POLYCET - 2025

PHYSICS

STUDY MATERIAL

Contents

1.REFLECTION OF LIGHT

CHAPTER AT A GLANCE

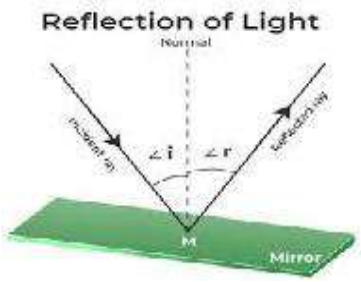
- A transparent substance in which light can travel is called an optical medium.
  Ex: air, water, alcohol, glass etc….
- The material which do not allow light to pass through them are called opaque bodies
  Ex: brick, wood, iron plate……
- A medium in which speed of light is more is said to be optically **rarer medium.**
- A medium in which speed of light is less is said to be optically **denser medium**.
- One can be said either denser or rarer on comparison with another medium.

Speed of light in different media:

Medium	Speed (in m/s)
Vaccum or air	3×10^8
Water	2.25×10^8
Glass	2×10^8
Diamond	1.24×10^8

Reflection of light:

- When a ray of light falls on a smooth polished surface and the light ray bounces back, it is called **the reflection of light**.
- The ray that bounces back is called the reflected ray.



A highly polished surface, such as a mirror, reflects most of the light falling on it.

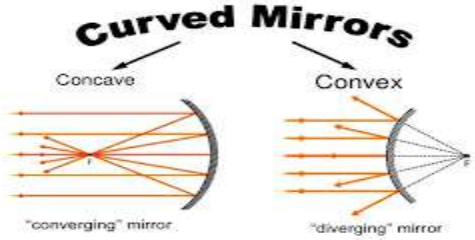
Laws of reflection:

(i) The angle of incidence is equal to the angle of reflection, $\angle i = \angle r$ and
(ii) The incident ray, the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane.

- **For plane mirror**, The size of the image is equal to that size of the object.
- The image is virtual and image
- The image formed is as far behind the mirror as the object is in front of it.
- The image is laterally inverted.

SPHERICAL MIRRORS:

- A spherical mirror, whose reflecting surface is curved inwards, that is, faces towards the centre of the sphere, is called **a concave mirror**
- A spherical mirror whose reflecting surface is curved outwards, is called **a convex mirror**



- The centre of sphere to which a spherical mirror belongs, is called **centre of curvature** (3).
- The geometric centre of the mirror is **pole (P) of the mirror**.
- a straight line passing through the pole and the centre of curvature of a spherical mirror is called the **principal axis.**
- The distance between pole and centre of curvature is called the **radius of curvature**(R) of the mirror.
- The rays which are parallel to the principal axis of a concave mirror on reflection meet at **focus or focal point**
- The distance between pole and focus is called **focal length(f).**
- The diameter of the reflecting surface of spherical mirror is called its aperture.
- The relation between radius of curvature (R) and focal length (f) is given by
- **R = 2f**

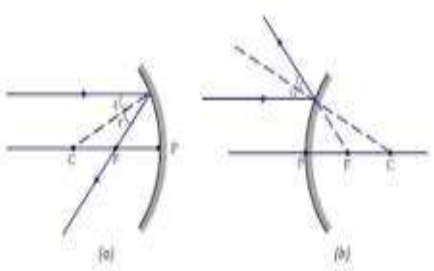
Where R is Radius of curvature and

f is the foal length of spherical mirror.

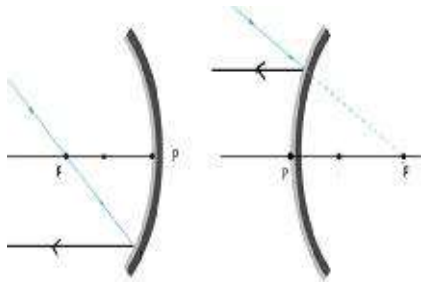
Rules for Image Formation by Spherical Mirrors:

(i) A ray parallel to the principal axis, after reflection,will**pass through the principal focus** as shown in fig(i)

(ii) A ray passing through the principal focus of a concave mirror , after reflection, **will emerge parallel to the principal axis.** ……fig(ii)



