Paper-18-03-2021-Morning Shift

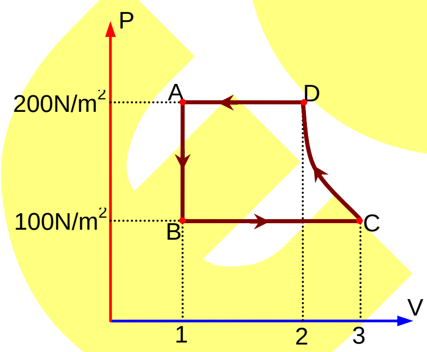
PHYSICS

SECTION – A

Q1. An oil drop of radius 2 mm with a density $3 gcm^{-3}$ is held stationary under a constant electric field $3.55\times10^{5} Vm^{-1}$ in the Millikan's oil drop experiment. What is the number of excess electrons that the oil drop will possess? Consider $g = 9.81 m/s^2$.

(A) 1.73×10^{10} (2) 48.8×10^{11}
(C) 1.73×10^{12} (3) 17.3×10^{10}

Q2. The P-V diagram of a diatomic ideal gas system going under cyclic process as shown in figure. The work done during an adiabatic process CD is (use $\gamma = 14$):



(A) -500J (B) 400J
(C) -400J (D) 200J

Q3. In Young's double slit arrangement, slits are separated by a gap of 0.5 mm, and the screen is placed at a distance of 0.5 m from them. The distance between the first and the third bright fringe formed when the slits are illuminated by a monochromatic light of $5890\overset{0}{A}$ is :

(A) $1178\times10^{-6}m$ (B) $1178\times10^{-12}m$
(C) $1178\times10^{-9}m$ (B) $5890\times10^{-7}m$

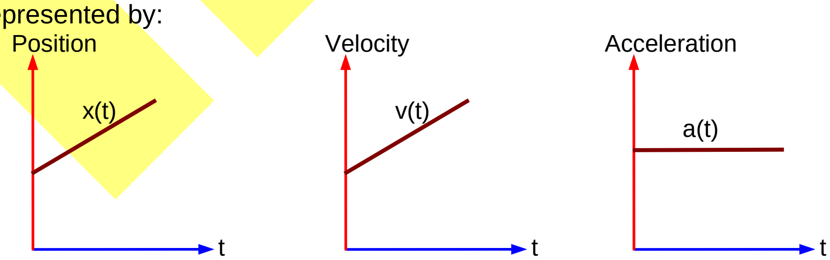
Q4. **Match List – I with List – II.**

List – I	List – II
(A) 10 km height over earth's surface	(i) Thermosphere
(B) 70 km height over earth's surface	(ii) Mesosphere
(C) 180 km height over earth's surface	(iii) Stratosphere
(D) 270 km height over earth's surface	(iv) Troposphere

(A) $(a)-(ii),(b)-(i),(c)-(iv),(d)-(iii)$ (B) $(a)-(iv),(b)-(iii),(c)-(ii),(d)-(i)$
(C) $(a)-(iii),(b)-(ii),(c)-(i),(d)-(iv)$ (D) $(a)-(i),(b)-(iv),(c)-(iii),(d)-(ii)$

Q5. The position, velocity and acceleration of a particle moving with a constant acceleration can be represented by:

(A)



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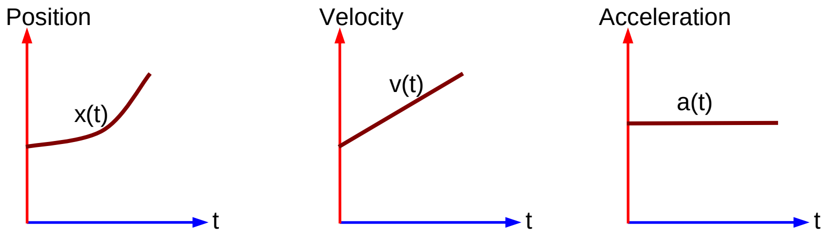

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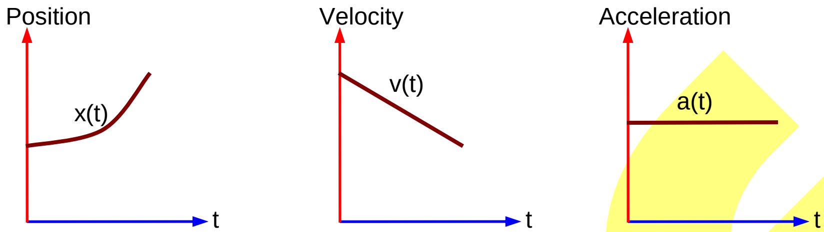

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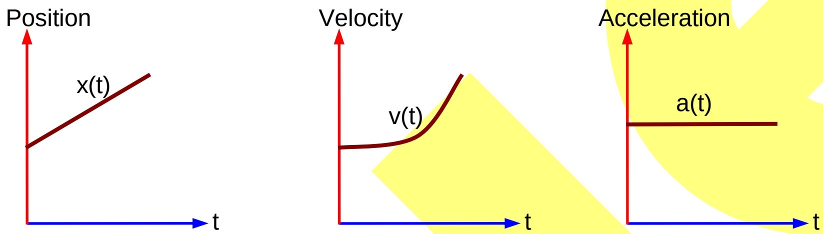


Q6. In the experiment of Ohm's law, a potential difference of 5.0V is applied across the end of a conductor of length 10.0 cm and diameter of 5.00 mm. The measured current in the conductor is 2.00 A. The maximum permissible percentage error in the resistivity of the conductor is:

(A) 3.9 (B) 8.4
(C) 3.0 (D) 7.5

Q7. A thin circular ring of mass M and radius r is rotating about its axis with an angular speed ω. Two particles having mass m each are now attached at diametrically opposite points. The angular speed of the ring will become:

(A) $\omega\frac{M-2m}{M+2m}$ (B) $\omega\frac{M+2m}{M}$
(C) $\omega\frac{M}{M+m}$ (D) $\omega\frac{M}{M+2m}$

Q8. Your friend is having eye sight problem. She is not able to see clearly a distant uniform window mesh and it appears to her non-uniform and distorted. The doctor diagnosed the problems as:

(A) Myopia with Astigmatism (B) Myopia and hypermetropia
(C) Astigmatism (D) Presbyopia with Astigmatism

Q9. A constant power delivering machine has towed a box, which was initially at rest, along a horizontal straight line. The distance moved by the box in time 't' is proportional to:

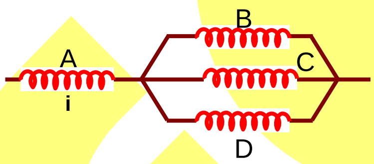
(A) $t^{1/2}$ (B) t
(C) $t^{3/2}$ (D) $t^{2/3}$

Q10. What will be the average value energy along one degree of freedom for an ideal gas in thermal equilibrium at a temperature T? (k_B is Boltzmann constant)

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

(C) $\frac{3}{2}k_BT$ (D) $\frac{1}{2}k_BT$

Q11. Four identical long solenoids A, B, C and D are connected to each other as shown in the figure. If the magnetic field at the centre of A is 3T,the field at the centre of C would be: (Assume that the magnetic field is confined with in the volume of respective solenoid).



(A) 9 T (B) 6 T
(C) 12 T (D) 1 T

Q12. A plane electromagnetic wave of frequency 100 MHz is traveling in vacuum along the x-direction. At a particular point in space and time, $\vec{B} = 2.0 \times 10^{-8}\hat{k}$ T. (where, $\hat{k}$ is unit vector along z-direction) What is $\vec{E}$ at this point ? (speed of light $c = 3 \times 10^8 m/s$)

(A) $0.6\ \hat{j}$ V/m (B) $6.0\ \hat{j}$ V/m

(C) $0.6\ \hat{k}$ V/m (D) $6.0\ \hat{k}$ V/m

Q13. A radioactive sample disintegrates via two independent decay processes having half lives $T_{1/2}^{(1)}$ and $T_{1/2}^{(2)}$ respectively. The effective half-life, $T_{1/2}$ of the nuclei is :

(A) None of the above (B) $T_{1/2} = T_{1/2}^{(1)} + T_{1/2}^{(2)}$

(C) $T_{1/2} = \frac{T_{1/2}^{(1)} + T_{1/2}^{(2)}}{T_{1/2}^{(1)} - T_{1/2}^{(2)}}$ (D) $T_{1/2} = \frac{T_{1/2}^{(1)} T_{1/2}^{(1)}}{T_{1/2}^{(1)} + T_{1/2}^{(2)}}$

Q14. The time period of satellite in a circular orbit of radius R is T. The period of another satellite in a circular orbit of radius 9R is:

(A) 12 T (B) 9 T
(C) 27 T (D) 3 T

Q15. Imagine that the electron in a hydrogen atom is replaced by a muon (μ). The mass of muon particle is 207 times that of an electron and charge is equal to the charge is of an electron. The ionization potential of this hydrogen atom will be :

(A) 13.6 eV (B) 2815.2 eV
(C) 331.2 eV (D) 27.2 eV

Q16. A loop of flexible wire of irregular shape carrying current is placed in an external magnetic field . Identify the effect of the field on the wire.

(A) Wire gets stretched to become straight.
(B) Loop assumes circular shape with its plane parallel to the field .
(C) Shape of the loop remains unchanged .
(D) Loop assumes circular shape with its plane normal to the field .

Q17. A particle is traveling 4 times as fast as an electron. Assuming the ratio of de- Broglie wavelength of a particle to that of electron is 2 : 1, the mass of the particle is :

(A) $\frac{1}{16}$ times the mass of e^- (B) 8 times the mass of e^-

(C) $\frac{1}{8}$ times the mass of e^- (D) 16 times the mass of e^-

Q18. In a series LCR resonance circuit, if we change the resistance only, from a lower to higher value :

(A) The quality factor will increase
(B) The resonance frequency will increase
(C) The quality factor and the resonance frequency will remain constant
(D) The band width of resonance circuit will increase

Q19. The time period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{\ell}{g}}$. The measured value of the length of pendulum is 10cm known to a 1 mm accuracy. The time for 200 oscillations of the pendulum is found to be 100 second using a clock of 1 s resolution. The percentage accuracy in the determination of 'g' using this pendulum is 'x'. The value of 'x' to the nearest integer is,

(A) 4% (B) 3%
(C) 2% (D) 5%

Q20. An AC source rated 220 V, 50Hz is connected to a resistor. The time taken by the current to change from its maximum to the rms value is :

(A) 25 ms (B) 2.5 ms
(C) 0.25 ms (D) 2.5 s

Section-B

Q1. An npn transistor operates as a common emitter amplifier with a power gain of 10^6. The input circuit resistance is $100\,\Omega$ and the output load resistance is $10\,k\Omega$. The common emitter current gain 'β' will be -----------. (Round off to the Nearest Integer)

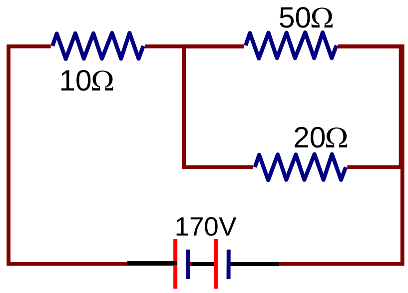
Q2. A parallel plate capacitor has plate area $100\,m^2$ and plate separation of $10\,m$. The space between the plates is filled up to a thickness 5m with material of dielectric constant of 10. The resultant capacitance of the system is 'x' pF.

The value of $\varepsilon_0 = 8.85 \times 10^{-12}\,F.m^{-1}$

The value of 'x' to the nearest integer is ---------.

