MENIIT

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JEE MAIN-2022

COMPUTER BASED TEST (CBT)

DATE : 24-06-2022 (EVENING SHIFT) | TIME : (3.00 PM to 6.00 PM)

Duration 3 Hours | Max. Marks : 300

QUESTIONS & 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 pair of physical quantities that have same dimensions :

(A) velocity gradient and decay constant

(B) wien's constant and Stefan constant

(C) angular frequency and angular momentum

(D) wave number and Avogadro number

Ans. **A**

2. The distance between Sun and Earth is R. The duration of year if the distance between Sun and Earth becomes 3R will be :

(A) $\sqrt{3}$years (B) 3 years (C) 9 years (D) $3\sqrt{3}$years

Ans. **D**

Sol. $$\frac{T_2}{T_1} = \left(\frac{r_2}{r_1}\right)^{3/2} = \left(\frac{3r}{r}\right)^{3/2}$$

$$\frac{T_2}{T_1} = 3\sqrt{3}$$

3. A stone of mass m. tied to a single is being whirled in a vertical circle with a uniform speed. The tension in the string is

(A) the same throughout the motion.

(B) minimum at the highest position of the circular path.

(C) minimum at the lowest position of the circular path.

(D) minimum when the rope is in the horizontal position.

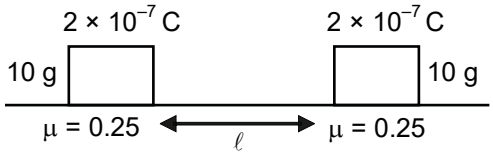
Ans. **B**

4. Two identical charged particles each having a mass 10g and charged 2.0×10^{-7} C are placed on a horizontal table with a separation of L between then such that they stay in limited equilibrium. If the coefficient of friction between each particle and the table is 0.25, find the valuer of L. [Use g = $10ms^{-2}$]

(A) 12 cm (B) 10 cm (C) 8 cm (D) 5 cm

Ans. **A**

Sol.



$$\frac{kq^2}{\ell^2} = \mu mg$$

$\frac{1}{4}$

5. A Carnot engine take 5000 kcal of heat from a reservoir at 727°C and gives heat to a sink at 127°C. Then work done by the engine is

(A) 3×10^6J (B) Zero (C) 12.6×10^6J (D) 8.4×10^6J

Ans. **C**

Sol. Given

$T_1 = 727 + 273 = 1000K$

$T_2 = 227 + 273 = 400K$

$Q_1 = 3000$ K.cal

Efficiency

$$n = \frac{w}{Q_1} = 1 - \frac{T_2}{T_1}$$

$$n = Q_1\left(1 - \frac{T_2}{T_1}\right) = 5000\left(1 - \frac{400}{1000}\right)10^3 = 5000\left(\frac{3}{5}\right)10^3 \text{cal}$$

$= 3 \times 10^6$ cal $= 3 \times 4.2 \times 10^6$J $= 12.6 \times 10^6$ J

6. Two massless springs with spring constant 2 k and 9 k, carry 50 g and 100g masses at their free ends. These two masses oscillate vertically such that their maximum velocities are equal. Then, the ratio of their respective amplitudes will be :

(A) 1 : 2 (B) 3 : 2 (C) 3 : 1 (D) 2 : 3

Ans. **B**

Sol. $V_{man} = \omega_1 A_1 = \omega_2 A_2$

$$\frac{A_1}{A_2} = \frac{\omega_2}{\omega_1} = \frac{\sqrt{K_2/m_2}}{\sqrt{K_1/m_1}}$$

$$= \frac{\sqrt{K_2}}{\sqrt{K_1}} \times \frac{\sqrt{m_2}}{\sqrt{m_1}}$$

$$= \frac{\sqrt{9k}}{\sqrt{2k}} \times \frac{\sqrt{50}}{\sqrt{1000}} = \frac{3}{2}$$

7. What will be the most suitable combination of three resistors A=2Ω , B=4Ω, C = 6Ω so that $\left(\frac{22}{3}\right)\Omega$ is equivalent resistance of combination?

(A) Parallel combination of A and C connected in series with B.

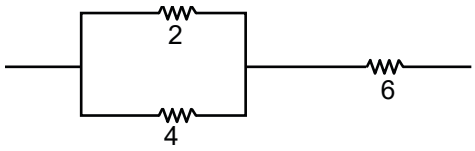
(B) Parallel combination of A and C connected in series with C.

(C) Series combination of A and C connected in parallel with B.

(D) Series combination of B and C connected in parallel with A.

Ans. **B**

Sol.



$$R_{eq} = \frac{22}{3}$$

8. The soft-iron is a suitable material for making an electromagnet. This is because soft-iron has

(A) low-coercivity and high retentivity. (B) low-coercivity and low retentivity.

(C) high permeability and high retentivity. (D) high permeability and high retentivity.

Ans. **C**

9. A proton, a deuteron and α-particle with same kinetic energy enter into a uniform magnetic field at right angle to magnetic field. The ration of the radii of their respective circular paths is

(A) $1:\sqrt{2}:\sqrt{2}$ (B) $1:1:\sqrt{2}$ (C) $\sqrt{2}:1:1$ (D) $1:\sqrt{2}:1$

Ans. **D**

Sol. For circular path in magnetic field.

$$r = \frac{\sqrt{2mE}}{qB} \qquad E = \text{kinetic energy}$$

So

	d	p	α
m	2	1	4
q	e	+e	2e

$$r_1 : r_2 : r_3 = \frac{\sqrt{m_1}}{q_1} : \frac{\sqrt{m_2}}{q_2} : \frac{\sqrt{m_3}}{q_3} = \frac{\sqrt{1}}{e} : \frac{\sqrt{2}}{e} : \frac{\sqrt{4}}{2e} = 1:\sqrt{2}:1$$

10. Given below are two statements :

Statement-I: The reactance of an as circuit is zero. It is possible that the circuit contains a capacitor and an inductor.

Statement- II : In ac circuit, the average power delivered by the source never becomes zero.

In the light of the above statement, choose the correct answer from the options given below

(A) Both Statement I and Statement II are true.

(B) Both Statement I and Statement II are false.

(C) Statement I is true but Statement II are false.

(D) Statement I and Statement II are false.

Ans. **C**

11. Potential energy as a function of r is given by $U = \frac{A}{r^{10}} - \frac{B}{r^5}$, where r is the interatomic distance. A and B are positive constants. The equilibrium distance between the two atoms will be :

(A) $\left(\frac{A}{B}\right)^{\frac{1}{5}}$ (B) $\left(\frac{B}{A}\right)^{\frac{1}{5}}$ (C) $\left(\frac{2A}{B}\right)^{\frac{1}{5}}$ (D) $\left(\frac{B}{2A}\right)^{\frac{1}{5}}$

Ans. **C**

Sol. $F = -\frac{du}{dr} = 0$

$\Rightarrow -10r^{-11}A + 5r^{6}B = 0$

$\Rightarrow r = \left[\frac{2A}{B}\right]^{\frac{1}{5}}$

12. An object of mass 5 kg is thrown vertically upwards from the ground. The air resistance produces a constant retarding force of 10 N throughout the motion. The ratio of time of ascent to the time of descent will be equal to : [Use $g = 10ms^{-2}$].

(A) 1 : 1 (B) $\sqrt{2} : \sqrt{3}$ (C) $\sqrt{3} : \sqrt{2}$ (D) 2 : 3

Ans. **B**

Sol. Let a be the retardation produced by air resistive force $a = \frac{F_{air}}{M} = \frac{10}{5} = 2$, T_a and T_b be the time of ascent and time descent respectively.