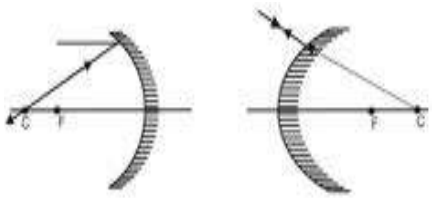
Fig(i)



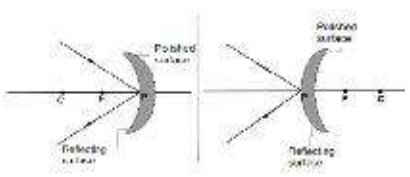
fig(ii)

(iii) A ray passing through the centre of curvature of a concave mirror, after reflection, is **reflected back along the same path**……..fig(iii)

(iv) A ray incident obliquely to the principal axis is **reflected obliquely**…….fig(iv)



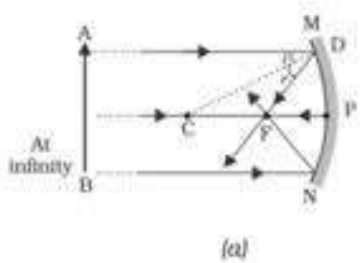
fig(iii)



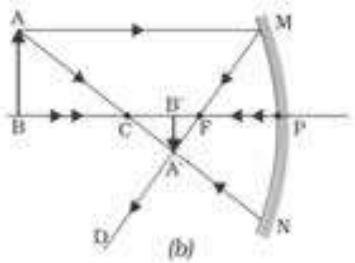
fig(iv)

IMAGES FORMATION OF CONCAVE MIRRORS FOR VARIOUS POSITIONS OF OBJECT

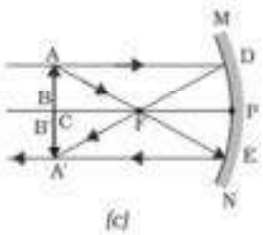
Position of the object	Position of the image	Position of the image	Nature of the image
1) At infinity	Focal point	Highly diminished	Real and Inverted (*fig* 1)
2) beyond centre of curvature C	Between C and F	Point size, diminished	Real and Inverted (*fig* 2)
3) At the centre of curvature C	At C	Same size	Real and Inverted (*fig* 3)
4) between centre of curvature and focal point C and F	Beyond centre of curvature	Magnified	Real and Inverted (*fig* 4)
5) At focal point F	At infinity	Highly Magnified	Real and Inverted (*fig* e)
6) Between focal point F and pole (P)	On the same side of the mirror of the object	Magnified	Virtual and erect (*fig* f)



(a)



(b)



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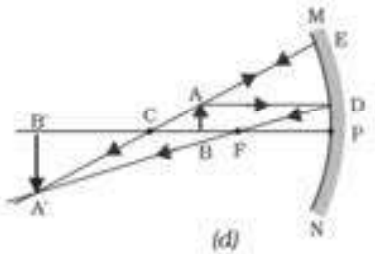
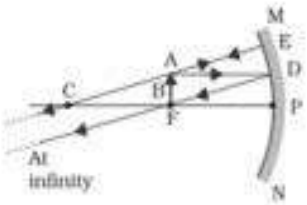
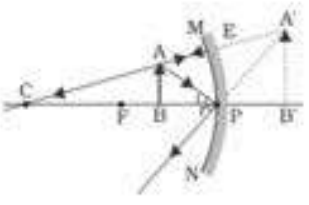


(d)

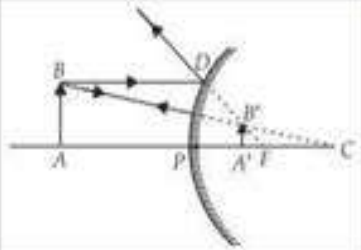
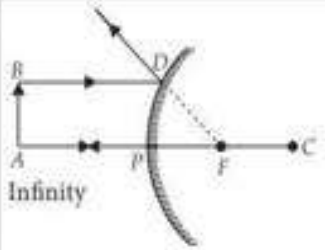


(e)

