MOTION™

SAMPLE PAPER – JEE MAIN

Duration: 3 Hours **Max. Marks : 300**

INSTRUCTIONS

In each part of the paper contains 30 questions. Please ensure that the Questions paper you have received contains ALL THE QUESTIONS in each Part.

In each Part of The paper **Section A** Contain **20 Questions**. Each Question has four choices (A), (B), (C), (D) out of which **only one is correct** & carry **4 marks** each. **1 mark** will be deducted for each wrong answer.

In each Part of The paper **Section B** Contains **10 Numeric Value type questions. Candidates have to attempt any 5 Ques. out of 10**. For each question, enter the correct numerical value ((If the numerical value has more than two decimal places, truncate/ round-off the value to TWO decimal places; e.g. 6.25, 7.00, 0.33, 30.27, 127.30.)

Each Question Carry **4 Marks** & **No** Negative marking in these Section.

NOTE : GENERAL INSTRUCTION FOR FILLING THE OMR ARE GIVEN BELOW.

1. Use only **blue/black pen (avoid gel pen)** for darkening the bubble.
2. Indicate the correct answer for each question by filling appropriate bubble in your OMR answer sheet.
3. The Answer sheet will be checked through computer hence, the answer of the question must be marked by shading the circles against the question by dark **blue/black pen**.
4. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers and Electronic Gadgets in any form are **not** allowed to be carried inside the examination hall.

MOTION EDUCATION PVT. LTD., 394 - Rajeev Gandhi Nagar, Kota-5 (Raj.)

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PART - I [MATHEMATICS]

SECTION - A

[STRAIGHT OBJECTIVE TYPE]

Q.1 to ***Q.20*** has four choices (A), (B), (C), (D) out of which ***ONLY ONE*** is correct

1. Equations $x^3 + 4x^2 + px + q = 0$ and $x^3 + 9x^2 + px + r = 0$ are two roots in common, their third roots are γ_1 & γ_2 respectively. If x, y, z be three positive real numbers in G.P. such that $|\gamma_1|$ is A.M. between x & y and 9 is H.M. between y and z, then y is equal to

(A) 4 (B) 6

(C) 8 (D) 12

2. A party is thrown for families having boys, girls, ladies and gentleman. When one member is randomly selected, odds against being a boy is $\frac{27}{5}$, odds in favour of being a girl is $\frac{7}{25}$ and probability of being a lady is $\frac{11}{32}$, then the odds in favour of the chosen person being a gentleman, is

(A) $\frac{9}{23}$ (B) $\frac{9}{32}$ (C) $\frac{23}{9}$ (D) $\frac{23}{32}$

3. Let f : R $\to$ [1, ∞) be defined as

f (x) = $\log_{10}\left(\sqrt{3x^2-4x+k+1}+10\right)$.

If f (x) is surjective, then

(A) k = $\frac{1}{3}$ (B) k < $\frac{1}{3}$

(C) k > $\frac{1}{3}$ (D) k = 1

4. Mean of 100 observations is 45. It was later found that the two observations 19 and 31 were incorrectly recorded as 91 and 13. The correct mean is

(A) 44 (B) 44.46

(C) 45.00 (D) 45.54

5. A circle having centre (0, k) with k > 6 is tangent to the line pair $x^2 - y^2 = 0$ and

y = 6. the radius of the circle is

(A) 6 ($\sqrt{2}$ – 1) (B) 12

(C) 6$\sqrt{12}$ (D) 6$\sqrt{2}$ + 6

(SPACE FOR ROUGH WORK)

6. If a line passing through (– 2, 1, b) and (4, 1, 2) is perpendicular to the vector $\hat{i}+3\hat{j}-2\hat{k}$ and is parallel to the plane containing the vectors $\hat{i}+c\hat{k}$ and $c\hat{j}+b\hat{k}$, then ordered pair (b, c) can be

(A) $\left(-1, \frac{-1}{2}\right)$ (B) (1, – 6)

(C) (– 1, 0) (D) $\left(1, \frac{1}{2}\right)$

7. A man on the top of a cliff 100 m high, observes the angles of depression of two points on the opposite sides of the cliff as 30° and 60° respectively. The distance between the two points is equal to

(A) $400\sqrt{3}$ m (B) $\frac{400}{\sqrt{3}}m$

(C) $\frac{100}{\sqrt{3}}m$ (D) $\frac{200}{\sqrt{3}}m$

8. $(\sim P \wedge (\sim Q \wedge R)) \vee ((Q \wedge R) \vee (P \wedge R))$ is equivalent to

(A) P (B) Q

(C) R (D) ~ R

9. A parabola $y = ax^2 + bx + c$ crosses the x-axis at $(\alpha, 0)$, $(\beta, 0)$ both to the right of origin. A circle also passes through these two points. The length of a tangent from the origin to the circle is

(A) $\sqrt{\frac{bc}{a}}$ (B) ac^2

(C) $\frac{b}{a}$ (D) $\sqrt{\frac{c}{a}}$

10. The area of the region for which $0 < y < 3 - 2x - x^2$ and $x > 0$ is

(A) $\frac{5}{3}$ (B) 3

(C) $\frac{13}{3}$ (D) 9

11. Let $\vec{a}, \vec{b}, \vec{c}$ be vectors representing three coterminous edges of a tetrahedron such that

$\vec{a}\,\hat{}\,\vec{b} = \vec{b}\,\hat{}\,\vec{c} = \vec{c}\,\hat{}\,\vec{a} = \frac{\pi}{3}$ and

$4(\vec{a}\cdot\vec{a}) + 3(\vec{b}\cdot\vec{b}) + 2(\vec{c}\cdot\vec{c}) = 144$. If V is the volume of the tetrahedron, then the maximum value of V is

(A) 4 (B) 6 (C) 8 (D) 10

(SPACE FOR ROUGH WORK)

12. The value of

$$\lim_{n\to\infty}\left(\frac{1}{n+m}+\frac{1}{n+2m}+\frac{1}{n+3m}+....+\frac{1}{n+nm}\right)$$

is equal to

[**Note :** where m > 0.]

(A) $\frac{\ln(m)}{m}$ (B) $\frac{\ln(1+m)}{(1+m)}$

(C) $\frac{\ln(1+m)}{m}$ (D) $\frac{\ln m}{1+m}$

13. If z_1 = 2 + 3i , z_2 = 3 -2i and z_3= -1-2$\sqrt{3}i$ then which of the following is true ?

(A) $\arg\left(\frac{z_3}{z_2}\right)=\arg\left(\frac{z_3-z_1}{z_2-z_1}\right)$

(B) $\arg\left(\frac{z_3}{z_2}\right)=\arg\left(\frac{z_2}{z_1}\right)$

(C) $\arg\left(\frac{z_3}{z_2}\right)=2\arg\left(\frac{z_3-z_1}{z_2-z_1}\right)$

(D) $\arg\left(\frac{z_3}{z_2}\right)=\frac{1}{2}\arg\left(\frac{z_3-z_1}{z_2-z_1}\right)$

14. If

$$f(x)=\begin{vmatrix}\text{Cos}(x+\alpha) & \text{Cos}(x+\beta) & \text{Cos}(x+\gamma)\\ \text{Sin}(x+\alpha) & \text{Sin}(x+\beta) & \text{Sin}(x+\gamma)\\ \text{Sin}(\beta-\gamma) & \text{Sin}(\gamma-\alpha) & \text{Sin}(\alpha-\beta)\end{vmatrix}$$

and f(2) = 6 then $\sum_{r=1}^{25} f(r)$ is equal to :-

(A) 36 (B) 75

(C) 150 (D) 25

15. Let f(x) = $(\sec x)^{\text{cosec}x}$ + $(\cot x)^{\sin x}$.Then the value of $\lim_{x\to 0^+}$ f(x) is equal to

(A) –1 (B) 0

(C) 1 (D) 2

16. Number of integers in the domain of function

f(x) = $\sec^{-1}x$ + $\text{cosec}^{-1}x+\sqrt{4-x^2}$ + $\log_e x$

is

(A) 0 (B) 1

(C) 2 (D) infinite

(SPACE FOR ROUGH WORK)

17. Let y = y(x) satisfies the differential equation $\frac{dy}{dx} = xy^2 + x - y^2 \sin x - \sin x$, y(0)=0, then y(x) is given by

(A) $2y = \tan\left(\frac{x^2}{2} + \cos x - 1\right)$

(B) $y = \tan\left(\frac{x^2}{2} + \cos x - 1\right)$

(C) $y = \tan\left(\frac{x^2}{2} + \cos x + 1\right)$

(D) $2y = \tan\left(\frac{x^2}{2} + \cos x + 1\right)$

18. The image of the centre of the circle $x^2 + y^2 = 2a^2$ with respect to the line $x + y = 1$ is

(A) $\left(\sqrt{2}, \sqrt{2}\right)$ (B) $\left(\frac{1}{\sqrt{2}}, \sqrt{2}\right)$

(C) $\left(\sqrt{2}, \frac{1}{\sqrt{2}}\right)$ (D) none of these

19. $2\tan\frac{\pi}{10} + 3\sec\frac{\pi}{10} - 4\cos\frac{\pi}{10} =$

(A) 0 (B) $\sqrt{5}$

(C) 1 (D) None of these

20. Let f(x) = $\int_{x^2}^{x^2+1} e^{-t^2} dt$, x ∈ (– ∞ , ∞) then the interval for which f(x) is increasing is –

(A) (– ∞ , 0] (B) [0, ∞)

(C) [–2, 2) (D) None

SECTION – B

[NUMERICAL VALUE TYPE]

Q.1 to ***Q.10*** are **NUMERIC VALUE TYPE** Questions. **Candidates have to attempt any 5 Ques. out of 10.**

1. Let z ∈ C such that | z – 1 – 3i | + | z + 1 – 3i | = 6. If M and m be the maximum and minimum value of | | z – 6 – 3i |^2 – 1|, then M + m is equal to

2. If $\sum_{k=1}^{10} k \cdot \frac{{}^nC_k}{{}^nC_{k-1}}$ = 5n, then n is equal to

3. If eccentricity of conjugate hyperbola of the hyperbola $\left|\sqrt{(x-1)^2+(y-2)^2} - \sqrt{(x-5)^2+(y-5)^2}\right|$ = 3 is e, then the value of 8e is equal to

(SPACE FOR ROUGH WORK)

4. The length of perpendicular from the foci S and S' on any tangent to the ellipse $\frac{x^2}{4}+\frac{y^2}{9}=1$ are a and c respectively then the value of $\int_{-ac}^{ac}\{2x\}$ dx is equal to

[**Note :** Where { · } represents fractional part of x.]

