide is reduced by which compound.

3. Given below are two statements :

Statement-I : In the titration between strong acid and weak base methyl orange is suitable as an indicator.

Statement-II : For titration of acetic acid with NaOH phenolphthalein is not a suitable indicator.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement-I is false but Statement-II is true

(2) Both Statement-I and Statement-II are false

(3) Statement-I is true but Statement-II is false

(4) Both Statement-I and Statement-II are true

Ans. (3)

Sol. (1) MeOH is suitable indicator for titration of strong acid and weak base.

(2) Hph is suitable indicator for titration of weak acid and strong base.

4. What the products formed in sequence when excess of CO_2 is passed in slaked lime ?

(1) $CaCO_3$, $Ca(HCO_3)_2$ (2) $Ca(HCO_3)_2$, $CaCO_3$

(3) CaO, $Ca(HCO_3)_2$ (4) CaO, $CaCO_3$

Ans. (1)

Sol. Slaked lime $\xrightarrow[CO_2]{\text{Pass}}$ $CaCO_3$ $\xrightarrow[\text{Passage of } CO_2]{\text{Prolong}}$ $Ca(HCO_3)_2$

5. Which one of the following methods is most suitable for preparing deionized water ?

(1) Permutit method (2) Synthetic resin method

(3) Calgon's method (4) Clark's method

Ans. (2)

Sol. Pure de-mineralised (de-ionised) water free from all soluble mineral salt is obtained by passing water successively through a cation exchange and an anion exchange resins.

$2RH(S) + M^{2+}(aq) \rightleftharpoons MR_2(S) + 2H^+(aq)$

6. Which one of the following when dissolved in water gives coloured solution in nitrogen atmosphere ?

(1) Cu_2Cl_2 (2) $CuCl_2$ (3) $ZnCl_2$ (4) AgCl

Ans. (2)

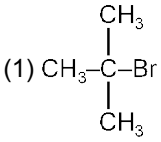
Sol. $CuCl_2$ dissolve in water & give coloured solutions.

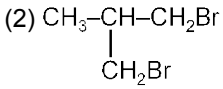
AgCl not soluble in water.

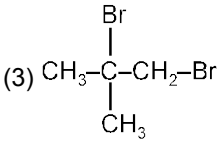
Cu_2Cl_2 is not soluble in water.

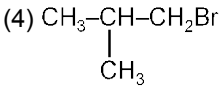
$ZnCl_2$ is soluble but colourless.

7. Excess of isobutene on reaction with Br_2 in presence of light at 125°C gives which one of the following, as the major product ?

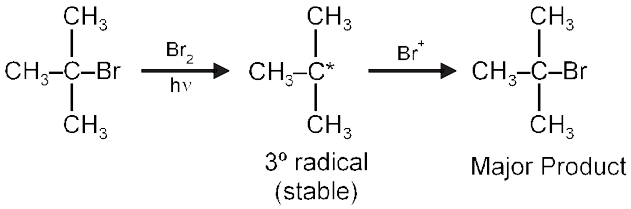
(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. 

8. Which one of the following, is correct for the adsorption of a gas at a given temperature on a solid surface?

(1) $\Delta H < 0, \Delta S < 0$ (2) $\Delta H > 0, \Delta S < 0$ (3) $\Delta H > 0, \Delta S > 0$ (4) $\Delta H < 0, \Delta S > 0$

Ans. (1)

Sol. Adsorption of gas on solid surface is exothermic process & entropy is decrease in this process so

$\Delta H < 0, \Delta S < 0$

9. Given below are two statements :

Statement-I : Frekel defects are vacancy as well as interstitial defects.

Statement-II : Frenkel defect leads to colour in ionic solids due to presence of F-centres.

Choose the most appropriate answer for the statements from the options given below :

(1) Both Statement-I and Statement-II are false

(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 true

Ans. (2)

Sol. Frenkel defect is dislocation defect, it is not interstitial defect and it is not responsible for colour of solid.

Note : NTA ans. is (2), But Zigyan ans. is (1).

10. Given below are two statements :

Statement-I : The limiting molar conductivity of KCl (strong electrolyte) is higher compared to that of CH_3COOH (weak electrolyte).

Statement-II : Molar conductivity decreases with decrease in concentration of electrolyte.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement-I is true but Statement-II is false

(2) Both Statement-I and Statement-II are true

(3) Statement-I is false but Statement-II is true

(4) Both Statement-I and Statement-II are false

Ans. (4)

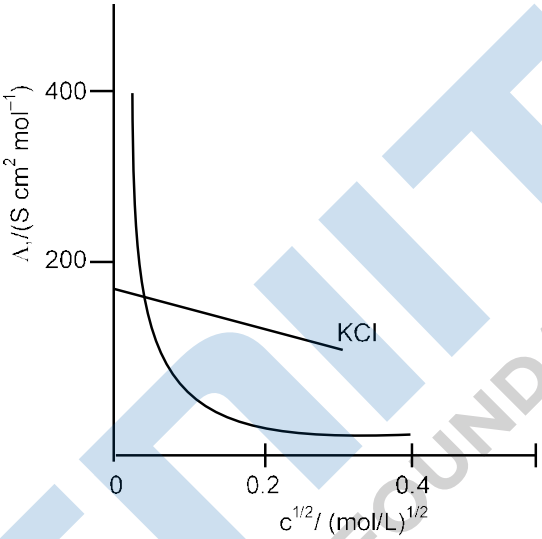
Sol.

Ion	K^+	Cl^-	CH_3COO^-	H^+
$\lambda°/(S\ cm^2mol^{-1})$	73.5	76.3	40.9	349.6

$\lambda°_M(CH_3COOH) = \lambda°_M(H^+) + \lambda°_M(CH_3COO^-) = 349.6 + 40.9 = 390.5\ S\ cm^2mol^{-1}$

$\lambda°_M(KCl) = \lambda°_M(K^+) + \lambda°_M(Cl^-) = 73.5 + 76.3 = 149.8\ S\ cm^2mol^{-1}$

So, statement-I is false.



For an electrolyte the dilution increases (or) decrease in concentration, the number of ions increases due to increase of degree of dissociation. So, the molar conductance increases. Hence Statement-II is false.

11. The incorrect statement is :

(1) On hydrolysis CIF forms HOCl and HF.

(2) Cl_2 is more reactive than CIF.

(3) F_2 is more reactive than CIF.

(4) F_2 is a stronger oxidizing agent than Cl_2 in aqueous solution.

Ans. (2)

Sol. In general, interhalogen compounds are more reactive than halogens (except fluorine). This is because X – X' bond in interhalogens is weaker than X – X bond in halogens except F – F bond. All these undergo hydrolysis giving halide ion derived from the smaller halogen and a hypohalite (when XX'), halite (when XX'_3), halate (when XX'_5) and perhalate (when XX'_7) anion derived from the larger halogen.

$$XX' + H_2O \rightarrow HX' + HOX$$

12. The conversion of hydroxyapatite occurs due to presence of F– ions in water. The correct formula of hydroxyapatite is :

(1) $[3Ca_3(PO_4)_2.CaF_2]$ (2) $[3Ca(OH)_2.CaF_2]$

(3) $[Ca_3(PO_4)_2.CaF_2]$ (4) $[3Ca_3(PO_4)_2.Ca(OH)_2]$

Ans. (4)

Sol. Hydroxyapatite $\rightarrow [3Ca_3(PO_4)_2.Ca(OH)_2]$

Hydroxyapatite in presence of F– ions converts to fluorapatite $[3Ca_3(PO_4)_2.CaF_2]$.

13. Given below are two statements :

Statement-I : According to Bohr's model of an atom, qualitatively the magnitude of velocity of electron increases with decrease in positive charges on the nucleus as there is no strong hold on the electron by the nucleus.

