Chemistry:

Q. 1.

a. Two silver rods are dipped in 1M HCl and 1M HNO_3. In which of the two acids will the silver rods dissolve under standard conditions? Given:

$E^0_{Ag/Ag^+} = -0.79\ volt,\ E^0_{NO_3^-/NO} = +0.96\ volt$

b. A 0.1M acetic acid solution ionizes to 1.2%. What is its Ka ?

Sol. Silver rod will dissolve more readily in HNO_3 than HCl because HCl is a non-oxidizing acid. Me[illegible]e establish E^0_{cell} for the reaction

$Ag + HNO_3 \rightarrow Ag^+ + NO + H_2O\ then \quad E^0_{cell} = +0.96 - (-0.79) = +1.75\ volt$

As the E^0_{cell} is positive the reaction would take place spontaneously under sta[illegible]ard conditions.

Q. 2.

$For\ 0.5\ M\ H_2SO_3\ solution\ Ka_1 = 1.8 \times 10^{-2}\ and\ Ka_2 = 8.3 \times 10^{-5}$

$Find\ the\ concentrations\ of\ H^+,\ HSO_3^-\ and\ SO_3^{2-}$?

a.

b. N_2O_4 dissociates with a degree of dissoci[illegible]n as 0[illegible] Establish $K\chi$. Relation between $K\chi$ and Kp and the value of Kp . Given total pre[illegible]ure [illegible]atm [illegible] T = 315 K

c. 1 Mole of nitrogen and 4 mo[illegible] of Hy[illegible]ge[illegible]acts to form ammonia in a 20 ltr vessel. 10 litres of water are added and the vessel properly [illegible]aken [illegible] will be the pressure of the residual gases?

Sol.

$H_2SO_3 \leftrightarrow H^+ + HSO_3^- \qquad Ka_1 = 1.8 \times 10^{-2}$

$HSO_3^- \leftrightarrow H^+ + SO_3^{2-} \qquad Ka_2 = 8.3 \times 10^{-5}$

$H_2SO_3 \leftrightarrow H^+ + HSO_3^-$

$0.5 - x \qquad x \qquad x$

$$\Rightarrow 1.8 \times 10^{-2} = \frac{x^2}{0.5 - x}$$

$or\ 0.9 \times 10^{-2} - 1.8 \times 10^{-2}\ x = x^2 \quad or \quad x^2 + 1.8 \times 10^{-2} x - 0.9 \times 10^{-2} = 0$

$\Rightarrow x^2 + 0.018x - 0.009 = 0$

$$Value\ of\ x = [H^+] = [HSO_3^-] = 0.08625\ mol/1 \quad Ka_2 = \frac{[SO_3^{2-}\ [H^+]]}{HSO_3^-}$$

$= 8.3 \times 10^{-5}\ As\ [H^+] = [HSO_3^-]$

a. $[so_3^{2-}]CONC = Ka_2 = 8.3 \times 10^{-5}\ mol/1$

$N_2O_4 \qquad 2NO_2 \qquad Total\ moles$

$t = eq\ 1 - 0.4 = 0.6 \leftrightarrow 0.4 \times 2 = 0.8 \quad 1.4$

$$K\chi = \frac{(\chi_{NO_2})^2}{(\chi_{N_2O_4})} = \frac{\left(\frac{0.8}{1.4}\right)^2}{\left(\frac{0.6}{1.4}\right)} = \frac{0.8 \times 0.8}{1.4 \times 1.4} \times \frac{1.4}{0.6} = 0.76$$

b. $Also,\ K_p = K\chi\ (P_{total})^{\Delta n_g} = 0.76\ (1)^1 = 0.76\ atm$

$N_2 \quad + \quad 3H_2 \quad \rightarrow \quad 2NH_3$

$1 Mole \qquad 4\ Mole \qquad 2\ mole$

c. $(1\ mole\ H_2\ leftout)$

The formed NH3 shall diss[illegible] in water on shaking

So. $P_{H_2} \times V = n \times R \times T \Rightarrow P_{H_2} \times 10 = 1 \times 0.0821 \times 298 = 2.45\ atm$

When 10 lits H-O [illegible] added, [illegible] effective volume of the vessel occupied by H_2 gas will be 20 [illegible] ltr

Q. 3.

[illegible] electron in which orbit of lithium will have same energy as an electron in the second orbit of hydrogen?

$I_2 + CH_3COCH_3 \rightarrow CH_3COCH_2I + HI$. *For the reaction, Rate* $= K\left[CH_3COCH_3\right]^1\left[H^+\right]^1$.

What is the order of the reaction with respect to I^2? *Also give the total order.*

$[I_2]$ *Mol / ltr*	$[CH_3COCH_3]$ *Mol / ltr*	$[H^+]$ *Mol / ltr*	*Rate Mol / ltr* sec
3×10^{-3}	2.5×10^{-2}	1.5×10^{-3}	2×10^{-2}

b. Also find the value and unit of the rate constant from the data given above.

c. For a photoelectron, the frequency is given by the expression $V = 3.3\times10^{15}\left(\frac{1}{2^2}-\frac{1}{n^2}\right)$. If the wavelength of the photoelectron is $6600\ \overset{0}{A}$, what will be the value of 'n'?