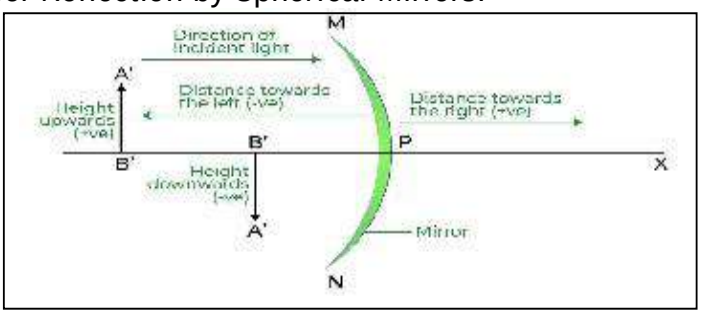


(f)

Images formation of convex mirror for various positions of object

	Ray diagram	Object position	Image position	Nature of image
(a)		Between infinity and the pole	Behind the mirror between the focus and the pole	Virtual, smaller and erect
(b)		At infinity	Behind the mirror at the focus *F*	Virtual, point-sized and erect

Sign Convention for Reflection by Spherical Mirrors:



- **Mirror formula:** $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$

Where u = object distance, v = image distance and f = focal length

Magnification(m):

It is expressed as the ratio of the height of the image to the height of the object.

$$m = \frac{Height\ of\ the\ image\ (h^1)}{Height\ of\ the\ object(h)} = \frac{h^1}{h}$$

The magnification m is also related to the object distance (u) and image distance (v).

$$\text{Magnification (m)} = \frac{h^1}{h} = -\frac{v}{u}$$

- For a convex mirror, *m* is +ve and less than one, as the image formed is virtual, erect and shorter than the object.
- For a concave mirror, *m* is +ve when image formed is virtual and *m* is –ve, when image formed is real.

Uses of Concave mirrors

- **Headlights**: Used in vehicles to focus light and illuminate a large area on the road
- **Shaving mirrors**: Used to magnify the reflection of the face
- **Solar furnaces**: Used to focus sunlight to create heat
- **Torches**: Used to reflect light

- **Makeup mirrors**: Used to magnify the reflection of the face
- **Ophthalmoscopes**: Used to illuminate the retina of the eye
- **Microscopes**: Used to focus light on specimens
- **Telescopes**: Used to gather and focus light to observe distant objects

Uses of Convex mirrors

- **Rear-view mirrors**: Used in vehicles to provide a wide field of view
- **Magnifying glasses**: Made by placing two convex mirrors back to back
- **Dental mirrors**: Used in dentistry.
- **Street light reflectors**: Reflect light from street lights

MULTIPLE CHOICE QUESTIONS

1. Focal length of plane mirror is
(a) At infinity (b) Zero (c) Negative (d) None of these

2. Image formed by plane mirror is
(a) Real and erect (b) Real and inverted
(c)Virtual and erect (d) Virtual and inverted

3. A concave mirror gives real, inverted and same size image if the object is placed
(a) At F (b) At infinity (c) At C (d) Beyond 'C'

4 . The laws of reflection hold good for
(a) Plane mirror only (b) Concave mirror only
(c) Convex mirror only (d) All mirror irrespective of their shape

5. The optical phenomena, twinkling of stars is due to
(a) atmospheric reflection (b) Total reflection
(c) atmospheric refraction (d) Total refraction

6. The magnification of 'X' is more than unity. Identify X.
(a) Convex mirror (b) Concave mirror (c) Plane mirror (d) Prism

7. An object of 10 cm in size placed at 20 cm in front of a concave mirror of focal length 10 cm, then the size of the image formed is……..
(a) 10 cm (b)5 cm (c) 20 cm (d) 15 cm

8. Concave mirror focus a real, point sized image at focus, the object is placed
(a) At focus (b) Between F and p (c) At infinity (d) At P

9. The unit of focal length of mirror is
(a) $centimeter^{-1}$ (b) Centimetre (c) Dioptre (d) M^{-1}

10. The radius of curvature of a mirror is 20cm the focal length is
(a) 20cm (b) 10cm (c) 40cm (d) 5cm

11. The distance between the pole and the centre of curvature of a convex mirror is called
(a) focal length (b) object distance
(c) image distance (d) radius of curvature

