CBSE MAINS

MEDICAL ENTRANCE

SOLVED PAPER 2005

PAPER-I

Physics

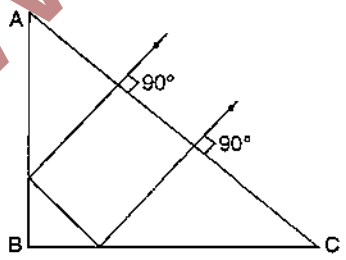
1. (a) A hypothetical experiment conducted to determine Young's formula $Y = \frac{\cos\theta T^x \cdot \tau}{l^3}$.

If Y = Young's modulus, T = time period, τ = torque and l = length, then find the value of x.

(b) A particle of mass m, strikes on ground with angle of incidence 45°. If coefficient of restitution $e = 1/\sqrt{2}$, find the velocity of reflection and angle of reflection.

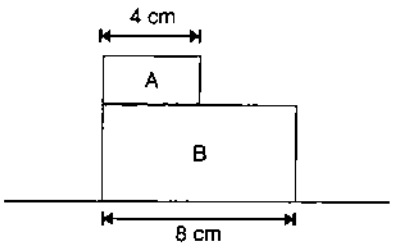
2. (a) Find the minimum stress to produce 1% strain, for density of string 4×10^3 kg/m^3 and velocity of sound 5000 m/s.

(b) As shown in figure $AB = AC$. Find the minimum value of refractive index μ for the given material.



3. 2 moles of He gas $\gamma = 5/3$ of 20 litre volume at 27° C subjected to constant pressure is expanded to double the initial volume. Then, it is adiabatically taken to initial temperature 27° C. What will be the work done in isobaric process ? Also find the final pressure, final volume and work done in adiabatic process.

4. Two blocks one of mass $A = 1$ kg and another applied on A. Coefficient of friction between A and B is 0.2 and that between B and horizontal surface is zero.

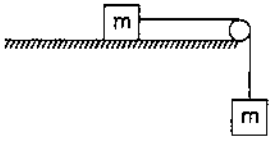


Find :

(a) acceleration of A w.r.t. B.

(b) the time taken for the front face of A to coincide with that of B.

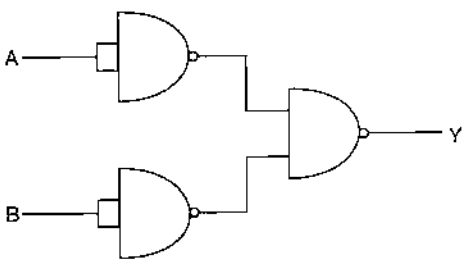
5. (a) As shown in figure mass of bodies is equal to m. If coefficient of friction between the horizontal surface and the mass m is equal to 0.2, then find acceleration of the system.



(b) A particle is moving in a circle with centripetal force $-\frac{k}{r^2}$. What is the total energy associated ?

6. A lens of focal length of 20 cm and of refractive index 1.5 is placed inside a shell containing liquid of refractive index 1.6. What will be the focal length inside the liquid ?

7. (a) Electric field and a dipole are in same direction. When the dipole is deflected in small angle does it exhibit SHM ?
   (b) Electric field inside a sphere varies with distance as Ar. Find the total charge enclosed within the sphere if $A = 3000$ V/m; $R = 30$ cm, where R is the radius of the sphere.
8. (a) If the radius of a coil is changing at the rate 10^{-2} units in a normal magnetic field 10^{-3} units, the induced emf is 1 μV. Find the final radius of the coil.
   (b) Name the type of gate used in the circuit given, find the relation between A, B and Y and draw the truth table.



   (c) Light of wavelength $\lambda = 4000$ Å is incident on a metal surface. If stopping potential needed to stop the ejected photoelectrons is 1.4 volt, then find out the work function of metal surface.
9. (a) Separation between two parallel plates facing each other is 2 cm and surface area $l^2 = 100$ cm^2. If 10^6 electrons of velocity 10^8 m/s projected into the gap between plates of potential difference 400 volt, find the deflection of an electron.
   (b) Of a resonance circuit at which angular frequency, potential difference leads the current ?
10. (a) Describe a β^- decay of a neutron.
    (b) For a radioactive material half-life period is 600 s. If initially there are 600 number of molecules find the time taken for disintegration of 450 molecules and the rate of disintegration.

Chemistry

1. (a) The energy of an α-particle is 6.8×10^{-18} J. What will be the wavelength associated with it ?
   ($h = 6.62 \times 10^{-34}$ J sec, 1 amu = 1.67×10^{-27} kg)
   (b) I^{131} has half life period 13.3 h. After 79.8 h. What fraction of the I^{131} will remain ?
2. (a) Density of Li atom is 0.53 g/cm^3. The edge length of Li is 3.5 Å. Find out the number of Li atoms in a unit cell ($N = 6.023 \times 10^{23}$, $M = 6.94$)
   (b) The ionisation energy of hydrogen in excited state is +0.85 eV. What will be the energy of photon emitted when it returns to the ground state ?
   (c) At which temperature average velocity of oxygen molecule is equal to the rms velocity at 27°C.
3. (a) In the titration of Fe^{2+} ions with $KMnO_4$ in acidic medium, why dilute H_2SO_4 is used and not dilute HCl ?
   (b) Why rusting of iron is more in saline water than in pure water ?
   (c) What is the hybrid state of $BeCl_2$? What will be the change in hybrid state of $BeCl_2$ in solid state ?
4. $A + 2B \rightarrow 3C + 2D$. The rate of disappearance of B is 1×10^{-2} mol L^{-1} s^{-1}. What will be the :
   (i) Rate of the reaction
   (ii) Rate of change in concentration of A and C ?
5. (a) A complex has empirical formula $PtCl_2 \cdot 2NH_3$ when ground with $AgNO_3$ it gives $[Pt(NH_3)_4(NO_3)_2]$ and an insoluble solid $Ag_2[PtCl_4]$ was also obtained. Name and mention the structure of the complex.
   (b) Draw the structure of $[PtCl_3(C_2H_4)]^-$.
   (c) Balance the following reaction :
   (i) $MnO_4^- + Fe^{2+} + H^+ \longrightarrow$
   (ii) $Cr_2O_7^{2-} + Sn^{2+} + H^+ \longrightarrow$
6. (a) Why mobility of H^+ ion in ice is greater as compared to liquid water ?
   (b) Why $BaSO_4$ is insoluble whereas $BeSO_4$ is soluble in water ?
   (c) BCl_3 is trigonal planar while $AlCl_3$ is tetrahedral in dimeric state. Explain.
7. (a) What will be the major organic product of the reaction :

$$C_6H_5C_2H_5 \xrightarrow[\text{(ii) NaCN}]{\text{(i) } Br_2,\ h\nu,\ \Delta} ?$$

   Give the reasons for it.

(b) What is the name of the reaction

$2CH_3CH_2CH_2SH \rightarrow CH_3CH_2CH_2 - S - S - CH_2CH_2CH_3$

(whether condensation, oxidation, reduction or polymerisation)

8. (a) $C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$

$\Delta H = -270.6$ kJ mol^{-1} K ^{1}, $\Delta S = -139.0$ J

(i) Is the reaction favoured by entroly, enthalpy both or none ?