Sol.

a. Energy of electron in second orbit of hydrogen

$= 1312\times\frac{1^2}{2^2}\ KJ/mole = -1312\times\frac{1}{4}\ KJ/mole$

For lithium $\left(Li^{+2}\right)$ ion energy should be $= -1312\times\frac{3^2}{6^2}\ KJ/mole$ *to be same.*

The electron must be in the sixth Bohr orbit of Li^{+2}

b. As I_2 does not feature in the rate law expression so, the order of the reaction w.r.t I_2 will be zero.The total order of the reaction = 2 Rate

$$\left(2\times10^{-2}\right) = K\left[2.5\times10^{-2}\right]\left[1.5\times10^{-3}\right] K = \frac{2\times10^{-2}}{2.5\times10^{-2}\times1.5\times10^{-3}} = 533\ mol^{-1}\ l\sec^{-1}$$

'K' value for second order of the reaction $= mol^{-1}\ l\sec^{-1}$

c. $$\frac{3.3\times10^8}{6600\times10^{-10}} = 3.3\times10^{15}\left(\frac{1}{2^2}-\frac{1}{n^2}\right) as\ v = \frac{c}{\lambda}\ n \approx 4\ \left(4^{th}\ orbit\right)$$

Q. 4.

a. Complete the reaction given below

Cyclohexanonoxime

b. Identify which of the following given compounds is optically active

(i)2-chloro 3-methyl pent -1, 4-diene

(ii) 3-methyl 3-hydroxy pentanol

(iii) 2-chloro 2-methyl butane

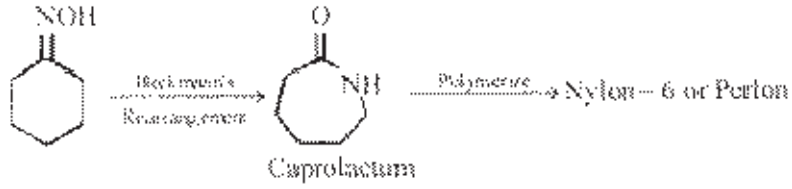
c. Convert:

(i) $Ph - C \equiv CH \rightarrow Ph - \underset{\underset{O}{\|}}{C} - CH_3$

(ii) $Ar - NH_2 \rightarrow ArNC$

d. An alkene C_4H_8 reacts with HBr both in the presence and absence of peroxides to give the same product. Identify the alkene.

Sol.

a. 

b. (i) $H_2C = \underset{\underset{CH_3}{|}}{C}(Cl) - CH - CH = CH^2$

(Optically active)

(ii) $CH_3 - CH_2 - \underset{\underset{OH}{|}}{C}(CH_3) - CH_2 - CH_2\ OH$

(Optically active)

$$CH_3 - \underset{\underset{CH_3}{|}}{\overset{\overset{CI}{|}}{C}} - CH_2 - CH_3$$

(iii)

(Optically inactive)

c. (i) $Ph - C \equiv CH \xrightarrow[H_2SO_4]{HgSO_4} Ph - \overset{OH}{\overset{|}{C}} = CH_2 \xrightarrow{\text{Tautomerize}} Ph - \overset{O}{\overset{\|}{C}} - CH_3$

(ii) $Ar - NH_2 \xrightarrow[Aq\,KOH]{CHCl_3} Ar - N \equiv C$ (Carbylamine Reaction)

d. As 2-butene $(C_4\ H_8)\left[CH_3 - CH = CH_3\right]$ is symmetric so, its reaction with HBr with or without a peroxide would yield the same product 2-Bromo butane.

Q. 5.

a. (i) $C_4H_{10}O$ is produced on reaction of an alkane with H_2O / H_2SO_4, which is not resolvable into optical isomers. Identify the compound?

b. (ii) Make two possible dipeptides from the [illegible] acids given below:

$$NH_2 - (CH_2)_5 - \underset{\underset{NH_2}{|}}{CH} - COOH \ \ and \ \ NH_2 - \underset{\underset{COOH}{|}}{CH} - (CH_2) - COOH$$

c. The amino acid alanine when kept in solution with pH less than its isoelectric point it coagulates at the cathode and if pH is greater than its isoelectric point it coagulates at anode. Explain this phenomenon.

d. Which out of 1-Butene and 2-Butene react easily with Br_2 in CS_2 and why?

Sol.

a. The [illegible] must be

$$CH_3 - \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{CH}} \xrightarrow{(O)} CH_3 - \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} - OH$$

2 - methyl propane (Isobutane) → Tertiary Butanol $(C_4H_{10}O)$

b. The two dipeptides would be

$$\left[\begin{array}{c} O \\ \| \\ H_2N-(CH_2)_5-\underset{\underset{NH_2}{|}}{CH}-\overset{\overset{O}{\|}}{C}-NH-\underset{\underset{COOH}{|}}{CH}-(CH_2)_3-COOH \end{array}\right] and$$

$$\left[\begin{array}{c} O \\ \| \\ H_2N-(CH_2)_5-\underset{\underset{COOH}{|}}{CH}-NH-\overset{\overset{O}{\|}}{C}-\underset{\underset{NH_2}{|}}{CH}-(CH_2)_3-COOH \end{array}\right]$$

c. (iii) In an acidic solution alanine exists as

$$\underset{NH_2}{CH_3-CH-COOH} \rightleftharpoons \left[\begin{array}{c} CH_3-\underset{\underset{+NH_3}{|}}{CH}-COOH \end{array}\right]$$

As the colloid is now positively charged it coagulates at the negative electrode (cathode) when $(P^H < 7)$ (Iso electric pH In basic media $(P^H > 7)$)

This colloid is now negatively charged so it coagulates at the anode (positive electrode)

d. 1-butene is less crowded than 2-butene and will react more readily with Br_2 / CS_2

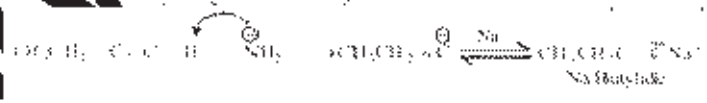
Q. 6.

a. Why 1-Butyne gives sodium salt with $NaNH_2$ but 2-butyne does not?

