MENIIT

NEET | IIT-JEE | FOUNDATION

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JEE MAIN-2020

COMPUTER BASED TEST (CBT)

DATE : 03-09-2020 (SHIFT-1) | TIME : (9.00 am to 12.00 pm)

Duration 3 Hours | Max. Marks : 300

QUESTION & SOLUTIONS

PART-A : PHYSICS

SECTION – 1 : (Maximum Marks : 80)

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.

Full Marks : +4 If ONLY the correct option is chosen.

Negative Marks : –1 (minus one) mark will be deducted for indicating incorrect response.

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1. The magnetic field of a plane electromagnetic wave is

$\vec{B} = 3\times10^{-8}\sin[200\pi(y+ct)\hat{i}\,T$

where c = 3 × 10^8 ms^{-1} is the speed of light.

the corresponding electric filed is :

(1) $\vec{E} = 9\sin[200\pi(y+ct)\hat{k}\,V/m$ (2) $\vec{E} = 10^{-6}\sin[200\pi(y+ct)\hat{k}\,V/m$

(3) $\vec{E} = 3\times10^{-8}\sin[200\pi(y+ct)\hat{k}\,V/m$ (4) $\vec{E} = 9\sin[200\pi(y+ct)(-\hat{k})V/m$

Ans. (4)

Sol. $E_0 = cB_0 \quad \because \vec{E}\times\vec{B}\,||\,\vec{C}\Rightarrow\hat{k}\times\hat{i}=\hat{j}$

$\vec{E} = 3\times10^8\times3\times10^{-8}\sin[200\pi(y+ct)(-\hat{k}) = 9\sin[200\pi(y+ct)(-\hat{k})$

2. Pressure inside two soap bubbles are 1.01 and 1.02 atmosphere, respectively. The ratio of their volumes is :

(1) 0.8 : 1 (2) 4 : 1 (3) 8 : 1 (4) 2 : 1

Ans. (3)

Sol. $P_1 - P_0 = \frac{4T}{R_1}$

$P_2 - P_0 = \frac{4T}{R_2}$

$\frac{1}{2} = \frac{R_2}{R_1}$

$R_1 = 2R_2$

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

3. A satellite is moving in a low nearly circular orbit around the earth. Its radius is roughly equal to that of the earth's radius Re. By firing rockets attached to it, its speed is instantaneously increased in the direction of its motion so that it becomes $\sqrt{\frac{3}{2}}$ times larger. Due to this the farthest distance from the centre of the earth that the satellite reaches is R. Value of R is :

(1) $2R_e$ (2) $3R_e$ (3) $2.5R_e$ (4) $4R_e$

Ans. (2)

Sol. $V = \sqrt{\frac{Gm}{R_e}}$

From energy conversation

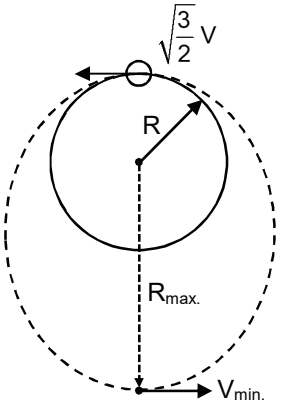
$$-\frac{GMm}{R_e}+\frac{1}{2}m\left(\sqrt{\frac{3}{2}}V\right)^2 = -\frac{GMm}{R_{max}}+\frac{1}{2}mV_{min}^2 \qquad ....(i)$$

From angular momentum conversation

$$\sqrt{\frac{3}{2}}VR_e = V_{min}R_{max} \qquad ....(ii)$$

Eliminating V_{min} from equation (i) and (ii) we get

$R_{max} = 3R_e$



4. In a radioactive material, fraction of active material remaining after tie t is $\frac{9}{16}$. The fraction that was remaining after t/2 is :

(1) $\frac{3}{5}$ (2) $\frac{3}{4}$ (3) $\frac{7}{8}$ (4) $\frac{4}{5}$

Ans. (2)

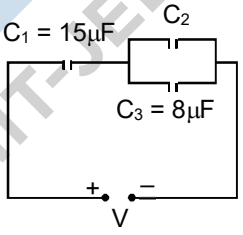
Sol. $N = N_o\, e^{-\lambda t}$ ...(1)

$N' = N_0 e^{\frac{\lambda t}{2}}$ ....(2)

from (1) & (2)

$$\left(\frac{N'}{N_0}\right)=\left(\frac{N}{N_0}\right)^{\frac{1}{2}}=\left(\frac{9}{16}\right)^{\frac{1}{2}}=\frac{3}{4}$$

5. In the circuit shown in the figure, the total charge is 750 μC and the voltage across capacitor C_2 is 20 V. Then the charge on capacitor C_2 is :



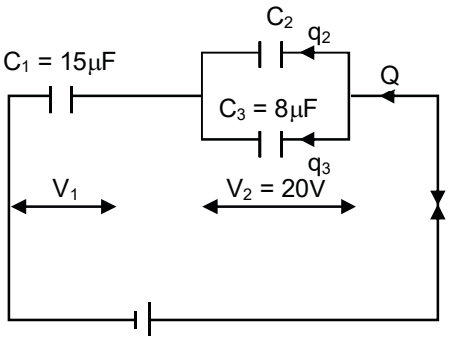
(1) 160 μC (2) 450 μC (3) 590 μC (4) 650 μC

Ans. (3)

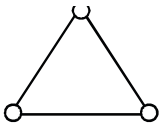
Sol. $q_2 + q_3 = 750$

$q_2 + 160 = 750$

$q_2 = 590$



6. Consider a gas of triatomic molecules. The molecules rigid rods whose vertices are occupied by atoms. The internal energy of a mol of the gas at temperature T is :



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

Ans. (3)

Sol. $U=\frac{f}{2}RT=\frac{6}{2}RT=3RT$

7. Using screw gauge of pitch 0.1 cm and 50 divisions on its circular scale, the thickness of an object is measured. it should correctly be recorded as :

(1) 2.124 cm (2) 2.123 cm (3) 2.125 cm (4) 2.121 cm

Ans. (1)

Sol. Thickness = M.S. Reading + Circular Scale Reading (L.C.)

