MOTION™

SAMPLE PAPER _ JEE MAIN

FULL SYLLABUS TEST

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.

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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. The following statement

$(p \to q) \to [(\sim p \to q) \to q]$ is:

(A) a fallacy

(B) a tautology

(C) equivalent $\sim p \to q$

(D) equivalent to $p \to \sim q$

2. If $|z + 2i| \le 1$, then greatest and least value of $|z - \sqrt{3} + i|$ are -

(A) 3, 1 (B) ∞, 0

(C) 1, 3 (D) None of these

3. If $\sqrt{4+\sqrt{8-\sqrt{32+\sqrt{768}}}} = a\sqrt{2}\cos\left(\frac{11\pi}{b}\right)$

then $\left(\frac{b}{a}\right)$ equals $\left(a, b \in R^{+}\right)$

(A) 12 (B) $\frac{1}{6}$

(C) 24 (D) 36

4. A student guesses of each of 30 true/false questions the chance that he gets at least 15 correct, is

(A) $\frac{1}{2}$ (B) $1-\frac{^{30}C_{15}}{2^{30}}$

(C) $\frac{1}{2}+\frac{^{30}C_{15}}{2^{31}}$ (D) $\frac{1}{2}+\frac{^{30}C_{15}}{2^{30}}$

5. The integral $\int_{\pi/24}^{5\pi/24} \frac{dx}{1+\sqrt[3]{\tan 2x}}$ is equal to

(A) $\frac{\pi}{18}$ (B) $\frac{\pi}{3}$

(C) $\frac{\pi}{12}$ (D) $\frac{\pi}{6}$

6. Water is running into an underground right circular conical reservoir, which is 10 m deep and radius of its base is 5m. If the rate of change in the volume of water in the reservoir is $\frac{3\pi}{2}\, m^3/\min$, then the rate(in m/min) at which water rises in it, when the water level is 4m, is:

(A) $\frac{3}{2}$ (B) $\frac{3}{8}$

(C) $\frac{1}{8}$ (D) $\frac{1}{4}$

(SPACE FOR ROUGH WORK)

7. Let $f : R^{+} \to R$ be a negative decreasing function with $\lim\limits_{x\to\infty} \frac{f\left(x - \frac{x^3}{6}\right)}{f(x)} = k$, then $\lim\limits_{x\to\infty} \frac{f(\sin x)}{f(x)}$ is

(A) less than k
(B) greater than k
(C) equal to k
(D) Nothing can be said

8. The scores of a batsman in 10 innings are 38, 70, 48, 34, 42, 55, 63, 46, 54, 44. The mean deviation about median is

(A) 8.6 (B) 7.6
(C) 8.2 (D) 8.4

9. If $y = \cos\left(x + \frac{\pi}{3}\right)\cos x - \cos^2\left(x + \frac{\pi}{6}\right)$, then its graph is

(A) a straight line through the origin
(B) a straight line passing through $\left(0, -\frac{1}{4}\right)$ and parallel to x-axis.
(C) a straight line passing through $\left(0, -\frac{1}{2}\right)$
(D) not a straight line.

10. If in the expansion of $\left(\frac{1}{x} + x\tan x\right)^5$, the ratio of 4^{th} term to the 2^{nd} term is $\frac{2}{27}\pi^4$, then value of x can be:

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

11. The sum $\sum_{n=1}^{\infty} \tan^{-1}\left(\frac{3}{n^2 + n - 1}\right)$ is equal to

(A) $\frac{3\pi}{4} - \cot^{-1} 2$ (B) $\frac{3\pi}{4} + \cot^{-1} 2$
(C) $\frac{\pi}{2} + \cot^{-1} 3$ (D) $\frac{\pi}{2} + \tan^{-1} 2$

12. A vertical pole stands at a point A on the boundary of a circular park of radius a and subtends an angle α at another point B on the boundary. If the chord AB subtends an angle α at the centre of the park, then the height of the pole is

(A) $2a \sin\frac{\alpha}{2} \tan\alpha$ (B) $2a\cos\frac{\alpha}{2} \tan\alpha$
(C) $2a \sin\frac{\alpha}{2} \cot\alpha$ (D) $2a\cos\frac{\alpha}{2} \cot\alpha$

(SPACE FOR ROUGH WORK)

13. Equation of line in the plane P : $2x - y + z - 4 = 0$ which is perpendicular to the line L : $\frac{x-2}{1} = \frac{y-2}{-1} = \frac{z-3}{-2}$ and which passes through the point of intersection of L and P is

(A) $\frac{x-1}{3} = \frac{y-3}{5} = \frac{z-5}{1}$

(B) $\frac{x-2}{2} = \frac{y-1}{-1} = \frac{z-1}{1}$

(C) $\frac{x+2}{2} = \frac{y+1}{-1} = \frac{z+1}{1}$

(D) $\frac{x-1}{3} = \frac{y-3}{5} = \frac{z-5}{-1}$

14. The least integral value of m for which the angle between the two vectors $\vec{V}_1 = x^2\hat{i} - 4\hat{j} + (3m + 1)\hat{k}$ and $\vec{V}_2 = m\hat{i} - x\hat{j} + \hat{k}$ is acute $\forall x \in R$ is

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

15. Let A be a 3×3 matrix with real entries. If $AA^T = I$, then the value of $\det(A^2 - I_3)$ ______

(A) 0 (B) 1

(C) 2 (D) 3

16. If in a triangle $\left(1 - \frac{r_1}{r_2}\right)\left(1 - \frac{r_1}{r_3}\right) = 2$, then the triangle is

(A) equilateral

(B) isosceles

(C) right - angled

(D) right - angled isosceles

17. If the ratio of the roots of $x^2 + ax + b = 0$ and that of $x^2 + cx + d = 0$ are equal, then

(A) $ad^2 = b^2c$ (B) $bd^2 = a^2c$

(C) $b^2d = ac^2$ (D) $a^2d = bc^2$

18. The straight line $x - y = 2$ rotates about the point at which it cuts the x - axis and in the new position it is perpendicular to $x + 2y + 5 = 0$. Then the equation of the line in its new position is

(A) $x + 2y - 5 = 0$

(B) $x - 2y + 10 = 0$

(C) $y - 2x + 4 = 0$

(D) $y - 2x + 10 = 0$

(SPACE FOR ROUGH WORK)

19. The equation of the curve satisfying the differential equation $\frac{d^2y}{dx^2}(x^2+1) = 2x\frac{dy}{dx}$ passing through (0,1) and having slope of the tangent at x = 0 as 3 is

(A) $y = x^2 + 3x + 2$

(B) $y^2 = x^2 + 3x + 1$

(C) $y = x^3 + 3x + 1$

(D) $y^2 = x^3 + 3x + 1$

20. Value of integral

$\int_0^1 \frac{1}{(5+2x-2x^2)(1+e^{(2-4x)})}dx$ is

(A) $\frac{1}{2\sqrt{7}}\log\left(\frac{\sqrt{3}+\sqrt{5}}{2}\right)$

(B) $\frac{1}{2\sqrt{11}}\log\left(\frac{\sqrt{11}+1}{\sqrt{11}-1}\right)$

(C) $\frac{1}{2\sqrt{11}}\log\left(\frac{\sqrt{7}+3}{\sqrt{7}-3}\right)$

(D) none of these

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. Locus of the point of intersection of the pair of perpendincular tangents to the circle $x^2+y^2= 1$ and $x^2+y^2 = 7$ is the director circle of the circle with radius 'r' then find the value of 'r'

2. Let

$$f(x) = \begin{cases} (\cos x - \sin x)^{\operatorname{cosec} x} & ; \ -\frac{\pi}{2} < x < 0 \\ a & ; \ x = 0 \\ \frac{e^{1/x}+e^{2/x}+e^{3/x}}{a.e^{2/x}+b.e^{3/x}} & ; \ 0 < x < \frac{\pi}{2} \end{cases}$$

If f(x) is continuous at x = 0, then find the value of a.b

3. If $\int \frac{f'(x)g(x)-g'(x)f(x)}{(f(x)+g(x))\sqrt{f(x)g(x)-g^2(x)}}dx$ is equal to $\sqrt{m}\tan^{-1}\left(\sqrt{\frac{f(x)-g(x)}{ng(x)}}\right)+c$, where m, n $\in$ N and 'c' constant of integration (g(x) > 0) then find $m^2 + n^2$ is

4. Latus rectum of the parabola whose focus is (3, 4) and whose tangent at vertex has the equation x + y = 7 + 5 $\sqrt{2}$ is 'L' then find the value of 'L' is

(SPACE FOR ROUGH WORK)

5. The sum of 20 terms of the series $\frac{1}{1}+\frac{1+2}{2}+\frac{1+2+3}{3}+$ .... is

6. If f(x) is a function satisfying f(x+y+1) = f(x).f(y) for all non - negative integers x, y such that f(0) = 2, $\sum_{x=1}^{n} f(x)=1020$, then the value of n is