5. $\int_{2}^{4}\left(\log_x 2-\frac{(\log_x 2)^2}{\ln 2}\right)$dx is equal to

6. If the sum of 11 consecutive natural numbers is 2761. Then the median of numbers is :-

7. Coefficient of x^{2009} in$(1+x+x^2+x^3+x^4)^{1001}(1-x)^{1002}$ is

8. If $f(x)\left(\frac{1}{2x^2-1}\right) = \sec^{-1}$, Then $\sqrt{3}\,f'\left(-\frac{1}{2}\right)$ is equal to

9. $\int_{-1}^{3}\left[x+\frac{1}{2}\right]$dx = (where [.] represents G.I.F.)

10. If $\vec{a}=4\hat{i}+6\hat{j}$ and $\vec{b}=3\hat{j}+4\hat{k}$, the component of $\vec{a}$ along $\vec{b}$ is K then the value of [K] (where [.] represents G.I.F.)

(SPACE FOR ROUGH WORK)

PART - II [PHYSICS]

SECTION - A

[STRAIGHT OBJECTIVE TYPE]

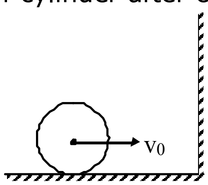
Q.1 to ***Q.20*** has four choices (A), (B), (C), (D) out of which ***ONLY ONE*** is correct

1. A ball of mass m is projected with velocity u making an angle θ with the horizontal. What is its angular momentum at the highest point?

(A) $\frac{mu}{2g}\sin^2\theta\cos\theta$ (B) $\frac{mu}{2g}\sin\theta\cos^2\theta$

(C) $\frac{mu^3}{2g}\sin\theta\cos^2\theta$ (D) $\frac{mu^3}{2g}\sin^2\theta\cos\theta$

2. A cylinder is rolling over frictionless horizontal surface with velocity v_0 as shown in figure. Coefficient of friction between wall and cylinder is $\mu = \frac{1}{4}$. If the collision between cylinder and wall is completely inelastic, then kinetic energy of cylinder after collision -



(A) Zero (B) $\frac{mv_0^2}{32}$

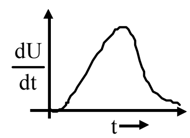
(C) $\frac{mv_0^2}{4}$ (D) $\frac{3mv_0^2}{32}$

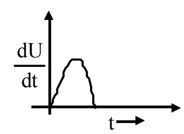
3. A solid ball of density ρ_1 and radius r falls vertically through a liquid of density ρ_2. Assume that the viscous force acting on the ball is F = krv, where k is a constant and v its velocity. What is the terminal velocity of the ball ?

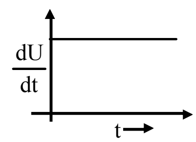
(A) $\frac{4\pi r^2(\rho_1 - \rho_2)}{3k}$ (B) $\frac{2\pi r(\rho_1 - \rho_2)}{3gk}$

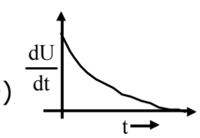
(C) $\frac{2\pi g(\rho_1 + \rho_2)}{3gr^2k}$ (D) none of these

4. Rate of increment of energy in an inductor with time in series LR circuit getting charge with battery of e.m.f. E is best represented by [inductor has initially zero current] -

(A) 

(B) 

(C) 

(D) 

5. Fringe width observed in the Young's double slit experiment is β. If the frequency of the source is doubled, the fringe width will –

(A) remain β (B) become $\beta/2$

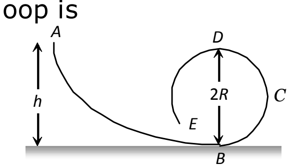
(C) become 2β (D) remain $3\beta/2$

(SPACE FOR ROUGH WORK)

6. Binding energy per nucleon of $_1H^2$ and $_2He^4$ are 1.1. MeV and 7.0 MeV respectively. Energy released in the process $_1H^2 + {_1H^2} = {_2He^4}$ is -
(A) 20.8 MeV (B) 16.6 MeV
(C) 25.2 MeV (D) 23.6 MeV

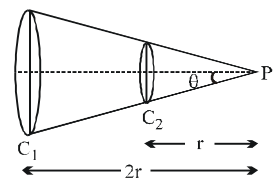
7. The frequency of vibration f of a mass m suspended from a spring of spring constant K is given by a relation of this type $f = Cm^xK^y$; where C is a dimensionless quantity. The value of x and y are
(A) $x = \frac{1}{2}, y = \frac{1}{2}$
(B) $x = -\frac{1}{2}, y = -\frac{1}{2}$
(C) $x = \frac{1}{2}, y = -\frac{1}{2}$
(D) $x = -\frac{1}{2}, y = \frac{1}{2}$

8. A frictionless track ABCDE ends in a circular loop of radius R. A body slides down the track from point A which is at a height h = 5 cm. Maximum value of R for the body to successfully complete the loop is



(A) 5 cm (B) $\frac{15}{4}$ cm
(C) $\frac{10}{3}$ cm (D) 2 cm

9. The coils C_1 and C_2 have same number of turns and carry equal currents in the same sense. They subtend the same angle θ to P. If the magnetic field produced by C_1 at P is B then that produced by C_2 will be



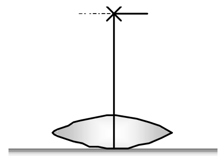
(A) B (B) 2B
(C) B/2 (D) None

10. A particle in S.H.M. is described by the displacement function $x(t)=a\cos(\omega t+\theta)$. If the initial (t = 0) position of the particle is 1 *cm* and its initial velocity is π cm/s. The angular frequency of the particle is π rad/s, then it's amplitude is
(A) 1 *cm* (B) $\sqrt{2}$ cm
(C) 2 *cm* (D) 2.5 *cm*

11. A litre of dry air at STP expands adiabatically to a volume of 3 litres. If γ = 1.40, the work done by air is ($3^{1.4} = 4.6555$)
[Take air to be an ideal gas]
(A) 100.8 J (B) 60.7 J
(C) 48 J (D) 90.5 J

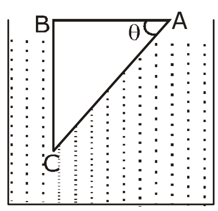
(SPACE FOR ROUGH WORK)

12. A lens when placed on a plane mirror then object needle and its image coincide at 15 *cm*. The focal length of the lens is



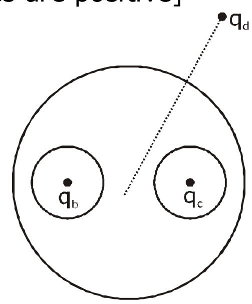
(A) 15 *cm* (B) 30 *cm*
(C) 20 *cm* (D) ∞

13. A glass prism of refractive index 1.5 is immersed in water (refractive index 4/3). A light beam incident normally on the face AB is totally reflected to reach the face BC, if



(A) $\sin\theta \geq 8/9$
(B) $2/3 < \sin\theta \leq 8/9$
(C) $\sin\theta \leq 2/3$
(D) $\sin\theta \leq 8/9$

14. A spherical conductor A contains two spherical cavities. The total charge on the conductor itself is zero. However, there is a point charge q_b at the centre of one cavity and q_c at the centre of the other. A considerable distance r away from the centre of the spherical conductor, there is another charge q_d. Force acting on q_b,q_c and q_d are F_1 ,F_2 and F_3 respectively.[Assume all charges are positive]



(A) $F_1 < F_2 < F_3$ (B) $F_1 = F_2 < F_3$
(C) $F_1 = F_2 > F_3$ (D) $F_1 > F_2 > F_3$

15. When an ideal gas at pressure P, temperature T and volume V is isothermally compressed to V/n, its pressure becomes P_1. If the same amount of same gas is compressed adiabatically to V/n, its pressure becomes P_2. The ratio P_1/P_2 is :
(A) n (B) n^{γ}
(C) $\frac{1}{n^{\gamma-1}}$ (D) 1

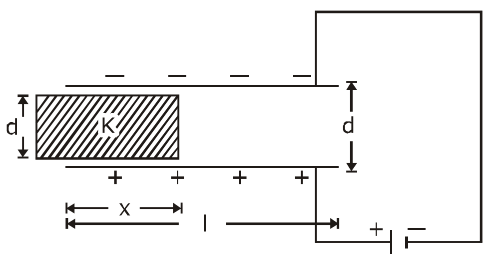
(SPACE FOR ROUGH WORK)

16. In a certain region uniform, electric $\vec{E}$ and magnetic $\vec{B}$ fields are present in opposite directions. A particle of mass m and of charge q enters in this region with a velocity v at an angle θ from the magnetic field. The time after which the speed of the particle would the minimum is equal to :

(A) $\frac{2\pi m}{qB}$ (B) $\frac{mv\sin\theta}{qE}$

(C) $\frac{mv\cos\theta}{qE}$ (D) $\frac{mv}{qE}$

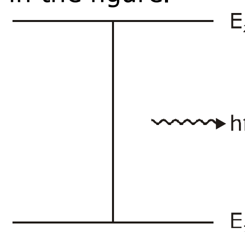
17. A parallel plate capacitor with plates of width 4 cm. length 10 cm and separation between plates in 4 cm, is connected across a 12 v emf battery. A dielectric slab of dielectric constant 7 is slowly introduced between the plates. Force exerted on dielectric slab by the field is



(A) $114\varepsilon_0$ (B) $432\varepsilon_0$

(C) $7\varepsilon_0$ (D) $326\varepsilon_0$

18. In Bohr's atom, energy is absorbed or radiated when an electron makes a transition between two stationary states. If f is the frequency of emitted radiation and E_1 and E_2 are the energies of electron in two states, then practically which is correct for a hydrogen like atom for the transition as shown in the figure.