Here, LC $=\frac{0.1}{50}=0.002$ cm per division

8. In Young's double slit experiment, light of 500 nm is used to produce and interference pattern. When the distance between the slits is 0.05 mm, the angular width (in degree) of the fringes formed on the distance screen is close to :

(1) 0.17º (2) 0.07º (3) 0.57º (4) 1.7º

Ans. (3)

Sol. $\beta_0=\frac{\lambda}{d}=\frac{500\times10^{-9}}{5\times10^{-5}}=10^{-2}\,\text{Radian}=0.57°$

9. When a diode is forward biased, it has a voltage drop of 0.5 v. the safe limit of current through the diode is 10 mA. If a battery of emf 1.5 V is used in the circuit, the value of minimum resistance to be connected in series with the diode so that the current does not exceed the safe limit is :

(1) 50 Ω (2) 300 Ω (3) 200 Ω (4) 100 Ω

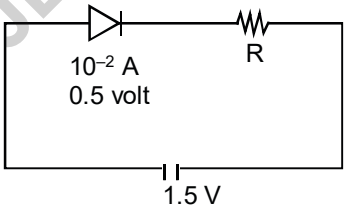
Ans. (4)

Sol. V_{diode} = 0.5 volt

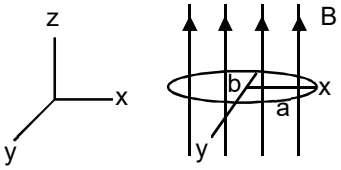
V_R = 1.5 – 0.5 = 1 volt

iR = 1

$R=\frac{1}{i}=\frac{1}{10^{-2}}=100\,\Omega$



10. An elliptical loop having resistance R, of semi major axis a, and semi minor axis b is placed in a magnetic field as shown in the figure. If the loop is rotated about the x-axis with angular frequency ω, the average power loss in the lop due to Joule heating is :



(1) $\frac{\pi^2a^2b^2B^2\omega^2}{2R}$ (2) $\frac{\pi^2a^2b^2B^2\omega^2}{R}$ (3) $\frac{\pi abB\omega}{R}$ (4) zero

Ans. (1)

Sol. $\varepsilon = NAB\omega\cos\omega t$

$$< P > = < \frac{\varepsilon^2}{R} >$$

$$= < \frac{A^2B^2\omega^2\cos^2\omega t}{R} >$$

$$= \frac{A^2B^2\omega^2}{R}\left(\frac{1}{2}\right)$$

$$= \frac{\pi^2a^2b^2B^2}{2R}(\omega^2)$$

11. Magnitude of magnetic field (in SI units) at the centre of a hexagonal shape coil of side 10 cm, 50 turns and carrying current I (Ampere) in units of $\frac{\mu_0 I}{\pi}$ is :

(1) $250\sqrt{3}$ (2) $5\sqrt{3}$ (3) $500\sqrt{3}$ (4) $50\sqrt{3}$

Ans. (3)

Sol. $B = 50 \times 6 \times \frac{\mu_0 i}{4\pi\left(\frac{10}{100}\cos 30°\right)}[\sin 30° + \sin 30°]$

$$2 \times 75 \times 10\frac{\mu_0 i}{\sqrt{3}\pi}\left(\frac{1}{2} + \frac{1}{2}\right)$$

$$\frac{1500}{\sqrt{3}}\frac{\mu_0 i}{\pi} = 500\sqrt{3}\frac{\mu_0 i}{\pi}$$

$$500\sqrt{3}$$

12. A charged particle carrying charge 1 μC is moving with velocity $(2\hat{i} + 3\hat{j} + 4\hat{k})$ ms^{-1}. If an external magnetic field of $(5\hat{i} + 3\hat{j} - 6\hat{k})$ × 10^{-3}T exists in the region where the particle is moving then the force on the particle is $\vec{F}$ × 10^{-9}N. the vector $\vec{F}$ is :

(1) $-30\hat{i} + 32\hat{j} - 9\hat{k}$ (2) $-3.0\hat{i} + 32\hat{j} - 0.9\hat{k}$

(3) $-0.30\hat{i} + 0.32\hat{j} - 0.09\hat{k}$ (4) $-300\hat{i} + 320\hat{j} - 90\hat{k}$

Ans. (1)

Sol. $\vec{F} = 10^{-6} \times 10^{-3}\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 3 & 4 \\ 5 & 3 & -6 \end{vmatrix}$

$$= (-30\hat{i} + 32\hat{j} - 9\hat{k}) \times 10^{-9}\text{N}$$

13. Two isolated conducting spheres S_1 and S_2 of radius $\frac{2}{3}$R and $\frac{1}{3}$R have 12 μC and –3 μC charges, respectively, and are at a large distance from each other, They are now connected by a conducting wire. A long time after this is done the charges on S_1 and S_2 are respectively :

(1) 6 μC and 3 μC (2) 4.5 μC of both

(3) +4.5 μC and –4.5 μC (4) 3 μC and 6 μC

Ans. (1)

Sol. Total charge = 12 – 3 = 9 μC

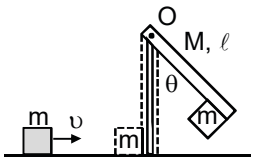
If final charges are q_1 and q_2

$$\frac{q_1}{q_2} = \frac{R_1}{R_2} = \frac{2}{1}$$

$q_1 = 6\ \mu C$

$q_2 = 3\ \mu C$

14. A block of mass m = 1 kg slides with velocity v = 6 m/s on a frictionless horizontal surface and collides with a uniform vertical rod and sticks to it as shown. The rod is pivoted about O and swings as a result of the collision making angle θ before momentarily coming to rest. if the rod has mass M = 2 kg, and length ℓ = 1 m, the value of θ is approximately (take g = 10 m/s^2)



(1) 69° (2) 63° (3) 55° (4) 49°

Ans. (2)

Sol. Angular momentum

$$mv\ell = \left(m\ell^2 + \frac{2m\ell^2}{3}\right)\omega$$

$$mv\ell = \frac{5}{3}m\ell^2\omega$$

$$\omega = \frac{3v}{5\ell}$$

$$\frac{1}{2}I\omega^2 = 2mg\frac{\ell}{2}(1-\cos\theta) + mg\ell(1-\cos\theta)$$

$$\frac{1}{2}\left(\frac{5}{3}m\ell^2\right)\frac{9v^2}{25\ell^2} = 2mg\ell(1-\cos\theta)$$

$$\frac{3}{5\times 2}mv^2 = 2mg\ell(1-\cos\theta)$$

$$\frac{3}{10}\times\frac{36}{2\times 10} = 1-\cos\theta$$

$$1-\frac{27}{50} = \cos\theta$$

$$\cos\theta = \frac{23}{50}$$

$\theta = 63°$

15. A balloon filled with helium (32º C and 1.7 atm) bursts. Immediately afterwards the expansion of helium can be considered as :

(1) reversible adiabatic (2) reversible isothermal

(3) irreversible isothermal (4) irreversible adiabatic

Ans. (4)

Sol. Theory based

16. When the wavelength of radiation falling on a metal is changed from 500 nm to 200 nm, the maximum kinetic energy of the photoelectrons becomes three times larger. The work function of the metal is close to :

(1) 1.02 eV (2) 0.61 eV (3) 0.52 eV (4) 0.81 eV

Ans. (2)

Sol. $KE_{max} = \frac{hc}{\lambda} - \phi = \frac{hc}{500} - \phi$ .....(i)