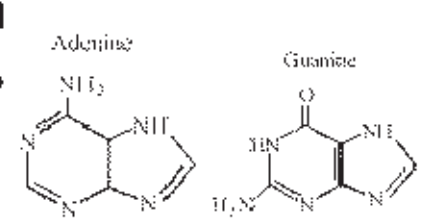
b. Draw the structures of DNA purines?

Sol.

a. The terminal hydrogen in 1-Butyne is acidic. There is no such available hydrogen is 2-Butyne.



b.



Q. 7.

a. Why NH_3 is more soluble in water than PH_3?

b. Why BH_3 dimerizes but BF_3 does not?

c. The complex $K\left[PtCl_3C_2H_4\right]$ has 3 chlorine atoms bonded to platinum. Why is the chlorine atom lying opposite to ethene have higher bond length?

Sol.

a. Nitrogen in NH_3 is electron dense and electronegative, it has the ability to hydrogen bond with water. Phosphorous does not show hydrogen bonding.

b. BF_3 is stabilized by $P\pi - P\pi$ back bonding due to which the electron deficiency of the central boron is satisfied. Backbonding is not seen in BH3 due to which it involves in bridge bonding.

c. Ethene is $\pi -$ a donor ligand when the $\pi -$ cloud of ethane is polarized for donation into the d-orbitals of Pt, the chlorine lying opposite to it experiences repulsions. This causes the bond length to increase.

Q. 8.

a. Why PO_4^{3-} ions exist but NO_4^{3-} ions don't?

b. Why B_2 is paramagnetic but C_2 is not?

c. For a octahedral fields splitting $\Delta_0 > P$ when the pairing energy is less and $\Delta_0 < P$ when pairing energy is higher. Explain the spin magnetic moments acquired by d^5 and d^6 configurations of metal ions in this field.

Sol.

a. In order to form NO_3^{4-} nitrogen will have to exceed its octet and utilize d-orbitals to form multiple bonds with oxygen. As nitrogen does not have d-orbitals this is not possible.

b. B_2 has a total of $B10\,e^-$ with a M.O configuration

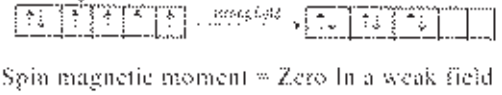
$$\sigma_{1s}{}^2\ \sigma_{1s}{}^{*2}\ \sigma_{2s}{}^2\ \sigma_{2s}{}^{*2}\begin{cases}\pi^1\ 2_{py}\\ \pi^1\ 2_{pz}\end{cases}$$

C_2 has 12 electrons due to which the $\pi -$ bonding molecular orbitals fill up completely making it diamagnetic.

In strong field

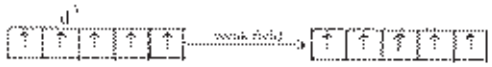
Complex will be paramagnetic.

Spin magnetic moment $= \sqrt{1\,(1+2)}\ B.M = 1.732\ B.M$



Complex will be diamagnetic.

Spin magnetic moment = Zero In a weak field



Spin magnetic moment $= \sqrt{(5)(5+2)}\ B.M = 5.8\ B.M$

Spin magnetic moment $= \sqrt{(4)(4+2)}\ B.M = 4.8\ B.M$

Q. 9.

a. The empirical formula of an insoluble compound is $PtCl_2.(NH_3)_2$. On charging this compound with $AgNO_3$ we get $[Pt(NH_3)_4]Cl_2$ and $Ag_2[PtCl_4]$. The molecular formula of the compound will be?

b. Out of trimethyl amine and triethyl phosphine, which one has higher dipole moment?

Sol.

a. From the products we understand that the complex must be a higher empirical derivative of $PtCl_2.(NH_3)_2$ that is $[Pt(NH_3)_4]^{+2}[PtCl_4]^{2-}$

The complex is tetraammineplatinum (II) tetrachloroplatinate (II)

b. $(CH_3)_3\ddot{N}$ $\mu = 5.02\ D$ $(C_2H_5)_3\ddot{P}$ $\mu = 4.89\ D$

Both molecules shown above are pyramidal. Due to repulsions that arise between three Ethyl groups in triethyl phosphine the bond angle is larger which results in a lower Dipole moment.

Q. 10.

a. Why is F_2 more reactive than Cl_2?

b. Why is CrO_4^{2-} more oxidizing than MoO_4^{2-}

c. Out of $(SiH_3)_2O$ and $(CH_3)_2O$ which is more basic and why?

Sol.

a. Due to high charge density of the Fluorine atom, inner electrons repel each other in the F – F bond making it weak and increasing the reactivity of F_2.

b. Most oxo ions of chromium are very strongly oxidizing. The most stable oxidation state of chromium is (+III), this results in spontaneous reduction of CrO_4^{2-} to form Cr^{+3}. For molybdenum (+III) state is uncommon, in fact MoO_4^{2-} has Mo in (+VI) state which is the most stable.

c. $H_3Si-\ddot{O}:-SiH_3 \longleftrightarrow H_3Si=\overset{\oplus}{O}-SiH_3$ shows $p\pi-d\pi$ bonding due to the presence of vacant d-orbitals with Si. This however is not possible with carbon in CH_3-O-CH_3 due to absence of d-orbitals making it more basic.