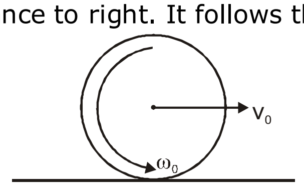
(A) $hf = |E_1 - E_2|$

(B) $hf < |E_1 - E_2|$

(C) $hf > |E_1 - E_2|$

(D) $|E_1 - E_2| \le hf \le |E_1 + E_2|$

19. A uniform circular disc of radius r is placed on a rough horizontal surface and given a linear velocity v_0 and angular velcoity ω_0 as shown. The disc comes to rest after moving some distance to right. It follows that



(A) $3v_0 = 2\omega_0 r$ (B) $2v_0 = \omega_0 r$

(C) $v_0 = \omega_0 r$ (D) $2v_0 = 3\omega_0 r$

(SPACE FOR ROUGH WORK)

20. An aeroplane with 20m wings span in flying at 250m/sec towards south and parallel to the earth surface. The horizontal component of earth magnetic field is 2×10^{-5} wb/m^2 and angle of dip is 60° then induced emf between the tips of wings :-

(A) 17.3V (B) 173V

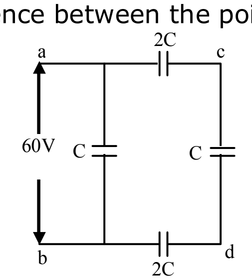
(C) 1.73V (D) 0.173V

SECTION – B
[NUMERICAL VALUE TYPE]

Q.1 to ***Q.10*** are **NUMERIC VALUE TYPE** Questions. **Candidates have to attempt any 5 Ques. out of 10.**

1. Two waves are propagating to the point P along a straight line produced by two sources A and B of simple harmonic and of equal frequency. The amplitude of every wave at P is 'a' and the phase of A is ahead by $\pi/3$ than that of B and the distance AP is greater than BP by 50 cm. The resultant amplitude at the point P will be $n \times a$. If the wavelength is 1 meter, then find n -

2. In the circuit shown in figure, a potential difference of 60 V is applied between a and b. The potential difference between the points c and d is

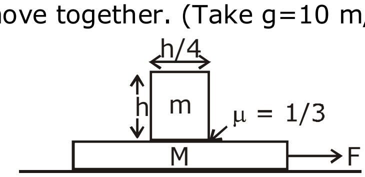


3. The half-life of Bi^{210} is 5 days. What time is taken by (7/8)th part of the sample to decay

4. A 120 m long train is moving towards west with a speed of 10 m/s. A bird flying towards east with a speed of 5 m/s crosses the train. The time taken by the bird to cross the train will be

5. A particle is oscillating according to the equation $x = 7 \cos 0.5\pi t$, where t is in second. The point moves from the position of equilibrium to maximum displacement in time

6. A block of mass m = 2kg is placed on a plank of mass M = 10 kg which is placed on a smooth horizontal plane. The coefficient of friction between the block and the plank is $\mu = \frac{1}{3}$. If a horizontal force F is applied on the plank, then find the maximum value of F for which the block and the plank move together. (Take g=10 m/s^2)



(SPACE FOR ROUGH WORK)

7. A simple microscope consists of a concave lens of power −10 D and a convex lens of power +20 D in contact. If the image formed at infinity, then the magnifying power is $\frac{x}{2}$, the value of x is :
(Take the least distance of distinct vision, D = 25 cm)

8. A conservative force of magnitude 100 N is directed along the line y = 3 + x is acting on a block of mass m = 1 kg. Find work done by the conservative force, when block displaces from A(3,1) to B (1,3)

9. A simple pendulum has time period T_1. The point of suspension is now moved upward according to the relation $y=Kt^2$. ($K = 1 m/s^2$) where y is the vertical displacement. The time period now becomes T_2.The ratio of $\frac{T_1^2}{T_2^2} = \frac{x}{10}$. Find the value of x ($g = 10 m/s^2$)

10. 12 cells each having same emf are connected in series with some cells wrongly connected. The arrangement connected in series with an ammeter and two identical cells. Current is 3A when cells and battery aid each other and is 2A when cells and battery oppose each other. The number of cells wrongly connected is :-

(SPACE FOR ROUGH WORK)

PART - III [CHEMISTRY]

SECTION - A

[STRAIGHT OBJECTIVE TYPE]

Q.1 to ***Q.20*** has four choices (A), (B), (C), (D) out of which ***ONLY ONE*** is correct

1. At the given condition of CH_4–O_2 fuel cell the cell emf is 0.8 V and the enthalpy of combustion of CH_4 (g) is –772 kJ/mol. The maximum efficiency of the given fuel cell in the given condition is :

(A) 60 % (B) 75 %
(C) 80 % (D) 90 %

2. Which of the following is NOT true ?

(A) The catalyst ZSM-5 converts alcohols directly into gasoline (petrol).
(B) Charge on Lyophilic colloids depends on pH of medium.
(C) The charged colloidal particles of the sol formed by addition of $FeCl_3$ in excess NaOH (aq.) move towards cathode during electrophoresis.
(D) Physisorption is reversible in nature

3. What is the pH of the solution obtained by mixing equal volumes of two solutions having pH values 9 and 11? Assume no components of the two solutions reacts. **[Given : log 5 = 0.7]**

(A) 3.3 (B) 10.7
(C) 11.3 (D) 10.3

4. A mixture of $NaHC_2O_4$ and $H_2C_2O_4$ requires 50 mL, 0.1 M $KMnO_4$ (aq.) solution during titration in acidic medium. The same mass of $NaHC_2O_4$ and $H_2C_2O_4$ requires 50 mL, 0.4 M NaOH (aq.) solution for the complete neutralisation. Calculate the mass of $H_2C_2O_4$ in the initial mixture.

(A) 1.250 g (B) 0.900 g
(C) 0.450 g (D) 0.675 g

5. Identify the **incorrect** statement :

(A) During an adiabatic expansion of an ideal gas temperature will always decrease.
(B) During an isothermal expansion of a real gas temperature will always remain constant throughout.
(C) $\Delta_{rxn}S$ must be zero for A(g) + B(g) $\rightarrow$ 2AB(g)
(D) During reversible adiabatic expansion of an ideal gas entropy of system will remain constant.

6. Calculate the weight of urea (NH_2CONH_2) which must be dissolved in 490 g water so that the solution obtained has vapour pressure 2% less than vapour pressure of pure water.

(A) 60 g (B) 30 g
(C) 33.33 g (D) 40 g

(SPACE FOR ROUGH WORK)

7. For the reaction : A $\longrightarrow$ Product having order of the reaction 2.5. The half life period of the reaction is given as

$t_{1/2} \propto \dfrac{1}{[A]_0^m}$.

[Here, $[A]_0$ is the initial concentration of A]. Then the value of "m" is :

(A) 0.5 (B) 3.5

(C) 2.5 (D) 1.5

8. Which of the following is coloured tetrahedral complex species?

(A) $[Cu(PPh_3)_4]^+$ (B) $[Zn(H_2O)_6]^{2+}$

(C) $[Cu(NH_3)_4]SO_4$ (D) MnO_4^-

9. An alkali metal 'M' reacts with air and products are hydrolysed. If gas obtained turns red litmus into blue then metal 'M' can be :

(A) Li (B) Na (C) K (D) Al

10. Which one of the following is an **incorrect** statement ?

(A) The ionisation potential of nitrogen is greater than that of chlorine

(B) The electron affinity of fluorine is greater than that of chlorine

(C) The ionisation potential of beryllium is greater than that of boron.

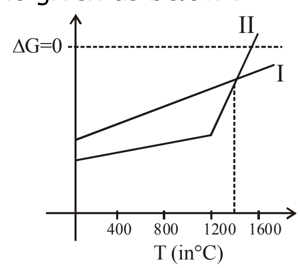
(D) The electronegativity of fluorine is greater than that of chlorine.

11. If ΔG vs T graph of

I $\rightarrow \frac{4}{3}Al + O_2 \longrightarrow \frac{2}{3}Al_2O_3$

II $\rightarrow$ $2Mg + O_2 \longrightarrow 2MgO$

is given as below :



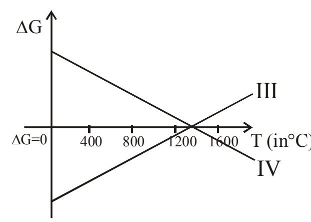
Then ΔG vs T graph of reaction

III $\rightarrow 3Mg + Al_2O_3 \longrightarrow 3MgO + 2Al$

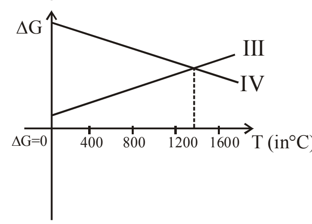
IV $\rightarrow 3MgO + 2Al \longrightarrow 3Mg + Al_2O_3$

are :

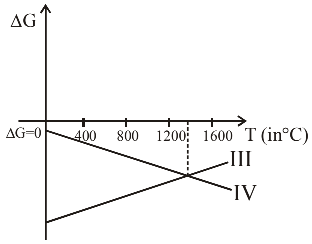
(A)

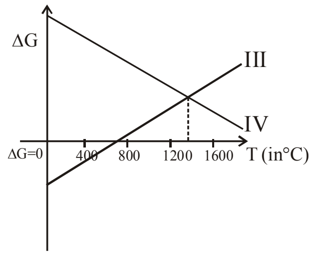


(B)



(SPACE FOR ROUGH WORK)

(C) 

(D) 

12. During the process of electrolytic refining of copper, some metals present as impurity settle as 'anode mud'. These are –

(A) Pb and Zn (B) Sn and Ag
(C) Fe and Ni (D) Ag and Au

13. What will be the dihedral angle present in hydrogen peroxide (H_2O_2) in solid phase.

(A) 111.5° (B) 180°
(C) 90.2° (D) 0°

14. Borohydrides are prepared by reaction of metal hydrides with B_2H_6 in diethyl ether. Select **incorrect** statement:

(A) Hybridisation of Boron changes
(B) Metal M can be Li or Na
(C) Geometry around Boron is Tetrahedral in both reactant and product
(D) Boron hydrides are used as reducing agent

15. Which is not true for reducing & non reducing sugars ?

(A) Both depends on the position of Linkage between two monosaccharides unit
(B) Sucrose is a non reducing, as linkage involves the carbonyl functional group of both monosaccharides units
(C) Maltose and Lactose are reducing sugar, as one of the carbonyl functional group in anyone of monosaccharide unit is free
(D) Maltose is reducing sugar while lactose and sucrose both are non reducing sugar.