Statement-II : According to Bohr's model of an atom, qualitatively the magnitude of velocity of electron increases with decrease in principal quantum number.

In the light of the above statements, choose the most appropriate answer from the options gien below :

(1) Statement-I is true but Statement-II is false

(2) Statement-I is false but Statement-II is true

(3) Both Statement-I and Statement-II are false

(4) Both Statement-I and Statement-II are true

Ans. (2)

Sol. $V_n \quad (2.18 \quad 10^6) \quad \frac{Z}{n} m/sec; V_n \quad \frac{1}{n}; n \quad , V_n$

14. Which one of the following complexes is violet in colour ?

(1) $Fe_4[Fe(CN)_6]_3.H_2O$ (2) $[Fe(CN)_5NOS]^{4-}$

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

Ans. (2)

Sol. $S^{2-} + Na_2[Fe(CN)_5(NO)^+] \longrightarrow Na_4[Fe(CN)_5(NOS)]$

Sodium nitroprusside Violet colour

15. The correct sequential addition of reagents in the preparation of 3-nitrobenzoic acid from benzene is :

(1) $Br_2/AlBr_3$, HNO_3/H_2SO_4, Mg/ether, CO_2, H_3O^+

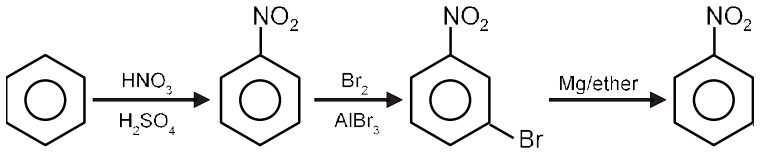
(2) $Br_2/AlBr_3$, NaCN, H_3O^+, HNO_3/H_2SO_4

(3) HNO_3/H_2SO_4, $Br_2/AlBr_3$, Mg/ether, CO_2, H_3O^+

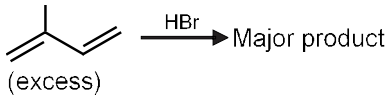
(4) $Br_2/AlBr_3$, HNO_3/H_2SO_4, NaCN, H_3O^+

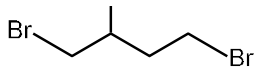
Ans. (3)

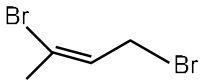
Sol.

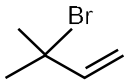


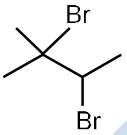
16. The major product formed in the following reaction is :



(1) 

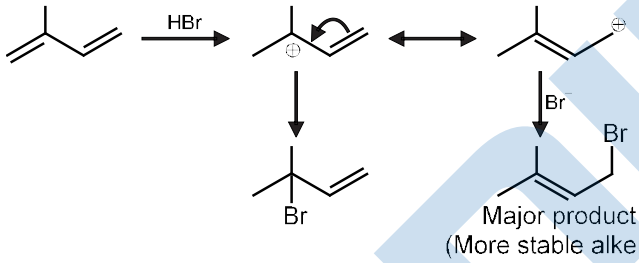
(2) 

(3) 

(4) 

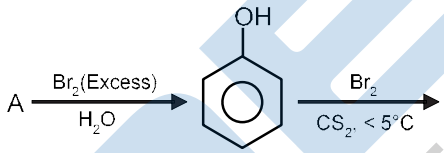
Ans. (2)

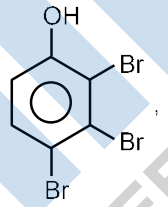
Sol.

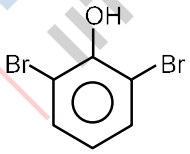


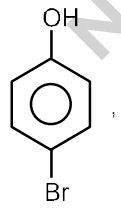
At 25°C thermodynamically controlled Product is formed as major product.

17. The correct options for the products A and B of the following reactions are :

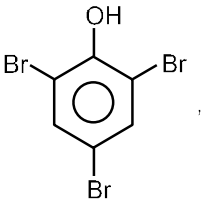
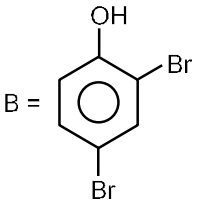


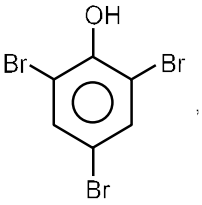
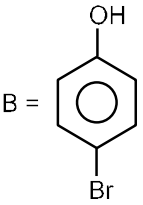
(1) A = 

, B = 

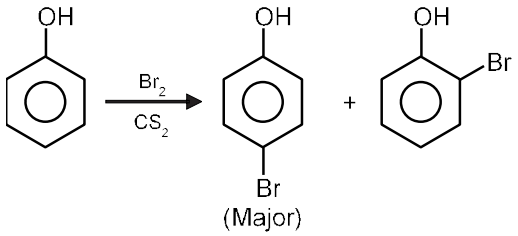
(2) A = 

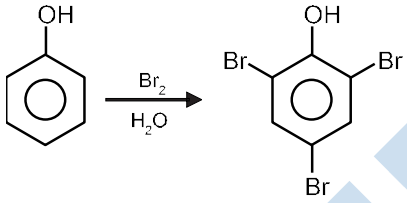
, B = 

(3) A =  , B = 

(4) A =  , B = 

Ans. (4)

Sol. 



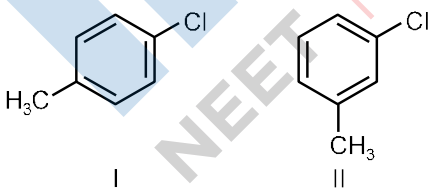
18. The polymer formed on heating Novolac with formaldehyde is :

(1) Bakelite (2) Polyester (3) Melamine (4) Nylon 6, 6

Ans. (1)

Sol. Note → Novalac on heating with formaldehyde undergoes cross linking to form infusible solid mass called Bakelite.

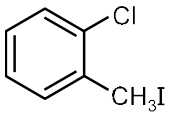
19. Among the following compounds I-IV, which one forms a yellow precipitate on reacting sequentially with (i) NaOH (ii) dil. HNO_3 (iii) $AgNO_3$?



I II III

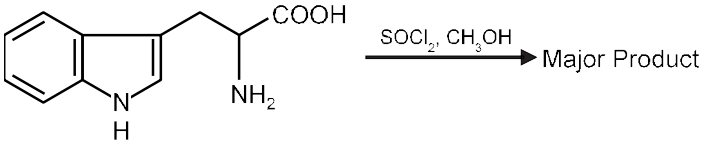
(1) I (2) III (3) II (4) IV

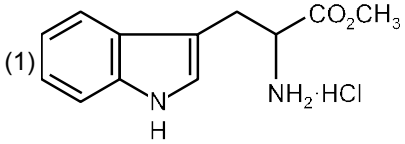
Ans. (4)

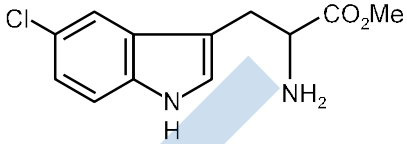
Sol. Only in  , I^- can be substituted by OH^-, I^- combine with Ag^+ to form yellow ppt of AgI.

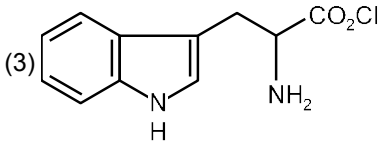
While in I, II and III substitution reaction is not possible due to partial double bond character.