If the particle reses upto a height h

then $h = \frac{1}{2}(g+a)t_{a^2}$ and $h = \frac{1}{2}(g+a)t_a^{\,2}$

$\therefore \quad h = \frac{t_a}{td} = \sqrt{\frac{g-a}{g+a}} = \sqrt{\frac{10-2}{10+2}} = \sqrt{\frac{2}{3}}$

Ans. $\sqrt{\frac{2}{3}}$

13. A fly wheel is accelerated uniformly from rest and rotates through 5 rad in the first second. The angle rotated by the fly wheel in the next second, will be :

(A) 7.5 rad (B) 15 rad (C) 20 rad (D) 30 rad

Ans. **B**

Sol. $\theta = \omega t + \frac{1}{2}\alpha t^2$

$\theta_1 = \frac{1}{2}\alpha(1)^2$ ..... (i)

$\theta_1 + \theta_2 = \frac{1}{2}\alpha(2)^2$ .....(ii)

so $\theta_2 = 3\theta_2 = 3 \times 5 = 15$

14. A 100 g of iron nail is hit by a 1.5 kg hammer striking at a velocity of 60 ms^{-1}.

What will be the rise in the temperature of the nail if one fourth of energy of the hammer goes into heating the nail?

[Specific heat capacity of iron = $0.42Jg^{-1}\,°C^{-1}$]

(A) 675°C (B) 1600°C (C) 16.07°C (D) 6.75°C

Ans. **C**

Sol. $\frac{1}{4}$ kinetic energy of hammer is converted into heat. Which is transfer to the nail.

$$\frac{1}{4}\left(\frac{1}{2}M_{harmmer}\times v^2\right)=M_{nail}s\Delta\theta$$

$$\Delta\theta=\frac{1}{8}\frac{M_{hammer}}{M_{nail}}\frac{v^2}{s}=\frac{1\times1.5\times(20)^2}{8\times0.1\times0.42}=\frac{1.5\times20\times20}{8\times100\times0.42}=\frac{15\times20\times20}{8\times42\times100}\times100=17.85^{\circ}C$$

15. If the charge on a capacitor is increased by 2 C, the energy stored in it increased by 44%. The original charge on the capacitor is (in C)

(A) 10 (B) 20 (C) 30 (D) 40

Ans. **A**

Sol. $U=\frac{Q^2}{2C}$

New charge $\Rightarrow$ Q + 2

U' = new energy $=\frac{(Q+2)^2}{2C}$

$$U'=U+U\times\frac{44}{100}=U\times1.44$$

$$\frac{(Q+2)^2}{2C}=\frac{Q^2}{2C}\times1.44$$

$$Q+2=Q\times\sqrt{1.44}$$

Q + 2 = Q + 1.2

2 = 0.2 Q

Q = 10 coulomb

16. A long cylindrical volume contains a uniformly distributed of destiny ρ. The radius of cylindrical volume is R. A charge particle (q) revolves around the cylinder in a circular path. The kinetic energy of the particle is :

(A) $\frac{\rho qR^2}{4\varepsilon_0}$ (B) $\frac{\rho qR^2}{2\varepsilon_0}$ (C) $\frac{q\rho}{4\varepsilon_0R^2}$ (D) $\frac{4\varepsilon_0R^2}{q\rho}$

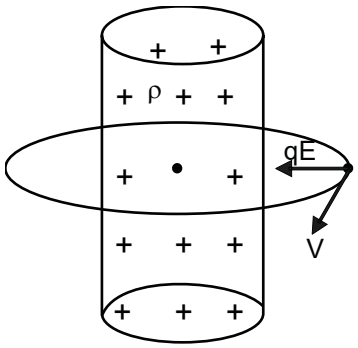
Ans. **A**

Sol. Charge (λ) per unit length of cylinder $=\frac{Q}{\ell}$

$$=\frac{\rho\times\pi R^2\ell}{\ell}=\rho\pi R^2$$

$$E=\frac{\lambda}{2\pi\varepsilon_0 r}=\frac{\rho\pi R^2}{2\pi\varepsilon_0 r}=\frac{\rho R^2}{2\varepsilon_0 r}$$

$$qE=\frac{mV^2}{r}$$



$$\frac{q \times \rho R^2}{2\varepsilon_0 r} = \frac{mV^2}{r}$$

$$mV^2 = \frac{q\rho R^2}{2\varepsilon_0}$$

$$KE = \frac{1}{2}mV^2 = \frac{q\rho R^2}{4\varepsilon_0}$$

17. An electric bulb is rated as 200W. What will be the peak magnetic field at 4 m distance produced by the radiations coming for this bulb? Consider this bulb as a point source with 3.5% efficiency.

(A) 1.19×10^{-8}T (B) 1.71×10^{-8}T (C) 0.84×10^{-8}T (D) 3.36×10^{-8}T(A)

Ans. **Given Ans. B & Zigyan Given Ans. A**

Sol. Power of light = power = $100 \times \frac{3.5}{100}$

$$I = \text{Intensity} = \frac{\text{Power}}{4\pi r^2} = \frac{3.5 \times 100}{100 \times 4\pi (4)^2} w/m^2 = 0.0173 w/n^2$$

$$I = \frac{B_0^2 C}{2\mu_0}; B_0 = \sqrt{\frac{I \times 2\mu_0}{C}}; B_0 = 1.2 \times 10^{-8} T$$

18 The light of two different frequencies whose photons have energies 3.8 eV and 1.4 eV respectively. Illuminate a metallic surface whose work function is 0.6 eV successively. The ratio of maximum speeds of emitted electrons for the two frequency respectively will be :

(A) 1 : 1 (B) 2 : 1 (C) 4 : 1 (D) 1 : 4

Ans. **B**

Sol. $\frac{V_{1max}}{V_{2max}} = \sqrt{\frac{3.8 - 0.6}{1.4 - 0.6}} = \frac{2}{1}$

19. Two light beams of intensities in the ration of 9 : 4 are allowed to interface. The ratio of the intensity of maxima and minima will be :

(A) 2 : 3 (B) 16 : 81 (C) 25 : 169 (D) 25 : 1

Ans. **D**

Sol. Given

$$\frac{I_1}{I_2} = \frac{9}{4}$$

$$\frac{I_{max}}{I_{min.}} = \frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2} = \frac{\left(\frac{\sqrt{I_1}}{\sqrt{I_2}}+1\right)^2}{\left(\frac{\sqrt{I_1}}{\sqrt{I_2}}-1\right)^2} = 25:1$$

20. In Bohr's atomic model of hydrogen let K, P and E are the kinetic energy, potential energy and total energy of the electron respectively. Choose the correct option when the electron undergoes transitions to a higher level :

(A) All K, P and E increase.

(B) K decreases, P and E increase.

(C) P decreases, K and E increase.

(D) K increase, P and E decrease.

Ans. **B**

Sol. Information

Numeric Value Type

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

21. A body is projected from the ground at an angle of 45° with the horizontal. Its velocity after 2s in $20ms^{-1}$. The maximum height reaches by the body during its motion is _____ m. (use $g = 10ms^{-2}$)

Ans. **20**

Sol. Assume initial speed is u

then $\vec{u} = \frac{u}{\sqrt{2}}\hat{i} + \frac{u}{\sqrt{2}}\hat{j}$

at 2 sec

$\vec{v} = \frac{u}{\sqrt{2}}\hat{i} + \left(\frac{u}{\sqrt{2}} - g \times 2\right)\hat{j}$

given $\Rightarrow v = 20 = \sqrt{\left(\frac{u}{\sqrt{2}}\right)^2 + \left(\frac{u}{\sqrt{2}} - 2g\right)^2}$

$400 = \frac{u^2}{2} + \frac{u^2}{2} + 400 - \frac{40u}{\sqrt{2}}; u^2 - \frac{40}{\sqrt{2}}u = 0 \;;\; u\left(u - \frac{40}{\sqrt{2}}\right) = 0 \Rightarrow u = 0 \text{ or } u = \frac{40}{\sqrt{2}} m/s$

Maximum height $= \frac{u^2(\sin^2\theta)}{2g} = \frac{\left(\frac{40}{\sqrt{2}}\frac{1}{\sqrt{2}}\right)^2}{2g} = \frac{(20)^2}{20} = 20m$

22. An antenna is placed in a dielectric medium of dielectric constant 6.25, if the maximum size of that antenna is 5.0 mm, it can radiate a signal of minimum frequency of _____GHZ.