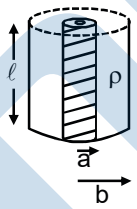
Now, $3KE_{max} = \frac{hc}{200} - \phi$ .....(ii)

From equation (i) and (ii)

$$\frac{(ii)}{(i)} = \frac{3}{1} = \frac{\frac{hc}{200} - \phi}{\frac{hc}{500} - \phi}$$

Put the value of hc = 1237.5 and solving ϕ = 0.61 eV

17. Model a torch battery of length ℓ to be made up of a thin cylindrical bar of radius 'a' and a concentric thin cylindrical shell of radius 'b' filled in between with an electrolyte of resistivity ρ (see figure). If the battery is connected to a resistance of value R, the maximum Joule heating in R will take place for :



(1) $R = \frac{\rho}{2\pi\ell}\left(\frac{b}{a}\right)$ (2) $R = \frac{\rho}{\pi\ell}\ell n\left(\frac{b}{a}\right)$ (3) $R = \frac{2\rho}{\pi\ell}\ell n\left(\frac{b}{a}\right)$ (4) $R = \frac{\rho}{2\pi\ell}\ell n\left(\frac{b}{a}\right)$

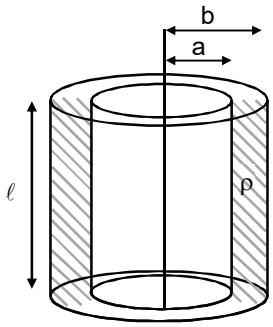
Ans. (4)

Sol. The resistance of small element

$$\Delta R = \frac{\rho dr}{2\pi\ell}$$

$$R = \frac{\rho}{2\pi\ell}\int_a^b \frac{dr}{r}$$

$$R = \frac{\rho}{2\pi\ell}\ell n\frac{b}{a}$$



18. Moment of inertia of a cylinder of mass m> length L and radius R about an axis passing through its centre and perpendicular to the axis of the cylinder is $I = M\left(\frac{R^2}{4} + \frac{L^2}{12}\right)$. If such a cylinder is to be made for a given mass of a material, the ratio $\frac{L}{R}$ for it to have minimum possible I is :

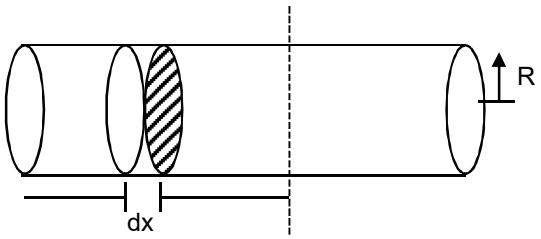
(1) $\sqrt{\frac{2}{3}}$ (2) $\frac{2}{3}$ (3) $\frac{3}{2}$ (4) $\sqrt{\frac{3}{2}}$

Ans. (4)

Sol. Let a cylinder of mass m_1 length L and sodium R then Let take elementary disc of sodium R and trickiness dx at a distance of x from axis Oo' then moment of inertia about Oo' as this element

$$dI = \frac{dmR^2}{4} + dmx^2$$

$$I = \int dI = \int \frac{dmR^2}{4} + \int_{n=L/2}^{n=-L/2} \frac{M}{L} dx \times x^2$$



$$I = \frac{MR^2}{4} + \frac{ML^2}{12}$$

$$I = \frac{M}{4} \times \frac{V}{\pi L} + \frac{ML^2}{12}$$

$$I = \frac{MV}{4\pi L} + \frac{ML^2}{12}$$

$$\frac{dI}{dL} = -\frac{mV}{4\pi L^2} + \frac{M \times 2L}{12} = 0$$

$$\Rightarrow \quad V = \frac{2}{3}\pi L^3 \quad \Rightarrow \quad \pi R^2 L = \frac{2}{3}\pi L^3 \quad \Rightarrow \quad \frac{L}{R} = \sqrt{\frac{3}{2}}$$

19. A uniform thin rope of length 12 m and mass 6 kg hangs vertically from a rigid support and a block of mass 2 kg is attached to its free end. A transverse short wave train of wavelength 6 cm is produced at the lower and the rope. What is the wavelength of the wave train (in cm) when it reaches the top of the rope ?

(1) 12 (2) 6 (3) 9 (4) 3

Ans. (1)

Sol. $V = f\lambda$

$$\frac{V_1}{\lambda_1} = \frac{V_2}{\lambda_2}$$

$$\lambda_2 = \frac{V_2}{V_1}\lambda_1 = \sqrt{\frac{T_2}{T_1}}\lambda_1 \qquad T_2 = 8g(\text{Top})$$

$$\sqrt{\frac{8g}{2g}}\lambda_1 \qquad T_1 = 2g(\text{Top})$$

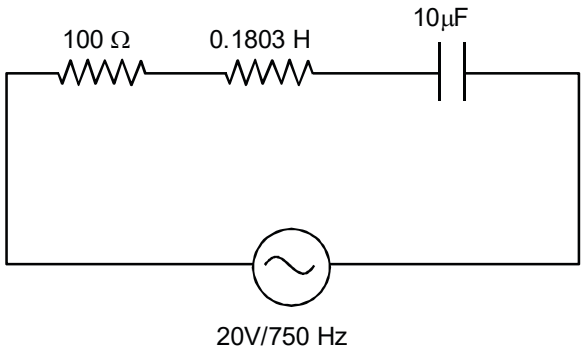
$= 2\lambda_1 = 12$ cm

20. A 750 Hz, 20 V (rms) source is connected to a resistance of 100 Ω, an inductance of 0.1803 H and a capacitance of 10μF all in series. the time in which the resistance (heat capacity $\frac{2J}{°C}$) will get heated by 10°C. (assume no loss of heat to the surroundings) is close to :

(1) 365 s (2) 418 s (3) 348 s (4) 245 s

Ans. (3)

Sol.



R = 100, XL = Lω = 0.1803 × 750 × 2π = 850 Ω, $X_C = \frac{1}{C\omega} = \frac{1}{10^{-5} \times 2\pi \times 750} = 21.23\Omega$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

$H = i_{rms}^2 Rt = (ms)\Delta t$

$\frac{20}{835} \times \frac{20}{835} \times 100t = (2) \times 10$

t = 348.61 sec

SECTION – 2 : (Maximum Marks : 20)

This section contains FIVE (05) questions. The answer to each question is **NUMERICAL VALUE** with two digit integer and decimal upto one digit.

If the numerical value has more than two decimal places truncate/round-off the value upto TWO decimal places.

Full Marks : +4 If ONLY the correct option is chosen.

Zero Marks : 0 In all other cases

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21. A Bakelite beaker has volume capacity of 500 cc at 30ºC. When it is partially filled with V_m volume (at 30ºC) of mercury, it is found that the unfilled volume of the beaker remains constant as temperature is varied. If $\gamma_{(beaker)} = 6 \times 10^{-6}$ ºC^{-1}, where γ is the coefficient of volume expansion, then V_m (in cc) is close to .....