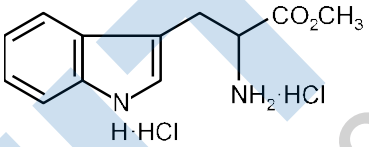
20. The major product formed in the following reaction is :



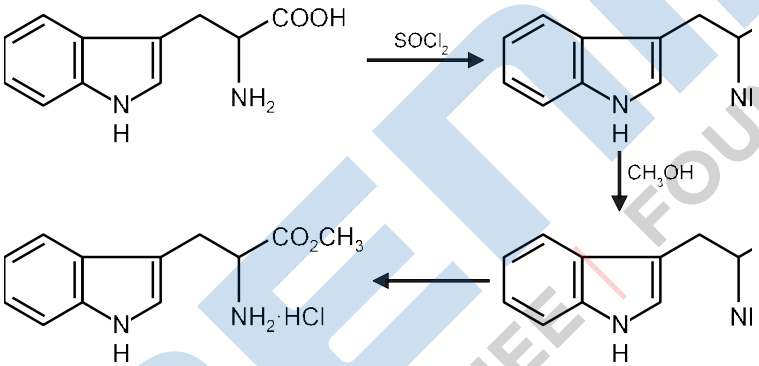
(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. 

Numeric Value Type

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

1. The number of 4f electrons in the ground state electronic configuration of Gd^{2+} is……..

[Atomic number of Gd = 64]

Ans. (7)

Sol. Gd = [Xe] $4f^7\ 5d^1\ 6s^2$

Gd^{2+} = [Xe] $4f^8$ [due to orbital contraction]

2. An aqueous KCl solution of density 1.20 g mL^{-1} has a molality of 3.30 mol kg^{-1}. The molarity of the solution in mol L^{-1} is……

Ans. (3)

Sol. $$\text{Molality(m)} \quad \frac{M \quad 1000}{1000 \quad d \quad M \quad M_{solute}}$$

$$3.3 \quad \frac{M \quad 1000}{1000 \quad 1.20 \quad M \quad 74.5}$$

$3960 - 245.85\ M = 1000\ M$

$1245.85\ M = 3960$

$$M \quad \frac{3960}{1245.85} \quad 3.17 \quad 3M$$

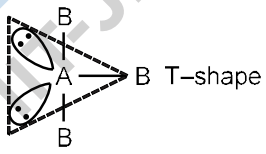
3. AB_3 is an interhalogen T-shaped molecule. The number of lone pairs of electrons on A is……

Ans. (2)

Sol. In interhalogen compound AB_3

Central atom A is halogen so it contain 7 electrons in its outer most shell.

so its structure is



So central atom A contain 2 lone pairs of electrons.

4. Of the following four aqueous solutions, total number of those solutions whose freezing point is lower than that of 0.10 M C_2H_5OH……..

(i) 0.10 M $Ba_3(PO_4)_2$ (ii) 0.10 M Na_2SO_4 (iii) 0.10 M KCl (iv) 0.10 M Li_3PO_4

Ans. (4)

Sol. $\Delta T_f = ik_fm$

As m is same for all solution so ΔT_f depends on vantHoff factor (i).

Greater is i small is freezing point.

Compound	i
C_2H_5OH	1
$Ba_3(PO_4)_2$	5
Na_2SO_4	3
KCl	2
Li_3PO_4	4

So the given solutions have lower freezing point than ethanol.

5. The Born-Haber cycle for KCl is evaluated with the following data :

$\Delta_fH^\ominus$ for KCl = – 436.7 kJ mol^{-1} ; $\Delta_{sub}H^\ominus$ for K = 89.2 kJ mol^{-1} ;

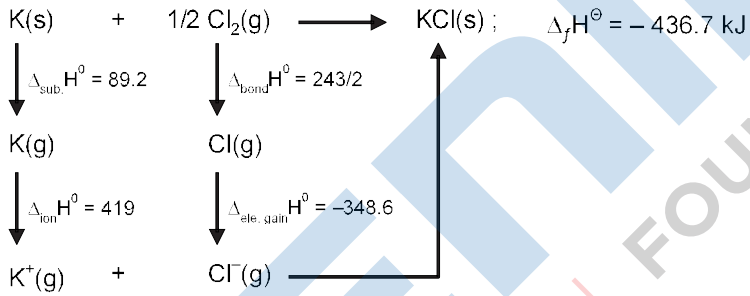
$\Delta_{ionization}H^\ominus$ for K = 419 kJ mol^{-1} ; $\Delta_{electron\ gain}H^\ominus$ for Cl(g) = –348.6 kJ mol^{-1} ;

$\Delta_{bond}H^\ominus$ for Cl2 = 243.0 kJ mol^{-1}

The magnitude of lattice enthalpy of KCl in kJ mol^{-1} is……

Ans. (718)

Sol.



so, $\Delta_fH^\ominus = \Delta_fH^\ominus (KCl) = \Delta_{sub}H^\ominus + \Delta_{1st\ ionisation}H^\ominus (K) + ½\Delta_{bond}H^\ominus (Cl_2(g)) + \Delta_{electron\ gain}H^\ominus + \Delta_{lattice}H^\ominus$

$– 436.7 = 89.2 + 419 + ½(243) + (–348.6) + \Delta_{lattice}H^\ominus$

$\Delta_{lattice}H^\ominus = – 717.8$ kJ $mole^{-1} \approx – 718$ kJ $mole^{-1}$

6. These are physical properties of an element

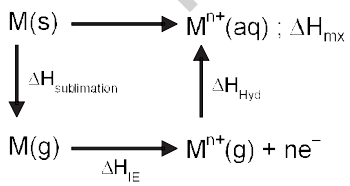
(A) Sublimation enthalpy (B) Ionisation enthalpy

(C) Hydration enthalpy (D) Electron gain enthalpy

The total number of above properties that affect the reduction potential is……

Ans. (3)

Sol.



So reduction potential depends of sublimation, ionization and Hydration energy.

7. The ratio of number of water molecules in Mohr's salt and potash alum is..... $\times 10^{-1}$.

Ans. (5)

Sol. Mohr's salt = $FeSO_4(NH_4)_2SO_4 \cdot 6H_2O$

Potash alum = $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$

So water molecule ratio $\frac{6}{24}$ $\frac{1}{4}$ 0.25 2.5 10^{1}

Note : NTA ans. is 5, but Reso ans. is 2.5.

8. The following data was obtained for chemical reaction given below at 975 K.

$2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$

	[NO]	$[H_2]$	Rate
	mol L^{-1}	mol L^{-1}	mol L^{-1} s^{-1}
(A)	8×10^{-5}	8×10^{-5}	7×10^{-9}
(B)	24×10^{-5}	8×10^{-5}	2.1×10^{-8}
(C)	24×10^{-5}	32×10^{-5}	8.4×10^{-8}

The order of the reaction with respect to NO is.....

Ans. (1)

Sol. rate = $K[NO]^x [H_2]^y$

From (A) $7 \times 10^{-9} = K(8 \times 10^{-5})^x (8 \times 10^{-5})^y$ ..... (1)

From (B) $2.1 \times 10^{-8} = K(24 \times 10^{-5})^x (8 \times 10^{-5})^y$ ..... (2)

(1)/(2) $\Rightarrow$ $\frac{7 \quad 10^{9}}{2.1 \quad 10^{8}}$ $\frac{K(2 \quad 10^{5}) \quad (8 \quad 10^{5})y}{K(24 \quad 10^{5}) \quad (8 \quad 10^{5})y}$

$\frac{1}{3}$ $\frac{1}{3}^{x}$

$\Rightarrow$ $x = 1$

Order of reaction w.r.t. NO is x = 1.

9. The OH^- concentration in a mixture of 5.0 mL of 0.0504 M NH_4Cl and 2 mL of 0.0210 M NH_3 solution is $x \times 10^{-6}$ M. The value of x is.....