(ii) Find ΔG if $T = 300$ K

(b) Molarity of H_2SO_4 is 0.8 and it density is 1.06 g/cm^3. What will be its concentration in terms of molality and mole fraction ?

9. (a) What is blood buffer. How it acts ?

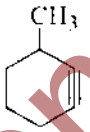
(b) What is the monomer of

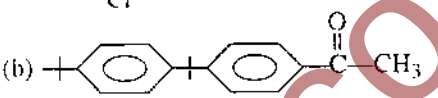
$(-CH_2-CH_2-O-CH_2-CH_2-O)_n$

(c) Which alkaloid is used for

(i) Hypertension (ii) Malaria fever

10. (a) Write the IUPAC name of

(i) $CH_3-\underset{\underset{Cl}{|}}{C}=CHCOOCH_3$ (ii) 

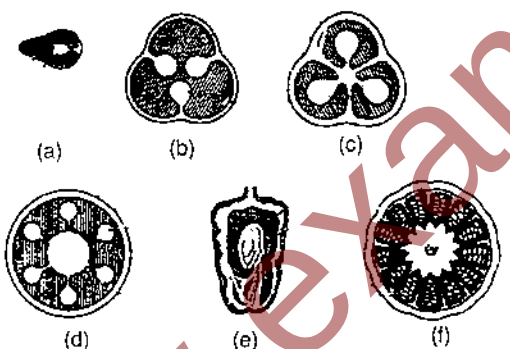
(b) 

(b) Which will be eluted first in moderately polar solvent and why ?

PAPER-II

Biology

1. (a) Identify the placentation shown in following figures.



(b) Write the type of placentation found in following plants.

(i) Mustard (ii) *Dianthus*

(iii) Pea (iv) Marigold

(v) Lemon (vi) Argemone

2. Match the following :

Column-I		Column-II
1. Temp. bacteriophage	(i)	Unicellular
2. DNA	(ii)	Diatom
3. Auxospore	(iii)	ϕ x 174
4. *Cephaleuros*	(iv)	TMV
5. Aplanogamy	(v)	Parasite
6. *Chlamydomonas*	(vi)	*Spirogyra*
7. Heterotrichous	(vii)	*Fritschiella*
8. Coenocyte	(viii)	*Cycas*
9. Fission yeast	(ix)	*Saccharomyces*
10. Peristome	(x)	*Schizosaccharomyces*
	(xi)	*Funaria*
	(xii)	*Equisetum*
	(xiii)	*Vaucheria*
	(xiv)	Lambda phage

3. Find out the false statement from the following.

(i) *Fucus* and *Sargassum* both show heterothallic habbit.

(ii) Auxospores are found in diatom.

(iii) Viruses are more abundant in marine habitat.

(iv) All plant infecting bacteria are gram positive and rod shaped.

(v) Red algae occurs both in marine and fresh water.

(vi) *Marsilea*, *Salvinia*, *Azolla* are aquatic, eusporangiate and heterosporous.

(vii) All bacteria have single circular chromosome per cell.

(viii) All desmids are found in marine habitat but diatoms are found as phytoplankton large in deep lakes.

(ix) *Welwitschia* has reproductive structure in its juvenile stage.

(x) Moss shows diplobiontic life cycle.

4. Match column-A with column-B

Column - A		**Column - B**
1. Cup shaped chloroplast	(i)	*Agaricus*
2. Ribbon shaped chloroplast	(ii)	Lichen
3. Budding yeast	(iii)	*Spirogyra*
4. White rust	(iv)	*Zygonema*
5. Brown rust	(v)	*Puccinia*
6. Smut	(vi)	*Albugo*
7. Elaters	(vii)	*Chlamydomonas*
8. Saprophytes	(viii)	*Chara*
9. Globule, nucule	(ix)	*Vaucheria*
10. Symbiotic	(x)	*Ustilago*
	(xi)	*Anthoceros*
	(xii)	*Saccharomyces*
	(xiii)	*Sachizo saccharomyces*

5. Match the column-A with any two of column-B

Column-A	**Column-B**
(A) Phyletic evolution	1. Interacting population
(B) Biological species	2. Energy flow
(C) Community	3. Anagenesis
(D) Upright pyramid	4. Interbreeding
(E) Hydrologic cycle	5. Biomass
	6. Solar energy
	7. Gravity
	8. H.S. Glissan
	9. Food chain
	10. Single lineage
	11. Earnst Mayr
	12. Cladogenesis
	13. *Rhizobium*

6. Answers from the following columns according to given instruction.

Animal information given

(a) *Archaeopteryx* ..... Chordate class and evolutionary significance

(b) *Echidna* ..... Common English name and country to which it belongs

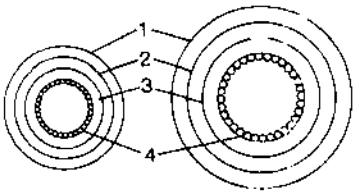
(c) *Biston betularia* ..... Common English name and phenomenon it described by industrialisation

(d) Worker honey bee ..... Sex and average life span in week

(e) *Wuchereria bancrofti* ..... Phylum and disease caused

7. (a) Identify structures 1, 2, 3, 4 from the given diagram.

(b) Fill in the blanks. The poorly oxygenated blood comes from the body parts and poured into (1) and then pumped into (2) from which, through (3) artery to lungs. Then

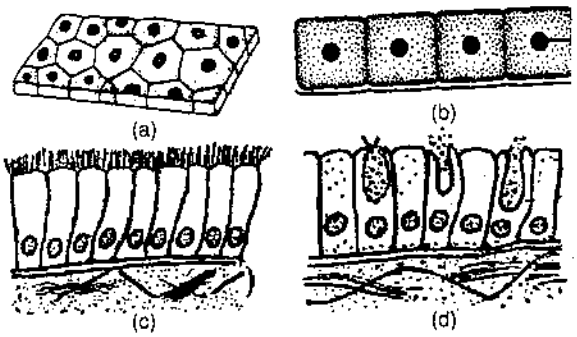


from lungs oxygenated blood enters into (4) through pulmonary (5) Then pumped into (6) from this the oxygenated blood passes through (7) to the body except lungs.

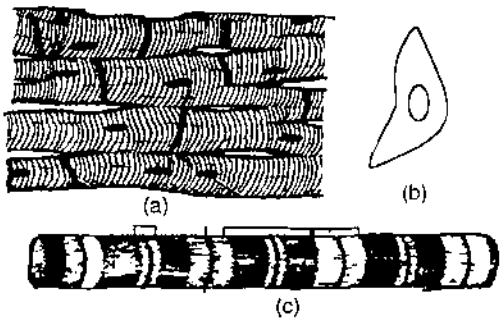
8. Match the column-A with any two of column-B

Column-A	**Column-B**
(a) Xeroderma pigmentosum	1. Skin cancer
(b) Bar eye of *Drosophila melanogaster*	2. Ascorbic acid deficiency
(c) AB blood group	3. X-linked
(d) Double fertilization	4. Dominant mutation
(e) Mitosis	5. Co-dominance
	6. Universal recepient
	7. Nucleus and endosperm
	8. Microtubule
	9. Congression
	10. Diploid and triploid cell
	11. DNA repair
	12. Crossing over

9. Identify A to D and mention one location and one function in the body.



10. (a) Identify the tissues 1, 2 and 3



(b) Fill in the blanks :

..... (1) muscles are associated with locomotion and are innervated by ..... (2) nervous system. Whereas .....(3) muscles are innervated by autonomic nervous system and associated with internal organs and ..... (4) muscles are associated with ..... (5) nervous system associated with pumping of blood ..... (6) and ..... (7) are uninucleated where as .....(8) is multinucleated.