Ans. 20.00

Sol. $\Delta V_m = \Delta V_C$

$V_m\gamma_M \Delta T = V_C\gamma_C \Delta T$

$$V_m = \frac{V_C\gamma_C}{\gamma_m} = \frac{500 \times 6 \times 10^{-6}}{1.5 \times 10^{-4}} = 20 \text{ cc}$$

22. A person of 80 kg mass is standing on the rim of a circular platform of mass 200 kg rotating about its axis at 5 revolutions per minute (rpm). The person now starts moving towards the centre of the platform. What will be the rotational speed (in rpm) of the platform when the person reaches its centre....

Ans. 09.00

Sol. $$\left(mR^2 + \frac{MR^2}{2}\right)\omega = \frac{MR^2}{2}\omega'$$

$$\left(80 + \frac{200}{2}\right) \times 5 = \frac{200}{2}\omega'$$

ω' = 9 rev/sec.

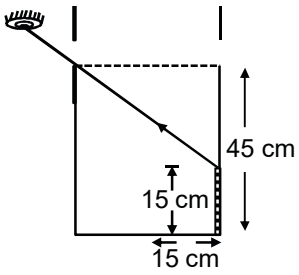
23. When a long glass capillary tube of radius 0.015 cm is dipped in a liquid, the liquid rises to a height of 15 cm within it. If the contact angle between the liquid and glass to close to 0º, the surface tension of the liquid, in milliNewton m^{-1}, is [$\rho_{(liquid)}$ = 900 kg m^{-3}, g = 10 m s^{-2}] (Given answer in closed integer)

Ans. 101

Sol. $$\frac{2T}{r} = h\rho g$$

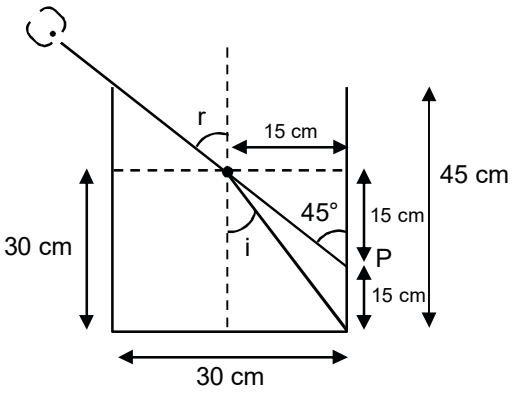
$$T = \frac{rh\rho g}{2} = \frac{15 \times 10^{-5} \times 15 \times 10^{-2} \times 900 \times 10}{2} = 101 \text{ milliNewton m}^{-1}$$

24. An observer can see through a small hole on the side of a jar (radius 15 cm) at a point at height of 15 cm from the bottom (see figure). The hole is at a height of 45 cm. When the jar is filled with a liquid up to a height of 30 cm the same observer can see the edge at the bottom of the jar. If the refractive index of the liquid is $\frac{N}{100}$, where N is an integer, the value of N is



Ans. 158

Sol.



From Shell's Law

$\mu \times \sin i = 1 \times \sin r$

$$\mu \times \frac{15}{\sqrt{15^2 + 30^2}} = 1 \times \sin 45°$$

$$\mu = \sqrt{\frac{5}{2}} = 158 \times 10^{-2}$$

25. A cricket ball of mass 0.15 kg is thrown vertically up by a bowling machine so that it rises to a maximum height of 20 m after leaving the machine. If the part pushing the ball applies a constant force F on the ball applies a constant force F on the ball and moves horizontally a distance of 0.2 m while launching the ball, the value of F (in N) is ($g = 10\ ms^{-2}$)

Ans. 150.00

Sol. From work energy theorem F (0.2) – mg (20) = 0

$$F = mg\frac{(20)}{0.2}$$

$$= mg\left(\frac{200}{2}\right)$$

$$= 0.15 \times 10 \times \frac{200}{2}$$

= 150.00 N

PART-B : CHEMISTRY

SECTION – 1 : (Maximum Marks : 80)

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.

Full Marks : +4 If ONLY the correct option is chosen.

Negative Marks : –1 (minus one) mark will be deducted for indicating incorrect response.

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26. The mechanism of S_N1 reaction is given as:

$$R-X \longrightarrow \underset{\text{Ion pair}}{R^{\oplus}X^{\ominus}} \longrightarrow \underset{\substack{\text{Solvent}\\ \text{Separated ion}\\ \text{pair}}}{R^{\oplus}\,\|\,X^{\ominus}} \xrightarrow{Y^{\ominus}} R-Y + X^{\ominus}$$

A student writes general characteristics based on the given mechanism as :

(a) The reaction is favoured by weak nucleophiles.

(b) $R^{\oplus}$ would be easily formed if the substituents are bulky

(c) The reaction is accompanied by racemization

(d) The reaction i`s favoured by non-polar solvents.

Which observations are correct ?

(1) (b) and (d) (2) (a) and (c) (3) (a) and (b) (4) (a), (b) and (c)

Ans. (4)

Sol. Above reaction is S_N1 reaction as it proceed via formation of carbocation. Polar protic solvent is more suitable for S_N1 and racemisation takes place.

27. The atomic number of the element unnilennium is :

(1) 119 (2) 109 (3) 108 (4) 102

Ans. (2)

Sol. un = 1

nil = 0

enn = 9

So Atomic number = 109

28. Thermal power plants can lead to :

(1) Eutrophication (2) Acid rain

(3) Ozone layer depletion (4) Blue baby syndrome

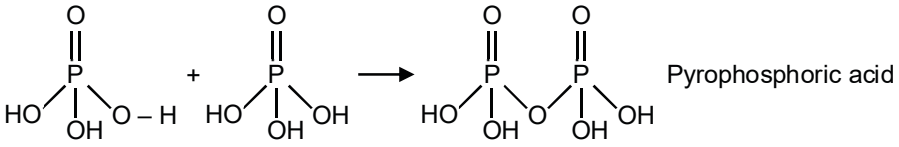
Ans. (2)

Sol. burning of fossil fuels (which contain sulphur and nitrogenous matter) such as coal and oil in power stations and furnaces produce sulphur dioxide and nitrogen oxides which causes acid rain.

29. In a molecule of pyrophosphoric acid, the number of P – OH, P = 0 and P – O – P bonds/moiety(ies) respectively are :

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

Ans. (1)

Sol. 

Pyrophosphoric acid

No. of P = 0 bond = 2.

P–OH bond = 4.

P–O–P bond = 1.

30. It is true that :

(1) A first order reaction is always a single step reaction

(2) A second order reaction is always a multistep reaction

(3) A zero order reaction is a single step reaction

(4) A zero order reaction is a multistep reaction

Ans. (4)

Sol. Zero order reaction is always multi step reaction.