[Given $K_w = 1 \times 10^{-14}$ and $k_b = 1.8 \times 10^{-5}$]

Ans. (3)

Sol. $[NH_4Cl] = [NH_4^+] = 0.0504$ M V = 5.0 mL

$[NH_3] = 0.0210$ M V = 2.0 mL

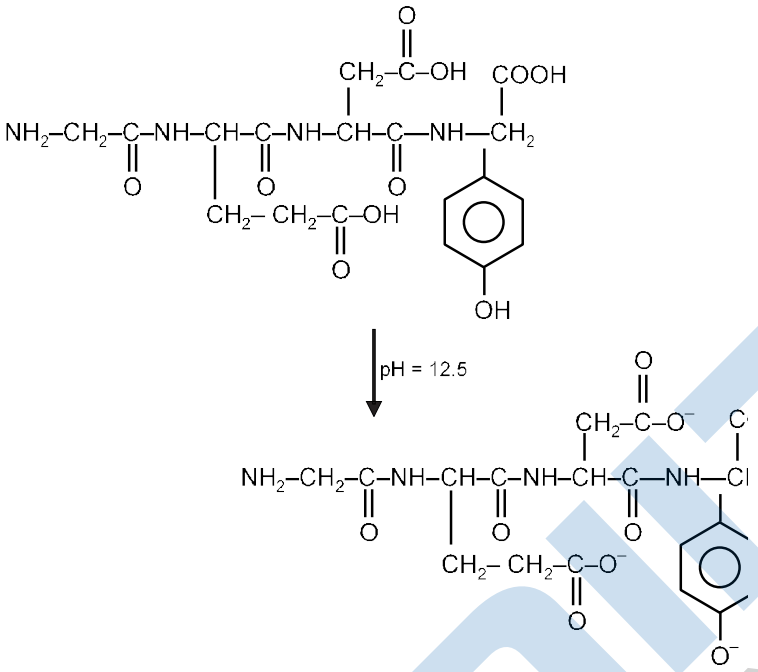
K_b $\frac{[NH_4][OH^-]}{[NH_3]}$

$$[OH^-] \quad \frac{K_b \quad [NH_3]}{[NH_4^+]} \quad \frac{1.8 \quad 10^{-5} \quad 0.0210 \quad 2}{0.0504 \quad 5} \quad 3 \quad 10^{-6} M$$

10. The total number of negative charge in the tetrapeptide, Gly-Glu-Asp-Tyr, at pH 12.5 will be…….

Ans. (4)

Sol.



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. The sum of solutions of the equation $\frac{\cos x}{1 \quad \sin x} \quad |\tan 2x|, x \quad \frac{}{2}, \frac{}{2} \quad \frac{}{4}, \frac{}{4}$ is :

(1) $\frac{}{10}$ (2) $\frac{7}{30}$ (3) $\frac{}{15}$ (4) $\frac{11}{30}$

Ans. (4)

Sol. $\frac{\cos x}{1 \quad \sin x} \quad |\tan 2x| \qquad x \quad \frac{}{2}, \frac{}{2} \quad \frac{}{4}, \frac{}{4}$

Case-I $0 \quad x \quad \frac{}{4} \quad \& \quad \frac{}{2} \quad x \quad \frac{}{4}$

$\frac{\cos x}{1 \quad \sin x} \quad \frac{2\sin x \cos x}{\cos^2 x \quad \sin^2 x} \quad \cos x(\quad 4\sin^2 x \quad 2\sin x \quad 1) \quad 0$

$\cos x = 0 \; \& \quad 4\sin^2 x + 2\sin x - 1 = 0$

$\sin x \quad \frac{2 \quad 2\sqrt{5}}{8} \quad \frac{1 \quad 2\sqrt{5}}{8} \quad \frac{1 \quad \sqrt{5}}{4}$

$x \quad \frac{}{10}, \frac{3}{10}$

Case-II $x \quad \frac{}{4}, \frac{}{2} \quad \& \quad x \quad \frac{}{4} \quad x \quad 0$

$\cos x = 0 \; \& \quad \sin x \quad \frac{1}{2} \quad x \quad \frac{}{6}$

sum of solutions $\frac{}{10} \quad \frac{3}{10} \quad \frac{}{6} \quad \frac{11}{30}$

2. Out of all the patients in a hospital 89% are found to be suffering from heart ailment and 98% are suffering from lungs infection. If K% of them are suffering from both ailments, then K can not belong to the set :

(1) {80, 83, 86, 89} (2) {84, 87, 90, 93} (3) {79, 81, 83, 85} (4) {84, 86, 88, 90}

Ans. (3)

Sol. Let H and L is set of people suffered from heart ailment and lungs infections respectively.

$n(H) = 89\%$

$n(L) = 98\%$

$n(H \cap L) = x\%$

$\max\{0, n(H) + n(L) - n(H \cup L)\} \le n(H \cap L) \le \min\{n(H), n(L)\}$

So, $87\% \le x \le 89\%$

3. Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = \hat{j} - \hat{k}$. If $\vec{c}$ is a vector such that $\vec{a} \times \vec{c} = \vec{b}$ and $\vec{a} \cdot \vec{c} = 3$, then $\vec{a} \cdot \vec{b} \times \vec{c}$ is equal to:

(1) – 6 (2) 6 (3) –2 (4) 2

Ans. (3)

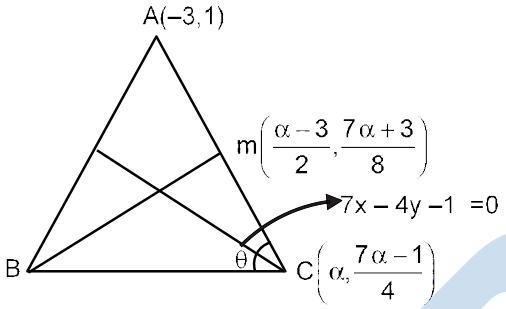
Sol. $[\vec{a}\ \vec{b}\ \vec{c}] - [\vec{c}\ \vec{a}\ \vec{b}] = (\vec{c} \times \vec{a}) \cdot \vec{b} = \vec{b} \cdot \vec{b} = 2$

4. Let ABC be a triangle with A (–3, 1) and $\angle ACB = \theta$, $0 < \theta < \frac{\pi}{2}$. If the equation of the median through B is $2x + y - 3 = 0$ and the equation of angle bisector of C is $7x - 4y - 1 = 0$, then $\tan\theta$ is equal to :

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

Ans. (4)

Sol.



Let C $\left(\alpha, \frac{7\alpha - 4}{4}\right)$ $\because$ (C lies on $7x - 4y - 1 = 0$)

mid point of AC is m M $\left(\frac{\alpha - 3}{2}, \frac{7\alpha - 3}{8}\right)$

now M lies on $2x + y - 3 = 0$

So, C (3,5)

slope of AC is $\frac{2}{3}$ and slope of $7x - 4y - 1 = 0 \Rightarrow$ Slope $\frac{7}{4}$

$$\tan\theta = \left|\frac{\frac{7}{4} - \frac{2}{3}}{1 + \frac{7}{4}\cdot\frac{2}{3}}\right| = \frac{1}{2}$$

$$\tan\theta = \left|\frac{2 - \frac{1}{2}}{1 + \frac{1}{4}}\right| = \frac{4}{3} \quad \tan\theta = \frac{4}{3}$$

5. Let $f(x) = \cos\left(2\tan^{-1}\left(\sin\left(\cot^{-1}\sqrt{\frac{1+x}{x}}\right)\right)\right)$, $0 < x < 1$. Then :

(1) $(1 - x)^2 f'(x) + 2 (f(x))^2 = 0$ (2) $(1 - x)^2 f'(x) - 2 (f(x))^2 = 0$

(3) $(1 + x)^2 f'(x) + 2 (f(x))^2 = 0$ (4) $(1 + x)^2 f''(x) - 2 (f(x))^2 = 0$

Ans. (1)