Physics:

Q. 1.

a. How many photons of wavelength 439 nm should strike on a perfectly reflecting surface in one second so that it may exert a force of 10N?

b. Can water be boiled without heating?

Sol.

a. When photon incident on perfectly reflecting surface the change in momentum per second $= \frac{2h}{\lambda}$

Let n photons incident per second then force exerted,

$$F = \frac{2nh}{\lambda}$$

$$10 = 2 \times n \times \frac{6.6 \times 10^{-34}}{439 \times 10^{-9}} \; So, n = \frac{439\,10^{-8}}{2 \times 6.6 \times 10^{-34}} = \frac{439 \times 10^{-8+35}}{132} = 3.325 \times 10^{27}$$

b. On increasing pressure onto the surface of water in a pressure cooker its boiling point is elevated, similarly on decreasing pressure in a vessel containing water its boiling point will be lowered and water will begin to boil without supplying heat.

Q. 2.

a. When 4 amp current flows through battery from positive to negative terminal potential difference is 12V obtained when 2 amp current passes from negative to positive terminal of the battery potential difference 9V is obtained, calculate emf and internal resistance of the battery.

b. A pulley of radius 20 cm and moment of inertia 0.32 kg m2 is used to hang a 2kg mass with the help of massless string. If this load is released then calculate acceleration of the block.

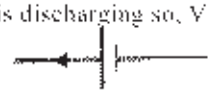
Sol.

a. In first case, cell is Charging so, V = E + Ir ;

12 = E + 4 r .....(i)

In 2nd case, cell is discharging so, V = E - Ir ;

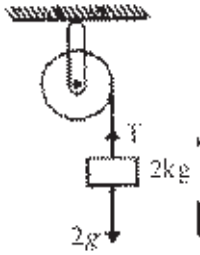
9 = E - 2 r ...(ii)



Subtracting (ii) from (i)

$3 = 6r,\ r = 1/2\Omega$ by putting value of r in equation (ii) $E = 9 + (2 \times 1/2) = 10\,V$

b. Considering linear motion of load (2kg) 2g - T = 2a ....(i)



For rotational motion of pulley

$$TR = I\alpha \quad T = 0.32 \times \frac{\alpha}{\left(20 \times 10^{-2}\right)^2} \qquad ...(ii)$$

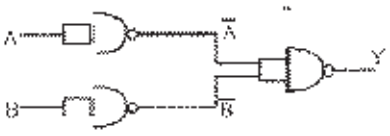
$$\textit{Fitting the value of } T \textit{ in (i)}\ 2\,g - \frac{0.32\,a}{400 \times 10^{-4}} = 2a \qquad ...(i)$$

$$2\,g - \frac{0.32\,(a)}{0.04} = 2\,(a);\ 2\,g = 10a;\ a = \frac{2\,g}{10} = 2m/\sec^2$$

Q. 3.

a. Prove that for a monoatomic gas ratio of specific heat $\gamma = 5/3$

b. Give the truth table of the following



Sol.

a. $\therefore \gamma = 1 + \frac{2}{f} = 1 + \frac{2}{3} = 5/3$. The degree of freedom is the number of independent ways in which a molecule can have energy. Since mono-atomic gas can move linearly but cannot rotate. So it has only 3 degrees of freedom.

b. $Y = \left(\overline{\overline{A}} . \overline{\overline{B}}\right) = \overline{\overline{A}} | + \overline{\overline{B}} = A + B$

Truth table

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Q. 4.

a. Write the difference between nuclear force and coulombic force.

b. An airplane is moving horizontally with speed of 100 m/sec at height of 2000 m from ground. A small object isdetached from it and strikes the ground. Calculate the angle from vertical with which it strikes the ground.

c. Which of the following quantities have same dimension formula? Angular momentum, impulse, energy, torque, force and moment of inertia.

Sol.

a. There are following differences between coulombic force and nuclear force

Coulombic force	Nuclear force
a. Coulombic force is charge dependent	a. Nuclear force is charge independent.
b. It obeys inverse square law of distance	b. It does not obey inverse square law but it obeys inverse law of rawhere nis very large number.
c. The nature of coulombic force does not change with distance.	c. The nature of nuclear force changes with distance.
d. It is weaker than nuclear force	d. It is very stronger than coulombic force.

b. The velocity of the object along vertical downward $V_y = \sqrt{2gh} = \sqrt{2 \times 10 \times 2000} = 200\ m/s$

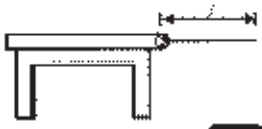
c. While velocity along horizontal Vx = 100 m/s Let the angle made by object with vertical downward is

$$\theta \quad Then\ \tan\theta = \frac{V_x}{V_y} = \frac{100\ m/s}{200\ m/s} = 1/2; \quad \theta = \tan^{-1}(1/2).$$

d. A dimensional formula of torque $= \left[M^1\ L^2\ T^2\right]$ and that of energy is $= \left[M^1\ L^2\ T^2\right]$. So, both have same dimensional formula.

Q. 5.

a. From a table, a rod is hinged as shown in the figure. When the support is withdrawn calculate the acceleration of center of mass.



b. There are two wires each produces frequency of 500Hz. By what percentage tension in one wire is increased so that 5 beats per second can be heard?