(Given $\mu_r = 1$ for dielectric medium)

Ans. **06.00**

Sol. $R.I. = \sqrt{\varepsilon_r \mu_r} = 2.5$

$v = \frac{c}{2.5}$

$l > \frac{\lambda}{4} \Rightarrow l > \frac{v}{4f}$

$f > \frac{v}{4l} \Rightarrow f > 6GHz$

23. A potentiometer wire of length 10 m and resistance 20 Ω is connected in series with a 25 V battery and an external resistance 30 Ω. A cell of emf E in secondary circuit is balanced by 250 cm long potentiometer wire. The value of E (in volt) is $\frac{x}{10}$. The value of x is _____.

Ans. **25**

Sol. $I = \frac{25}{R + R_n} = \frac{25}{20 + 30} = \frac{25}{50} = \frac{1}{2} Amp$

Y = potential gradient $= \frac{iR}{L} = \frac{1}{2} \times \frac{20}{10} = 1V/m$

Balanced length = 250cm = 2.5 metre

E = y × Balance length = 1 × 2.5 = 2.5 volt = x/10

x = 25

24. Two travelling waves of equal amplitudes and equal frequency move in opposite directions along a string. They interfere to produce a stationary wave whose equation is given by

$$y = \left(10\cos\pi\sin\frac{2\pi t}{T}\right)\text{cm}$$

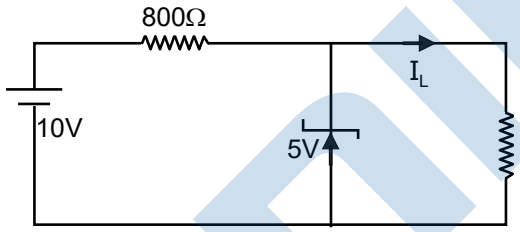
The amplitude of the particle at $x = \frac{4}{3}$ cm will be _____ cm.

Ans. **05.00**

Sol. $A = 10\cos\frac{4\pi}{3} = 5\text{cm}$

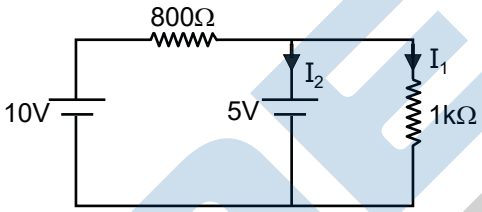
25. In the given circuit, the value of current I_L will be _____ mA.

(When R_L = 1k Ω)



Ans. **5**

Sol.



$-10 + 800I + 5 = 0$

$$I = \frac{5}{800}\text{Amp}$$

$$I_1 = \frac{5}{800}\text{Amp}$$

$$I_2 = I - I_1 = \frac{5}{800} - \frac{5}{1000} = 1.125\text{mA}$$

26. A sample contains 10^{-2} kg each of two substance A and B with half lives 4 s and 8 s respectively. The ratio of their atomic weights is 1 : 2. The ratio of the amounts of A and B after 16 s is $\frac{x}{100}$. The value of x is _____.

Ans **25.00**

Sol. $m = \frac{m_0}{2^n}$

$$\text{Ratio} = \frac{1/2^4}{1/2^2} = \frac{1}{4} = x/100; x = 25$$

27. A ray of light is incident at an angle of incidence 60° on the glass slab of refractive index $\sqrt{3}$. After refraction, the light ray emerges out from other parallel faces and lateral shift between incident ray and emergent ray is $4\sqrt{3}$ cm. The thickness of the glass slab is _____cm.

Ans. **12.00**

Sol. Here r = 30°

$$d = \frac{t}{\cos r}\sin(i-r)$$

$$4\sqrt{3} = \frac{1}{\sqrt{3}/2} \times \frac{1}{2}t = 12$$

28. A circular coil of 1000 turns each with area $1m^2$ is rotated about its vertical diameter at the rate of one revolution per second in a uniform horizontal magnetic field of 0.07T. The maximum voltage generation will be _____ V.

Ans. **440**

Sol. $E_{max} = NBA\omega = 1000 \times 0.07 \times 1 \times 2 \times 3.14 = 440$ volt

29. A monoatomic gas performs a work of $\frac{Q}{4}$ where Q is the heat supplied to it. The molar heat capacity of the gas will be _____ R during this transformation.
Where R is the gas constant.

Ans. **2**

Sol. W = Q/4

Q = Q/4 + ΔU

ΔU = 3Q/4

$$nC_V\Delta T = \frac{3}{4}Q$$

nCΔT = Q

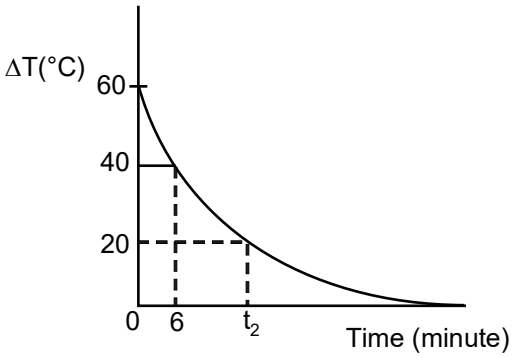
Cv/C = 3/4

C = 4/3 C_V

= 4/3 × 3/2 R

= 2R

30. In an experiment to verify Newton's law of cooling, a graph is plotted between, the temperature difference (ΔT) of the water and surroundings and time as shown in mentioned in the graph will be _____.



Ans. **16**

Sol. $\Delta T = T_{water} - T_{sourrounding} = T - T_s$

At t = 0 $\Delta T = 60$ and $T = 80°C$

$80 - T_s = 60$ $\therefore T_s = 20°C$

Newton law of cooling

$$-\frac{(T_f - T_i)}{\Delta t} = k\left(\frac{T_1 + T_{fi}}{2} - T_s\right)$$

Between 0 to 6 minute

$$\frac{20}{6\,min} = k\left[\left(\frac{40+20}{2} + 20\right) - 20\right]$$

Between 6 to t_2 minute

$$\frac{20}{t_2 - 6} = k\left[\left(\frac{40+20}{2} + 20\right) - 20\right]$$

After divided by $t_2 = 16$ min.

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. 120 g of an organic compound that contains only carbon and hydrogen gives 330 g of CO_2 and 270g of water on complete combustion. The percentage of carbon and hydrogen, respectively are

(A) 25 and 75 (B) 40 and 60 (C) 60 and 40 (D) 75 and 40

Ans. D

Sol. Weight of CO_2 = 330 gram

Weight of H_2O = 27 gram

$$\text{Mole of } CO_2 = \frac{330}{44}\text{gram}$$

$$\text{Mole of } H_2O = \frac{270}{18}\text{gram}$$

$$\text{Mole of C} = \frac{330}{44}\text{gram}$$

$$\text{Weight of H} = \frac{270}{18} \times 1\text{gram}$$

$$\text{Weight of C} = \frac{3300}{44} \times 12\,\text{gram}$$

$$\%\text{ of H} = \frac{270 \times 100}{18 \times 120} = 25\%$$

$$\%\text{ of C} = \frac{330 \times 12 \times 100}{44 \times 120} = 75\%$$

2. The energy of one mole of photons of radiations of wavelength 300 nm is

(Given : h = 6.63 × 10^{-34} J s. N_A = 6.02 × 10^{23} mol^{-1}, c = 3 × 10^8 m s^{-1})

(A) 235 kJ mol^{-1} (B) 325 kJ mol^{-1} (C) 399 kJ mol^{-1} (D) 435 kJ mol^{-1}

Ans. C

Sol. $$E_T = \frac{N_A hc}{\lambda}$$

$$\text{or } E_T = \frac{6.02 \times 10^{23} \times 6.63 \times 10^{-34} \times 3 \times 10^8}{300 \times 10^{-9}}$$

= 0.399 × 106 = 399 K

3. The correct order of bond order of O_2^{2-}, N_2^{2-} and O_2^{2-} is, respectively

(A) $C_2^{2-} < N_2^{2-} < O_2^{2-}$ (B) $O_2^{2-} < N_2^{2-} < C_2^{2-}$ (C) $C_2^{2-} < O_2^{2-} < N_2^{2-}$ (D) $N_2^{2-} < C_2^{2-} < O_2^{2-}$

Ans. B

Sol.