7. The value of the determinant $\begin{vmatrix} \tan^2\frac{\pi}{7} & \operatorname{cosec}^2\frac{5\pi}{14} & \sin\frac{3\pi}{2} \\ -\operatorname{cosec}^2\frac{5\pi}{14} & \cos\pi & -\tan^2\frac{\pi}{7} \\ \tan\frac{\pi}{4} & -\tan^2\frac{\pi}{7} & \operatorname{cosec}^2\frac{5\pi}{14} \end{vmatrix}$ is

8. A five digit number divisible by 12, is to be formed by using the digits 0,1,2,3,4,5 without repetition. The total number of ways in which this can be done is

9. If $(1 + 2x - x^2)^7 = 1 + a_1x + a_2x^2 + ...a_{14} x^{14}$, then the value of $a_1 + a_3 + a_5 + ... a_{13}$ equals

10. Are bounded by the curves $y=\left[\frac{x^2}{64}+2\right]$, y = x - 1 and x = 0 above the x-axis ([.] denotes the greatest integer function) is

(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 cannon on a level plane is aimed at an angle θ above the horizontal and a shell is fired with a muzzle velocity v_0 towards a vertical cliff a distance *D* away. Then the height from the bottom at which the shell strikes the side walls of the cliff is

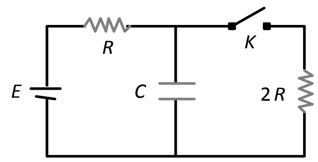
(A) $D\sin\theta - \dfrac{gD^2}{2v_0^2\sin^2\theta}$

(B) $D\cos\theta - \dfrac{gD^2}{2v_0^2\cos^2\theta}$

(C) $D\tan\theta - \dfrac{gD^2}{2v_0^2\cos^2\theta}$

(D) $D\tan\theta - \dfrac{gD^2}{2v_0^2\sin^2\theta}$

2. In the circuit, shown in fig. '*K*' is open. The charge on capacitor *C* in steady state is q_1. Now key is closed and at steady state, the charge on *C* is q_2. The ratio of charges $\left(\dfrac{q_1}{q_2}\right)$ is



(A) $\dfrac{3}{2}$ (B) $\dfrac{2}{3}$

(C) 1 (D) $\dfrac{1}{2}$

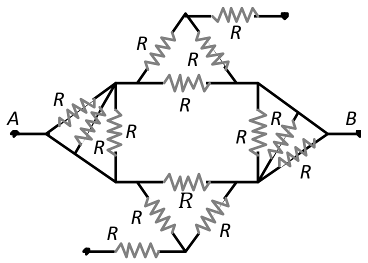
3. A body of mass m is projected with velocity v at an angle of 45° with the horizontal. If air resistance is negligible, then total change in momentum when it strikes the ground is

(A) 2mv (B) $\sqrt{2}$mv

(C) mv (D) mv / $\sqrt{2}$

(SPACE FOR ROUGH WORK)

4. Find equivalent resistance between *A* and *B*



(A) R (B) $\frac{3R}{4}$

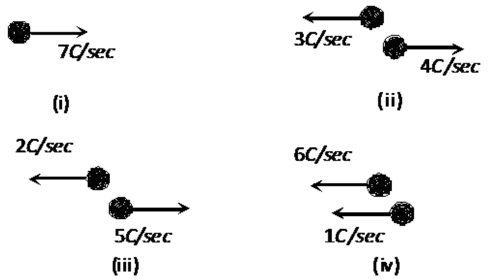
(C) $\frac{R}{2}$ (D) 2R

5. Two weights w_1 and w_2 are suspended from the ends of a light string passing over a smooth fixed pulley. If the pulley is pulled up at an acceleration *g*, the tension in the string will be

(A) $\frac{4w_1w_2}{w_1 + w_2}$ (B) $\frac{2w_1w_2}{w_1 + w_2}$

(C) $\frac{w_1w_2}{w_1 + w_2}$ (D) $\frac{w_1w_2}{2(w_1 + w_2)}$

6. Following figure shows four situations in which positive and negative charges moves horizontally through a region and gives the rate at which each charge moves. Rank the situations according to the effective current through the region greatest first



(A) $i = ii = iii = iv$ (B) $i > ii > iii > iv$

(C) $i = ii = iii > iv$ (D) $i = ii = iii < iv$

7. A motor car has a width 1.1 *m* between wheels. Its centre of gravity is 0.62 *m* above the ground and the coefficient of friction between the wheels and the road is 0.8. What is the maximum possible speed, if the centre of gravity inscribes a circle of radius 15 *m* ? (Road surface is horizontal)

(A) 7.64 *m/s* (B) 6.28 *m/s*

(C) 10.84 *m/s* (D) 11.23 *m/s*

(SPACE FOR ROUGH WORK)

8. A nucleus ruptures into two nuclear parts which have their velocities in the ratio of 2 : 1. What will be the ratio of their nuclear sizes (radii)?

(A) $2^{1/3} : 1$ (B) $1 : 2^{1/3}$

(C) $3^{1/2} : 1$ (D) $1 : 3^{1/2}$

9. Work done in time *t* on a body of mass *m* which is accelerated from rest to a speed *v* in time t_1 as a function of time *t* is given by

(A) $\frac{1}{2}m\frac{v}{t_1}t^2$ (B) $m\frac{v}{t_1}t^2$

(C) $\frac{1}{2}\left(\frac{mv}{t_1}\right)^2 t^2$ (D) $\frac{1}{2}m\frac{v^2}{t_1^2}t^2$

10. The resistance of the filament of a lamp increases with the increase in temperature. A lamp rated 100 *W*, 220 *V* is connected across 220 *V* power supply. If the voltage drops by 10% then the power of lamp will be

(A) 90 *W*

(B) 81 *W*

(C) Between 90 *W* and 100 *W*

(D) Between 81 *W* and 90 *W*

11. What is the shape of the graph between the speed and kinetic energy of a body

(A) Straight line (B) Hyperbola

(C) Parabola (D) Exponential

12. If resistance of the filament increases with temperature, what will be power dissipated in a 220 *V*- 100 *W* lamp when connected to 110 *V* power supply

(A) 25 *W* (B) < 25 *W*

(C) > 25 *W* (D) None of these

13. When a body moves with some friction on a surface

(A) It loses kinetic energy but momentum is constant

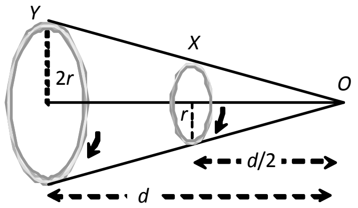
(B) It loses kinetic energy but gains potential energy

(C) Kinetic energy and momentum both decrease

(D) Mechanical energy is conserved

(SPACE FOR ROUGH WORK)

14. Two circular coils X and Y, having equal number of turns, carry equal currents in the same sense and subtend same solid angle at point O. If the smaller coil, X is midway between O and Y, then if we represent the magnetic induction due to bigger coil Y at O as B_Y and that due to smaller coil X at O as B_X , then



(A) $\frac{B_Y}{B_X} = 1$

(B) $\frac{B_Y}{B_X} = 2$

(C) $\frac{B_Y}{B_X} = \frac{1}{2}$

(D) $\frac{B_Y}{B_X} = \frac{1}{4}$

15. A fixed horizontal wire carries a current of 200 A. Another wire having a mass per unit length $10^{-2}\,\text{kg/m}$ is placed below the first wire at a distance of 2 cm and parallel to it. How much current must be passed through the second wire if it floats in air without any support? What should be the direction of current in it

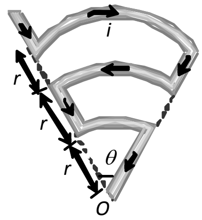
(A) 25A (direction of current is same to first wire)

(B) 25A (direction of current is opposite to first wire)

(C) 49 A (direction of current is same to first wire)

(D) 49 A (direction of current is opposite to first wire)

16. Find magnetic field at O



(A) $\frac{5\mu_0 i\theta}{24\pi r}$

(B) $\frac{\mu_0 i\theta}{24\pi r}$

(C) $\frac{11\mu_0 i\theta}{24\pi r}$

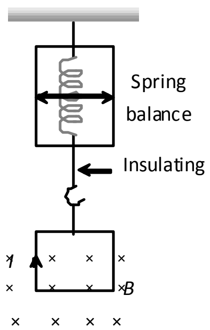
(D) Zero

(SPACE FOR ROUGH WORK)

17. Two wires *A* and *B* of same length, same area of cross-section having the same Young's modulus are heated to the same range of temperature. If the coefficient of linear expansion of *A* is 3/2 times of that of wire *B*. The ratio of the forces produced in two wires will be

(A) 2/3 (B) 9/4
(C) 4/9 (D) 3/2

18. A square loop of side a hangs from an insulating hanger of spring balance. The magnetic field of strength *B* occurs only at the lower edge. It carries a current *I*. Find the change in the reading of the spring balance if the direction of current is reversed

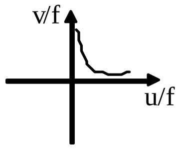


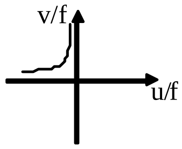
(A) *IaB* (B) 2 *IaB*
(C) $\frac{IaB}{2}$ (D) $\frac{3}{2}IaB$