The muscle ..... (9) and ..... (10) are involuntary where as ..... (11) muscle is voluntary.

11. (a) Who 1st proposed semi-conservative replication of DNA ?

(b) Which organism is used in this experiment.

(c) Name two technique, used.

(d) What is the result of 1st, 2nd and 3rd generation ?

12. Which of the following satisfy the characters of rice and corn. Fill the suitable words in the space provided.

Pedigree, allogamy, autogamy, clonal, mutation, self incompatibility, cleistogamy, chasmogamy, dichogamy, dioecism, monoecism.

Homozygous.....Homogenous,
Homogenous.....Heterozygous,
Heterogenous.....Heterozygous,
Heterogenous.....Homozygous.

	Rice	Corn
Mode of reproduction		
Structure of flower in relation to floral parts		
Genetic make up		
Method of crop improvement		
Progeny of crop improvement		

13. T.H. Morgan while going on a walk, found a fruit covered with flies. He took the flies to their laboratory. He along with his students performed experiment for several generations. They surpsed to see some of characters does not obey Mendelian principal of independent assortment.

(i) Write common name of the flies and also its scientific name.

(ii) The tendency of two characters to remain inherited together for different generations is called as .....

(iii) Tendency of two characters to stay separately for different generation is .....

(iv) Draw the diagram of physical basis of this type of inheritance.

14. $\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$

(a) Which type of growth curve does it represents ?

(b) What does these notations represent?

(i) $\frac{dN}{dt}$ (ii) r (iii) N (iv) K

15. Colour blindness is a sex linked disease. It is due to X-chromosome. Normal parents have three daughter, all normal and one son colour blind. What is the reason for it.

The possible reasons are given. Find out which are correct.

1. It is an autosomal linked inheritance
2. It is a sex linked inheritance
3. Father is carrier
4. Mother is carrier
5. Son acquired character from mother
6. Son acquired character from father
7. Daughter is heterozygous for colour blindness
8. Daughter is homozygous for colourblindness
9. Daughter is heterozygous and homozygous for normal vision
10. In future the family may have normal sons.

16. The term apomixis was first given by .....(1) Apomixis is unusual sexual reproduction where there is no (2) .....and (3) .....Apomixis is mainly of two types (4) ..... and (5) ..... Development of embryos directly from sporophytic tissue like (6) .....and (7) ..... is adventitive embryony. Development of

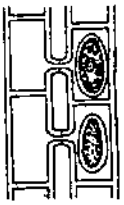
embryo sac directly from the cell of nucellus (2n) is called (8) .....

17. Answer the following questions
(i) The process which takes palce in mitochondria, chloroplast, peroxisomes.
(ii) Pigment which perceive light requirement for plants.
(iii) Plants with open stomata during night.
(iv) Plant whose whole DNA sequence is known.
(v) α-amylase activity of starch is initiated by .....
(vi) Bacterial respiratory enzymes are located in which part.
(vii) Plant which form coralloid root .....
(viii) Pigment present in beet root .....
(ix) Development of fruits without fertilization is ...
(x) Who gave the concept of totipotency ?

18. Identify the figure a-d and name any one part of it.

(a) 

(b) 

(c) 

(d) 

HINTS & SOLUTIONS

Physics

PAPER-I

1. (a) We have,

$$Y = \frac{\cos\theta T^x \cdot \tau}{l^3} \quad \ldots(i)$$

We know, $[Y] = [ML^{-1}T^{-2}]$

$[T] = [T^1]$

$[\tau] = [ML^2T^{-2}]$

θ = dimensionless

$[l] = [L]$

Thus, Eq. (i) becomes

$$[ML^{-1}T^{-2}] = \frac{[T^1]^x\,[ML^2T^{-2}]}{[L]^3}$$

or $[ML^{-1}T^{-2}] = [ML^{-1}T^{-2+x}]$

Comparing the powers, we have

$-2 + x = -2$

$\therefore \quad x = 0$

(b) The horizontal component of velocity

$$v_x = v\cos 45° = \frac{v}{\sqrt{2}}$$

Vertical component of velocity

$$v_y = v\sin 45° = \frac{v}{\sqrt{2}}$$

After collision,

$$v_x' = \frac{v}{\sqrt{2}}$$

Now, coefficient of restitution is

$$e = \frac{\text{normal component of velocity of separation}}{\text{normal component of velocity of approach}}$$

$$= \frac{v_y' - 0}{v_y - 0}$$

$$\Rightarrow \quad v_y' = ev_y = \frac{1}{\sqrt{2}} \times \frac{v}{\sqrt{2}} = \frac{v}{2}$$

Thus, velocity of reflection

$$v' = \sqrt{(v_x')^2 + (v_y')^2}$$

$$= \sqrt{\left(\frac{v}{\sqrt{2}}\right)^2 + \left(\frac{v}{2}\right)^2}$$

$$= \sqrt{\frac{3v^2}{4}} = \frac{\sqrt{3}}{2}v$$

and angle of reflection is given by

$$\tan\theta = \frac{v'_x}{v'_y} = \frac{v/\sqrt{2}}{v/2} = \frac{2}{\sqrt{2}} = \sqrt{2}$$

or $\quad \theta = \tan^{-1}(\sqrt{2})$

2. (a) We have,

$$v = \sqrt{\frac{Y}{\rho}}$$

Given, $v = 5000$ m/s, $\rho = 4 \times 10^3$ kg/m^3

$$\therefore \quad 5000 = \sqrt{\frac{Y}{4 \times 10^3}}$$

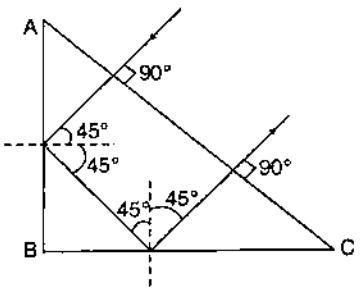
or $Y = (5000)^2 \times (4 \times 10^3) = 1 \times 10^{11}$ N/m^2