Sol. Put $x = \sin^2\theta$, $0 < x < 1$

$\sin \sqrt{x}$

$f(x) \cos 2\tan^{-1}\sin \cot^{-1}\sqrt{\frac{1-\sin^2}{\sin^2}}$

$\Rightarrow f(x) = \cos(2\tan^{-1}(\sin\theta))$

$f(x) \cos(2\tan^{-1}\sqrt{x})$

$\frac{1-\tan^2(\tan^{-1}\sqrt{x})}{1-\tan^2(\tan^{-1}\sqrt{x})}$

$f(x) \frac{1-x}{1-x}$

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

$(1-x)^2 f'(x) + 2f(x))^2 = 0$ option (1) satisfied

6. The sum of the series $\frac{1}{x-1} \frac{2}{x^2-1} \frac{2^2}{x^4-1} \dots \frac{2^{100}}{x^{2^{100}}-1}$ when $x = 2$ is :

(1) $1 \frac{2^{101}}{4^{101}-1}$ (2) $1 \frac{2^{100}}{4^{100}-1}$ (3) $1 \frac{2^{101}}{4^{101}-1}$ (4) $1 \frac{2^{100}}{4^{100}-1}$

Ans. (Bonus)

Sol. Adding and subtracting $\frac{1}{x-1}$

$S \frac{1}{x-1} \frac{1}{x-1} \frac{1}{x-1} \frac{2}{x^2-1} \frac{2^2}{x^4-1} \dots \frac{2^{100}}{x^{2^{100}}-1}$

$S \frac{1}{x-1} \frac{2}{x^2-1} \frac{2}{x^2-1} \frac{2^2}{x^4-1} \dots \frac{2^{100}}{x^{2^{100}}-1}$

$S \frac{1}{x-1} \frac{2^{101}}{x^{2^{101}}-1}$

For $x = 2 \Rightarrow S 1 \frac{2^{101}}{2^{2^{101}}-1}$

7. The value of $\lim_{n} \frac{1}{n} \sum_{r=0}^{2n-1} \frac{n^2}{n^2-4r^2}$ is :

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

Ans. (1)

Sol. $I = \lim_{n} \frac{1}{n} \sum_{r=0}^{2n-1} \frac{n^2}{n^2 + 4r^2} \quad I = \lim_{n} \sum_{r=0}^{2n-1} \frac{1}{n} \frac{1}{1 + 4\left(\frac{r}{n}\right)^2} \quad I = \int_0^2 \frac{1}{1+4x^2} dx$

$$\frac{1}{4} \int_0^2 \frac{1}{\frac{1}{4} + x^2} dx = \frac{1}{4} 2 \tan^{-1} 2x \Big|_0^2 = \frac{1}{2} \tan^{-1}(4)$$

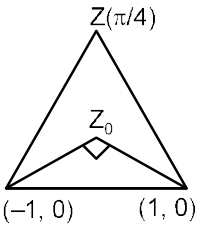
8. The equation $\arg \frac{z-1}{z+1} = \frac{\pi}{4}$ represents a circle with :

(1) centre at (0, 0) and radius $\sqrt{2}$ (2) centre at (0, 1) and radius $\sqrt{2}$

(3) centre at (0, –1) and radius $\sqrt{2}$ (4) centre at (0, 1) and radius 2

Ans. (2)

Sol.



$$\text{Arg} \frac{z_0 - 1}{z_0 + 1} = \frac{\pi}{2}$$

$$\frac{z_0 - 1}{z_0 + 1} = \left|\frac{z_0 - 1}{z_0 + 1}\right| e^{i\frac{\pi}{2}} \quad \frac{z_0 - 1}{z_0 + 1} = i \quad z_0 = \frac{1+i}{1-i}$$

$$z_0 = \frac{(1+i)^2}{2}$$

$\Rightarrow Z_0 = i$

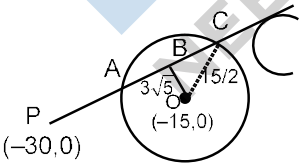
$\Rightarrow$ Centre (0, 1) & radius $\sqrt{2}$

9. If a line along a chord of the circle $4x^2 + 4y^2 + 120x + 675 = 0$, passes through the point (–30, 0) and is tangent to the parabola $y^2 = 30x$, then the length of this chord is :

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

Ans. (1)

Sol.



Equation of tangent to parabola $y^2 = 30x$ is

$y = mx + \frac{30}{4m}$ (which passes through (–30,0))

0 30m $\frac{30}{4m}$

$4m^2 = 1$

m $\frac{1}{2}$

for m $\frac{1}{2}$

y $\frac{x}{2}$ 15

x – 2y + 30 = 0

Length of OB $\frac{15 \quad 0 \quad 30}{\sqrt{5}}$ $3\sqrt{5}$, radius of circle $\frac{15}{2}$

Length of BC $\sqrt{\frac{225}{4} \quad 45}$ BC $\frac{3\sqrt{5}}{2}$

Length of chord AC 2 $\frac{3\sqrt{5}}{2}$ $3\sqrt{5}$

similarly for m $\frac{1}{2}$ length of chord AC $3\sqrt{5}$

10. A plane P contains the line x + 2y + 3z + 1 = 0 = x – y – z – 6, and is perpendicular to the plane –2x + y + z + 8 = 0. Then which of the following point lies on P ?

(1) (1, 0, 1) (2) (0, 1, 1) (3) (–1, 1, 2) (4) (2, –1, 1)

Ans. (2)

Sol. A plane which containing the line x + 2y + 3z + 1 = 0 = x – y – z – 6 is

(x + 2y + 3z + 1) + k(x – y – z – 6) = 0

$\Rightarrow$ (1 + k) x + (2 – k)y + (3 – k) z + 1 – 6k = 0

This plane is perpendicular to the plane –2x + y + z + 8 = 0 then

– 2(1 + k) + 1(2 – k) + 1(3 – k) = 0 $\Rightarrow$ k $\frac{3}{4}$

Equation of plane is $\frac{7}{4}x \quad \frac{5}{4}y \quad \frac{9}{4}z \quad \frac{14}{4} \Rightarrow 7x + 5y + 9z = 14$

(0, 1, 1) lies on the plane

11. The value of $\int_{\frac{1}{\sqrt{2}}}^{\frac{1}{\sqrt{2}}} \frac{x \quad 1}{x \quad 1}^{2} \quad \frac{x \quad 1}{x \quad 1}^{2} \quad 2^{\frac{1}{2}} dx$ is :

(1) $\log_e 4$ (2) $\log_e 16$ (3) $2 \log_e 16$ (4) $4\log_e 3 \quad 2\sqrt{2}$

Ans. (2)

Sol. $\int_{\frac{1}{\sqrt{2}}}^{\frac{1}{\sqrt{2}}} \sqrt{\left(\frac{x}{x}\frac{1}{1}\right)\left(\frac{x}{x}\frac{1}{1}\right)^2}\,dx$

$\int_{\frac{1}{\sqrt{2}}}^{\frac{1}{\sqrt{2}}} \sqrt{\left(\frac{4x}{x^2}\frac{}{1}\right)^2}\,dx$

$\int_{\frac{1}{\sqrt{2}}}^{\frac{1}{\sqrt{2}}} \sqrt{\frac{16x^2}{1\quad x^2{}^2}}dx$

$\int_{\frac{1}{\sqrt{2}}}^{\frac{1}{\sqrt{2}}} \frac{4|x|}{1\quad x^2}dx$

$8\int_0^{\frac{1}{\sqrt{2}}} \frac{x}{1\quad x^2}dx \qquad 4\ell n|1\quad x^2|_0^{\frac{1}{\sqrt{2}}} \qquad \log_e 16$

