STUDY MATERIAL

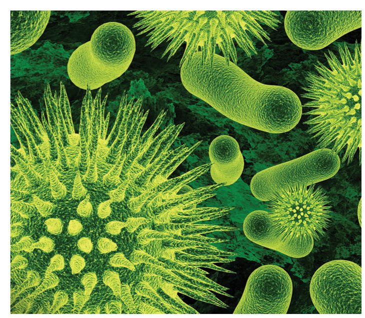
NEET

XI & XII STD

PHYSICS

CHEMISTRY

BIOLOGY



CP PUBLICATION

Study Material for NEET preparation

Prepared by Career Point Kota Experts

CONTENTS OF THE PACKAGE AT A GLANCE

PHYSICS

Class 11

Mechanics (Part-I)
- Basic Mathematics
- Unit & Dimension
- Errors in Measurement
- Vector
- Motion in one Dimension
- Projectile Motion
- Circular Motion
- Gravitation
- Simple Harmonic Motion

Mechanics (Part-II)
- Newton's Laws of Motion & Friction
- Work, Power, Energy & Laws of Conservation
- Rotational Motion
- Properties of Matter
- Fluid Mechanics

Heat & Wave
- Wave Theory
- Doppler Effect
- Calorimetry
- Kinetic Theory of Gases
- Thermodynamics
- Mode of Heat Transfer
- Thermal Expansion

Class 12

Electrodynamics
[A]
- Electrostatics
- Capacitance
- Current Electricity
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[B]
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- Magnetism
- Magnetic material
- Electro Magnetic Induction
- Alternating Current
- Electro Magnetic Wave

Optics
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  Prism (Deviation & Dispersion)
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- **Photometry**

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- Positive Rays
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- Communication System

CHEMISTRY

Class 11

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Class 12

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- Solution, Colligative Properties & Volumetric Analysis
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- Nitrogen Compounds
- Biomolecules, Polymers & Chemistry in everyday life

Inorganic Chemistry

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- Chalcogen Family
- Halogen family
- Inert Gas
- d & f Block and Coordination compound
- Metallurgy

BIOLOGY

Class 11

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- Plant Kingdom

Animal Diversity

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- Animal Kingdom (Chordata)

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- Morphology of Flowering Plants
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- Cell : the unit of life
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Class 12

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- Sexual Reproduction in Flowering Plants
- Strategies for Enhancement in food production

Reproduction in Human

- Human Reproduction
- Embryology
- Reproductive health
- Strategies for enhancement in food production

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- Molecular basis of Inheritance
- Biotechnology : Principles and Process
- Biotechnology and Its Applications

Evolution & Biology in Human Welfare

- Evolution
- Human Health and disease
- Microbes in human welfare

Ecology

- Organisms and populations
- Ecosystem
- Biodiversity and Conservation
- Environmental Issues

Features of The Product

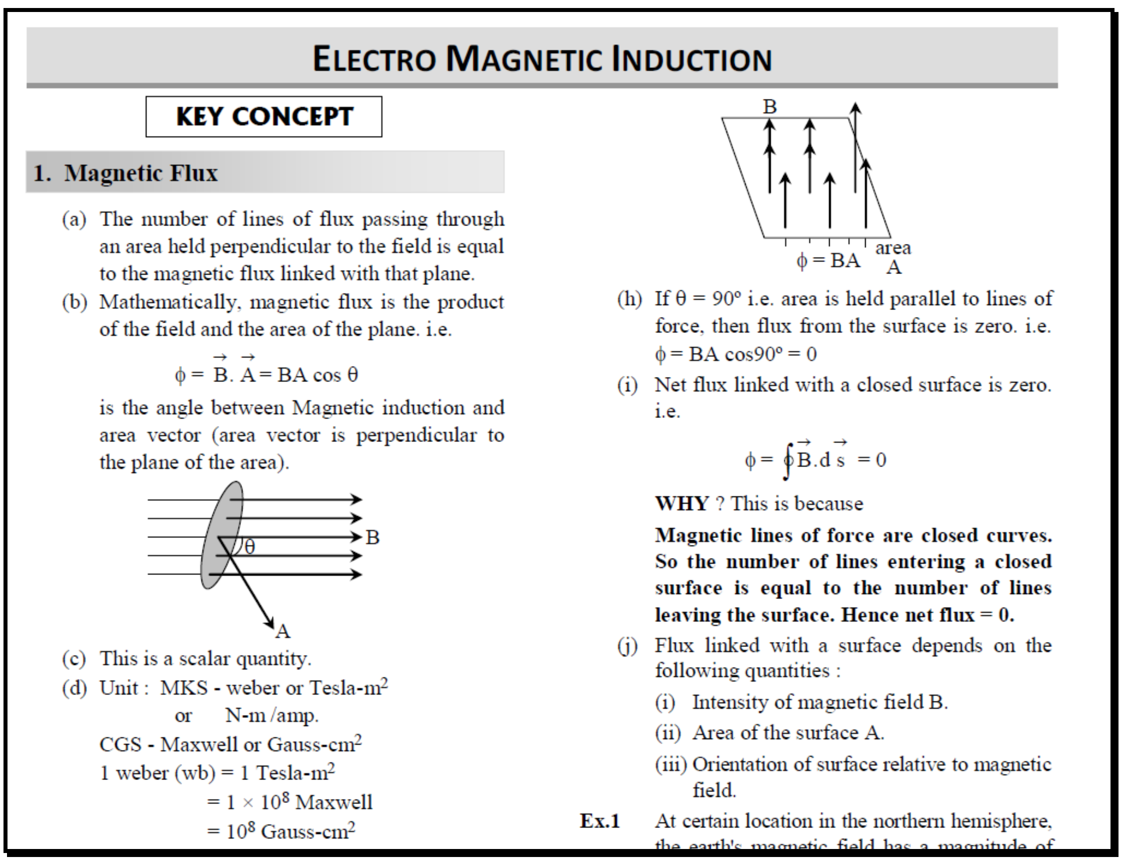
This study material is especially designed for NEET aspirants. The entire study material is arranged in such a way so that the learning process progresses gradually from the basic to advanced stages. This easy-to-grasp material enables students to apply the fundamentals they have learned and boost their confidence to tackle the problems asked in the NEET and other medical competitive examinations.

The NEET Study Material comprises 25 books: **Physics** – a set of 7 books, **Chemistry** – a set of 6 books, and **Biology** – a set of 12 books.

Key Features of the Chapter

Theory & Concepts

Theory provides all the basic concepts in clear and precise manner. It comprises all the related and required diagrams, tables, graphs, real life examples, info graphics, conceptual questions that makes it more comprehensive. It also highlights tips and tricks, facts, notes, misconceptions, key points, and problem solving tactics.



ELECTRO MAGNETIC INDUCTION

KEY CONCEPT

1. Magnetic Flux

(a) The number of lines of flux passing through an area held perpendicular to the field is equal to the magnetic flux linked with that plane.

(b) Mathematically, magnetic flux is the product of the field and the area of the plane. i.e.

$$\phi = \vec{B}.\vec{A} = BA\cos\theta$$

is the angle between Magnetic induction and area vector (area vector is perpendicular to the plane of the area).

(c) This is a scalar quantity.

(d) Unit : MKS - weber or Tesla-m^2
or N-m /amp.
CGS - Maxwell or Gauss-cm^2
1 weber (wb) = 1 Tesla-m^2
$= 1 \times 10^8$ Maxwell
$= 10^8$ Gauss-cm^2

$\phi = BA$

(h) If $\theta = 90^\circ$ i.e. area is held parallel to lines of force, then flux from the surface is zero. i.e. $\phi = BA\cos 90^\circ = 0$

(i) Net flux linked with a closed surface is zero. i.e.

$$\phi = \oint \vec{B}.d\vec{s} = 0$$

WHY ? This is because

Magnetic lines of force are closed curves. So the number of lines entering a closed surface is equal to the number of lines leaving the surface. Hence net flux = 0.

(j) Flux linked with a surface depends on the following quantities :

(i) Intensity of magnetic field B.

(ii) Area of the surface A.

(iii) Orientation of surface relative to magnetic field.

Ex.1 At certain location in the northern hemisphere,

In Chapter Examples

To clarify the application of theory & concept accurately & correctly, there is numenr of solved in-chapter questions follpowng each topic. It proves practically very effective to understand and correct application of related theory.

Ex.3 A rectangular coil of size 10 cm × 20 cm has 60 turns. It is rotating in magnetic field 0.5 Wb/m^2 with a rate of 1800 revolutions per minutes. The maximum induced e.m.f. across the ends of the coil is-

(1) 111 V (2) 112 V

(3) 113 V (4) 114 V

Sol. (4) Given, area = $10 \times 20\ cm^2 = 200 \times 10^{-4}\ m^2$

B = 0.5 T

N = 60

$\omega = 2\pi \times 1800/60$

$\because e = -\frac{d(N\phi)}{dt} = -N\frac{d}{dt}(BA\cos\omega t)$

$= NBA\omega \sin\omega t$

$\therefore e_{max} = NAB\omega$

$= 60 \times 2 \times 10^{-2} \times 0.5 \times 2\pi \times 1800/60$

= 113 volt.

Ex.5 A coil having 100 turns and area of 0.001 m^2 is free to rotates about an axis. The coil is placed perpendicular to a magnetic field of 1 Wb/m^2. If the coil is rotates rapidly through an angle of 180º, the charge flown through coil will be-

(The resistance of the coil is 10Ω).

(1) 0.01 C (2) 0.02 C

(3) 0.03 C (4) 0.04 C

Sol. (2) The flux linked with the coil, when the plane of the coil is perpendicular to the magnetic field is.

$\phi = nAB\cos\theta = nAB$

The change in flux on rotating the coil by 180º is $d\phi = nAB - (-nAB) = 2nAB$

$\therefore$ induced charge = $\frac{d\phi}{R} = \frac{2nAB}{R}$

$\therefore$ induced charge = $\frac{2 \times 100 \times 0.001 \times 1}{10}$

= 0.02 C

Points To Remember

This part contain important Theories, concepts, formulas of chapter at one place in short manner, So that student can revise all these in short time.

POINTS TO REMEMBER

1. The unit of magnetic flux ϕ is weber. Since $B = \phi/A$, so the unit of magnetic field is also expressed as 'weber/meter^2'. That is why the magnetic field induction B is also called the 'magnetic flux density'. As we have read, the unit of B is also newton /(ampere-meter).
2. C.G.S. unit of flux is Maxwell. 1 weber = 10^8 Maxwell.
3. 1 weber/m^2 = 1 Tesla.
4. If a plane is parallel to the magnetic field, then no flux-line will pass through it and the magnetic flux linked with that plane will be zero.
5. Magnetic flux can change in a number of ways, Some of them are-

   (i) If a coil with plane area A be kept perpendicular to a magnetic field B, then the magnetic flux linked with the coil will be $\phi_1 = BA$.

Solved Examples

To understand the concept application, in end of the each chapter there is suffiecient number of solved examples.

SOLVED EXAMPLES

Ex.1 A loop of wire is placed in a magnetic field $\vec{B} = 0.02\ \hat{i}$ tesla. Then the flux through the loop is its area vector is $\vec{A} = 30\hat{i} + 16\hat{j} + 23\hat{k}$ cm^2, is .

(1) 60μW (2) 32μ Wb

(3) 46μ Wb (4) 138μ Wb

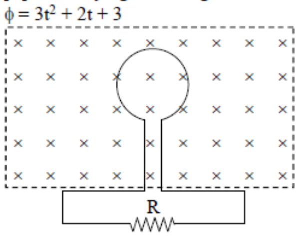
Sol.(1) $\phi = \vec{B}.\vec{A}$

$= (0.02\hat{i}).(30\hat{i} + 16\hat{j} + 23\hat{k}) \times 10^{-4}$

$= 0.6 \times 10^{-4}$ Wb = 60μ Wb

Ex. 2 The magnetic flux passing perpendicular to the plane of the coil and directed into the paper is varying according to the relation.

$\phi = 3t^2 + 2t + 3$



Where ϕ is in milliwebers and t is in seconds. Then the magnitude of emf induced in the loop when t = 2 second is-

(1) 31 mV (2) 19 mV

(3) 14 mV (4) 6 mV

Sol.(3) The induced emf

Sol.(1) Initial magnetic flux $\phi_1 = 5.5 \times 10^{-4}$ weber.

Final magnetic flux $\phi_2 = 5 \times 10^{-5}$ weber.

∴ change in flux

$\Delta\phi = \phi_2 - \phi_1 = (5 \times 10^{-5}) - (5.5 \times 10^{-4})$

$= -50 \times 10^{-5}$ weber.

Time interval for this change, $\Delta t = 0.1$ sec.

∴ induced emf in the coil

$e = -N\frac{\Delta\Phi}{\Delta t} = -1000 \times \frac{(-50\times10^{-5})}{0.1} = 5$ volt.

Resistance of the coil, R = 10 ohm. Hence induced current in the coil is

$i = \frac{e}{R} = \frac{5\text{ volt}}{10\text{ ohm}} = 0.5$ ampere.

Ex.4 A gramophone disc of brass of diameter 30 cm rotates horizontally at the rate of 100/3 revolutions per minute. If the vertical component of the earth's magnetic field be 0.01 weber / meter^2, then the emf induced between the centre and the rim of the disc will be-

(1) 7.065×10^{-4} V (2) 3.9×10^{-4} V

(3) 2.32×10^{-4} V (4) none of the above.

Sol. (2) Magnetic flux passing through the disc is $\phi = BA$

$= 0.01 \frac{\text{weber}}{\text{meter}^2} \times 3.14 \times (15 \times 10^{-2}\text{ meter})^2$

$= 7.065 \times 10^{-4}$ weber.

The line joining the centre and the circumference of the disc cuts 7.065×10^{-4}

Practice Exercises

Exercise Level -1 : It contains TOPIC WISE single objective correct (SCQ) type concept building questions.

Exercise Level -2: It contains single objective type good quality questions on all the concepts of the chapter in mixed manner.

EXERCISE # 2

Q.1 The coefficient of mutual inductance of two circuits A and B is 3 mH and their respective resistances are 10 ohm and 4 ohm. How much current should change in 0.02 second in the circuit A. So that the induced current in B should be 0.006 ampere-

(1) 0.24 amp (2) 1.6 amp

(3) 0.18 amp (4) 0.16 amp

Q.2 The coefficient of self inductance is 5 mH. If the emf of the cell in the circuit is 1.1 volt and at any instant the rate of increase of current is 6 ampere/second, then at that instant, the resultant e.m.f. in the circuit will be-

(1) 1.13 V (2) 0.13 V

(3) 1.07 V (4) 1.4 V

Q.7 A solenoid of inductance 50 mH and resistance 10 Ω is connected to a battery of 6 V. The time elapsed before the current acquires half of its steady-state value will be-

(1) 3.01 s (2) 3.02 s (3) 3.03 s (4) 3.5 ms

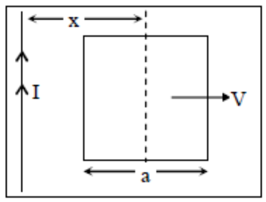
Q.8 An inductor - resistance battery circuit is switched on at t = 0. If the emf of the battery is E. The charge which passes through the battery in one time constant τ will be-

(1) $i_0\ \tau/e$ (2) $i_0\ e/\tau$ (3) $\tau\ e/i_0$ (4) $i_0\ e\ \tau$

Q.9 Two conducting circular loops of radii R_1 and R_2 are placed in the same plane with their centres coinciding. The mutual inductance between them assuming $R_2 << R_1$, will be-

Exercise Level -3 : It contains previous years NEET exam quesiotns from 2005 to upto to present year.

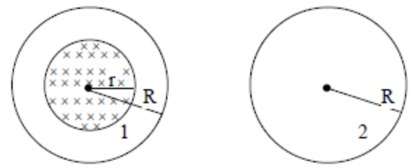
Q.43 A conducting square frame of side 'a' and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity 'V'. The emf induced in the frame will be proportional to : **[AIPMT-2015]**



(1) $\frac{1}{x^2}$ (2) $\frac{1}{(2x-a)^2}$

(3) $\frac{1}{(2x+a)^2}$ (4) $\frac{1}{(2x-a)(2x+a)}$

Q.46 A uniform magnetic field is restricted within a region of radius r. The magnetic field changes with time at a rate $\frac{d\vec{B}}{dt}$. Loop 1 of radius $R > r$ enclosed the region r and loop 2 of radius R is outside the region of magnetic field as shown in the figure below. Then the e.m.f. generated is **[NEET-2-2016]**



(1) Zero in loop 1 and zero in loop 2

(2) $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 2

(3) $-\frac{d\vec{B}}{dt}\pi R^2$ in loop 1 and zero in loop 2

Answer key

Above mentioned all exercises provided with answer key

ANSWER KEY

EXERCISE-1

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	1	1	4	3	3	4	4	4	1	4	4	3	4	1	2	3	2	1
Q.No.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	1	1	3	1	2	2	2	2	4	3	2	2	2	3	4	1	1	3	4
Q.No.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	3	4	1	1	1	4	3	4	2	2	2	3	3	3	3	4	1	4	3
Q.No.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78		
Ans.	3	2	1	3	2	2	2	1	2	1	3	1	1	2	3	1	2	2		

Revision Plan

We emphasis that every student should prepare his/her own revision plan. For this purpose there is Revision Plan Section in each chapter which student should prepare while going thorugh the study material. This will be useful at the time of final revision before final exam for quick & effective revision.

Index : Preparing your own list of Important/Difficult Questions

Revision Plan

Prepare Your Revision plan today!

After attempting Exercise Sheet, please fill below table as per the instruction given.

A. Write Question Number (QN) which you are unable to solve at your own in **column A**.

B. After discussing the Questions written in **column A** with faculty, strike off them in the manner so that you can see at the time question number during Revision, to solve such questions again.

C. Write down the Question Number you feel are important or good in the **column B**.

EXERCISE	COLUMN A	COLUMN B
	Questions unable to solve in first attempt	Good or Important questions
Exercise-1		
Exercise-2		
Exercise-3		

Online Solutions

Self explanatory and detailed soltuion of all excercises mentioned above are available on Career Point website **www.careerpoint.ac.in**

CURRENT ELECTRICITY

EXERCISE -1

Answer Key & Solution

Question Number	Solution	Question Number	Solution	Question Number	Solution	Question Number	Solution
1	Click Here	12	Click Here	23	Click Here	34	Click Here
2	Click Here	13	Click Here	24	Click Here	35	Click Here
3	Click Here	14	Click Here	25	Click Here	36	Click Here
4	Click Here	15	Click Here	26	Click Here	37	Click Here
5	Click Here	16	Click Here	27	Click Here	38	Click Here
6	Click Here	17	Click Here	28	Click Here	39	Click Here
7	Click Here	18	Click Here	29	Click Here	40	Click Here
8	Click Here	19	Click Here	30	Click Here	41	Click Here
9	Click Here	20	Click Here	31	Click Here	42	Click Here
10	Click Here	21	Click Here	32	Click Here		
11	Click Here	22	Click Here	33	Click Here		

Sol.1 [B]

Given

$I = 1.1$ A

$e = 1.6 \times 10^{-19}$ C

$A = \pi r^2 = p \times (0.05)^2$

$= 78.5 \times 10^{-4}$ cm^2

$$v_d = \frac{I}{neA}$$

$$n = \frac{6\times10^{23}}{7cm^3} = 0.86 \times 10^{23} / m^3$$

$$v_d = \frac{1.1}{0.86\times1.6\times10^{-19}\times78.5\times10^{-4}}$$

(volume of 63g Cu)

$v_d = 0.01$ cm/s.

$= 0.1$ mm/s

Top

ELECTRO MAGNETIC INDUCTION

NEET SYLLABUS

1. *Faraday's law of electromagnetic induction.*

2. *Lenz's law.*

3. *Induced emf.*

4. *Self and mutual inductance.*

Revision Plan

Prepare Your Revision plan today!

After attempting Exercise Sheet, please fill below table as per the instruction given.

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B. After discussing the Questions written in **column A** with faculty, strike off them in the manner so that you can see at the time question number during Revision, to solve such questions again.

C. Write down the Question Number you feel are important or good in the **column B**.

EXERCISE	COLUMN A	COLUMN B
	Questions unable to solve in first attempt	Good or Important questions
Exercise-1		
Exercise-2		
Exercise-3		

Revision Strategy:

Whenever you wish to revision this chapter, follow the following steps-

Step-1: Review your theory notes.

Step-2: Solve Questions of column A

Step-3: Solve Questions of Column B

Step-4: Solve questions from other Question Bank, Problem book etc.

KEY CONCEPT

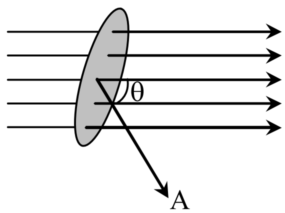
1. Magnetic Flux

(a) The number of lines of flux passing through an area held perpendicular to the field is equal to the magnetic flux linked with that plane.

(b) Mathematically, magnetic flux is the product of the field and the area of the plane. i.e.

$$\phi = \vec{B}.\vec{A} = BA\cos\theta$$

is the angle between Magnetic induction and area vector (area vector is perpendicular to the plane of the area).



(c) This is a scalar quantity.

(d) Unit : MKS - weber or Tesla-m^2
or N-m /amp.
CGS - Maxwell or Gauss-cm^2
1 weber (wb) = 1 Tesla-m^2
$= 1 \times 10^8$ Maxwell
$= 10^8$ Gauss-cm^2

Note: (i) $\textbf{weber} = \dfrac{\textbf{newton}}{\textbf{amp.m}} \times \textbf{m}^2 = \dfrac{\textbf{newton.m}}{\textbf{amp}}$

$= \dfrac{\textbf{joule}}{\textbf{amp}} = \dfrac{\textbf{volt} \times \textbf{coul}}{\textbf{amp}}$

$= \dfrac{\textbf{volt} \times \textbf{amp.sec}}{\textbf{amp}} = \textbf{volt.sec.}$

(ii) $\textbf{weber} = \dfrac{\textbf{volt} \times \textbf{coul}}{\textbf{amp}} = \textbf{ohm-coul.}$

(iii) **weber = volt-sec**

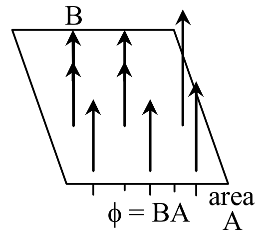
$= \dfrac{\textbf{volt}}{\textbf{amp/sec}} \times \textbf{amp} = \textbf{henry-amp.}$

(e) Dimension : $[ML^2T^{-2}A^{-1}]$

(f) Net flux leaving a surface $= \phi = \oint \vec{B}.d\vec{s}$

(g) If = 0 i.e. area is held perpendicular to the Magnetic lines of force, then flux from the surface is maximum.

$$\phi_{max} = BA$$



(h) If θ = 90º i.e. area is held parallel to lines of force, then flux from the surface is zero. i.e. $\phi = BA\cos 90^\circ = 0$

(i) Net flux linked with a closed surface is zero. i.e.

$$\phi = \oint \vec{B}.d\vec{s} = 0$$

WHY ? This is because

Magnetic lines of force are closed curves. So the number of lines entering a closed surface is equal to the number of lines leaving the surface. Hence net flux = 0.

(j) Flux linked with a surface depends on the following quantities :

(i) Intensity of magnetic field B.
(ii) Area of the surface A.
(iii) Orientation of surface relative to magnetic field.

Ex.1 At certain location in the northern hemisphere, the earth's magnetic field has a magnitude of 42 μT and points down ward at 57º to vertical. The flux through a horizontal surface of area 2.5 m^2 will be-
(given cos 33º = 0.839, cos 57º = 0.545)
(1) 42×10^{-6} Wb (2) 42×10^{-6} Wb/m^2
(3) 57×10^{-6} Wb (4) 57×10^{-6} Wb/m^2

Sol. (3) The flux through the area is
$\phi = BA\cos 57^\circ = 42 \times 10^{-6} \times 2.5 \times 0.545$
$= 57 \times 10^{-6}$ Wb.

2. Faraday's Laws of Electromagnetic Induction

(a) Whenever the number of magnetic lines of force or magnetic flux passing through a circuit changes an emf is produced in the circuit called induced emf.

(b) If the circuit is closed a current flows through it called induced current.

(c) The induced emf is given by rate of change of magnetic flux linked with the circuit i.e.

$$e = \frac{d\phi}{dt}$$

or $$e = \frac{d(N\phi)}{dt}$$

where e = induced emf

N = Total number of turns.

(d) emf is induced in the circuit only till there is a change in the flux linked with it.

(e) From $e = \frac{d\phi}{dt}$, we can say that $1 \text{ Volt} = \frac{1\text{wb}}{\text{sec}}$

3. Lenz's Law

(a) This gives the direction of induced emf.

(b) According to this law, the direction of induced emf or current in the coil in such a way such as to oppose the change that produces it.

(c) From Lenz's law and Faraday's Law, induced emf is given by $e = -\frac{d\phi}{dt}$, Where minus sign is to show that emf opposes the change of flux linked with it.

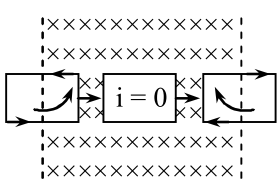
(d) This law is based upon Law of conservation of energy.

(e) Mechanical energy and Magnetic energy get converted into Electrical of energy in this Phenomenon called electromagnetic induction.