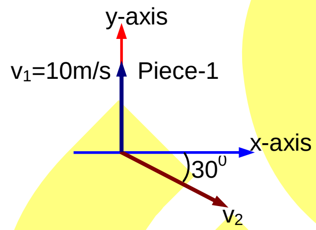
Q3. The voltage across the $10\,\Omega$ resistor in the given circuit is x volt.

The value of 'x' to the nearest integer is -----------.



Q4. A bullet of mass 0.1 kg is fired on a wooden block to pierce through it, but it stops after moving a distance of 50 cm into it. If the velocity of bullet before hitting the wood is 10m/s and slows down with uniform deceleration, then magnitude effective retarding force on the bullet is 'x' N.
The value of 'x' to the nearest integer is----------.

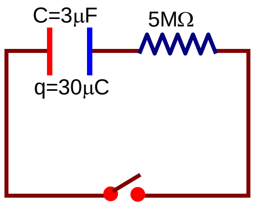
Q5. A ball of mass 10kg, moving with a velocity $10\sqrt{3}\,m/s$ along, the x- axis, hits another ball of mass 20kg which is at rest. After the collision, first ball comes to rest while second ball disintegrates into two equal pieces. One piece starts moving along y –axis with a speed of 10 m/s. The second piece starts moving at an angle of 30^0 with respect to the x-axis .
The velocity of the ball moving at 30^0 with x-axis is x m/s.
The configuration of pieces after collision is shown in the figure below.
The value of x to the nearest integer is---------.



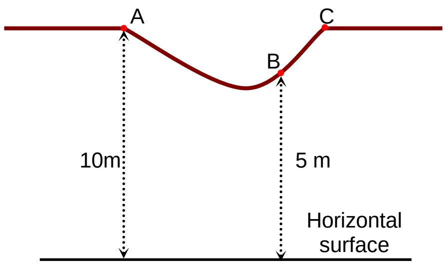
Q6. A person is swimming with a speed of $10\,m/s$ at an angle of 120^0 with the flow and reaches to a point directly opposite on the other side of the river. The speed of the flow is 'x' m/s. The value of 'x' to the nearest integer is-----------.

Q7. Two separate wires A and B are stretched by 2 mm and 4 mm respectively, when they are subjected to a force of 2 N. Assume that both the wires are made up of same material and the radius of wire B is 4 times that of the radius of wire A. The length of the wires A and B are in the ratio of a : b. Then $\frac{a}{b}$ can be expressed as $\frac{1}{x}$ where x is---------.

Q8. The circuit shown in the figure consists of a charged capacitor of capacity $3\,\mu F$ and a charge of $30\,\mu C$. At time $t = 0$, when the key is closed, the value of current flowing through the $5\,M\Omega$ resistor is 'x' μA.
The value of 'x' to the nearest integer is---------.



Q9. As shown in the figure, a particle of mass 10 kg is placed at a point A. When the particle is slightly displaced to its right, it starts moving and reaches the point B. The speed of the particle at B is x m/s. (Take g = 10 m/s^2)
The value of 'x' to the nearest integer is----------.



Q10. A particle performs simple harmonic motion with a period of 2 second. The time taken by the particle to cover a displacement equal to half of its amplitude from the mean position is $\frac{1}{a}$s.
The value of 'a' to the nearest integer is-----------.

CHEMISTRY

SECTION A

Q1. Reagent, 1-naphthylamine and sulphanilic acid in acetic acid is used for the detection of :

(A) NO (B) N_2O

(C) NO_2^- (D) NO_3^-

Q2. Match List – I with List – II:

List – I (Class of Drug)	**List – II (Example)**
(a) Antacid	(i) Novestrol
(b) Artificial Sweetener	(ii) Cimetidine
(c) Antifertility	(iii) Valium
(d) Tranquilizers	(iv) Alitame

Choose the **most appropriate** match.

(A) (a)-(iv), (b)-(i), (c)-(ii), (d)-(iii) (B) (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii)

(C) (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i) (D) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)

Q3. Match List – I with List – II:

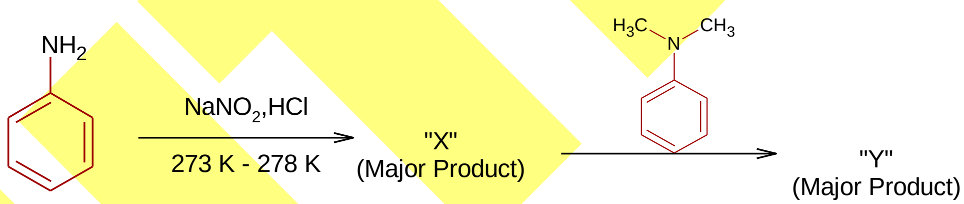
List – I (Process)	**List – II (Catalyst)**
(a) Deacon's process	(i) ZSM-5
(b) Contact process	(ii) $CuCl_2$
(c) Cracking of hydrocarbons	(iii) Particles 'Ni'
(d) Hydrogenation of vegetable oils	(iv) V_2O_5

Choose the **most appropriate** answer from the options given below:

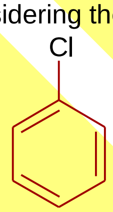
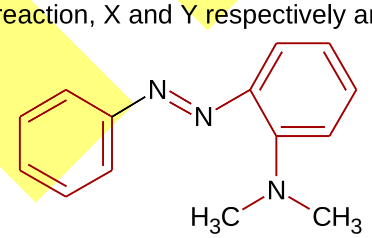
(A) (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv) (B) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

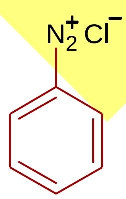
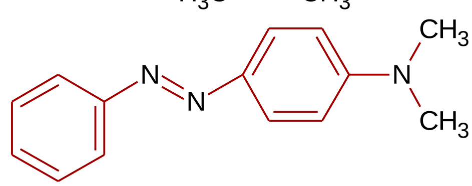
(C) (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii) (D) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)

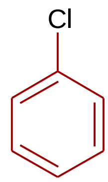
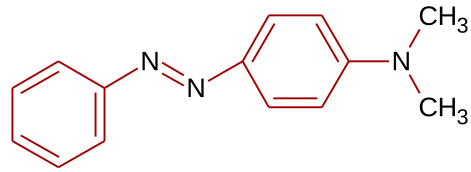
Q4.

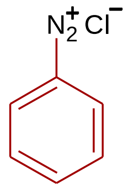
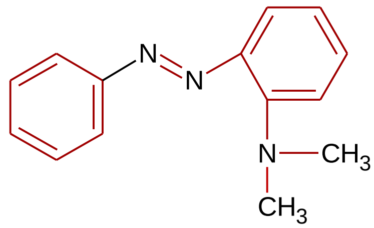


Considering the above reaction, X and Y respectively are:

(A)  and 

(B)  and 

(C)  and 

(D)  and 

Q5. Match List – I with List – II:

List – I	List – II
(a) $Ca(OCl)_2$	(i) Antacid
(b) $CaSO_4.\frac{1}{2}H_2O$	(ii) Cement
(c) CaO	(iii) Bleach
(d) $CaCO_3$	(iv) Plaster of Paris

Choose the **most appropriate** answer from the options given below:

(A) (a)-(iii),(b)-(ii),(c)-(iv),(d)-(i)
(B) (a)-(iii),(b)-(ii),(c)-(i),(d)-(iv)
(C) (a)-(iii),(b)-(iv),(c)-(ii),(d)-(i)
(D) (a)-(i), (b)-(iv),(c)-(iii),(d)-(ii)

Q6. Given below are two statements : One is labelled as **Assertion A** and the other is labelled as **Reason R:**

Assertion A : During the boiling of water having temporary hardness, $Mg(HCO_3)_2$ is converted to $MgCO_3$.

Reason R: The solubility product of $Mg(OH)_2$ is greater than that of $MgCO_3$.

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

(A) Both **A** and **R** are true and **R** is the correct explanation of **A**
(B) **A** is false but **R** is true
(C) **A** is true but **R** is false
(D) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**

Q7. A certain orbital has no angular nodes and two radial nodes. The orbital is:

(A) 3s
(B) 3p
(C) 2s
(D) 2p

Q8. Compound with molecular formula C_3H_6O can show:

(A) Metamerism
(B) Both positional isomerism and metamerism
(C) Positional isomerism
(D) Functional group isomerism

Q9. The chemical that is added to reduce the melting point of the reaction mixture during the extraction of aluminium is:

(A) Kaolite
(B) Bauxite
(C) Calamine
(D) Cryolite

Q10. Match List – I with List – II:

List – I (Chemicals)	**List – II (Use / Preparation / Constituent)**
(a) Alcoholic potassium hydroxide	(i) electrodes in batteries
(b) Pd/ $BaSO_4$	(ii) obtained by addition reaction
(c) BHC (Benzene hexachloride)	(iii) used for β-elimination reaction
(d) Polyacetylene	(iv) Lindlar's Catalyst

Choose the **most appropriate** match:

(A) (a)-(ii),(b)-(iv),(c)-(i),(d)-(iii)
(B) (a)-(ii),(b)-(i),(c)-(iv),(d)-(iii)
(C) (a)-(iii),(b)-(i),(c)-(iv),(d)-(ii)
(D) (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)

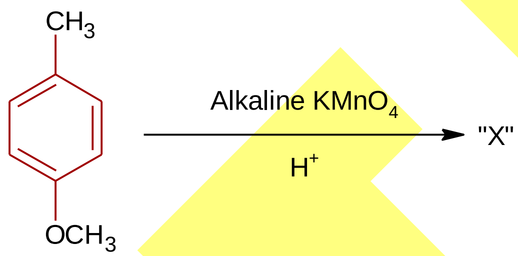
Q11. Match **List – I** with **List – II**

List – I	**List – II**
(a) Chlorophyll	(i) Ruthenium
(b) Vitamin – B_{12}	(ii) Platinum
(c) Anticancer drug	(iii) Cobalt
(d) Grubbs catalyst	(iv) Magnesium

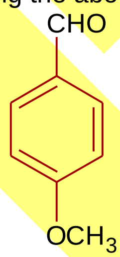
Choose the **most appropriate** answer from the options given below:

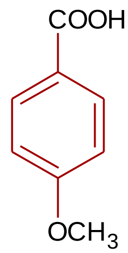
(A) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)
(B) (a)-(iv), (b)-(iii),(c)-(i), (d)-(ii)
(C) (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)
(D) (a)-(iv),(b)-(ii),(c)-(iii), (d)-(i)

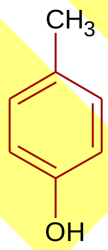
Q12.