Ion	Bond order
(i) C_2^{2-}	3
(ii) N_2^{2-}	2
(iii) O_2^{2-}	1

4. At 25° can 1 atm pressure, the enthalpies of combustion are as given below :

Substance	H_2	C(graphite)	$C_2H_6(g)$
$\frac{\Delta_c H^{\oplus}}{kJmol^{-1}}$	–394.0	–394.0	–1560.0

The enthalpy of formation of ethane is

(A) +54.0 kJ mol^{-1} (B) –68.0 kJ mol^{-1} (C) –86.0 kJ mol^{-1} (D) +97.0 kJ mol^{-1}

Ans. **C**

Sol. Given

(i) $C_2H_6(g)+\frac{7}{2}O_2(g)\longrightarrow 2CO_2(g)+3H_2O(\ell)\,\Delta H^{o}_{comb}=-1560.0kJ/mole$

(ii) $C(s)+O_2(g)\longrightarrow CO_2(g)\,\Delta H^{o}_{comb}=-394.0kJ/mole$

(iii) $H_2(g)+\frac{1}{2}O_2(g)\longrightarrow H_2O(g)\,\Delta H^{o}_{comb}=-286.0kJ/mole$

Target $2C(s)+3H_2(g)\longrightarrow C_2H_6(g)\,\Delta H^{o}_{rx^n}=\Delta H^{o}_{f}(C_2H_6,g)$

$\Delta H^{o}_{f}=\Delta H^{o}_{c}(reactant)-\Delta H^{o}_{c}(Product)$

= 2 ×(–394) + 3 (–286) – (–1560)

= –788 – 858 + 1560

= –86.0 KJ/mole

5. For a first order reaction, the time required for completion of 90% reaction is 'x' times the half life of the reaction. The value of 'x' is

(Given : In 10 = 2.303 and log 2 = 0.3010)

(A) 1.12 (B) 2.43 (C) 3.32 (D) 33.31

Ans. C

Sol. $T_{90\%}=\frac{2.303}{K}\log\left(\frac{100}{10}\right)=\frac{2.303}{K}\log 10$

$T_{50\%}=\frac{2.303}{K}\log\left(\frac{100}{50}\right)=\frac{2.303}{K}\log 2$

$\frac{T_{90\%}}{T_{50\%}}=\frac{\log 10}{\log 2}=\frac{1}{0.3010}=3.32$

6. Metals generally melt at very high temperature. Amongst the following, the metal with the highest melting point will be

(A) Hg (B) Ag (C) Ga (D) Cs

Ans. B

Sol.

Metal	Melting point
Ag	961.8°C
Ga	29.76°C
Cs	28.5°C

Hg	–38.3°C

7. Which of the following chemical reactions represents Hall-Heroult Process ?

(A) $Cr_2O_3 + 2Al \rightarrow Al_2O_3 + 2Cr$ (B) $2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2$

(C) $FeO + CO \rightarrow FeO + CO_2$ (D) $2[Au(CN)_2]^-(aq) + Zn(s) \rightarrow 2Au(s) + [Zn(CN_4)]^{2-}$

Ans. B

Sol. The electolysis of the molten mass is carried out in an electrolytic cell using carbon electrodes. The oxygen liberated at anode reacts with the carbon of anode producing CO and CO_2. The electrolytic reactions are :

Cathode : $Al^{3+}(melt) + 3e^- \longrightarrow A(\ell)$

Anode : $C(s) + O^{2-}(melt) \longrightarrow CO(g) + 2e^-$

$C(s) + 2O^{2-}(melt) \longrightarrow CO_2(g) + 4e^-$

Net Reaction : $2Al_2O_3 + 3C \longrightarrow 4A\ell + 3CO_2$

8. In the industrial production of which of the following molecular hydrogen is obtained as a byproduct ?

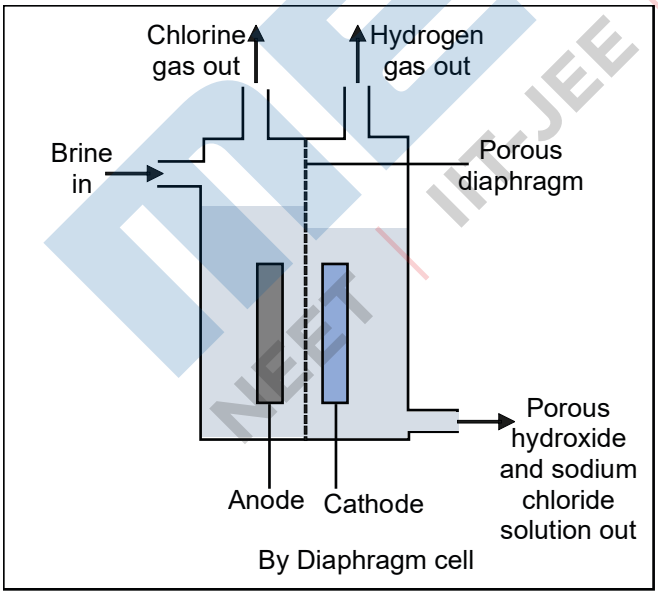
(A) NaOH (B) NaCl (C) Na metal (D) Na_2CO_3

Ans. A

Sol. $Cathode : Na^+ + e^- \xrightarrow{Hg} Na - amalgam$

$Anode : Cl^- \longrightarrow \frac{1}{2}Cl_2 + e^-$

$2Na\text{-amalgam} + 2H_2O \longrightarrow 2NaOH + 2Hg + H_2$



By Diaphragm cell

9. Which one of the following compound is used as a chemical in certain type of fire extinguishers ?

(A) Baking soda (B) Soda ash (C) Washing soda (D) Caustic Soda

Ans. A

Sol. Fire extinguisher contain sodium bicarbonate (Baking soda)

10. PCl_5 is well known, but NCl_5 is not. Because,

(A) nitrogen is less reactive than phosphorous.

(B) nitrogen doesn't have d-orbitals in its valence shell.

(C) catenation tendency is weaker in nitrogen than phosphorous

(D) size of phosphorous is larger than nitrogen.

Ans. B

Sol. Nitrogen do not have vacant d-orbitals so it do not expands it's octet, while phosphorous have vacant 3d orbitals so it can expands it is octet.

11. Transition metal complex with highest value of crystal field splitting (Δ_0) will be

(A) $[Cr(H_2O)_6]^{3+}$ (B) $[Mo(H_2O)_6]^{3+}$ (C) $[Fe(H_2O)_6]^{3+}$ (D) $[Os(H_2O)_6]^{3+}$

Ans. D

Sol. 5d series member have more value of Δ_0 in comparison to 3d & 4d complexes.

12. Some gases are responsible for heating of atmosphere (green house effect).

Identify from the following the gaseous species which does not cause it.