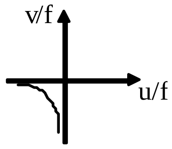
19. A wire of area of cross-section $10^{-6} m^2$ is increased in length by 0.1%. The tension produced is 1000 *N*. The Young's modulus of wire is

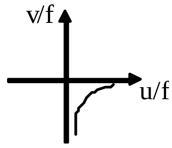
(A) $10^{12}\ N/m^2$ (B) $10^{11}\ N/m^2$
(C) $10^{10}\ N/m^2$ (D) $10^{9}\ N/m^2$

20. A virtual erect image by a diverging lens is represented by (u, v, f are coordinates)

(A)


(B)


(C)


(D)


(SPACE FOR ROUGH WORK)

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. On a planet a freely falling body takes 2 *sec* when it is dropped from a height of 8 *m*, the time period of simple pendulum of length 1 *m* on that planet is

2. Assuming that the mass of proton is nearly equal to mass of neutron the minimum kinetic energy in 10^1 eV of a neutron for inelastic head on collision with a ground state hydrogen atom at rest is -

3. The angle of contact between glass and water is 0° and it rises in a capillary upto 6 *cm* when its surface tension is 70 *dynes/cm*. Another liquid of surface tension 140 *dynes/cm*, angle of contact 60° and relative density 2 will rise in the same capillary by

4. The binding energy of an electron in ground state of He is equal to 24.6 eV. Then in 10^1 eV, energy required to remove both electrons is –

5. To break a wire of one meter length, minimum 40 *kg wt.* is required. Then the wire of the same material of double radius and 6 *m* length will require breaking weight

6. The mass defect for the nucleus of helium is 0.0302 amu. The binding energy per nucleon for helium in MeV is approximately

$$\left(1\text{ amu} = 930\frac{\text{MeV}}{c^2}\right)$$

7. A stone is projected from the ground with velocity 50 *m/s* at an angle of 30°. It crosses a wall after 3 *sec*. How far beyond the wall the stone will strike the ground $(g = 10\,m/sec^2)$

8. The half-value thickness of an absorber is defined as the thickness that will reduce exponentially the intensity of a beam of particles by a factor of 2. Calculate the half-value thickness in (μm) for lead assuming X-ray beam of wavelength 20 pm, μ = 50 cm^{-1} for X-rays in lead at wavelength λ = 20 pm.

(SPACE FOR ROUGH WORK)

9. Find the wavelength of K_α line (in picometer) in copper (Z = 29) if the wavelength of K_α = line in iron (Z = 26) is known to be equal to193 picometer.

10. A X-ray tube is operating at 12 kV and 5 mA. Calculate speed of electrons striking the target in 10^7 m/s.

(SPACE FOR ROUGH WORK)

PART - III[CHEMISTRY]

SECTION - A

[STRAIGHT OBJECTIVE TYPE]

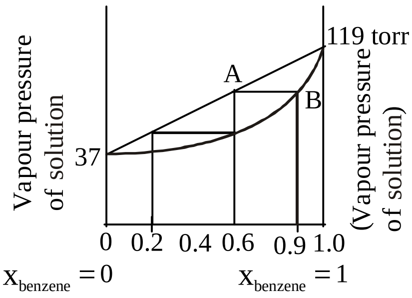
Q.1 to ***Q.20*** has four choices (A), (B), (C), (D) out of which ***ONLY ONE*** is correct

1. Which of the following phenomenon is used for purification of colloidal solution?
(A) Peptization
(B) Electrodialysis
(C) Coagulation
(D) Adsorption

2. If radius of ${}^{27}_{13}Al$ nucleus is taken to be 'x' then the radius of ${}^{125}_{53}Te$ nucleus will be :
(A) $\left(\frac{53}{13}\right)x$ (B) $\frac{5x}{3}$
(C) $\frac{13x}{53}$ (D) $\frac{3x}{5}$

3. Which of the following transition will produce light of visible spectrum of He^+?
(A) $2 \rightarrow 1$ (B) $3 \rightarrow 2$
(C) $4 \rightarrow 2$ (D) $8 \rightarrow 4$

4. For a solution of Benzene and Toluene choose the correct option from the following diagram:

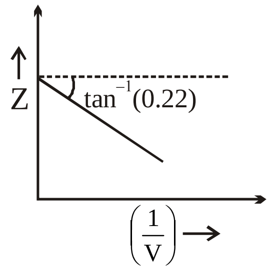


$x \rightarrow$ represents mole fraction in liquid state
$y \rightarrow$ represents mole fraction in vapour state
(A) At point A : $y_{benzene} = 0.6$
(B) At point B : $x_{toluene} = 0.1$
(C) At point A : $x_{toluene} = 0.4$
(D) At point B : $y_{benzene} = 0.1$

5. At 27ºC the reaction,
$C_6H_6(l) + \frac{15}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l)$
proceeds spontaneously because the magnitude of-
(A) $\Delta H = T\Delta S$
(B) $\Delta H > T\Delta S$
(C) $\Delta H < T\Delta S$
(D) $\Delta H > 0, T\Delta S < 0$

(SPACE FOR ROUGH WORK)

6. In certain low pressure region for 1 mol of real gas curve of Z v/s $\frac{1}{V}$ is plotted at constant temperature as follows -



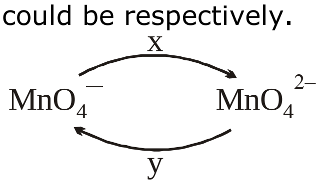
then temperature (T) of above mentioned real gas is -
[**Given :** a = 5.5 atmL^2/mol^2 , R = 0.08 atm-L/mol-K]
(A) 273.15 K (B) 300 K
(C) 312.5 K (D) 230.4 K

7. An ionic compound XY crystallises in ideal ZnS type structure. If the edge length of unit cell is 654 pm then **correct** statement about this compound is-
(A) It has BCC type unit cell.
(B) Zn^{2+} is present at body centre.
(C) Number of tetrahedral and octahedral voids are 4 and 8 respectively.
(D) Closest distance between X^+ and Y^- is 283.15 pm.

8. Select the **incorrect** match for the extraction process involved for the given metal ore.
(A) Cu_2S : Self reduction
(B) $CuCO_3.Cu(OH)_2$: Carbon Reduction
(C) $CuFeS_2$: Froth floatation
(D) FeS_2 : Self Reduction

9. A species 'X' can show reaction with both HCl and NaOH. 'X' cannot be :
(A) Al_2O_3 (B) Zn
(C) PbS (D) $ZnCO_3$

10. For the following conversion 'x' and 'y' could be respectively.



(A) H_2O_2/H^+ and H_2O_2/OH^-
(B) Heat and O_3/Δ
(C) H^+ and OH^-
(D) Cooling and Heating

11. Which of the following reactions is not feasible?
(A) $[Fe(en)_3]^{+3} + 6CN^- \rightarrow [Fe(CN)_6]^{3-} + 3\ en$
(B) $[Co(en)_3]^{+3} + EDTA^{4-} \rightarrow [Co(EDTA)]^{-1} + 3\ en$
(C) $[Cr(CO)_6] + 4NO \rightarrow [Cr(NO)_4] + 6CO$
(D) $[Fe(CO)_5] \xrightarrow{\text{Dimerisation}} [Fe_2(CO)_{10}]$

(SPACE FOR ROUGH WORK)

12. Find the number of nodal plane in HOMO of O_2 molecule.

(A) 0 (B) 1 (C) 2 (D) 3

13. Select the correct match for metals and its appropriate reducing agent used for its extraction from its common ore.

(A) Zn : CO

(B) Ag : Electrolytic reduction

(C) Al : Cr

(D) Sn : C

14. X_2 (Halogen) would not be produced in :

(A) Electrolysis of brine solution

(B) Reaction of NaCl with conc. H_2SO_4

(C) Reaction of NaBr with conc. H_2SO_4

(D) NaI and $NaIO_3$ mixed in dil.H_2SO_4

15. Which of the following is not a common component of DNA?

(A) Ribose (B) Phosphate

(C) Cytosine (D) Thymine

16. Identify sugar which doesn't give silver mirror test with Tollen's reagent ($AgNO_3$ + NH_4OH)?

(A) Fructose (B) Maltose

(C) Lactose (D) Sucrose

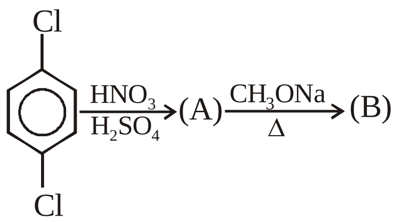
17. Which of the following is a proper name for$(CH_3)_2CHCH_2NHCH_2CH_2CH(CH_3)_2$?

(A) 2,7-dimethyl-4-azaoctane

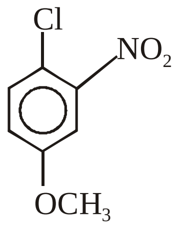
(B)3-methyl-N(2-methlypropyl)-1-butana-mine

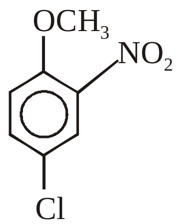
(C) 2,7-dimethylpropylbutylamine

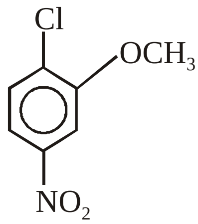
(D)3-amino-2,7-dimethyloctane

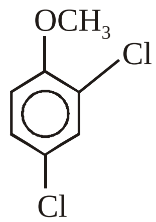
18. 