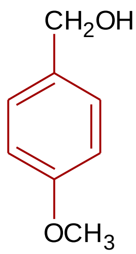


Considering the above chemical reaction, identify the product "X":

(A) X -


(B) X -


(C) X -


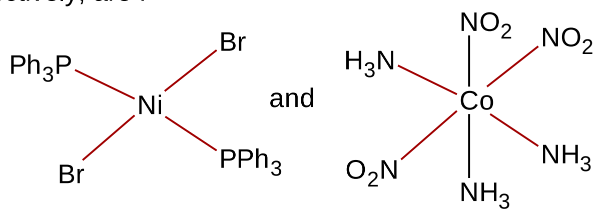
(D) X -


Q13. A non-reducing sugar "A" hydrolyses to give two reducing mono saccharides. Sugar A is:

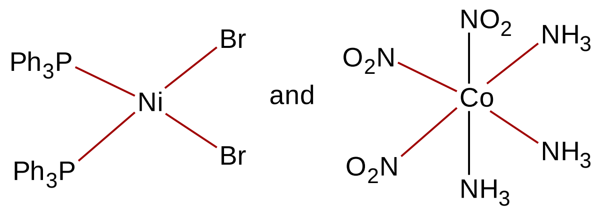
(A) Galactose
(B) Fructose
(C) Glucose
(D) Sucrose

Q14. The correct structures of trans-$[NiBr_2(PPh_3)_2]$ and meridonial-$[Co(NH_3)_3(NO_2)_3]$, respectively, are :

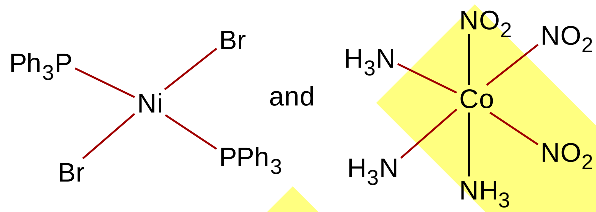
(A)



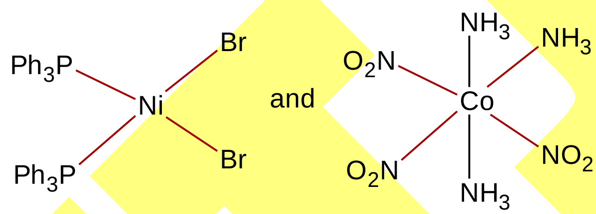
(B)



(C)



(D)



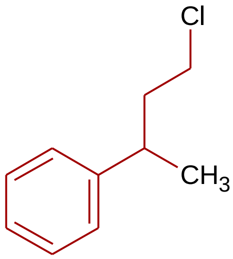
Q15. The ionic radius of Na^+ ion is 1.02 $\overset{o}{A}$. The ionic radii (in $\overset{o}{A}$) of Mg^{2+} and Al^{3+}, respectively are:

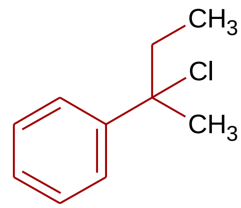
(A) 0.85 and 0.99 (B) 0.68 and 0.72
(C) 0.72 and 0.54 (D) 1.05 and 0.99

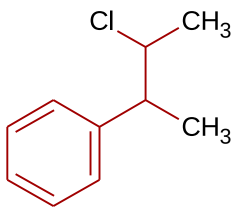
Q16. In a binary compound, atoms of element A form a hcp structure and those of element M occupy 2/3 of the tetrahedral voids of the hcp structure. The formula of the binary compound is:

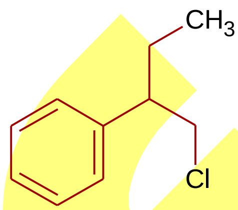
(A) M_2A_3 (B) MA_3
(C) M_4A (D) M_4A_3

Q17. Reaction of Grignard reagent, C_2H_5MgBr with C_8H_8O followed by hydrolysis gives compound "A" which reacts instantly with Lucas reagent to give compound B, $C_{10}H_{13}Cl$. The compound B is:

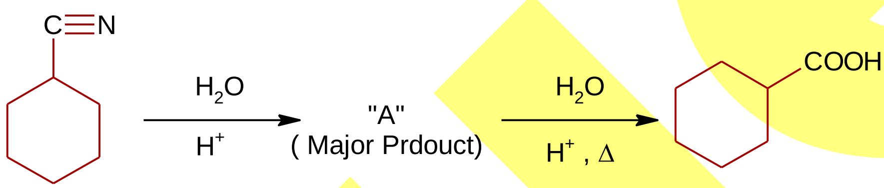
(A) 

(B) 

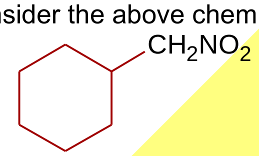
(C) 

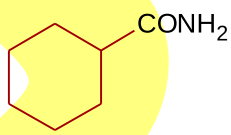
(D) 

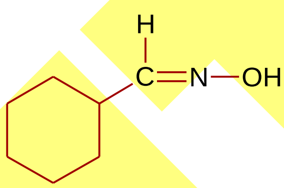
Q18.

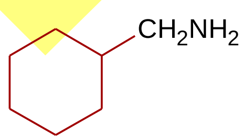


Consider the above chemical reaction and identify product "A":

(A) 

(B) 

(C) 

(D) 

Q19. The number of ionisable hydrogens present in the product obtained from a reaction of phosphorus trichloride and phosphonic acid is:

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

Q20. The statements that are **TRUE:**

(A) Methane leads to both global warming and photochemical smog.
(B) Methane is generated from paddy fields.
(C) Methane is a stronger global warming gas than CO_2.
(D) Methane is a part of reducing smog.

Choose the **most appropriate** answer from the options given below:

(A) (A), (B), (C) only (B) (A) and (B) only
(C) (A), (B), (D) only (D) (B), (C), (D) only

SECTION B

Q1. A reaction of 0.1 mole of Benzylamine with bromomethane gave 23g of Benzyl trimethyl ammonium bromide. The number of moles of bromomethane consumed in this reaction are $n\times10^{-1}$, when n=__________. (Round off to the nearest integer).
[Given: Atomic masses: C=12.0u, H:1.0u, N:14.0u, Br:80.0u]

Q2. For the reaction $C_2H_6 \rightarrow C_2H_4 + H_2$ the reaction enthalpy Δ_rH =____________ kJ mol^{-1}. (Round off to the nearest integer).
[Given: Bond enthalpies in kJ mol^{-1} : C-C: 347, C=C:611; C-H:414,H-H:436]

Q3. In order to prepare a buffer solution of pH 5.74, sodium acetate is added to acetic acid. If the concentration of acetic acid in the buffer is 1.0 M, the concentration of sodium acetate in the buffer is ___________M. (Round off to the nearest integer).
[Given: pKa (acetic acid) = 4.74]

Q4. AX is a covalent diatomic molecule where A and X are second row elements of periodic table. Based on molecular orbital theory, the bond order of AX is 2.5. The total number of electrons in AX is _____________. (Round off to the nearest integer).

Q5. For the reaction
$$2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(s)$$
The magnitude of the standard molar free energy change,
$\Delta_r G_m^o = -$ _________________kJ (Round off to the nearest integer).
$$\begin{bmatrix} E^o_{Fe^{2+}/Fe(s)} = -0.440V; & E^o_{Fe^{3+}/Fe(s)} = -0.036V \\ E^o_{I_2/2I^-} = 0.539V; & F = 96500C \end{bmatrix}$$

Q6. ___________ grams of 3-Hydroxy propanal (MW = 74) must be dehydrated to produce 7.8g of acrolein (MW = 56) (C_3H_4O) if the percentage yield is 64.
(Round off to the nearest integer).
[Given: Atomic masses : C: 12.0u, H:1.0u, O:16.0u]

Q7. $2NO(g) + Cl_2(g) \rightleftharpoons 2NOCl(s)$
This reaction was studied at -10°C and the following data was obtained

run	$[NO]_0$	$[Cl_2]_0$	r_0
1	0.10	0.10	0.18
2	0.10	0.20	0.35
3	0.20	0.20	1.40

$[NO]_0$ and $[Cl_2]_0$ are the initial concentrations and r_0 is the initial reaction rate. The overall order of the reaction is ___________. (Round off to the nearest integer).

Q8. 2 molal solution of a weak acid HA has a freezing point of 3.885°C. The degree of dissociation of this acid is ___________ $\times10^{-3}$. (Round off to the nearest integer).
[Given : Molal depression constant of water = 1.85 K kg mol^{-1},
Freezing point of pure water = 0°C]

Q9. Complete combustion of 3 g of ethane gives $x\times10^{22}$ molecules of water. The value of x is __________. (Round off to the nearest integer).
[Use : $N_A = 6.023\times10^{23}$; Atomic masses in u: C:12.0,O:16.0; H:1.0]

Q10. The total number of unpaired electrons present in the complex $K_3[Cr(oxalate)_3]$ is______.

MATHEMATICS
SECTION A

Q1. If the equation $a|z|^2 + \overline{\bar{\alpha}z + \alpha\bar{z}} + d = 0$ represents a circle where a, d are real constants, then which of the following condition is correct ?

(A) $|\alpha|^2 - ad \neq 0$
(B) $\alpha = 0, a, d \in R^+$
(C) $|\alpha|^2 - ad \geq 0 \text{ and } a \in R$
(D) $|\alpha|^2 - ad > 0 \text{ and } a \in R - \{0\}$

Q2. Let $A + 2B = \begin{bmatrix} 1 & 2 & 0 \\ 6 & -3 & 3 \\ -5 & 3 & 1 \end{bmatrix}$ and $2A - B = \begin{bmatrix} 2 & -1 & 5 \\ 2 & -1 & 6 \\ 0 & 1 & 2 \end{bmatrix}$. If Tr(A) denotes the sum of all diagonal elements of the matrix A, then Tr(A) – Tr(B) has value equal to:

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

Q3. For the four circles M,N, O and P, following four equations are given :

Circle M : $x^2 + y^2 = 1$

Circle N : $x^2 + y^2 - 2x = 0$

Circle O : $x^2 + y^2 - 2x - 2y + 1 = 0$

Circle P : $x^2 + y^2 - 2y = 0$

If the centre of circle M is joined with centre of the circle N, further centre of circle N is joined with centre of the circle O, centre of circle O is joined with the centre of circle P and lastly, centre of circle P is joined with centre of circle M, then these lines form the sides of a :

(A) Square
(B) Rhombus
(C) Rectangle
(D) Parallelogram

Q4. A vector $\vec{a}$ has components 3p and 1 with respect to a rectangular Cartesian system. This system is rotated through a certain angle about the origin in the counter clockwise sense. If, with respect to new system, $\vec{a}$ has components p + 1 and $\sqrt{10}$, then a value of p is equal to :

(A) -1
(B) $\frac{4}{5}$
(C) $-\frac{5}{4}$
(D) 1

Q5. The real function $f(x) = \frac{\operatorname{cosec}^{-1} x}{\sqrt{x - [x]}}$, where $[x]$ denotes the greatest integer less than or equal to x, is defined for all x belonging to :

(A) all integers except 0, -1, 1
(B) all non-integers except the interval $[-1,1]$
(C) all reals except the interval $[-1,1]$
(D) all reals except integers

Q6. If α, β are natural numbers such that $100^\alpha - 199\beta = (100)(100) + (99)(101) + (98)(102) + ... + (1)(199)$, **then the slope of the line passing through** (α, β) **and origin is :**

(A) 510
(B) 530
(C) 540
(D) 550

Q7. $(1 + x + 2x^2)^{20} = a_0 + a_1x + a_2x^2 + ... + a_{40}x^{40}$. **Then,** $a_1 + a_3 + a_5 + ... + a_{37}$ **is equal to :**

(A) $2^{20}(20^{20} + 21)$
(B) $2^{19}(2^{20} + 21)$

(C) $2^{19}\left(2^{20}-21\right)$ **(D)** $2^{20}\left(2^{20}-21\right)$

Q8. $\frac{1}{3^2-1}+\frac{1}{5^2-1}+\frac{1}{7^2-1}+.....+\frac{1}{(201)^2-1}$ is equal to :