Problems :

(i)

Magnetic flux through square is increasing



Magnetic flux through square is decreasing

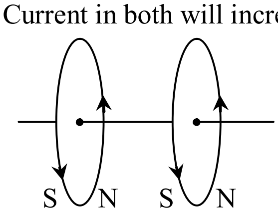
No change in Magnetic flux

(ii) Case 1 : brought closer → ←

⇒ Current in both will decrease

Case 2 : brought apart ← →

⇒ Current in both will increase.



(iii) Case 1 : brought closer → ←

⇒ Current in both will increase

Case 2 : brought apart ← →

⇒ Current in both will decrease

Ex.2 A coil of metal wire is stationary in a non-uniform magnetic field. Is there any induced e.m.f in coil ?

Sol. No, since magnetic flux is not changing.

4. Some General Points

(a) Induced emf is given by $e = -\frac{d\phi}{dt}$

∵ Sign is given by Lentz's Law.

(b) If magnetic flux linked with a circuit changes from ϕ_1 to ϕ_2 in time 'Δt' then induced emf

E is given by $E = -\frac{(\phi_2 - \phi_1)}{\Delta t}$

(c) If circuit is a closed one, then induced current is given by

$$i = \frac{E}{R} = -\frac{(\phi_2 - \phi_1)}{\Delta t\, R} \text{ amp}$$

or $$i = -\frac{1}{R}\frac{d}{dt}(N\phi)$$

(d) Value of induced emf does not depend on the resistance of the circuit.

(e) Value of induced current depends on resistance.

i.e. $I \propto \frac{1}{R}$

(f) If circuit is open or $R = \infty$, then there will be an induced emf but no current flowing.

(g) Induced current depends on the following-

(a) $i \propto \frac{d\phi}{dt}$

(b) $i \propto N$

(c) $i \propto \frac{1}{R}$

(h) If dq charge flows due to induction in time 'dt' then

$$i = \frac{dq}{dt} = \frac{1}{R}\frac{d\phi}{dt} \Rightarrow dq = \frac{d\phi}{R}$$

$$\Rightarrow q = \frac{1}{R}\int \frac{d\phi}{dt} = \frac{(\phi_2 - \phi_1)}{R} \text{ (Imp)}$$

(i) This flow of charge is called induced charge.

(j) The charge induced does not depend on the time interval in which flux through the circuit changes. It simply depends on the net change in flux and resistance of the circuit.

Ex.3 A rectangular coil of size 10 cm × 20 cm has 60 turns. It is rotating in magnetic field 0.5 Wb/m^2 with a rate of 1800 revolutions per minutes. The maximum induced e.m.f. across the ends of the coil is-

(1) 111 V (2) 112 V
(3) 113 V (4) 114 V

Sol. (4) Given, area = $10 \times 20\ cm^2 = 200 \times 10^{-4}\ m^2$

B = 0.5 T

N = 60

$\omega = 2\pi \times 1800/60$

$\because\ e = -\dfrac{d(N\phi)}{dt} = -N\dfrac{d}{dt}\ (BA\cos\omega t)$

$= NBA\omega \sin\omega t$

$\therefore\ e_{max} = NAB\omega$

$= 60 \times 2 \times 10^{-2} \times 0.5 \times 2\pi \times 1800/60$

= 113 volt.

Ex.4 A closed coil of copper whose area is 1m x 1m is free to rotate about an axis. The coil is placed perpendicular to a magnetic field of 0.10 Wb/m^2. It is rotated through 180º in 0.01 second. The induced e.m.f. and induced current in the coil will respectively be-

(The resistance of the coil is 2.0 Ω)

(1) 20 V, 10A
(2) 10 V, 20 A
(3) 10 V, 10 A
(4) 20 V, 20 A

Sol. (1) The change is flux linked with the coil on rotating it through 180º is

$= nAB - (-nAB) = 2nAB$

$\therefore$ induced e.m.f. $= -\dfrac{d\phi}{dt}$

$= 2nAB/dt$ (numerically) $= \dfrac{2\times1\times0.1}{0.01} = 20$ V

The coil is closed and has a resistance of 2.0 Ω. Therefore i = 20/2 = 10A.

Note : When the coil is opened, the induced e.m.f. is still present in it but the induced current becomes zero.

Ex.5 A coil having 100 turns and area of 0.001 m^2 is free to rotates about an axis. The coil is placed perpendicular to a magnetic field of 1 Wb/m^2. If the coil is rotates rapidly through an angle of 180º, the charge flown through coil will be-

(The resistance of the coil is 10Ω).

(1) 0.01 C (2) 0.02 C
(3) 0.03 C (4) 0.04 C

Sol. (2) The flux linked with the coil, when the plane of the coil is perpendicular to the magnetic field is.

$\phi = nAB\cos\theta = nAB$

The change in flux on rotating the coil by 180º is $d\phi = nAB - (-nAB) = 2nAB$

$\therefore$ induced charge $= \dfrac{d\phi}{R} = \dfrac{2nAB}{R}$

$\therefore$ induced charge $= \dfrac{2\times100\times0.001\times1}{10}$

= 0.02 C

5. No E.M.I. Cases

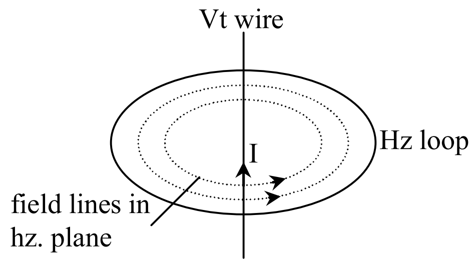
Condition of No EMI. if

$\phi = 0$ (No flux linkage through the coil) $\Rightarrow$ No EMI

ϕ = constant Flux linkage through the coil is constant $\Rightarrow$ No EMI

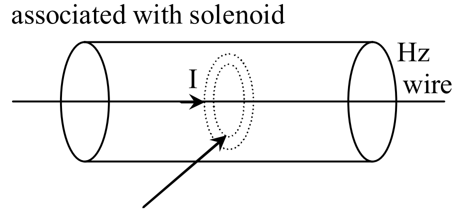
CASES

(i) If current I increases with respect to time, no emf induced in loop because no flux associated with it, as plane of circular field lines of straight wire is parallel to the plane of loop.

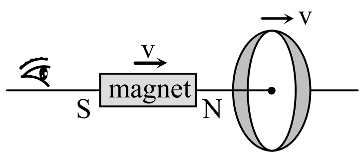


($\phi = 0$)

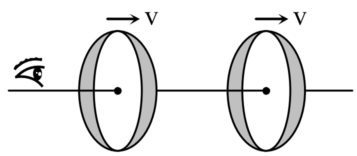
(ii) If current I increases with respect to time no emf induced in solenoid because no flux associated with solenoid



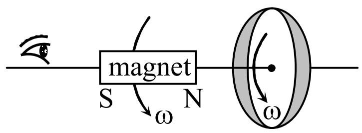
field lines in Vt plane ($\phi = 0$)

(iii) (a) 

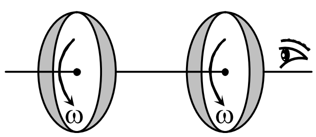
No relative motion
(ϕ = const.)

(b) 

No relative motion
(ϕ = const.)

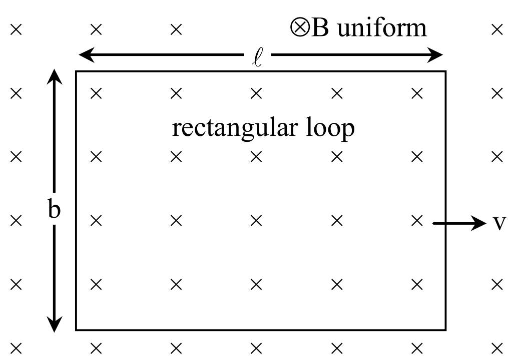
(c) 

No relative motion
(ϕ = const.)

(d) 

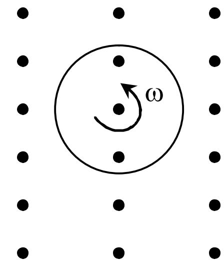
No relative motion
(ϕ = const.)

(iv) Any rectangular coil or loop translates within the uniform transverse magnetic field, no emf induced in it because its flux remains constant.



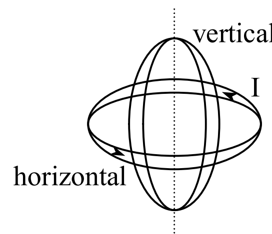
ϕ = constant

(v) Any coil or loop rotates about its geometrical axis in uniform transverse magnetic field, no emf induced in it because its flux remains constant.

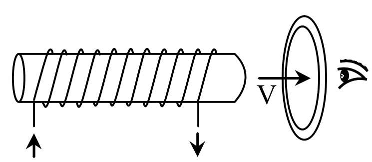


(ϕ = const.)

(vi) If current of one coil (or loop) either increase or decrease, no emf induced in another coil (or loop) because no flux associated for the coils (or loops) which are placed mutually perpendicular.



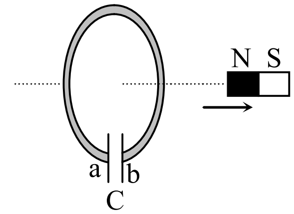
Ex.6 A current carrying solenoid is approaching a conducting loop as shown in the figure. The direction of induced current as observed by an observer on the other side of the loop will be -



(1) anticlockwise (2) clockwise
(3) east (4) west

Sol. The direction of current in the solenoid is clockwise. On displacing it towards the loop a current in the loop will be induced in clockwise direction so as to oppose its approach. Therefore the direction of induced current as observed by the observer will be anticlockwise. Hence the correct answer will be (1).

Ex.7 Consider the arrangement shown in figure in which the north pole of a magnet is moved away from a thick conducting loop containing capacitor. Then excess positive charge will arrive on -



(1) plate a

(2) plate b

(3) On both plates a and b

(4) On neither a nor b plates.

Sol. When north pole of the magnet is moved away, then south pole is induced on the face of the loop in front of the magnet i.e. as seen from the magnet side, a clockwise induced current flows in the loop. This makes free electrons to move in opposite direction, to plate a. Thus excess positive charge appear on plate b. The correct answer is (2).

Ex.8 The current changes in an inductance coil of 100 mH from 100 mA to zero in 2 millisecond. The e.m.f. induced in the coil will be :

(1) –5V (2) 5V

(3) –50 V (4) 50 V

Sol.(2) $E = -L\dfrac{dI}{dt}$

$= -100 \times 10^{-3}\dfrac{(0-100)\times 10^{-3}}{2\times 10^{-3}} = 5.0$ V

Ex.9 When a small piece of wire passes between the magnetic poles of a horse-shoe magnet in 0.1 sec, emf of 4×10^{-3} volt is induced in it. The magnetic flux between the poles is :

(1) 4×10^{-2} weber (2) 4×10^{-3} weber

(3) 4×10^{-4} weber (4) 4×10^{-6} weber

Sol.(3) $E = -\dfrac{d\phi}{dt}$ or $d\phi = -Edt = (0 - \phi)$

or $\phi = 4 \times 10^{-3} \times 0.1 = 4 \times 10^{-4}$ Wb.

Ex.10 The normal magnetic flux passing through a coil changes with time according to following equation $\phi = 10t^2 + 5t + 1$.Where ϕ is in milliweber and t is in second. The value of induced e.m.f. produced in the coil at t = 5s will be –

(1) zero (2) 1V

(3) 2V (4) 0.105 V

Sol.(4) $e = \dfrac{d\phi}{dt} = -\dfrac{d}{dt}[10t^2 + 5t + 1] \times 10^{-3}$

$= -[10 \times 10^{-3}(2t) + 5 \times 10^{-3}]$

at t = 5 second

$e = -[10 \times 10^{-2} + 5 \times 10^{-3}] \Rightarrow |e| = 0.105$V

6. Types of E.M.I.

For a loop flux, (ϕ = BA cosθ) changes w.r.t. time in following three manner and according to it electro magnetic induction classify in three ways:

(A) If (A, θ) $\rightarrow$ const & $\dfrac{dB}{dt} \rightarrow \dfrac{d\phi}{dt} \Rightarrow$ **Static EMI**

(1) Self Induction (In this case EMI occurs for rest coil)

(2) Mutual Induction

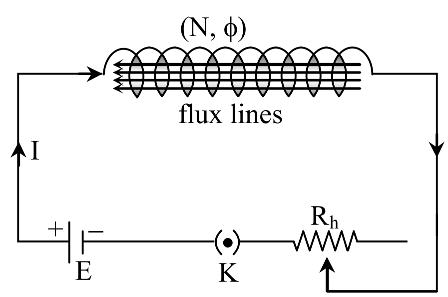
(B) If (B, θ) $\rightarrow$ const & $\dfrac{dA}{dt} \rightarrow \dfrac{d\phi}{dt} \Rightarrow$ **Dynamic EMI** (In this case EMI occurs for a moving straight wire)

(C) If (A, B) $\rightarrow$ const & $\dfrac{d\theta}{dt} \rightarrow \dfrac{d\phi}{dt} \Rightarrow$ **Periodic E.M.I** (In this case E.M.I. occurs for a rotating coil)

(A) Static E.M.I. $\Rightarrow \dfrac{dI}{dt} \rightarrow \dfrac{dB}{dt} \rightarrow \dfrac{d\phi}{dt} \Rightarrow$ **Static EMI**

(1). Self Induction : When current through the coil changes, with respect to time then magnetic flux linked with the coil also changes with respect to time. Dut to this an emf and a current induced in the coil. According to Lenz law induced current opposes the change in magnetic flux. This phenomenon is called self induction and a factor by virtue the coil shows opposition for change in magnetic flux called self inductance of coil. Considering this coil circuit in two cases:-

Case-I : Current through the coils constant:-



If I $\rightarrow$ B $\rightarrow \phi \rightarrow$ Const. $\Rightarrow$ No EMI

total flux of coil (Nϕ) $\propto$ curent through the coil(I)

$N\phi \propto I \Rightarrow N\phi = LI$

$$\boxed{L = \frac{N\phi}{I} = \frac{NBA}{I} = \frac{\phi_{Total}}{I}}$$

Where L : self inductance of coil

S.I. unit of L $\rightarrow 1\dfrac{\text{weber}}{\text{A}} = 1\text{ henry} = 1\dfrac{\text{N}-\text{m}}{\text{A}^2} = 1\dfrac{\text{J}}{\text{A}^2}$

Dimension: $[M^1L^2T^{-2}A^{-2}]$

Sp. Note:- L is constant of coil it **does not depends on current** through the coil.

Case-II: Current through the coil changes w.r.t.:-

If $\dfrac{dI}{dt} \rightarrow \dfrac{dB}{dt} \rightarrow \dfrac{d\phi}{dt} \Rightarrow$ Static EMI

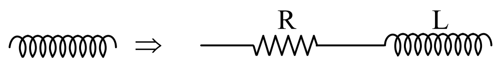
$N\phi = LI$

$-N\dfrac{d\phi}{dt} = -L\dfrac{dI}{dt}$, where $-N\dfrac{d\phi}{dt}$ called self induced emf of coil 'e_s' $\boxed{e_s = -L\dfrac{dI}{dt}}$

S.I. unit of L $\rightarrow \dfrac{\text{V}-\text{sec}}{\text{A}}$

(i) Thin wire____________ $R \neq 0$ & $L = 0$

$\Rightarrow$ Role of R $\rightarrow$ to opposes flow of current, now this wire moulded in form of coil.



$R \neq 0$ R-L series combination

$L \neq 0$

Role of L $\rightarrow$ to opposes changes in current, if current becomes constant, then no role of 'L'

Note: Resistance is possible without inductance but inductance is not possible without resistance.

(ii) If w.r.t. $I\uparrow \Rightarrow \dfrac{dI}{dt}$ (+ve) $\Rightarrow e_s$(–ve) opposite emf

$\Rightarrow \boxed{E_{net} = E - e_s}$

(iii) If w.r.t. $I\downarrow \Rightarrow \dfrac{dI}{dt}$ (–ve) $\Rightarrow e_s$(+ve) same directed emf $\Rightarrow \boxed{E_{net} = E + e_s}$

(iv) Current variation with key:-

(a) Just closing of key $\Rightarrow I\uparrow = dI$ (+ve) $\Rightarrow e_s$(–ve)

(b) Just opening of key (source emf E cut out) $\Rightarrow I\downarrow = dI$(–ve) $\Rightarrow e_s$(+ve)

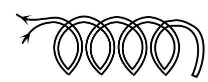
(c) At the time of sudden opening of key, due to high inductance of circuit a high momentarily emf induced and sparking occurs at key position. To avoid sparking a capacitor is connected parallel to the key.

(v) Self inductance always opposes the change of current in electric circuit so it is also called inertia of electric circuit.

(vi) Mechanics v/s Electricity:-

Mechanics	Electricity
Mass inertia (m)	Electric Inertia (L)
Velocity (v)	Current (I)
Momentum (mv)	Magnetic Flux (LI)
Kinetic energy (½ mv^2)	Energy stored in Inductor (½ LI^2)
Retarding force (–m dv/dt)	Self induced emf (–L dI/dt)

(vii) Resistance coil of resistance box, wound in two layer in opposite manner. The self inductance of coil becomes negligible



$R \neq 0$

L 0 (Non inductive resistance)

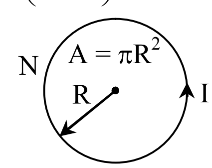
(viii) In checking balancing of wheat stone. Bridge, firstly we always pressed cell key and after wards galvanometer key, so that momentarily induced current due to self inductance of coil becomes almost zero or disappear.

Different Coefficient of Self inductance:-

(i) Plane circular coil-

$L_{coil} = \dfrac{NBA}{I}$ where $B = \dfrac{\mu_0 NI}{2R}$

$L_{coil} = \dfrac{N}{I}\left(\dfrac{\mu_0 NI}{2R}\right)\pi R^2$



$\boxed{L_{coil} = \dfrac{\mu_0 N^2 \pi R}{2}}$ $\rightarrow$
- $L_m \propto \mu_r$ (effect of medium)
- $L \propto N^2$ ($R \rightarrow$ same)
- $L \propto R$ ($N \rightarrow$ same)

(ii) Solenoid : $L_s = \dfrac{NBA}{I}$ where $B = \mu_0\dfrac{N}{\ell}I$

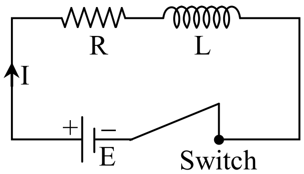
$L_s = \dfrac{N}{I}\left(\dfrac{\mu_0 NI}{\ell}\right)A$

$\boxed{L_s = \dfrac{\mu_0 N^2 A}{\ell} = \mu_0 n^2 A\ell = \mu_0 n^2 V}$

Where V: - Volume of solenoid = $A\ell$

and A:- Area of cross-section of frame of solenoid.

R-L d.c. Circuit:-



Case-I : Current Growth:-

(i) Emf equation:- $\boxed{E = IR + L\frac{dI}{dt}}$

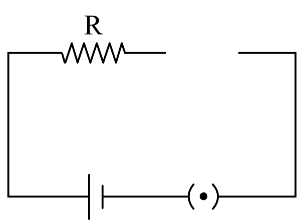
(ii) Current at any instant:- When key is closed the current in circuit increases exponentially with respect to time. The current in circuit at any instant 't' given by:-

$$\boxed{I = I_0(1 - e^{-t/\lambda})}$$

t = 0 (Just after the closing of key) $\Rightarrow I = 0$

$t \to \infty$ (Some time after closing of key) $\Rightarrow I \to I_0$

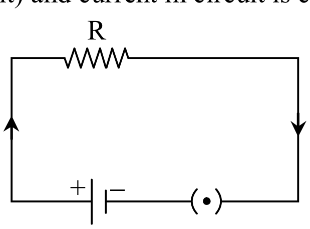
(iii) Just after the closing of the key inductance behaves like open circuit and current in circuit is zero.



(Open circuit, t = 0, I = 0)

(Inductor provide infinite resistence)

(iv) Some time after closing of the key inductance behaves like simple connecting wire (short circuit) and current in circuit is constant.



(short circuit $t \to \infty$, $I \to I_0$)

(Inductor provide zero resistance)

$\boxed{I_0 = \frac{E}{R}}$ (Final, steady, maximum or peak value of current)

Note : Peak value of current in circuit does not depends on self inductance of coil.

(v) Time constant of circuit (λ):- $\boxed{\lambda = \frac{L}{R}}$ sec.

It is a time in which current increases up to 63% or 0.63 times of peak current value.

(vi) Half life (T):- It is a time in which current increases upto 50% or 0.50 times of peak current value.

$$I = I_0\,(1 - e^{-t/\lambda})$$

$t = T$, $I = I_0/2$ $\qquad \frac{I_0}{2} = I_0(1 - e^{-T/\lambda})$

$$\Rightarrow e^{-T/\lambda} = \frac{1}{2} \Rightarrow e^{T/\lambda} = 2$$

$$\frac{T}{\lambda}\log_e e = \log_e 2$$

$$\boxed{\begin{array}{l} T = 0.693\lambda \\ T = 0.693\frac{L}{R} \end{array}}\ \text{sec}$$

(vii) Rate of growth of current at any instant:-

$$\boxed{\left(\frac{dI}{dt}\right) = \frac{E}{L}(e^{-t/\lambda})}$$

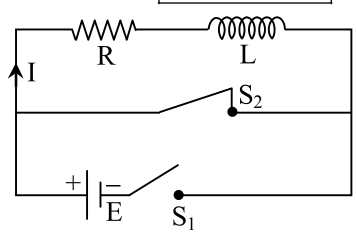
at $t = 0 \Rightarrow \left(\frac{dI}{dt}\right)_{max} = \frac{E}{L}$

at $t \to \infty \Rightarrow \left(\frac{dI}{dt}\right)_{min} \to 0$

Note: Maximum or initial value of rate of growth of current does not depends upon resistance of coil.

Case-II : Current Decay:-

(i) Emf equation:- $\boxed{IR + L\frac{dI}{dt} = 0}$



(ii) Current at any instant:- Once current acquires its final max steady value, if suddenly switch is put off then current start decreasing exponentially with respect to time. The current in circuit at any instant 't' is given by:-

$$\boxed{I = I_0(e^{-t/\lambda})}$$

(Just after opening of key) $t = 0 \Rightarrow I = I_0 = \frac{E}{R}$

(Some time after opening of key) $t \to \infty \Rightarrow I \to 0$

(iii) Time constant(λ):- It is a time in which current decreases up to 37% or 0.37 times of peak current value. $\boxed{\lambda = \frac{L}{R}}$ sec

(iv) Half life(T):- It is a time in which current decreases upto 50% or 0.50 times of peak current value.

$\boxed{T = (0.693)\lambda}_{sec}$

(v) Rate of decay of current at any instant:-

$$\boxed{\left(-\frac{dI}{dt}\right) = \left(\frac{E}{L}\right)e^{-t/\lambda}}$$

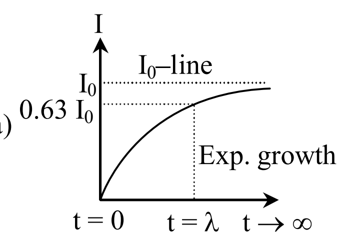
at $t = 0 \quad \Rightarrow \quad \left(-\frac{dt}{dt}\right)_{max} = \frac{E}{L}$

at $t \to \infty \quad \Rightarrow \quad \left(-\frac{dI}{dt}\right)_{min} \to 0$

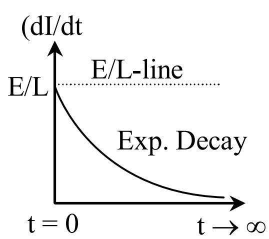
Special graph for R-L circuit:-

Current Growth:-

(a)

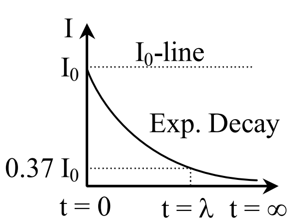


(b)

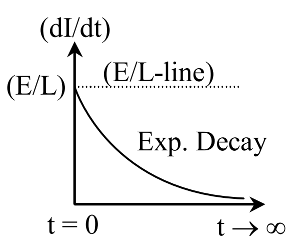


Current decay:-

(a)

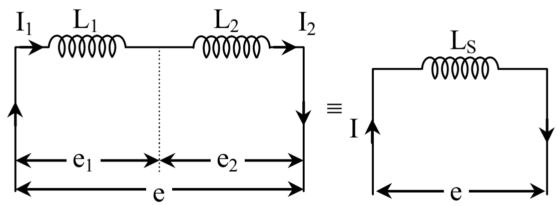


(b)



Combination of Inductances:-

(a) Series combination



Potential divides, $\quad e = e_1 + e_2$

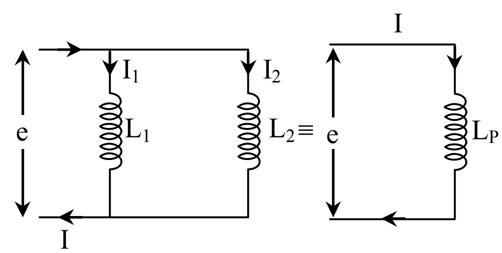
$$L_s\frac{dI}{dt} = L_1\frac{dI_1}{dt} + L_2\frac{dI_2}{dt} \quad (\text{as } e = -L\frac{dI}{dt})$$

Current remains same $I = I_1 = I_2$

$$\text{i.e. } \frac{dI}{dt} = \frac{dI_1}{dt} = \frac{dI_2}{dt}$$

$$\boxed{L_S = L_1 + L_2}$$

(b) Parallel combination:



Current divides, $\quad I = I_1 + I_2$

$$\frac{dI}{dt} = \frac{dI_1}{dt} + \frac{dI_2}{dt}$$

$$\frac{e}{L_P} = \frac{e_1}{L_1} + \frac{e_2}{L_2}$$

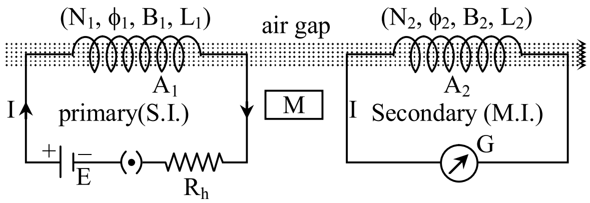
$$\left[\text{as } e = -L\frac{dI}{dt} \text{ i.e.} \frac{dI}{dt} = -\frac{e}{L}\right]$$

Potential remains same, $\quad e = e_1 = e_2$

$$\frac{1}{L_P} = \frac{1}{L_1} + \frac{1}{L_2} \Rightarrow \boxed{L_P = \frac{L_1L_2}{L_1 + L_2}}$$

(2). Mutual Induction:-(M.I.)