What is the final product(B) ?

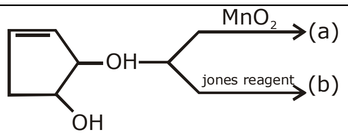
(A) 

(B) 

(C) 

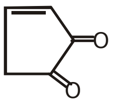
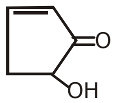
(D) 

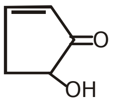
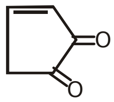
(SPACE FOR ROUGH WORK)

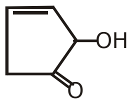
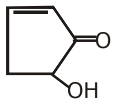
19. 

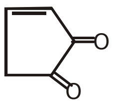
The compound (a) and (b) respectively are :

(a) (b)

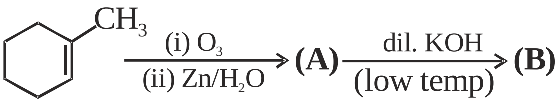
(A)  

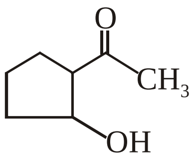
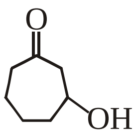
(B)  

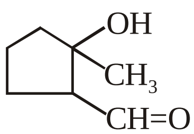
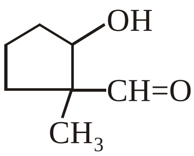
(C)  

(D) Both 

20. Find the major product of the given reaction.



(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. A sample of hard water has its hardness due to $MgSO_4$ only. When this water is passed through anion exchange resin, SO_4^{2-} ions are replaced by OH^-. 25 ml of hard water sample so treated require 20 ml of 10^{-3} M H_2SO_4. What is hardness of water expressed in term of ppm of $CaCO_3$?

2. Decomposition of a certain mass of $CaCO_3$ produce 112 dm^3 of $CO_2(g)$ at 1atm and 273 K. After decomposition, residue is dissolved in water to produce $Ca(OH)_2$, what mass of HCl is required to completely neutralise the base -

3. A crystal arrangement is formed such that it consists of A atoms forming cubic close packing and B occupy all the octahedral voids. Assuming no distortion, calculate packing efficiency of the crystal. ***Express answer in percentage.***

[**Use :** $[1 + (0.414)^3] = 1.07$, $\frac{\pi}{3\sqrt{2}} = 0.74$]

(SPACE FOR ROUGH WORK)

4. The boiling point of a solution of 0.512 gm of napthalene, $C_{10}H_8$, in 24 gm of chloroform is 0.5 °C higher than that of pure chloroform. The molal boiling point elevation constant of chloroform is **(in K-kg/mol)**

5. Consider the following orders –

(1) $F_2 > Cl_2 > Br_2 > I_2$: boiling point

(2) $F_2 > Cl_2 > Br_2 > I_2$: oxidizing nature

(3) $F_2 > Cl_2 > Br_2 > I_2$: EN

(4) $F_2 > Cl_2 > Br_2 > I_2$: BDE

(5) $F_2 > Cl_2 > Br_2 > I_2$: EA

(6) $F_2 > Cl_2 > Br_2 > I_2$: Reactivity

(7) $HOCl > HClO_2 > HClO_3 > HClO_4$: Acidic nature

(8) $HOCl > HClO_2 > HClO_3 > HClO_4$: Oxidizing nature

Then calculate $(x^2 + y^2)$ when x is correct order and y is incorrect order.

6. For oxy acid $HClO_x$ if x = y = z (x, y and z are natural number) then calculate the value of (x + y + z), Where

x = number of atoms

y = Total number of lone pairs at central atom

z = Total number of Pi(π) electrons in the oxy acid.

7. Consider I_2Cl_6 compound and calculate the value of $(x + y) \div z$

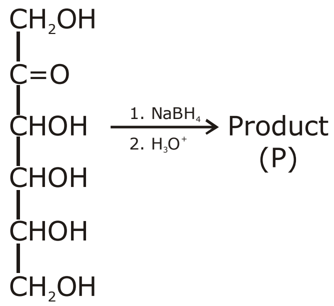
Where :

x = Total no. of ($2C - 2e^-$) bond

y = Total no. of ($3C - 2e^-$) bond

z = Total no. of ($3C - 4e^-$) bond

8.



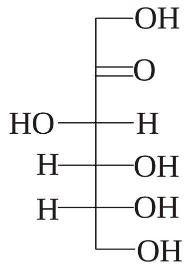
How many stereoisomer of product (P) is possible ?

9. Consider the following chain of amino acids.

Ala–Gly–Phe–Leu–Gly

The isoelectric point will be : (give your answer in nearest integer)

10. How many chiral carbon are present in D-fructose.



(SPACE FOR ROUGH WORK)

SAMPLE PAPER – JEE MAIN

FULL SYLLABUS TEST

PART - I [MATHEMATICS]

SECTION : A									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	A	C	C	C	B	B	A	B	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	A	D	B	A	C	D	C	C	B
SECTION : B									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2	1	8	20	115	8	0	54	128	4

PART - II [PHYSICS]

SECTION : A									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C	A	B	C	A	C	C	B	D	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	C	C	C	C	A	D	B	A	A
SECTION : B									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
3.14	20.4	3	79	160	7	86.6	139	154	6

PART - III [CHEMISTRY]

SECTION : A									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	B	D	C	B	C	D	D	C	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	C	D	B	A	D	B	B	B	A
SECTION : B									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
80	365	79	3	32	6	2	10	7	3

SECTION – A

1. **B**

$(p\to q)[(\sim p \to q)\to q]$

p	q	$\sim p$	$p\to q$	$\sim p\to q$	$\sim(p\to q)\to q$	$(p\to q)\to((\sim p\to q)\to q)$
T	F	F	F	T	F	T
T	T	F	T	T	T	T
F	F	T	T	F	T	T
F	T	T	T	T	T	T

$\therefore$ It is tautology

2. **A**

$|z - \sqrt{3} + i| = |(z + 2i) - (\sqrt{3} + i)|$

$\le |(z + 2i)| + |(\sqrt{3} + i)|$

$\le 1 + 2 = 3$

$\Rightarrow$ The greatest value of $|z-\sqrt{3} + i|$ is 3.

Again $|z - \sqrt{3} + i|$

$= |(z + 2i) - (\sqrt{3} + i)|$

$\ge |\sqrt{3} + i| - |z + 2i|$

$\ge 2 - 1 = 1$

Thus least value of $|z - \sqrt{3} + i|$ is 1.

3. **C**

$= \sqrt{4+\sqrt{8-\sqrt{32+16\sqrt{3}}}}$

$= \sqrt{4+\sqrt{8-\left(\sqrt{8}+\sqrt{24}\right)^2}}$

$= \sqrt{4+\sqrt{8}\times\sqrt{1-\cos\left(\frac{\pi}{12}\right)}}$

$= \sqrt{4+\sqrt{8}\times\sqrt{2}\sin\left(\frac{\pi}{24}\right)}$

$= 2\sqrt{1+\cos\left(\frac{\pi}{2}-\frac{\pi}{24}\right)}$

$= 2\sqrt{2\cos^2\left(\frac{11\pi}{48}\right)} \Rightarrow 2\sqrt{2}\cos\left(\frac{11\pi}{48}\right)$

$\Rightarrow a = 2,\ b = 48$

$\Rightarrow \frac{b}{a} = 24$

4. **C**

$P(E) = \frac{1}{2^{30}}\left[{}^{30}C_{15} + {}^{30}C_{16} + {}^{30}C_{17} + \ldots {}^{30}C_{30}\right] \ldots(1)$

$P(E) = \frac{1}{2^{30}}\left[{}^{30}C_{0} + {}^{30}C_{1} + {}^{30}C_{2} + \ldots + {}^{30}C_{15}\right] \ldots(2)$

(i) + (ii)

$2P(E) = \frac{1}{2^{30}}\left[{}^{30}C_{0} + {}^{30}C_{1} + \ldots + {}^{30}C_{15} + {}^{30}C_{16}\right.$

$\left. + \ldots + {}^{30}C_{30} + {}^{30}C_{15}\right]$

$= \frac{1}{2^{30}}\left[2^{30} + {}^{30}C_{15}\right] = 1 + \frac{{}^{30}C_{15}}{2^{30}}$

$P(E) = \frac{1}{2} + \frac{{}^{30}C_{15}}{2^{31}}$

5. **C**

$\int_{\frac{\pi}{24}}^{\frac{5\pi}{24}} \frac{\sqrt[3]{\cos 2x}\,dx}{\sqrt[3]{\sin 2x}+\sqrt[3]{\cos 2x}}$

Put $2x = 1$

$I = \frac{1}{2}\int_{\frac{\pi}{12}}^{\frac{5\pi}{12}} \frac{\sqrt[3]{\cos t}\,dt}{\sqrt[3]{\sin t}+\sqrt[3]{\cot t}} \qquad \ldots(1)$