Sol.

a. Torque on the rod about axis of rotation

$$I\alpha = mg\frac{1}{2} \qquad \left(\alpha\ \frac{\alpha}{I/2}\right)$$

$$I\frac{\alpha}{I/2} = mg\frac{1}{2},\ a = \frac{mg}{I}\frac{I^2}{4} = \frac{mg\ I^2}{\frac{mI^2}{3}\times 4} = \frac{3g}{4}\ m/\sec^2$$

$$Frequency\ \nu \propto T^{1/2}\ (T\ is\ tension)$$

$$\Rightarrow \frac{\Delta\nu}{\nu} = \frac{1}{2}\frac{\Delta T}{T} \qquad \Rightarrow \frac{5}{500} = \frac{1}{2}\frac{\Delta T}{T} \qquad \Rightarrow \frac{5\times 100}{500} = \frac{1}{2}\frac{\Delta T}{T}\times 100$$

$$\Rightarrow Change\ in\ tension = 2\%$$

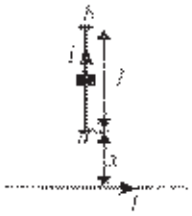
b.

Q.

a. Find the force on conductor carrying current i as shown the figure.

b. A conducting cone is given charge q. How will the charge density and electric potential varies at different points of cone?

Sol.



a. The magnetic field at distance x from infinitely long conductor $B = \frac{\mu_0 I}{2\pi y}$ Force acting on dy length dF = idyB

$$\therefore \text{Total force } F = \int_x^{(x+l)} B\,dy\,i = \int_x^{(x+l)} \frac{\mu_0 I i dy}{2\pi y} = \frac{\mu_0 I i}{2\pi}\left[\log y\right]_x^{x+1};$$

$$F = \frac{\mu_0 I i}{2\pi}\log\frac{x+l}{x} = \frac{\mu_0 I i}{2\pi}\log\left[1+\frac{l}{x}\right]$$

b. Charge density $\sigma = \frac{q}{4\pi r^2}$ $so, q = \sigma . 4\pi r^2$

Since potential on surface of any conductor is constant

$$\therefore \frac{kq}{r} = cons\tan t$$

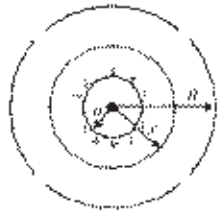
$$or\ k\sigma\frac{4\pi r^2}{r} = cons\tan \quad or \quad \sigma \propto \frac{1}{r}$$

7.

a. Equation for two waves is given as

$y_1 = a\ \sin\ (\omega t + \phi_1), y_2 = a = \sin\ (\omega t + \phi_2)$ If amplitude and time period of resultant wave does not change then calculate $(\phi_1 - \phi_2)$

b. A solid sphere of radius a having charge q is placed inside spherical shell of inner radius r, outer radius R. Find potential at distance x, where r < x < R .



Sol.

a. $$Let\ \phi = \phi_1\ \phi_2\ and\ resul\tan t\ amplitude\ A = a$$
$$A^2 = a^2 + a^2 + 2aa\cos(\phi_1 - \phi_2) \Rightarrow a^2 = 2a^2 + 2a^2\cos(\phi_1 - \phi_2)$$
$$\cos(\phi_1 - \phi_2) = -\frac{1}{2}\ i.e,\ (\phi_1 - \phi_2) = 120^0$$

b. V_1 = potential due to solid sphere of radius $\frac{kq}{x}$

V_2 = potential due to inner surface of shell $= \frac{k(-q)}{x}$; V_3 = potential due to outer surface of shell $= \frac{kq}{R}$

$$Total\ potential = \frac{kq}{x} + \frac{k(-q)}{x} + \frac{kq}{R} = \frac{kq}{R}$$

Q. 8.

a. In photoelectric effect, photon of wavelength $3300\,\overset{0}{A}$ is incident on metal surface of work function 2.5eV. Now emitted electrons enter in transverse magnetic field $6.7 \times 10^{-6}\ T$ and turn in a circular path of radius 2.5cm. Calculate charge of electron from the given data?

b. If temperature and magnetic field applied across paramagnetic substance are tripled, how many times intensity of magnetization of substance will change?

a. Energy of incident light

$$= \left(\frac{hc}{\lambda}\right) = \left(\frac{6.63\times10^{-34}\times3\,10^{8}}{3.3\times10^{-7}}\right) = 6\times10^{-19}\ J$$

$$Now,\ r = \frac{\sqrt{2m\left(KE\right)}}{eB} \quad 0.5 = \frac{\sqrt{2\times9.1\times10^{-31}\times\left(2\times10^{-19}\right)}}{e\times6.7\times10^{-6}}$$

$$e = \frac{6\times10^{-25}}{6.7\times10^{-6}\left(\frac{1}{2}\right)} = \frac{12}{6.7}\times10^{-19}\ coloumb = 1.79\times10^{-19}\ C\ (approx)$$

b. From curie's law $I \propto \frac{B}{T}$

If temperature and applied magnetic field are tripled then. $I' \propto \frac{3B}{3T}; \propto \frac{B}{T}$ i.e. unchanged

Q. 9.

a. Two coils m & n having 10 turns and 15 turns respectively are placed close to each other. When 2A current is passing through coil m, then flux linked in coil n is 1.8×10^{-4} Weber per turn. If 3A current is passed through coil n then, calculate the flux linked per turn in coil m.

b. A string having tension 360N and mass length $4\times10^{-3}\ kg/m$. It produces 10 consecutive resonant frequencies with a tuning fork, which are 375 Hz and 450 Hz. Find mass of string.