Whenever current passing through primary coil or circuit change with respect to time then magnetic flux in neighbouring secondary coil or circuit will also changes with respect to time. According to Lenz Law for opposition of flux change an emf and a current induced in the neighbouring coil or circuit. This phenomenon called as 'Mutual induction'.



Due to air gap always $\phi_2 < \phi_1$ and $\phi_2 = B_1A_2$ $(\theta = 0)$

Case-I : When current through primary is constant:-

Total flux of secondary is directly proportional to current flow through the primary coil

$N_2\ \phi_2 \propto I_1$

$N_2\ \phi_2 = MI_1$

$$\boxed{M = \frac{N_2\phi_2}{I_1} = \frac{N_2B_1A_2}{I_1} = \frac{(\phi_T)_s}{I_p}},$$

Where M : mutual inductance of circuits.

(i) The units and dimension of M are same as 'L'.

(ii) The mutual inductance does not depends upon current through the primary and it is constant for both circuits.

Case-II: When current through primary chenges w.r.t.

If $\frac{dI_1}{dt} \rightarrow \frac{dB_1}{dt} \rightarrow \frac{d\phi_1}{dt} \rightarrow \frac{d\phi_2}{dt} \Rightarrow$ Static EMI

$$N_2\phi_2 = MI_1$$

$-N_2\ \frac{d\phi_2}{dt} = -\ M\frac{dI_1}{dt}$, $\left(-N_2\frac{d\phi}{dt}\right)$ called total mutual induced emf of secondary coil e_m.

$$\boxed{e_m = -M\left(\frac{dI_1}{dt}\right)}$$

Secondary ← → Primary

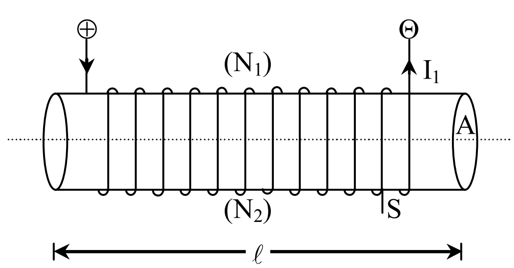
Different mutual inductances:-

(a) In terms of their number of turns

(b) In terms of their self inductances

(a) In terms of their number of turns (N_1 , N_2):-

(1) Two co-axial solenoids :-

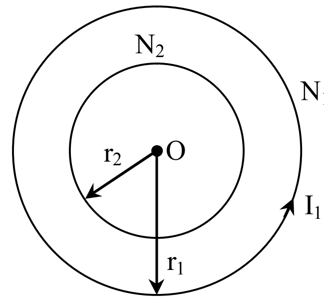


$$M_{S_1S_2} = \frac{N_2B_1A}{I_1}$$

$$= \frac{N_2}{I_1}\left(\frac{\mu_0N_1I_1}{\ell}\right) A, \text{ where } B_1 = \frac{\mu_0N_1I_1}{\ell}$$

$$\Rightarrow \boxed{M_{s_1s_2} = \left(\frac{\mu_0N_1N_2A}{\ell}\right)}$$

(2) Two concentric and coplanar coils :-



$(r_1 >> r_2)$

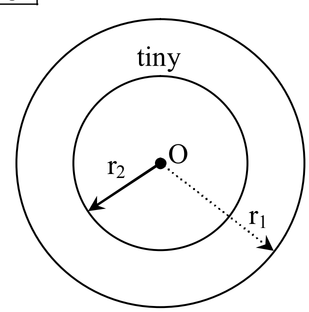
$$M_{c_1c_2} = \frac{N_2B_1A_2}{I_1}, \text{where } B_1 = \frac{\mu_0N_1I_1}{2r_1} \ \&\ A_2 = \pi r_2^2$$

$$M_{c_1c_2} = \frac{N_2}{I_1}\left(\frac{\mu_0N_1I_1}{2r_1}\right)(\pi r_2^2)$$

$$\Rightarrow \boxed{M_{c_1c_2} = \frac{\mu_0N_1N_2\pi r_2^2}{2r_1}}$$

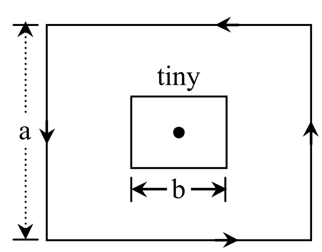
(i) Two concentric and coplanar loops:-

$\boxed{M \propto \frac{r_2^2}{r_1}}$ $(r_1 >> r_2)$



(ii) Two concentric and coplanar square loops:-

$\boxed{M \propto \frac{b^2}{a}}$



SOLVED EXAMPLES

Ex.1 A loop of wire is placed in a magnetic field $\vec{B} = 0.02\ \hat{i}$ tesla. Then the flux through the loop is its area vector is $\vec{A} = 30\hat{i} + 16\hat{j} + 23\hat{k}$ cm^2, is .

(1) 60μW (2) 32μ Wb
(3) 46μ Wb (4) 138μ Wb

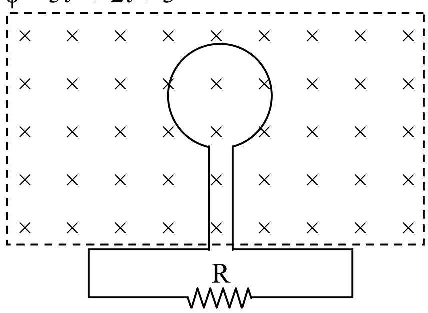
Sol.(1) $\phi = \vec{B} \cdot \vec{A}$

$= (0.02\hat{i}) \cdot (30\hat{i} + 16\hat{j} + 23\hat{k}) \times 10^{-4}$

$= 0.6 \times 10^{-4}$ Wb = 60μ Wb

Ex. 2 The magnetic flux passing perpendicular to the plane of the coil and directed into the paper is varying according to the relation.

$\phi = 3t^2 + 2t + 3$



Where ϕ is in milliwebers and t is in seconds. Then the magnitude of emf induced in the loop when t = 2 second is-

(1) 31 mV (2) 19 mV
(3) 14 mV (4) 6 mV

Sol.(3) The induced emf

$E = -\,d\phi/dt = -\dfrac{d}{dt}(3t^2 + 2t + 3) \times 10^{-3}$

(because given flux is in mWb).

Thus $E = (-6t - 2) \times 10^{-3}$

at t = 2 sec,

$E = (-6 \times 2 - 2) \times 10^{-3} = -14$ mV.

Note : The direction of the current flow in the resistance R would be anticlockwise. Think why ?

Ex.3 5.5×10^{-4} magnetic flux lines are passing through a coil of resistance 10 ohm and number of turns 1000. If the number of flux lines reduces to 5×10^{-5} in 0.1 sec. The electromotive force and the current induced in the coil will be respectively-

(1) 5V, 0.5 A
(2) 5×10^{-4} V, 5×10^{-4} A
(3) 50 V, 5 A
(4) none of the above.

Sol.(1) Initial magnetic flux $\phi_1 = 5.5 \times 10^{-4}$ weber.

Final magnetic flux $\phi_2 = 5 \times 10^{-5}$ weber.

∴ change in flux

$\Delta\phi = \phi_2 - \phi_1 = (5 \times 10^{-5}) - (5.5 \times 10^{-4})$

$= -50 \times 10^{-5}$ weber.

Time interval for this change, $\Delta t = 0.1$ sec.

∴ induced emf in the coil

$$e = -N\frac{\Delta\Phi}{\Delta t} = -1000 \times \frac{(-50\times10^{-5})}{0.1} = 5 \text{ volt.}$$

Resistance of the coil, R = 10 ohm. Hence induced current in the coil is

$$i = \frac{e}{R} = \frac{5 \text{ volt}}{10 \text{ ohm}} = 0.5 \text{ ampere.}$$

Ex.4 A gramophone disc of brass of diameter 30 cm rotates horizontally at the rate of 100/3 revolutions per minute. If the vertical component of the earth's magnetic field be 0.01 weber / meter^2, then the emf induced between the centre and the rim of the disc will be-

(1) 7.065×10^{-4} V (2) 3.9×10^{-4} V
(3) 2.32×10^{-4} V (4) none of the above.

Sol. (2) Magnetic flux passing through the disc is $\phi = BA$

$= 0.01\ \dfrac{\text{weber}}{\text{meter}^2} \times 3.14 \times (15 \times 10^{-2}\text{ meter})^2$

$= 7.065 \times 10^{-4}$ weber.

The line joining the centre and the circumference of the disc cuts 7.065 x 10^{-4} weber flux in one round. So, the rate of cutting flux (i.e. induced emf)

= flux x number of revolutions per second

$= 7.065 \times 10^{-4} \times \dfrac{100}{60\times3} = 3.9 \times 10^{-4}$ volt.

Ex.5 A closed coil consists of 500 turns on a rectangular frame of area 4.0 cm^2 and has a resistance of 50 ohm. The coil is kept with its plane perpendicular to a uniform magnetic field of 0.2 weber/meter^2. The amount of charge flowing through the coil if it is turned over (rotated through 180º) will be -

(1) 1.6×10^{-19} C (2) 1.6×10^{-9} C
(3) 1.6×10^{-3} C (4) 1.6×10^{-2} C

Sol. (3) The magnetic flux passing throug each turn of a coil of area A, perpendicular to a magnetic field B is given by

$\phi_1 = BA.$

The magnetic flux through it on rotating it through 180º will be

$\phi_2 = -$ BA.(– sign is put because now the flux lines enters the coils through the outer face)

$\therefore$ change in magnetic flux

$\Delta \phi = \phi_1 - \phi_2 = -BA - (BA) = -2BA.$

Suppose this change takes in time Δt. According to Faraday's law, the emf induced in the coil is given by

$$e = -N\frac{\Delta\Phi}{\Delta t} = \frac{2NBA}{\Delta t},$$

where N is number of turns in the coil. The current in the coil will be

$$i = \frac{e}{R} = \frac{1}{R}\frac{2NBA}{\Delta t}$$

where R is the resistance of the circuit. The current persists only during the change of flux i.e. for the time interval Δt second. So, the charge passed through the circuit is

$$q = i \times \Delta t = \frac{2NBA}{R}.$$

Here N = 500, B = 0.2 weber/meter^2,

A = 4.0 cm^2 = 4.0 × 10^{-4} meter^2 and R = 50 ohm.

$$\therefore \quad q = \frac{2\times500\times0.2\times4.0\times10^{-4}}{50}$$

$= 1.6 \times 10^{-3}$ coulomb.

Note : Rotating the coil slow or fast has no effect on the charge flown through the coil. Charge flow depends upon the total change in magnetic flux, not on the rate of change of magnetic flux.

Ex.6 A very small circular loop of area 5×10^{-4} m^2, resistance 2 ohm and negligible inductance is initially coplanar and concentric with a much larger fixed circular loop of radius 0.1 m. A constant current of 1 ampere is passed in a bigger loop and the smaller loop is rotated with angular velocity ω rad/sec about a diameter. Calculate (i) the flux linked with the smaller loop, (ii) induced emf, and ((iii) induced current in the smaller loop, as a function of time

($\mu_0 = 4\pi \times 10^{-7}$ V-s/A-m).

Sol. The magnetic field at the centre of the larger loop of radius a is

$$B = \frac{\mu_0 i}{2a} = \frac{(4\pi\times10^{-7})\times1}{2\times0.1}$$

$= 2\pi \times 10^{-6}$ weber/m^2.

This field is perpendicular to the plane of the loop. The instantaneous magnetic flux linked with the smaller loop (area A) placed at the centre of the larger loop is

$\Phi = \vec{B} . \vec{A} = BA \cos \omega t$

$= (2\pi \times 10^{-6}) \times (5 \times 10^{-4}) \cos \omega t.$

$= \pi \times 10^{-9} \cos \omega t$ weber.

(ii) Induced emf

$$e = -\frac{d\Phi}{dt} = BA\omega \sin \omega t = \pi \times 10^{-9}\, \omega \sin \omega t \text{ volt.}$$

(iii) Induced current

$$i = \frac{e}{R} = \frac{\pi}{2} \times 10^{-9}\, \omega \sin \omega t. \text{ ampere}$$

Ex.7 A copper disc of radius 0.1 m rotates about its centre with 10 revolutions per second in 'a uniform magnetic field of 0.1 tesla. The emf induced across the radius of the disc is-

(1) π/10 V (2) 2π/10 V

(3) 10π mV (4) 20π mV

Sol. (3) The induced emf between centre and rim of the rotating disc is

$$E = \frac{1}{2}B\omega R^2 = \frac{1}{2} \times 0.1 \times 2\pi \times 10 \times (0.1)^2$$

$= 10\pi \times 10^{-3}$ volt,

Ex.8 Two rail tracks, insulated from each other and the ground, are connected to millivoltmeter. What is the reading of the milli voltmeter when a train passes at a speed of 180 km/hr along the track, given that the horizontal component of earth's magnetic field is 0.2×10^{-4} Wb/m^2 and rails are separated by 1 meter.

(1) 1 mV (2) 10 mV

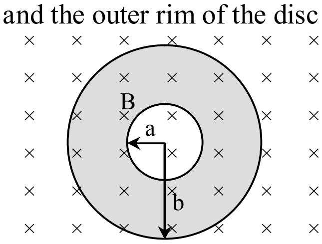
(3) 100 mV (4) 1 V

Sol.(1) The induced emf

$E = B\ell v = 0.2 \times 10^{-4} \times 1 \times 180 \times 1000/3600$

$= 0.2 \times 18/3600 = 1 \times 10^{-3}$. V = 1mV

Ex.9 The annular disc of copper, with inner radius a and outer radius b is rotating with a uniform angular speed ω, in a region where a uniform magnetic field B along the axis of rotation exists. Then, the emf induced between inner side and the outer rim of the disc is-



(1) Zero (2) $\frac{1}{2}B\omega a^2$

(3) $\frac{1}{2}B\omega b^2$ (4) $\frac{1}{2}B\omega (b^2 - a^2)$

Sol.(4) The induced emf is obtained by considering a strip on the disc fig. Then, the linear speed of a small element dr at a distance r from the centre is = ωr. The induced emf across the ends of the small element is-

de = B(dr)v = B ωr dr

Thus the induced emf across the inner and outer sides of the disc is

$$e = \int_a^b B\omega r\, dr = \frac{1}{2} B\omega (b^2 - a^2)$$

Ex.10 A coil with 200 turns and area of 70 cm^2 is placed in a uniform magnetic field of strength 0.3 tesla pointing normal to the plate of the coil. If the coil turns through 180° in 0.1 sec, then the value of induced emf is-

(1) 4.2 V (2) 8.4 V

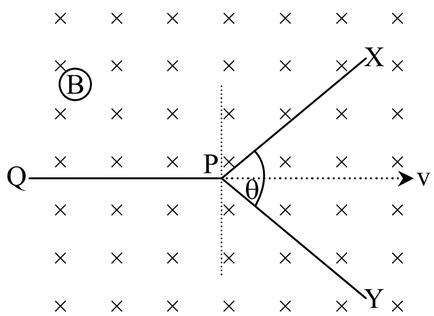
(3) 42 V (4) 84 V

Sol.(2) The change is flux = 2 BAN

Thus induced emf $e = \frac{2BAN}{0.1}$

$= 2 \times 0.3 \times 200 \times 10^{-4} \times 70/0.1 = 8.4$ V

Ex.11 A conducting wire in the shape of Y; with each side of length ℓ is moving in a uniform magnetic field B, with a uniform speed v as shown in fig. The induced emf at the two ends X and Y of the wire will be-



(1) Zero (2) 2 Bℓv

(3) 2 Bℓv sin (θ/2) (4) 2 Bℓv cos (θ/2)

Sol.(3) the induced emf $e = -(\vec{v} \times \vec{B}) \cdot \vec{\ell}$

For the part PX,, $\vec{v} \perp \vec{B}$, and the angle between $(\vec{v} \times \vec{B})$ direction (the dotted line in figure and $\vec{\ell}$ is (90 – θ). Thus

$e_P - e_x = vB\ell \cos(90 - \theta/2) = vB\ell \sin(\theta/2)$

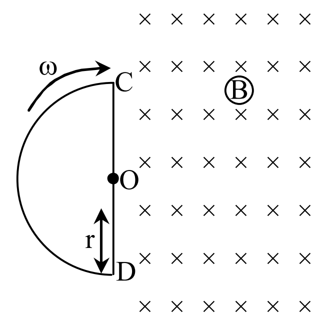
Similarly $e_y - e_p = vB\ell \sin(\theta/2)$

Therefore induced emf

between X and Y is $e_{yx} = 2\, B\, v\ell \sin(\theta/2)$

Note : **The induced emf between points P and Q is zero because is parallel to . The induced emf between Q and X is Bvℓ sin(θ/2). The end Y is positive while X is negative. If the movement of the wire segment was upwards or downwards in fig, than $e_{xy} = 0$.**

Ex.12 In fig, CODF is a semicircular loop of a conducting wire of resistance R and radius r. It is placed in a uniform magnetic field B, which is directed into the page (perpendicular to the plane of the loop). The loop is rotated with a constant angular speed ω about an axis passing through the centre O, and perpendicular to the page. Then the induced current in the wire loop is-



(1) Zero (2) Br^2 ω/R

(3) Br^2 ω/2R (4) $B\pi r^2$ ω/R

Sol.(3) The area swept by radius OC in one half circle is $\pi r^2/2$. The flux change in time T/2 is thus (πr^2 B/2). The induced emf is then

$e = \pi r^2 B/T$

$= 2\pi r^2 B/Tx^2 = B\omega r^2/2$

The induced current is then

$I = e/R = B\omega r^2/2R$

Ex.13 A 10-meter wire is kept in east-west direction. It is falling down with a speed of 5.0 meter/second, perpendicular to the horizontal component of earth's magnetic field of 0.30 $\times 10^{-4}$ weber/meter^2. The momentary potential difference induced between the ends of the wire will be-

(1) 0.0015 V (2) 0.015 V

(3) 0.15 V (4) 1.5 V

Sol. (1) If a wire, ℓ meter in length, moves perpendicular to a magnetic field of B weber/meter^2 with a velocity of v meter/second, then the e.m.f. induced in the wire is given by

V = B vℓ volt.

Here, B = 0.30 × 10^{-4} weber/meter^2,

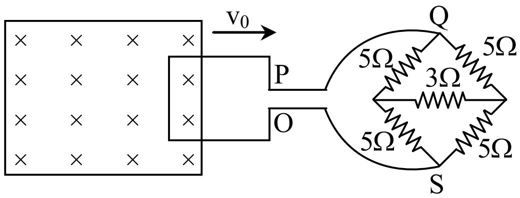
v = 5.0 meter/second and ℓ = 10 meter.

∴ B = 0.30 × 10^{-4} × 5.0 × 10 = 0.0015 volt

= 1.5 millivolt.

Note: **According to the Fleming's left-hand rule, the magnetic force on the positive charge in the wire placed in the magnetic field will act towards east. Hence the magnetic force on the free electrons will act towards west and so they will move to the western end of the wire. Hence the eastern end of the wire be at higher (positive) potential.**

Ex.14 A metallic square wire-loop of side 10 cm and resistance 1 ohm is moved with a constant velocity v_d in a uniform magnetic field of induction B = 2 weber/meter^2 as shown in the fig. The magnetic field lines are perpendicular to the plane of the loop (directed into the paper). The loop is connected to a network of resistors each of value 5 ohm. The resistance of the lead wires OS and PQ are negligible. What should be the speed of the loop so as to have a steady current of 1 milliampere in it ? Give the direction of current in the loop.



Sol. The mesh of the resistances OCSA is a 'balanced' Wheatstone's bridge so that the resistance CA is ineffective. Let the equivalent resistance of the bridge be R'. Then

$$\frac{1}{R'} = \frac{1}{10} + \frac{1}{10} = \frac{1}{5} \quad \text{or} \quad R' = 5 \text{ ohm}$$

Total resistance of the circuit, R = 5 + 1 = 6 ohm.

The e.m.f. induced in the loop $e = Bv\ell$.

therefore current in the loop, $i = \frac{e}{R} = \frac{Bv\ell}{R}$.

So speed of loop, $v = \frac{iR}{B\ell}$.

If current i = 1 milliampere

= 1×10^{-3} ampere, then

$$v = \frac{(1\times10^{-3})\times 6}{2\times 0.1} = 3 \times 10^{-2} \text{ meter/second.}$$

According to the Fleming's right-hand the current in the loop will be clockwise.

Ex.15 The current flowing in a coil whose coefficient of self-induction is 0.4 mH changes by 250 mA in 0.1 sec. The electromotive force (e.m.f.) induced in the coil will be-

(1) 100 mV (2) 30 mV

(3) .01 mV (4) 1mV

Sol. (4) Induced e.m.f $e = -L\frac{\Delta i}{\Delta t}$

Here L = 0.4 mH = 0.4×10^{-3} henry,

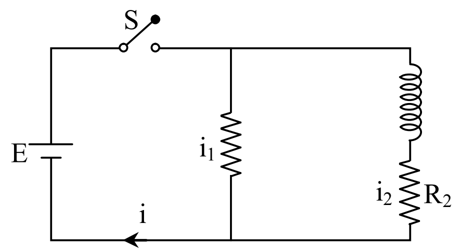
$\Delta i = 0.250$ ampere

$\therefore e = -(0.4 \times 10^{-3})\frac{0.250}{0.1}$

$= 1 \times 10^{-3}$ volt = 1 millivolt.

The minus sign indicates that the direction of the induced e.m.f. is such as to oppose the change in current.

Ex.16 In the circuit, E = 10 volt, R_1 = 5.0 ohm, R_2 = 10 ohm and L = 5.0 henry. Calculate the current i_1, i_2 and i



(i) just when the switch S is pressed,

(ii) after sufficient time the switch S is pressed.

Sol. (i) 'Immediately' after pressing the switch S, the current in the coil L, due to its self-induction will be zero, that is $i_2 = 0$.

The current will only be found in the resistance R_1 and this will be the total current in the circuit.

$$\therefore\ i = i_1 = \frac{E}{R_2} = \frac{10 \text{ volt}}{5.0 \text{ volt}} = 2.0 \text{ ampere.}$$

(ii) After some time the switch S is pressed, the current will be established in L and in R_2 also. Because R_1 and R_2 are in parallel, the equivalent resistance in the circuit is

$$R = \frac{R_1R_2}{R_1+R_2} = \frac{5.0\times10}{5.0\times10} = \frac{10}{3}\text{ ohm.}$$

$\therefore$ total current in the circuit is

$$i = \frac{E}{R} = \frac{10 \text{ volt}}{(10/3)\text{ohm}} = 3.0 \text{ ampere.}$$

Since the internal resistance of the cell is negligible, the potential difference across R_1 is V = 10 volt. Hence the current in R_1 is

$$i_1 = \frac{V}{R_1} = \frac{10 \text{ volt}}{5.0 \text{ ohm}} = 2.0 \text{ ampere.}$$

The current in R_2 is

$$i_2 = i - i_1 = 3.0 - 2.0 = 1.0 \text{ ampere.}$$

EXERCISE # 1

Q.1 A flux of 1m Wb passes through a strip having an area A = 0.02 m^2. The plane of the strip is at an angle of 60º to the direction of a uniform field B. The value of B is-
(1) 0.1 T
(2) 0.058 T
(3) 4.0 mT
(4) none of the above.