Using $I = \int_a^b f(x)\,dx = \int_a^b f(a+b-x)\,dx$

$I = \frac{1}{2}\int_{\frac{\pi}{12}}^{\frac{5\pi}{12}} \frac{\sqrt[3]{\sin t}\,dt}{\sqrt[3]{\sin t}+\sqrt[3]{\cos t}} \qquad \ldots(2)$

$2I = \frac{1}{2}\left[\frac{\pi}{3}\right]$

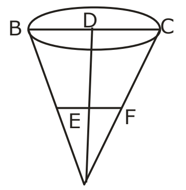
$\Rightarrow I = \frac{\pi}{12}$

6. **B**

Let EF = r and AE = h

$\Delta AEF - \Delta ADC$

$\therefore \frac{r}{5} = \frac{h}{10};\ r = \frac{h}{2}$



$V = \frac{1}{3}\pi r^2 h$; $V = \frac{1}{3}\pi \frac{h^3}{4}$

$\Rightarrow \frac{dv}{dt} = \frac{3\pi h^2}{12} \cdot \frac{dh}{dt}$

$\frac{3\pi}{2} = \frac{\pi}{4}(4)^2 \frac{dh}{dt} \left\{\frac{dv}{dt} = \frac{3\pi}{2} m^3 / \min\right\}$

$\frac{dh}{dt} = \frac{3}{8} m / \min$

7. **B**

$x - \frac{x^3}{6} < \sin x < x \ \forall \ x > 0$

$\Rightarrow f\left(x - \frac{x^3}{6}\right) > f(\sin x) > f(x)$

$\Rightarrow \frac{f\left(x - \frac{x^3}{6}\right)}{f(x)} < \frac{f(\sin x)}{f(x)} < 1$

$\Rightarrow \lim\limits_{x\to\infty} \frac{f\left(x - \frac{x^3}{6}\right)}{f(x)} < \lim\limits_{x\to\infty} \frac{f(\sin x)}{f(x)} < 1$

8. **A**

Median = $\frac{46+48}{2}$ = 47

So, $\sum|x_i - 47|$ = 86

$\therefore$ Mean deviation = $\frac{\sum|x_i - 47|}{10}$ = 8.6

9. **B**

$2y = 2\cos\left(x + \frac{\pi}{3}\right)\cos x - 2\cos^2\left(x + \frac{\pi}{6}\right)$

$= \cos\left(2x + \frac{\pi}{3}\right) + \cos\frac{\pi}{3}$

$- \left(1 + \cos\left(2x + \frac{\pi}{3}\right)\right)$

$= \cos\frac{\pi}{3} - 1 = \frac{1}{2} - 1 = \frac{-1}{2}$

$\Rightarrow y = -\frac{1}{4}$

10. **B**

$T_4 = {}^5C_3 \left(\frac{1}{x}\right)^2 (x \tan x)^3 = 10x \tan^3 x$

and $T_2 = {}^5C_1 \left(\frac{1}{4}\right)^4 (x \tan x) = \frac{5\tan x}{x^3}$

Now $\frac{T_4}{T_2} = \frac{2}{27}\pi^4 \Rightarrow 2x^4 \tan^2 x = \frac{2\pi^4}{27}$

$\Rightarrow x^2 \tan x = \pm \frac{1}{3\sqrt{3}}\pi^2$

i.e. only $-\frac{\pi}{3}$ satisfies.

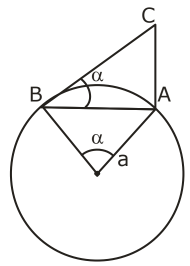
11. **B**

$\sum_{n=1}^{\infty} \tan^{-1}\left(\frac{3}{n^2+n-1}\right)$

$= \sum_{n=1}^{\infty} \tan^{-1} \frac{(n+2)-(n-1)}{1+(n-1)(n+2)}$

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

12. **A**



AB = 2a sin $\frac{\alpha}{2}$

In ΔABC, tan $\alpha = \frac{AC}{AB}$

$\therefore$ Ac 2a sin $\frac{\alpha}{2}$ tan α

13. **D**

Let the direction ratio's of the line be (a, b ,c). Then

$\therefore$ 2a – b + c = 0 .....(1)

a – b – 2c = 0 .....(2)

Solving (1) and (2), we get $\frac{a}{3} = \frac{b}{5} = \frac{c}{-1}$

Thus, the direction rations of the line are (3, 5, –1).

Any point on the line L is

$(2 + \lambda, 2 - \lambda, 3 - 2\lambda)$.

It ies on the plane P if

$2(2 + \lambda) - (2 - \lambda) + (3 - 2\lambda) = 4$

$\Rightarrow \lambda = -1$

So, the point of intersection of the line and the plane is (1, 3, 5).

Hence, the equation of the required line is:

$$\frac{x-1}{3} = \frac{y-3}{5} = \frac{z-5}{-1}$$

14. B

Angle between vectors

$\vec{v}_1 = x^2\hat{i} - 4\hat{j} + (3m+1)\hat{k}$ and $\vec{v}_2 = m\hat{i} - x\hat{j} + \hat{k}$

is acute.

$\vec{V_1}.\vec{V_2} > 0K\forall x \in R$

$\therefore mx^2 + 4x + (3m+1)0\forall x \in R$

$\therefore mx^2 + 4x + (3m + 1) > 0 \ \forall x \in R$

$\therefore m > 0$ and $D < 0$

$\therefore$ Now, $D < 0$

$\Rightarrow 16 - 3m^2 - m < 0$

$\Rightarrow 4 - 3m^2 - m < 0$

$\Rightarrow (m - 1)(3m + 4) > 0$

$\Rightarrow m > 1$ (As $m > 0$)

Hence, the least integral value of m is 2.

15. A

$$\det\left(A^2 - I_3\right) = \det\left(A^2 - AA^T\right) = \det\left(A\left(A - A^T\right)\right)$$

$$= \det\left(A - A^T\right)\det(A)$$

Further $\det(A) = \pm 1$, and matrix $A - A^T$ is a skew symmetric matrix with odd order hence its determinant is 0.

16. C

$$\left(1 - \frac{r_1}{r_2}\right)\left(1 - \frac{r_1}{r_3}\right) = 2$$

$$\Rightarrow \left(1 - \frac{s-b}{s-a}\right)\left(1 - \frac{s-c}{s-a}\right) = 2$$

$$\left(\because r_1 = \frac{\Delta}{s-a} \text{ etc.}\right)$$

$\Rightarrow (b - a)(c - a) = 2(s - a)^2$

$\Rightarrow$ *$a^2 = b^2 + c^2$ on simplification*

17. D

Let α_1, β_1 be the roots of $x^2 + ax + b = 0$ and α_2, β_2, be the roots of $x^2 + cx + d = 0$

$\Rightarrow \alpha_1 + \beta_1 = -a$, $\alpha_1\beta_1 = b$, $\alpha_2 + \beta_2 = -c$, $\alpha_2\beta_2 = d$

Then given that $\frac{\alpha_1}{\beta_1} = \frac{\alpha_2}{\beta_2}$

$$\Rightarrow \frac{\alpha_1 + \beta_1}{\alpha_1 - \beta_1} = \frac{\alpha_2 + \beta_2}{\alpha_2 - \beta_2}$$

$$\Rightarrow \frac{(\alpha_1 + \beta_1)^2}{(\alpha_1 - \beta_1)^2} = \frac{(\alpha_2 + \beta_2)^2}{(\alpha_2 - \beta_2)^2} \Rightarrow \frac{a^2}{a^2 - 4b} = \frac{c^2}{c^2 - 4d}$$

$\Rightarrow$ *$a^2d = bc^2$*

18. C

The given straight line passes through (2, 0) and it is perpendicular to $x + 2y + 5 = 0$ so that its slope is 2.

Hence the equation of the staight line is

$y = 2(x - 2)$

i.e., $y - 2x + 4 = 0$

19. C

The given differential equation is

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

i.e., $\frac{dp}{dx}(x^2 + 1) = 2xp$ where $p = \frac{dy}{dx}$

$\therefore \log p = \log(x^2 + 1) + \log c$ on integration

$p = 3$ when $x = 0$

$\therefore \log 3 = \log c \Rightarrow c = 3$

$\therefore p = 3(x^2 + 1) \Rightarrow \frac{dy}{dx} = 3(x^2 + 1)$

Integrating again $y = x^3 + 3x + k$

and $x = 0$, $y = 1 \Rightarrow k = 1$

Hence the required eqaution is

$y = x^3 + 3x + 1$.