(A) $\frac{25}{101}$ **(B)** $\frac{99}{400}$

(C) $\frac{101}{408}$ **(D)** $\frac{101}{404}$

Q9. **The solutions of the equation**

$$\begin{vmatrix} 1+\sin^2 x & \sin^2 x & \sin^2 x \\ \cos^2 x & 1+\cos^2 x & \cos^2 x \\ 4\sin 2x & 4\sin 2x & 1+4\sin 2x \end{vmatrix} = 0, (0 < x < \pi), \text{are :}$$

(A) $\frac{7\pi}{12},\frac{11\pi}{12}$ (B) $\frac{\pi}{6},\frac{5\pi}{6}$

(C) $\frac{\pi}{12},\frac{\pi}{6}$ (D) $\frac{5\pi}{12},\frac{7\pi}{12}$

Q10. The equation of one of the straight lines which passes through the point $(1,3)$ and makes an angle $\tan^{-1}\left(\sqrt{2}\right)$ with the straight line, $y+1=3\sqrt{2}x$ is :

(A) $4\sqrt{2}x-5y-\left(5+4\sqrt{2}\right)=0$ (B) $5\sqrt{2}x+4y-\left(15+4\sqrt{2}\right)=0$

(C) $4\sqrt{2}x+5y-4\sqrt{2}=0$ (D) $4\sqrt{2}x+5y-\left(15+4\sqrt{2}\right)=0$

Q11. If the functions are defined as $f(x)=\sqrt{x}$ and $g(x)=\sqrt{1-x}$, then what is the common domain of the following functions: $f+g,\ f-g,\ f/g,\ g/f,\ g-f$ where

$(f\pm g)(x)=f(x)\pm g(x),(f/g)(x)=\frac{f(x)}{g(x)}$

(A) $0\le x<1$ (B) $0<x<1$

(C) $0<x\le 1$ (D) $0\le x\le 1$

Q12. The number of integral values of m so that the abscissa of point of intersection of lines $3x+4y=9$ and $y=mx+1$ is also an integer, is:

(A) 1 (B) 3

(C) 0 (D) 2

Q13. The differential equation satisfied by the system of parabolas $y^2=4a(x+a)$ is :

(A) $y\left(\frac{dy}{dx}\right)^2+2x\left(\frac{dy}{dx}\right)-y=0$ (B) $y\left(\frac{dy}{dx}\right)^2-2x\left(\frac{dy}{dx}\right)+y=0$

(C) $y\left(\frac{dy}{dx}\right)^2-2x\left(\frac{dy}{dx}\right)-y=0$ (D) $y\left(\frac{dy}{dx}\right)+2x\left(\frac{dy}{dx}\right)-y=0$

Q14. Let α,β,γ be the real roots of the equation, $x^3+ax^2+bx+c=0,(a,b,c\in R$ and $a,b\ne 0)$. If the system of equations $(in u,v,w)$ given by $\alpha u+\beta v+\gamma w=0;\beta u+\gamma v+\alpha w=0;$

$\gamma u + \alpha v + \beta w = 0$ has non-trivial solution, then the value of $\frac{a^2}{b}$ is :

(A) 5
(B) 3
(C) 1
(D) 0

Q15. The integral $\int \frac{(2x-1)\cos\sqrt{(2x-1)^2+5}}{\sqrt{4x^2-4x+6}}dx$ is equal to :

(where c is a constant of integration)

(A) $\frac{1}{2}\sin\sqrt{(2x-1)^2+5}+c$
(B) $\frac{1}{2}\sin\sqrt{(2x+1)^2+5}+c$
(C) $\frac{1}{2}\cos\sqrt{(2x+1)^2+5}+c$
(D) $\frac{1}{2}\cos\sqrt{(2x-1)^2+5}+c$

Q16. If $\lim\limits_{x\to 0}\frac{\sin^{-1}x-\tan^{-1}x}{3x^3}$ is equal to L, then the value of $(6L+1)$ is :

(A) 6
(B) $\frac{1}{2}$
(C) 2
(D) $\frac{1}{6}$

Q17. The sum of all the 4-digit distinct numbers that can be formed with the digits 1, 2, 2, and 3 is:

(A) 122234
(B) 26664
(C) 122664
(D) 22264

Q18. If $f(x)=\begin{cases}\frac{1}{|x|} & ;|x|\ge 1\\ ax^2+b & ;|x|<1\end{cases}$ is differentiable at every point of the domain, then the values of a and b are respectively ;

(A) $-\frac{1}{2},\frac{3}{2}$
(B) $\frac{1}{2},-\frac{3}{2}$
(C) $\frac{1}{2},\frac{1}{2}$
(D) $\frac{5}{2},-\frac{3}{2}$

Q19. The value of $3+\cfrac{1}{4+\cfrac{1}{3+\cfrac{1}{4+\cfrac{1}{3+.....\infty}}}}$ is equal to :

(A) $3+2\sqrt{3}$
(B) $2+\sqrt{3}$
(C) $1.5+\sqrt{3}$
(D) $4+\sqrt{3}$

Q20. Choose the correct statement about two circles whose equations are given below:

$x^2+y^2-10x-10y+41=0$

$x^2+y^2-22x-10y+137=0$

(A) circles have no meeting point
(B) circles have two meeting points
(C) circles have only one meeting point
(D) circles have same centre

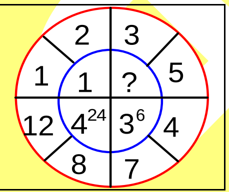
SECTION B

Q1. If $f(x)=\int \frac{5x^8+7x^6}{\left(x^2+1+2x^7\right)^2}dx,(x\geq 0)$, $f(0)=0$ and $f(1)=\frac{1}{K}$, then the value of K is ------.

Q2. Let the plane $ax+by+cz+d=0$ bisect the line joining the points $(4,-3,1)$ and $(2,3,-5)$ at the right angles. If a, b, c, d are integer, then the minimum value of $\left(a^2+b^2+c^2+d^2\right)$ is ---------.

Q3. The mean age of 25 teachers in a school is 40 years. A teacher retires at the age of 60 years and a new teacher is appointed in his place. If the mean age of the teachers in this school now is 39 years, then the age (in years) of the newly appointed teacher is:---------.

Q4. The missing value in the following figure is ----------.



Q5. Let z_1, z_2 be the roots of the equation $z^2+az+12=0$ and z_1, z_2 form an equilateral triangle with origin. Then, The value of $|a|$ is------------.

Q6. The equation of the planes parallel to the plane $x-2y+2z-3=0$ which are at unit distance from the point $(1,2,3)$ is $ax+by+cz+d=0$. If $(b-d)=K(c-a)$, then the positive value of K is -----------.

Q7. A square ABCD has all its vertices on the curve $x^2y^2=1$. The midpoints of its sides also lie on the same curve. Then, the square of area of ABCD is -----------.

Q8. Let $f(x)$ and $g(x)$ be two functions satisfying $f\left(x^2\right)+g(4-x)=4x^3$ and $g(4-x)+g(x)=0$, the value of $\int_{-4}^{4} f\left(x^2\right)dx$ is ------------.

Q9. The number of times the digit 3 will be written when listing the integers from 1 to 1000 is -------------

Q10. The number of solutions of the equations $|\cot x|=\cot x+\frac{1}{\sin x}$ in the interval $[0,2\pi]$ is -----

ANDSWER: Paper-18-03-2021-Morning Shift

PHYSICS	CHEMISTRY	MATHEMATICS
Section-A	**SECTION – A**	**SECTION – A**
Ans1. A	**Ans1.** C	**Ans1. D**
Ans2. A	**Ans2.** D	**Ans2. B**
Ans3. A	**Ans3.** D	**Ans3. A**
Ans4. B	**Ans4.** C	**Ans4. A**
Ans5. B	**Ans5.** C	**Ans5. B**
Ans6. A	**Ans6.** C	**Ans6. D**
Ans7. D	**Ans7.** A	**Ans7. C**
Ans8. A	**Ans8.** D	**Ans8. A**
Ans9. C	**Ans9.** D	**Ans9. A**
Ans10. D	**Ans10.** D	**Ans10. D**
Ans11. D	**Ans11.** A	**Ans11. B**
Ans12. B	**Ans12.** B	**Ans12. D**
Ans13. D	**Ans13.** D	**Ans13. A**
Ans14. C	**Ans14.** A	**Ans14. B**
Ans15. B	**Ans15.** C	**Ans15. A**
Ans16. D	**Ans16** D	**Ans16. C**
Ans17. C	**Ans17.** B	**Ans17. B**
Ans18. D	**Ans18.** B	**Ans18. A**
Ans19. B	**Ans19.** D	**Ans19. C**
Ans20. B	**Ans20.** A	**Ans20. C**
Section-B	**SECTION – B**	**SECTION – B**
Ans1. 100	**Ans1.** 3	**Ans1. 4**
Ans2. 161	**Ans2.** 128	**Ans2. 28**
Ans3. 70	**Ans3.** 10	**Ans3. 35**
Ans4. 10	**Ans4.** 15	**Ans4. 4**
Ans5. 20	**Ans5.** 45	**Ans5. 6**
Ans6. 5	**Ans6.** 16	**Ans6. 4**
Ans7. 32	**Ans7.** 3	**Ans7. 80**
Ans8. 2	**Ans8.** 50	**Ans8. 512**
Ans9. 10	**Ans9.** 18	**Ans9. 300**
Ans10. 6	**Ans10.** 3	**Ans10. 1**

SOLUTION: Paper-Jee-Main-18-03-0-2021-Morning Shift
PHYSICS
SECTION – A

Sol1. $qE = mg \Rightarrow neE = \frac{4}{3}\pi r^3.\rho g$

$$\Rightarrow n = \frac{4\pi r^3 \rho g}{3eE} = \frac{4\times 3.14\times\left(2\times10^{-3}\right)^3\times3\times10^3\times9.81}{3\times1.6\times10^{-19}\times3.55\times10^5} = 1.73\times10^{10}$$

Sol2. For adiabatic process CD,

$$W = \frac{P_1V_1 - P_2V_2}{\gamma-1} = \frac{100\times4-200\times3}{1.4-1} = -500J$$

Sol3. Fringe width, $\beta = \frac{\lambda D}{d} = \frac{5890\times10^{-10}\times0.5}{0.5\times10^{-3}} = 589\times10^{-6}m$

Distance between first and third bright fright $= 2\beta = 1178\times10^{-6}m.$

Sol4. Layers of atmosphere are in order of (from bottom) troposphere, stratosphere, mesosphere, thermosphere.

Sol5. For constant acceleration, a,

$x = ut + \frac{1}{2}at^2 \Rightarrow x-t$ graph is parabola.

$v = u + at \Rightarrow v-t$ graph is straight line with positive slope.

Sol6. From ohm's Law, $V = IR = I\frac{\rho\ell}{\pi\frac{d^2}{4}} \Rightarrow \rho = \frac{\pi d^2 V}{4\ell I}$

Relative error in resistively,

$$\frac{\Delta\rho}{\rho} = 2.\frac{\Delta d}{d} + \frac{\Delta V}{V} + \frac{\Delta\ell}{\ell} + \frac{\Delta I}{I} = 2\times\frac{0.01}{5.00} + \frac{0.1}{5.0} + \frac{0.1}{10.0} + \frac{0.01}{2000} = 0.039$$

Percentage error $= \frac{\Delta\delta}{\delta}\times100 = 3.9\%$

Sol7. **Using conservation of Angular momentum along axis of rotation, we can write**

$$Mr^2\omega = \left(Mr^2 + 2mr^2\right)\omega_n \Rightarrow \omega_n = \frac{M\omega}{M+2m}$$

Sol8. An eye with defect of myopia can not see distant objects clearly, while that of astigmatism sees objects non- uniform and distorted.