31. Let C_{NaCl} and C_{BaSO_4} be the conductances (in S) measured for saturated aqueous solutions of NaCl and $BaSO_4$ respectively, at a temperature T. Which of the following is false?

(1) Ionic mobilities of ions from both salts increase with T.

(2) $C_{NaCl} >> C_{BaSO_4}$ at a given T

(3) $C_{BaSO_4}(T_2) > C_{BaSO_4}(T_1)$ for $T_2 > T_1$

(4) $C_{NaCl}(T_2) > C_{NaCl}(T_1)$ for $T_2 > T_1$

Ans. (1) {NTA answer given is (4)}

Sol. (i) Ionic mobilities decrease with increase in temperature due to increase in random motion and hence decrease in relaxation time so decrease in drift speed.

(ii) NaCl is completely soluble salt while $BaSO_4$ is sparingly soluble salt so C= >> C_2.

(iii) On increase in temperature conductance increase.

32. Tyndall effect is observed when :

(1) The diameter of dispersed particles is similar to the wavelength of light used.

(2) The refractive index of dispersed phase is greater than that of the dispersion medium.

(3) The diameter of dispersed particles is much smaller than the wavelength of light used

(4) The diameter of dispersed particles is much larger than the wavelength of light used.

Ans. (1)

Sol. According to NCERT text

*The diameter of the dispersed particles is not much smaller than the wavelength of the light used

*The intensity of scattered light depends on the difference between the refractive indice of the D.P and D.M., In lyophobic colloids, this difference is appreciable and therefore the tyndal effect is quite well defined but in lyophilic sols the difference is very small and the tyndal effect is very weak.

So, to show Tyndall effect the refractive indices of the dispersed phase and dispersion medium differ greatly in magnitude.

33. An acidic buffer is obtained on mixing :

(1) 100 mL of 0.1 M CH_3COOH and 200 mL of 0.1 M NaOH

(2) 100 mL of 0.1 M CH_3COOH and 100 mL of 0.1 M NaOH

(3) 100 mL of 0.1 M HCl and 200 mL of 0.1 M CH_3COONa

(4) 100 mL of 0.1 M HCl and 200 mL of 0.1 M NaCl

Ans. (3)

Sol. Mixture of weak acid and its salt with strong base acts as buffer solution.

34. the antifertility drug "Novestrol" can react with :

(1) $ZnCl_2$ / HCl ; $FeCl_3$; Alcoholic HCN

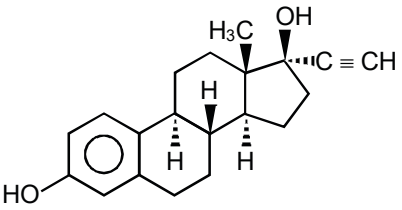
(2) Alcoholic HCN ; NaOCl ; $ZnCl_2$ / HCl

(3) Br_2 / water, $ZnCl_2$ / HCl ; NaOCl

(4) Br_2 / water, $ZnCl_2$ / HCl ; $FeCl_3$

Ans. (4)

Sol.



Novestrol (Anti Fertility Drugs)

Novestrol has phenolic functional group, alcoholic functional group and Terminal alkyne.

35. The electronic spectrum of $[Ti(H_2O)_6]^{3+}$ shows a single broad peak with a maximum at 20,300 cm^{-1}. The crystal field stabilization energy (CFSE) of the complex ion, in kJ mol^{-1}, is : (1 kJ mol^{-1} = 83.7 cm^{-1})

(1) 242.5 (2) 145.5 (3) 83.7 (4) 97

Ans. (4)

Sol. $[Ti(H_2O)_6]^{3+} \Rightarrow Ti^{3+} = 3d^1\ 4s^0$

$\Rightarrow t_{2g}^{1,0,0}, e_g^{0,0}$

$CFSE = [-0.4n_{t2g} + 0.6n_{eg}]\ \Delta_0 + n(p)$

$= [-0.4 \times 1]\ 20300$

$= -8120\ cm^{-1}$

$= \frac{-8120}{83.7} kJ/mol$

$= -97\ kJ/mol$

36. Glycerol is separated in soap industries by :

(1) Steam distillation (2) Differential distillation

(3) Fractional distillation (4) Distillation under reduced pressure

Ans. (4)

Sol. Glycerol can be separated from spent-lye in soap industry by using Reduce pressure Distillation technique.

37. Henry's constant (in kbar) for four gases α, β, γ and δ in water at 298 K is given below :

	α	β	γ	δ
K_H	50	2	2×10^{-5}	0.5

(density of water = 10^3 kg m^{-3} at 298 K) This table implies that :

(1) Solubility of γ at 308 K is lower than at 298 K

(2) The pressure of a 55.5 molal solution of γ is 1 bar

(3) The pressure of a 55.5 molal solution of δ is 250 bar

(4) α has the highest solubility in water at a given pressure

Ans. (3)

Sol. (i) Though solubility of gas will decrease with increase in temperature but this conclusion can not be drawn from the given table.

(ii) For γ

$$(P)\gamma = (p_H)\,\gamma\,.\,(X)\,\gamma$$

$$= 2\times10^{-2}\left[\frac{55.5}{55.5+\frac{1000}{18}}\right] = 10^{-2}\text{bar}$$

(iii) For $\delta \Rightarrow P_\delta = (kH)_\delta\,.\,(X)_\delta$

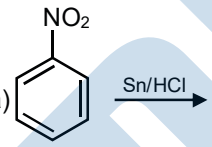
$$= 0.5\times10^3\times\frac{1}{2} = 250\,\text{bar}.$$

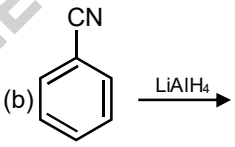
(iv) From Henery's law

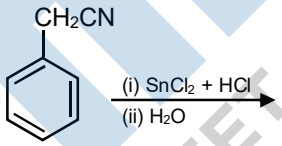
$$P = k_H(X)$$

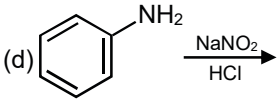
Higher the value of k_H smaller will be solubility so γ is more soluble.