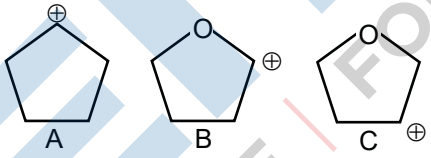
(A) CH_4 (B) O_3 (C) H_2O (D) N_2

Ans. D

Sol. Green house gasses are CO_2, CH_4, Cholorofluoro carbon, O_3, N_2O, H_2O

Note : Gas, which is not a green house gas is nitrogen.

13. Arrange the following carbocations in decreasing order of stability]

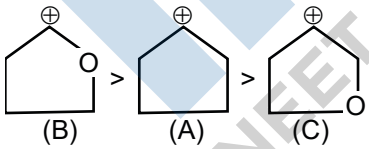


(A) A > C > B (B) A > B > C (C) C > B > A (D) C > A > B

Ans. BONUS

Sol. No correct answer given.

Correct answer is



Due to zigyan in B.

14. Given below are two statements.

Statement I : The presence of weaker p-bonds make alkenes less stable than alkanes.

Statement II : The strength of the double bond is greater than that of carbon-carbon single bond.

In the light of the above statement, Choose the correct answer from the options given below :

(A) Both Statement I and Statement II are correct.

(B) Both Statement I and Statement II are incorrect.

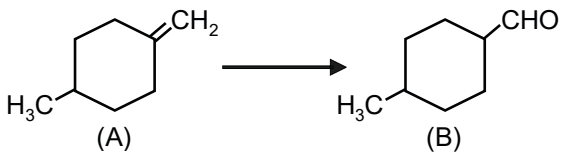
(C) Both Statement I is correct but Statement II is incorrect.

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

Ans. A

Sol. p bond is weaker than σ bond

15. Which of the following reagents/reactions will convert 'A' to 'B' ?



(A) PCC oxidation

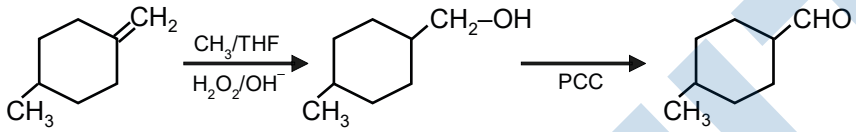
(B) Ozonolysis

(C) BH_3, $H_2O_2/^-OH$ followed by PCC oxidation

(D) HBr, hydrolysis followed by oxidation by $K_2Cr_2O_7$.

Ans. C

Sol.

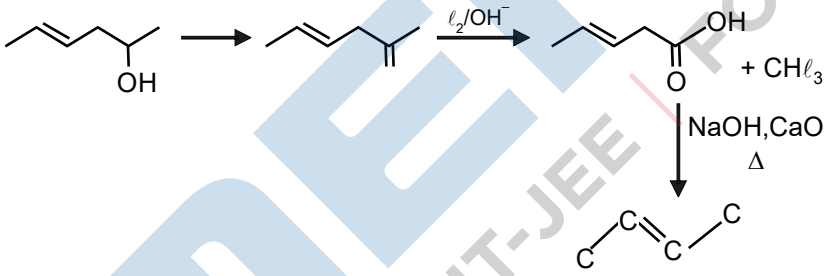


16. Hex-4-ene-ol on treatment with PCC gives 'A'. 'A' on reaction with sodium hypoiodite give 'B' which on further heating with soda lime gives 'C'. The compound 'C' is

(A) 2-pentene (B) proponaldehyde (C) 2-butene (D) 4-methylpent-2-ene

Ans. C

Sol.



17. The conversation of propan-1-ol to n-butylamine involves the sequential addition of reagents. The correct sequential order of reagents is

(A) (i) $SOCl_2$ (ii) KCN (iii) H_2/Ni, $Na(Hg)/C_2H_5OH$

(B) (i) HCl (ii) H_2/Ni, $Na(Hg)/C_2H_5OH$

(C) (i) $SOCl_2$ (ii) KCN (iii) CH_3NH_2

(D) (i) HCl (ii) CH_3NH_2

Ans. **A**

Sol.

$$CH_3CH_2CH_2OH \xrightarrow{SOC\ell_2} CH_3CH_2CH_2C\ell \xrightarrow{KCN} CH_3CH_2CH_2CN \xrightarrow[Na\text{-}Hg/C_2H_5OH]{H_2/Ni} CH_3CH_2CH_2CH_2NH_2$$

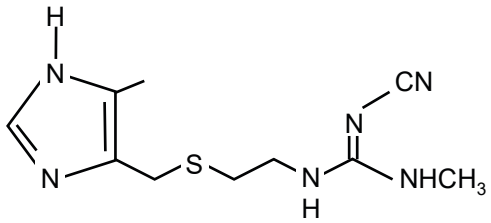
18. Which of the following in not an example of a condensation polymer ?

(A) Nylon 6, 6 (B) Decron (C) Buna-N (D) Silicone

Ans. C

Sol. Buna-N is a addition polymer of Buta-di an and styrene.

19. The structure shown below is of which well-known drug molecule ?



(A) Ranitidine (B) Seldane (C) Cimetidine (D) Codeine

Ans. C

Sol. It is fact

20. In the flame test of a mixture of salts, a green flame with blue centre was observed. Which one of the following cations may be present?

(A) Cu^{2+} (B) Sr^{2+} (C) Ba^{2+} (D) Ca^{2+}

Ans. A

Sol.

Colour of flame	Meta ion in salt
Green with Blue centre	Cu^{2+}
Apple green	Ba^{+2}
Pink violet	K^{+2}
Crimson Red	Li^{+2}

Numeric Value Type

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

21. At 300K, a sample of 3.g of gas A occupies the same volume as 0.2 g of hydrogen at 200K at the same pressure. The molar mass of gas A is _____ g mol^{-1}. (nearest integer) Assume that the behaviour of gases as ideal.

Ans. 45

Sol. From PV = nRT, according to question :

$$(PV)_{gas} = (PV)_{H_2}$$

$$(nRT)_{gas} = (nRtT)_{H_2}$$

$$\frac{3}{(MM)_{gas}} \times 300 = \frac{0.2}{2} \times R \times 200$$

$(MM)_{gas}$ = 45g/mole

22. A company dissolves 'x' amount of CO_2 at 298 K in 1 litre of water to prepare soda water. X =_____ × 10^{-3}g. (nearest integer)

(Given : partial pressure of CO_2 at 298K = 0.835 bar.

Henry 's low constant for CO_2 at 298K = 1.67kbar.

Atomic mass of H.C and O is 1. 12 and 6 g mol^{-1}. Respectively)

Ans. 1221

Sol. Using Henry's law

$P_{gas} = K_H X_{gas}$

$$10^{-3} \times [0.835] = 1.67 \left[\frac{n_{CO_2}}{n_{CO_2} + 55.5} \right]$$

$$10^{-3} \times [0.5] = \frac{n_{CO_2}}{n_{CO_2} + 55.5}$$

$$\frac{n_{CO_2}}{55.5} = 0.5 \times 10^{-3}$$

$$n_{CO_2} = 27.75 \times 10^{-3} \text{mole}$$

$$n_{CO_2} = \left(27.75 \times 10^{-3}\right) \times 44$$

= 1221 × 10^{-3}

23. PCl_5 dissociates as

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

5 moles of PCl_5 are placed in 200 litre vessel which contains 2 moles of N_2 and is maintained at 600K. The equilibrium pressure is 2.46 atm. The equilibrium constant K_P for the dissociation of PCl_5 is _____ × 10^{-3}. (nearest integer)

(Given : R = 0.0082 L atm K^{-1} mol^{-1} : Assume ideal gas behaviour)