12. Let A and B be independent events such that P(A) = p, P(B) = 2p, The largest value of p, for which P (exactly one of A, B occurs) $\frac{5}{9}$ is :

(1) $\frac{5}{12}$ (2) $\frac{1}{3}$ (3) $\frac{4}{9}$ (4) $\frac{2}{9}$

Ans. (1)

Sol. Probability (exactly one of A and B) $\frac{5}{9}$

$P(A)\quad P(B)\quad 2P(A)\,P(B)\quad \frac{5}{9}$

$p\quad 2p\quad 4p^2\quad \frac{5}{9}$

$36p^2 - 27p + 5 = 0$

$\Rightarrow (12p - 5)\,(3p - 1) = 0$

$p\quad \frac{1}{3}$ or $\frac{5}{12}$

13. If ${}^{20}C_r$ is the co-efficient of x^r in the expansion of $(1+x)^{20}$, then the value of $\sum_{r\ 0}^{20} r^2\ {}^{20}C_r$ is equal to

(1) 420×2^{18} (2) 380×2^{19} (3) 380×2^{18} (4) 420×2^{19}

Ans. (1)

Sol. $\sum_{r=0}^{20} r^2\ {}^{20}C_r \quad r\ r\ {}^{20}C_r \quad \sum_{r=1}^{20} r\ 20\ {}^{19}C_{r-1}$

$20\sum_{r=0}^{20} r\ \ 1\ \ 1\ {}^{19}C_{r-1} \quad 20\sum_{r=1}^{20} r\ \ 1\ \ {}^{19}C_{r-1} \quad \sum_{r=1}^{20} {}^{19}C_{r-1}$

$20\ 19\sum_{r=2}^{20} {}^{18}C_{r-2} \quad \sum_{r=1}^{20} {}^{19}C_{r-1}$

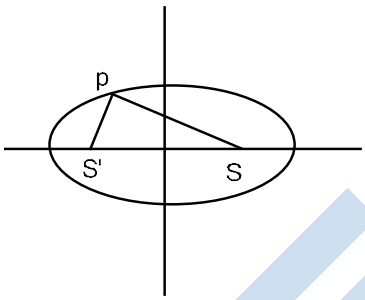
$\Rightarrow (380)2^{18} + 20.\ 2^{19} \Rightarrow 2^{20}.\ (95 + 10) = (105)2^{20} = 420 \times 2^{18}$

14. On the ellipse $\frac{x^2}{8} \quad \frac{y^2}{4}$ 1 let P be a point in the second quadrant such that the tangent at P to the ellipse is perpendicular to the line x + 2y = 0. Let S and S' be the foci of the ellipse and e be its eccentricity. If A is the area of the triangle. SPS' then, the value of $(5 - e^2)$. A is

(1) 12 (2) 6 (3) 14 (4) 24

Ans. (2)

Sol. $p\ \sqrt{8}\cos\ ,2\sin$



Equation of tangent at point p

$\frac{x}{\sqrt{8}}\cos \quad \frac{y}{2}\sin \quad 1 \quad 0$

Slope $\frac{1}{\sqrt{2}}\cot \quad 2$

$\cot \quad 2\sqrt{2} \quad \cos \quad \frac{2\sqrt{2}}{3}, \sin \quad \frac{1}{3}$

So, point P $\frac{8}{3}, \frac{2}{3}$

$A \quad \frac{1}{2} \quad 2ae \quad \frac{2}{3} \quad \frac{4}{3} \quad e \quad \frac{1}{\sqrt{2}}$

So, $(5 \quad e^2)\ A \quad 5 \quad \frac{1}{2} \quad \frac{4}{3} \quad 6$

15. Let $0, \frac{}{2}$. If the system of linear equations.

$(1 + \cos^2\theta)\, x + \sin^2\theta\, y + 4\sin3\theta\, z = 0$

$\cos^2\theta\, x + (1 + \sin^2\theta)\, y + 4\sin3\theta\, z = 0$

$\cos^2\theta\, x + \sin^2\theta\, y + (1 + 4\sin3\theta)\, z = 0$

has a non-trivial solution, then the value of θ is :

(1) $\frac{}{18}$ (2) $\frac{5}{18}$ (3) $\frac{4}{9}$ (4) $\frac{7}{18}$

Ans. (4)

Sol. $\begin{vmatrix} 1 & \cos^2 & \sin^2 & 4\sin3 \\ \cos^2 & 1 & \sin^2 & 4\sin3 \\ \cos^2 & \sin^2 & 1 & 4\sin3 \end{vmatrix} \quad 0$

$R_3 \to R_3 - R_2$

$\begin{vmatrix} 1 & \cos^2 & \sin^2 & 4\sin3 \\ \cos^2 & 1 & \sin^2 & 4\sin3 \\ 0 & & 1 & 1 \end{vmatrix}$

$C_2 \to C_2 + C_3$

$\begin{vmatrix} 1 & \cos^2 & \sin^2 & 4\sin3 & 4\sin3 \\ \cos^2 & 1 & \sin^2 & 4\sin3 & 4\sin3 \\ 0 & & 0 & & 1 \end{vmatrix} \quad 0$

$\Rightarrow 2(1+2\sin3\theta) = 0 \Rightarrow 2\sin3\theta = -1$

$\sin3 \quad \frac{1}{2} \quad \frac{7}{18}$

16. The mean and standard deviation of 20 observations were calculated as 10 and 2.5 respectively. It was found that by mistake one data value was taken as 25 instead of 35. If α and $\sqrt{}$ are the mean and standard respectively for correct data, then (α, β) is

(1) (10.5, 26) (2) (10.5, 25) (3) (11, 25) (4) (11, 26)

Ans. (1)

Sol. $x_1 + x_2 + x_3 + \ldots\ldots\ldots + x_{19} + 25 = 200$

$\Rightarrow x_1 + x_2 + x_3 + \ldots\ldots\ldots + x_{19} = 175$

New mean $\frac{x_1 \quad x_2 \quad x_3 \quad \ldots\ldots \quad x_{19} \quad 35}{20} \quad \frac{175 \quad 35}{20} \quad 10.5$

S.D. $\sqrt{\frac{x_1^2 \quad x_2^2 \quad x_3^2 \quad \ldots\ldots \quad x_{19}^2 \quad (25)^2}{20} \quad (10)^2}$

$2.5 \quad \sqrt{\frac{x_1^2 \quad x_2^2 \quad x_3^2 \quad \ldots\ldots \quad x_{19}^2 \quad (25)^2}{20} \quad (10)^2}$

$x_1^2 \quad x_2^2 \quad x_3^2 \quad .... \quad x_{19}^2 \quad 1500$

New S.D. $\sqrt{\frac{x_1^2 \quad x_2^2 \quad x_3^2 \quad .... \quad x_{19}^2 \quad (35)^2}{20} \quad (10.5)^2}$

$\sqrt{\frac{1500 \quad (35)^2}{20} \quad (110.25)}$

$\sqrt{26}$

$(\alpha, \beta) = (10.5, 26)$

17. If the sum of an infinite GP a, ar, ar^2, ar^3,.....is 15 and the sum of the squares its each term is 150, then the sum of ar^2, ar^4, ar^6, ...is :

(1) $\frac{25}{2}$ (2) $\frac{9}{2}$ (3) $\frac{5}{2}$ (4) $\frac{1}{2}$

Ans. (4)

Sol. Given $\frac{a}{1 \quad r} \quad 5$ ..... (1)

and $\frac{a^2}{1 \quad r^2} \quad 150 \quad \frac{a}{1 \quad r} \quad \frac{a}{1 \quad r} \quad 150 \quad \frac{a}{1 \quad r} \quad 10$ ..... (2)

solving equation (1) and (2)

$r \quad \frac{1}{5}$ $\therefore$ a = 12 from equation (1)