(SPACE FOR ROUGH WORK)

16. Decreasing order of relative nucleophilicity of the following nucleophiles in protic solvent is -

$\overset{\ominus}{S}H$, $Ac\overset{\ominus}{O}$, $Ph\overset{\ominus}{O}$, $\overset{\ominus}{O}H$, H_2O

(A) $\overset{\ominus}{S}H > \overset{\ominus}{O}H > H_2O > Ac\overset{\ominus}{O} > Ph\overset{\ominus}{O}$

(B) $\overset{\ominus}{S}H > \overset{\ominus}{O}H > Ph\overset{\ominus}{O} > Ac\overset{\ominus}{O} > H_2O$

(C) $\overset{\ominus}{S}H > Ph\overset{\ominus}{O} > \overset{\ominus}{O}H > H_2O > Ac\overset{\ominus}{O}$

(D) $\overset{\ominus}{O}H > \overset{\ominus}{S}H > Ph\overset{\ominus}{O} > Ac\overset{\ominus}{O} > H_2O$

17. Match list-I (Monomer) with list-II (Polymer) and select the correct answer using the codes given below the lists:

List-I	**List-II**
(I) Hexamethylenediamine	A. Bakelite
(II) Phenol	B. Dacron
(III) Phthalic acid	C. Glyptal
(IV) Terephthalic acid	D. Melamine
	E. Nylon-6,6

Codes:

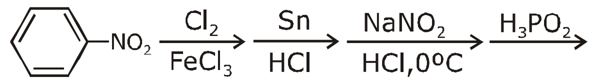
(A) I–E, II–A, III–B, IV–C

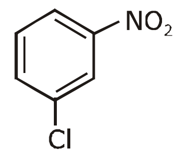
(B) I–E, II–A, III–C, IV–B

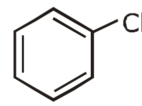
(C) I–D, II–C, III–A, IV–B

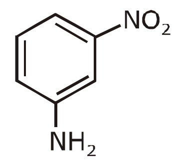
(D) I–D, II–C, III–A, IV–B

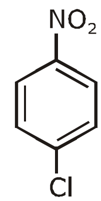
18. What is the final product of the given reaction sequence ?

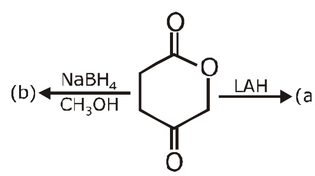


(A) 

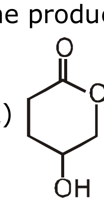
(B) 

(C) 

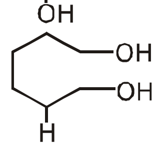
(D) 

19. 

The products (a) and (b) are :

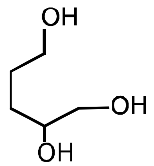
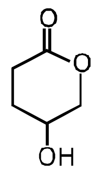
(A) 

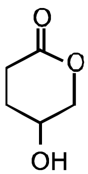
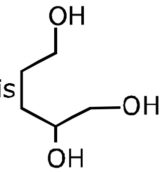
in both cases

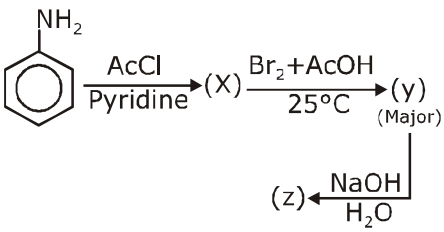
(B) 

in both cases

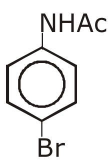
(SPACE FOR ROUGH WORK)

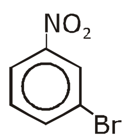
(C) a is  and b is 

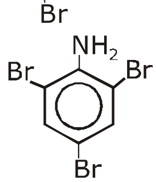
(D) a is  and b is 

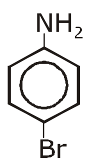
20. 

(z) would be :

(A) 

(B) 

(C) 

(D) 

SECTION – B

[NUMERICAL VALUE TYPE]

Q.1 to ***Q.10*** are **NUMERIC VALUE TYPE** Questions. **Candidates have to attempt any 5 Ques. out of 10.**

1. The molar mass of a gas is 50 g / mol. The density of the gas at critical temperature and critical pressure of 30 atm is 125 g / L. What is the critical temperature of the gas?
[**Take :** R = 0.08 L atm mol^{-1} K^{-1}]

2. A photon of energy 9.4 eV strikes to the electron present in third excited state of He^+. What is the wavelength of the electron after absorption of the 9.4 eV energy of the photon?

3. A substance AB crystallizes in cubic closest packing (C.C.P.) with B occupying half the tetrahedral voids. One litre of the crystal is doped with 1 mole atoms of C some of which replace the B atoms and remaining occupy few interstitial voids without affecting the dimensions of cubic crystal lattice. If density of crystal before doping is 4.8 gm/millilitre and density after doping is 4.795 gm /ml then calculate % of C added with replace B atoms. **(Given : Atomic weight : A, B and C : 40, 30, 15)**

(SPACE FOR ROUGH WORK)

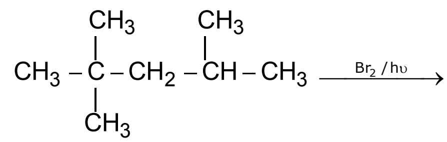
4. At 27°C, the rate of the forward reaction at a time 't' between reactants 'A' and 'B' to form the product 'P' is 12 times greater than the reverse rate. Calculate the magnitude of free energy change involved at same time in J/mole? (Assume elementary) [Given : R = 8.3 J / mol / K, ln 12 = 2.5]

5. Consider the following complex :
$[M(NH_3)_4(H_2O)(Cl)]$
Find the total number of stereoisomers–

6. For reaction:
$$IO_3^-(aq) + I^-(aq) + H^+(aq) \longrightarrow X + H_2O$$
Find out value of expression P – Q.
where; P = Number of lone pairs in a molecule of 'X',
Q = Number of covalent bond(s) in a molecule of X.

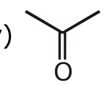
7. Which of the following species are pseudohalides ?
$CN^{\ominus}$, $SCN^{\ominus}$, $OCN^{\ominus}$, acac, SO_3^{2-}, $S_2O_3^{2-}$, en, $NC^{\ominus}$, $TeCN^{\ominus}$, $N_3^{\ominus}$, CO_3^{2-}

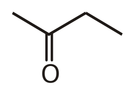
8. For the given reaction how many products are optically active (all isomers) :

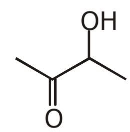


9. How many of the following can given fehling solution test ?

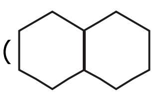
(i) HCHO (ii) CH_3CHO

(iii) PhCHO (iv) 

(v) 

(vi) 

(vii) Glucose (viii) Fructose

10. Total number of stereoisomers are possible in decalin ().

(SPACE FOR ROUGH WORK)

MOTION

HINT & SOLUTION

SAMPLE PAPER – JEE MAIN

Duration: 3 Hours | Max. Marks : 300

PART - I [MATHEMATICS]

SECTION : A									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	A	A	B	D	C	B	C	D	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	C	C	C	D	C	B	D	A	A
SECTION : B									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
88	9	10	4	0	251	0	4	4	3

PART - II [PHYSICS]

SECTION : A									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	D	A	A	B	D	D	D	B	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	A	A	B	C	C	B	B	B	D
SECTION : B									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	30	15	8	1	30	5	0	12	1

PART - III [CHEMISTRY]

SECTION : A									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C	**C**	**B**	**D**	**C**	**C**	**D**	**D**	**A**	**B**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	**D**	**C**	**A**	**A**	**B**	**B**	**B**	**C**	**D**
SECTION : B									
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
400	**5**	**66.67**	**6225**	**2**	**5**	**6**	**4**	**5**	**3**

1. **B**

Let common roots be α and β

$\therefore\ \alpha\beta + \beta\gamma_1 + \gamma_1\alpha = p = \alpha\beta + \beta\gamma_2 + \gamma_2\alpha$

$\Rightarrow (\alpha + \beta)(\gamma_1 - \gamma_2) = 0$

$\therefore\ \alpha + \beta = 0$

$\therefore\ \alpha + \beta + \gamma_1 = -4 \Rightarrow \gamma_1 = -4$ and $\gamma_2 = -9$