Sol.

a. Flux linked through coil n

$$15\times\phi_n = M\ I_m;\ 15\times1.8\times10^{-4} = M\times2;\ 13.5\times10^{-4}\ H = M$$

$$Now,\ flux\ through\ coil\ m,\ 10\phi_m = MI_n;\ 10\phi_m = 13.5\times10^{-4}\times3;\ \phi_m = 40.5\times10^{-5}\ Wb$$

b. Velocity of transverse wave in string

$$V = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{360}{4\times10^{-3}}} = \sqrt{90000} = 300\ m/s$$

$$Let\ \frac{nV}{2l} = 375\ .....(i) \quad and\ \ (n+1)\frac{V}{2l}\ 450 \quad ...(ii)$$

$$Subtract\ (i)\ from\ (ii),\ we\ get\ \left((n+1)n\right)\frac{V}{2l}\ 450-375;\ \frac{300}{2l} = 75,\ l = 2m$$

$$Mass\ per\ length = 4\times10^{-3};\ \frac{m}{l} = 4\times10^{-3};\ m = l\times4\times10^{-3} = 2\times4\times10^{-3} = 8\times10^{-3}\ kg$$

Q. 10.

a. Capacitance of $6\mu F$ is charged by 6V battery. Now it is connected with inductor of 5mH. Find current in inductor when 1/3rd of total energy is magnetic.

b. An object is thrown vertically upward with some speed. It crosses 2 points p, q which are separated by h metre. If t_p is the time between p and highest point and coming back and t_q is the time between q and highest point and coming back, relate acceleration due to gravity t_p , t_q and h

Sol.

a. Initial total energy

$$= \frac{1}{2}CV^2 = \frac{1}{2}\times 6\times 10^{-6}\times 36 = 108\times 10^{-6}\ J$$

$$And\ magnetic\ energy = \frac{1}{3}\ total\ energy, \Rightarrow \frac{1}{2}LI^2 = \frac{1}{3}\times 108\times 10^{-6}$$

$$I = \sqrt{\frac{2}{3L}\times 108\times 10^{-6}} = \sqrt{\frac{2\times 108\times 10^{-6}}{3\times 5\times 10^{-3}}} = \sqrt{\frac{72}{5}\times 10^{-3}} = 1.69\times 10^{-3}\ A$$

b. $$t_p = 2\sqrt{\frac{2(H+h)}{g}} \qquad t_q = 2\sqrt{\frac{2h}{g}};\ h = \frac{1}{8}g\,t_q^2; H+h = \frac{1}{8}g\,t_p^2; H = \frac{1}{8}g\left(t_p^2 - t_q^2\right)\ g = \frac{8H}{\left(t_p^2 - t_q^2\right)}$$

Biology:

Q. 1. Write the location and function of the following

a. Cytoskeleton
b. Physol chain
c. Synergid
d. Sieve tube element
e. Centromere

Sol.

a. Location Cytoplasm of eukaryotic cell.
Function Support to the cell
b. Location Chlorophyll
Function Anchors the chlorophyll molecule into the lipid part of thylakoid membrane.
c. Location Embryo sac
Function Secreting chemotactically active substance for attracting pollen tube and forming seat for pollen tube discharge.

d. Location Phloem
Function Translocation of solute

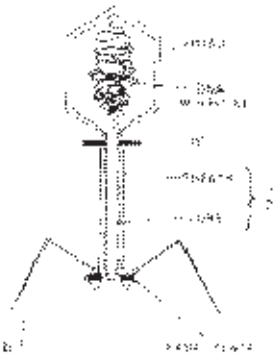
e. Location Chromosome
Function Attachment of spindle fibres.

Q. 2.

(a)

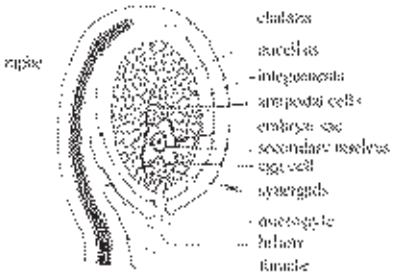
What is shown in diagram (a)?
What are (P) and (Q)?

(b)



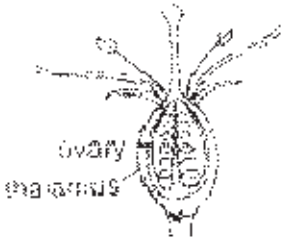
Tell whether it is T_2- phage or T_5- phage?

(c)



Which type of ovule is this?
Give one reason.

(d)



What is this type of flower called?
Give examples of such flower.

(e)

Which type of aestivation is this? Give examples?

a. Nostoc : (P) = Heterocyst; (Q) = Akinete
b. T_5 -phage. (a) collar. (b) Tail fibre
c. Anatropous ovule. Body of the ovule is inverted.
d. Epigynous flower. e.g., Cucurbitaceae, Asteraceae
e. Vexillary or descending imbricate. e.g., Soyabean, Gram, Crotolaria, etc.

Q. 3. Write down the types of placentation, inflorescence and fruit of the following

a. Pea
b. Coriander
c. Wheat
d. Sunflower
e. Mustard

Sol.