Q.2 A small loop of area of cross section 10^{-4} m^2 is lying concentrically and coplanar inside a bigger loop of radius 0.628m. A current of 10A is passed in the bigger loop. The smaller loop is rotated about is diameter with an angular velocity ω. The magnetic flux linked with the smaller loop will be-
(1) 10^{-7} sin ωt (2) 10^{-7} cos ωt
(3) 10^{-9} sin ωt (4) 10^{-9} cos ωt

Q.3 A coil of N turns and area A is rotated at the rate of n rotations per second in a magnetic field of intensity B, the magnitude of the maximum magnetic flux will be-
(1) NAB (2) nAB
(3) NnAB (4) 2πnNAB

Q.4 The number of turns in a long solenoid is 500. The area of cross-section of solenoid is 2×10^{-3} m^2. If the value of magnetic induction, on passing a current of 2 amp, through it is 5×10^{-3} Tesla, the magnitude of magnetic flux connected with it in Weber will be-
(1) 5×10^{-3} (2) 10^{-2}
(3) 10^{-5} (4) 2.5

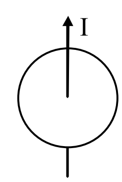
Q.5 The instantaneous flux associated with a closed circuit of 10Ω resistance is indicated by the following reaction $\phi = 6t^2 - 5t + 1$, then the value in amperes of the induced current at t = 0.25 sec will be-
(1) 1.2 (2) 0.8
(3) 6 (4) 0.2

Q.6 A cylindrical bar magnetic is lying along the axis of a circular coil. If the magnet is rotated about the axis of the coil then-
(1) e.m.f. will be induced in the coil
(2) Only induced current will be generated in the coil
(3) No current will be induced in the coil
(4) Both e.m.f. and current will be induced in the coil

Q.7 When a coil of area 2 cm^2 and having 30 turns, whose plane is normal to the magnetic field, is drawn out of the magnetic field, a charge of 1.5×10^{-4} coulomb flows in the circuit. If its resistance is 40 ohm, then the magnetic flux density in Tesla will be-
(1) 10 (2) 0.1 (3) 1 (4) 0.01

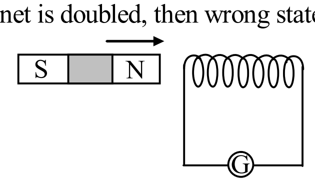
Q.8 When a magnet is being moved towards a coil, the induced emf does not depend upon-
(1) the number of turns of the coil
(2) the motion of the magnet
(3) the magnetic moment of the magnet
(4) the resistance of the coil

Q.9 A wire carrying current I, lie on the axis of a conducting ring. The direction of the induced current in the ring, when I is decreasing at a steady rate is-



(1) clockwise
(2) anticlockwise
(3) alternatively clock and anticlockwise
(4) no induced current flow in the ring

Q.10 A magnet is brought towards a fixed coil rapidly. Due to this induced emf, current and charge are E, I and Q respectively. If the speed of the magnet is doubled, then wrong statement is-



(1) E increases (2) I increases
(3) Q remains unchanged (4) Q increases

Q.11 A field of $5 \times 10^4/\pi$ ampere-turns/metre acts at right angles to a coil of 50 turns of area 10^{-2} m^2. The coil is removed from the field in 0.1 second. Then the induced emf in the coil is-

(1) 0.1 V (2) 80 KV
(3) 7.96 V (4) none of the above

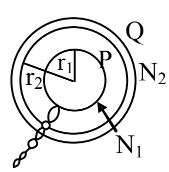
Q.12 A coil having n turns and area A is initially placed with its plane normal to the magnetic field B. It is then rotated through 180º in 0.2 sec. The emf induced at the ends of the coils is-

(1) 0.1 nAB (2) nAB
(3) 5 nAB (4) 10 nAB

Q.13 A conducting circular loop is placed in a uniform magnetic field B = 40 mT with its plane perpendicular to the field. If the radius of the loop starts shrinking at a constant rate of 2mm/s, then the induced emf in the loop at an instant when its radius is 1.0 cm is-

(1) $0.1\ \pi\ \mu$ V (2) $0.2\ \pi\ \mu$ V
(3) $1.0\ \pi\ \mu$ V (4) $1.6\ \pi\ \mu$ V

Q.14 Two plane circular coils P and Q have radii r_1 and r_2, respectively, ($r_1 << r_2$) and are coaxial as shown in fig. The number of turns in P and Q are respectively N_1 and N_2. If current in coil Q is varied steadily at a rate x ampere/sec then the induced emf in the coil P will be approximately-



(1) $\mu_0 N_1 N_2 \pi r_1^2$
(2) $\mu_0 N_1 N_2 \pi r_1^2 x$
(3) $\mu_0 N_1 N_2 \pi r_1^2 x / 2r_2$
(4) 0

Q.15 The rate of change of magnetic flux density through a circular coil of area 10^{-2} m and number of turns 100 is 10^3 Wb/m^2/s. The value of induced e.m.f. will be -

(1) 10^{-2}V (2) 10^{-3}V
(3) 10V (4) 10^3V

Q.16 A long solenoid contains 1000 turns/cm and an alternating current of peak value 1A is flowing in it. A search coil of area of cross-section 1×10^{-4} m^2 and having 50 turns is placed inside the solenoid with its plane perpendicular to the axis of the solenoid. A peak voltage of $2\pi^2 \times 10^{-2}$V is produced in the search coil. The frequency of current in the solenoid will be -

(1) 50 Hz (2) 100 Hz
(3) 500 Hz (4) 1000 Hz

Q.17 A coil of cross-sectional area 5×10^{-4} m^2 and having number of turns 1000 is placed perpendicular to a magnetic field of 10^{-2} T. The coil is connected to a galvanometer of resistance 500Ω. The induced charge generated in the coil on rotating it through an angle of π radian will be -

(1) 10 μC (2) 20 μC
(3) 50 μC (4) 100 μC

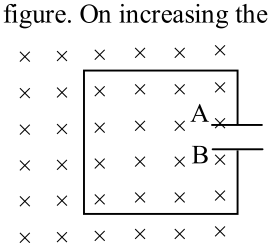
Q.18 Lenz's law is consistent with law of conservation of -

(1) current (2) emf
(3) energy (4) all of the above

Q.19 The north pole of a magnet is brought near a coil. The induced current in the coil as seen by an observer on the side of magnet will be-

(1) in the clockwise direction
(2) in the anticlockwise direction
(3) initially in the clockwise and then anticlockwise direction
(4) initially in the anticlockwise and then clockwise direction.

Q.20 A magnetic field is directed normally downwards through a metallic frame as shown in the figure. On increasing the magnetic field-



(1) plate B will be positively charged
(2) plate A will be positively charged
(3) none of the plates will be positively charged
(4) all of the above

EXERCISE # 2

Q.1 The coefficient of mutual inductance of two circuits A and B is 3 mH and their respective resistances are 10 ohm and 4 ohm. How much current should change in 0.02 second in the circuit A. So that the induced current in B should be 0.006 ampere-

(1) 0.24 amp (2) 1.6 amp
(3) 0.18 amp (4) 0.16 amp

Q.2 The coefficient of self inductance is 5 mH. If the emf of the cell in the circuit is 1.1 volt and at any instant the rate of increase of current is 6 ampere/second, then at that instant, the resultant e.m.f. in the circuit will be-

(1) 1.13 V (2) 0.13 V
(3) 1.07 V (4) 1.4 V

Q.3 The phase difference between the flux linkage and the induced e.m.f. in a rotating coil in a uniform magnetic field is-

(1) π (2) $\pi/2$
(3) $\pi/4$ (4) $\pi/6$

Q.4 A dynamo is sometimes said to generate electricity. It actually acts as a source of-

(1) charge
(2) magnetism
(3) e.m.f.
(4) energy

Q.5 In a step-down transformer the number of turns in-

(1) primary are less
(2) primary are more
(3) primary and secondary are equal
(4) primary are infinite

Q.6 An inductor coil stores 32 J of magnetic field energy and dissipates energy as heat at the rate of 320 W, when a current of 4 A is passed through it. The time constant of the circuit when this coil is joined across an ideal battery will be-

(1) 0.2 s (2) 0.3 s
(3) 0.4 s (4) 0.5 s

Q.7 A solenoid of inductance 50 mH and resistance 10 Ω is connected to a battery of 6 V. The time elapsed before the current acquires half of its steady-state value will be-

(1) 3.01 s (2) 3.02 s (3) 3.03 s (4) 3.5 ms

Q.8 An inductor - resistance battery circuit is switched on at t = 0. If the emf of the battery is E. The charge which passes through the battery in one time constant τ will be-

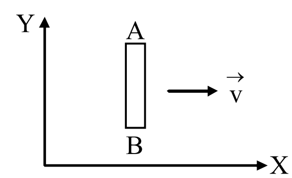
(1) $i_0 \tau/e$ (2) $i_0 e/\tau$ (3) $\tau e/i_0$ (4) $i_0 e \tau$

Q.9 Two conducting circular loops of radii R_1 and R_2 are placed in the same plane with their centres coinciding. The mutual inductance between them assuming $R_2 << R_1$, will be-

(1) $\frac{\mu_0 \pi R_2^2}{2R_1}$ (2) $\frac{\mu_0 R_2^2}{2R_1}$

(3) $\frac{\mu_0 R_2}{2R_1}$ (4) $\frac{\mu_0 \pi R_2^2}{2R_1^2}$

Q.10 A conductor rod AB moves parallel to X-axis in a uniform magnetic field, pointing in the positive Z-direction. The end A of the rod gets-

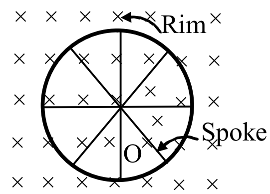


(1) positively charged
(2) negatively charged
(3) neutral
(4) first positively charged and then negatively charged

Q.11 A closed coil of copper whose area is 1m × 1m is free to rotate about an axis. The coil is placed perpendicular to a magnetic field of 0.10 Wb/m^2. It is rotated through 180º in 0.01 second. The induced e.m.f. and induced current in the coil will respectively be-
(The resistance of the coil is 2.0 Ω)

(1) 20 V, 10A (2) 10 V, 20 A
(3) 10 V, 10 A (4) 20 V, 20 A

Q.12 A bicycle wheel of radius 0.5 m has 32 spokes. It is rotating at the rate of 120 revolutions per minute, perpendicular to the horizontal component of earth's magnetic field $B_H = 4 \times 10^{-5}$ Tesla. The emf induced between the rim and the centre of the wheel will be-



(1) 6.28×10^{-5} V (2) 4.8×10^{-5} V
(3) 6.0×10^{-5} V (4) 1.6×10^{-5} V

Q.13 The current in a coil varies with respect to time t as $I = 3t^2 + 2t$. If the inductance of coil be 10 mH, the value of induced e.m.f. at t = 2s will be-
(1) 0.14 V (2) 0.12 V
(3) 0.11 V (4) 0.13 V

Q.14 If circular coil with N_1 turns is changed in to a coil of N_2 turns. What will be the ratio of self inductances in both cases-
(1) $\frac{N_1}{N_2}$ (2) $\frac{N_2}{N_1}$
(3) $\frac{N_1^2}{N_2^2}$ (4) $\sqrt{\frac{N_1}{N_2}}$

Q.15 A solenoid has an inductance of 50 mH and a resistance of 0.025 Ω. If it is connected to a battery, how long will it take for the current to reach one half of its final equilibrium value ?
(1) 1.34 s (2) 1.2 s
(3) 6.32 s (4) 0.23 s

Q.16 5.5×10^{-4} magnetic flux lines are passing through a coil of resistance 10 ohm and number of turns 1000. If the number of flux lines reduces to 5×10^{-5} in 0.1 sec. The electromotive force and the current induced in the coil will be respectively-
(1) 5V, 0.5 A
(2) 5×10^{-4} V, 5×10^{-4} A
(3) 50 V, 5 A
(4) none of the above

Q.17 A closed coil consists of 500 turns on a rectangular frame of area 4.0 cm^2 and has a resistance of 50 ohm. The coil is kept with its plane perpendicular to a uniform magnetic field of 0.2 Weber/meter^2. The amount of charge flowing through the coil if it is turned over (rotated through 180º) will be -
(1) 1.6×10^{-19} C (2) 1.6×10^{-9} C
(3) 1.6×10^{-3} C (4) 1.6×10^{-2} C

Q.18 When the current through a solenoid increases at a constant rate, the induced current-
(1) is a constant and is in the direction of the inducing current
(2) is a constant and is opposite to the direction of the inducing current
(3) increase with time and is in the direction of the inducing current
(4) increase with time and opposite to the direction of the inducing current

Q.19 According to Faraday's Laws of electro magnetic induction-
(1) The direction of the induced current is such that it opposes itself
(2) The induced emf in the coil is proportional to the rate of change of magnetic flux associated with it
(3) The direction of induced emf is such that it opposes it self
(4) None of the above

Q.20 A coil having an area of 2m^2 is placed in a magnetic field which changes from 1 Weber/m^2 to 4 Weber/m^2 in 2 seconds. The e.m.f. induced in the coil will be-
(1) 4 volt (2) 3 volt
(3) 2 volt (4) 1 volt

Q.21 A conducting loop is placed in an uniform magnetic field with its plane perpendicular to the field. An emf is induced in the loop if-
(a) It is translated within magnetic field
(b) It is rotated about its axis
(c) It is rotated about a diameter
(d) It is deformed
(1) b,c (2) b,d (3) c, d (4) a,c,d

EXERCISE # 3

Q.1 A magnet is allowed to fall through a metal ring. During fall its acceleration will be- **[AIPMT-1996]**
(1) equal to g
(2) greater than g
(3) less than g
(4) less than or greater than g depending on which pole is pointing downwards

Q.2 An ideal transformer is used on 220 V line to deliver 2A at 110 V. The current through the primary is- **[AIPMT-1996]**
(1) 10A (2) 5A (3) 1A (4) 0.1A

Q.3 Which of the following combination has the dimension of time- **[AIPMT-1996]**
(1) R/L (2) LC (3) 1/LC (4) L/R

Q.4 The primary winding of a transformer has 500 turns whereas its secondary has 5000 turns. The primary is connected to a supply of 20V, 50 Hz. The secondary will have an output of- **[AIPMT-1997,AIIMS-1999]**
(1) 200 V, 50 Hz (2) 2 V, 50 Hz
(3) 200 V, 500 Hz (4) 2 V, 5 Hz

Q.5 Two coil have a mutual inductance 0.005 H. The current changes in first coil according to equation $I = I_0 \sin \omega t$, where $I_0 = 2A$ and $\omega = 100\pi$ rad/sec. The maximum value of induced emf in second coil is- **[AIPMT-1998]**
(1) $4\pi V$ (2) $3\pi V$ (3) $2\pi V$ (4) πV

Q.6 Turn ratio of a step-up transformer is 1 : 25. If current in load coil is 2A, then the current in primary coil will be- **[AIPMT-1998]**
(1) 25A (2) 50A
(3) 0.25A (4) 0.5A

Q.7 Initially plane of coil is parallel to the uniform magnetic field B. In time Δt it makes to perpendicular to the magnetic field, then charge flows through the coil depends on this time as- **[AIPMT-1999]**
(1) $\propto \Delta t$ (2) $\propto \frac{1}{\Delta t}$
(3) $\propto (\Delta t)^0$ (4) $\propto (\Delta t)^2$

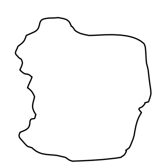
Q.8 For an inductor coil L = 0.04 H, then work done by source to establish a current of 5A in it is- **[AIPMT-1999]**
(1) 0.5 J (2) 1.00 J
(3) 100 J (4) 20 J

Q.9 For a coil having L = 2 mH, current flow through it is $I = t^2 e^{-t}$ then the time at which induced emf become zero- **[AIPMT-2001]**
(1) 2 sec (2) 1 sec
(3) 4 sec (4) 3 sec

Q.10 The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in a time Δt. The total quantity of electric charge Q that passes any point in the circuit during the time Δt is represented by- **[AIPMT-2004]**
(1) $Q = \frac{\Delta\phi}{R}$ (2) $Q = \frac{\Delta\phi}{\Delta t}$
(3) $Q = R \cdot \frac{\Delta\phi}{\Delta t}$ (4) $Q = \frac{1}{R} \cdot \frac{\Delta\phi}{\Delta t}$

Q.11 A coil of 40 henry inductance is connected in series with a resistance of 8 ohm and the combination is joined to the terminals of a 2 volt battery. The time constant of the circuit is- **[AIPMT-2004]**
(1) $\frac{1}{5}$ sec (2) 40 sec (3) 20 sec (4) 5 sec

Q.12 As a result of change in the magnetic flux linked to the closed loop shown in the figure, an e.m.f. V volt is induced in the loop. The work done (joules) in taking a charge Q coulomb once along the loop is- **[AIPMT-2005]**



(1) QV (2) QV/2 (3) 2QV (4) Zero

Q.13 Two coils of self inductances 2mH and 8 mH are placed so close together that the effective flux in one coil is completely linked with the other. The mutual inductance between these coils is- **[AIPMT-2006]**
(1) 10 mH (2) 6 mH (3) 4 mH (4) 16 mH

Q.14 The primary and secondary coils of a transformer have 50 and 1500 turns respectively. If the magnetic flux ϕ linked with the primary coil is given by $\phi = \phi_0 + 4t$, where ϕ is in webers, t is time in seconds and ϕ_0 is a constant, the output voltage across the secondary coil is- **[AIPMT-2007]**

(1) 30 volts (2) 90 volts
(3) 120 volts (4) 220 volts

Q.15 A transformer is used to light a 100 W and 110 V lamp from a 220 V mains. If the main current is 0.5 amp, the efficiency of the transformer is approximately- **[AIPMT-2007]**

(1) 10% (2) 30% (3) 50% (4) 90%

Q.16 An electric bulb in series with a large inductor when connected across a DC source take a little time before reaching a stable glow. If an iron core is inserted to the inductor, the delay will-

(1) increases **[AIIMS-1994]**
(2) decreases
(3) remain the same
(4) may change in either direction depending upon the values of inductance and resistance

Q.17 The device that does not work on the principle of mutual induction is- **[AIIMS-1996]**

(1) motor (2) tesla coil
(3) transformer (4) induction coil

Q.18 To induce an emf in a coil, the magnetic flux linking- **[AIIMS-1996]**

(1) can either increase or decrease
(2) must remain constant
(3) must increase
(4) must decrease

Q.19 The bob of a simple pendulum is replaced by a magnet. The oscillation are set along the length of the magnet. A copper coil is added so that one pole of the magnet passes in and out of the coil. The coil is shortcircuited. Then which of the following happens ? **[AIIMS-1996]**

(1) period does not change
(2) oscillations are damped
(3) amplitude increases
(4) period decreases

Q.20 A coil of copper having 1000 turns is placed in a magnetic field ($B = 4 \times 10^{-3}$ T) perpendicular to its plane. The cross sectional area of the coil is 0.05 m^2. If it turns through 180º in 0.01 sec, then the induced emf in the coil is- **[AIIMS-1997]**

(1) 0.4 V (2) 0.2 V (3) 40 V (4) 4 V

Q.21 In Lenz's law, there is conservation of- **[AIIMS-1997]**

(1) charge (2) momentum
(3) energy (4) current

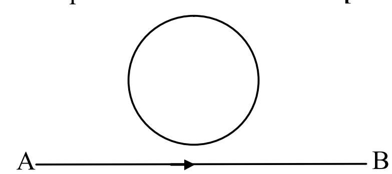
Q.22 If the rotational velocity of a dynamo armature is doubled, then induced e.m.f. will become- **[AIIMS-1999,2000]**

(1) half (2) two times
(3) four times (4) unchanged

Q.23 The north pole of a magnet is brought near a metallic ring. The direction of the induced current in the ring will be- **[AIIMS-1999]**

(1) clockwise (2) anticlockwise
(3) towards north (4) towards south

Q.24 The current flows from A to B as shown in the figure. The direction of the induced current in the loop is- **[AIIMS-2001]**



(1) clockwise (2) anticlockwise
(3) straight line (4) none of these

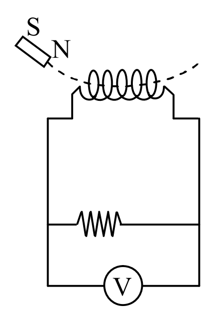
Q.25 The mutual inductance of two coils when magnetic flux changes by 2×10^{-2} Wb and current changes by 0.01 A is- **[AIIMS-2002]**

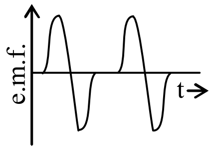
(1) 2 H (2) 3 H (3) 4 H (4) 8 H

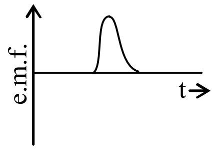
Q.26 A conducting ring of radius 1 meter is placed in an uniform magnetic field B of 0.01 T, oscillating with frequency 100 Hz with its plane at right angles to magnetic field. What will be the induced electric field- **[AIIMS-2005]**

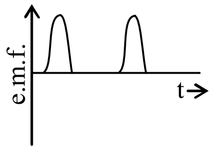
(1) π volts/m (2) 2 π volts/m
(3) 10 volts/m (4) 62 volts/m

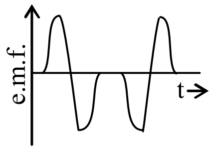
Q.27 A magnet is made to oscillate with a particular frequency, passing through a coil as shown in figure. The time variation of the magnitude of e.m.f. generated across the coil during one cycle is- **[AIIMS-2005]**



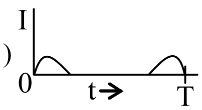
(1) 

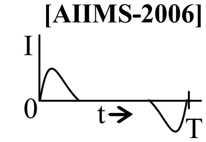
(2) 

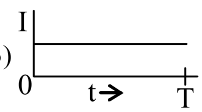
(3) 

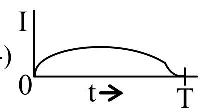
(4) 

Q.28 A metallic ring is dropped down, keeping its plane perpendicular to a constant and horizontal magnetic field. The ring enters the region of magnetic field at t = 0 and completely emerges out at t = T sec. The current in the ring varies as- **[AIIMS-2006]**

(1) 

(2) 

(3) 

(4) 

Q.29 The current passing through a choke coil of 5H is decreasing at the rate of 2 amp./sec. The e.m.f. developing across the coil is- **[CPMT-82,MPPMT-90,AIIMS-97]**
(1) 10 V (2) –10 V (3) 2.5 V (4) – 2.5 V

Q.30 Transformer works on the basis of the following phenomenon- **[AIIMS-98, RPMT-89]**
(1) Self-induction
(2) Mutual induction
(3) Electrical discharge
(4) Generation of electro-magnetic waves

Q.31 A long solenoid has 500 turns. When a current of 2 ampere is passed through it, the resulting magnetic flux linked with each turn of the solenoid is 4×10^{-3} wb. The self-inductance of the solenoid is- **[AIPMT-2008]**
(1) 1.0 henry (2) 4.0 henry
(3) 2.5 henry (4) 2.0 henry

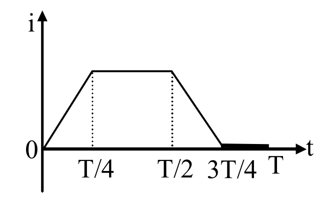
Q.32 A conducting circular loop is placed in a uniform magnetic field 0.04 T with its plane perpendicular to the magnetic field. The radius of the loop starts shrinking at 2 mm/s. The induced emf in the loop when the radius is 2 cm is- **[AIPMT-2009]**
(1) 3.2 $\pi\mu$V (2) 4.8 $\pi\mu$V
(3) 0.8 $\pi\mu$V (4) 1.6 $\pi\mu$V

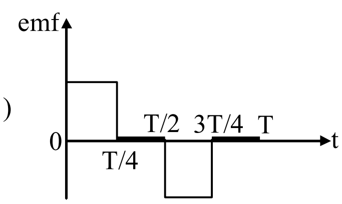
Q.33 A rectangular, a square, a circular and an elliptical loop, all in the (x – y) plane, are moving out of a uniform magnetic field with a constant velocity, $\vec{V} = v\hat{i}$. The magnetic field is directed along the negative z-axis direction. The induced emf, during the passage of these loops, come out of the field region, will not remain constant for- **[AIPMT-2009]**
(1) the rectangular, circular and elliptical loops
(2) the circular and the elliptical loops
(3) only the elliptical loop
(4) any of the four loops

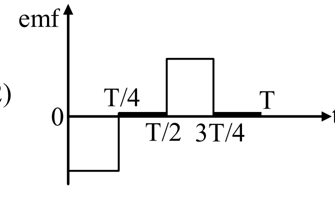
Q.34 A conducting circular loop is placed in a uniform field, B = 0.025 T with its plane perpendicular to the loop. The radius of the loop is made to shrink at a constant rate of 1 mm/s. The induced e.m.f. when the radius is 2cm, is- **[AIPMT Pre-2010]**
(1) 2 μV (2) $2\pi\mu$V (3) $\pi\mu$V (4) $\frac{\pi}{2}\mu$V

Q.35 A 220-volt input is supplied to a transformer. The output circuit draws a current of 2.0 ampere at 440 volts. If the efficiency of the transformer is 80%, the current drawn by the primary windings of the transformer is- **[AIPMT Pre-2010]**
(1) 5.0 ampere (2) 3.6 ampere
(3) 2.8 ampere (4) 2.5 ampere

Q.36 The current i in a coil varies with time as shown in the figure. The variation of induced emf with time would be : **[AIPMT Pre-2011]**



(1) 

(2) 

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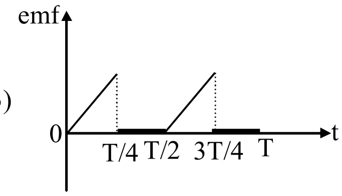

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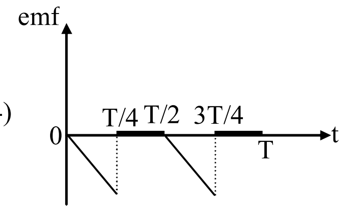
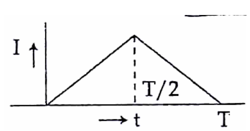


Q.37 A coil of resistance 400Ω is placed in a magnetic filed. If the magnetic flux ϕ (wb) linked with the coil varies with times t(sec) as $\phi = 50\ t^2 + 4$. The current is the coil at t = 2 sec is - : **[AIPMT (Pre)-2012]**

(1) 2A (2) 1A

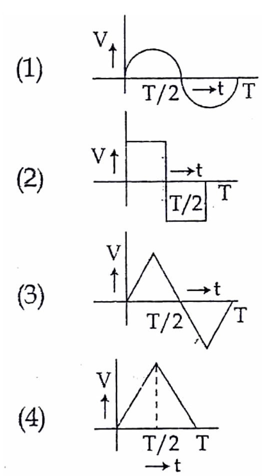
(3) 0.5A (4) 0.1 A

Q.38 The current (I) in the inductance is varying with time according to the plot shown in figure.