But $$Y = \frac{\text{stress}}{\text{strain}}$$

$$\therefore \quad \text{Stress} = Y \times \text{strain}$$

$$= 1 \times 10^{11} \times \frac{1}{100} = 10^9 \text{ N/m}^2$$

(b) The ray diagram is shown below. As there is total internal reflection, thus



$$\sin C = \frac{1}{\mu}$$

But $C = i = 45°$ here

$$\therefore \quad \mu = \frac{1}{\sin C} = \frac{1}{\sin 45°}$$

$$= \frac{1}{1/\sqrt{2}} = \sqrt{2}$$

3. In an isobaric process or at constant pressure

$$V \propto T$$

or $$\frac{V_2}{V_1} = \frac{T_2}{T_1}$$

or $$\frac{T_2}{T_1} = \frac{2V}{V} = 2$$

or $$T_2 = 2T_1 = 2 \times 300 = 600 \text{ K}$$

Work done in isobaric process

$$W_1 = P(V_2 - V_1) = \mu R (T_2 - T_1)$$

$$= 2 \times 8.3 (600 - 300)$$

$$= 2 \times 8.3 \times 300 = 4980 \text{ J}$$

Now, in adiabatic process

$$T V^{\gamma - 1} = \text{constant}$$

or $$\left(\frac{V_2}{V_1}\right)^{\gamma - 1} = \frac{T_1}{T_2}$$

Here, in adiabatic process

$T_1 = 600$ K, $T_2 = 300$ K

$$\therefore \quad \left(\frac{V_2}{40}\right)^{\frac{5}{3} - 1} = \frac{600}{300}$$

or $V_2 = (2)^{3/2} \times 40$

or $V_2 = 2\sqrt{2} \times 40$

$\therefore$ Final volume = 112.8 litre

Again PV^{γ} = constant

$$\Rightarrow \quad \frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{\gamma} = \left(\frac{1}{2}\right)^{5/2}$$

$$\Rightarrow \quad P_2 = \left(\frac{1}{2}\right)^{5/3} \times \frac{2 \times 8.3 \times 300}{20 \times 10^{-3}}$$

$$= \left(\frac{1}{2}\right)^{5/3} \times 249 \times 10^3 \text{ N-m}^{-2}$$

Thus, final pressure = 44.15×10^3 N-m^{-2}

Work done in adiabatic process

$$= \frac{\mu R (T_1 - T_2)}{\gamma - 1}$$

$$= \frac{2 \times 8.3 (600 - 300)}{(5/3) - 1}$$

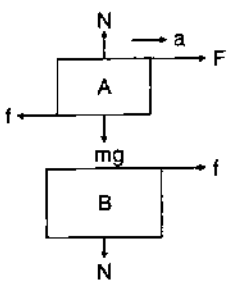
$$= 2 \times 8.3 \times 300 \times 3/2$$

$$= 7470 \text{ J}$$

4. (a) The free body diagram of two blocks is shown in figure.

$$F - f = ma$$

or $$F - \mu N = ma$$



or $5 - 0.2 \times 1 \times 10 = 1 \times a_A$

or $a_A = 3 \text{ m/s}^2$

This is the acceleration of A w.r.t. B.

(b) The time taken for the front surface of A to coincide with that of B

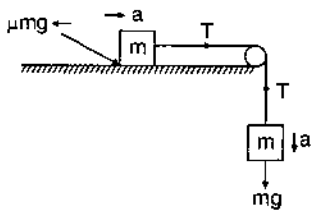
= the time taken by A to cover a distance 4 m to coincide with B

i.e., $$s = ut + \frac{1}{2} a_A t^2$$

$$4 = 0 + \frac{1}{2} \times 3 \times t^2$$

or $$t^2 = \frac{8}{3} \text{ or } t = \sqrt{\frac{8}{3}} \text{ s}$$

5. (a) The system may be represented as follows,



From force diagram

$$mg - T = ma \quad \ldots(i)$$

and $$T - \mu mg = ma \quad \ldots(ii)$$

From Eqs. (i) and (ii), we get

$$mg - \mu mg = ma + ma$$

or $$2ma = mg - \mu mg$$

or $$a = \frac{g - \mu g}{2}$$

or $$a = \frac{10 - 0.2 \times 10}{2}$$

$\therefore$ $$a = 4\ m/s^2$$

(b) Centripetal force

$$|F| = \frac{mv^2}{r} = \frac{k}{r^2}$$

or $$mv^2 = \frac{k}{r}$$

or $$K = \frac{1}{2}mv^2 = \frac{k}{2r}$$

and $$U = -\int F dr = -\int -\frac{k}{r^2}\,dr = -\frac{k}{r}$$

Hence, total energy is given by

$$E = K + U = \frac{k}{2r} - \frac{k}{r} = -\frac{k}{2r}$$

6. The focal length in air is given by

$$\frac{1}{f_a} = ({}_a\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \ldots(i)$$

The focal length in liquid is given by

$$\frac{1}{f_l} = ({}_l\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \ldots(ii)$$

or $$\frac{1}{f_l} = \left(\frac{{}_a\mu_g}{{}_a\mu_l} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Dividing Eq. (i) by Eq. (ii), we have

$$\frac{f_l}{f_a} = \frac{({}_a\mu_g - 1)}{\left(\frac{{}_a\mu_g}{{}_a\mu_l} - 1\right)} = \frac{(1.5 - 1)}{\left(\frac{1.5}{1.6} - 1\right)}$$

$$= \frac{0.5}{-0.1/1.6} = -8$$

$\therefore$ $$f_l = -8 f_a = -8 \times 20\ cm = -160\ cm$$

– ve signifies that convex lens inside liquid will behave as a concave lens.

7. (a) The torque applied on electric dipole is given by

$$\tau = -pE \sin\theta$$

As θ is small

$\therefore$ $$\sin\theta \approx \theta$$

$\therefore$ $$\tau = -pE\,\theta$$

Also,

$$\tau = I\alpha = I\frac{d^2\theta}{dt^2}$$

$\therefore$ $$I\frac{d^2\theta}{dt^2} = -pE\,\theta$$

or $$\frac{d^2\theta}{dt^2} = -\frac{p}{I}E\theta$$

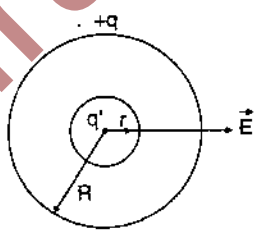
or $$\frac{d^2\theta}{dt^2} = -\omega^2\theta$$

This is the condition of angular SHM with time period

$$= \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{I}{pE}}$$

where $$\omega = \sqrt{\frac{pE}{I}}$$

(b) Let charge enclosed by the sphere be q'. Here,



$$q' = \frac{q}{(4/3)\pi R^3} \cdot \frac{4}{3}\pi r^3$$

$$= q\frac{r^3}{R^3} \quad \ldots(i)$$

According to Gauss's law, flux associated with spherical surface of radius r (or Gaussian surface) is given by

$$\phi = \frac{1}{\varepsilon_0}q' = \frac{1}{\varepsilon_0}\frac{qr^3}{R^3} \quad \ldots(ii)$$