Let x, y, z be $\frac{y}{r}$, y, yr where r is common ratio

$\therefore\ \frac{\frac{y}{r}+y}{2} = 4 \Rightarrow \frac{y+yr}{r} = 8$ ....(1)

and $\frac{2y\cdot yr}{y+yr} = 9 \Rightarrow \frac{y^2r}{y+yr} = \frac{9}{2}$ ....(2)

$\frac{(1)}{(2)} \times (2) \Rightarrow y^2 = 36 \Rightarrow y = 6$. **Ans.**]

2. **A**

odds against a boy = 27 : 5

$\therefore$ P(boy) = $\frac{5}{32}$

odds in favour of a girl = 7 : 25

$\therefore$ P(girl) = $\frac{7}{32}$ and P(lady) = $\frac{11}{32}$

$\therefore$ P (Gentleman) =

$1 - \frac{5}{32} - \frac{7}{32} - \frac{11}{32} = \frac{9}{32}$

$P(\overline{Gentleman}) = \frac{23}{32}$

$\therefore$ odds in favour of gentleman

= 9 : 23 = $\frac{9}{23}$

3. **A**

$\because$ f (x) is surjective

$\therefore$ Range of f (x) = $[1, \infty)$

$\therefore\ \log_{10}\left(\sqrt{3x^2-4x+k+1}+10\right) \ge 1$

$\Rightarrow 3x^2 - 4x + k + 1 \ge 0$

$\therefore$ D = 0 for range to be $[0, \infty)$ for $3x^2 - 4x + k + 1$

$\therefore\ 16 - 4\cdot 3(k+1) = 0 \Rightarrow k = \frac{1}{3}$

4. **B**

$\because 91 + 13 + x_3 + x_4 + \ldots\ldots\ x_{100} = 4500$

$\Rightarrow x_3 + x_4 + \ldots\ldots\ x_{100} = 4500 - 104$

$\Rightarrow 19 + 31 + x_3 + x_4 + \ldots\ldots\ x_{100}$
$= 4500 - 104 + 50$

$\Rightarrow \frac{19+31+x_3+x_4+\ldots\ldots x_{100}}{100} = 44.46.$

5. **D**

Radius of the circle is radius of ex-circle opposite to vertex (0, 0) of triangle with vertices (0, 0), (6,6) and (– 6, 6)

$\therefore\ r_3 = s\tan\frac{C}{2} = \left(\frac{6\sqrt{2}+6\sqrt{2}+12}{2}\right)\tan 45° = 6(\sqrt{2}+1).$

6. **C**

$\because$ Vector along the line $\vec{V} = 6\hat{i} + 0\hat{j} + (2-b)\hat{k}$ is perpendicular to $\hat{i} + 3\hat{j} - 2\hat{k}$.

$\therefore\ 6 - 2(2 - b) = 0 \Rightarrow b = -1$

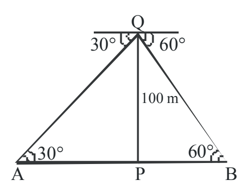
$\therefore\ \vec{V} = 6\hat{i} + 3\hat{k}$

7. **B**

Clearly AP = 100 cot 30° = $100\sqrt{3}$

and BP = 100 cot 60° = $\frac{100}{\sqrt{3}}$

$\therefore$ AB = AP + BP



$= 100\sqrt{3} + \frac{100}{\sqrt{3}}$

$= \frac{400}{\sqrt{3}}$ m.

8. **C**

Given statement

$= ((\sim P \wedge \sim Q) \wedge R) \vee ((Q \vee P) \wedge R)$

$= ((\sim (P \vee Q)) \vee (P \vee Q) \wedge R$

$= t \wedge R$ (t = tautology)

$= R$ $(\sim P \vee P = t)$

9. **D**

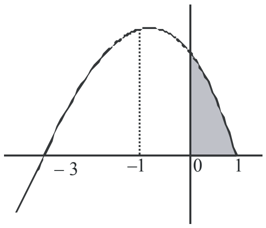
Equation of circle is $S + \lambda L = 0$

$\Rightarrow (x-\alpha)(x-\beta) + y^2 + \lambda y = 0$
and length of tangent from (0, 0) is

$= \sqrt{S_1} = \sqrt{\alpha\beta + 0} = \sqrt{\alpha\beta} = \sqrt{\frac{c}{a}}$

10. A

Area $= \int_0^1 (3 - 2x - x^2)\ dx = \left(3x - x^2 - \frac{x^3}{3}\right)_0^1$



$= 3 - 1 - \frac{1}{3} = \frac{5}{3}$

11. C

Let $|\vec{a}| = x$, $|\vec{b}| = y$ and $|\vec{c}| = z$

$\vec{a}\cdot\vec{b} = xy \cos\frac{\pi}{3} = \frac{1}{2}xy$, $\vec{b}\cdot\vec{c} = \frac{1}{2}yz$ and

$\vec{c}\cdot\vec{a} = \frac{1}{2}zx$

$$\because \left[\vec{a}\ \vec{b}\ \vec{c}\right]^2 = \begin{vmatrix} \vec{a}\cdot\vec{a} & \vec{a}\cdot\vec{b} & \vec{a}\cdot\vec{c} \\ \vec{b}\cdot\vec{a} & \vec{b}\cdot\vec{b} & \vec{b}\cdot\vec{c} \\ \vec{c}\cdot\vec{a} & \vec{c}\cdot\vec{b} & \vec{c}\cdot\vec{c} \end{vmatrix}$$

$$= \begin{vmatrix} x^2 & \frac{1}{2}xy & \frac{1}{2}xz \\ \frac{1}{2}xy & y^2 & \frac{1}{2}yz \\ \frac{1}{2}zx & \frac{1}{2}yz & z^2 \end{vmatrix}$$

$$= \frac{1}{8}xyz \begin{vmatrix} 2x & y & z \\ x & 2y & z \\ x & y & 2z \end{vmatrix} = \frac{1}{2}x^2y^2z^2$$

$\therefore \left[\vec{a}\ \vec{b}\ \vec{c}\right] = \frac{1}{\sqrt{2}}\ xyz$

$\therefore$ Volume of tetrahedron $= \frac{1}{6\sqrt{2}}\ xyz.$

$\because 4(\vec{a}\cdot\vec{a}) + 3(\vec{b}\cdot\vec{b}) + 2(\vec{c}\cdot\vec{c})$
$= 4x^2 + 3y^2 + 2z^2 = 144$
AM $\geq$ GM

$\Rightarrow \frac{4x^2 + 3y^2 + 2z^2}{3} \geq \left(4x^2 \cdot 3y^2 \cdot 2z^2\right)^{\frac{1}{3}}$

$\Rightarrow 24(xyz)^2 \leq (48)^3 \Rightarrow xyz \leq 48\sqrt{2}$

$\therefore$ Volume $\leq 8 \Rightarrow$ maximum of volume $=8$

12. C

Given expression $= \lim_{n\to\infty} \sum_{r=1}^{n} \frac{1}{n + rm}$

$= \int_0^1 \frac{1}{1+mx}\,dx$

$= \frac{1}{m}\left(\ln(1+mx)\right)_0^1 = \frac{\ln(1+m)}{m}$

13. C

14. C

$f'(x)=0 \Rightarrow f(x) = \text{constant} = 6$

so $\sum_{r=1}^{25} f(x) = 6\times25 = 150$

15. D

$L_1 = \lim_{x\to0} (\sec x)^{\text{cosec}x}$ $(1^\infty$ from$)$

$= e^{\lim_{x\to0} \text{cosec}x(\sec x - 1)} = e^{\lim_{x\to0} \frac{1-\cos x}{\sin 2x}} = e^0 = 1$

$L_2 = \lim_{x\to0} (\cot x)^{\sin x}$ $(\infty^\circ$ form$)$

$\therefore \log_e L_2 = \lim_{x\to0} (\sin x).\log_e(\cot x)$

$= \lim_{x\to0} \frac{\log_e(\cot x)}{\text{cosec}x}$

$= \lim_{x\to0} \frac{\text{cosec}^2 x}{\cot x} \frac{1}{\text{cosec}x \cot x}$

$= \lim_{x\to0} \frac{\sin x}{\cos^2 x} = 0$

$\therefore L_2 = e^\circ = 1$

So, $L_1 + L_2 = 1 + 1 = 2$

16. C

$f(x) = \sec^{-1}x + \text{cosec}^{-1}x + \sqrt{4-x^2} + \log_e x$

$\Rightarrow |x| \geq 1$ and $|x| \leq 2$ and $x > 0$

$\Rightarrow 1 \leq |x| \leq 2$

$\Rightarrow x \in [1,2]$

17. B

$\frac{dy}{dx} = xy^2 + x - y^2 \sin x - \sin x$

$\Rightarrow \frac{dy}{dx} = (x - \sin x)(y^2 + 1)$

Hence, $\int \frac{dy}{y^2+1} = \int (x - \sin x)\,dx$

$\Rightarrow \tan^{-1} y = \frac{x^2}{2} + \cos x + C$

Since, $y(0) = 0 \Rightarrow c = -1$

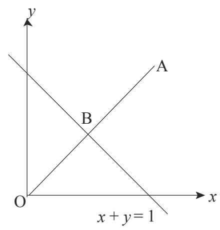
So, $y = \tan\left(\frac{x^2}{2} + \cos x - 1\right)$

18. D

Centre of the circle is (0, 0)
A is the image of the origin in the line $x+y=1$

$OB = \frac{1}{\sqrt{2}} \Rightarrow OA = \sqrt{2}$

$\therefore \; A \equiv (1,1)$



19. A

$\frac{2\sin 18^\circ}{\cos 18^\circ} + \frac{3}{\cos 18^\circ}$ – 4cos18º

$= \frac{2\sin 18^\circ + 3 - 4\cos^2 18^\circ}{\cos 18^\circ} \Rightarrow$

$\frac{2\sin 18^\circ + 3 - 2\left(1+\cos 36^\circ\right)}{\cos 18^\circ}$

$= \frac{\frac{2\left(\sqrt{5}-1\right)}{4} + 3 - 2 - 2\times\frac{\sqrt{5}+1}{4}}{\cos 18^\circ} = \frac{0}{\cos 18^\circ} = 0$