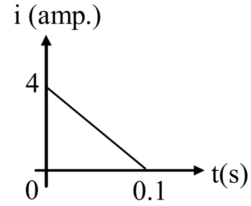


Which one of the following is the correct variation of voltage with time in the coil ?

[AIPMT (Pre)-2012]



Q.39 In a coil of resistance 10 Ω, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in Weber is - **[AIPMT Mains–2012]**



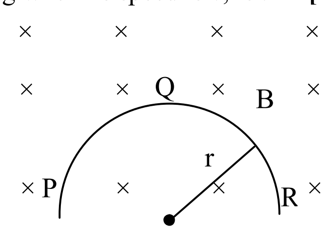
(1) 2 (2) 6 (3) 4 (4) 8

Q.40 Two cities are 150 km apart. Electric power is sent from one city to another city through copper wires. The fall of potential per km is 8 volt and the average resistance per km is 0.5Ω. The power loss in the wire is : **[AIPMT-2014]**

(1) 19.2 W (2) 19.2 kW

(3) 19.2 J (4) 12.2 kW

Q.41 A thin semicircular conducting ring (PQR) of radius 'r' is falling with its plane vertical in a horizontal magnetic field B, as shown in figure. The potential difference developed across the ring when its speed is v, is : **[AIPMT-2014]**



(1) Zero

(2) $Bv\pi r^2/2$ and P is at higher potential

(3) πrBv and R is at higher potential

(4) 2rBv and R is at higher potential

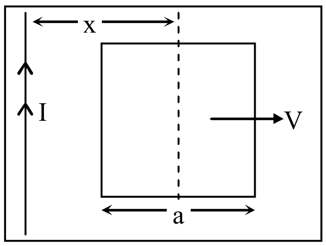
Q.42 A transformer having efficiency of 90% is working on 200 V and 3 kW power supply. If the current in the secondary coil is 6A, the voltage across the secondary coil and the current in the primary coil respectively are :

[AIPMT-2014]

(1) 300 V, 15 A (2) 450 V, 15 A

(3) 450 V, 13.5 A (4) 600 V, 15 A

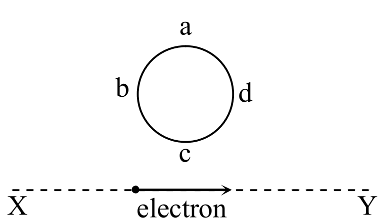
Q.43 A conducting square frame of side 'a' and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity 'V'. The emf induced in the frame will be proportional to : **[AIPMT-2015]**



(1) $\frac{1}{x^2}$ (2) $\frac{1}{(2x-a)^2}$

(3) $\frac{1}{(2x+a)^2}$ (4) $\frac{1}{(2x-a)(2x+a)}$

Q.44 An electron moves on a straight line path XY as shown. The abcd is a coil adjacent to the path of electron. What will be the direction of current, if any, induced in the coil ? **[Re-AIPMT-2015]**

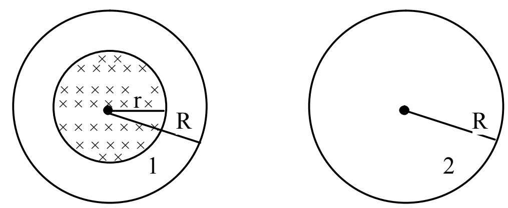


(1) No current induced
(2) abcd
(3) adcb
(4) The current will reverse its direction as the electron goes past the coil

Q.45 A long solenoid has 1000 turns. When a current of 4A flows through it, the magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb. The self-inductance of the solenoid is : **[NEET-1-2016]**

(1) 3 H (2) 2 H
(3) 1 H (4) 4 H

Q.46 A uniform magnetic field is restricted within a region of radius r. The magnetic field changes with time at a rate $\frac{d\vec{B}}{dt}$. Loop 1 of radius $R > r$ enclosed the region r and loop 2 of radius R is outside the region of magnetic field as shown in the figure below. Then the e.m.f. generated is **[NEET-2-2016]**



(1) Zero in loop 1 and zero in loop 2
(2) $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 2
(3) $-\frac{d\vec{B}}{dt}\pi R^2$ in loop 1 and zero in loop 2
(4) $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and zero in loop 2

ANSWER KEY

EXERCISE-1

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	1	1	4	3	3	4	4	4	1	4	4	3	4	1	2	3	2	1

EXERCISE-2

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	3	2	3	2	1	4	1	1	2	1	1	1	1	1	1	3	2	2	2
Q.No.	21																			
Ans.	3																			

EXERCISE-3

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	3	4	1	4	2	3	2	1	1	4	1	3	3	4	1	1	1	2	3
Q.No.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	2	2	4	1	1	1	2	1	2	1	1	2	3	1	2	3	2	1	2
Q.No.	41	42	43	44	45	46														
Ans.	4	2	4	4	3	4														

SOLID STATE

NEET SYLLABUS

1. *Clasification : - Molecular, ionic, covalent, mattallic , amorphous & crystalline solid.*
2. *Unit cells in two & three dimensional lattice.*
3. *Calculate of density in unit cell.*
4. *Packing in solids, voids.*
5. *No. of atoms per unit cell in a cubic unit cell.*
6. *Point defects, electrical and magnetic properties.*

Index : Preparing your own list of Important/Difficult Questions

Revision Plan

Prepare Your Revision plan today!

After attempting Exercise Sheet, please fill below table as per the instruction given.

A. Write Question Number (QN) which you are unable to solve at your own in **column A**.

B. After discussing the Questions written in **column A** with faculty, strike off them in the manner so that you can see at the time question number during Revision, to solve such questions again.

C. Write down the Question Number you feel are important or good in the **column B**.

EXERCISE	COLUMN A	COLUMN B
	Questions unable to solve in first attempt	Good or Important questions
Exercise-1		
Exercise-2		
Exercise-3		

Revision Strategy:

Whenever you wish to revision this chapter, follow the following steps-

Step-1: Review your theory notes.

Step-2: Solve Questions of column A

Step-3: Solve Questions of Column B

Step-4: Solve questions from other Question Bank, Problem book etc.

SOLID STATE

KEY CONCEPT

1. Solids

Solids are characterised by the state of matter in which particles are closely packed and held together by strong inter molecular attractive force.

1.1 <u>Properties of solids</u>

(a) In solid state the particles are not able to move randomly.

(b) They have definite shape and volume.

(c) Solids have high density .

(d) Solids have high and sharp melting point which depends on the strength or value of binding energy.

(e) They are almost incompressible.

(f) They show very slow diffusion.

1.2 <u>Types of Solids</u>

Solids

Crystalline Solids | **Amorphous Solids**

1.2.1 <u>Crystalline solids</u>

(a) In this type of solids the atoms or molecules are arranged in a regular pattern in the three dimensional network.

(b) They have well defined geometrical pattern, sharp melting point, definite heat of fusion and anisotropic nature.

(c) Anisotropic means they exhibit different physical properties in all directions.

eg. The electrical and thermal conductivities are different in different directions.

(d) They are generally incompressible.

(e) The general examples of crystalline solids are Ice, Quartz, diamond etc.

1.2.2 <u>Amorphous Solids</u>

(a) In this type of solids, the arrangement of building constituents is not regular.

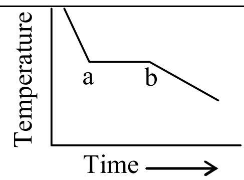
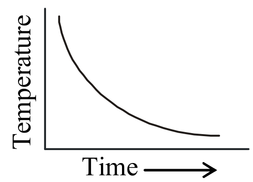
(b) They are regarded as super cooled liquids with high viscosity in which the force of attraction holding the molecules together are so great, that the material becomes rigid but there is no regularity in structure.

(c) They do not have sharp melting points.

(d) They are isotropic as they exhibit same physical properties in all the directions.

(e) The general examples of this solids are glass, Rubber, plastics, wax, paper, wood etc.

1.3 Difference between crystalline and amorphous solids

S.No.	Property	Crystalline solids	Amorphus solids
1	Shape	They have definite and regular geometrical form	They do not have definite and regular geometrical form
2	Melting point	They have definite melting point	They do not have definite melting point
3	Heat of fusion	They have a definite heat of fusion	They do not have definite heat of fusion
4	compressibility	They are rigid and incompressible	These may be compressed to any appreciable extent
5	Cutting with a sharp edged tool	They are given cleavage i.e. they break into two pieces with plane surface	They are given irregular cleavage i.e. they break into two pieces with irregular surface
6	Cooling Curve	 Their cooling curve is discontinuous	 Their cooling curve is continuous
7	Isotropy and Anisotropy	They are anisotropic.	They are isotropic.

2. Classification of Crystals

According to attractive forces which hold crystal together thus crystal can be classified into four types :

2.1 Ionic Crystals

(a) The lattice in ionic crystal consists of alternative positive and negative ions in equivalent amount arranged in an order so that the potential energy of the ions in the lattice is minimum.

(a) Such crystal are normally found in ionic compound.

eg. $NaCl \rightarrow Na^+ + Cl^-$

2.2 Covalent Crystals

(a) In covalent crystals, atoms at their lattice point are held together by shared pairs of electrons between them.

(b) The covalent bonding extends through out the crystals in three dimension and has no small molecules in the conventional sense.

eg. Diamond, Graphite.

2.3 Molecular Crystals

(a) In molecular crystals, the repeating unit is chemically identifiable atoms or molecules which do not carry a net charge.

(b) Molecular bonds are formed for those elements or compounds whose electronic configuration is such that there is little transfer of electrons between their atoms.

eg. Noble gases.

(c) The molecules having H-atom attached on N, O or F give hydrogen bonding crystals. The existence of H-bonding in the crystal lattice is beyond doubt.

eg. Ice Crystal etc.

2.4 Metallic Crystals

In metallic crystals, the lattice consists of assemblage of positive ions immersed in a sea of mobile electrons. The binding force is due to-

(a)Attraction between positive ions or ion cores of the metal and electron cloud .

(b)The mutual repulsion of free electrons.

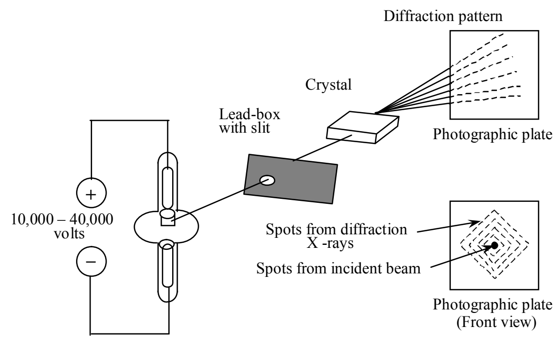
(c) The mutual repulsion of ion cores.

3. Experimental method Of Determining Crystal Structure

Crystal structure has been obtained by studying on the diffraction of X-rays by solids.

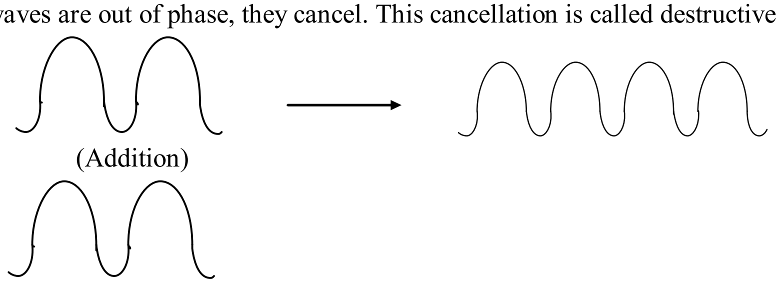
A crystal, having constituents particles arranged in planes at very small distances in three dimension array, acts as diffraction grating for X-rays which have wavelengths of the same order as the spacing in crystal.

Thus X-ray diffraction results from the scattering of X - rays by a regular arrangement of atoms or ions.

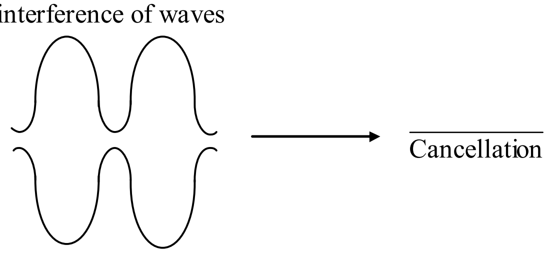


When a beam of X - rays passes through a crystalline solid, each atom in the beam scatters some of the radiations. If waves are on same phase means if their peak and through coincides they add together to give a wave of greater amplitude. This enhancement of intensity is called constructive interference.

If waves are out of phase, they cancel. This cancellation is called destructive interference.



(a) Constructive interference of waves

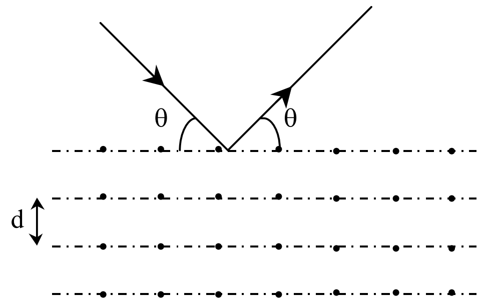


(b) Destructive interference of waves

3.1 Bragg's Law

X-rays are electromagnetic waves of short wavelength and may be diffracted by suitable diffracting centres.

In solid crystals, atoms are arranged in fairly regular pattern with interatomic gaps of the order of 0.1 nm. Common salt is an example of a crystalline solid. Almost all the metals at ordinary temperature are crystalline. These metals may act as a natural three-dimensional gratings for the diffraction of X-rays.



The structure of a solid can be showed as a series of parallel planes of atoms separated by a distance d. Suppose, an X - ray beam is incident on a solid, making an angle θ with the planes of the atoms. These X - ray are diffracted by different atoms and the interference is constructive and we are obtained strong reflected X- ray. The analysis shows that there will be a strong reflected X - ray beam only if

$$2d\sin\theta = n\lambda$$

where, 'n' is an integer. For monochromatic X - rays is fixed and there are some specific angles θ_1, θ_2, θ_3, ... etc, corresponding to n = 1, 2, 3, ... etc, in the above equation. Thus, if the X - rays are incident at one of these, they are reflected ; otherwise they are absorbed. When they are reflected, the laws of reflection are obeyed i.e. (a) the angle of incidence is equal to the angle of reflection and (b) the incident ray, the reflected ray and the normal to the reflecting plane are coplanar.

By using a monochromatic X - ray beam and nothing the angles of strong reflection, the interplaner spacing d and several informations about the structure of the solid can be obtained.

4. Study of Crystals

4.1 Crystal : A crystal is a homogenous portion of a solid substance made by regular pattern of structural units bonded by plane surface making definite angles with each other.

4.2 Space lattice : The arrangement of constituents like atom, ions and molecules in different sites in three dimensional space is called space lattice.

4.3 Unit cell : The smallest repeating unit in space lattice which when repeats over and over again, results in a crystal of the given substance called unit cell.

4.4 Face : The plane surface of the crystal are called faces.

4.5 Edge : An edge is formed by the intersection of two adjacent faces.

4.6 Corner : A corner is formed by intersection of two or more edges.

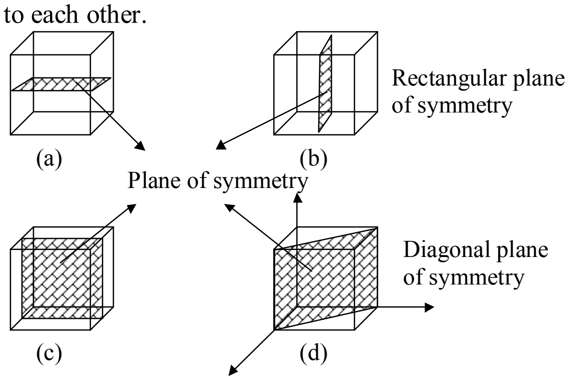
4.7 Interfacial angles : The angle between the perpendiculars two intersecting faces called interfacial angles.

5. Types of Symmetry

A crystal possesses following three types of symmetry.

5.1 Plane of symmetry

It is an imaginary plane which passes through the centre of a crystal can divide it into two equal portions which are exactly the mirror images to each other.



5.2 <u>Axis of symmetry</u>

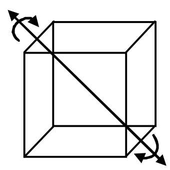
(a) It is an imaginary line about which the crystal may be rotated so that it presents the same appearance more than once in a complete rotation through 360º.

(b) The axes of symmetry are called diad, triad, tetrad and hexad respectively. It is the original appearance and is repeated twice (180º), thrice (120º), four times (90º) and six times (60º) in one rotation.

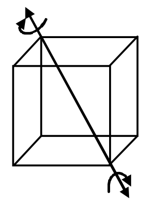
(c) These axes of symmetry are also called as two fold, three fold, four fold and six fold respectively.

(d) Five fold symmetry is not found in crystals.

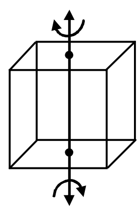
(e)



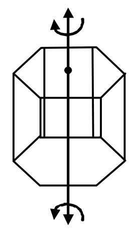
(i) Axis of two fold symmetry.



(ii) Axis of three fold symmetry.



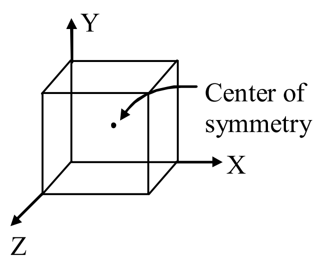
(iii) Axis of four fold symmetry.



(iv) Axis of six fold symmetry.

5.3 <u>Centre of symmetry</u>

(a) It is a point in the crystal that any line drawn through it intersects the surface of the crystal at equal distance on either side.



Note :- Only simple cubic system have one centre of symmetry. Other system do not have centre of symmetry.

6. Elements of Symmetry

(a) The total number of planes, axes and centre of symmetries possessed by a crystal is termed as elements of symmetry.

(b) A cubic crystal possesses total 23 elements of symmetry.

(i) Plane of symmetry (3 + 6) = 9

(ii) Axes of symmetry (3 + 4 + 6) = 13

(iii) Centre of symmetry = 1

Total symmetry = 23

7. Crystal System

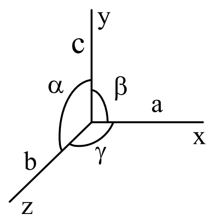
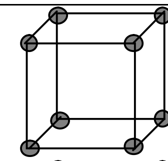
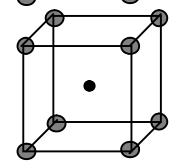
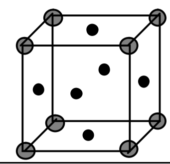
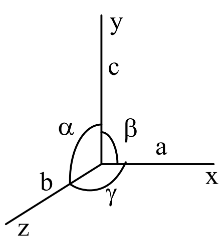
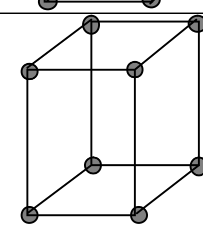
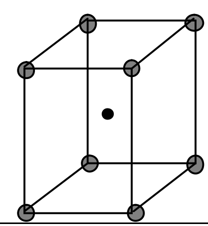
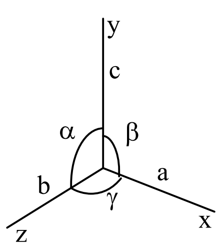
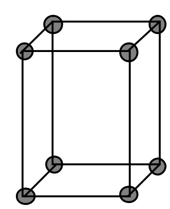
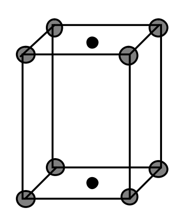
(a) On the basis of geometrical consideration theoretically there can be 32 different combinations of elements of symmetry of crystal.

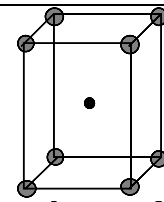
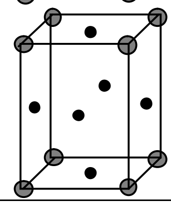
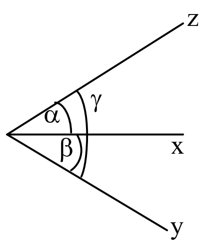
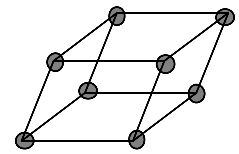
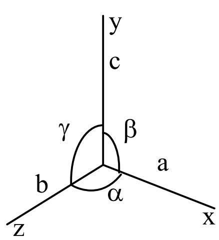
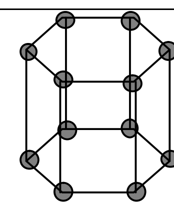
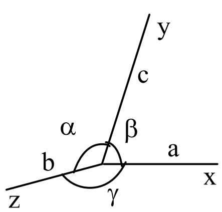
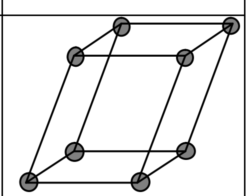
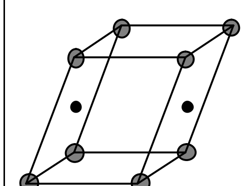
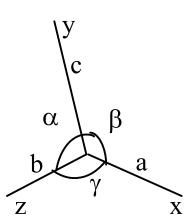
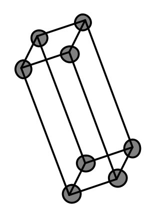
(b) But on the other hand Bravais showed that there are only seven types of crystal system.

These are :–

(a) Cubic (b) Tetragonal (c) Orthorhombic (d) Rhombohedral
(e) Hexagonal (f) Monoclinic (g) Triclinic
(c) There are 14 Bravais lattices under seven crystal systems as follows :

The Bravais is Lattices

S. No.	Crystal System	Axial distance	Axial angles	Space lattice	Unit cell
1.	Cubic 	a = b = c	$\alpha = \beta = \gamma = 90^o$	a Simple : – Lattice points at the eight corners of the unit cells. b. Body centered : – Points at the eight corners and at the body centered. c. Face centered : – points at the eight corners and at the six face centres.	
2.	Tetragonal 	$a = b \neq c$	$\alpha = \beta = \gamma = 90^o$	d. Simple : – Points at the eight corners of the unit cell. e. Body centered : – Points at the eight corners and at the body centre.	
3.	Orthorhombic 	$a \neq b \neq c$	$\alpha=\beta= \gamma = 90^o$	f. Simple : – Points at the eight corners of the unit cell. g. End centered : – Also called side centered or base centered. Points at the eight corners and at two face centres opposite to each other. h. Body centered : – Points at the eight corners and at the body centre. i. Face centered : – Points at the eight corners and at the six face centres.	

					 
4.	Rhombohedral or Trigonal 	a=b = c	α=β = γ ≠ 90º	j. Simple : – Points at the eight corners of the unit cell.	
5.	Hexagonal 	a=b ≠ c	α = β = 90º γ = 120º	k. Simple : – i. Points at the twelve corners of the unit cell out lined by thick line.	
6.	Monoclinic 	a≠b ≠ c	α = γ = 90º, β ≠ 90º	l. Simple : – Points at the eight corners of the unit cell. m. End centered : – Point at the eight corners and at two face centres opposite to the each other.	 
7.	Triclinic 	a≠b ≠ c	α ≠ β ≠ γ ≠ 90º	n. Simple : – Points at the eight corners of the unit cell.	

S.No.	Crystal system	Space lattice	Examples
1.	Cubic	Simple	Pb, Hg, Ag, Au,Cu, Diamond, NaCl, KCl, ZnS,Cu_2O, CaF_2 and Alums.
2.	Tetragonal	Simple	SnO_2, ZnO_2,TiO_2, $NiSO_4$, $ZrSiO_4$, $PbWO_4$, White Sn.
3.	Orthorhombic	Simple	KNO_3, K_2SO_4, $PbCO_3$, $BaSO_4$, Rhombic sulphur, $MgSO_4$, $7H_2O$.
4.	Rhombohedral	Simple	$NaNO_3$, $CaSO_4$, Calcite, ICI, Quartz, As, Sb, Bi.
5.	Hexagonal	Simple	ZnO, PbI_2,CdS, HgS, Graphite, Ice, Beryl, Mg, Zn, Cd.
6.	Monoclinic	Simple	$Na_2 SO_4 . 10 H_2O$, $Na_2 B_4O_7 . 10 H_2O$, $CaSO_4 . 2H_2 O$, Monoclinic sulphur
7.	Triclinic	Simple	$CuSO_4 . 5H_2O$, $K_2Cr_2O_7$, H_3BO_3.