12. If i and r be the angle of incidence and angle of reflection respectively, which one is correct for plane mirrors?
(a) i = r (b) i< r (c) i > r (d) None of the above

13. If u, v and f are the object distance, image distance and the focal length respectively, then the mirror formula is given by
(a) $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ (b) $\frac{1}{v}+\frac{1}{u}=\frac{1}{2f}$ (c) $\frac{1}{f}$ = u + v (d) $\frac{1}{f}$ = u - v

14. A light ray incidents on a plane mirror at an angle of 33°. Then what is the angle of reflection
(a) 33° (b) 66° (c) 22° (d) 16.5°

15. **The diameter of the reflecting surface of spherical mirror is called**
(a) focal length (b) pole (c) aperture (d) radius of curvature
16. **The negative sign in magnification indicates that the image is**
(a) erected (b) inverted (c) real (d) virtual
17. **If R is radius of curvature of mirror and f is the focal length, then**
(a).R = f (b) R = 2f (c) R = f/2 (d) R + 2f = 0
18. **Type of mirror used by dentists is**
(a)Convex mirror (b) Concave mirror (c) Plane mirror (d) None
19. **A spherical mirror whose reflecting surfaces curved outwards is……..**
(a) Convex mirror (b) Concave mirror (c)Plane mirror (d) None
20. **When a girl of 4 feet height sees her image in the plane mirror, the size of her image (in feet)**
(a) 8 (b) 4 (c) 1 (d) 2

KEY

1.a	2.c	3. c	4.d	5.c	6.b	7.a	8.c	9.b	10.b
11.d	12.a	13. a	14.a	15.c	16.b	17.b	18.b	1 9.a	20.b

PREVIOUS POLYCET QUESTIONS

1. **The image formed by concave mirror when the object is held at a distance less than the focal length is**
(a). Erect (b) virtual and inverted (c) inverted (d)None
2. **The property of which mirror when the object is held close less than the focal length is used as a shaving mirror**
(a) plane Mirror (b) convex mirror (c) concave mirror (d)none
3. **Mirror used by dentists is**
(a) concave mirror (b) convex mirror (c) Plane mirror (d)None
4. **Which mirror focuses the parallel sun rays at the focal point of the mirror**
(a) convex mirror (b) concave mirror (c) Any mirror (d) plane mirror
5. **Solar cooker works on the property of which mirror?**
(a) concave mirror (b) convex mirror (c) Plane mirror (d)None
6. **Archimedes burnt the ships using which property of concave mirror?**
(a) Parallel rays converge at focal point of the mirror
(b) Parallel rays diverge from pole
(c) Deviated from centre of curvature after reflection
(d) None of the above.
7. **A full-length image of a distant tall building can definitely by seen by using**
(a) A concave mirror (b) A convex mirror
(c) A plane mirror (d) Both concave as well as plane mirror
8. **In torches, search lights and headlights of vehicles, the bulb is placed**
(a) Between the pole and the focus of the reflector.
(b) Very near to the focus of the reflector.
(c) Between the focus and centre of curvature of the reflector.
(d) At the center of curvature of the reflector.

9. Magnification produced by a rear view mirror fitted in vehicles:
(a) is less than one (b) is more than one
(c) is equal to one
(d) can be more than or less than one, depending upon the position of the object in front of it

10. A student conducts an activity using a flask of height 15 cm and a concave mirror. He finds that the image formed is 45 cm in height. What is the magnification of the image
(a) -3 times (b) -1/ 3 times (c) 1/ 3 times ((d) 3 times

11. When a plane mirror is rotated through a certain angle, the reflected ray turns through twice as much and the size of the image:
(a) is doubled (b) is halved (c) becomes infinite (d) remains the same

12. Which of the given is NOT paired correctly
(a) Solar furnace-concave mirror (b) Rear -view mirror-convex mirror
(c) Magnifying glass -convex lens (d) None of these