38. The Kjeldahl method of Nitrogen estimation fails for which of the following reaction products ?

(a) 

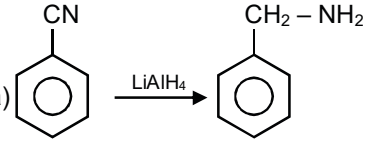
(b) 

(c) 

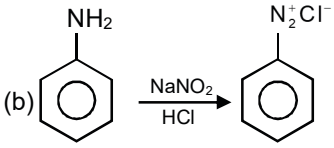
(d) 

(1) (a) and (d) (2) (a), (c) and (d) (3) (b) and (c) (4) (c) and (d)

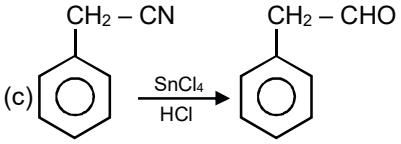
Ans. (4)

Sol. (a) 

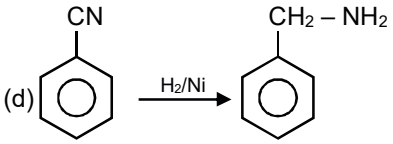
(N – present in product so will show Kjeldhal Test)

(b) 

($-N_2^+$ Never show Kjeldhal Test)

(c) 

(N–absent, wo will not show Kjeldhal Test)

(d) 

(will give positive Kjeldhal test due to presence of $-NH_2$ group)

39. If the boiling point of H_2O is 373 K, the boiling point of H_2S will be :

(1) equal to 373 K (2) greater than 300 K but less than 373 K

(3) less than 300 K (4) more than 373 K

Ans. (3)

Sol. At room temperature water is liquid and has boiling point 373 K due to hydrogen bonding. Where as H_2S is gas and it has no hydrogen bonding. Hence boiling point of H_2S is less than 300 K [Boiling point of H_2S is –60ºC]

40. Of the species, NO, NO^+, NO^{2+} and NO^-, the one with minimum bond strength is :

(1) NO (2) NO^{2+} (3) NO^{-1} (4) NO^+

Ans. (3)

Sol.

	Species	Bond order
(1)	NO^+	3
(2)	NO^{2+}	2.5
(3)	NO^-	2
(4)	NO	2.5

Bond strength α bond order

41. An organic compound [A], molecular formula $C_{10}H_{20}O_2$ was hydrolysed with dilute sulphuric acid to given a carboxylic acid [B] and an alcohol [C]. Oxidation of [C] with $CrO_3 - H_2SO_4$ produced [B]. Which of the following structures are not possible for [A]

(1) $CH_3 - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - COOCH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2CH_3$

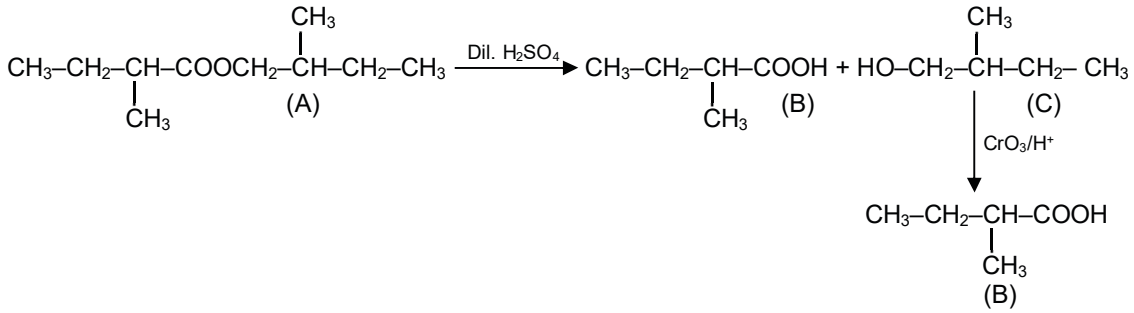
(2) $CH_3 - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - OCOCH_2\underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2CH_3$

(3) $(CH_3)_3 - C - COOCH_2C(CH_3)_3$

(4) $CH_3CH_2CH_2COOCH_2CH_2CH_2CH_3$

Ans. (2)

Sol.



42. The complex that can show optical activity is :

(1) trans-$[Cr(Cl_2)(ox)_2]^{3-}$ (2) trans-$[Fe(NH_3)_2(CN)_4]^-$

(3) cis-$[Fe(NH_3)_2(CN)_4]^-$ (4) cis-$[CrCl_2(ox)_2]^{3-}$ (ox = oxalate)

Ans. (4)

Sol. Only cis-$[CrCl_2(OX)_2]^{3-}$ show optical isomerism while its trans form do not show optical isomerism due to presence of plane of symmetry.

43. Aqua regia is used for dissolving noble metals (Au, Pt, etc.). The gas evolved in this process is :

(1) N_2 (2) NO (3) N_2O_5 (4) N_2O_3

Ans. (2)

Sol. Aqua regia is HNO_3 : HCl

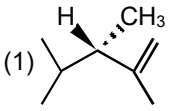
1 : 3

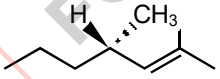
$$HNO_3 + 3HCl \longrightarrow 2H_2O + NO + 3[Cl]$$

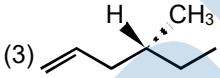
(i) $Au + 3[Cl] \longrightarrow AuCl_3 \xrightarrow{HCl} HAuCl_4$

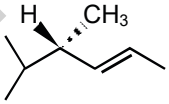
(ii) $Pt + 4[Cl] \longrightarrow PtCl_4 \xrightarrow{HCl} H_2PtCl_6$

44. Which of the following compounds produces an optically inactive compound on hydrogenation ?

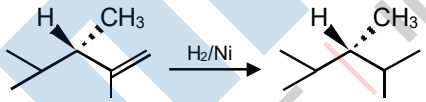
(1) 

(2) 

(3) 

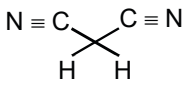
(4) 

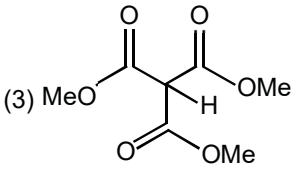
Ans. (1)

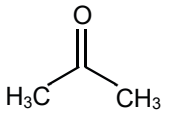
Sol. 

Optically inactive

45. Which one of the following compounds possesses the most acidic hydrogen ?

(1) $H_3C - C \equiv C - H$ (2) 

(3) 

(4) 

Ans. (3)

Sol. Acidic strength $\propto$ –I, –M effect due to strong –I, –M effect of 3 – $COOCH_3$, it has most acidic Hydrogen.

SECTION – 2 : (Maximum Marks : 20)

This section contains FIVE (05) questions. The answer to each question is **NUMERICAL VALUE** with two digit integer and decimal upto one digit.

If the numerical value has more than two decimal places truncate/round-off the value upto TWO decimal places.

Full Marks : +4 If ONLY the correct option is chosen.