Sol9. $\Rightarrow m\frac{dv}{dt}.v = P \Rightarrow \int_0^v vdv = \frac{P}{m}\int_0^t dt \Rightarrow v = \left(\sqrt{\frac{2P}{m}}\right)t^{1/2}$

$$\Rightarrow \int_0^x dx = \left(\sqrt{\frac{2P}{m}}\right)\int_0^t t^{1/2}dt \Rightarrow x = \left(\sqrt{\frac{2P}{m}}\right)\left(\frac{2}{3}t^{3/2}\right) \Rightarrow x\ \alpha\ t^{3/2}$$

Sol10. According to principle of equi-partition of Energy , the average energy per molecules associated with each degree of freedom is $\frac{1}{2}k_BT$.

Sol11. Magnetic field at centre of a solenoid is proportional to the current through it.
Current through C will be one -third of the current through A . So
Magnetic field at the centre of $C = \frac{3}{3} = 1T.$

Sol12. Direction of $\vec{E}$ is perpendicular to the direction of propagation and that of $\vec{B}$.

$E = cB = 3\times10^8\times2\times10^{-8} = 6\quad V/m$

Sol13. From Radioactive Decay Law,

$$-\frac{dN}{dt} = \lambda_1 N + \lambda_2 N = \lambda_{eff} N$$

$$\Rightarrow \lambda_{eff} = \lambda_1 + \lambda_2 \Rightarrow \frac{\ln 2}{T_{1/2}} = \frac{\ln 2}{T_{1/2}^{(1)}} + \frac{\ln 2}{T_{1/2}^{(2)}} \Rightarrow T_{1/2} = \frac{T_{1/2}^{(1)} T_{1/2}^{(2)}}{T_{1/2}^{(1)} + T_{1/2}^{(2)}}$$

Sol14. $T^2 = \alpha R^3$

$$\Rightarrow \left(\frac{T_2}{T_1}\right)^2 = \left(\frac{R_2}{R_1}\right)^3 \Rightarrow T_2 = 9^{\frac{3}{2}} T = 27T$$

Sol15. $E \alpha m \Rightarrow \frac{E}{13.6} = 207 \Rightarrow E = 207 \times 13.6\,eV = 2815.2\,eV$

Sol16. In external magnetic field, a magnetic force acts on every small part of the loop in direction perpendicular to the wire. Thus, loop assumes a shape (circular) in which it covers maximum area.

Sol17. $\frac{\lambda}{\lambda_e} = \frac{m_e v_e}{mv} \Rightarrow m = \frac{v_e}{v} . \frac{\lambda_e}{\lambda} m_e = \frac{1}{4} \times \frac{1}{2} m_e = \frac{1}{8} m_e$

Sol18. Resonance frequency is independent of R.

Quality factor $= \frac{\omega L}{R} \Rightarrow$ Quality factor decreases with increase in R.

Bandwidth of resonance circuit $= \frac{R}{L} \Rightarrow$ increases with increase in R.

Sol19. $\ell = 10.0 \pm 0.1$cm.

$$T = \frac{100 \pm 1}{200} = 0.5 \pm 0.005$$

$$T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow g = \frac{4\pi^2 \ell}{T^2}$$

$$\frac{\Delta g}{g} = \frac{\Delta \ell}{\ell} + 2\frac{\Delta T}{T} = \frac{0.1}{10.0} + 2 \times \frac{0.005}{0.5} = 0.03$$

Percentage error $= \frac{\Delta g}{g} \times 100 = 3\%$

Sol20. $\omega = 2\pi f = 100\pi$ rad/s

$$i_{rms} = \frac{i}{\sqrt{2}}$$

While current changes from its maximum to its rms value, its phase changes by $\frac{\pi}{4}$ rad.

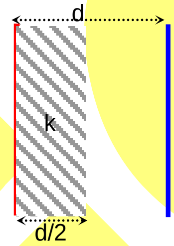
$$t = \frac{\pi/4}{\omega} = \frac{\pi}{4 \times 100\pi} = 2.5 \times 10^{-3}\,s = 2.5\,ms.$$

SECTION - B

Sol1. Power gain $= \frac{i_C^2 R_C}{i_B^2 R_B} \Rightarrow \left(\frac{i_C}{i_B}\right)^2 . \frac{10^4}{10^2} . = 10^6$

$\Rightarrow \frac{i_C}{i_B} = 100 \Rightarrow \beta = \frac{i_C}{i_B} = 100$

Sol2.



$$\frac{1}{C} = \frac{5}{\varepsilon_0 \times 100} + \frac{5}{10 \times \varepsilon_0 \times 100}$$

$$\Rightarrow C = \frac{\varepsilon \times 1000}{55} = \frac{8.85 \times 10^{-12} \times 1000}{55} = 1.61 \times 10^{-10}\,F = 161\,pF$$

Sol3. $R_{eq} = 10 + \frac{50 \times 20}{50 + 20} = \frac{170}{7}\Omega$

$\Rightarrow i = \frac{170}{\frac{170}{7}} = 7A$

$\Rightarrow x = 10 \times 7 = 70\,V \Rightarrow$ Voltage across 10Ω resistor

Sol4. Deceleration, $a = \frac{u^2}{2S} = \frac{10^2}{2 \times 0.5} = 100\ m/s^2$.

Retarding force, $F = ma = 0.1 \times 100 = 10N$

Sol5. **Apply conservation of momentum along y –axis, we can write**

$10v_1 - 10v_2 \sin 30^\circ = 0$

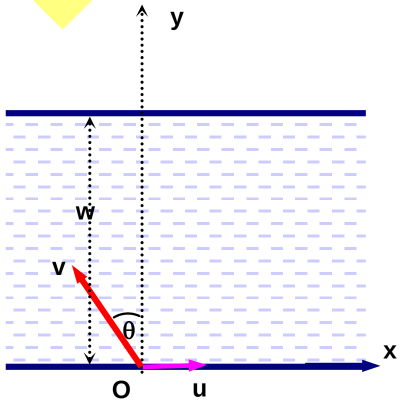
$\Rightarrow v_2 = 20 m/s$

Sol6.

Angle from direction of flow $= 90^0 + \theta = 120^0$

$\Rightarrow \theta = 30^\circ$

$\sin 30^0 = \frac{u}{v} \Rightarrow \frac{u}{10} = \frac{1}{2} \Rightarrow u = 5\ m/s$



Sol7. **For Wire-A**

$\frac{F}{\pi r_A^2} = Y \frac{2}{\ell_A}$ ………..(1)

For Wire-B

$\frac{F}{\pi r_B^2} = Y \frac{4}{\ell_B}$ ……..(2)

From equations (1) and (2) ,we can write

$$\frac{\ell_A}{\ell_B} = \frac{2}{4} \times \frac{r_A^2}{r_B^2} = \frac{2}{4} \times \left(\frac{1}{4}\right)^2 = \frac{1}{32} \Rightarrow x = \frac{\ell_B}{\ell_A} = 32$$

Sol8. Potential difference across resistor at time $t = V = \frac{30}{3} = 10V$

Current, $i = \frac{10}{5\times10^6} = 2\ \mu A$

Sol9. **Using Conservation of Mechanical Energy at point-A and at point-B, we can write**

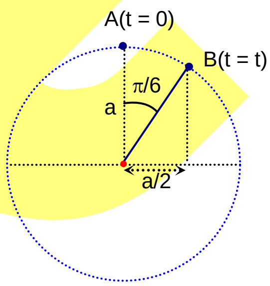
$K_B = U_A - U_B \qquad [\text{Since } K_A = 0]$

$\Rightarrow \frac{1}{2}mv_B^2 = mg(h_A - h_B)$

$\Rightarrow v_B = \sqrt{2\times10\times(10-5)} = 10\,m/s$

Sol10. While the particle moves from mean position to displacement, half of its amplitude, its phase changes by $\frac{\pi}{6}$ rad. So,

Time taken, $t = \frac{\pi/6}{\omega} = \frac{T}{12} = \frac{2}{12} = \frac{1}{6}$ s

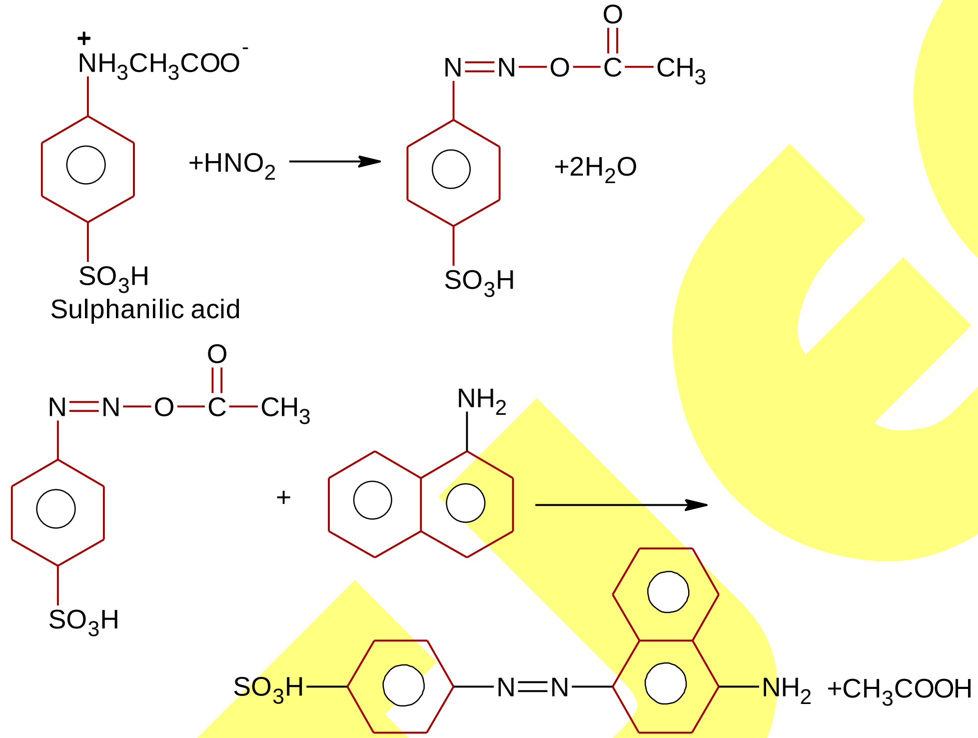


$a = 6$

CHEMISTRY

SECTION – A

Sol1. $NO_2^- + CH_3COOH \longrightarrow HNO_2 + CH_3COO^-$



(Red Azodye)

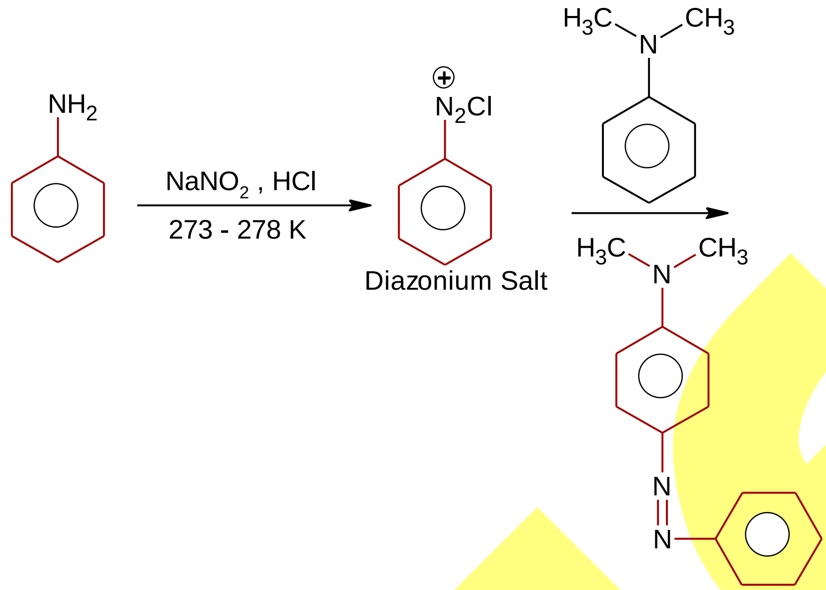
Sol2.