But $$\phi = E \times 4\pi r^2$$

$$\therefore \quad E \times 4\pi r^2 = \frac{1}{\varepsilon_0}\frac{qr^3}{R^3}$$

or $$E = \left(\frac{1}{4\pi\varepsilon_0}\frac{q}{R^3}\right) r$$

Given, $E = Ar$

$$\therefore \quad A = \frac{1}{4\pi\varepsilon_0}\frac{q}{R^3}$$

$$= \frac{1}{4\pi\varepsilon_0} \times \frac{q'}{r^3} \qquad \text{[From Eq. (i)]}$$

$$\therefore \quad q' = Ar^3 \times 4\pi\varepsilon_0$$

$$= 3000 \times (0.3)^3 \times \frac{1}{9 \times 10^9}$$

$$= 9 \times 10^{-9}\ \text{C}$$

8. (a) Induced emf is given by

$$|e| = \frac{d\phi}{dt} = B\frac{dA}{dt} \qquad (\because \phi = BA)$$

$$= \pi B \frac{d}{dt}(r^2) = \pi B \,.\, 2r\frac{dr}{dt}$$

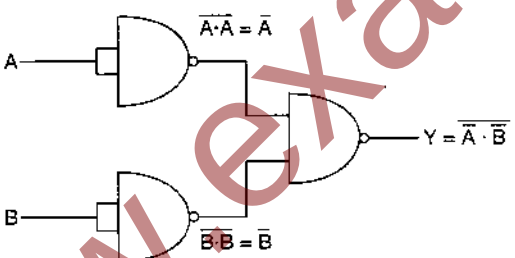
Given : $\frac{dr}{dt} = 10^{-2}$ units, $B = 10^{-3}$ units, $e = 1\ \mu\text{V}$

$$\therefore \quad 1 \times 10^{-6} = 3.14 \times 10^{-3} \times 2 \times r \times 10^{-2}$$

or $$r = \frac{10^{-6}}{3.14 \times 10^{-5} \times 2}$$

$$= 0.016\ \text{m} = 1.6\ \text{cm}$$

(b) The gates used in the given circuits are NAND gates.



The simplified form of circuit is shown in figure.

$$\therefore \quad = \overline{\bar{A} \cdot \bar{B}} = \bar{\bar{A}} + \bar{\bar{B}} = A + B$$

Hence, this circuit works as OR gate.

(c) Max. kinetic energy of an electron

= stopping potential

$$= \frac{hc}{\lambda} - \text{work function}$$

$$\therefore \text{ Work function} = \frac{hc}{\lambda} - \text{KE}$$

$$= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{4000 \times 10^{-10} \times 1.6 \times 10^{-19}}\ \text{eV} - 1.4\ \text{eV}$$

$$= 3.09\ \text{eV} - 1.4\ \text{eV}$$

$$= 1.69\ \text{eV}$$

9. (a) The reflection of electron is given by

$$y = 0 + \frac{1}{2}at^2$$

$$= \frac{1}{2}\left(\frac{eE}{m}\right)\left(\frac{l}{v}\right)^2$$

$$= \frac{eEl^2}{2mv^2} = \frac{eVl^2}{2mdv^2}$$

$$= \frac{1.6 \times 10^{-19} \times 400 \times 10^{-2}}{2 \times 9.1 \times 10^{-31} \times 2 \times 10^{-2} \times (10^8)^2}$$

$$= 0.176 \times 10^{-2}\ \text{m}$$

$$= 0.176\ \text{cm} = 1.76\ \text{mm}$$

(b) For the condition that potential difference leads the current,

$$\omega L - \frac{1}{\omega C} > 0$$

or $$\omega L > \frac{1}{\omega C} \qquad \Rightarrow \omega^2 > \frac{1}{LC}$$

or $$\omega > \frac{1}{\sqrt{LC}}$$

10. (a) In β^- decay of neutron, a neutron decays to a proton (${}_1H^1$), an electron (${}_{-1}\beta^0$) and an antineutrino ($\bar{\nu}$). Thus,

$${}_0n^1 \rightarrow {}_1H^1 + {}_{-1}\beta^0 + \bar{\nu}$$

(b) Initial number of molecules $N_0 = 600$

Disintegrated number of molecules = 450

So, undisintegrated number of molecules

$$N = 600 - 450 = 150$$

$$N = N_0\left(\frac{1}{2}\right)^n$$

$$\therefore \quad 150 = 600\left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$$

or $$\frac{150}{600} = \left(\frac{1}{2}\right)^{t/600}$$

or $$\frac{1}{4} = \left(\frac{1}{2}\right)^{t/600}$$

or $$\left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{t/600}$$

$$\therefore \quad \frac{t}{600} = 2$$

or $$t = 600 \times 2 = 1200\ \text{s}$$

Now, rate of disintegration,

$$R = \frac{dN}{dt} = -\lambda N = \frac{0.693}{T_{1/2}} \times N$$

$$= \frac{0.693}{600} \times 150 = 0.173\ \text{disintegrations/s.}$$

1. (a) Given, $E = 6.8 \times 10^{-18}$ J

$\lambda = ?$

According to de-Broglie equation ⇒

wavelength associated to a particle $(\lambda) = \frac{h}{mv}$

or, $\lambda = \frac{h}{m\left(\sqrt{\frac{2E}{m}}\right)}$ $\left(\because E = \frac{1}{2}mv^2\right)$

$= \frac{h}{\sqrt{E \cdot m}}$

$= \frac{6.62 \times 10^{-34}}{\sqrt{6.8 \times 10^{-18} \times 4 \times 1.67 \times 10^{-27}}}$

$= 2.2 \times 10^{-17}$ m

(b) Given, $t_{1/2} = 13.3$ h, $T = 79.8$ h $\frac{N}{N_0} = ?$

We know that,

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{T}{t_{1/2}}}$

$= \left(\frac{1}{2}\right)^{\frac{79.8}{13.3}} = \left(\frac{1}{2}\right)^6$

$= \frac{1}{64}$

2. (a) Given, density $(\rho) = 0.53$ g/cm^3

$a = 3.5$ Å $= 3.5 \times 10^{-8}$ cm

$N_A = 6.023 \times 10^{23}$

Atomic weight = 6.94

We know that,

atoms per unit cell

$(n) = \frac{\rho \times \text{volume} \times N_A}{\text{atomic weight}}$

$= \frac{0.53 \times (3.5 \times 10^{-8})^3 \times 6.023 \times 10^{23}}{6.94}$

≈ 2

(b) The energy of a hydrogen atom in its ground state is −13.6 eV.

The ionisation energy of hydrogen in its excited state is +0.85 eV.

∴Energy emitted = +0.85 − (−13.6)=14.45 eV

(c) Average velocity = $\sqrt{\frac{8RT}{\pi M}}$

Root mean square velocity = $\sqrt{\frac{3RT}{M}}$

According to question

$\sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{3R \times 300}{M}}$

or, $\frac{8T}{\pi} = 3 \times 300$

$T = \frac{22}{7} \times \frac{3 \times 300}{8} = 353.57$ K $= 80.57$ °C

3. (a) H_2SO_4, being an oxidising agent, facilitates the oxidation of Fe^{2+} to Fe^{3+} whereas HCl, being a reducing agent, react with $KMnO_4$ to form chlorine gas.

$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5O$

$(2FeSO_4 + H_2SO_4 + O \longrightarrow Fe_2(SO_4)_3 + H_2O) \times 5$

$10FeSO_4 + 2KMnO_4 + 3H_2SO_4 \longrightarrow 5Fe_2(SO_4)_3 + K_2SO_4 + 2MnSO_4 + 8H_2O$

$2KMnO_4 + 16HCl \longrightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2\uparrow$

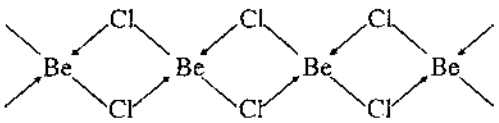
(b) When a piece of iron is left exposed to ordinary moist air, it is found covered by a reddish-brown coating which can be easily detached and is called rust. Analysis shows that it is probably a mixture of ferrous and ferric oxides and carbonates.