20. A

By Newton – Leibnitz Formula

f '(x) = 2x

$2x\left(e^{-\left(x^2+1\right)^2} - e^{-x^4}\right) > 0$

$\Rightarrow$ x< 0

SECTION – B

1. 88

$\because$z lies on ellipse with foci (1, 3) and (–1, 3)

$\therefore$ Centre = (0, 3) and major axis = 6

$\Rightarrow$ a = 3

$\therefore$ maximum value of | | z – 6 – 3i $|^2$ – 1|

= 9^2 – 1 = 80 = M

and minimum value of | | z – 6 – 3i $|^2$ – 1|

= 3^2 – 1 = 8 = m

$\therefore$ M + m = 88

2. 9

$\because \sum_{k=1}^{10} k\cdot\frac{{}^nC_k}{{}^nC_{k-1}} = \sum_{k=1}^{10} k\cdot\frac{(n-k+1)}{k}$ = 5n

$\Rightarrow \sum_{k=1}^{10} n - \sum_{k=1}^{10}(k-1)$ = 5n $\Rightarrow$ 10n – 45 = 5n

$\Rightarrow$ n = 9

3. 10

Clearly foci are (1, 2) and (5, 5)

distance between foci = 5 and

transverse axis = 3

$\therefore$ eccentricity of hyperbola, e' = $\frac{5}{3}$

$\because \frac{1}{e^2} + \frac{1}{e'^2} = 1 \Rightarrow e = \frac{5}{4}$

$\therefore$ 8e = 10

4. 4

$\because$ product of lengths of perpendicular

= (semi minor axis)^2 = 4

$\therefore$Given integral $\int_{-4}^{4}\{2x\}$ = dx = 16.

$\int_0^{\frac{1}{2}}\{2x\}$ dx

= 16 $\cdot \int_0^{\frac{1}{2}}(2x)$ dx = 16 $\cdot\left(x^2\right)_0^{\frac{1}{2}}$ = 4

5. 0

I = $\int_2^4\left(\frac{\ln 2}{\ln x} - \frac{\ln 2}{(\ln x)^2}\right)$dx

(Let $l$nx = t $\Rightarrow$ x = e^t)

= ln2 $\cdot \int_{\ln 2}^{ln4} e^t\left(\frac{1}{t} - \frac{1}{t^2}\right)$ dt = ln2 $\cdot \left(\frac{e^t}{t}\right)_{\ln 2}^{ln4}$

= ln2 $\cdot \left(\frac{e^t}{t}\right)_{\ln 2}^{ln4}$ = 0

6. 251

7. 0

$\left(\frac{1-x^5}{1-x}\right)^{1001}$ $(1-x)^{1002}$= (1-x) $(1-x^5)^{1001}$

so all power of x will be of 5m or 5m+1 (M$\in$ I) so coefficient of x^{2009} will be zero.

8. 4

f(x) = $\sec^{-1}\left(\frac{1}{2x^2-1}\right)$

Let $\cos^{-1}$ x = θ i.e. x= cosθ

$\Rightarrow \sec^{-1}$

$\Rightarrow$ $\sec^{-1}$ sec (2π – 2θ)(Here,2θ= $\frac{4\pi}{3}$)

= 2π-2θ =2π -2$\cos^{-1}$x

$f'(x) = \frac{2}{\sqrt{1-x^2}} \Rightarrow f'\left(\frac{-1}{2}\right) = \frac{4}{\sqrt{3}}$

9. **4**

$x+\frac{1}{2}=t$

dx = dt

$I \int_{-\frac{1}{2}}^{3+\frac{1}{2}}[t]dt$

$$I=\int_{-\frac{1}{2}}^{0}[t]dt+\int_{0}^{1}[t]dt+\int_{1}^{2}[t]dt+\int_{2}^{3}[t]dt+\int_{3}^{3+\frac{1}{2}}[t]dt$$

$$I=\int_{-\frac{1}{2}}^{0}[t]dt+0+\int_{1}^{2}[t]dt+\int_{2}^{3}[t]dt+\int_{3}^{3+\frac{1}{2}}[t]dt$$

$$=\int_{-\frac{1}{2}}^{0}-1dt+0+\int_{1}^{2}1dt+\int_{2}^{3}2dt+\int_{3}^{3+\frac{1}{2}}3dt$$

$$=\int_{-\frac{1}{2}}^{0}-1dt+0+\int_{1}^{2}1dt+\int_{2}^{3}2dt+\int_{3}^{3+\frac{1}{2}}3dt$$

$$=(-t)_{-1/2}^{0}+(t)_{1}^{2}+2(t)_{2}^{3}+3(t)_{3}^{7/2}$$

$$=-\frac{1}{2}+1+2+\frac{3}{2}=4$$

10. **3**

The component of along is given by

$$\left|\left\{\frac{\vec{a}.\vec{b}}{\left|\vec{b}\right|^{2}}\right\}\vec{b}\right|=\left|\frac{18}{25}(3\hat{j}+4\hat{k})\right|=\frac{18}{25}\sqrt{9+16}$$

$$=\frac{18}{5}=3.60$$

SECTION – A

1. **D**

J = m×v×r

r = perpendicular distance

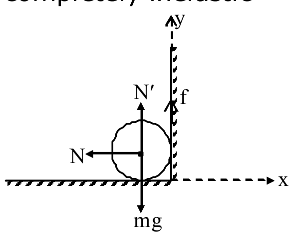
$= H_{max} = \dfrac{u^2 \sin^2\theta}{2g}$

$V_{HZ} = u\cos\theta$

$J = m \times (u\cos\theta) \times \left(\dfrac{u^2\sin^2\theta}{2g}\right)$

2. **D**

Collision between wall and cylinder is completely inelastic



$\therefore \int N dt = mv_0$

$\int f dt = mv_y$

v : velocity of cylinder in upward direction after collision]

$\Rightarrow v_y = \mu v_0$

Now, Angular impulse due to friction force

$\dfrac{mR^2\omega}{2} - \dfrac{mR^2}{2} \cdot \dfrac{v_0}{R} = -\int f.R.dt$

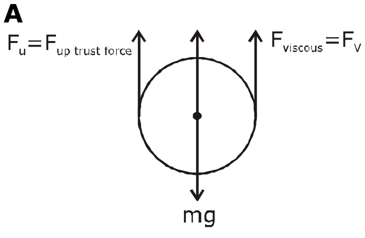
[ω : Angular velocity of cylinder after collision]

$\Rightarrow \omega = \dfrac{v_0(1-2\mu)}{R}$

Kinetic energy after collision

$= \dfrac{1}{2}mv^2 + \dfrac{1}{2}I\omega^2 = \dfrac{3}{32}\ mv_0^2$

3. **A**



$F_u + F_v = mg$

$V.\rho_2\ g + Krv_T = mg$

$V_T = \dfrac{(m - v\rho_2)g}{Kr}$

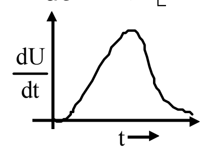
$V_T = \dfrac{Vg(\rho_1-\rho_2)}{Kr}$ $\quad \{m = \rho \times \text{volume}\}$

$V_T = \dfrac{4\pi r^2(\rho_1-\rho_2)}{3K}$ $\quad V = \dfrac{4}{3}\pi r^3$

4. **A**

Rate of increment of energy in inductor

$= \dfrac{dU}{dt} = \dfrac{d}{dt}\left[\dfrac{1}{2}Li^2\right] = Li\ \dfrac{di}{dt}$



Current in the inductor at time t is:

$i = i_0\ (1 - e^{\frac{-t}{\tau}})$ and $\dfrac{di}{dt} = \dfrac{i_0}{\tau}\ e^{\frac{-t}{\tau}}$

$\dfrac{dU}{dt} = \dfrac{Li_0^2}{\tau}\ e^{\frac{-t}{\tau}}\ (1 - e^{\frac{-t}{\tau}})$

$\dfrac{dU}{dt} = 0$ at t = 0 and t = ∞

Hence E is best represented by (A).

5. **B**

Width of fringe = β

If frequency is doubled then, wavelength becomes halved, because velocity of light in air remain same

$\beta \propto \lambda \Rightarrow \dfrac{\beta'}{\beta} = \dfrac{\lambda'}{\lambda} = \dfrac{\lambda/2}{\lambda} = \dfrac{1}{2}$ $\quad \boxed{\beta' = \dfrac{\beta}{2}}$

6. **D**

Energy released

ΔE = Total binding energy of

$_2He^4$ – 2(total binding energy of $_1H^2$)

= 4 × 7.0 – 2(1.1) (2)

= 23.6 MeV

7. **D**

By putting the dimensions of each quantity both the sides

we get $[T^{-1}] = [M]^x\ [MT^{-2}]^y$

Now comparing the dimensions of quantities in both sides

we get x + y = 0 and 2y = 1

$x = -\dfrac{1}{2}, y = \dfrac{1}{2}$

8. **D**

Condition for vertical looping

$h = \dfrac{5}{2}\ r = 5cm$

$\therefore$ r = 2 cm

9. **B**

$$B = \frac{B_{centre}}{\left(1+\frac{x^2}{a^2}\right)^{3/2}}$$

$(B_{centre})_2 = 2\,(B_{centre})_1$

but $\left(\frac{x}{a}\right)_1 = \left(\frac{x}{a}\right)_2$

$\therefore\ B_2 = 2B_1$

10. **B**

$x = a\cos(\omega t + \theta)$ ....(i)

and $\upsilon = \frac{dx}{dt} = -a\omega\sin(\omega t + \theta)$ ....(ii)

Given at t = 0, x = 1cm and $\upsilon = \pi$ and $\omega = \pi$

Putting these values in equation (i) and (ii) we will get $\sin\theta = \frac{-1}{a}$ and $\cos\theta = \frac{1}{a}$

$\Rightarrow \sin^2\theta + \cos^2\theta = \left(\frac{-1}{a}\right)^2 + \left(\frac{1}{a}\right)^2$

$\Rightarrow a = \sqrt{2}$ cm

11. **D**

P_1 = 1atm, T_1 = 273 K

$P_1V_1^{\gamma} = P_2V_2^{\gamma}$

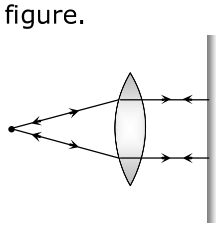
$P_2 = P_1\left[\frac{V_1}{V_2}\right]^{\gamma} = 1\text{ atm}\left(\frac{1}{3}\right)^{1.4}$

now work done $= \frac{P_1V_1 - P_2V_2}{\gamma - 1}$ = 88.7 J

Closest ans is 90.5 J

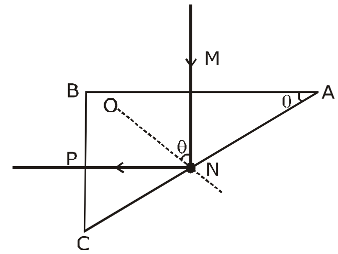
12. **A**

When the object is placed at focus the rays are parallel. The mirror placed normal sends them back. Hence image is formed at the object itself as illustrated in figure.