Now, $ar^2 + ar^4 + ar^6 + ... \infty$

$\frac{ar^2}{1 \quad r^2} \quad \frac{12 \quad \frac{1}{25}}{1 \quad \frac{1}{25}} \quad \frac{1}{2}$

18. If $A \quad \begin{matrix} \frac{1}{\sqrt{5}} & \frac{2}{\sqrt{5}} \\ \frac{2}{\sqrt{5}} & \frac{1}{\sqrt{5}} \end{matrix}$, $B \quad \begin{matrix} 1 & 0 \\ i & 1 \end{matrix}$, $i \quad \sqrt{1}$, and $Q = A^TBA$, then the inverse of the matrix

$A \, Q^{2021} \, A^T$ is equal to :

(1) $\begin{matrix} 1 & 2021i \\ 0 & 1 \end{matrix}$ (2) $\begin{matrix} 1 & 0 \\ 2021i & 1 \end{matrix}$ (3) $\begin{matrix} \frac{1}{\sqrt{5}} & 2021 \\ 2021 & \frac{1}{\sqrt{5}} \end{matrix}$ (4) $\begin{matrix} 1 & 0 \\ 2021i & 1 \end{matrix}$

Ans. (4)

Sol. $AA^T \quad \begin{matrix} \frac{1}{\sqrt{5}} & \frac{2}{\sqrt{5}} & \frac{1}{\sqrt{5}} & \frac{2}{\sqrt{5}} \\ \frac{2}{\sqrt{5}} & \frac{1}{\sqrt{5}} & \frac{2}{\sqrt{5}} & \frac{1}{\sqrt{5}} \end{matrix} \quad \begin{matrix} 1 & 0 \\ 0 & 1 \end{matrix} \quad I$

$Q = A^TBA$

$\Rightarrow Q^2 = (A^TBA)(A^TBA) = A^TB^2A$

$\Rightarrow Q^3 = A^TB^3A$

$\Rightarrow Q^{2021} = A^TB^{2021}A$

Now let $P = AQ^{2021}A^T$

$P = A(A^TB^{2021}A)A^T$

given $AA^T = I$

$P = B^{2021}$

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

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

.....

.....

$B^{2021} \begin{matrix} 1 & 0 \\ 2021\,i & 1 \end{matrix}$

inverse of $p \quad p^{-1} \quad B^{2021^{-1}} \begin{matrix} 1 & 0 \\ 2021\,i & 1 \end{matrix}$

19. If the truth value of the Boolean expression $((p \vee q) \wedge (q \rightarrow r) \wedge (\sim r)) \rightarrow (p \wedge q)$ is false, then the truth value of the statements p, q, r respectively can be :

(1) T F T (2) T F F (3) F F T (4) F T F

Ans. (2)

Sol.

p	q	r	$p \vee q$	$q \rightarrow r$	$\sim r$	$(p \vee q) \wedge (q \rightarrow r) \wedge \sim r$	$p \wedge q$	$((p \vee q) \wedge (q \rightarrow r) \wedge \sim r) \rightarrow p \wedge q$
T	T	T	T	T	F	F	T	T
T	T	F	T	F	T	F	T	T
T	F	T	T	T	F	F	F	T
T	F	F	T	T	T	T	F	F
F	T	T	T	T	F	F	F	T
F	T	F	T	F	T	F	F	T
F	F	T	F	T	F	F	F	T
F	F	F	F	T	T	F	F	T

20. Let $y = y(x)$ be a solution curve of the differential equation $(y + 1)\tan^2 x\,dx + \tan x\,dy + y\,dx = 0$, $x \in \left(0, \frac{\pi}{2}\right)$, if $\lim_{x \to 0} xy(x) = 1$, then the value of $y\left(\frac{\pi}{4}\right)$ is :

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

Ans. (3)

Sol. $\frac{dy}{dx} + (1 + y)\tan x = y\cot x$

$\frac{dy}{dx} - y(\tan x - \cot x) = -\tan x$

I.F. $= e^{\int -(\tan x - \cot x)dx}$

$= e^{\int \frac{\tan^2 x - 1}{\tan x}dx}$

$= \tan x$

$y \tan x = -\int \tan^2 x\,dx + c$

$y \tan x = -\int (1 - \sec^2 x)dx + c$

$y \cdot \tan x = x - \tan x + c$

$\lim_{x \to 0} xy = 1 \Rightarrow \lim_{x \to 0} \frac{x}{\tan x}(x - \tan x + c) = 1 \Rightarrow 1(0 - 0 + c) = 1 \Rightarrow c = 1$

Then the function is $y \cdot \tan x = x - \tan x + 1$

$y\left(\frac{\pi}{4}\right) = y\,1 \Rightarrow \frac{\pi}{4} - 1 + 1 = y\left(\frac{\pi}{4}\right)$

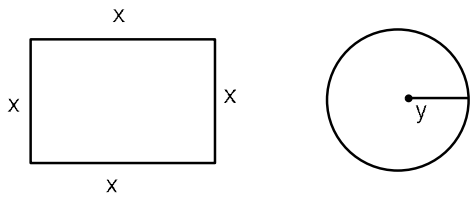
Numeric Value Type

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

1. A wire of length 36m is cut into two pieces, one of the pieces is bent to form a square and the other is bent to form a circle, If the sum of the areas of the two figures is minimum, and the circumference of the circle is k (meter), then $\frac{4}{\quad}$ 1 k is equal to _____.

Ans. (36)

Sol.



$4x + 2\pi y = 36$ (given)

Area $= x^2 + \pi y^2$

$A \quad x^2 \quad \frac{1}{\quad}(18 \quad 2x)^2$

$\frac{dA}{dx} \quad 2x \quad \frac{2}{\quad}(18 \quad 2x)(\ 2)$

$\frac{dA}{dx} \quad \frac{2 \ x \ (36 \quad 4x)(\ 2)}{\quad}$

$\frac{dA}{dx} \quad 0 \quad 2 \ x \quad 72 \quad 8x \quad 0 \quad x \quad \frac{36}{4} \quad \frac{d^2A}{dx^2} \quad 0$

K [circumference of circle) $= 2\pi y \quad K \quad \frac{36}{(\quad 4)}$

Value of $\frac{4}{\quad}$ k 36

2. Let $a, b \in R, b \neq 0$. Define a function

$$f(x) \quad \begin{matrix} a\sin\frac{}{2}(x \quad 1), & \text{for } x \quad 0 \\ \frac{\tan 2x \quad \sin 2x}{bx^3}, & \text{for } x \quad 0 \end{matrix}$$

If f is continuous at x = 0, then 10 – ab is equal to .....