Favourable conditions for rusting are presence of moisture, presence of weakly acidic atmosphere and impurity in iron. Thus rusting process becomes fast in presence of salinity in water.

(c) In the vapour (gaseous) state, beryllium chloride has *sp* hybridisation and linear structure :

Cl—Be—Cl

But in solid state, $BeCl_2$ remains in polymeric form in which each Be atom undergoes sp^3-hybridisation and molecule has tetrahedral structure.



4. $A + 2B \longrightarrow 3C + 2D$

(i) Rate of reaction $= -\frac{1}{2}\frac{d[B]}{dt}$

$= \frac{1}{2} \times 1 \times 10^{-2}$

$= 0.5 \times 10^{-2}$ mol L^{-1} s^{-1}

(ii) Rate of disappearance of $A = -\frac{d[A]}{d}$

$= 0.5 \times 10^{-2}$ mol L^{-1} s^{-1}

Rate of appearance of C = 3×rate of reaction

$= 3 \times 0.5 \times 10^{-2}$

$= 1.5 \times 10^{-2}$ mol L^{-1} s^{-1}

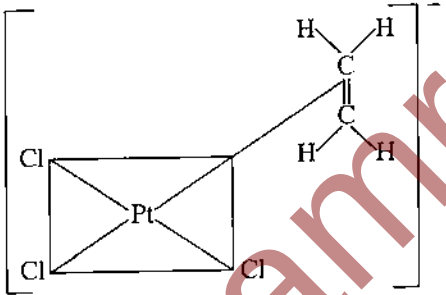
5. (a) The reaction can be written as :

$[Pt(NH_3)_4][PtCl_4] + 2AgNO_3 + H_2O$

$\longrightarrow [Pt(NH_3)_4](NO_3)_2 + Ag_2[PtCl_4] \downarrow$

The IUPAC name of the complex is tetraamine platinum (II) tetrachloro platinate (II).

(b)



(c) (i) $MnO_4^- + Fe^{2+} + H^+ \longrightarrow$

This reaction involves oxidation of Fe^{2+} into Fe^{3+}.

Hence,

$MnO_4^- + Fe^{2+} + H^+ \longrightarrow Mn^{2+} + Fe^{3+} + H_2O$

Reduction half reaction :

$MnO_4^- \longrightarrow Mn^{2+} + H_2O$

(a) Balancing oxygen and hydrogen

$MnO_4^- + 8H^+ \longrightarrow Mn^{2+} + 4H_2O$

(b) Balancing charge

$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ ...(i)

Oxidation half reaction :

$Fe^{2+} \longrightarrow Fe^{3+}$

or $(Fe^{2+} \longrightarrow Fe^{3+} + e^-$ ...(ii) $\times 5$

Adding half equation (i) and (ii), we get

$\Rightarrow \quad MnO_4^- + 5Fe^{2+} + 8H^+ \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

(ii) $Cr_2O_7^{2-} + Sn^{2+} + H^+ \longrightarrow$

This reaction involves oxidation of Sn^{2+} into Sn^{4+}

Reduction half reaction :

$Cr_2O_7^{2-} + H^+ \longrightarrow Cr^{3+} + H_2O$

(a) Balancing Cr atom, oxygen and hydrogen

$Cr_2O_7^{2-} + 14H^+ \longrightarrow 2Cr^{3+} + 7H_2O$

(b) Balancing charge

$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$ ...(i)

Oxidation half reaction :

$Sn^{2+} \longrightarrow Sn^{4+}$

or, $(Sn^{2+} \longrightarrow Sn^{4+} + 2e^-$ ...(ii)) $\times 3$

Adding half reaction (i) and (ii), we get

$Cr_2O_7^{2-} + 3Sn^{2+} + 14H^+ \longrightarrow 2Cr^{3+} + 3Sn^{4+} + 7H_2C$

6. (a) Ice has less density than liquid water therefore H^+ ions have greater mobility in ice than in water. Also in liquid water H^+ ions hydrate to form H_3O^+ (hydronium) ions which have even lesser mobility due to bigger size.

(b) The solubility of ionic solids depends on two factors :

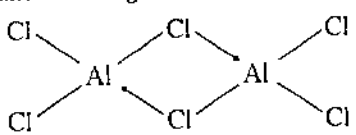
(i) Lattice energy

(ii) Hydration energy.

These two factors have opposite effect on solubility. If lattice energy is high, the ions will be tightly packed and the solubility will be low. If, however, hydration energy is high, the ions will have greater tendency to be hydrated and hence solubility will be high.

In case of $BaSO_4$, lattice energy is higher than its hydration energy (due to big size of Ba^{2+}), therefore it is insolube in water. Whereas $BeSO_4$ is soluble in water as its hydration energy is greater than its lattice energy (due to very small size of Be^{2+}).

(c) Aluminium halides exists as dimer and in this molecule Al has sp^3-hybridisation and tetrahedral bridged structure.

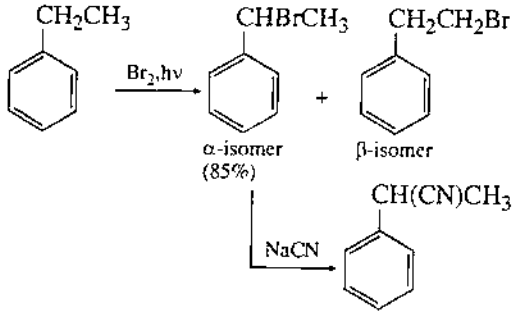


Halides

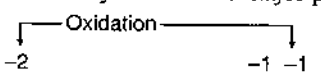
However, boron halides do not form dimer like aluminium halides. Due to smaller atomic size of boron (85 pm) than aluminium (143 pm), boron cannot accommodate four large sized halide ions like Cl^-, Br^- or I^- around it. But this explanation can not be applied to BF_3 as BF is known to form stable $[BF_4]^-$ complex ion This is possible due to very small size o

the F^- ion. A possible explanation for the non-existence of the dimer of boron trihalide is that the energy released by the formation of an additional bond to another halogen atom is not sufficient to compensate for the loss in energy to the system in over coming the $p\pi - p\pi$ back-bonding.

7. (a) The reaction proceeds in the following way :
In the presence of sunlight, this reaction follows free-radical pathway. α-free radical



is more stable than β-free radical due to having resonance in benzene ring. Hence, α-bromo ethyl benzene is major product.

(b) 

$$2CH_3CH_2CH_2SH \rightarrow CH_3CH_2CH_2 - S - S - CH_2CH_2CH_3$$

This reaction is an oxidation reaction as in it oxidation state of sulphur is increasing from -2 to -1. Thiols in the presence of mild oxidising agent like air, H_2O_2 etc. form dialkyl sulphides.

8. (a) $C_2H_4 + Cl_2 \longrightarrow C_2H_4Cl_2$

$\Delta H = -270.6\ kJ\ mol^{-1}\ K^{-1}$

$\Delta S = -139.0\ J$

This reaction is favoured by only enthalpy as ΔH is negative, therefore the reaction is favourable.

But entropy change (ΔS) is negative, hence reaction is not favourable for entropy consideration.