S. N.	Plant	Placentation	Inflorescence	Fruit
(a)	Pea	Marginal	Solitary axillary or terminal, raceme	Legume
(b)	Coriander	Axile	Compound umbel	Cremocarp
(c)	Wheat	Basal	Spike of spike or spikelet	Caryopsis
(d)	Sunflower	Basal	Capitulum	Cypsela
(e)	Mustard raceme	Parietal	Corymbose	Siliqua

Q. 4. Differentiate between the following [Give one important difference]

a. Culm and Caudex
b. Slime moulds and fungi
c. Cyathium and hypanthodium
d. Biological magnification and eutrophication
e. White rust and Brown rust

Sol.

(a)	Culm	Caudex
	Joint stem with solid nodes and hollow internodes e.g. Bambusa	Unbranched cylindrical stem with crown of leaves at apex. Marked with scars of fallen leaves e.g., Coconut
(b)	**Slime moulds**	**Fungi**
	Vegetative cell without cell wall but spores with cellulosic cell wall	Vegetative cell with cell wall made up of either fungal cellulose or chitin or both.
(c)	**Cyathium**	**Hypanthodium**
	Peduncle terminates into a single female flower. It is surrounded by a large number	Main axis forms a fleshy cup-shaped receptacle. It has an apical opening called ostiole. Unisexual

	of male flowers in scorpoid cyme. Whole inflorescence is enclosed within a cup shaped involucre. Male flowers are represented only by a single stamen. Female flower is represented only by a tricarpellary pistil e.g.. Euphorbia.	flowers are borne on the inner wall of the cup in cymose groups. Male flower are near the ostiole and fertile female flowers at the base of the cup. Besides these, sterile female flowers called gall flowers are also present e.g.. Ficus.
(d)	**Biological magnification**	**Eutrophication**
	Non-biodegradable pesticides pass into food chain and increase in amount per unit weight of organisms with the rise in trophic level due to their accumulation in fat tissue. The phenomenon is called biomagnification.	Due to run off from fields, lawns and detergent rich sewage into the water body there is nutrient enrichment of the water body. This phenomenon is called eutrophication. It supports excessive growth of algae called algal bloom.
(e)	**White rust**	**Brown rust**
	It is a fungal disease caused by Cystopus candidus or Albugo candidaoa vegetative parts of crucifers.	It is a fungal disease caused by Puccinia reconditaon vegetative parts of wheat plant.

Q. 5. Match the column-I and Column-II

Column-I	**Column-II**
(a) Jacob and Monod	(i) Neurospora
(b) One gene one enzyme hypothesis	(ii) Operon
(c) Griffith	(iii) Reverse Transcriptase
(d) Temin and Baltimore	(iv) Okazaki fragments
(e) DNA polymerase	(v) Transformation
	(vi) Transduction
	(vii) Conjugation

Sol. (a) (ii), (b) (i), (c) (v), (d) (iii), (e) (iv)

Q. 6. Fill in the blanks with suitable words given in boxes:

Marsilea	Coralloid root	Usnea	Eichhornia

Monoecious		Pneumatophores	Geitonogamy	Cycas
Pinus	Dioecious	Vivipary	Xenogamy	Oscillatoria

a. Rhizophorahas both _____and _____

b. (b) Aquatic plants are _____(Pteridophyte) and_____(Angiosperm)

c. (c) Plant bearing both male and female flowers is called_____and the pollination between different flowers of the same plant is called_____.

d. _____has _____.

Sol.

a. Pneumatophores, Vivipary

b. Marsilea, Eichhornia

c. Monoecious, Geitonogamy

d. Cycas, Coralloid root

Q. 7.

a. Give any two conditions for seed habit.

b. Which of these shows tendency of seed habit?

Lycopodium	Selaginella	Dryopteris
Equisetum	Pteris	Pteridina

c. Suggest three ways to break seed dormancy.

Sol.

a. Gametophyte, formation of female gametophyte inside magasporangium.

b. Selaginella

c. Mechanical scarification, stratification, impaction.

Q. Fill in the blanks

a. Mutation can be defined as _____variation.

b. Mutation leads to evolution of _____ of a gene.

c. Genes expressed only in homozygous state are_____.

d. When both alleles of a gene are expressed it is _____.

e. Gene, which is most frequent is ..... type.

Sol.

a. Sudden heritable
b. New alleles
c. Recessive
d. Codominance
e. Wild type

Q. 9.

a. Who discovered photoperiodism?
b. Select one SDP and one LDP from following plantsChrysanthemum , Oat, Spinach, Barley, Radish
c. Who gave the term 'Phytochrome'? Give one specific feature of phytochrome.

Sol.

a. Garner and Allard
b. SDP Chrysanthemum
LDP Spinach
c. Borthwick. Induction of flowering

Q. 10. Match the Column-I and Column-II

Column-I	Column-II
(a) Indian Rhinoceros	(i) Extinct
(b) Acid rain	(ii) Endangered
(c) Somaclonal variations	(iii) Gir forest
(d) Protoplast fusion	(iv) Corbett National Park
(e) Biopiracy	(v) CFC
	(vi) Nitrogen oxide
	(vii) Sulphur oxide
	(viii) PEG
	(ix) Mutation
	(x) Tumeric

Sol. (a) (iv), (b) (vi), (c) (xi), (d) (viii), (e) (x)

Q. 11. Differentiate between

a. Habitat and Niche
b. Flora and Vegetation

(a)

Habitat	Niche
Habitat is a place where an organism lives. It represents a particular set of environmental conditions suitable for its successful growth.	Niche represents not only the place where an organism lives but the range of conditions and resource qualities within which a species can survive and reproduce.