Ans. 1107

Sol. Volume = 200 litre

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

Intial mole	5 mole	–	–
	(5 – x)	×	×

$$n_{total} = (5 + x) + n_{N_2} = (7 + x)$$

At equilibrium $\Rightarrow$ PV = nRT

$$n_{total} = \frac{PV}{RT} = \frac{2.46 \times 200}{0.082 \times 600} = 10$$

$= (7 + x) = 10$; $x = 3$

$$K_P = \frac{\left(\frac{3}{10} \times 2.46\right)\left(\frac{3}{10} \times 2.46\right)}{\left(\frac{2}{10} \times 2.46\right)} = \frac{3}{10 \times 2} \times 2.46 \times 3 = \frac{9 \times 2.46}{10 \times 2a} = 1107$$

24. The resistance of a conductivity cell containing 0.01 M KCl solution at 298K is 1750 Ω. If the conductivity of 0.01M KCl solution at 298K is 0.152×10^{-3} S cm^{-1}. then the cell constant of the conductivity cell is _____ $\times 10^{-3}$ cm^{-1}

Ans. 266

Sol. For KCl solution $\Rightarrow$ R = 1750 Ω

$$K = 0.152 \times 10^{-3} \text{ S cm}^{-1}$$

$$K = \left(\frac{\ell}{a}\right)\frac{1}{R}$$

$$= \frac{1}{1000} \times 28$$

$$= 266 \times 10^{-3} \text{ cm}^{-1}$$

25. When 200 mL of 0.2 M acetic acid is shaken with 0.6 g of wood charcoal, the final concentration of acetic acid after adsorption is 0.1M. The mass of acetic acid adsorbed per gram of carbon is _____ g.

Ans. 2

Sol. Mole of acetic acid absorved (on 0.6 gram charcoal) = $[0.2 \times 200] \times 10^{-3} - (0.1 \times 200)10^{-3}$

$= 40 \times 10^{-3} - 20 \times 10^{-3} = 20 \times 10^{-3}$

Weight of CH3COOH absorved (on 0.6 gram charcoal) = $(20 \times 10^{-3})60$

$= 1200 \times 10^{-3}$ gram = 1.2 gram

Mass of CH_3COOH absorved per gram $= \frac{1.2}{0.6} = 2\text{gram}$

26. (a) Baryte, (b) Galena, (c) Zinc blende and (d) Copper pyrites. How many of these mineral are sulphide based?

Ans. 3

Sol. (a) $BaSO_4$-Baryte

(b) Pbs – Galena

(c) ZnS – Zinc blende

(d) $CuFeS_2$ – Copper pyrite

27. Manganese (VI) has ability to disproportionate in acidic solution. The difference in oxidation states of two ions it forms in acidic solution is _____ .

Ans. 3

Sol. In acidic solution Mn(VI) become unstable relative to Mn(VII) and Mn(IV)

$$3MnO_4^{2-}(aq.) + 4H^+(aq.) \longrightarrow 2Mn\overset{+7}{O}_4 + Mn\overset{+4}{O}_2 + 2H_2O$$

So difference in oxidation state of product ions of Mn is = 3

28. 0.2 g of an organic compound was subjected to estimation of nitrogen by Dumas method in which volume of N_2 evolved (at STP) was found to be 22.400mL. The percentage of nitrogen in the compound is _____ .[nearest integer]

(Given : Molar mass of N_2 is 28 g mol^{-1}, Molar volume of N_2 at STP : 22.4L)

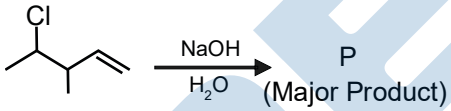
Ans. 14

Sol. Vol of N_2 gas = 22.4 ml at STP

Mole of N_2 gas $\frac{22.4}{22400} = \frac{1}{1000}$ mole

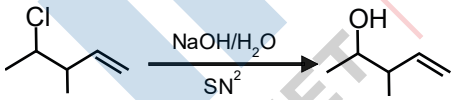
Weight of N_2 gas $= \frac{1}{1000} \times 28$

% of N in organic compound is $\frac{28}{1000} \times \frac{100}{0.2} = 14\%$

29. 

Consider the above reaction. The number of π electrons present in the product 'P' is _____.

Ans. 2

Sol. 

30. In alanylglycylleucylalanylvaline, the number of peptide linkages is _____.

Ans. 4

Sol. Ala-Gly-Leu-Ala-Val

The amino acids are connected to each other by peptide linkage.

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. Let $x*y = x^2 + y^3$ and $(x*1)*1 = x*(1*1)$.

Then a value of $2\sin^{-1}\left(\frac{x^4+x^2-2}{x^4+x^2+2}\right)$ is

(A) $\frac{\pi}{4}$ (B) $\frac{\pi}{3}$ (C) $\frac{\pi}{2}$ (D) $\frac{\pi}{6}$

Ans. **B**

Sol. $(x*1)*1 = x*(1*1)$

$(x^2 + 1)*1 = -x(2)$

$(x^2 + 1) = 1 = x^2 + 8$

$X^4 + x^2 - 6 = 0$

$\Rightarrow 2\sin^{-1}\left(\frac{x^4+x^2-2}{x^4+x^2+2}\right) = 2\sin^{-1}\left|\frac{4}{8}\right| = \frac{\pi}{3}$

2. The sum of all the real roots of the equation $(e^{2x}-4)(6e^{2x} - 5e^x + 1) = 0$ is

(A) $\log_e 3$ (B) $-\log_e 3$ (C) $\log_e 6$ (D) $-\log_e 6$

Ans. **B**

Sol. $e^{2x} = 4$, $(3e^x-1)(2e^x-1) = 0$

$2x = \ln 4$, $e^x = \frac{1}{3}, \frac{1}{2}$

$x = \ln 3, -\ln 2$

sum of $\ln 2 - \ln 3 - \ln 2 = -\ln 3$

3. Le the system of linear equations

$x + y + \alpha z = 2$

$3x + y + z = 4$

$x + 2z = 1$

have a unique solution (x^*, y^*, z^*). If (α, x^*), (y^*, α) and $(x^*, -y^*)$ are collinear points, then the sum of absolute values of all possible values of α is

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

Ans. **C**

4. Let $x,y > 0$. If $x^3y^2 = 2^{15}$, then the leas value of $3x + 2y$ is

(A) 30 (B) 32 (C) 36 (D) 40

Ans. **D**

5. Let $f(x)\begin{cases} \dfrac{\sin([x])}{x-[x]} & , \quad x \in (-2,-1) \\ \max\{2x, 3[|x|]\} & , \quad |x|<1 \\ 1 & , \quad \text{otherwise} \end{cases}$

When [t] denotes greatest integer $\leq$ t. If m is the number of points where f is not continuous and n is the number of points where f is not differentiable. then the ordered pair (m, n) is :

(A) (3, 3) (B) (2, 4) (C) (2, 3) (D) (3, 4)

Ans. **C**

6. The value of the integral

$\int_{-\pi/2}^{\pi/2} \dfrac{dx}{(1+e^x)(\sin^6 x+\cos^6 x)}$ is equal to

(A) 2π (B) 0 (C) π (D) $\dfrac{\pi}{2}$

Ans. **C**

Sol. $I = \int_{-\pi/2}^{\pi/2} \dfrac{dx}{(1+e^x)(\sin^6 x+\cos^6 x)}$

$= \int_0^{\pi/2} \left(\dfrac{1}{(1+e^x)(\sin^6 x+\cos^6 x)} + \dfrac{1}{(1+e^{-x})(\sin^6+\cos^6 x)} \right) dx$