20. B

Let $I = \int_0^1 \frac{dx}{(5+2x-2x^2)(1+e^{2-4x})}$ ....(1)

Then $I = \int_0^1 \frac{dx}{[5+2(1-x)-2(1-x)^2][1+e^{2-4(1-x)}]}$

or $I = \int_0^1 \frac{dx}{(5+2x-2x^2)(1+e^{-(2-4x)})}$

$= \int_0^1 \frac{e^{2-4x}}{(5+2x-2x^2)(e^{2-4x}+1)}$

(1) + (2)

$\Rightarrow 2I = \int_0^1 \frac{dx}{5+2x-2x^2} = -\frac{1}{2}\int_0^1 \frac{dx}{x^2-x-\frac{5}{2}}$

$= -\frac{1}{2}\int_0^1 \frac{dx}{\left(x-\frac{1}{2}\right)^2-\left(\frac{\sqrt{11}}{2}\right)^2}$

$= \therefore I = \frac{1}{2\sqrt{11}}\log\left(\frac{\sqrt{11}+1}{\sqrt{11}-1}\right)$

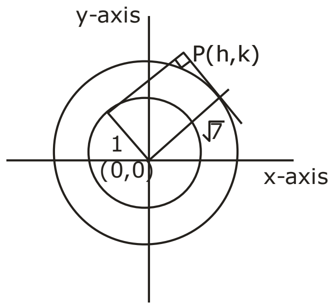
SECTION – B

1. 2

$h^2 + k^2 = 1 + 7$

$\therefore$ Locus of the point P is $x^2 + y^2 = 8$

This is the director circle of circle $x^2 + y^2 = 4$



$\therefore x^2 + y^2 = 8$ is director circle of a circle with radius = 2.

2. 1

$L_1 = \lim_{x\to 0^-} (\cos x - \sin x)^{\text{cosec } x} = e^{\ell}$

$\ell = \lim_{x\to 0^-}\left(\frac{\cos x - \sin x - 1}{\sin x}\right)$

$= \lim_{x\to 0^-}\left(\frac{1-2\sin^2\frac{x}{2}-2\sin\frac{x}{2}.\cos\frac{x}{2}-1}{2\sin\frac{x}{2}.\cos\frac{x}{2}}\right)$

$= -\lim_{x\to 0^-}\left(\frac{\sin\frac{x}{2}+\cos\frac{x}{2}}{\cos\frac{x}{2}}\right) = -1$

$\Rightarrow L_1 = e^{-1}$ $\therefore$ a = 1/e (as function is continuous)

$L_2 = \lim_{x\to 0^+}\frac{e^{1/x}+e^{2/x}+e^{3/x}}{a\cdot e^{2/x}+b\cdot e^{3/x}}$

Divided N^r & D^r by $e^{3/x}$

$= \lim_{x\to 0^+}\frac{e^{-2/x}+e^{-1/x}+1}{a\cdot e^{-1/x}+b} = \frac{1}{b}$

$\Rightarrow L_2 = \frac{1}{b}$ $\therefore$ a.b = 1

3. 8

$I = \int \frac{(f'g-g'f)/g^2}{(f/g+1)\sqrt{f/g-1}}\,dx$

Let f/g = t $\Rightarrow \frac{f'g-g'f}{g^2}\,dx = dt$

$= \int \frac{dt}{(t+1)\sqrt{t-1}}$

Let $t - 1 = z^2 \Rightarrow dt = 2zdz$

$= \int \frac{2zdz}{(z^2+2)z} = 2\int\frac{dz}{z^2+2}$

$= \sqrt{2}\tan^{-1}\frac{z}{\sqrt{2}} + c$

$= \sqrt{2}\tan^{-1}\sqrt{\frac{f-g}{2g}} + c$

4. 20

a = $\perp^r$ distance from (3, 4) to the tangent at vertex

$= \left|\frac{3+4-7-5\sqrt{2}}{\sqrt{2}}\right|$

a = 5

LR = 4a = 20

5. 115

$t_r = \frac{1+2+3+.....+r}{r} = \frac{r+1}{2}$

$\therefore \sum_{r=1}^{20} t_r = \frac{1}{2}\left\{20+\frac{20\times 21}{2}\right\} = 115$

6. **8**

$f(x + y + 1) = f(x).\ f(y)$

Put $x = y = 0$

$\therefore f(1) = \{f(0)\}^2 = 2^2$

Put $x = 1, y = 0$

$\therefore f(2) = f(1).\ f(0) = 2^3$

,,

$f(n) = 2^{n+1}$

$\therefore$ the required sum $= 2^2 + 2^3 + 2^4 ...+ 2^{n+1}$

$= 2^2 (1 + 2 + 2^2 + ...+ 2^{n-1})$

$= 2^2 (2^n-1) = 2^{n+2} - 4 = 1020$

$\Rightarrow 2^{n+2} = 1024 = 2^{10} \Rightarrow n = 8$

7. **0**

The given determinant

$$\begin{vmatrix} \tan^2\frac{\pi}{7} & -\operatorname{cosec}^2\frac{5\pi}{14} - \tan^2\frac{\pi}{7} + \sin\frac{3\pi}{2} & \sin\frac{3\pi}{2} \\ \operatorname{cosec}^2\frac{5\pi}{14} & \cos\pi + \operatorname{cosec}^2\frac{5\pi}{14} - \tan^2\frac{\pi}{7} & -\tan^2\frac{\pi}{7} \\ \tan\frac{\pi}{4} & -\tan^2\frac{\pi}{7} - \tan\frac{\pi}{4} + \operatorname{cosec}^2\frac{5\pi}{14} & \operatorname{cosec}^2\frac{5\pi}{14} \end{vmatrix}$$

$(C_2 \to C_2 - C_1 + C_3)$

$$\begin{vmatrix} \tan^2\frac{\pi}{7} & 0 & \sin\frac{3\pi}{2} \\ -\operatorname{cosec}^2\frac{5\pi}{14} & 0 & -\tan^2\frac{\pi}{7} \\ \tan\frac{\pi}{4} & 0 & \operatorname{cosec}^2\frac{5\pi}{14} \end{vmatrix}$$

$\left(\because \operatorname{cosec}^2\frac{5\pi}{14} = \operatorname{cosec}^2\left(\frac{\pi}{2} - \frac{\pi}{7}\right) = \sec^2\frac{\pi}{7} = 1 + \tan^2\frac{\pi}{7}\right) = 0$

8. **54**

For a five digit number to be divisible by 12, it must be divisible by 3 and 4. For the number to be divisible by 3, the sum of the digits should be a multiple of 3.

Case : I

Let one of the digits be 0. Then the other digits should be only 1,2,4,5. So for the number to be divisible by 4 the last two digits should be as follows.

40, 04, 12, 20, 24, 52.

Hence in this case the number of required numbers $= 3\underline{|3} + 3(2 \times 2 \times 1)$

$= 18 + 12 = 30$

case: II

Suppose 0 is not a digit. Then the digits should be 1,2,3,4,5. The sum of all these digits is a multiple of 3.

In this cas the last two digits must be 12 or 24 or 32 or 52.

Hnece the required number - $4\underline{|3} = 24$.

$\therefore$ *total number = 30 + 24 = 54.*

9. **128**

$(1 + 2x - x^2)^7 = 1 + a_1x + a_2x^2 + ...+ a_{14}x^{14}$

Put $x = 1$, $2^7 = 1 + a_1 + a_2 + ...+ a_{14}$

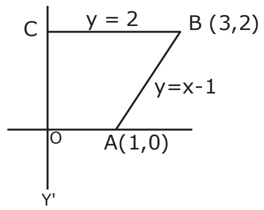
Put $x = -1$, $-2^7 = 1 - a_1 + a_2 - a_3 + ... + a_{14}$

Hence subtracting

$2.2^7 = 2(a_1+a_3+....+a_{13})$

$\Rightarrow a_1 + a_3 + ... + a_{13} = 2^7 = 128.$

10. **4**



$y = \left[\frac{x^2}{64} + 2\right] = 2$ when $x < 8$ and the line $y = 2$ cuts $y = x - 1$ in $(3, 2)$.

$\therefore$ the required area = area ofthe trapezium

$OABC = \frac{1}{2}(OA + CB)OC$

$= \frac{1}{2}(1 + 3)2$ *= 4 sq. units*

SECTION – A

1. **C**

Equation of trajectory for oblique projectile motion

$$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$$

Substituting $x = D$ and $u = v_0$

$$h = D\tan\theta - \frac{gD^2}{2u_0^2\cos^2\theta}.$$

2. **A**

When key is open, charge in steady state will be $q_1 = CE$.