13. Two big mirrors A and B are fitted side by side on a wall. A man is standing at such a distance from the wall that he can see the erect image of his face in both the mirrors. When the man starts walking towards the mirrors, he finds that the size of his face in mirror A goes on increasing but that in mirror B remains the same:
(a) Mirror A is concave and mirror B is convex
(b) Mirror A is plane and mirror B is concave
(c) Mirror A is concave and mirror B is plane
(d) Mirror A is convex and mirror B is concave

14. An object is placed at 100 mm in front of a concave mirror which produces an upright image (erect image). The radius of curvature of the mirror is:
(a) Less than 100 mm (b) Between 100 mm and 200 mm
(c) Exactly 200 mm (d) More than 200 mm

15. The radius of curvature of a mirror is 20cm the focal length is
(a) 20cm (b) 10cm (c) 40cm (d) 5cm

16. A full length image of a distant tall building can definitely be seen by using
(a) a concave mirror (b) a convex mirror
(c) a plane mirror (d) both concave as well as plane mirror

17. A 10 mm long awl pin is placed vertically in front pin is formed at 30cm in front of the mirror. The focal length of this mirror is:
(a) -30 cm (b) -20 cm (c) -40 cm (d) -60 cm

KEY

1.d	2.c	3. a	4.b	5.a	6.a	7.b	8.b	9.a	1O.a
11.d	1 2.d	13. c	1 4.d	15.b	16.d	17.b			

* * *

2. REFRACTION OF LIGHT AT PLANE SURFACES

CHAPTER AT A GLANCE

Refraction of light:

- The process of changing speed at an interface when light travels from one medium to another resulting in a change in direction in another medium.

OR

- The bending of light ray when it is travelling from one medium to another medium is called Refraction
  (i) In refraction, speed of light changes at the interface.
  (ii) The direction of light ray changes from one medium to another medium.

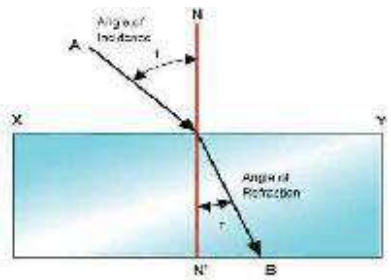


Fig : shows light travelled from rarer to denser medium.

- When light travels from rarer medium (air) to denser medium (glass), Light bends towards the normal in the denser medium, i.e wave length decreases as speed of light decreases.
- Angle of refraction(r) is lesser than angle of incidence(i).(i > r)

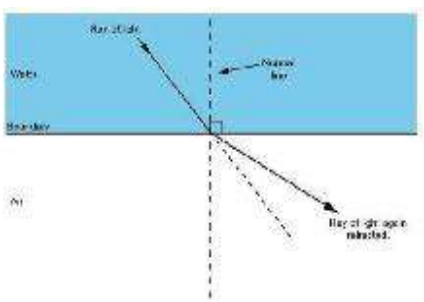


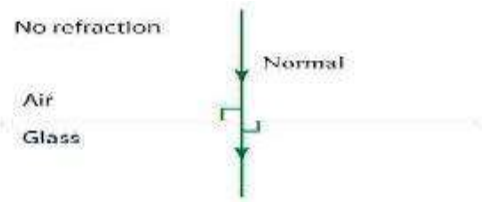
Fig : shows light travelled from denser to lighter medium

- When light travels from denser medium (glass) to rarer (air) then, Light bends away from the normal in rarer medium. i.e wavelength increases as speed of light increases.
  - Angle of refraction(r)is greater than the angle of incidence(i) .(i< r)

Examples of refraction:

(1) The pencil appears to be bent when it is placed in a bucket filled with water.
(2) A coin kept at the bottom of a vessel filled with water appears to be raised.
(3) A lemon kept in a glass of water appears to be bigger than it so original size.
(4) The printed letters below the glass lab appears to be raised.

- No bending of light when incidents normally at the interface of two media.