Ans. (14)

Sol. If function is continuous at x = 0

then, L.H.L = R.H.L. = f(0)

L.H.L. = – a

R.H.L. $\lim\limits_{x \ 0} \frac{\tan 2x \quad \sin 2x}{bx^3}$

$$\sin x \quad x \quad \frac{x^3}{3!} \quad \frac{x^5}{5!} \quad ....$$

$$\tan x \quad x \quad \frac{x^3}{3} \quad \frac{2x^5}{15} \quad ....$$

$$\lim_{x \to 0} \frac{\frac{(2x)^3}{3} \quad \frac{(2x)^3}{6}}{bx^3} \quad \frac{\frac{8}{3} \quad \frac{8}{6}}{b} \quad \frac{4}{b}$$

$$f(0) \quad a\sin \frac{}{2}(0 \quad 1) \quad a\sin \frac{}{2} \quad a$$

$\Rightarrow$ L.H.L. = R.H.L. = f(0) $\frac{4}{b}$ a $\Rightarrow$ – ab = 4 $\Rightarrow$ 10 – ab = 14

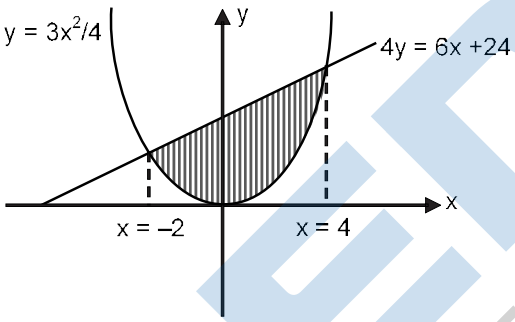
3. The area of the region S = {(x, y) : $3x^2 \le 4y \le 6x + 24$} is

Ans. (27)

Sol. S = {(x, y) : $3x^2 \le 4y \le 6x + 24$}

$$y \quad \frac{3x^2}{4} \qquad 4y = 6x + 24$$

area of the region



$$A \quad \int_{2}^{4} \frac{6x \quad 24}{4} \quad \frac{3x^2}{4} \, dx$$

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

A = 20 – (–7) = 27 square unit

4. The sum of all integral values of k ($k \neq 0$) for which the equation $\frac{2}{x \quad 1} \quad \frac{1}{x \quad 2} \quad \frac{2}{k}$ in x has no real roots, is

Ans. (66)

Sol. $\frac{2}{x \quad 1} \quad \frac{1}{x \quad 2} \quad \frac{2}{k} \quad \frac{2x \quad 4 \quad x \quad 1}{(x \quad 1)(x \quad 2)} \quad \frac{2}{k} \Rightarrow 2x^2 - (6 + k)x + 3k + 4 = 0$

for no real roots D < 0

$\Rightarrow (6 + k)^2 - 8(3k + 4) < 0 \Rightarrow k^2 + 12k + 36 - 24k - 32 < 0 \Rightarrow (k - 6)^2 - 32 < 0$

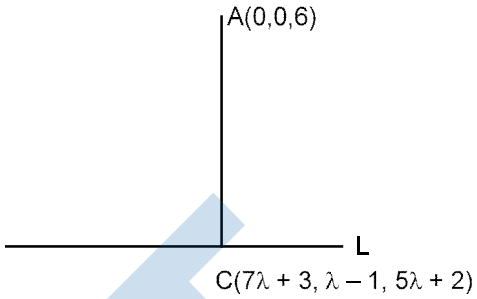
Integral value of k = 1,2,3,4,5,6,7,8,9,10,11

Sum = 66

5. Let the line L be the projection of the line $\frac{x-1}{2} = \frac{y-3}{1} = \frac{z-4}{2}$ in the plane $x - 2y - z = 3$. If d is the distance of the point (0,0,6) from L, then d^2 is equal to …….

Ans. (26)

Sol. Any point on the line P(2r + 1, r + 3, 2r + 4)



foot of perpendicular on the plane

$$\frac{x-(2r+1)}{1} = \frac{y-(r+3)}{2} = \frac{z-(2r+4)}{1} = \frac{r-6}{3}$$

$$x = \frac{7r-9}{3}; y = \frac{r-3}{3}; z = \frac{5r-6}{3}$$

$\Rightarrow$ Projection line $L : \frac{x-3}{7} = \frac{y-1}{1} = \frac{z-2}{5}$ ……(i)

Direction ratio of AC are $7\lambda + 3, \lambda - 1, 5\lambda - 4$

Now AC is perpendicular to the projection line (i) So, $\lambda = 0 \Rightarrow C(3, -1, 2) \Rightarrow d^2 = AC^2 = 26$

6. The number of three –digit even numbers, formed by the digits 0,1,3,4,6,7 if the repetition of digits is not allowed, is ……

Ans. (52)

Sol. 0,1,3,4,6,7

The number of three –digit even numbers ending with 0 = 5 × 4 = 20

The number of three –digit even numbers ending with 4 = 4 × 4 = 16

The number of three –digit even numbers ending with 6 = 4 × 4 = 16

Total three digits even numbers = 20 + 16 + 16 = 52

7. If y = y (x) is an implicit function of x such that $\log_e (x + y) = 4xy$, then $\frac{d^2y}{dx^2}$ at x = 0 is equal to

Ans. 40

Sol. when x = 0 then y = 1

$\ell n(x + y) = 4xy$

$\Rightarrow x + y = e^{4xy}$

Now differentiate

$\Rightarrow 1 + y' = e^{4xy}(4y + 4xy')$ …….. (i)

at (0, 1) $\Rightarrow y'(0) + 1 = 4 \Rightarrow y'(0) = 3$

No, again differentiate equation (i)

$\Rightarrow y''(0) = e^{4xy}(4y + 4xy')^2 + e^{4xy}(4y' + 4y' + 4xy'')$

at (0, 1)

$\Rightarrow y'(0) = 1\,(4 \times 1 + 0)^2 + 1(4 \times 3 + 4 \times 3 + 0)$

$\Rightarrow y'(0) = 16 + 24 = 40$

$\Rightarrow y''(0) = 40$

8. Let $z \quad \frac{1 \quad i\sqrt{3}}{2}, i \quad \sqrt{1}$. Then the value of $21 \quad z \quad \frac{1}{z}^{3} \quad z^2 \quad \frac{1}{z^2}^{3} \quad z^3 \quad \frac{1}{z^3}^{3} \quad ..... \quad z^{21} \quad \frac{1}{z^{21}}^{3}$ is

Ans. (13)

Sol. $z = -\omega$

Let $k \quad z \quad \frac{1}{z}^{3} \quad z^2 \quad \frac{1}{z^2}^{3} \quad z^3 \quad \frac{1}{z^3}^{3} \quad ..... \quad z^{21} \quad \frac{1}{z^{21}}^{3}$

$k \quad \frac{1}{}^{3} \quad {}_{2} \quad \frac{1}{2}^{3} \quad {}_{3} \quad \frac{1}{3}^{3} \quad ..... \quad {}_{21} \quad \frac{1}{21}^{3}$

$k = -8$

$\Rightarrow 21 + k = 21 - 8$

$= 13$

9. If ${}^{1}P_{1} + 2.{}^{2}P_{2} + 3.{}^{3}P_{3} + \ldots + 15.{}^{15}P_{15} = {}^{q}P_{r} - s,\ 0 \le s \le 1$, then ${}^{q+s}C_{r-s}$ is equal to.....

Ans. (136)

Sol. ${}^{1}P_{1} + 2.{}^{2}P_{2} + 3.{}^{3}P_{3} + \ldots + 15.{}^{15}P_{15}$

$= 1! + 2.2! + 3.3! + ...+ 15.15! = 1! + (3!.2!) + (4!.3!) + ...+ (16.15!)$

$= 16! - 1! = {}^{q}P_{r} - s \Rightarrow q = r = 16$ and $s = 1$

So, ${}^{q}{}^{s}P_{r}{}_{s} \quad {}^{17}C_{15} \quad \frac{17 \quad 16}{2} \quad 136$

10. The locus of a point, which moves such that the sum of squares of its distance from the points (0,0),(1,0) (0,1), (1,1) is 18 units, is a circle of diameter d. Then d^2 is equal to .....

Ans. 16

Sol. Let P (x,y)

$x^2 + y^2 + (x-0)^2 + (y-1)^2 + (x-1)^2 + (y-0)^2 + (x-1)^2 + (y-1)^2 = 18$

$4x^2 + 4y^2 - 4x - 4y + 4 = 18$

$x^2 \quad y^2 \quad x \quad y \quad \frac{14}{4} \quad 0$

Centre $\frac{1}{2}, \frac{1}{2} \qquad r \quad \sqrt{\frac{1}{4} \quad \frac{1}{4} \quad \frac{14}{4}} \quad 2$

$d = 2r = 2 \times 2 = 4$

So, $d^2 = 16$