8. Mathematical Analysis of Cubic System (Types and Analysis)

Simplest crystal system is to be studied in cubic system. Three types of cubic systems are following.

(a) **Simple Cubic (SC) :** Atoms are arranged at the corners of the cube.

(b) **Body Centered Cubic (BCC) :** Atoms are arranged at the corners and at the centre of the cube.

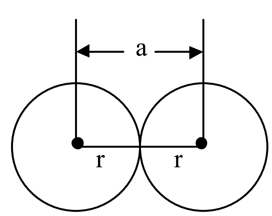
(c) **Face Centered Cubic (FCC) :** Atoms are arranged at the corners and at the centre of the each face.

8.1 Atomic radius

It is defined as the half of the distance between nearest neighbouring atoms in a crystal. It is expressed in terms of length of the edge (a) of the unit cell of the crystal.

(a) Simple cubic structure (S.C.)

Radius of atom 'r' = $\frac{a}{2}$



(b) Face centered cubic structure (FCC) 'r' = $\frac{a}{2\sqrt{2}}$

SOLVED EXAMPLES

Ex.1 The edge length of cube is 400 pm. Its body diagonal would be-

(A) 500 pm (B) 693 pm

(C) 600 pm (D) 566 pm

Sol. **(B)**

Since in body centre cubic, the body diagonal

$= \sqrt{3}\ a \quad = \sqrt{3} \times 400$ pm

$= 692.82$ pm or say 693 pm

Ex.2 What is the simplest formula of a solid whose cubic unit cell has the atom A at each corner, the atom B at each face centre and a C atom at the body centre-

(A) AB_2C (B) A_2BC

(C) AB_3C (D) ABC_3

Sol. **(C)**

An atom at the corner of a cube is shared among 8 unit cells. As there are 8 corners in a cube, number of corner atom (A) per unit cell

$= 8 \times \frac{1}{8} = 1.$

A face-centered atom in a cube is shared by two unit cells. As there are 6 faces in a cube, number of face-centered atoms (B) per unit cell

$= 6 \times \frac{1}{2} = 3.$

An atom in the body of the cube is not shared by other cells.

$\therefore$ Number of atoms (C) at the body centre per unit cell = 1.

Hence, the formula of the solid is AB_3C.

Ex.3 A compound alloy of gold and copper crystallizes in a cube lattice in which the gold atoms occupy the corners of a cube and the copper atoms occupy the centres of each of the cube faces.The formula of this compound is-

(A) AuCu (B) $AuCu_2$

(C) $AuCu_3$ (D) None

Sol. **(C)**

One-eighth of each corner atom (Au) and one-half of each face-centered atom (Cu) are contained with in the unit cell of the compound.

Thus, the number of Au atoms per unit cell $= 8 \times \frac{1}{8} = 1$ and the number of Cu atoms per unit cell $= 6 \times \frac{1}{2} = 3$. The formula of the compound is $AuCu_3$.

Ex.4 Select the correct statement (s)-

(a) The C.N. of cation occupying a tetrahedral hole is 4.

(b) The C.N. of cation occupying a octahedral hole is 6.

(c) In schottky defects, density of the lattice decreases.

(A) a, b (B) b, c

(C) a, b, c (D) a, c

Sol. **(C)**

Since tetrahedral holes are surrounded by 4 nearest neighbours. So, the C.N. of cation occupying tetrahedral hole is 4. Since octahedral hole is surrounded by six nearest neighbours. So, C.N. of cation occupying octahedral is 6. In schottky a pair of anion and cation leaves the lattice. So, density of lattice decreases.

Ex.5 The unit cell of a metallic element of atomic mass 108 and density 10.5 g/cm^3 is a cube with edge length of 409 pm. The structure of the crystal lattice is -

(A) fcc (B) bcc

(C) hcp (D) None of these

Sol. **(A)**

$\rho = \frac{Z \times M}{N \times a^3}$

Here, M = 108, $N_A = 6.023 \times 10^{23}$

a = 409 pm = 4.09×10^{-8} cm,

$\rho = 10.5\ g/cm^3$

Put on these values and solving we get-

n = 4 = number of atoms per unit cell

So, The structure of the crystal lattice is fcc.

Ex.6 At room temperature, sodium crystallises in a body centred cubic cell with a = 4.24 Å. The theoretical density of sodium is –(Atomic mass of sodium = 23.0 g mol^{-1})

(A) 2.05 g cm^{-3} (B) 3.45 g cm^{-3}

(C) 1.00 g cm^{-3} (D) 3.55 g cm^{-3}

Sol. **(C)**

The value of Z for a bcc unit cell is 2.

Volume V = $(4.24\ Å)^3$

$$\therefore \rho = \frac{ZM}{NV} = \frac{2 \times 23}{(6.023 \times 10^{23}) \times (4.24 \times 10^{-8})^3}$$

$= 1.00\ g / cm^3$

Ex.7 In a face centred cubic arrangement of A and B atoms where A are present at the corner and B at the face centres, A atoms are missing from 4 corners in each unit cell ? What is the simplest formula of the compound ?

Ans. Number of A atoms = $4 \times \frac{1}{8} = \frac{1}{2}$

Number of B atoms = $6 \times \frac{1}{2} = 3$

Formula = $A_{\frac{1}{2}} B_3 = AB_6$

Ex.8 An element cryastallises in a structure having fcc unit cell of an edge 200 pm. Calculate its density, if 200 g of this element contains 24×10^{23} atoms ?

Ans. Molar mass = $\frac{200}{24 \times 10^{23}} \times 6.023 \times 10^{23}$

= 50.19 gm/mol.

for FCC, n = 4, V = a^3 V= $(200 \times 10^{-10})^3$

apply crystal density = $\frac{n \times M}{V \times N_A}$ = 41.68 gm/cm^3

Ex.9 A compound containing A, B and C spheres on crystallization A spheres are present at all corners and B at all face centres except one, the C spheres are present at alternating edge centres. Find out molecular formula of compound.

Sol. The contribution of corner face centre and edge centre is $\frac{1}{8}$, $\frac{1}{2}$ and $\frac{1}{4}$

$A = 8 \times \frac{1}{8} = 1$

$B = 5 \times \frac{1}{2} = 2.5$ [one face is missing]

$C = 4 \times \frac{1}{4} = 1$ [At alternating edge centre only]

$A\,B_{2.5}\,C$ or $A_2B_5C_2$

Ex.10 In a ccp crystal having rock salt type arrangement A^+ and B^- spheres. If spheres along one axis form origin are removed then calculate the formula of resulting compound.

Sol. In rock salt (NaCl) type crystal cations are present at all edge centre and at body centre and anion at all corners and face centre. If one axis is removed the two anions from corner and one cation from edge centre is removed that the formula is -

$A^+ = 11 \times \frac{1}{4} + 1 \times 1 = \frac{15}{4}$

at edge centre and at body centre

$B^- = 6 \times \frac{1}{8} + 6 \times \frac{1}{2} = \frac{6}{8} + 3 = \frac{30}{8}$

$A_{\frac{15}{4}} B_{\frac{30}{8}}$ formula of compound = AB

(can be in fraction)

EXERCISE # 1

Q.1 Which of the following is not a characteristic of crystalline solids ?

(1) They have a regular geometry

(2) They have sharp melting points

(3) They are isotropic

(4) They undergo a clean cleavage

Q.2 Which of the following is not a crystalline solid ?

(1) Common salt (2) Sugar

(3) Iron (4) Rubber

Q.3 A pseudo solid is -

(1) glass (2) pitch

(3) KCl (4) Glass and pitch both

Q.4 Solid CO_2 is an example of -

(1) Ionic crystal (2) Covalent crystal

(3) Metallic crystal (4) Molecular crystal

Q.5 Wax is an example of -

(1) Ionic crystal (2) Covalent crystal

(3) Molecular crystal (4) Metallic crystal

Q.6 $a \neq b \neq c$, $\alpha = \gamma = 90°$, $\beta \neq 90°$ represents -

(1) tetragonal system

(2) orthorhombic system

(3) monoclinic system

(4) triclinic system

Q.7 The most unsymmetrical crystal system is -

(1) Cubic (2) Hexagonal

(3) Triclinic (4) Orthorhombic

Q.8 Bravais lattices are of -

(1) 10 types (2) 8 types

(3) 7 types (4) 14 types

Q.9 In a simple cubic cell, each point on a corner is shared by -

(1) 2 unit cells (2) 1 unit cell

(3) 8 unit cells (4) 4 unit cells

Q.10 In a face centred cubic cell, an atom at the corner contributes to the unit cell -

(1) 1 part (2) 1/2 part

(3) 1/4 part (4) 1/8 part

Q.11 In face centred cubic cell, an atom at the face centres is shared by -

(1) 4 units cells (2) 2 unit cells

(3) One unit cell (4) 6 unit cells

Q.12 In a face centred cubic cell, an atom at the face contributes to the unit cell -

(1) 1 part (2) 1/2 part

(3) 1/4 part (4) 1/8 part

Q.13 In a body centred cubic cell, an atom at the body centre is shared by -

(1) 1 unit cell (2) 2 unit cell

(3) 3 unit cell (4) 4 unit cell

Q.14 Which of the following type of cubic lattice has maximum number of atoms per unit cell ?

(1) Simple cubic

(2) Body centred cubic

(3) Face centred cubic

(4) All have same

Q.15 The number of atoms present in a unit cell of a monoatomic substance (element) of simple cubic lattice, body-centred cubic and face centred cubic respectively are -

(1) 8, 9 and 14 (2) 1, 2 and 4

(3) 4, 5 and 6 (4) 2, 3 and 5

Q.16 Which one of the following is primitive unit cell ?

(1) Simple cubic

(2) Body-centred cubic

(3) Face-centred cubic

(4) Both body-centred and face-centred cubic

Q.17 In a body centred cubic unit cell, a metal atom at the centre of the cell is surrounded by how many other metal atoms -

(1) 8 (2) 6

(3) 12 (4) 4

Q.18 An alloy of copper, silver and gold is found to have copper constituting the fcc lattice. If silver atoms occupy the edge centres and gold is present at body centre, the alloy has a formula -

(1) Cu_4Ag_2Au (2) Cu_4Ag_4Au

(3) Cu_4Ag_3Au (4) CuAgAu

Q.19 Sodium metal crystallizes in bcc lattice with the cell edge a = 42.29 Å. What is the radius of sodium atom ?

(1) 1.86 Å (2) 1.90 Å

(3) 18.3 Å (4) 1.12 Å

Q.20 An element has bcc structure having unit cells 12.08×10^{23}. The number of atoms in these cell is -

(1) 12.08×10^{23} (2) 24.16×10^{23}

(3) 48.38×10^{23} (4) 12.08×10^{22}

Q.21 A metal has bcc structure and the edge length of its unit cell is 3.04 Å. The volume of the unit cell in cm^3 will be -

(1) 1.6×10^{-21} cm^3 (2) 2.81×10^{-23} cm^3

(3) 6.02×10^{-23} cm^3 (4) 6.6×10^{-24} cm^3

Q.22 A compound having bcc geometry has atomic mass 50. Calculate the density of the unit cell, if its edge length is 290 pm -

(1) 6.81 g cm^{-3} (2) 3.40 g cm^{-3}

(3) 13.62 g cm^{-3} (4) None of these

Q.23 An element, density 6.8 g cm^{-3} occurs in bcc structure with cell edge 290 pm. Calculate the number of atoms present in 200 g of the element.

(1) 2.4×10^{42} (2) 1.2×10^{42}

(3) 1.2×10^{24} (4) 2.4×10^{24}

Q.24 An element A crystallizes in fcc structure. 200 g of this element has 4.12×10^{24} atoms. The density of A is 7.2 g cm^{-3} Calculate the edge length of the unit cell -

(1) 26.97×10^{-24} cm (2) 299.9 pm

(3) 5×12^{-12} cm (4) 2.99 cm

Q.25 The more efficient mode of packing of identical atoms in one layer is -

(1) Square close packing pattern

(2) Hexagonal close packing pattern

(3) Both (1) and (2)

(4) None of the two

Q.26 The ABAB….packing and ABC ABC….packing are respectively called as -

(1) hexagonal close packing(hcp) and cubic close packing (ccp)

(2) ccp and hcp

(3) body centred cubic (bcc) packing and hexagonal close packing

(4) hcp and bcc

Q.27 The space occupied in bcc arrangement is -

(1) 74 % (2) 70 %

(3) 68 % (4) 60.4 %

Q.28 The vacant space in bcc unit cell is -

(1) 32% (2) 10%

(3) 23% (4) 46%

Q.29 The empty space in the hcp and ccp is about -

(1) 26 % (2) 30 % (3) 35 % (4) 40%

EXERCISE # 2

Q.1 A metal (atomic mass = 50) has a body centred cubic crystal structure. The density of metal is 5.96 g cm^{-3}. Find the volume of the unit cell.

(1) 13.9×10^{-24} cm^3 (2) $27.8 \times 10^{-24}$$cm^3$

(3) 6.95×10^{-24} cm^3 (4) $55.6 \times 10^{-24}$$cm^3$

Q.2 An element crystallises in BCC structure. The edge length of its unit cell is 288 pm. If the density of the crystal is 7.2 g cm^{-3}, what is the atomic mass of the element ?

(1) 51.8 (2) 103.6 (3) 25.9 (4) 207.2

Q.3 The coordination number of hexagonal closest packed (hcp) structure is ?

(1) 12 (2) 10 (3) 8 (4) 6

Q.4 The available space occupied by spheres of equal size in three dimensions in both hcp and ccp arrangement is -

(1) 74% (2) 70% (3) 60.4% (4) 52.4%

Q.5 Which one of the following statements is incorrect about rock salt type ?

(1) It has fcc arrangement of Cl^-

(2) Na^+ and Cl^- ions have a co-ordination number of 6 : 6

(3) A unit cell of NaCl consists of four NaCl units

(4) All halides of alkali metals have rock-salt type structure

Q.6 In sodium chloride, Cl^- ions form ccp arrangement. Which site a Na^+ ion will occupy in this structure ?

(1) Cubic (2) Tetragonal

(3) Octahedral (4) Trigonal bipyramidal

Q.7 The NaCl structure can be converted into CsCl structure -

(1) by application of high pressure

(2) by heating to 760 K

(3) both by heat and pressure

(4) the conversion is not possible

Q.8 The co-ordination number of calcium fluorite (CaF_2) type structure is -

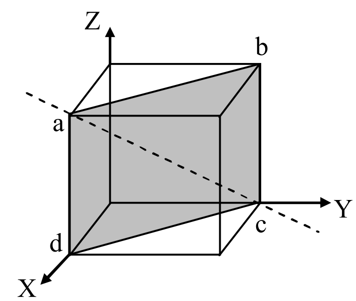
(1) 1 : 2 (2) 4 : 4 (3) 4 : 8 (4) 8 : 4

Q.9 KF has NaCl structure. What is the distance between K^+ and F^- in KF if density is 2.48 g cm^{-3} ?

(1) 268.8 pm (2) 537.5 pm

(3) 155.3×10^{-24} (4) 5.375 cm

Q.10 The shaded plane *abcd* is referred to as -



(1) rectangular plane of symmetry

(2) diagonal plane of symmetry

(3) unit plane

(4) none of these

Q.11 Which of the following defect, if present, lowers the density of the crystal-

(1) Frenkel

(2) Schottky

(3) Edge dislocation

(4) Constitution of F-centres.

Q.12 The yellow colour of ZnO and conducting nature produced in heating is due to-

(1) Metal excess defects due to interstitial cation

(2) Extra positive ions present in an interstitial site

(3) Trapped electrons

(4) All

Q.13 How many number of atoms are there in a cube based unit cell having one atom on each corner and two atoms on each body diagonal of cube -

(1) 8 (2) 6 (3) 4 (4) 9

EXERCISE # 3

Q.1 How many Cl^- ions are there around Na^+ ion in NaCl crystal -

[NCERT 78, 89, AIPMT-88, BHU-82, 87 AMU-04]

(1) 3 (2) 4 (3) 6 (4) 8

Q.2 The number of atoms contained in a fcc unit cell of a monoatomic substance is -

IPMT-86,89, MP-CEE-93, AMU- 03]

(1) 1 (2) 2 (3) 4 (4) 6

Q.3 An octahedral void is surrounded by how many spheres ? **[AIPMT-90]**

(1) 6 (2) 4 (3) 8 (4) 1 2

Q.4 Most crystals show good cleavage because their atoms, ions or molecules are - **[AIPMT-93]**

(1) weakly bonded together

(2) strongly bonded together

(3) spherically symmetrical

(4) arranged in planes

Q.5 For orthorhombic system axial ratio are $a \neq b \neq c$ and the axial angles are **[AIPMT-91]**

(1) $\alpha = \beta = \gamma \neq 90^o$ (2) $\alpha = \beta = \gamma = 90^o$

(3) $\alpha \neq \beta = \gamma = 90^o$ (4) $\alpha \neq \beta \neq \gamma = 90^o$

Q.6 In the fluorite structure, the co-ordination number of Ca^{2+} ion is - **[AIPMT-93]**

(1) 4 (2) 6 (3) 8 (4) 3

Q.7 The number of atoms in 100 g of an FCC crystal with density d = 10g cm^{-3} and cell edge as 200 pm is equal to - **[AIPMT-94]**

(1) 3×10^{25} (2) 0.5×10^{25}

(3) 1×10^{25} (4) 2×10^{25}

Q.8 When electrons are trapped into the crystal in anion vacancy, the defect is known as

[AIPMT-94]

(1) Schottky defect (2) Frenkel deferct

(3) Stoichiometric defect (4) F-centres

Q.9 The edge length of face centred unit cubic cell is 508 pm. Then the radius of that atom will be -

[AIPMT-98]

(1) 179.6 pm (2) 288 pm

(3) 618 pm (4) 398 pm

Q.10 Zn convert its molten state to its solid state, it has h.c.p structure then find out number of nearest atoms - **[AIPMT-2001]**

(1) 6 (2) 8 (3) 12 (4) **4**

Q.11 In a bcc unit cell, the number of atom is -

[AIPMT-2002]

(1) 1 (2) 2 (3) 4 (4) 6

Q.12 The pykometric density of sodium chloride crystal is 2.165×10^3 kg m^{-3} while its X-ray density is 2.178×10^3 kg m^{-3}. The fraction of unoccupied sites in sodium chloride crystal is -

[AIPMT-2003]

$$\left[\begin{array}{l}\text{Hint : Fraction of unoccupied sites} \\ = \dfrac{\text{X - ray density} - \text{pyknometric density}}{\text{X} - \text{ray density}}\end{array}\right]$$

(1) 5.96 (2) $5.96\ 0 \times 10^{-2}$

(3) 5.96×10^{-1} (4) 5.96×10^{-3}

Q.13 What is the co-ordination number of sodium in Na_2O - **[AIIMS-2003]**

(1) 6 (2) 4

(3) 8 (4) 2

Q.14 A compound formed by element X and Y crystallizes in a cubic structure in which the X atoms are at the corners of a cube and the Y atoms are at the face-centres. The formula of the compound is - **[AIPMT-2004]**

(1) X_3Y (2) XY

(3) XY_2 (4) XY_3

Q.15 The crystal system of a compound with unit cell dimensions a = 0.387, b = 0.387 and c = 0.504 nm and $\alpha = \beta = 90^\circ$ and $\gamma = 120^\circ$ is -

[AIIMS- 2004]

(1) Cubic (2) Hexagonal
(3) Orthorhombic (4) Rhomhombic

Q.16 In a NaCl type crystal distance between Na^+ and Cl^- ion is 2.814 Å and the density of solid is 2.167 g cm^{-3} then find out the value of Avogadro constant. **[AIPMT-2004]**

(1) 6.05×10^{23} (2) 3.02×10^{23}
(3) 12.10×10^{23} (4) None

Q.17 If 'Z' is the number of atoms in the unit cell that represents the closest packing sequence ---A B C A B C ----, the number of tetrahedral voids in the unit cell is equal to - **[AIIMS-2005]**

(1) Z (2) 2 Z (3) Z/2 (4) Z/4

Q.18 In a face-centered cubic lattice, an unit cell is shared equally by how many unit cells :

[AIPMT-2005]

(1) 4 (2) 2 (3) 6 (4) 8

Q.19 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 an unit cell. (Na = 6.023×10^{23}), (M = 6.94 g mol^{-1}) **[AIPMT-2005]**

(1) 2 (2) 8 (3) 4 (4) 6

Q.20 The Ca^{2+} and F^- are located in CaF_2 crystal, respectively at face centred cubic lattice points and in - **[AIIMS-2006]**

(1) Tetrahedral voids (2) Half of tetrahedral voids
(3) Octahedral void (4) half of octahedral voids

Q.21 CsBr crystallises in a body centred cubic lattice. The unit cell length is 436.6 pm. Given that the atomic mass of Cs = 133 and that of Br = 80 amu and Avogadro number being 6.023×10^{23} mol^{-1}, the density of CsBr is - **[AIPMT-2006]**

(1) 42.5 g cm^{-3} (2) 0.425 g cm^{-3}
(3) 8.25 g cm^{-3} (4) 4.25 g cm^{-3}

Q.22 NaCl is doped with 10^{-4} mol% $SrCl_2$, the concentration of cation vacancies is -

[AIPMT-2007]

$$\left[\text{Hint: Concentration of vacancies} = \frac{10^{-4}}{100} N_A\right]$$

(1) 6.02×10^{15} mol^{-1} (2) 6.02×10^{16} mol^{-1}
(3) 6.02×10^{17} mol^{-1} (4) 6.02×10^{14} mol^{-1}

Q.23 The fraction of total volume occupied by the atoms present in a simple cube is –

(1) $\frac{\pi}{6}$ (2) $\frac{\pi}{3\sqrt{2}}$ (3) $\frac{\pi}{4\sqrt{2}}$ (4) $\frac{\pi}{4}$

Q.24 Percentage of free space in a body centred cubic unit is –

(1) 32 % (2) 34 % (3) 28 % (4) 30 %

Q.25 If 'a' stands for the edge length of the cubic systems : simple cubic, body centred cubic and face centred cubic, then the ratio of radii of the spheres in these system will be respectively.

[AIPMT-2008]

(1) $\frac{1}{2}a : \sqrt{3}a : \frac{1}{\sqrt{2}}a$ (2) $\frac{1}{2}a : \frac{\sqrt{3}}{2}a : \frac{\sqrt{2}}{2}a$

(3) $1a : \sqrt{3}a : \sqrt{2}a$ (4) $\frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a$

Q.26 Which of the following statement/s is /are not correct ? **[AIPMT-2008]**

(1) Molecular solids are generally volatile
(2) The numbers of carbon atoms in an unit cell of diamond is 4
(3) The number of Bravais lattices in which a crystal can be categorized is14
(4) The fraction of the total volume occupied by the atoms in a primitive cell is 0.48

Q.27 Cupper crystallizes in a face-centred cubic lattice with a unit cell length of 361 pm. What is the radius of cupper atom in pm ?

[AIPMT-2009]

(1) 128 (2) 157 (3) 181 (4) 108

Q.28 Lithium metal crystallises in a body centred cubic crystal. If the length of the side of the unit cell of lithium is 351pm, the atomic radius of lithium will be : **[AIPMT-2009]**

(1) 240.8 pm (2) 151.8 pm

(3) 75.5 pm (4) 300.5 pm

Q.29 AB crystallizas in a body centred cubic lattice with edge length 'a' equal to 387 pm. The distance between two oppositively charged ions in the lattice is : **[AIPMT-2010]**

(1) 335 pm (2) 250 pm

(3) 200 pm (4) 300 pm

Q.30 A solid compound XY has NaCl structure. If the radius of the cation is 100 pm, the radius of the anion (Y^-) will be- **[AIPMT MAINS-2011]**

(1) 165.7 pm (2) 275.1 pm

(3) 322.5 pm (4) 241.5 pm

Q.31 The number of octahedral void(s) per atom present in a cubic close-packed structure is : **[AIPMT-2012]**

(1) 2 (2) 4 (3) 1 (4) 3

Q.32 A metal crystallizes with a face-centered cubic lattice. The edge of the unit cell is 408 pm. The diameter of the metal atom is **[AIPMT-2012]**

(1) 144 pm (2) 204 pm (3) 288 pm (4) 408 pm

Q.33 The number of carbon atoms per unit cell of diamond unit cell is - **[NEET-2013]**

(1) 4 (2) 8 (3) 6 (4) 1

Q.34 A metal has a fcc lattice. The edge length of the unit cell is 404 pm. The density of the metal is 2.72 g cm^{-3}. The molar mass of the metal is :

[N_A Avogadro's constant = 6.02×10^{23} mol^{-1}]

[NEET-2013]

(1) 40 g mol^{-1} (2) 30 g mol^{-1}

(3) 27 g mol^{-1} (4) 20 g mol^{-1}

Q.35 If a is the length of the side of a cube, the distance between the body centred atom and one corner atom in the cube will be: **[AIPMT-2014]**

(1) $\frac{2}{\sqrt{3}}a$ (2) $\frac{4}{\sqrt{3}}a$

(3) $\frac{\sqrt{3}}{4}a$ (4) $\frac{\sqrt{3}}{2}a$

Q.36 Lithium has a bcc structure. Its density is 530 kg m^{-3} and its atomic mass is 6.94 g mol^{-1}. Calculate the edge length of a unit cell of Lithium metal. (N_A = 6.02×10^{23} mol^{-1}) **[NEET-1-2016]**

(1) 352 pm (2) 527 pm

(3) 264 pm (4) 154 pm

Q.37 The ionic radii of A^+ and B^- ions are 0.98×10^{-10} m and 1.81×10^{-10} m. The coordination number of each ion in AB is :

[NEET-1-2016]

(1) 4 (2) 8

(3) 2 (4) 6

Q.38 In calcium fluoride, having the fluorite structure, the coordination numbers for calcium ion (Ca^{2+}) and fluoride ion (F^-) are

[NEET-2-2016]

(1) 4 and 2 (2) 6 and 6

(3) 8 and 4 (4) 4 and 8

ANSWER KEY

EXERCISE # 1

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	4	4	4	3	3	3	4	3	4	2	2	1	3	2
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
Ans.	1	1	3	3	2	2	1	4	2	2	1	3	1	1	

EXERCISE # 2

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Ans.	2	1	1	1	4	3	1	4	1	2	2	4	4

EXERCISE # 3

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	3	1	4	2	3	2	4	1	3	2	4	2	4	2
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	2	3	1	1	4	3	1	1	4	4	1	2	1	4
Q.No.	31	32	33	34	35	36	37	38							
Ans.	3	3	2	3	4	1	4	3							

DIGESTION AND ABSORPTION

Chapter Contents

✓ Introduction

- Food is one of the basic requirements of all living organisms. The major components of our food are carbohydrates, proteins and fats. Vitamins and minerals are also required in small quantities. Food provides energy and organic materials for growth and repair of tissues.
- The water we take in, plays an important role in metabolic processes and also prevents dehydration of the body. Biomacromolecules in food cannot be utilised by our body in their original form.
- They have to be broken down and converted into simple substances in the digestive system. This process of conversion of complex food substances to simple absorbable forms is called digestion and is carried out by our digestive system by mechanical and biochemical methods.