Refractive Index:

- Refractive index is a property of transparent medium.
- Refractive index is a **dimensionless** quantity.
- Absolute Refractive index $=\frac{\text{Speed of light in vacuum(c)}}{\text{Speed of light in medium(v)}}$

$$\mathbf{n=\frac{c}{v}}$$

- If refractive index is **high,** speed of light in medium is **low.**
- Refractive index depends on 1) nature of material, 2)wave length of light

Relative Refractive index (n_r)$=\frac{speed\ of\ light\ in\ medium\ 1}{speed\ of\ light\ in\ medium\ 2}=\frac{v_1}{v_2}$

$$n_r=\frac{n_2}{n_1}=\frac{Refractive\ index\ of\ second\ medium\ (n_2)}{Refractive\ index\ of\ first\ medium\ (n_1)}$$

- Refractive index of glass $=\frac{speed\ of\ light\ in\ air}{speed\ of\ light\ in\ glass}$

$$=\frac{3\times10^8\ m/s}{2\times10^8\ m/s}=3/2=\mathbf{1.5}$$

- Refractive index of water $=\frac{speed\ of\ light\ in\ air}{speed\ of\ light\ in\ water}$

$$=\frac{3\times10^8\ m/s}{2.25\times10^8\ m/s}=4/3=\mathbf{1.33}$$

- The refractive index of ice is **1.31**
- The refractive index of diamond is **2.42**
- The refractive index of Alcohol is **1.36**

Laws of refraction :

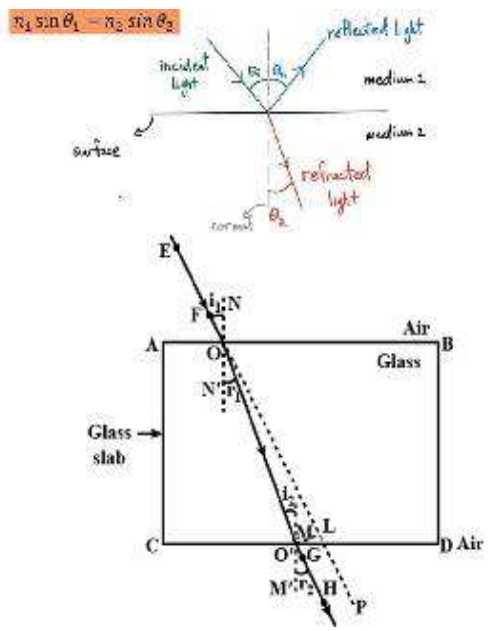
(i) The incident ray, the refracted ray and the normal to the interface of two transparent media, all lie on the same plane at the point of incidence.

(ii) Light follows Snell's law in refraction.

Snell's law :

$$\frac{Sin\, i}{Sin\, r} = \frac{n_2}{n_1} = \frac{v_1}{v_2} = \text{Constant.}$$

Refraction through a Rectangular Glass Slab:



When a ray of light passes through a rectangular glass slab, it bends twice, once when it enters the glass and again when it exits. The emergent ray is parallel to the incident ray.

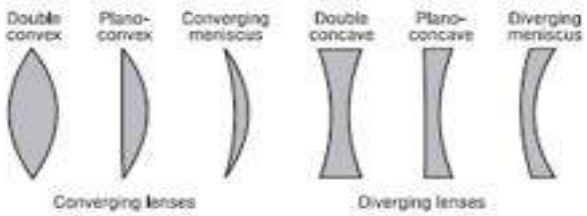
- Light bends towards the normal when it passes from air to glass because glass is denser than air.
- The light bends away from the normal when it passes from glass to air.
- The extent of bending at the opposite parallel faces of the glass slab is equal and opposite.
- The emergent ray is parallel to the incident ray because of this.
- The perpendicular distance between the incident ray and the emergent ray is called the lateral displacement.

REFRACTION OF LIGHT AT CURVED SURFACES

- A transparent material bound by two surfaces, of which one or both surfaces are spherical, forms a lens.
- The glasses used in spectacles and that by a watchmaker are examples of lenses.

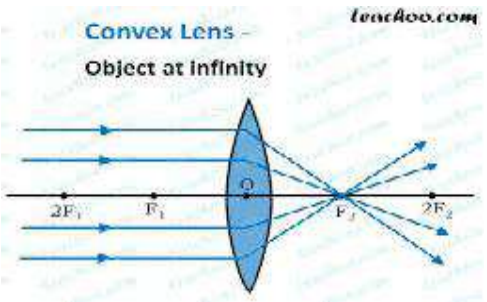
- Lens works on the principle of **Refraction of light** , meaning that when light travels from one medium to another with a different density and it bends at the boundary.
- Consider a curved surface which is a part of a sphere. The centre of the sphere is called centre of curvature (C).
- Depending on their curvature, lenses can be convex (converging light) or concave (diverging light).