When key is closed, potential difference across capacitor will be $V = \frac{2R}{R+2R}E = \frac{2}{3}R$

Charge in steady state will be $q_2 = \frac{2}{3}CE$

$$\Rightarrow \frac{q_1}{q_2} = \frac{3}{2}.$$

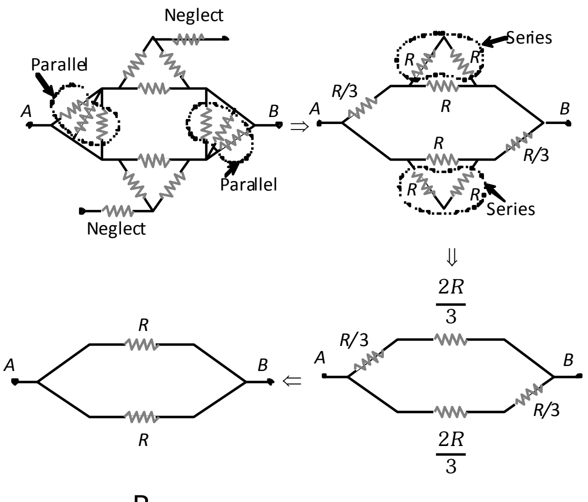
3. **B**

Change in momentum

$= 2mv\sin\theta = 2mv\sin\frac{\pi}{4} = \sqrt{2}\ mv$

4. **C**

Given circuit can be redrawn as follows



$$\Rightarrow R_{eq} = \frac{R}{2}$$

5. **A**

$$T = \frac{2m_1m_2}{(m_1+m_2)}(g+a) = \frac{2m_1m_2(g+g)}{m_1+m_2}$$

$$\Rightarrow T = \frac{4m_1m_2}{m_1+m_2}g = \frac{4w_1w_2}{w_1+w_2}$$

6. **C**

For figure (i) $i_1 = 7A$

For figure (ii) $i_2 = 4+3 = 7A$

For figure (iii) $i_3 = 5+2 = 7A$

For figure (iv) $i_4 = 6-1 = 5A$

7. **C**

$$v = \sqrt{\mu\ g\ r} = \sqrt{0.8\times 9.8\times 15} = 10.84\ m/s$$

8. **B**

$$\frac{r_1}{r_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$$

From linear momentum conservation $\left[\frac{A_1}{A_2}\right] = \frac{V_2}{V_1}$

$A\times 0 = A_1V_1 + A_2V_2$

$$\Rightarrow \frac{r_1}{r_2} = \left(\frac{V_2}{V_1}\right)^{1/3} = \left(\frac{1}{2}\right)^{1/3}$$

9. **D**

Work done

$$= F\times s = ma\times\frac{1}{2}at^2\left[\text{from } s = ut + \frac{1}{2}at^2\right]$$

$$\therefore W = \frac{1}{2}ma^2t^2 = \frac{1}{2}m\left(\frac{v}{t_1}\right)^2 t^2 \quad \left[\text{As } a = \frac{v}{t_1}\right]$$

10. **D**

Let the resistance of the lamp filament be *R*. Then $100 = \frac{(220)^2}{R}$. When then voltage drops, expected power is $P = \frac{(220\times 0.9)^2}{R'}$.

Here *R′* will be less than *R*, because now the rise in temperature will be less. Therefore *P* is more than

$$\frac{(220\times 0.9)^2}{R} = 81W$$

But it will not be 90% of earlier value, because fall in temperature is small. Hence (d) is correct.

11. **C**

Kinetic energy $k = \frac{1}{2}mv^2 \Rightarrow k \propto v^2$

It means the graph between the speed and kinetic energy will parabola

12. **C**

If resistance does not vary with temperature *P* consumed

$= \left(\frac{V_A}{V_R}\right)^2 \times P_R = \left(\frac{110}{220}\right)^2 \times 100 = 25W$. But in second cases resistance decreases so consumed power will be more than 25 *W*

13. **C**

Friction is a non-conservative external force to the system, it decreases momentum and kinetic energy both.

14. **C**

Magnetic field at *O* due to bigger coil *Y*, is

$$B_Y = \frac{\mu_0}{4\pi}\cdot\frac{2\pi i(2r)^2}{\{d^2+(2r)^2\}^{3/2}} = \frac{\mu_0}{4\pi}\cdot\frac{8\pi ir^2}{(d^2+4r^2)^{3/2}}$$

Magnetic field at *O* due to smaller coil *X* is

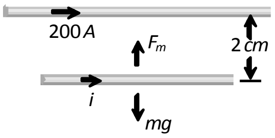
$$B_X = \frac{\mu_0}{4\pi}\cdot\frac{2\pi ir^2}{\left\{\left(\frac{d}{2}\right)^2+r^2\right\}^{3/2}} = \frac{\mu_0}{4\pi}\cdot\frac{16\pi ir^2}{(d^2+4r^2)^{3/2}}$$

$\Rightarrow \frac{B_Y}{B_X} = \frac{1}{2}$

15. **C**

For floating the second wire

$\left|\text{Down ward weight of second wire}\right| = \left|\text{Magnetic force on it}\right|$



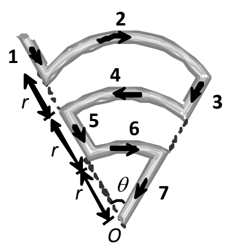
$$\Rightarrow mg = \frac{\mu_0}{4\pi}\cdot\frac{2i_1i_2}{a}\times l$$

$$\Rightarrow \left(\frac{m}{l}\right)g = \frac{\mu_0}{4\pi}\cdot\frac{2i_1i_2}{a}$$

$$\Rightarrow 10^{-2}\times 9.8 = 10^{-7}\times\frac{2\times 200\times i}{2\times 10^{-2}} \Rightarrow i = 49A$$

(Direction of current is same to first wire)

16. **A**



$B_1 = B_3 = B_5 = 0$

$B_2 = \frac{\mu_0}{4\pi}\cdot\frac{\theta i}{3r}\otimes$, $B_4 = \frac{\mu_0}{4\pi}\cdot\frac{\theta i}{2r}\odot$

and $B_6 = \frac{\mu_0}{4\pi}\cdot\frac{\theta i}{r}\otimes$

$\therefore$ Net magnetic field at *O*,

$$B_{net} = B_2 - B_4 + B_6 = \frac{\mu_0}{4\pi}\cdot\frac{\theta i}{r}\left(\frac{1}{3}-\frac{1}{2}+1\right) = \frac{5\mu_0\theta i}{24\pi r}$$

17. **D**

$F = YA\alpha\Delta\theta$

If *Y*, *A* and $\Delta\theta$ are constant then

$\frac{F_A}{F_B} = \frac{\alpha_A}{\alpha_B} = \frac{3}{2}$

18. **B**

Initially $F_1 = mg + IaB$ (down wards)

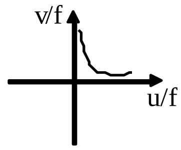
when the direction of current is reversed

$F_2 = mg - IaB$ (down wards) $\Rightarrow \Delta F = 2IaB$

19. **A**

$Y = \frac{FL}{Al} = \frac{1000\times 100}{10^{-6}\times 0.1} = 10^{12}N/m^2$

20 **A**



SECTION - B

1 **3.14**

On a planet, if a body dropped initial velocity (*u* = 0) from a height *h* and takes time *t* to reach the ground then

$h = \frac{1}{2}g_Pt^2 \Rightarrow g_P = \frac{2h}{t^2} = \frac{2\times 8}{4} = 4m/s^2$

Using $T = 2\pi\sqrt{\frac{l}{g}}$

$\Rightarrow T = 2\pi\sqrt{\frac{1}{4}} = \pi = 3.14$ *sec.*

2 **20.4**

Let V = speed of neutron before collision

V_1 = speed of neutron after collision

V_2 = speed of hydrogen atom after collision

ΔE = energy of excitation

from conservation of momentum

$mV = mV_1 + mV_2$ ...(1)

from conservation of energy

$\frac{1}{2}mV^2 = \frac{1}{2}mV_1^2 + \frac{1}{2}mV_2^2 + \Delta E$ ...(2)

from (1) and (2)

$2V_1V_2 = \frac{2\Delta E}{m}$

$\therefore (V_1 - V_2)^2 = (V_1 + V_2)^2 - 4V_1V_2$

$= V^2 - \frac{4\Delta E}{m}$

As $V_1 - V_2$ must be real

$\therefore V^2 - 4\dfrac{\Delta E}{m} \geq 0$

$\therefore \dfrac{1}{2}mV^2 \geq 2\Delta E$

$\therefore \dfrac{1}{2}mV_{min}^2 = 2 \times 10.2 = 20.4$ eV

3. **3**

$h = \dfrac{2T\cos\theta}{rdg} \quad \therefore \dfrac{h_2}{h_1} = \dfrac{T_2}{T_1} \times \dfrac{\cos\theta_2}{\cos\theta_1} \times \dfrac{d_1}{d_2} \times \dfrac{r_1}{r_2}$

$\dfrac{h_2}{h_1} = \dfrac{140}{70} \times \dfrac{\cos 60^\circ}{\cos 0^\circ} \times \dfrac{1}{2} \times 1 = \dfrac{1}{2} \Rightarrow h_2 = \dfrac{h_1}{2}$

$= 3\text{cm}$

4 **79**

When one electron is removed, the remaining atom is hydrogen like atom whose energy in first orbit is

$E_1 = -(2)^2 (13.6 \text{ eV}) = -54.4$ eV

$\therefore$ to remove both electrons energy required is

$(24.6 + 54.4)$ eV $= 79$ eV

5. **160**

Breaking force = Breaking stress × Area of cross
section of wire

$\therefore$ Breaking force $\propto r^2$ (Breaking distance is constant)

If radius becomes doubled then breaking force will become 4 times

i.e. 40 × 4 = 160 *kg wt*

6 **7**

B.E. = Δmc^2

$= 0.0302 \times 930$

B.E. = 28.086

$\dfrac{B.E.}{\Delta} = \dfrac{28.086}{4} = 7\text{MeV}$

7 **86.6**

Total time of flight

$= \dfrac{2u\sin\theta}{g} = \dfrac{2 \times 50 \times 1}{2 \times 10} = 5\,s$

Time to cross the wall = 3 *sec* (given)