(b)

Flora	Vegetation
Total number of plant species found in an area constitutes it's flora.	Types of plants found in an area constitute the vegetation of the area e.g., Xerophytic vegetation is found in deserts.

Q. 11. Differentiate between

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(b)

Flora	Vegetation
Total number of plant species found in an area constitutes it's flora.	Types of plants found in an area constitute the vegetation of the area e.g., Xerophytic vegetation is found in deserts.

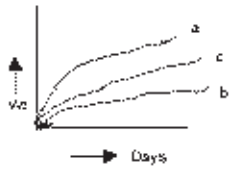
Q. Answer the following question:

a. Apart from CO_2, name other green house gases
b. What is the type of movement of twiner and opening of flower?

Sol.

a. CFCs, CH_4 (methane), N2O (nitrous oxide)
b. Thigmotropism, Epinasty.

Q. 13. Three groups of baby mice



a. kept on complete diet
b. fed basal diet without nutrient to be tested
c. basal diet + carotene by feeding carrots

(a) What is the trend shown by the graph?
(b) Which nutrient deficiency is prevented is group c.
(c) How does the overdose of Retinol, pyridoxine and ascorbic acid is dealt by the body?

Sol. (a) Growth and weight are diet dependent.
(i) a shows complete growth.
(ii) c shows moderate kind of growth.
(iii) b shows retarded growth.

(b) Vitamin A
(c) Overdoses of Retinol lead to Hyper vitaminosis because it is a fat solable vitamin while pyridoxine and ascorbic acid are excreted in urine.

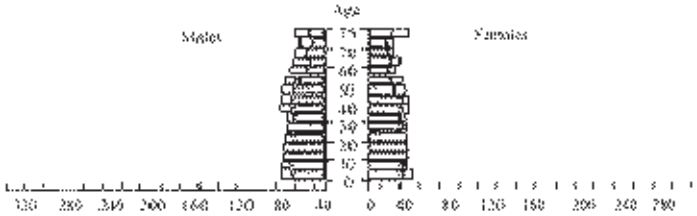
Q. 14. Out of following animals answer the questions
Whale, Earthworm, Bat, Starfish, Scorpion, Honey bee, Peafowl.

a. Which animal is different from rest of animals?
b. How many of these are poisonous, which class they belong to?
c. Which animals belong to same class?
d. Which animals are only representatives of their phylum?
e. Which of the following have 3 ear ossicles. Name the ossicles in the order of sound transmission.

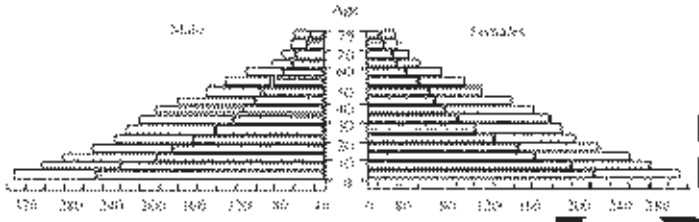
Sol.

a. Starfish: Starfish has radial symmetry while others have Bilateral ymmetry.
b. Honey bee and scorpion are poisonous. Honey bee belongs to class insecta while scorpion belongs to class Arachinida.
c. Whale and Bat both belong to class mammalia.
d. Starfish and Earthworm belong to only representative of their phylum.
e. Bat and Whale have malleus, Incus, Stapes in order of sequence.

Q. 15. Age-Sex pyramid of (a) developed (b) developing nation.



Pollution



Pollution

a. In the next 30 – 40 years what would be the trend of population growth
b. Where would the economic development per capita be greater?
c. Where will there be more professional job opportunities, leading to migration? In IT, Nurses.

Sol.

a. $A \rightarrow$ population remains stable, $B \rightarrow$ exponential growth.
b. A
c. A. migration takes place from $B \rightarrow A$

Q. 16.

Diagram: Diagrammatic presentation of reflex action (showing knee jerk reflex)

b. Which reflex is it?
c. Where is it striking?
d. What are errors in the above diagram?

Sol.

a. It is knee jerk reflex.
b. Patella is striked to Judge the reflex.
c. Efferent and Afferent pathway are reversed.
d. White matter and gray matter are reversed.

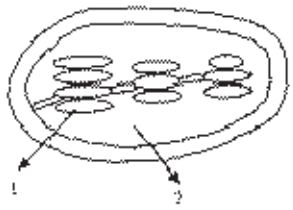
Q. 17.

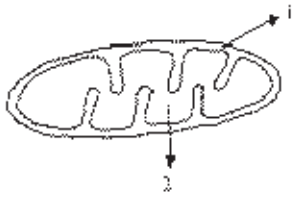
a. Nictitating membrane and Vermiform appendix are examples of which type of organs.
b. Define vestigial organs
c. Out of coccyx, mammary glands muscles of external ear and opacity of eye due to cataract, are these 4 in same categories.

Sol.

a. They are vestigial organs.
b. Vestigial organs are those organs which were functional in ancestors but have become functionless.
c. Opacity of eye due to cataract is not vestigial.

Q. 18.

a. 

b. 

Function of (1) and (2) in each diagram

Q. 19. In photorespiration, RuBP is oxidized to form glycolate and glycerate. Glycolate enters the PCO cycle to form glycerate. Draw a flow diagram of photorespiration to show different intermediates and the cell organelles involved.