Antacid:	Cimetidine
Artificial Sweetner:	Alitame
Antifertility:	Novestrol
Tranquilizers:	Valium

Sol3.

(a) Deacon's process:	$CuCl_2$ used as catalyst
(b) Contact process :	V_2O_5 used as catalyst
(c) Cracking of hydrocarbon:	ZSM-5 used as catalyst
(d) Hydrogenation of vegetable oil:	Particles Ni used as catalyst

Sol4.



Sol5. $Ca(OCl)_2$: Bleach

$CaSO_4.\frac{1}{2}H_2O$: Plaster of paris

CaO: Component of cement

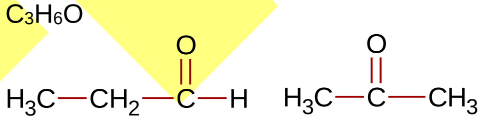
$CaCO_3$: Antacid

Sol6. $Mg(HCO_3)_2 \xrightarrow{\Delta} \underset{\text{white ppt}}{Mg(OH)_2} \downarrow + 2CO_2$

$MgCO_3$ is more soluble than $Mg(OH)_2$, so ppt of $Mg(OH)_2$ is formed.
K_{sp} of $Mg(OH)_2$ is higher than $MgCO_3$.

Sol7. Total Node = n–1 $\ell \Rightarrow$ Azimuthal Q.N
Radial Node = n- ℓ -l
Angular Node : ℓ
Angular node = 0
ℓ = 0 i.e S orbital
Radial nodes = 2
n- ℓ -1 = 2
n-0-1 = 2 $\Rightarrow$ n=3
so; orbital is 3s

Sol8. Functional group isomers.
C_3H_6O



Aldehyde   Ketone

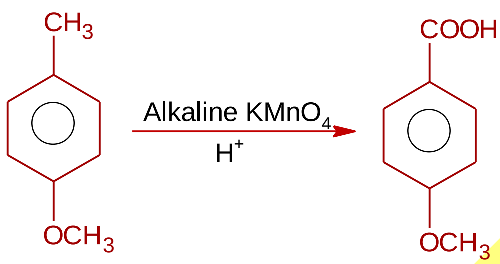
Sol9. When we add crylolite in extraction of aluminium the melting point of alumina decreases
Crylolite Na_3AlF_6

Sol10. Alcoholic potassium hydroxide (Alc KOH):- used for β - elimination
Pd / $BaSO_4$: - Lindlar's Catalyst

BHC (Benzene hexa chloride) : - Obtained by addition reaction
Polyacetylene : Electrodes in batteries.

Sol11. Chlorophyll: Magnesium present in chlorophyll
Vitamin – B_{12} : Cobalt (cynocobalamin)
Anticancer drug: Platinum (Co-ordination compound of platinum)
Grubbs catalyst:- Ruthenium

Sol12.



Sol13.

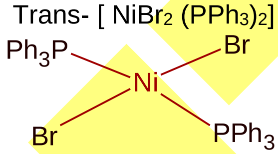
Sucrose $\xrightarrow{H_2O}$ Glucose + Fructose

Sucrose ↓ Non Reducing Sugar

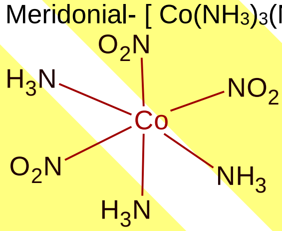
Glucose ↓ Reducing Sugar

Fructose ↓ Reducing Sugar

Sol14. Trans- [$NiBr_2(PPh_3)_2$]



Meridonial- [$Co(NH_3)_3(NO_3)_3$]



Sol15.

	electron	
Na^+	10	isoelectronic
Mg^{2+}	10	
Al^{3+}	10	

But Z_{eff} value $Al^{3+} > Mg^{2+} > Na^+$

Ionic Radius $Na^+ > Mg^{2+} > Al^{3+}$

Mg^{2+} ↓ 0.72 Al^{3+} ↓ 0.54

Sol16. Let number of atoms be N;
Tetrahedral voids = 2N
Atoms of element A = N

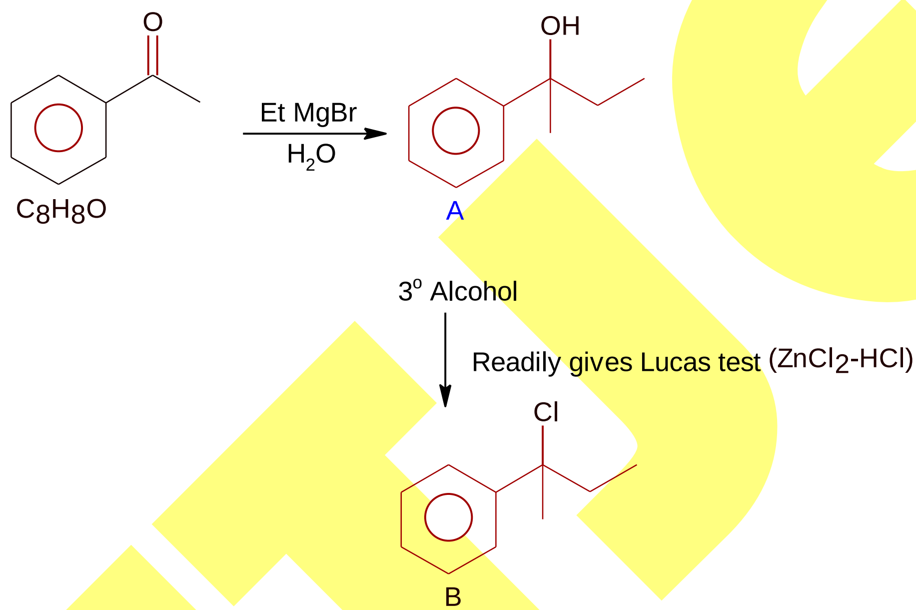
Atoms of element M = $\frac{2}{3} \times 2N$

M : A

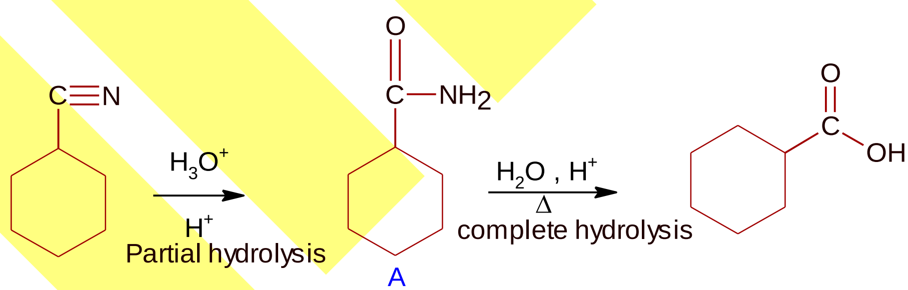
$\frac{4}{3} : 1$

So, formula of the compound is M_4A_3

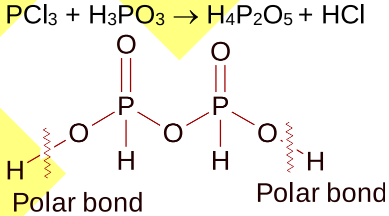
Sol17.



Sol18.



Sol19. Phosphrous Trichloride + Phosphonic acid
$PCl_3 + H_3PO_3 \rightarrow H_4P_2O_5 + HCl$

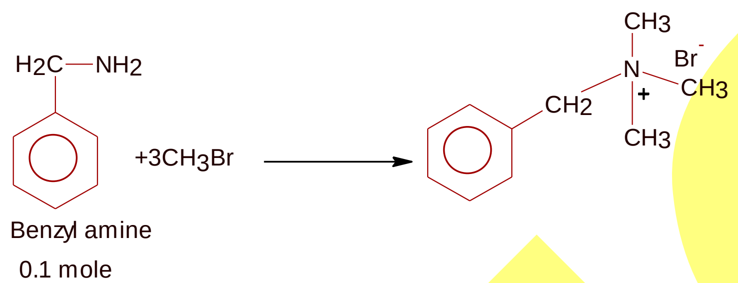


O-H bond is polar bond, so number of ionisable hydrogens are 2.

Sol20. CH_4(methane) is produced / generated from paddy fields. And methane leads both global warming and photochemical smog.
$CO_2 \rightarrow$ used in photosynthesis, acid rain etc. but methane is not consume
So methane is stronger global warming gas than CO_2

SECTION – B

Sol1.

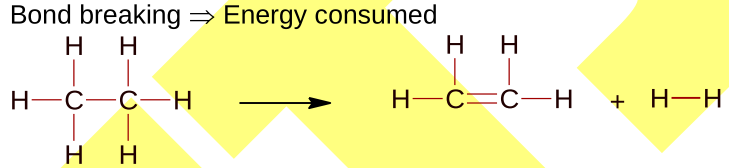


Moles of Benzyl trimethyl ammonium bromide = $\frac{23}{230} = 0.1\,\text{mol}$

$n_{CH_3Br} = 0.3 = 3 \times 10^{-1}$

$n = 3$

Sol2. $C_2H_6 \rightarrow C_2H_4 + H_2$
Bond formation $\Rightarrow$ Energy released
Bond breaking $\Rightarrow$ Energy consumed



$\Delta H_f = [\Delta H_{C-C} + 6\Delta H_{C-H}] - \Delta H_{C=C} - 4\Delta H_{C-H} - \Delta H_{H-H}$

$= \Delta H_{C-C} + 2\Delta H_{C-H} - \Delta H_{C=C} - \Delta H_{H-H}$

$= 347 + 2 \times 414 - 611 - 436$

$= 128\,\text{kJ/mol}$

Sol3. Acidic Buffer solution

$pH = pK_a + \log\frac{[Base]}{[Acid]}$

$5.74 = 4.74 + \log\frac{[Base]}{1}$

$1 = \log[Base]$

$[Base] = 10M$

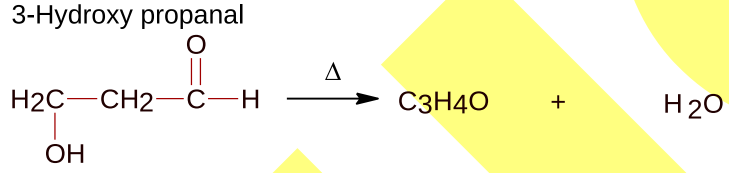
Sol4. AX$\Rightarrow$ Diatomic molecule
Bond order is 2.5
Compound is NO $\rightarrow$ Total number of electrons = 15 (7+8)

Sol5.

$$Fe^{3+} \xrightarrow{E_1^o} Fe^{2+} \xrightarrow{E_2^o} Fe$$
$$Fe^{3+} \xrightarrow{E_3^o} Fe$$

$$E_1^o + 2E_2^o = 3E_3^o$$
$$E_1^o = 3E_3^o - 2E_2^o$$
$$= 3(-0.036) - 2(-0.44)$$
$$= 0.772\,V$$
$$E_{cell}^o = E^o_{Fe^{3+}/Fe^{2+}} - E^0_{I_2/2I^-}$$
$$= 0.233\,V$$
$$\Delta G^o = -nE_{cell}^o F$$
$$= -2 \times 96.5 \times 0.233$$
$$= -45 kJ$$

Sol6. 3-Hydroxy propanal



mole $x/74$ - -

7.8/56 mole

$$\frac{x}{74} = \frac{7.8}{56}$$

$x = \frac{7.8 \times 74}{56}$ mole of 3- hydroxy propanal.