(iii) From Gibb's-Helmholtz equation,

$$\Delta G = \Delta H - T\Delta S$$

$$\therefore \quad \Delta G = (-270.6 \times 10^3) - 300 \times (-139.0)$$

$$= -270600 + 41700 = -228900\ J$$

$$= -228.9\ kJ$$

(b) Molarity of H_2SO_4 solution = 0.8 M

$\therefore$ Mole of H_2SO_4 in one litre solution = 0.8

$\therefore$ Weight of H_2SO_4 in one litre solution

$$= 0.8 \times 98 = 78.4\ g/L$$

Now, density of this 0.8 M H_2SO_4 solution

$$= 1.06\ g/mL\ 1060\ g/L$$

Hence, in this solution weight of solvent (*i.e.*, water)

$$= 1060 - 78.4 = 981.6\ g$$

(i) Molality = ?

$$\text{Molality} = \frac{\text{Mole of solute}}{\text{Weight of solvent (in kg)}}$$

$$= \frac{0.8 \times 1000}{981.6} = 0.815$$

(ii) Mole-fraction of H_2SO_4

$$= \frac{\text{Mole of } H_2SO_4}{\text{Total mole in solution}} = \frac{0.8}{0.8 + \frac{981.6}{18}}$$

$$= \frac{0.8}{0.8 + 54.53} = \frac{0.8}{55.33}$$

$$= 0.014$$

9. (a) Following two buffer systems are found in human blood :

(i) Buffer of $H_2CO_3 + NaHCO_3$

(ii) Buffer of $H_3PO_4 + Na_2HPO_4$

Due to these buffers, the pH of blood remains 7.4. The maintenance of blood pH is essential for biological processes as enzymes are sensitive to pH.

(b) The polymer

$$+CH_2 - CH_2 - O - CH_2 - CH_2 - O+_n$$

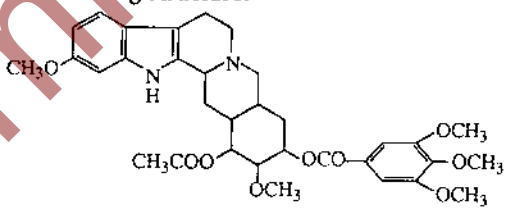
CH_2—OH

|

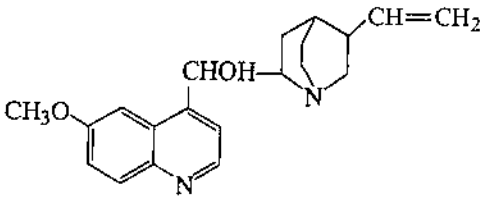
CH_2—OH

is poly ethylene glycol (PEG) whose monomer is ethylene glycol *i.e.*, $CH_2OH - CH_2OH$

(c) (i) Reserpine is an alkaloid which is used as antihypertensive or hypotensive agent. It has following structure.

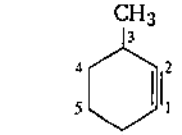


(ii) Quinine is an antimalarial alkaloid. It is obtained from cinchona bark. It has following structure.



10. (a) (i) $\overset{4}{C}H_3 - \overset{3}{C}(Cl) = \overset{2}{C}H\overset{1}{C}OOCH_3$

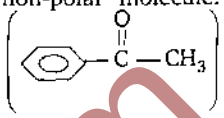
Methyl-(3-chloro)-but-2-ene-oate

(ii) 

3-methyl cyclohexyne

(b) 

(di-tert-butyl benzene) has symmetrical structure, hence it has zero dipole moment. Thus, this is almost non-polar molecule.

Whereas acetophenone 

has substantial dipole moment and is polar. Therefore acetophenone will be eluted first in polar solvent than ditert-butyl benzene.

PAPER-II

Biology

1. (a)

(i) Marginal
(ii) Parietal
(iii) Axial
(iv) Free central
(v) Basal
(vi) Superficial

(b)

(i)	Mustard	Parietal
(ii)	*Dianthus*	Free central
(iii)	Pea	Marginal
(iv)	Marigold	Basal
(v)	Lemon	Superficial
(vi)	*Argemone*	Parietal

2.

	Column- I		**Column -II**
(1)	Temp. bacteriophage	(xiv)	Lambda (λ) phage
(2)	DNA	(iii)	ϕx 174
(3)	Auxospore	(ii)	Diatom
(4)	*Cephaleuros*	(v)	Parasite
(5)	Aplanogamy	(vi)	*Spirogyra*
(6)	*Chlamydomonas*	(i)	Unicellular
(7)	Heterotrichous	(vii)	*Fritschiella*
(8)	Coenocyte	(xiii)	*Vaucheria*
(9)	Fission yeast	(x)	*Schizosaccharomyces*
(10)	Peristome	(xi)	*Funaria*

3.

(iii) False
(iv) False
(vi) False
(viii) False
(ix) False

4.

	Column -A		**Column -B**
(1)	Cup shaped chloroplast	(vii)	*Chlamydomonas*
(2)	Ribbon shaped chloroplast	(iii)	*Spirogyra*
(3)	Budding yeast	(xii)	*Saccharomyces*
(4)	White rust	(vi)	*Albugo*
(5)	Brown rust	(v)	*Puccinia*
(6)	Smut	(x)	*Ustilago*
(7)	Elaters	(xi)	*Anthoceros*
(8)	Saprophytes	(i)	*Agaricus*
(9)	Globule, nucule	(viii)	*Chara*
(10)	Symbiotic	(ii)	Lichen

5.

Column -A		**Column-B**
(A) Phyletic evolution	10.	Single lineage
	12.	Cladogenesis
(B) Biological Species	4.	Interbreeding
	11.	Earnst Mayr
(C) Community	1.	Interacting population
	9.	Food chain
(D) Upright pyramid	2.	Energy flow
	5.	Biomass
(E) Hydrological cycle	6.	Solar energy
	7.	Gravity

6. (a) *Archaeopteryx* is a most ancient recognized fossil bird. It belongs to class aves. It exhibits mixture of reptilian and bird like characters and popularly known as connecting link between reptiles and birds.

(b) Spiny ant eater are commonly found in Australian zone.

(c) *Biston betularia* is commonly known as peppered moth. It describes industrial melanism.

(d) Worker is a sterile (diploid) female smaller than both queen and drone. They live for about 8 to 16 weeks.

(e) *Wuchereria bancrofti* belongs to phylum Nemathelminthes. It causes disease elephantiasis or filariasis.

7. (a)

1. - Tunica externa
2. - Tunica media
3. - Elastic membrane — Tunica interna
4. - Endothelium

(b)

1.	Right auricle	2.	Right ventricle
3.	Pulmonary artery	4.	Left auricle
5.	Pulmonary vein	6.	Left ventricle
7.	Systemic aorta		

8.

Column-A	Column-B
(a) Xeroderma pigmentosum	1. Skin cancer 3. X-linked
(b) Bar eye of *Drosophila melanogaster*	3. X-linked 4. Dominant mutation
(c) AB blood group	5. Co-dominance 6. Universal recipient
(d) Double fertilization	7. Nucleus and endosperm 10. Diploid and triploid cells
(e) Mitosis	8. Microtubule 9. Congression

9. A. Simple squamous epithelium composed of flattened cells that form a continuous delicate lining of blood capillaries, lungs and other surfaces where it permits the passive diffusion of gases and tissue fluids into and out of cavities.