13. **A**

Since ray MN is incident normally on face AB, hence $\angle MNQ = \theta\ \theta \geq C$



$\sin\theta \geq \sin C$

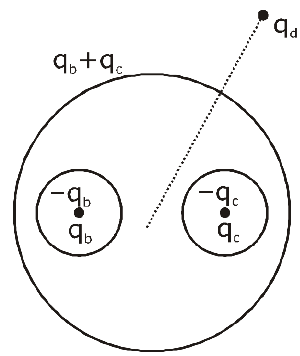
Now, $\frac{1.5}{4/3} = \frac{1}{\sin C}$

or $\sin C = \frac{8}{9} \Rightarrow \sin\theta \geq 8/9$

14. **B**

$F_3 = \frac{k(q_b + q_c)q_d}{r^2}$

$F_1 = F_2$ = zero



15. **C**

When the gas is compressed isothermally,
$PV = P_1V_1$

$P_1 = \frac{PV}{V_1} = \frac{PV}{V/n} = nP$

When the gas is compressed adiabatically,
$PV^{\gamma} = P_2V_2^{\gamma}$

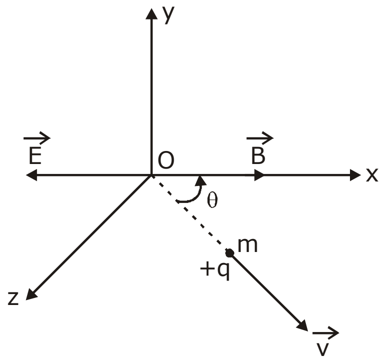
$P_2 = P\left(\frac{V}{V_2}\right)^{\gamma} = P\left(\frac{V}{V/n}\right)^{\gamma} = Pn^{\gamma}$

Now, $\frac{P_1}{P_2} = \frac{nP}{n^{\gamma}P} = n^{1-\gamma} = \frac{1}{n^{\gamma-1}}$

16. **C**

The charge experiences a retarding force $\vec{F} = q\vec{E}$ along x-axis.

Retardation $= \frac{qE}{m}$



It is clear that the speed of the particle will be minimum when its component of velocity along the direction of electric field is zero.

Thus, using the equation of motion

v = u + at

$O = v\cos\theta - \frac{qE}{m}t$

or $t = \frac{mv\cos\theta}{qE}$

17. **B**

Let dielectric moves through a distance dx inside the plates. This increases capacitance to C + dC. As potential difference remains constant at V. the battery supply more charge to capacitor.

and dQ = dC . V

So, work done by battery

$dW_b = VdQ = dC.V^2$

and work done by force dW_F

= –Fdx (F = force on slab)

$dc \cdot V^2 - Fdx = \frac{1}{2}(dc)\,v^2$

$$F = \frac{\varepsilon_0 \times 4\times10^{-2}\times(12)^2\times(7-1)}{2\times4\times10^{-2}}$$

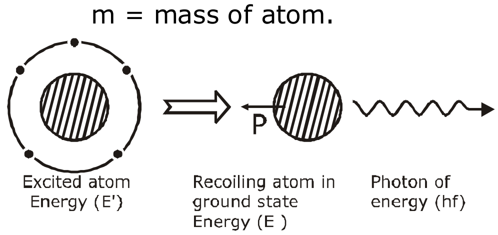
$F = 432\varepsilon_0$

18. **B**

when an atom that is in excited state E' and at rest in or frame of reference emits a photon of energy hf. the photon also carries a momentum $P = \frac{hf}{c} = \frac{hc}{\lambda}$.

Conservation of momentum requires the atom must recoil with a momentum p and so, will have a kinetic energy $\frac{P^2}{2m}$ where.

m = mass of atom.



So, conservation of energy gives.

$\Delta E = E' - E$

$= hf + \text{recoil KE of atom}$

$\Rightarrow hf = \Delta E - \frac{(P)^2}{2m}$

$\Rightarrow hf < \Delta E$

19. **B**

$L_{initial} = L_{final}$

$mv_0r = I_0\omega_0$

$mv_0r = \frac{1}{2}mr^2\omega_0 \Rightarrow 2v_0 = \omega_0 r$

20. **D**

Induced emf across tips of wings :-

$e = B_v v\,\ell_{w_1w_2}$, where $\tan\theta = \frac{B_v}{B_H}$

$= (B_H\tan\theta)\,v\,\ell_{w_1w_2}$ $\qquad B_v = (B_H\tan\theta)$

$= (2\times10^{-5}\times\tan60°)\times250\times20 = 0.173$ v

SECTION - B

1. **1**

$\Delta x = 50\text{cm} = \frac{1}{2}\text{m}$

$A_a = A_b = a$

$\lambda = 1\text{m}$

$\Delta\phi = \frac{2\pi}{\lambda}$ = Phase difference

$\Rightarrow \Delta\phi = \pi$

Total Phase difference = $\phi - \frac{\pi}{3} = \frac{2\phi}{3}$

$R = \sqrt{a^2 + a^2 + 2a^2\cos2\pi/3} = a$

2. **30**

$\frac{1}{C_{eq}} = \frac{1}{2c} + \frac{1}{c} + \frac{1}{2c} = \frac{2}{C} \Rightarrow C_{eq} = \frac{c}{2}$

$Q = C_{eq}V = \frac{C}{2}\times v$

Q_2 = charge in capacitor (C)

$Q_2 = Q = \frac{CV}{2} = C_2V_2 \Rightarrow \frac{CV}{2}$

$V_2 = \frac{60}{2} = 30\text{volt}$

3. **15**

By using $N = N_0\left(\frac{1}{2}\right)^{t/T}$ where

$N = \left(1 - \frac{7}{8}\right)N_0 = \frac{1}{8}N_0$

So $\frac{1}{8}N_0 = N_0\left(\frac{1}{2}\right)^{t/T} \Rightarrow \left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^{t/5}$

$\Rightarrow$ *t* =15 *days*.

4. **8**

Relative velocity = 10 + 5 = 15 m/s.
Time taken by the bird to cross the train
$= \frac{120}{15} = 8\,\text{sec}$

5. **1**

From given equation $\omega = \frac{2\pi}{T} = 0.5\pi$
$\Rightarrow T = 4$ sec
Time taken from mean position to the maximum displacement $= \frac{1}{4}T = 1$ sec.

6. **30**

For no slipping between m and M,
$F \le (M + m)g/3$
$F \le 40$ N
For no toppling of m block
$F \le (M + m)\, g/4$
$F \le 30$N
$\therefore F_{min} = 30$N

7. **5**

The lens power of combined lens is
$P = P_1 + P_1 = -10 + 20 = 10$ D
Focal length of combination
$F = \frac{1}{P} = \frac{100}{10}\text{cm} = 10\text{cm}$
For the final image at infinity,
the magnifying power of simple microscope is given by
$M = \frac{D}{f} = \frac{25}{10} = 2.5$

8. **0**

$\therefore Y = 3 + \times$
$\therefore \tan\theta = 1 \Rightarrow \theta = 45°$
$\therefore F = 100\cos 45°\,\hat{i} + 100\sin 45°\,\hat{j}$
$= \frac{100}{\sqrt{2}}\hat{i} + \frac{100}{\sqrt{2}}\hat{j}$
The displacement of the particle is
$s = \hat{i} + 3\hat{j} - (3\hat{i} + \hat{j})$
$= -2\hat{i} + 2\hat{j}$
$\therefore W = F \,.\, s = -\frac{200}{\sqrt{2}} + \frac{200}{\sqrt{2}} = 0$

9. **12**

$y = kt^2$
$\therefore \frac{dy}{dt} = 2kt$
or $\frac{d^2y}{dt^2} = 2k$ .... (i) ($k = 1\text{m/s}^2$ given)
or $a = 2\text{m/s}^2$
We know that $T = 2\pi\sqrt{\frac{\ell}{g}}$
$\therefore \frac{T_1^2}{T_2^2} = \frac{g_2}{g_1}$
$\Rightarrow \frac{T_1^2}{T_2^2} = \frac{12}{10} = \frac{6}{5}$
[$\because g_1 = 10\text{m/s}^2$ and $g_2 = g+2 = 12\text{m/s}^2$]

10. **1**

When x cells are wrongly connected then
$E_{net} = 12E - 2xE$
When cells and battery aid each other
then $3 = \frac{12E - 2xE + 2E}{R}$ ..... (1)
When they oppose each other
$2 = \frac{12E - 2xE - 2E}{R}$ ..... (2)
solve eq(1) and (2)
$x = 1$

PART - III [CHEMISTRY]

SECTION - A

1. **C**

$\Delta G = -nFE_{cell} = (-8 \times 96500 \times 0.8)$ J/mol

$\therefore$ % efficiency $= \dfrac{-8 \times 96500 \times 0.8}{-772 \times 1000} \times 100\%$

= 80 % Ans.