Weight = $\frac{7.8 \times 74}{56} \times \frac{100}{64}$ g

$= 16.10$ g

Ans = 16 (Rounded off)

Sol7. $2NO(g) + Cl_2(g) \rightleftharpoons 2NOCl(g)$

$$rate = K[NO]^m[Cl_2]^n$$

$rate_1 = k(0.1)^m(0.1)^n$ -------------------------(i)

(0.18)

$rate_2 = K(0.1)^m(0.2)^n$ ------------------------(ii)

(0.35)

$rate_3 = K(0.2)^m(0.2)^n$ -----------------------(iii)

(1.40)

$$\frac{0.35}{0.18} = \frac{k(0.1)^m(0.2)^n}{k(0.1)^m(0.1)^n}$$

$2 = 2^n$

$n = 1$

$$\frac{1.40}{0.35} = \frac{k(0.2)^m (0.2)^n}{k(0.1)^m (0.2)^n}$$

$4 = 2^m$

$2^2 = 2^m$

$m = 2$

Overall order $\Rightarrow m + n = 2 + 1 = 3$

Sol8. $K_f = 1.85 K \text{ kg mol}^{-1}$

$\Delta T_f = iK_f.m$

$3.885 = i \times 1.85 \times 2$

$i = 1.05$

$i = 1 + (n-1)\alpha$

$1.05 = 1 + (2-1)\alpha$

$1.05 = 1 + \alpha$

$\alpha = 0.05$

$\alpha = 50 \times 10^{-3}$

Sol9.

$$C_2H_6 + 7/2O_2 \longrightarrow 2CO_2 + 3H_2O$$

Mole of $C_2H_6 = \frac{3}{30} = 0.1 \text{mol}$

Moles of H_2O produced = 0.3mol

Number of H_2O molecules $= 0.3 \times 6.023 \times 10^{23}$

$= 18.06 \times 10^{22}$

So; x = 18 (Rounded off)

Sol10. $K_3\left[Cr(\text{oxalate})_3\right]$

$3K^+ + \left[Cr(\text{oxalate})_3\right]^{3-}$

$Cr^{3+} \Rightarrow$

$Cr(24) \rightarrow [Ar]4s^1 3d^5$

$Cr^{3+} \rightarrow [Ar]4s^o 3d^3$

no. of unpaired electron = 3

MATHEMATICS

Sol1. $a|z|^2+\overline{\bar{\alpha}z+\alpha\bar{z}}+d=0$

$az.\bar{z}+\alpha\bar{z}+\bar{\alpha}z+d=0$

$z.\bar{z}+\frac{\alpha}{a}\bar{z}+\frac{\bar{\alpha}}{a}z+\frac{d}{a}=0$

Centre $=\frac{-\alpha}{a}$

Radius $=\sqrt{\left|\frac{-\alpha}{a}\right|^2-\frac{d}{a}}$

$\therefore \left|\frac{-\alpha}{a}\right|^2-\frac{d}{a}\geq 0$

$|\alpha|^2-ad\geq 0, a\in R-\{0\}$

$|\alpha|^2-ad\geq 0, a\in R-\{0\}$

Sol2. $t_r(A+2B)=-1$..........................(I)

$t_r(A)+2t_r(B)=-1$

$t_r(2A-B)=3$

$2t_r(A)-t_r(B)=3$..........................(II)

Solving (I) and (II)

$t_r=(A)=1$

$t_r(B)=-1$

$t_r(A)-t_r(B)=2$

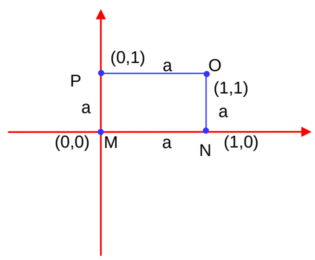
Sol3. $M: x^2+y^2=1,$ $N: x^2+y^2-2x=0$

$C\equiv(0,0)$ $C\equiv(1,0)$

$O: x^2+y^2-2x-2y+1=0,$ $P: x^2+y^2-2y$

$C\equiv(1,1)$ $C\equiv(0,1)$

As per question



Sol4. $\vec{a}=3p\hat{i}+\hat{j}$

$\vec{a}'=(p+1)\hat{i}+\sqrt{10}\hat{j}$

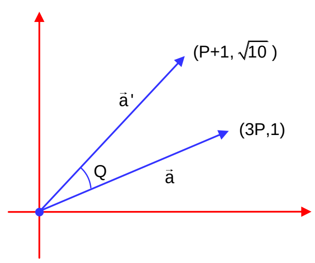
$\therefore|\vec{a}|=|\vec{a}|$

$|\vec{a}|=|\vec{a}'|$

$\therefore \phi\sqrt{(3P)^2+1}=\sqrt{(p+1)^2+\left(\sqrt{10}\right)^2}$

$4p^2-p-5=0$

$p=-1, p=\frac{5}{4}$



Sol5. $f(x) = \frac{\operatorname{cosec}^{-1}x}{\sqrt{x-[x]}}$

$\therefore$ $\operatorname{cosec}^{-1}x$ is defined on

$(-\infty,-1]\cup[1,\infty)$ and $x-[x]\neq 0$

$\{x\}\neq 0$

$x\notin I$

All non integer except in the interval $[-1,1]$

Sol6. $\sum_{r=0}^{99}(100-r)(100+r)$

$\sum_{r=0}^{99}\left\{(100)^2-r^2\right\}$

$=\sum_{r=0}^{99}(100)^2-\sum_{r=0}^{99}r^2$

$(100)^3-\frac{99(100)\times 199}{6}$

$=(100)^3-(1650)199$

$\therefore$ comparing with $\therefore (100)^2-199\beta$

$\therefore \alpha = 3\beta = 1650$

Slope = $\frac{\beta}{\alpha}$

$=\frac{1650}{3}$

$=550$

Sol7. $(1+x+2x^2)^{20} = a_0+a_1x+a_2x^2 + - - - - a_{40}x^{40}$

$\therefore$ Putting $x=1$

$4^{20} = a_0+a_1+a_2+a_3+------+a_{40}$

Putting $x=-1$

$(2)^{20} = a_0-a_1+a_2-a_3+-----+a_{40}$

Subtracting (II) from (I)

$4^{20}-2^{20} = 2a_1+2a_3+------+2a_{39}$

$2^{39}-2^{19} = a_1+a_3 ------+a_{37}+a_{39}$

$a_1+a_2+a_3+------+a_{37} = 2^{39}-2^{19}-a_{39}$

General term of expansion

$(1+x+x^2)^{20} = \frac{20!}{r_1!r_2!r_3!}(1)^{r_1};(x)^{r_2};(2x^2)^{r_3}$

$\therefore r_1+r_2+r_3=20$ and $r_2+2r_3=39$

$\therefore r_1=0, r_2=1, r_3=19$

$a_{39} = 2^{19}\frac{20!}{0!1!19!} = 2^{19}\frac{20!}{19!} = 2^{19}\times 20$

$\therefore a_1+a_2+a_3+-------+a_{37} = 2^{39}-2^{19}-2^{19}\times 20$

$$= 2^{19}\left(2^{20} - 21\right)$$

Sol8. $\frac{1}{3^2-1}+\frac{1}{5^2-1}+\frac{1}{7^2-1}+------\frac{1}{(201)^2-1}$

$$\therefore T_r = \frac{1}{(2r+1)^2-1} = \frac{1}{(2r+2)2r} = \frac{1}{2r(2r+2)}$$

$$S_n = \sum_{r=1}^{100}\frac{1}{2r(2r+2)}$$

$$= \frac{1}{2}\sum_{r=1}^{100}\frac{2}{2r(2r+2)}$$

$$= \frac{1}{4}\sum_{r=1}^{100}\frac{(r+1)-r}{r(r+1)}$$

$$= \frac{1}{4}\sum_{r=1}^{100}\left[\frac{1}{(r)}-\frac{1}{(r+1)}\right]$$

$$= \frac{25}{101}$$

Sol9.

$$\begin{vmatrix} 1+\sin^2 x & \sin^2 x & \sin^2 x \\ \cos^2 x & 1+\cos^2 x & \cos^2 x \\ 4\sin 2x & 4\sin 2x & 1+4\sin 2x \end{vmatrix} = 0$$

$R_1 \longrightarrow R_1 + R_2 + R_3$

$$= \begin{vmatrix} 2+4\sin 2x & 2+4\sin 2x & 2+4\sin 2x \\ \cos^2 x & 1+\cos^2 x & \cos^2 x \\ 4\sin 2x & 4\sin 2x & 1+4\sin 2x \end{vmatrix} = 0$$

$$\Rightarrow \sin 2x = \frac{-1}{2}$$

$$\Rightarrow x = \frac{7\pi}{12}, \frac{11\pi}{12}$$

Sol10. y = mx + C

Line passing through (1,3)

3 = x+c

$$y+1 = 3\sqrt{2}x$$

$$y = 3\sqrt{2}x - 1 \rightarrow m_1 = 3\sqrt{2}$$

$$\therefore \tan\theta = \left|\frac{m-m_1}{1+m.m_1}\right|$$

$$\therefore \sqrt{2} = \left|\frac{m-3\sqrt{2}}{1+3\sqrt{2}m}\right|$$

$$\pm\sqrt{2} = \frac{m-3\sqrt{2}}{1+3\sqrt{2}m}$$

For +ve

$\sqrt{2}+6m=m-3\sqrt{2}$

$m=\frac{-4\sqrt{2}}{5}$

For –ve

$-\sqrt{2}=\frac{m-3\sqrt{2}}{1+3\sqrt{2}m}$

$-\sqrt{2}-6m=m-3\sqrt{2}$

$m=\frac{2\sqrt{2}}{7}$

$\therefore$ Equation $=y=\frac{-4\sqrt{2}x}{5}+\frac{3+4\sqrt{2}}{5}$

Sol11. $f(x)+g(x)=\sqrt{x}+\sqrt{1-x}$ Domain $[0,1]$

$f(x)-g(x)=\sqrt{x}-\sqrt{1-x}$

$D_f\in[0,1]$

$g(x)-f(x)=\sqrt{1-x}-\sqrt{x}$

$D_f\in[0,1]$

$\frac{f(x)}{g(x)}=\frac{\sqrt{x}}{\sqrt{1-x}}$

$D_f\in[0,1)$

$\frac{g(x)}{f(x)}=\frac{\sqrt{1-x}}{\sqrt{x}}$

(0, 1)

$\therefore$ Common Domain (0,1)