Digestive System

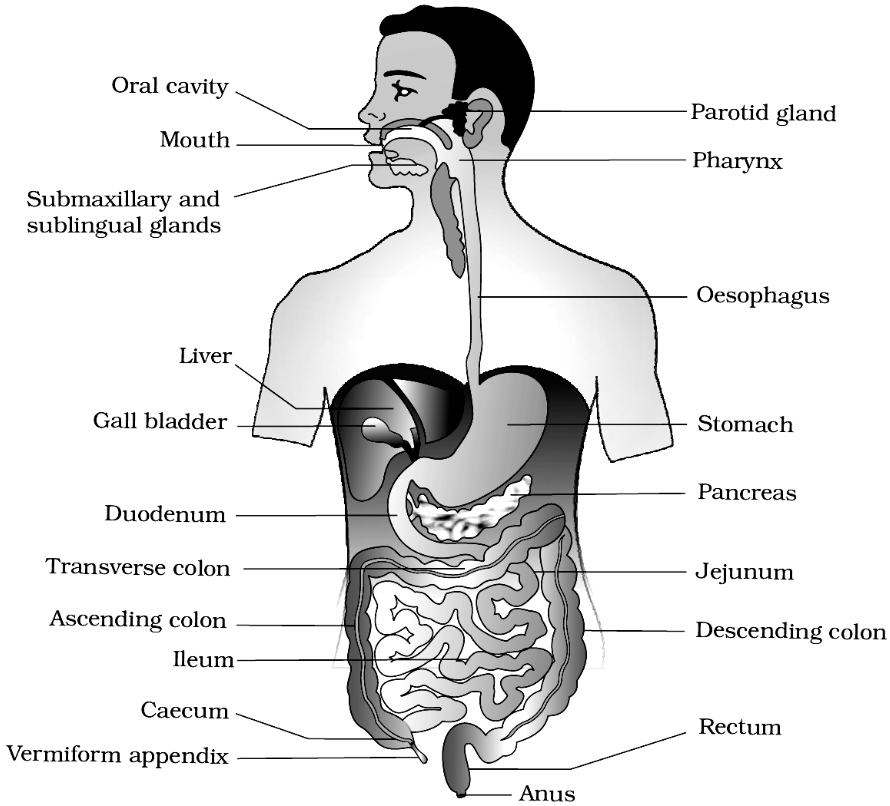
- The human digestive system consists of the alimentary canal and the associated glands.

Alimentary Canal

- The alimentary canal is tubular structure which extends from mouth to anus. It develops from ectoderm & endoderm.

AIIMS Advantage

- Ectoderm – up to hard palate
- Endoderm – from soft palate to rectum
- Ectoderm – from anal canal to Anus



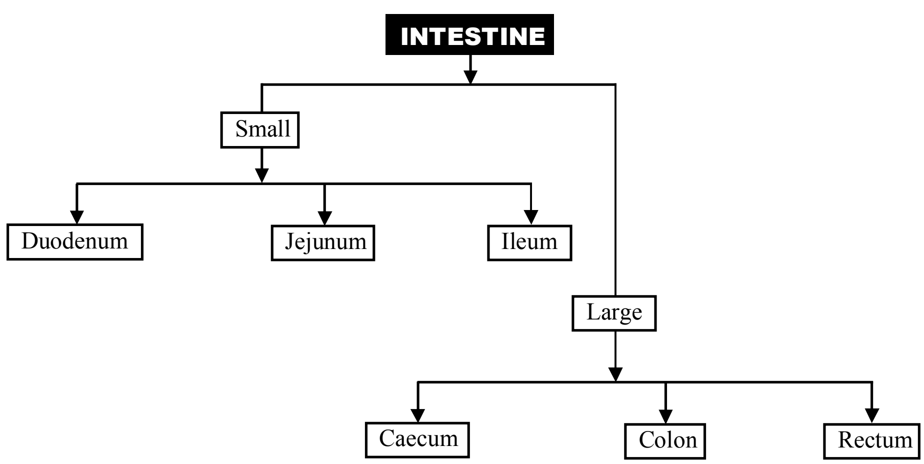
- The alimentary canal is divided into following parts–

  (1) Mouth and Buccopharyngeal cavity

  (2) Oesophagus

  (3) Stomach

  (4) Intestine



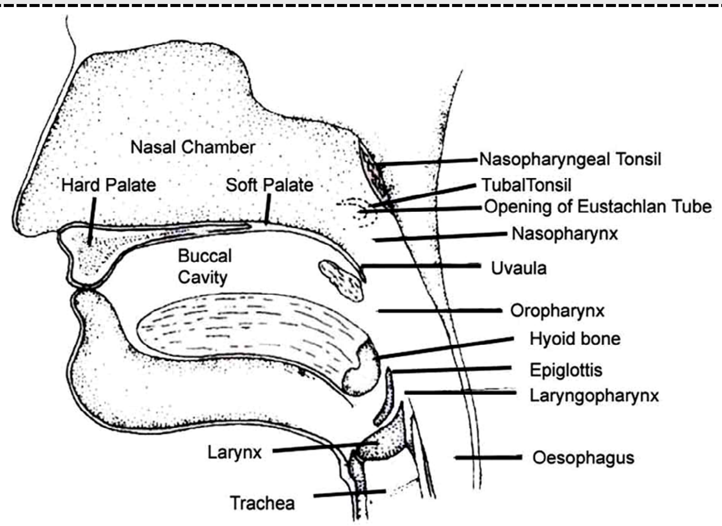
<u>Mouth and Buccopharyngeal Cavity :</u>

- Mouth is a horizontal transverse slit like aperture which is surrounded by upper and lower lip. Orbicularis oris voluntary muscles. are found in lips.

AIIMS Advantage

- Sebaceous glands are found on the outer part of lip. Serous glands are found on the inner part of lip.
- Serous glands is the modification of mucus glands. Its secretory substance is watery.
- In Rabbit a small cleft is found in the middle part of upper lip, such type of lip is called as **Hare lip**

(i) Buccal vestibule – It is a peripheral part which, present between the gums and cheeks where the food is stored temporarily for some time

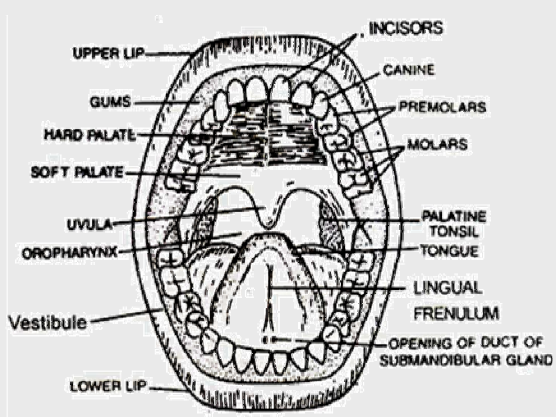


Section of head showing parts of pharynx

(ii) Oral cavity – It is inner & central part which, is surrounded by upper and lower Jaw. Lined by stratified squamous epithelium. Upper Jaw is Fixed and Lower jaw is Movable.

AIIMS Advantage

- The roof of oral cavity is called as **Palate.** This palate is horizontal partition which situated between oral cavity and nasal chamber



Human oral cavity.

Palate is differentiated into two parts :

(i) Hard Palate –

- It is the anterior part of the palate. It is made up of Maxilla and palatine bone in human. But in Rabbit it is made of Pre-maxilla, maxilla, palatine bone.
- On the ventral surface of hard palate, some projection or transverse ridges are present which are called as **palatine rugae.** These rugae prevent slip out of the food from buccal cavity during mastication. These rugae are well developed in carnivorous animals.
- In rabbit, one pair opening of Nasopalatine duct is present at the anterior part of hard palate, these connect the buccal cavity to the Nasal passage.
- In Rabbit some olfactory receptor are also found in nasopalatine duct which are called as **Jacobson's organ**. It makes them aware of the smell of food while chewing.

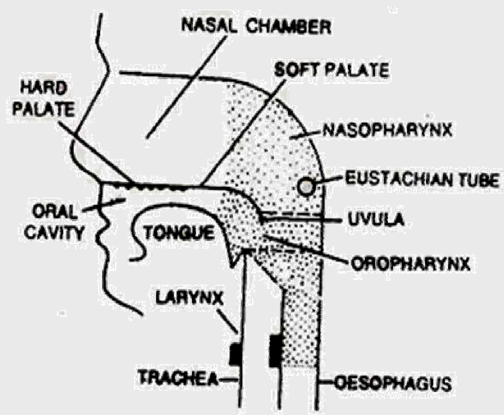


Diagram showing parts of phanyx

(ii) Soft Palate –

- It is the posterior part of palate. It is made up of involuntary muscle, fibrous connective tissues and mucous epithelium. (Stratified squamous epithelium)
- The posterior part of soft palate becomes out grow and hangs down in the form of finger like process called as **Uvula** or **Velum palati.** One pair of large lymph node is present on the posterolateral surface of soft palate, called as **Palatine tonsil** or **Tonsils**
- Soft palate is situated in the pharynx and is divided into two parts. Upper and dorsal part of pharynx is called as **Nasopharynx** which is related to the nasal chamber. The lower and ventral part of pharynx is called **oropharynx** which is related to the oral cavity. One pair of opening of **Eustachian tube** is present in the nasopharynx. This Eustachian tube is related to the middle ear.

✓ Teeth

- Teeth are ectomesodermal in origin. Major portion of teeth arises from **Dermis**. Part of tooth present outside the gums only is derived from ectoderm or **Epidermis (Enamel part).**
- In human teeth of upper jaw are attached to the maxilla bone. While teeth of lower jaw are attached to Mandible bone. But in rabbit upper incisors are attached to premaxilla. Upper pre molars and molars attached to the maxilla bone while lower teeth are attached to dentry bone.

AIIMS Advantage

Structure of Tooth

There are a three parts of the tooth

1. **Crown :** It is the outer part of the tooth, exposed outside gums
2. **Neck :** It is the middle part of the tooth which is embeded inside the gums.
3. **Root :** It is the part of tooth that is inserted inside the socket of jaw bone. (Alveoli)

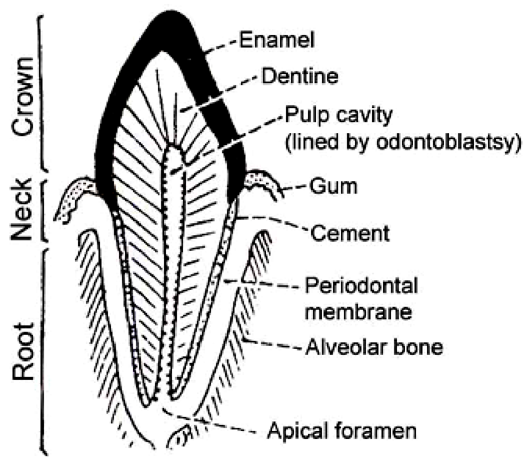


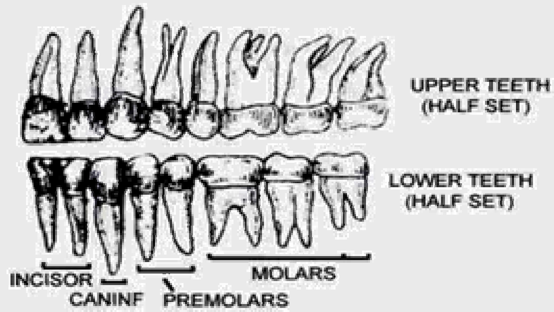
Fig. Parts of tooth

- The crown part of the tooth is made up of a very hard substance called the Enamel. It is the hardest material of animal kingdom. It helps in the mastication of food.

AIIMS Advantage

- Enamel is **ectodermal**. It is secreted by **Ameloblast** cells of the ectoderm. It has maximum amount of inorganic salt (96%) in it, Inorganic salt are mainly found in the form of phosphate and carbonate of Ca, Mg, Na and K. 3% of water is found in the enamel. Along with the keratin & ossein protein (1%) are also found in teeth. Ossein is a protein of bones. Remaining part of tooth develops from mesoderm of embryo.
- Dentine is the main part of tooth. Approximately 69% inorganic salts are present in dentine and 65% are present in cement. (62% inorganic salts are present in bones). Dentine surrounds a cavity called **pulp-cavity**. This cavity contains soft connective tissue, blood capillaries, nerve fibres.
- Pulp cavity is necessary for the nutrition and survival of the teeth. At the base of pulp-cavity an aperture is present . Through this aperture, blood capillaries and nerve fibres enter inside the teeth. This aperture is called **apical-foramen**. A special type of cells form the lining of the pulp-cavity called the **Odontoblast cells.** These cells are the dentine secreting cells. Cytoplasmic process of odontoblasts are embeded into dentine in the form of fine tubule.

- These processes are called canaliculi. These canaliculi secretes dentine. The teeth continue to grow till the odontoblast cells remain active. In adults, the adults, the pulp-cavity shrinks and the odontoblasts become inactive so the teeth stops to grow. The cement layer is made up of the cementocytes cells. Between the root and the bones of the teeth a periodontanl membrane is present.
- In Rabbit and Rat the pulp-cavity and pulp-pore of the incisor remains wide throughout their life, so these teeth grow continuously throughout their life span.



Arrangement of human permanent teeth

- If one incisor of Rabbit & Rat is broken then the opposite incisor grows continuously, finally the animal can neither can close the mouth nor gnaw the food. So the animal dies due to starving.

Four types of teeth found in mammals are:

1. **Incisor** – These are long, chisel like teeth for gnawing the food. They are more developed in gnawing animals e.g. lagomorphs, rodents, tusk of elephant are modification of upper Incisor. Tusk is used to protection from enemies, attack on enemies (not for feeding purpose)
2. **Canines –** These are sharp pointed teeth meant for tearing the food. Canines are most developed in carnivorous animals. canines are absent in herbivorous animals e.g. Rabbits do not have canines. In herbivorous, the space of canine in gums is empty and this empty space is called diastema.
3. **Pre molar** – These teeth are meant for chewing and crushing of food, they are triangular in shape.
4. **Molars (Cheek teeth)** – These also meant for chewing & crushing of food. They are rectangular in shape. Premolar and molar help in the mastication of food. In human teeth of upper jaw are attached to the maxilla bone. While teeth of lower jaw are attached to the mandible bone.

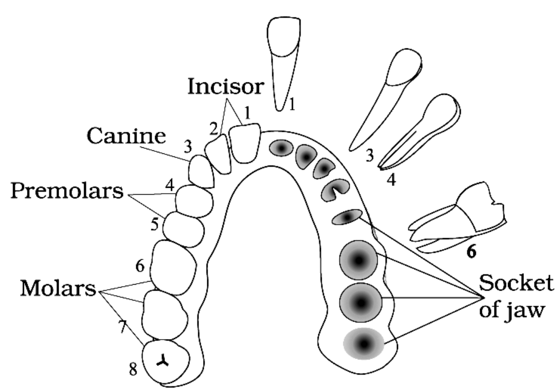


Fig. Arrangement of different types of teeth in the jaws
on one side and the sockets on the other side

- In animals, except Premolar and Last molar, all type of teeth appear twice in life. Teeth which appear during childhood are called milk teeth or temporary teeth. Due to the activity of osteoblast cells. These milk teeth are shed off then permanent teeth appear.
- When temporary molars shed, their socket are filled by premolar and new socket are formed for permanent molar. This occurs once in life time.

AIIMS Advantage

- In frog, only upper jaw has teeth.
- In Rabbit teeth of upper jaw are attached to the pre maxilla and maxilla bone, while teeth of lower jaw are attached to the dentry bone **Hippocampus, tortoise and birds do not have teeth.**

✓ Types of Teeth

1. **Monophyodont –** The teeth which appear only once in life e.g. Pre Molar & Last molar of man.
2. **Diphyodont –** The teeth which appear twice in life e.g. Incisors, Canines, Molars of human.
3. **Polyphyodont –** The teeth which appear more than twice in life. e.g. Fish, Amphibians.
4. **Thecodont –** The teeth which are present in bony socket of jaw. e.g. Man & crocodile
5. **Pleurodont –** The teeth which are present on the lateral side of jaw bone. e.g. Reptiles
6. **Acrodont** – The teeth which are present on the terminal part of Jaw bone. e.g. Fish, amphibian
7. **Heterodont –** When the teeth are of different type in mammals on the basis of structure and function. e.g. Mammal.
8. **Homodont** – Whether all teeth are of similar type in animal on the basis of structures and function e.g. Fish, Amphibians.

AIIMS Advantage

Secodont :

- These are canine teeth of carnivorous animals.
- In this type of structure canine teeth become long and pointed which, is bended towards the backward direction.

Hypsodont (Smiling teeth):

- In this type of teeth the crown part is large root is either absent or small such as **incisor** and **canine**. These teeth are also called as smiling teeth.

Brachyodont (Cheek teeth) :

- In this type of teeth crown part is small root is long such as **premolar** and **molar**
- **Wisdom teeth** – These are the last molar teeth of humans which appear in the age of 18 to 25 year.

Lophs or Cusps–

The upper surface of premolar & molar is broad and some small projections are present in the upper surface of premolar and molar.

These projections are called lophs or cusps. On the basis of structure of lophs, these teeth are of four types–

(i) Lophodont – In this type of teeth the lophs are large, wide and flat such as **Rabbit & Elephant.**

(ii) Bunodont – In this type of teeth. Lophs are small and spherical in shape, such as **Human**

(iii) Solenodont – In this type of teeth the lophs are large and semilunar shape e.g. **Ruminant animals (Cow, Buffalo).**

(iv) Carnesial – in this type of teeth the lophs are long & pointed e.g. **Carnivorous Animal**.

Dental Formula :

Child = $I\frac{2}{2}C\frac{1}{1}PM\frac{0}{0}M\frac{2}{2}=\frac{5}{5}\times 2=\frac{10}{10}=20$

17 yr. old = $I\frac{2}{2}C\frac{1}{1}PM\frac{2}{2}M\frac{2}{2}=\frac{7}{7}\times 2=\frac{14}{14}=28$

Adult = $I\frac{2}{2}C\frac{1}{1}PM\frac{2}{2}M\frac{3}{3}=\frac{8}{8}\times 2=\frac{16}{16}=32$

Note : In humans, premolar teeth appear in the alveoli of molar teeth while permanent molar teeth are developed in new alveoli.

AIIMS Advantage

Dental Formula in Rabbit = $I\frac{2}{1}C\frac{0}{0}PM\frac{3}{2}M\frac{3}{3}=\frac{8}{6}\times 2=\frac{16}{12}=28$

✓ Tongue

- On the floor of oral cavity a muscular, flat, fleshy plate like structure is present which is called **tongue.**
- The anterior part of tongue is free while posterior part of Tongue is connected to the Hyoid bone.
- The surface of tongue is connected to the floor of buccal cavity through a very flexible membrane/ligamentous fold called as **frenulum linguae**
- On the dorsal surface of tongue, it is divided into two unequal parts by a V shaped sulcus, called as sulcus terminalis.
- The two limbs of the 'V' meet at a median pit named **Foramen Caecum.**

AIIMS Advantage

It is divided into two parts –

(I) **Pharyngeal or Lymphoid Part :** It is the posterior 1/3 part of the tongue. Many small lymph nodes are present in this part which are called **Lingual tonsil.**

(II) **Oral or papillary Part :** It is anterior 2/3 part of tongue. Four types of papillae are found in this part in which gustatory or taste receptors are present.

(i) Fungiform Papillae –

- It is pink coloured, small & spherical in shape.

  It is found on the entire surface of tongue but Their maximum concentration at the anterior tip part of tongue.
- It is attached to tongue with the help of small pedicle.
- It provides pink colour to the tongue.

(ii) Filliform Papillae (Conical papillae) –

They are thread like, white coloured & conical in shape.

They are also found on the entire surface of tongue. They are most numerous.

(iii) Foliate Papillae –

They are found on the mid lateral surface of tongue.

They are vestigeal in the human. Their structures is leaf like present in rabbit and other mammals.

(iv) Circumvallate papillae –

They are large spherical shape papillae which are found near to sulcus terminalis.

They are least in number (approx 8 to 12)

AIIMS Advantage

Two types of muscles are present in tongue :

1. Extrinsic muscle

- It is found on outer and superficial part of tongue.
- It helps in outward and inward movement of tongue.

2. Intrinsic muscle

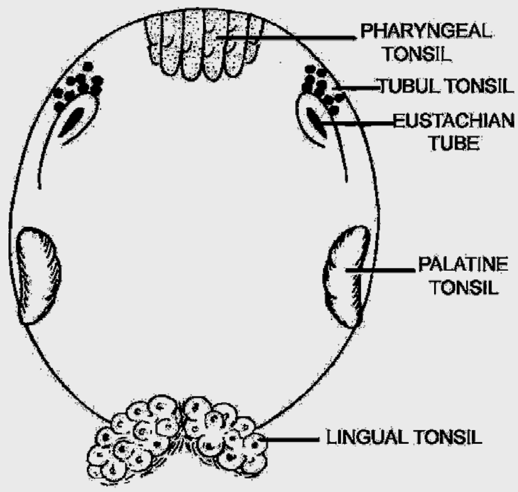
- It is situated in the deep part of tongue.
- It help in the change of shape of tongue

Pharynx

The oral cavity leads into pharynx. It is a common passage for food and air (breathing).

AIIMS Advantage

Waldeyer's Ring :– The lymphatic tissues of the pharynx and oral cavity are arranged in a ring like manner, which are collectively called Waldeyer's ring (= Waldeyer's lymphatic ring). The ring mainly consists of the following :



Waldeyer's Ring

(i) Nasopharyngeal Tonsil (= Pharyngeal Tonsil) : - Refer to the nasopharynx. In children nasopharyngeal tonsil may become enlarged and referred as **adenoids.** The resulting swelling may be a cause of obstruction to normal breathing.

(ii) Tubul Tonsil : – Refer to the nasopharynx.

(iii)Palatine Tonsils (= Faucial Tonsils) : Refer to the oropharynx. The Palatine tonsils are often infected **(tonsillitis)** leading to sort throat.

Such enlarged tonsils may become a focus of infection and their surgical removal **(Tonsillectomy)** becomes necessary.

(iv) Lingual Tonsil : – They are situated on posterior part of tongue

✓ Oesophagus

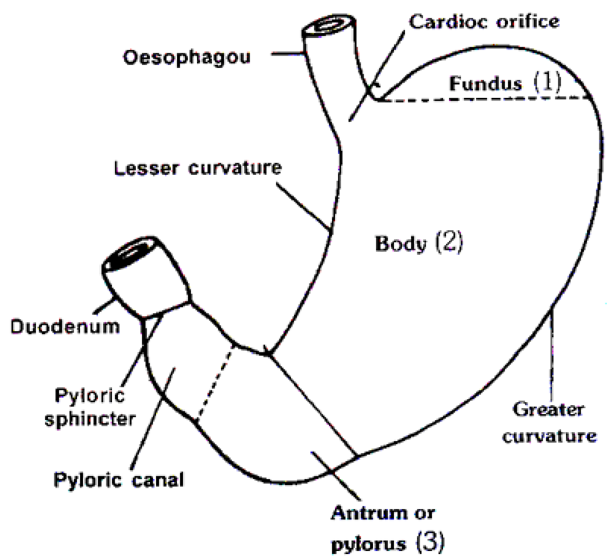
- Two apertures are found in central part of Buccopharyngeal cavity
- Ventral or lower aperture is called **Glottis** which is related to the Larynx. Which is guarded by cartilaginous flap called epiglottis
- The dorsal and upper aperture is called **Gullet** which open into oesophagus. Oesophagus is simple uniform tube which runs downward and pierces the diaphragm and finally opens into stomach.
- A muscular sphincter (gastro-oesophageal) regulates the opening of oesophagus into the stomach.
- Longitudinal folds are found on the inner surface of oesophagus. In it's lumen digestive glands are absent, only mucous glands are present here.