2. **C**

Theory based

3. **B**

For the solution 1 : pH = 9

$\therefore$ pOH = 5 $\therefore$ $[OH^-]_1 = 10^{-5}$ M

For the solution 2 : pH = 11

$\therefore$ pOH = 3 $\therefore$ $[OH^-]_2 = 10^{-3}$ M

$\therefore$ Resultant $[OH^-] = \left(\dfrac{10^{-3} + 10^{-5}}{2}\right)$M

$= 5 \times 10^{-4}$ M

$\therefore$ pOH $= -\log(5 \times 10^{-4}) = 4 - 0.7$

$\therefore$ Resultant pH $= 14 - (4 - 0.7) = 10.7$

4. **D**

Let, $n_{NaHC_2O_4}$ be a- mmol

& $n_{H_2C_2O_4}$ be b-mmol

$\therefore$ In 1st titration : $\dfrac{2a}{5} + \dfrac{2b}{5} = 0.1 \times 50$

$\therefore$ a + b = 12.5 ....(i)

In 2nd titration : a + 2b = 20 .....(ii)

solving (i) and (ii) : b = 7.5

$\therefore m_{H_2C_2O_4} = \dfrac{7.5}{1000} \times 90$ g = 0.675 g

5. **C**

Theory based.

6. **C**

$\because \dfrac{P^0 - P_s}{P_s} = \dfrac{n}{N}$

$\therefore \dfrac{2}{98} = \left(\dfrac{m_{urea}/60}{490/18}\right)$

$\therefore m_{urea} = 33.33$ g

7. **D**

For nth order reaction : $t_{1/2} \propto [A]_0^{1-n}$

$\therefore t_{1/2} \propto [A]_0^{1-2.5}$

$\Rightarrow t_{1/2} \propto \dfrac{1}{[A]_0^{1.5}}$

$\therefore$ m = 1.5 **Ans.**

8. **D**

(A) $[Cu(PPh_3)_4]^+ \rightarrow$ Tetrahedral ; SFL; $\Delta\uparrow$; Intensity$\downarrow$

(B) $[Zn(H_2O)_6]^{2+} \rightarrow$ Octahedral complex

(C) $[Cu(NH_3)_4]SO_4 \rightarrow$ Tetrahedral ; $\Delta\uparrow$; Intensity$\downarrow$; SFL

(D) $MnO_4^- \rightarrow d^3s$, Tetrahedral complex ; purple coloured due to LMCT

9. **A**

$Li + air \rightarrow Li_3N + Li_2O + Li_2O_2$

$\downarrow H_2O$

NH_3 + LiOH

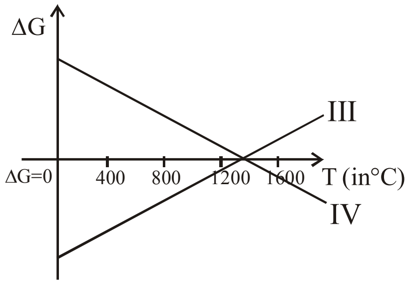
(Basic-turns red litmus into blue)

10. **B**

E.A. $\rightarrow$ Cl > F

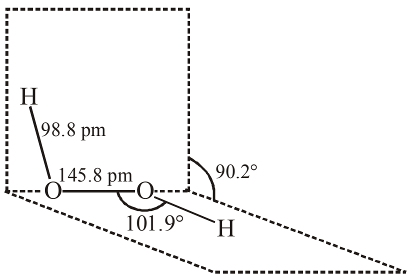
11. **A**

	at T < 1400°C	**at T > 1400°C**
III $\rightarrow$ $3Mg + Al_2O_3 \longrightarrow 3MgO + 2Al$	$\Delta G < 0$	$\Delta G > 0$
IV $\rightarrow$ $3MgO + 2Al \longrightarrow 3Mg + Al_2O_3$	$\Delta G > 0$	$\Delta G < 0$



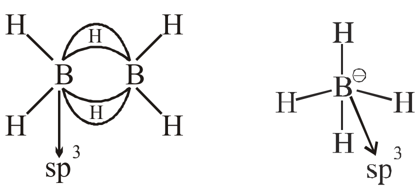
12. **D**

13. **C**



14. **A**

$2MH + B_2H_6 \longrightarrow 2M^+ [BH_4]^-$ {M = Li or Na}



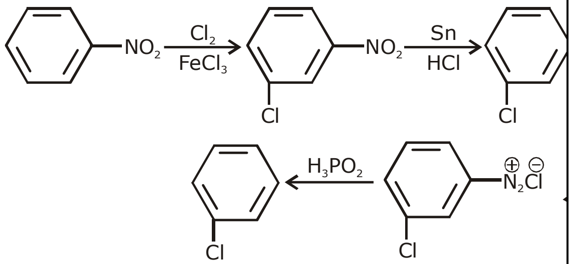
15. **A**

16. **B**

Nucleophilicity $\propto$ Size (in group)

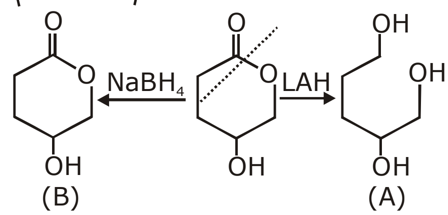
17. **B**

18. **B**

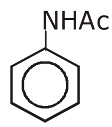


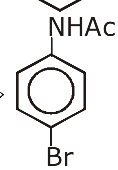
19. **C**

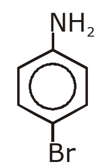
LAH reduces both ester (here cyclic ester and ($>C=O$) group to alcohols, whereas $NaBH_4$ reduces only ($>C=O$) group to ($>CH-OH$) group.



20. **D**

(A) $\Rightarrow$ 

(B) $\Rightarrow$ 

(C) alkaline hydrolysis of B; 

SECTION – B

1. **400**

$V_C = \dfrac{50}{125}$ L / mol = 0.4 L / mol

But, $Z_C = \dfrac{P_C V_C}{RT_C} = \dfrac{3}{8}$

$\Rightarrow T_C = \dfrac{8 P_C V_C}{3R} = \left(\dfrac{8 \times 30 \times 0.4}{3 \times 0.08}\right) K = 400\ K$

2. **5**

KE of the ejected electron

$= \left(9.4 - 13.6 \times \dfrac{2^2}{4^2}\right) eV = 6\ eV$

$\therefore \lambda = \left(\dfrac{150}{6}\right)^{\frac{1}{2}} Å = 5Å$

3. **66.67**

$4800 - 15x + 15y = 4795$

$x - y = \frac{1}{3}$; $x + y = 1$

$x = \frac{2}{3}$ $y = \frac{1}{3}$

$\% = \frac{2}{3} \times 100 = 66.667$

4. **6225**

$\Delta G = \Delta G^\circ + RT\, ln\, Q$

$\Delta G = -RT\, ln\, K_{eq} + RT\, ln\, Q$

$\Delta G = RT\, ln\, \frac{Q}{k_{eq}}$ ... (1)

$A + B \underset{k_b}{\overset{k_f}{\rightleftharpoons}} P$

At time t $\Rightarrow Q = \frac{[P]_t}{[A]_t[B]_t}$ ... (2)

Given $\frac{r_f}{r_b} = 12$, $\frac{k_f[A][B]}{k_b[P]} = 12$ $\Rightarrow$

$\frac{[P]_t}{[A]_t[B]_t} = \frac{k_f}{12\,k_b}$

Putting value of Q & K_{eq} in equation (1)

$\Delta g = RT\, ln\, \frac{k_f}{12k_b} \times \frac{k_b}{k_f}$

$\Delta g = -RT\, ln\, 12 = -6225$

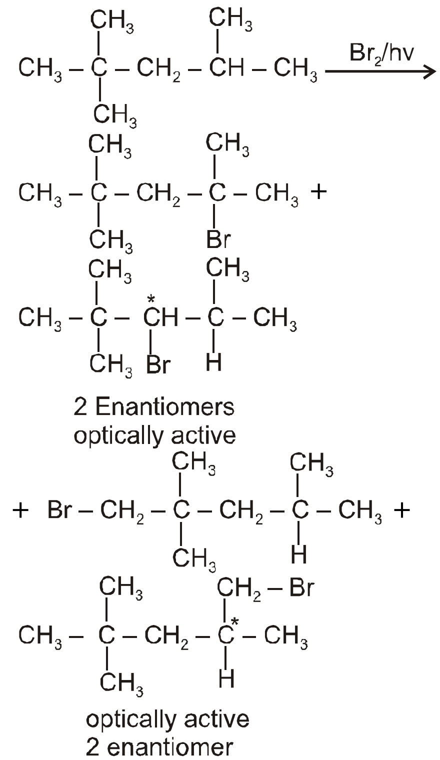
5. **2**

6. **5**

7. **6**

$CN^{\ominus}$, $SCN^{\ominus}$, $OCN^{\ominus}$, $NC^{\ominus}$, $N_3^{\ominus}$ and $TeCN^{\ominus}$ all are pseudohalides

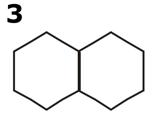
8. **4**

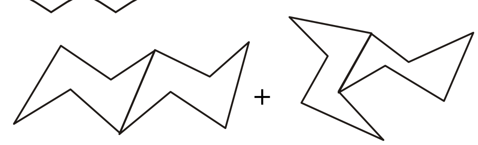


9. **5**

(i, ii, vi, vii, viii)

10. **3**

 can exist as



Optically inactive   Optically active

Total = 3