$= \int_0^{\pi/2} \dfrac{dx}{\sin^6 x+\cos^6 x}$

$\dfrac{\pi}{8}+\dfrac{1}{4}\log e^2$

$= \int_0^{\pi/2} \dfrac{\sec^4 x}{\tan^4 x-\tan^2 x+1} dx$

$= \int_0^{\pi/2} \dfrac{(1+\tan^2 x)(\sec^2 x}{\tan^4 x-\tan^2 x+1} dx$

Let tanx = t $\Rightarrow$ $\sec^2 x\, dx = dt$

$= \int_0^{\infty} \dfrac{(1+t^2)dt}{t^4-t^2+1} = \int_0^{\infty} \dfrac{\left(1+\frac{1}{t^2}\right)}{t^2-1+\frac{1}{t^2}} dt$

$= \int_0^{\infty} \dfrac{\left(1+\frac{1}{t^2}\right)}{\left(t-\frac{1}{t}\right)^2+1} dt$

$= \left[\tan^{-1}\left(t-\dfrac{1}{t}\right) \right]_0^{\infty}$

$= \frac{\pi}{2} + \frac{\pi}{2}$

$= \pi$

7. $\lim\limits_{n\to\infty}\left(\frac{n^2}{(n^2+1)(n+1)} + \frac{n^2}{(n^2+4)(n+2)} + \frac{n^2}{(n^2+9)(n+3)} + ... + \frac{n^2}{(n^2+n^2)(n+n)}\right)$

Is equal to

(A) $\frac{\pi}{8} + \frac{1}{4}\log e^2$ (B) $\frac{\pi}{4} + \frac{1}{8}\log e^2$ (C) $\frac{\pi}{4} - \frac{1}{8}\log e^2$ (D) $\frac{\pi}{8} + \log e^{\sqrt{2}}$

Ans. **A**

Sol. Given $\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\frac{n^2}{(n^2+r^2)(n+r)}$

$\lim\limits_{n\to\infty}\frac{1}{n}\sum\limits_{r=1}^{n}\frac{n^2}{(n^2+r^2)(n+r)}$

$\int\limits_0^1 \frac{dx}{(1+x^2)(1+x)}$

$= \frac{1}{2}\int\limits_0^1 \frac{dx}{x+1} + \frac{1}{2}\int\limits_0^1 \frac{1-x}{x^2+1}dx$

$\left[\frac{1}{2}\ell n(x+1) + \frac{1}{2}\tan^{-1}x - \frac{1}{4}\ell n(x^2+1)\right]_0^1$

$\frac{1}{2}\left(\ell n2 = \frac{\pi}{4} + \frac{1}{2}\ell n2\right)$

$= \frac{1}{2}\left(\frac{1}{2}\ell n2 + \frac{\pi}{4}\right) = \frac{1}{4}\ell n2 + \frac{\pi}{8}$

8. A particle is moving is the xy-plane along a curve C passing through the point (3, 3). The tangent to the curve C at the point P meets the x-axis at Q. if the y-axis bisects the segment PQ, then C is a parabola with

(A) length of latus rectum 3 (B) length of latus rectum 6

(C) focus $\left(\frac{4}{3}, 0\right)$ (D) focus $\left(0, \frac{3}{3}\right)$

Ans. **A**

Sol. Tangent at P (x, y) is

Y – y = m (X – x)

point at x – axis is $Q\left(x - \frac{y}{m}, 0\right)$

point at y axis is R (0,y – mx)

Now R is mid point at PQ

$$\therefore O = \frac{x + x - \frac{y}{m}}{2}$$

$$\Rightarrow 2x = \frac{y}{m} \Rightarrow \frac{dy}{dx} = \frac{y}{2x}$$

$$\Rightarrow \frac{2}{y}dy = \frac{1}{x}dx$$

$\Rightarrow 2\ln y = \ln x + \ln c$

$\Rightarrow y^2 = cx$

It passes through (3,3)

$\therefore p = 3c \Rightarrow c = 3$

$\therefore y^2 = 3x$

9. Let the maximum area of the triangle that can be inscribed in the ellipse $\frac{x^2}{a^2} + \frac{y^2}{4} = 1, \alpha > 2$, having one of its vertices at one end of the major axis of the ellipse and one of its sides parallel to the y-axis, be $6\sqrt{3}$. Then the eccentricity of the ellipse is :

(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{1}{2}$ (C) $\frac{1}{\sqrt{2}}$ (D) $\frac{\sqrt{3}}{4}$

Ans. **A**

10. Let the area of the triangle with vertices A(1, α), B(α, 0) and C(0, α) be 4 sq. units. If the points (α, $-\alpha$), ($-\alpha$, α) and (α^2, β) are collinear then β is equal to

(A) 64 (B) –8 (C) –64 (D) 512

Ans. **C**

11. The number of distinct real roots of the equation $x^7 - 7x - 2 = 0$ is

(A) 5 (B) 7 (C) 1 (D) 3

Ans. **D**

Sol. $f(x) = x^7 - 7x - 2 = 0$

$f'(x) = 7x^6 - 7$

$= 7(x^6 - 1)$

$= 7(x^3 + 1)(x^3 - 1)$

$f'(x) = 7(x + 1)(x - 1)(x^2 + x + 1)(x^2 - x + 1)$

$f'(x) = 0$ has two real roots

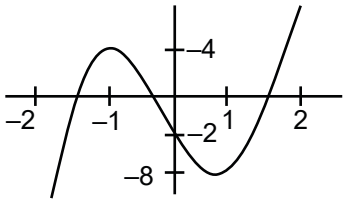
$f(1) = -8$

$f(-1) = 4$

$f(2) = 112$

$f(2) = -116$

$f(0) = -2$



So by graph f(x) = 0 has three real roots

12. A random variable X has the following probability distribution :

X	0	1	2	3	4
P(X)	k	2k	4k	6k	8k

The value of $P(1 < X < 4 \mid X \le 2)$ is equal to :

(A) $\frac{4}{7}$ (B) $\frac{2}{3}$ (C) $\frac{3}{7}$ (D) $\frac{4}{5}$

Ans. **A**

13. The number of solution of the equation $\cos\left(x+\frac{\pi}{3}\right)\cos\left(\frac{\pi}{3}-x\right)=\frac{1}{4}\cos^2 2x, x\in[-3\pi,3\pi]$ is :

(A) 8 (B) 5 (C) 6 (D) 7

Ans. **D**

14. If the shortest distance between the lines $\frac{x-1}{2}=\frac{y-2}{3}=\frac{z-3}{\lambda}$ and $\frac{x-1}{1}=\frac{y-4}{4}=\frac{z-5}{5}$ is $\frac{1}{\sqrt{3}}$, then the sum of all possible values of λ is :

(A) 16 (B) 6 (C) 12 (D) 15

Ans. **A**

15. Le the points on the plane P be equidistant from the point (–4, 2, 1) and (2, –2, 3). Then the acute angle between the plane P and the plane 2x + y + 3z = 1 is

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{4}$ (C) $\frac{\pi}{3}$ (D) $\frac{5\pi}{12}$

Ans. **C**

16. Let $\hat{a}$ and $\hat{b}$ two unit vectors such that $|(a + b) + 2(a \times b)| = 2$. If $\theta \in (0, \pi)$ is the angle between $\hat{a}$ and $\hat{b}$, then among the statements :

(S1) : $2|\hat{a}\times\hat{b}| = |\hat{a}-\hat{b}|$ (S2) : The projection of $\hat{a}$ on $(\hat{a}+\hat{b})$ is $\frac{1}{2}$

(A) Only (S1) is true. (B) Only (S2) is true.

(C) Both (S1) and (S2) are true. (D) Both (S1) and (S2) are False.