Sol12. $3x+4y=9$

Solving two equation

$3x+4(mx+1)=9$

$x=\frac{5}{3+4m}$

$\therefore(3+4m)=\pm1,\pm5$

$\therefore m=-1,\frac{-1}{2},-2,\frac{1}{2}$

$\therefore$ Two integral value , $-1,-2$

Sol13. $y^2=4a(x+a)$

$2y\frac{dy}{dx}=4a$

$\frac{dy}{dx}=\frac{4a}{2y}$

$a=\frac{y}{2}\frac{dy}{dx}$

$$y^2 = 4\left(\frac{y}{2}\right)\frac{dy}{dx}\left(x+\frac{y}{2}\frac{dy}{dx}\right)$$

$$y^2 = 2y\frac{dy}{dx}.x + y^2\frac{dy}{dx}$$

$$y^2.\frac{dy}{dx} + 2y\frac{dy}{dx} - y^2 = 0$$

$$y\frac{dy}{dx} + 2x\frac{dy}{dx} - y = 0$$

Sol14. $\begin{vmatrix} \alpha & \beta & \gamma \\ \beta & \gamma & \alpha \\ \gamma & \alpha & \beta \end{vmatrix} = 0$

$$-\left(\alpha^3+\beta^3+\gamma^3-3\alpha\beta\gamma\right)=0$$

$$-(\alpha+\beta+\gamma)\left(\alpha^2+\beta^2+\gamma^2-\alpha\beta-\beta\gamma-\gamma\alpha\right)=0$$

$$(\alpha+\beta+\gamma)\left(\alpha^2+\beta^2+\gamma^2-\alpha\beta-\beta\gamma-\gamma\alpha\right)=0$$

From given equation

$$\alpha+\beta+\gamma=(-a), \alpha\beta+\beta\gamma+\gamma\alpha=b$$

$$(-a)\left(a^2-2b-b\right)=0$$

$$a\left(a^2-3b\right)=0$$

$$a^2=3b$$

$$\frac{a^2}{b}=3$$

Sol15. $\int \frac{(2x-1)\cos\sqrt{(2x-1)^2+5}}{\sqrt{4x^2-4x+6}}dx$

$$=\int \frac{(2x-1)\cos\sqrt{(2x-1)^2+5}}{\sqrt{(2x-1)^2+5}}dx$$

$\therefore$ Let $(2x-1)^2+5=t^2$

$$2(2x-1).2dx = 2tdt$$

$$2(2x-1)dx = tdt$$

$$(2x-1)dx = \frac{t}{2}dt$$

$$\therefore \int \frac{t}{2}.\frac{\cos t}{t}.dt$$

$$=\frac{1}{2}\int \cos t.dt$$

$$=\frac{1}{2}\sin t + c$$

$$=\frac{1}{2}\sin\sqrt{(2x-1)^2+5}+c$$

Sol16. $\lim\limits_{x\to 0}\dfrac{\sin^{-1}x-\tan^{-1}x}{3x^3}$

$$L=\lim_{x\to 0}\frac{\left(x-\frac{x^3}{3!}+\frac{x^5}{5!}----\right)-\left(x-\frac{x^3}{3}----\right)}{3x^3}$$

$$3L=\frac{1}{2}$$

$$6L=1$$

$$6L+1=2$$

Sol17. Total distinct number is $\dfrac{4!}{2}=12$

At unit place

| | | | 1 | $=\frac{3!}{2!}=3$

| | | | 2 | $=3!=6$

| | | | 3 | $=\frac{3!}{2!}=3$

Sum of digit at unit place $=(3\times 1+6\times 2+3\times 3)$

$=3+12+9$

$=24$

$\therefore$ Sum of all digit $=24\left(10^3+10^2+10+1\right)$

$=24(1111)$

$=26664$

Sol18. f(x) is continuous at x=1

$\therefore 1=a+b$

f(x) is differentiable of x = 1

$\because -1=2a$

From above two relation

$$a=\frac{-1}{2},b=\frac{3}{2}$$

Sol19. From question

$$y=3+\cfrac{1}{4+\cfrac{1}{y}}$$

$$4y^2-12y-3=0$$

$$y=\frac{3\pm 2\sqrt{3}}{2}$$

$$y=1.5+\sqrt{3},y>0$$

Sol20. $x^2+y^2-10x-10y+41=0$

$$C_1\equiv(5,5),r_1=\sqrt{9}$$

$$r_1=3$$

$x^2+y^2-22x-10y+137=0$

$C_2 \equiv (11,5), r_2=\sqrt{9}$

$r_2=3$

$\therefore$ direction b/w centres

$d(C_1C_2)=6$

$\therefore r_1+r_2=6$

Circle touches externally, have one melting point

SECTION- B

Sol1. $f(x)=\int \frac{5x^8+7x^6}{\left(x^2+1+2x^7\right)^2}dx, (x \ge 0)$

$f(x)=\int \frac{5x^8+7x^6}{x^{14}\left(2+\frac{1}{x^5}+\frac{1}{x^7}\right)^2}dx$

$f(x)=\int \frac{\left(\frac{5}{x^6}+\frac{7}{x^8}\right)}{\left(2+\frac{1}{x^5}+\frac{1}{x^7}\right)^2}dx$

$2+\frac{1}{x^5}+\frac{1}{x^7}=t$

$-\left(\frac{5}{x^6}+\frac{7}{x^8}\right)dx=dt$

$f(x)=\int \frac{-dt}{t^2}$

$f(x)=\frac{1}{t}+c$

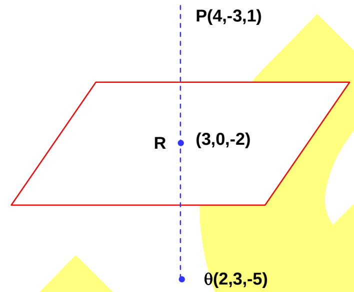
$f(x)=\frac{1}{2+\frac{1}{x^5}+\frac{1}{x^7}}+c$

$\therefore f(0)=0 \Rightarrow c=0$

$f(1)=\frac{1}{k}$

$k=4$

Sol2. DR's of line



$((2-4),(3+3),(-5-1))$

$(-2,6,-6)\equiv(a,b,c)$

$\therefore$ point R lie on plane

$ax+by+cz+d-0$

$3a-2c+d=0$

Line perpendicular to plane.

$\frac{a}{a_1}=\frac{b}{b_1}=\frac{C}{C_1}=k$

$\therefore a=-2k, b=6k, c=-6k$

$\therefore d=-6k$

$a^2+b^2+c^2+d^2=112k^2$

$k=\frac{1}{2}$ (a,b,c,d are integer)

$\therefore (a^2+b^2+c^2+d^2)_{min}=28$

OR

Plane $1(x-3)-3(y-0)+3(z+2)=0$

$x-3y+3z+3=0$

$\therefore (a^2+b^2+c^2+d^2)_{min}=28$

Sol3. $\overline{X}=\frac{\sum_{i=1}^{25}x_i}{25}=40$

$\sum_{i=1}^{25}x_i=1000$

After retirement of a teacher

$\sum_{i=1}^{24}x_i=1000-60=940$

New mean

$\overline{X'}=\frac{\sum_{i=1}^{24}x_i+x}{25}$

$39=\frac{940+x}{25}$

$\therefore x=35$

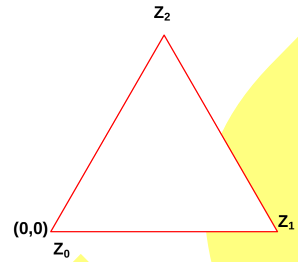
Sol4. $1=(2-1)^{1!}$

$3^6=(7-4)^{3!}$

$4^{24}=(12-8)^{4!}=4^{4!}=4^{24}$

$\therefore$ Blank space must be

$(5-3)^{2!}=2^2$



Sol5. $z_0^2 + z_1^2 + z_2^2 = z_0z_1 + z_1z_2 + z_2z_0$

$(z_1 + z_2)^2 = 3z_1.z_2$

$z_1 + z_2 = (-a), z_1.z_2 = 12$

$a^2 = 3 \times 12$

$a^2 = 36$

$|a| = 6$

Sol6. Equation of plane parallel to the plane

$x - 2y + 2z - 3 = 0$ is

$x - 2y + 2z + \lambda = 0$

As per question

$\frac{|1 - 4 + 6 + \lambda|}{\sqrt{1+4+4}} = 1$

$|\lambda + 3| = 3$

$\lambda + 3 = \pm 3$

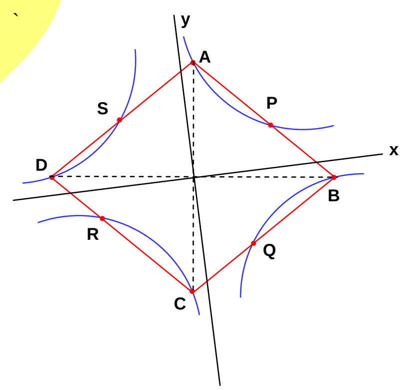
$\lambda = 0$ or -6

$\therefore k = \frac{b-d}{c-a}$

$k = \frac{(-2)-0}{2-1}$ or $\frac{(-2)+6}{2-1}$

$K = -2$ or 4

Sol7. $OA \perp OB$



$\therefore m(OA) = \frac{0 - \frac{1}{t_1}}{0 - t_1} = \frac{1}{t_1^2}$

$m(OB) = \frac{0 + \frac{1}{t_2}}{0 - t_2} = \frac{-1}{t_2^2}$

$\therefore m(OA) \times m(OB) = -1$

$\therefore \frac{1}{t_1^2} \times \frac{-1}{t_2^2} = -1$

$\therefore (t_1.t_2)^2 = 1$

$t_1^2 = \frac{1}{t_2^2}$ ....(I)

Mid point lie on the $x^2y^2 = 1$

$(t_1 + t_2)^2 (t_2 - t_1)^2 = 16$

$(t_2^2 - t_1^2)^2 = 16$

$t_2^2 - t_1^2 = \pm 4$

From (I)

$t_1^2 - \frac{1}{t_1^2} = \pm 4$

On solving

$\text{Area} = 4\left(\frac{1}{2}\right) \times (OA) \times (OB)$

$= 4 \times \sqrt{5}$

$= 4\sqrt{5}$

Sol8. $f(x^2) + g(4-x) - 4x^3 = 0$

$\Rightarrow \int_0^4 f(x^2)dx + \int_0^4 g(4-x)dx - \int_0^4 4x^3 dx = 0$ **..........(i)**

$\Rightarrow \int_0^4 f(x^2)dx = \int_0^4 g(x)dx - \int_0^4 4x^3 dx = 0$ **...........(ii)**

Adding (i) & (ii),

$\Rightarrow 2\int_0^4 f(x^2)dx + 0 = 8\int_0^4 x^3 dx = 512$

$\Rightarrow \int_{-4}^4 f(x^2)dx = 512$

Sol9. one '3'

3	–	–	$9 \times 9 \times 1 = 81$	
–	3	–	$9 \times 9 \times 1 = 81$	
–	–	=	$9 \times 9 \times 1 = 81$	

Two '3'

3	3	–	=	$9 \times 2 = 18$
3	–	3	=	$9 \times 2 = 18$
–	3	3	=	$9 \times 2 = 18$

Three '3'

$\underline{3}$	$\underline{3}$	$\underline{3}$	$= 1 \times 3 = 3$

Total = 300

Sol10. $|\cot x| = \cot x + \frac{1}{\sin x}$

Case 1 : when $\cot x \geq 0$ $\cot x = \cot x + \frac{1}{\sin x}$

$\frac{1}{\sin x} = 0$

Case 2 : when $\cot x \leq 0$ $-\cot x = \cot x = \frac{1}{\sin x}$

$-2\cot x = \frac{1}{\sin x}$

$\frac{-2\cos x}{\sin x} = \frac{1}{\sin x}$

$\cos x = \frac{-1}{2}$

$$\therefore x \in \left\{\frac{2\pi}{3}, \frac{4\pi}{3}\right\}$$

but $\cot x < 0$

$$\Rightarrow x = \frac{2\pi}{3}$$