B. Simple cuboidal epithelium is composed of short, box like cells. It usually lines small ducts and tubues such as those of the kidneys and salivary glands and may have active secretory or absorptive functions.

C. Ciliated columnar epithelium, similar to columnar epithelium except of varying height. Some cells have cilia and some may have microvilli. It lines nasal cavity and sinuses, ducts of some glands and some ducts of the male reproductive system.

D. Glandular epithelium, when cells of columnar epithelium possess secretory cells or multicellular secretory cells, called gland. It is known as glandular epithelium. There are two main types of secretory cells or glands *i. e.*, endocrine and exocrine. Product of endocrine gland is known as hormone while that of exocrine gland is of various types as saliva, wax, oil, mucus, milk, digestive enzymes etc.

10. (a) 1. Cardiac muscle
2. Unstriated muscle
3. Striated muscle

(b) Skeletal, peripheral, smooth, cardiac, autonomic, cardiac, smooth, striated, smooth cardiac, striated.

11. (a) Watson and Crick were first who suggested semiconservative mode of DNA replication. This prediction of DNA synthesis was tested in 1958 by M. Meselson and F. Stahl of the California Institute of Technology.

(b) *E. coli* (*Escherichia coli*) bacterium is used by M. Meselson and F. Stahl in this experiment.

(c) (i) By the use of autoradiography Taylor *et. al.*, (1957) demonstrated that DNA replication is semiconservative. He used *Vicia faba* as an experimental material.

(ii) In 1958, M. Meselson and F. Stahl used caesium chloride density gradient centrifugation technique to prove semiconservative mode of DNA replication.

(d) Results of I^{st}, II^{nd} and III^{rd} generations of replication are as followers :

o–generation no replication : *E. coli* bacterial DNA having heavy nitrogen (N^{15}) in their both strands.

This bacterium is grown into normal nitrogen containing medium (N^{14}).

I^{st} generation : Each DNA molecule has one strand of heavy nitrogen and other strand of normal nitrogen.

II^{nd} generation : Out of four formed DNAs two have normal nitrogen in their both strands and rest two have (each of them) one strand of heavy nitrogen (N^{15}) and other of normal nitrogen (N^{14}).

IIIrd generation : Out of eight formed DNA, six have normal nitrogen in their both strands and rest two DNA have (each of them) one strand of heavy nitrogen and other of normal nitrogen.

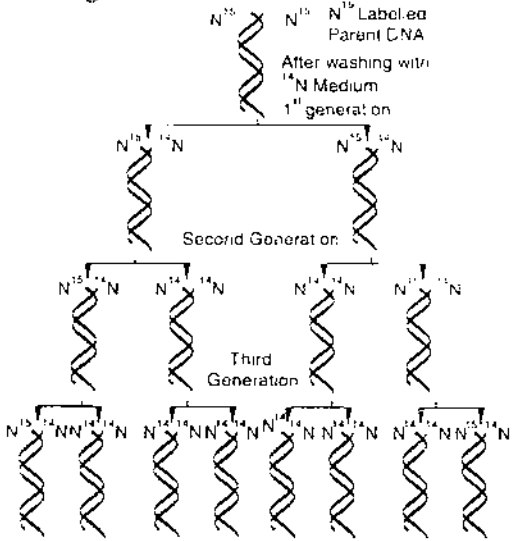
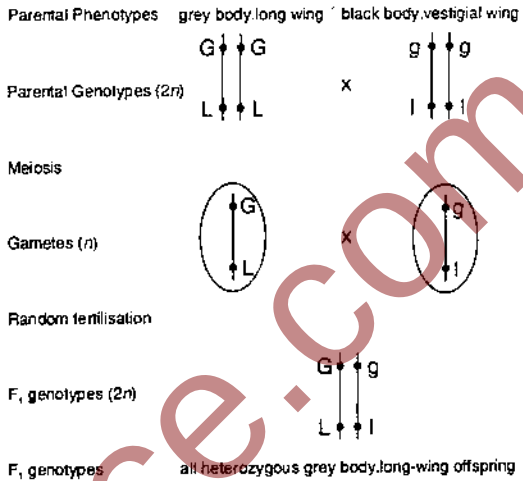


Fig : semiconservative replication of DNA

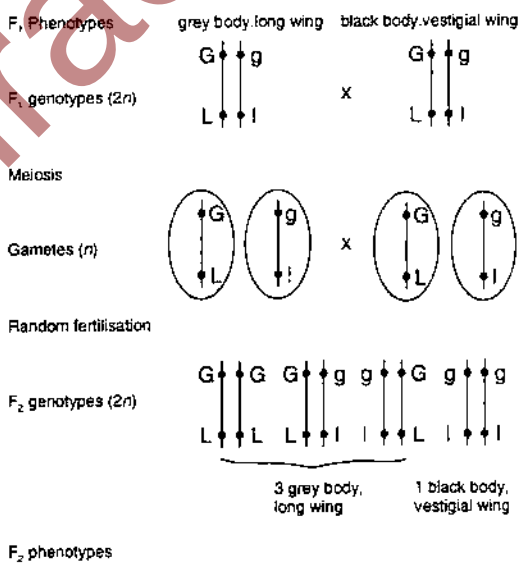
12.

	Rice	corn
Mode of reproduction	Autogamous	Allogamous
Struture of flower in relation to floral parts	Cleistogamous	Chasmogamous
Genetic makeup	Homozygous Homogenous	Heterozygous Heterogenous
Method of crop improvement	Mutation	Clonal
Progenny of crop improvement	Pedigree	Self incompatibility

13. (i) Common name —Fruit fly (Diptera)
Scientific name —*Drosophila melanogaster*
(ii) Complete linkage
(iii) Independent assortment
(iv)



The F_1 generation was allowed to interbreed



14. (a) When N is very small then $\frac{N}{K}$ is very small.

So, $\left(1-\frac{N}{K}\right)$ is approximately one and then equation will be

$$\frac{dN}{dt} = rN$$

This is equation for exponential growth.

(b) (i) $\frac{dN}{dt}$ = the average rate of change in the number of organisms per time.

r = difference between the instantaneous specific natality rate (*i. e.* rate per time per individual) and the instantaneous specific death rate.

N = The number of organisms of a population.

K = Carrying capacity for a particular population beyond which no major increase can occur.

15. 2, 4, 5, 7, 9, 10.

16. (1) Winkler (1908)
(2) Meiosis
(3) Syngamy (gametic union)
(4) Vegetative reproduction
(5) Agamospermy
(6) Nucellus (diploid)
(7) Integument (diploid)
(8) Apospory

17. (i) Photorespiration
(ii) Phytochrome
(iii) CAM (Crassulacean acid metabolism) plants.
(iv) *Arabidopsis thalsliana*, a cruciferous weed.
(v) Gibberellin
(vi) Mesosomes
(vii) *Cycas*
(viii) Anthocyanin
(ix) Parthenocarpy
(x) Steward

18. (a) *Marchantia* rhizoids
(b) *Riccia*, thallus
(c) *Spirogyra*, conjugation tube.
(d) *Cycas*, microsporangia.

❑