Time in air after crossing the wall

= (5 – 3) = 2 *sec*

$\therefore$ Distance travelled beyond the wall $= (u\cos\theta)t$

$= 50 \times \dfrac{\sqrt{3}}{2} \times 2 = 86.6\,m$

8 **0139**

$I = I_0 e^{-\mu x}$

$\dfrac{I_0}{2} = I_0 e^{-\mu x}$

$\mu x = \ell n\, 2$

$x = \dfrac{\ell n\, 2}{\mu} = \dfrac{0.693}{50} = 0.01386$ cm

$= 138.6\ \mu m\ 139\ \mu m$

9 **0154**

By Mosely law $\dfrac{1}{\lambda} \propto (Z - 1)^2$

$\dfrac{\lambda_2}{193} = \dfrac{(26-1)^2}{(29-1)^2}$

$\lambda_2 = \dfrac{193 \times 25^2}{28^2}$

$\lambda_2 = 153.8$ pm $\simeq$ 154 pm

10 **6**

$v = \sqrt{\dfrac{2eV}{m}}$

SECTION - A

1. **B**
Theory based

2. **B**
$r_{nuc.} = r_0 \cdot A^{1/3}$
$\frac{x}{r_{Te}} = \left(\frac{27}{125}\right)^{1/3} \Rightarrow r_{Te} = \frac{5.x}{3}$

3. **D**
Theory based

4. **C**
Theory based

5. **B**
Reaction is exothermic $\therefore \Delta H = -ve$
$\Delta G = \Delta H - T\Delta S$
Since process is spontaneous
$\Delta G = -$ ve
This is possible only if magnitude of
$\Delta H > T\Delta S$

6. **C**
$\left(P + \frac{a}{V^2}\right)(V) = RT$

$PV + \frac{a}{V} = RT$

$Z = 1 - \frac{a}{VRT}$

Slope $= \frac{a}{RT} = 0.22$

$\frac{5.5}{0.08T} = 0.22$

$T = \frac{5.5}{0.08 \times 0.22}$
$= 312.5$ K **Ans.**

7. **D**
$(r_{x^+} + r_{y^-}) = \frac{\sqrt{3}a}{4} = \frac{\sqrt{3}}{4} \times 654 = 283.15$

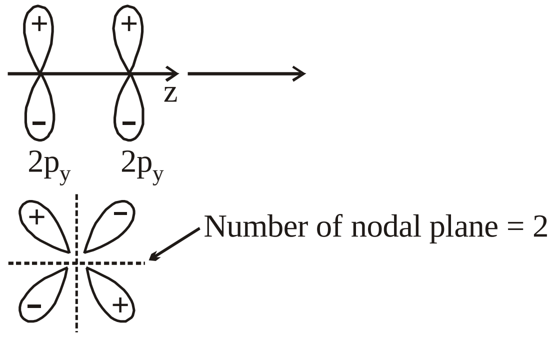
8. **D**
Self reduction is done for sulphide ores. FeS_2 is not suphide ore. so carbon reduction is done for FeS_2. Self reduction is done for Pb, Hg and Cu.

9. **C**
PbS + HCl (aq.) $\longrightarrow$ no reaction
PbS + NaOH $\longrightarrow$ no reaction

10. **B**
$MnO_4^- \xrightarrow[\text{Heat}]{\Delta} MnO_4^{2-}$
$\boxed{x=heat}$
$MnO_4^{2-} \xrightarrow{O_3/\Delta} MnO_4^-$
$(y = O_3/\Delta)$

11. **D**
$[Fe(CO)_5] \xrightarrow{\text{Dimerisation}} \times$
EAN = 26 – 0 + 5 × 2 = 36

12. **C**
HOMO of O_2 is π^*_{2p}

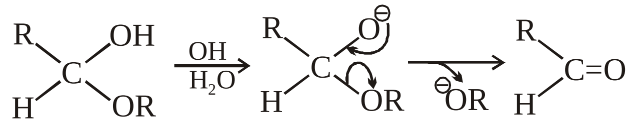


13. **D**
Sn (Main ore $\xrightarrow{\text{tinstone}}$ SnO_2)
$SnO_2 \xrightarrow{\text{roasting}} \underbrace{SnO_2 + CuSO_4 + FeSO_4}$
$\downarrow H_2O$
$SnO_2 \downarrow$
$FeSO_4 + CuSO_4$ (Soluble)
$\underset{\substack{\text{(Black tin)} \\ (60-70\%\text{pure})}}{SnO_2} \xrightarrow[]{\substack{\text{Anthracite coal} \\ >1000°C}} \underset{\text{(Impure)}}{Sn} + CO \uparrow$

14. **B**
$2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + HCl$

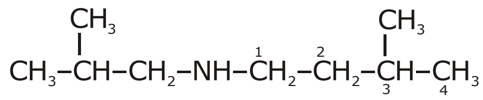
15. **A**
DNA : 2-Deoxyribosenucleic acid

16. **D**
Since sucrose doesn't have Hemiacetal linkage present. So it is not reducing sugar . Maltose and Lactose, all have hemiacetal link. So, they are reduced.



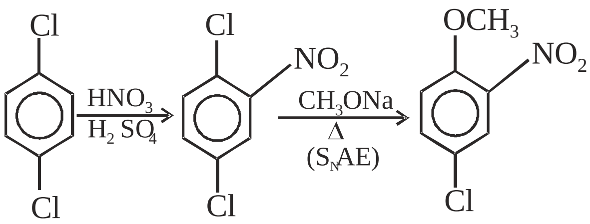
(Hemiacetal) (Aldehyde)

17. **B**



3-methyl-N-(2-methylpropyl)-1-butanamine

18. **B**

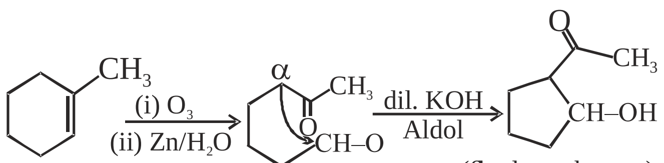


(A) **(B)**

19. **B**

MnO_2 selectively oxidises allyilic or benzylic hydroxyl group to (C = O) group, whereas Jones reagent oxidises 1° and 2° ROH to aldehydes and ketones respectively.

20. **A**



(β-hydroxy ketone)

Reactivity(Aldehyde > Ketone)

SECTION – B

1. **80**

$H_2SO_4 + 2OH^- \rightarrow SO_4^{2-} + 2H_2O$

$\therefore$ In 25 ml treated water,

$n_{OH^-} = 20 \times 10^{-3} \times 2$ mmol

$\therefore\ n_{MgSO_4} = \frac{n_{OH^-}}{2} = 20 \times 10^{-3}$ mmol

$\therefore$ In 1L $n_{MgSO_4} = \frac{20\times10^{-3}}{25} \times 1000$ mmol

$\frac{4}{5}$ = mmol

$\therefore$ In 1L hard water, equivalent n_{CaCO_3}

$= \frac{4}{5}$ mmol

$\therefore\ m_{CaCO_3} = \frac{4}{5}\times 100\text{mg} = 80$ mg

i.e. Hardness of water = 80 mg/L = 80 ppm

2. **365**

$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)$

$\frac{112}{22.4} = n_{CO_2}$

moles 0.5 0.5

$CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(aq)$

0.5

\- 0.5

$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

0.5

Required moles of HCl = 1

Required mass of HCl = 1 × 365 = 365 g

3. **79**

Packing efficiency (in %)

$$= \frac{4\times\frac{4}{3}\pi r^3 + 4\times\frac{4}{3}\pi(0.414r)^3}{a^3}\times 100 \ ;$$

$$= \frac{4\times\frac{4}{3}\pi r^3 + [1+(0.414r)^3]}{(2\sqrt{2})^3 r^3}\times 100$$

$$= \frac{\pi}{3\sqrt{2}}\times 1.07\times 100$$

= 0.74 × 1.07 × 100

= 79%

4. **3**

$\Delta T_b = K_b \times m$

$$0.5 = K_b\ \frac{\frac{0.512}{128}}{24}\times 1000$$

$K_b = 3$

5. **32**

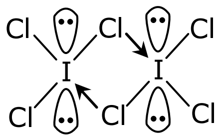
x = 4, y = 4

$(4^2 + 4^2) = 32$

6. **6**

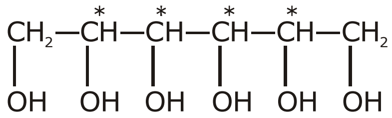
$HClO_2$, x = y = z = 2, x + y + z = 6

7. **2**



x = 4, y = 0, z = 2

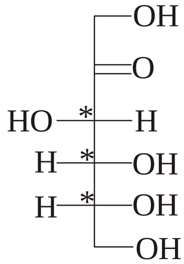
8. **10**



9. **7**

It is close to 7 because the component amino acid residues – Ala, Gly, Phe and Leu all are neutral amino acids.

10. **3**



Tetravalent carbon have 4 different valencies is known chiral carbon.