Ans. **C**

17. If $\tan^{-1}\left(\sec x^3-\tan x^3\right), \frac{\pi}{2} < x^3 < \frac{3\pi}{2}$, then

(A) xy" + 2y' = 0 (B) $x^2y"-6y+\frac{3\pi}{2}=0$

(C) x^2y" – 2y + 3π = 0 (D) xy" – 4y' = 0

Ans. **B**

Sol. $y = \tan^{-1}\left(\frac{1-\sin x^3}{\cos x^3}\right)$

$= \tan^{-1}\left[\frac{1-\cos\left(\frac{\pi}{2}-x^3\right)}{\sin\left(\frac{\pi}{2}-x^3\right)}\right]$

$= \tan^{-1}\left[\frac{2\sin^2\left(\frac{\pi}{4}-\frac{x^3}{2}\right)}{2\sin\left(\frac{\pi}{4}-\frac{x^3}{2}\right)\cos\left(\frac{\pi}{4}-\frac{x^3}{2}\right)}\right] = \tan^{-1}\left(\tan\left(\frac{\pi}{4}-\frac{x^3}{2}\right)\right)$

$y = \frac{\pi}{4} \times \frac{x^3}{2}$ $\left(\therefore -\frac{\pi}{2} < \frac{\pi}{4}-\frac{x^3}{2} < 0\right)$

$= y' = -\frac{3}{2}x^2$ $= y'' = -3x$

option (1) $xy'' + 2y' = -3x^2 + 2\left(\frac{-3}{2}x^2\right) = -6x^2$ hence 1 is incorrect

option (2) $x^2y'' - 6y' + \frac{3\pi}{2} = x^2(-3x) - 6\left(\frac{\pi}{4}-\frac{x^3}{2}\right) + \frac{3\pi}{2} = 0$ option 2 is correct similarly check other option

18. Consider the following statements :

A : Rishi is a judge.

B : Rishi is honest.

C : Rishi is not arrogant.

The negation of the statement "if Rishi is a judge and he is not arrogant, then he is honest" is

(A) $B \to (A \vee C)$ (B) $(\sim B) \wedge (A \wedge C)$ (C) $B \to (\sim A) \vee (\sim C))$ (D) $B \to (A \wedge C)$

Ans. **B**

Sol. Given statement is $(A \wedge C) \to B$

$\therefore$ Negation is $\sim((A \wedge C) \to B)$

$(A \wedge C) \wedge \sim B = \sim B \wedge (A \wedge C)$

19. The slope of normal at any point (x, y), x > 0, y > 0 on the curve y = y(x) is given by $\frac{x^2}{xy - x^2y^2 - 1}$. If the curve passes through the point (1, 1), then e·y(e) is equal to

(A) $\frac{1-\tan(1)}{1+\tan(1)}$ (B) tan (1) (C) 1 (D) $\frac{1+\tan(1)}{1-\tan(1)}$

Ans. **D**

20. Let λ^* be the largest value of λ for which the function $f_\lambda(x) = 4\lambda x^3 - 36\lambda x^2 + 36x + 48$ is increasing for all $x \in R$. Then $f_\lambda * (-1)$ is equal to :

(A) 36 (B) 48 (C) 64 (D) 72

Ans. **D**

Numeric Value Type

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

21. Let $S = \left\{z \in C : |z-3| \le 1 \text{ and } z(4+3i)+\bar{z}(4-3i) \le 24\right\}$. If $\alpha + \beta$ is the point in S which is closest to 4i, then $25(\alpha + \beta)$ is equal to _____.

Ans. **80**

22. Let $S = \left\{\begin{pmatrix} -1 & a \\ 0 & b \end{pmatrix}; a,b \in \{1,2,3,.....100\}\right\}$ and let $T_n = \{A \in S : A^{n(n+1)} = I\}$. Then the number of element in $\bigcap_{n=1}^{100} T_n$ is _____.

Ans. **100**

23. The number of 7-digit numbers which multiples of 11 and are formed using all the digits 1, 2, 3, 4, 5, 7 and 9 is ___.

Ans. **576**

24. The sum of all the element of the set $\{a \in \{1, 2,..... 100\} : HCF(\alpha, 24)$ is

Ans. **1633**

Sol. Let n(a) = number of numbers divisible by a , so

$n(2) = \{2,4,6.....100\} \Rightarrow 50$ numbers

$n(3) = \{3,6,9.....99\} \Rightarrow 33$ numbers

$n(2 \cap 3) = \{6,12,18.....96\} \Rightarrow 16$ numbers

$\Rightarrow$ Sum of all numbers divisible by $2 = \frac{50}{2}[2+100] = 50 \times 51$

Sum of all numbers divisible by $3 = \frac{33}{2}[3+99] = 33 \times 51$

Sum of all numbers divisible by either 2 or 3 = 50 × 51 + 33 × 51 – 16 × 51 = 67 × 51

Sum of all natural numbers from 1 to 100 $= \frac{100}{2}[1+100] = 0 \times 101$

Sum of required values of 'a' is 101 × 50 – 67 × 51 = 1633

25. The remainder on dividing $1 + 3 + 3^2 + 3^3 + ...+ 3^{2021}$ by 50 is __.

Ans. **4**

Sol. $1+3+3^2+.....3^{2021} = \frac{3^{2022}-1}{2} = \frac{9^{1011}-1}{2}$

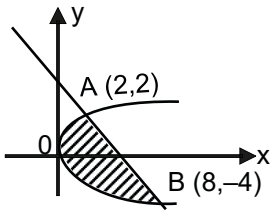
$\Rightarrow \frac{(10-1)^{1011}-1}{2} = \frac{100\lambda + {}^{1011}C_{1010} \times 10 - 2}{2} = 50\lambda + 5054$

When divided by 50 gives remainder = 4

26. The area (in sq. units) of the region enclosed between the parabola $y^2 = 2x$ and the line x + y = 4 is ___.

Ans. **18**

Sol. On solving both equations



$\frac{y^2}{2} + y = 4$

$y^2 + 2y - 8 = 0 \Rightarrow y = -4 , y = 2$

so A(2, 2) ; B(–8 , 4)

Required area $= \int_{-4}^{2} \left((4 - y) - \frac{y^2}{2} \right) dy$

$= \left[4y - \frac{y^2}{2} - \frac{y^3}{6} \right]_{-4}^{2} = 18$ sq. unit

27. Let a circle C : $(x - h)^2 + (y - k)^2 = r^2$, k>0, touch the x-axis at (1, 0). If the line x + y = 0 intersects the circle C at P and Q such that the length of the chord PQ is 2, then the value of h + k + r is equal to ___.

Ans. **7**

28. In an examination, there are 10 true-false type questions. Out of 10, a student can guess the answer of 4 questions correctly with probability $\frac{3}{4}$ and the remaining of questions correctly with probability $\frac{1}{4}$.If the probability that the student guesses the answer of exactly 8 questions correctly out of 10 is $\frac{27k}{4^{10}}$, then k is equal to

Ans. **479**

29. Let the hyperbola $H : \frac{x^2}{a^2} - y^2 = 1$ and the ellipse E : $3x^2 + 4y^2 = 12$ be such that the length of latus rectum of H is equal to the length of latus rectum of E. if e_H and a_E are the eccentricities of H and E respectively, then the value of $12\left(e_H^2 + e_E^2\right)$ is equal to ____.

Ans. **42**

Sol. Given $\frac{2(1)}{a} = \frac{2(3)}{2} \Rightarrow a = 2/3$

So $e_H = \sqrt{1 + \frac{9}{4}} = \frac{\sqrt{13}}{2}$

$e_E = \sqrt{1 - \frac{3}{4}} = \frac{1}{2}$ So, $12\left(e_H^2 + e_E^2\right) = 12\left(\frac{13}{4} + \frac{1}{4}\right) = 42$

30. Let P_1 a parabola with vertex (3, 2) and focus (4, 4) and P_2 be its mirror image with respect to the line x + 2y = 6. Then the directrix of P_2 is x + 2y = _____.

Ans. **10**