Zero Marks : 0 In all other cases

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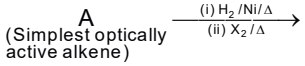
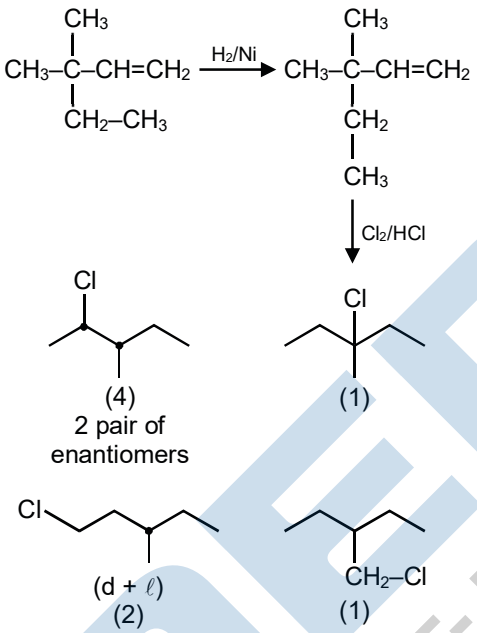
46. The total number of monohalogenated organic products in the following (including stereoisomers) reaction is_____.



Ans. (8)

Sol.



47. The photoelectric current from Na (work function, w_0 = 2.3 eV) is stopped by the output voltage of the cell

Pt(s)|H_2(g, 1bar) | HCl(aq., pH = 1) | AgCl(s) | Ag(s)

the pH of aq. HCl required to stop the photoelectric current from K(w_0 = 2.25 eV), all other conditions remaining the same, is ..... × 10^{-2} (to the nearest integer).

Given

$$2.303\frac{RT}{F} = 0.06\ V;\ E^0_{AgCl|Ag|Cl^-} = 0.22\,V$$

Ans. 142 {NTA answer given is 58}

Sol. **Sodium metal :**

$E = E_0 + (KE)_{max}$; $E^0_{cell} = 0.22\,V$

Cell reaction

Cathode : $AgCl(s) + e^- \longrightarrow Ag(s) + Cl^-(aq)$

Anode : $\frac{1}{2}H_2(g) \longrightarrow H^+(aq) + e^-$

Overall : $AgCl(s) + \frac{1}{2}H_2(g) \longrightarrow Ag(S) + H^+(aq) + Cl^-(aq)$

$$E_{Cell} = E^0_{cell} - \frac{0.06}{1}\log[H^+][Cl^-]$$

$$E_{Cell} = 0.22 - \frac{0.06}{1}\log[10^{-1}][10^{-1}] = 0.22 + 0.12 = 0.34\,V$$

$(KE)_{max} = E_{cell} = 0.34$ eV

So E = 2.3 + 0.34 = 2.64 eV = Energy of photon incident

For potassium metal :

$E = E_0 + (KE)^{max}$

$2.64 = 2.25 + (KE)_{max}$

$(KE)_{max} = 0.39 = E_{cell}$

Cell reaction

Cathode : $AgCl(s) + e^- \longrightarrow Ag(s) + Cl^-(aq)$

Anode : $\frac{1}{2}H_2(g) \longrightarrow H^+(aq) + e^-$

Overall : $AgCl(s) + \frac{1}{2}H_2(g) \longrightarrow Ag(S) + H^+(aq) + Cl^-(aq)$

$$E_{Cell} = E^0_{cell} - \frac{0.06}{1}\log[H^+][Cl^-]$$

$0.39 = 0.22 - 0.12 \log [H^+]$

$0.17 = 0.12 \times pH$

$pH = 17/12 = 1.4166 = 1.42$

48. The mol fraction of glucose ($C_6H_{12}O_6$) in an aqueous binary solution is 0.1. The mass percentage of water in it, to the nearest integer, is ……

Ans. 47

Sol. Let total mol of solution = 1

so mol of glucose = 0.1

mol of H_2O = 0.9

$$\%\ (w/w)\ \text{of}\ H_2O = \left[\frac{0.9 \times 18}{0.9 \times 18 + 0.1 \times 180}\right] \times 100$$

= 47.368

= 47.37

49. The volume strength of 8.9 M H_2O_2 solution calculated at 273 K and 1 atm is ……. (R = 0.0821 L atm K^{-1} mol^{-1}) (rounded off to the nearest integer)

Ans. 100

Sol. Molarity of H_2O_2 solution $= \left\{\frac{\text{Volume strength}}{11.2}\right\}$

Volume strength = 8.9 × 11.2

= 99.68 V

50. An element with molar mass 2.7×10^{-2} kg mol^{-1} forms a cubic unit cell with edge length 405 pm. If its density is 2.7×10^3 kg m^{-3}, the radius of the element is approximately ……. $\times 10^{-12}$ m (to the nearest integer)

Ans. 143

Sol. $d = \frac{Z \times M}{Na \times \text{Volume}}$

$2.7 = \frac{Z \times 27}{6.02 \times 10^{23} \times [4.05 \times 10^{-3}]^3}$

$Z = 4 \quad \Rightarrow$ fcc unit cell

For fcc unit cell $4r = \sqrt{2}a$

$r = \frac{1.414 \times 405}{4}$

= 143.1675 pm = 143.17 pm

PART-C : MATHEMATICS

SECTION – 1 : (Maximum Marks : 80)

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.

Full Marks : +4 If ONLY the correct option is chosen.

Negative Marks : –1 (minus one) mark will be deducted for indicating incorrect response.

---

51. A die is thrown two times and the sum of the scores appearing on the die is observed to be a multiple of 4. Then the conditional probability that the score 4 has appeared atleast once is :

(1) $\frac{1}{8}$ (2) $\frac{1}{9}$ (3) $\frac{1}{3}$ (4) $\frac{1}{4}$

Ans. (2)

52. The lines $\vec{r} = \left(\hat{i} - \hat{j}\right) + \ell\left(2\hat{i} + \hat{k}\right)$ and $\vec{r} = \left(2\hat{i} - \hat{j}\right) + m\left(\hat{i} + \hat{j} - \hat{k}\right)$

(1) Intersect when $\ell = 1$ and $m = 2$ (2) Intersect when $\ell = 1$ and $m = \frac{1}{2}$

(3) Do not intersect for any values of ℓ and m (4) Intersect for all values of ℓ and m

Ans. (3)

53. The foot of the perpendicular drawn from the point (4, 2, 3) to the line joining the points (1, –2, 3) and (1, 1, 0) lies on the plane :

(1) $x + 2y - z = 1$ (2) $x - 2y + z = 1$ (3) $x - y - 2z = 1$ (4) $2x + y - z = 1$

Ans. (2)

54. A hyperbola having the transverse axis of length $\sqrt{2}$ has the same foci as that of the ellipse $3x^2 + 4y^2 = 12$, then this hyperbola does not pass through which of the following points ?