AIIMS Advantage

- Voluntary muscles are found on the upper 2/3 part of oesophagus while, involuntary muscles are found in lower 1/3 part of oesophagus.
- The length of oesophagus depends on length of neck so the longest oesophagus is present in **Giraffe.**

Stomach

- It is situated on upper left side of abdominal cavity. **It is the widest part of alimentary canal.** It is a bag like muscular structure, J shaped in empty condition. The stomach is divided into three major parts - a cardiac portion into which the oesophagus opens, a fundic region and a pyloric portion which opens into the first part of small intestine
- It has two orifices (opening)



The stomach

(i) **Cardiac orifice :** It is proximal aperture of stomach which is joined by the lower end of the oesophagus.

(ii) **Pyloric orifice :** It distal aperture of stomach which opens into the duodenum.

AIIMS Advantage

- Mucous membrane of the stomach is thick. In empty stomach numerous longitudinal folds are found called gastric rugae.
- They disappear when stomach is distended. Stomach is covered by layer of peritoneum, fat tissue and lymph tissue deposits on the peritoneum.
- Such type of peritoneum are called Omentum. Left curved surface of stomach is called greater omentum. Right curved surface of stomach is called lesser omentum

✓ Compound Stomach

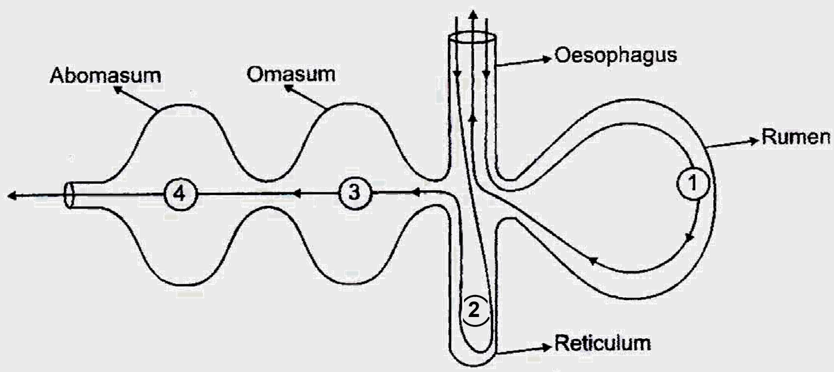
Stomach of Ruminant made of 4 chambers :

(i) Rumen → largest

(ii) Reticulum → Smallest

(iii) Omasum

(iv) Abomasum → true stomach



Gastric juice-secreted by abomasums, so it is called true stomach. Inner surface of rumen and reticulum lined by keratinised epithelium. Symbiotic bacteria found in rumen and reticulum. Voluntary muscles are found in rumen and oesophagus, hence reverse peristalsis are found in rumen and oesophagus which is controlled by will power of animal. Omasum is absent in camel and deer

Intestine

- (6 to 9 meters) : It is divided into two part -

  (i) Small intestine

  (ii) Large intestine

(i) Small Intestine – Small intestine is differentiated in to three part

  (i) Duodenum

  (ii) Jejunum

  (iii) Ileum

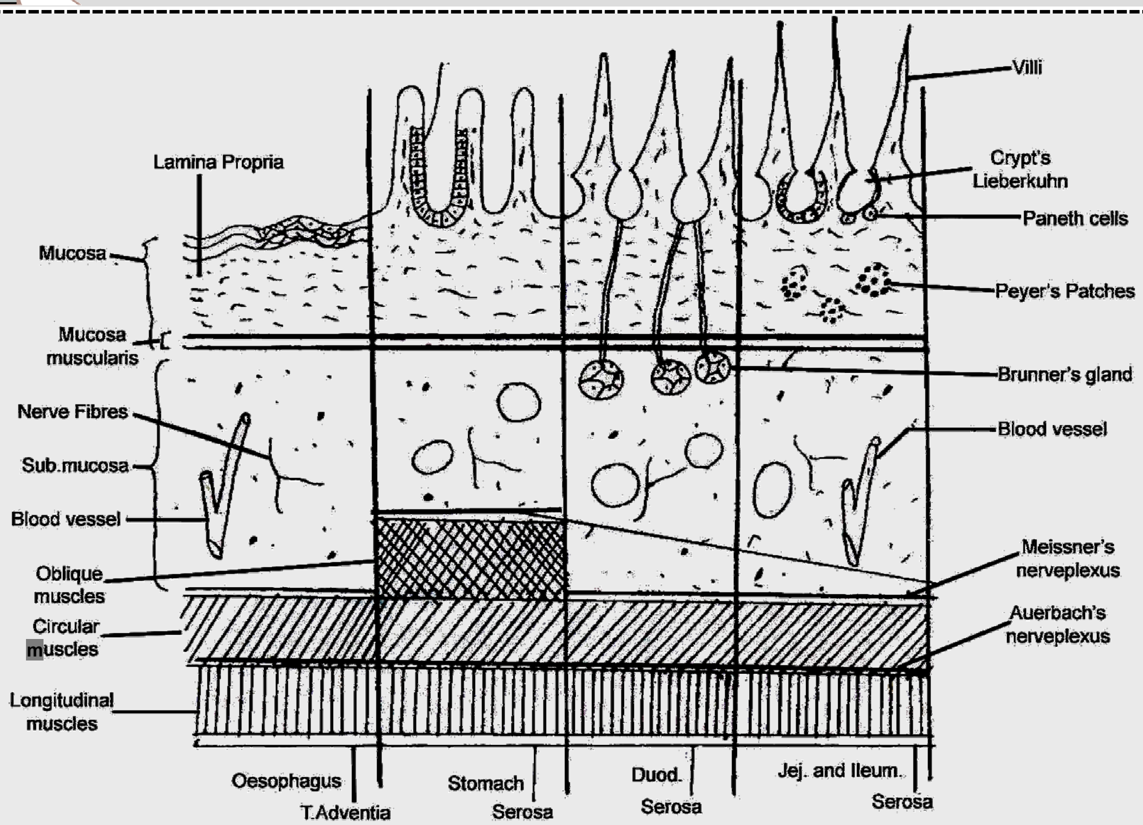
- The opening of the stomach into the duodenum is guarded by the pyloric sphincter.
- First part is **duodenum**, it is 25 cm long, c-shaped in humans and has opening of hepatopancreatic duct (bile duct + pancreatic duct)
- A small swelling is present at the opening of hepatopancreatic duct and is called 'Ampulla of Vater' or hapatopancreatic ampulla and the opening is regulated by sphincter of oddi.
- Next parts of small intestine are **jejunum** and **ileum**. The wall of intenstine has thin layers of longitudinal and circular muscles.Mucosa has folds **plicae circulare** (**folds of Kerkrings** or **Valvulae conniventes**) and **villi** towards lumen of the intestine.

- Epithelial cells lining the villi have microvilli which further increase the absorptive area. Intestinal glands or **Crypts of Lieberkuhn** have **epithelial cells** (secrete mucus), **Paneth cells** (secrete digestive enzymes) and **argentaffin cells** (probably secrete hormones).
- In duodenum Brunner's glands are also present (located in submucosa) which secrete mucus. Diffused patches of lymphoid tissue are present through out the small intestine and are aggregated in ileum to form **Peyer's patches**.

(ii) Large intestine :

- It is 1.5 m long and consists of three part **caecum**, **colon** and **rectum**. A blind pouch of caecum is a vestigial organ, **vermiform appendix**. These parts help in digestion of cellulose in herbivores. Wall of colon has sac like **haustra**.
- Histologically wall of colon has three bands of longitudinal muscles called taeniae coli. Another characteristics of colon surface is the presence of small fat filled projections called **epiploic appendages**.
- The colon part is divisible into ascending, transverse, descending and sigmoid colon. Sigmoid colon is also called as pelvic colon. Ascending colon is the smallest and is without mesentry. Last part of rectum is **anal canal** having a strong sphincter. It opens outside by anus.
- In certain conditions (like persistent constipations) rectal veins can get distanded or enlarged due to weakening of valves of it (varicosity). It leads to swollen areas called **haemorrhoids**.

AIIMS Advantage



✓ Histology of Alimentary Canal

Wall of alimentary canal is made up of four layer (outer to inner).

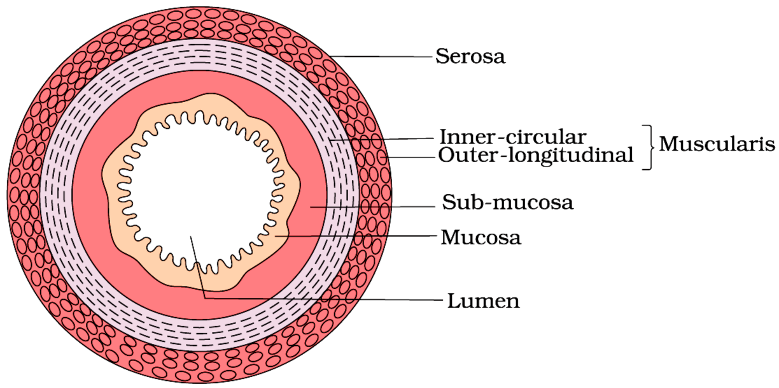


Fig. Diagrammatic representation of transverse section of gut

(1) **Serosa :** It is outer most layer of alimentary canal and is made up of a thin mesothelium (epithelium of visceral organs) with some connective tissues. It is called tunica adventia in oesophagus, which is made up of fibrous connective tissue. Except oesophagus, remaining part of alimentary canal in covered by serosa layer which is made up of visceral peritoneum while, tunica adventia is made up of white fibrous connective tissue.

(2) **Muscularis Externa or mucularis coat :** It is made up of two types of muscle outer muscle layer is made up of longitudinal muscle while inner layer is made up of circular muscle. Extra oblique muscles are found in stomach. Thickest muscular coat is found in stomach so maximum peristalsis are found in stomach least muscles are found in rectum so least peristalsis are found in rectum.

(3) **Sub mucosa :** It is made up of loose connective tissue layer with blood lymph vessels and nerves. In duodenum, glands are also present in sub-mucosa.

(4) **Mucosa :** It is the inner most layer of gut which contains the secretary and absorptive cells.

AIIMS Advantage

It is differentiated into 3 parts.

(i) Outer part : Called mucosa muscularis or muscularis interna

- It is made up to longitudinal and circular muscles.
- But these muscles are vestigial.
- They provide support to the folds of alimentary canal.

(ii) Middle part : Called lamina propria.

- It is made up of reticulate and fibrous connective tissue, dense network of blood capillaries are found in this part.

EXERCISE # 1

Q.1 If a man is allowed to live exclusively on the diet of milk, egg & bread he would suffer from - **[ST-1971]**
(1) Rickets (2) Beri-Beri
(3) Night blindness (4) Scurvey

Q.2 Deficiency of vitamin A causes – **[ST-1973]**
(1) Retarted growth
(2) Scurvy
(3) Beri-Beri
(4) Rickets

Q.3 Islets of langerhans are – **[ST-72]**
(1) Modified lymph glands
(2) Ductless glands in pancreas
(3) Specialized area in pituitary
(4) Small tubules in kidney

Q.4 Scurvy is a disease caused by – **[ST-72,73]**
(1) A virus (2) Deficiency of Vit E
(3) Def. of Vit. C (4) Def. of Vit. D

Q.5 Bilirubin and bilivirdin are found in – **[ST-73,CPMT-73]**
(1) Blood (2) Bile
(3) Saliva (4) None of these

Q.6 Vitamins are – **[ST-73, CPMT-73]**
(1) Inorganic substances and can't be synthesised by animals.
(2) Inorganic substances and can be synthesised by animals.
(3) Organic substances which cannot mostly be synthesised by animals.
(4) Organic substances which can mostly be synthesised by animals.

Q.7 Which of the following is the best source of Vit-A ? **[ST-73]**
(1) Carrot (2) Apple
(3) Peanuts (4) Honey

Q.8 Herbivorous animals can digest cellulose because **[ST-1973, CPMT-71, AIMS-81]**
(1) Their molar and premolar teeth can crunch and grind the food.
(2) Bacteria present in their caecum help in digestion of cellulose.
(3) Gastric Juice has digestive enzyme for cellulose digestion.
(4) Alimentary Canal is very long.

Q.9 Vitamin necessary for blood clotting – **[ST-73,77,CPMT-76,91,AFMC-83,BHU-83]**
(1) A (2) E
(3) C (4) K

Q.10 Dental formula of adult man is – **[ST-74, 76, CPMT-74, 81, BHU-81]**
(1) $\frac{2,1,2,3}{2,1,2,3}$ (2) $\frac{2,1,2,3}{2,1,2,2}$
(3) $\frac{2,1,2,3}{2,1,2,4}$ (4) $\frac{2,1,3,2}{2,1,3,2}$

Q.11 Islets of Langerhans are found in – **[ST-74, 75,CPMT-71,82,91]**
(1) Testis (2) Adrenal
(3) Pancreas (4) Ovary

Q.12 Vit-K is required for – **[ST-74,82,91]**
(1) Regulation of Ca and P metabolism
(2) Respiration
(3) Carbohydrate metabolism
(4) Synthesis of prothrombin in liver required

Q.13 Man needs carbohydrates as a source of energy and gets these from – **[ST-74]**
(1) Starch
(2) Cellulose
(3) Both
(4) None of these

Q.14 To keep people healthy, strong and energetic and long lived, it is necessary to provide them – **[ST-74]**
(1) high energy food
(2) large amt. of food
(3) Balanced diet
(4) Initiative and spirit

Q.15 Beri-Beri is caused due to – **[CPMT-71, BHU-83]**
(1) Def. of Vit B_1 (2) Def. of Vit B_2
(3) Det. of Vit. B_{12} (4) Def. of Vit C

Q.16 Ascorbic acid is the – **[CPMT-75, 86]**
(1) Vit-A (2) Vit-C
(3) Vit-E (4) Biotin

Q.17 Which one of these are most essential for body growth and formation of new cells – **[ST-75, CPMT-71,77,85]**
(1) Sugar (2) Fats
(3) Nucleic acid (4) Protein

Q.18 The most common concentrated source of proteins for vegetarians in our country is – **[ST-76]**
(1) Potatoes (2) Meat
(3) Eggs (4) Pulses

Q.19 Casien present in milk, which is – **[ST-76]**
(1) Bacterium (2) Sugar
(3) Protein (4) Fat

Q.20 Rumen of a cow is a part of its – **[ST-76]**
(1) Intestine (2) Stomach
(3) Caecum (4) Rectum

Q.21 The largest gland in human body is – **[CPMT-71]**
(1) Pancreas (2) Liver
(3) Thyroid (4) Pituitary

Q.22 Amylase enzyme acts on the – **[ST-77,CPMT-96]**
(1) Starch (2) Protein
(3) Fat (4) Cane sugar

Q.23 Sucrose is found in - **[ST-77]**
(1) Milk (2) Honey
(3) Sugarcane (4) Orange

Q.24 Vit A from carotene is synthesised in – **[BHU-77]**
(1) Spleen (2) Skin
(3) Pancreas (4) Liver

Q.25 Which one of the Carbohydrate is monosaccharide – **[ST-1977]**
(1) Glucose (2) Sucrose
(3) Starch (4) Cellulose

Q.26 Vitamin promoting wound healing is – **[BHU-78]**
(1) B (2) A
(3) D (4) C

Q.27 Night blindness is caused due to deficiency of Vit – **[BHU-1978,80,81,82]**
(1) B (2) C
(3) D (4) A

Q.28 The digestion of cellulose in rabbit and other herbivorous mammals takes place in – **[CPMT-71,75,77, AIMS-1981]**
(1) Vermiform appendix
(2) Colon
(3) Caecum
(4) Ileum

Q.29 Ptyalin is secreted by – **[CPMT-71]**
(1) Stomach
(2) Salivary gland
(3) Pancreas
(4) Bile

Q.30 Ptyalin, an enzyme work in saliva in – **[CPMT-71]**
(1) Alkaline medium
(2) Almost Neutral medium
(3) Acidic medium
(4) All medium

Q.31 Liver cells secrete – **[CPMT-71,75]**
(1) Amylopsin (2) Trypsin
(3) Lipase (4) Bile and no enzyme

Q.32 Which should not be eaten too much during hot months ? **[CPMT-71]**
(1) Vitamins (2) Fats
(3) Mineral salts (4) Proteins

Q.33 To get ample supply of Carbohydrates, one should eat – **[CPMT-71]**
(1) Meat (2) Gram
(3) Carrots (4) Rice

Q.34 Peristalsis found in different parts of alimentary canal. In which one of these there is least peristalsis – **[CPMT-71]**
(1) Stomach (2) Duodenum
(3) Rectum (4) Oesophagus

Q.35 In Colon, constrictions of its wall form a series of small pockets called **[CPMT-71]**
(1) Haustra
(2) Crypts of lieberkuhn
(3) Zymog en Cells
(4) Taenial

Q.36 Milk protein is curdled into calcium paracaseite by – **[CPMT-71, BHU-79]**
(1) Maltose (2) Rennin
(3) Trypsin (4) Lactose

Q.37 The enzyme invertase hydrolise – **[CPMT-72]**
(1) Glucose into sucrose
(2) Sucrose into glucose and fructose
(3) Starch into maltose
(4) Starch into sucrose

Q.38 Diastema is – **[CPMT-72]**
(1) A part of pelvic girdle in rabbit
(2) A type of tooth in rabbit
(3) Space in teeth lines in mammals
(4) Structure in eye of rabbit

Q.39 Vermiform appendix is a part of – **[CPMT-72]**
(1) Alimentary Canal
(2) Nervous System
(3) Vascular System
(4) Reproductive System

Q.40 From the point of ontogeny, liver is – **[CPMT-73]**
(1) Ectodermal
(2) Endodermal
(3) Mesodermal
(4) Ectodermal and endodermal

Q.41 Amino acids are absorbed in – **[CPMT-74]**
(1) Blood capillaries of villi
(2) Wall of rectum
(3) Lacteals and blood capillaries of villi
(4) Lacteals of villi

Q.42 Digestion of Carbohydrate is affected by – **[CPMT-75,77,79]**
(1) Amylopsin (2) Lipase
(3) Erepsin (4) Pepsin

Q.43 Trypsinogen is secreted by – **[CPMT-75]**
(1) Pancreas (2) Stomach
(3) Liver (4) Ileum

Q.44 Proteins are broken down into amino acids in– **[NCERT-73]**
(1) Buccal Cavity (2) Stomach
(3) Intestine (4) Rectum

Q.45 Which reserve a starving man first consumes– **[CPMT-75,85,88]**
(1) Fat (2) Protein
(3) Glycogen (4) Vitamin

Q.46 Ptyalin cannot work in stomach, because it becomes – **[CPMT-76]**
(1) Inactive due to HCl
(2) Inactive due to Renin
(3) Inactive due to Pepsin
(4) None of these

EXERCISE # 2

Q.1 Chymotrypsinogen is produced by **[Uttarachal 2004]**
(1) Liver (2) Pancreas
(3) Stomach (4) Duodenum

Q.2 Scurvy is caused due to deficiency of vitamin: **[Uttarachal 2005]**
(1) 'B' complex (2) C
(3) K (4) D

Q.3 Contraction of gall bladder is carried by : **[Uttarachal 2004]**
(1) citric acid + acetyl Co-A
(2) gastrin
(3) cholecystokinin
(4) none of these

Q.4 In human teeth, which help in cutting **[Bihar 2004]**
(1) Canine (2) Incisor
(3) Molar (4) Premolar

Q.5 HCl is secreted by which of the following cell of stomach **[Bihar 2004]**
(1) Chief cells
(2) Parietal cell (Oxyntic cells)
(3) Peptic cells
(4) Goblet cells

Q.6 Fatty liver syndrome is due to excessive intake of **[Bihar 2003]**
(1) Morphine (2) Alcohol
(3) Tobacco (4) both 1 and 2

Q.7 Enterogastrone is present in :
(1) Stomach (2) Small intestine
(3) Oesophagus (4) Both 1 and 2

Q.8 Carnesial teeth are modified for : **[Bihar 2006]**
(1) Crushing (2) Tearing
(3) Grinding (4) Cutting

Q.9 Glisson's capsules are present in **[UP CPMT 2003]**
(1) Liver (2) Lung
(3) Kidney (4) Stomach

Q.10 Osteomalacia occurs due to the deficiency of **[UP CPMT 2001]**
(1) Vitamin A (2) Vitamin B
(3) Vitamin C (4) Vitamin D

Q.11 Pulp cavity of teeth is lined by **[UP CPMT 2002]**
(1) Odontoblast (2) Chondroblast
(3) Osteoblast (4) Amyloblast

Q.12 Secretion of gastric juice is controlled by **[UP CPMT 2002]**
(1) Gastrin (2) Chlolecystokinin
(3) Enterogastrin (4) None of these

Q.13 Enzyme present in saliva is **[UP CPMT 2003]**
(1) Maltase (2) Ptyalin
(3) Sucrase (4) Invertase

Q.14 Which of the following metal is present in vitamin B_{12} **[UP CPMT 2003]**
(1) Cobalt (2) Copper
(3) Zinc (4) Magnesium

Q.15 Kupffer cells are present in **[UP CPMT 2003]**
(1) Liver (2) Pancreas
(3) Small intestine (4) Large intestine

Q.16 Teeth of rabbits are **[UP CPM 2004]**
(1) Thecodont (2) Diphyodont
(3) Heterodont (4) All of these

Q.17 Crypts of lieberkuhn are present in : **[UP CPMT 2006]**
(1) Intestine (2) Stomach
(3) Oesophagus (4) All of these

Q.18 Succus entericus is also called : **[UP CPMT 2006]**

(1) Gastric juice (2) Intestine juice
(3) Bile juice (4) Saliva

Q.19 Dental formula of rabbit is : **[UP CPMT 2007]**

(1) $\frac{2}{1}\frac{0}{0}\frac{3}{2}\frac{3}{3}$ (2) $\frac{2}{1}\frac{1}{0}\frac{3}{2}\frac{3}{3}$
(3) $\frac{2}{1}\frac{0}{0}\frac{2}{2}\frac{3}{3}$ (4) $\frac{1}{1}\frac{3}{2}\frac{0}{0}\frac{3}{3}$

Q.20 Deamination occurs in **[UP CPMT 2007]**

(1) Kidney (2) Liver
(3) Nephron (4) Both 1 and 2

Q.21 Digestion of protein is completed in **[UP CPMT 2007]**

(1) Stomach
(2) Duodenum
(3) Ileum
(4) Duodenum and ileum

Q.22 Enterogasterone is **[UP CPMT 2007]**

(1) Hormone secreted by mucosa
(2) Enzyme secreted by mucosa
(3) Hormone secreted by duodenal mucosa
(4) Secreted by endocrine gland related to digestion

Q.23 Part of bile juice useful in digestion is **[UP CPMT 2007]**

(1) Bile salt (2) Bile pigment
(3) Bile matrix (4) All of them

Q.24 bile secretion is proportional to the concentration of **[MP PMT 2007]**

(1) Protein (2) Fat
(3) Carbohydrate (4) None of these

Q.25 Secretion of pancreatic juice is stimulated by **[MP PMT 2007]**

(1) Gastrin (2) Secretin
(3) Enterogastrone (4) Enterokinase

Q.26 Just as hydrochloric acid is for pepsinogen, so is the : **[MP PMT 2004]**

(1) haemoglobin oxygen
(2) enterokinase to trypsinogen
(3) bile juice to fat
(4) glucagons to glycogen

Q.27 What is the function of goblet cells **[MP PMT 2004]**

(1) Production of enzyme
(2) Production of mucin
(3) Production of hormone
(4) Production of HCl

Q.28 Where the lysozymes are found **[MP PMT 2004]**

(1) In saliva and tears both
(2) In tears
(3) In saliva
(4) In mitochondria

Q.29 The hormone which lowers the secretion of hydro chloric acid and gastric juice is **[MP PMT 2005]**

(1) Secretin (2) Enterogastrone
(3) Enterokinin (4) Gastrin

Q.30 Which of the following is different from other ? **[MP PMT 2005]**

(1) Gastrin (2) Ptyalin
(3) Glucagon (4) Secretin

Q.31 Trypsin differs from pepsin because it digests : **[MP PMT 2005]**

(1) Carbohydrate in alkaline medium in stomach
(2) Protein, in alkaline medium in stomach
(3) Protein, in acidic medium of stomach
(4) Protein, in alkaline medium in duodenum

Q.32 Pancreatic juice is : **[MP PMT 2005]**

(1) Alkaline in nature
(2) Acidic in nature
(3) Enzymatic in nature
(4) Both acidic and alkaline in nature

ANSWER KEY

EXERCISE # 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	2	3	2	3	1	2	4	1	3	4	1	3	1	2	4	4	3	2
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	3	4	1	4	4	3	2	2	4	2	4	3	1	2	2	3	1	2
Ques.	41	42	43	44	45	46														
Ans.	1	1	1	3	3	1														

EXERCISE # 2

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	2	3	2	2	2	4	1	1	4	1	1	2	1	1	4	1	2	1	4
Ques.	21	22	23	24	25	26	27	28	29	30	31	32								
Ans.	4	3	4	2	2	2	2	1	2	2	4	1								