(1) $\left(1, -\frac{1}{\sqrt{2}}\right)$ (2) $\left(\sqrt{\frac{3}{2}}, \frac{1}{\sqrt{2}}\right)$ (3) $\left(\frac{1}{\sqrt{2}}, 0\right)$ (4) $\left(-\sqrt{\frac{3}{2}}, 1\right)$

Ans. (2)

55. The area (in sq. units) of the region $\{(x,y) : 0 \le y \le x^2 + 1, 0 \le y \le x + 1, \frac{1}{2} \le x \le 2\}$ is :

(1) $\frac{79}{16}$ (2) $\frac{23}{6}$ (3) $\frac{79}{24}$ (4) $\frac{23}{16}$

Ans. (3)

56. If the first term of an A.P. is 3 and the sum of its first 25 terms is equal to the sum of its next 15 terms, then the common difference of this A.P. is :

(1) $\frac{1}{4}$ (2) $\frac{1}{5}$ (3) $\frac{1}{7}$ (4) $\frac{1}{6}$

Ans. (4)

57. Let P be a point on the parabola, $y^2 = 12x$ and N be the foot of the perpendicular drawn from P on the axis of the parabola. A line is now drawn through the mid-point M of PN, parallel to its axis which meets the parabola at Q. If the y-intercept of the line NQ is $\frac{4}{3}$, then :

(1) $MQ = \frac{1}{3}$ (2) PN = 3 (3) $MQ = \frac{1}{4}$ (4) PN = 4

Ans. (3)

58. For the frequency distribution :

Variate (x) : x_1 x_2 x_3 .... x_{15}

Frequency (f) : f_1 f_2 f_3 .... f_{15}

where $0 < x_1 < x_2 < x_3 < .... < x_{15} = 10$ and $\sum_{i=1}^{15} f_i > 0$, the standard deviation cannot be :

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

Ans. (4)

59. $\int_{-\pi}^{\pi} |x - |x|| dx$ is equal to :

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

Ans. (1)

60. Consider the two sets :

A = {m ∈ R : both the roots of

$x^2 - (m + 1)x + m + 4 = 0$ are real} and

B = [–3, 5).

Which of the following is not true ?

(1) $A - B = (-\infty, -3) \cup (5, \infty)$ (2) $A \cap B = \{-3\}$

(3) $B - A = (-3, 5)$ (4) $A \cup B = R$

Ans. (1)

61. If $y^2 + \log_e(\cos^2 x) = y, x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$, then :

(1) |y''(0)| = 2 (2) |y'(0)| + |y''(0)| = 3 (3) |y'(0)| + |y''(0)| = 1 (4) y''(0) = 0

Ans. (1)

62. The function, $f(x) = (3x - 7)x^{2/3}$, $x \in R$, is increasing for all x lying in :

(1) $(-\infty, 0) \cup \left(\frac{3}{7}, \infty\right)$ (2) $(-\infty, 0) \cup \left(\frac{14}{15}, \infty\right)$ (3) $\left(-\infty, \frac{14}{15}\right)$ (4) $\left(-\infty, \frac{14}{15}\right) \cup (0, \infty)$

Ans. (2)

63. The value of ($2.{}^1P_0 - 3.{}^2P_1 + 4.{}^3P_2$ – .... up to 51^{th} term) + (1! – 2! + 3! – ..... up to 51^{th} term) is equal to :

(1) 1 + (51)! (2) 1 – 51(51)! (3) 1 + (52)! (4) 1

Ans. (3)

64. If $\Delta\begin{vmatrix} x-2 & 2x-3 & 3x-4 \\ 2x-3 & 3x-4 & 4x-5 \\ 3x-5 & 5x-8 & 10x-17 \end{vmatrix} = Ax^3+Bx^2+Cx+D$, then B + C is equal to :

(1) –1 (2) 1 (3) –3 (4) 9

Ans. (3)

65. The solution curve of the differential equation, $(1+e^{-x})(1+y^2)\frac{dy}{dx}=y^2$, which passes through the point (0, 1), is :

(1) $y^2=1+y\log_e\left(\frac{1+e^x}{2}\right)$ (2) $y^2+1=y\left(\log_e\left(\frac{1+e^x}{2}\right)+2\right)$

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

Ans. (1)

66. If the number of integral terms in the expansion of $(3^{1/2}+5^{1/8})^n$ is exactly 33, then the least value of n is:

(1) 264 (2) 256 (3) 128 (4) 248

Ans. (2)

67. If α and β are the roots of the equation $x^2 + px + 2 = 0$ and $\frac{1}{\alpha}$ and $\frac{1}{\beta}$ are the roots of the equation $2x^2 + 2qx + 1 = 0$, then $\left(\alpha-\frac{1}{\alpha}\right)\left(\beta-\frac{1}{\beta}\right)\left(\alpha+\frac{1}{\beta}\right)\left(\beta+\frac{1}{\alpha}\right)$ is equal to :

(1) $\frac{9}{4}(9+p^2)$ (2) $\frac{9}{4}(9-q^2)$ (3) $\frac{9}{4}(9-p^2)$ (4) $\frac{9}{4}(9+q^2)$

Ans. (3)

68. Let [t] denote the greatest integer $\le$ t. If for some $\lambda \in R-\{0,1\}, \lim_{x\to 0}\left|\frac{1-x+|x|}{\lambda-x+[x]}\right| = L$, then L is equal to :

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

Ans. (2)

69. $2\pi-\left(\sin^{-1}\frac{4}{5}+\sin^{-1}\frac{5}{13}+\sin^{-1}\frac{16}{65}\right)$ is equal to :

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

Ans. (3)

70. The proposition $p \to \sim (p \wedge \sim q)$ is equivalent to :

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

Ans. (1)

SECTION – 2 : (Maximum Marks : 20)

This section contains FIVE (05) questions. The answer to each question is **NUMERICAL VALUE** with two digit integer and decimal upto one digit.

If the numerical value has more than two decimal places truncate/round-off the value upto TWO decimal places.

Full Marks : +4 If ONLY the correct option is chosen.

Zero Marks : 0 In all other cases

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71. Let $A=\begin{bmatrix} x & 1 \\ 1 & 0 \end{bmatrix}, x \in R$ and $A^4 = [a_{ij}]$. If $a_{11} = 109$, then a_{22} is equal to _____.

Ans. (10)

72. If $\lim\limits_{x\to 0}\left\{\frac{1}{x^8}\left(1-\cos\frac{x^2}{2}-\cos\frac{x^2}{4}+\cos\frac{x^2}{2}\cos\frac{x^2}{4}\right)\right\} = 2^{-k}$, then the value of k is _____.

Ans. (8)

73. The diameter of the circle, whose centre lies on the line x + y = 2 in the first quadrant and which touches both the lines x = 3 and y = 2, is _____ .

Ans. (3)

74. The value of $(0.16)^{\log_{2.5}\left(\frac{1}{3}+\frac{1}{3^2}+\frac{1}{3^3}+.....\text{to }\infty\right)}$ is equal to _____ .

Ans. (4)

75. If $\left(\frac{1+i}{1-i}\right)^{\frac{m}{2}}-\left(\frac{1+i}{i-1}\right)^{\frac{n}{3}}=1, (m,n\in N)$ then the greatest common divisor of the least values of m and n is _____ .

Ans. (4)