Types of lens



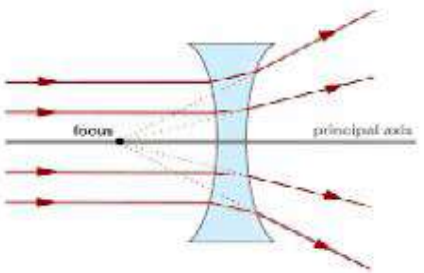
Double convex lens:

- It may have two spherical surfaces bulging outside
- It is called double convex lens or biconvex lens
- It is thick at the middle and thin at the edges
- It is called converging lens because it converges the rays of light falling on it.



Double concave lens:

- It may have two spherical surfaces (inward curved surfaces)
- It is called double concave lens or biconcave lens
- It is thin at the middle and thick at the edges
- It is called diverging lens because it diverges the rays of light falling on it.

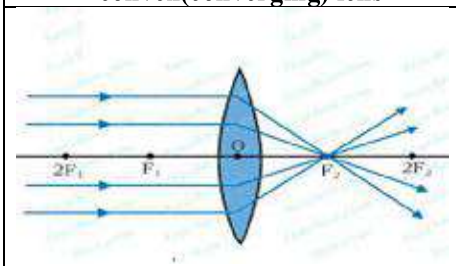
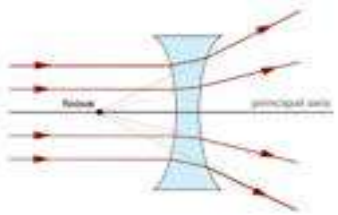


Centre of curvature:

- The centre of sphere contains lens part is called **centre of curvature (C**).
- The distance between curved surface and centre of curvature is called **Radius of curvature** (R).
- If the lens contains two curved surfaces, it will have two centre of curvatures namely C_1 and C_2.
- The line joining between two centres is called **principal axis**.
- The midpoint of the lens is called **optic centre**(P).

- The point of convergence or divergence where the rays appear to be meet is called Focus (F) of focal point
- The distance between optic centre and focal point is called focal length (f).
- The focal points are equidistant from the centre and pole of the lens.
  The distance between two focal points = $2F_1$ =$2F_2$.

Sign Convention for Spherical Lenses

convex(converging) lens	concave(diverging) lens
	
$R_1 \rightarrow +ve, U \rightarrow +ve$ $R_2 \rightarrow -ve, V \rightarrow -ve$ $f \rightarrow +ve$	$R_1 \rightarrow -ve, U \rightarrow +ve$ $R_2 \rightarrow +ve, V \rightarrow +ve$ $f \rightarrow -ve$

When a light ray incident on a lens:

- A ray is **undeviated** when passes through principal axis.
- A ray is **undeviated** when it passes through the optic centre. Fig(ii)
- The rays travelling parallel to principal axis **converge at the focus or diverge from the focus.** Fig(i)
- The light rays obeys the **principle of least time.**
- The ray passing **through the focus after refraction** will take a path parallel to principal axis. fig(iii)

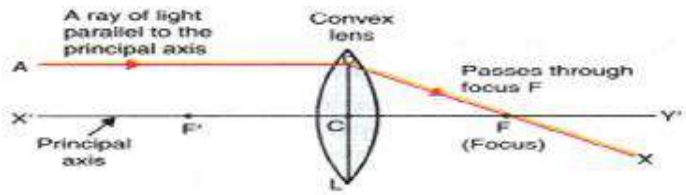
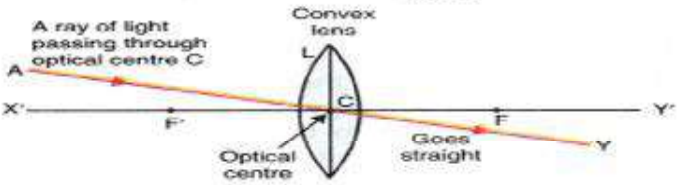
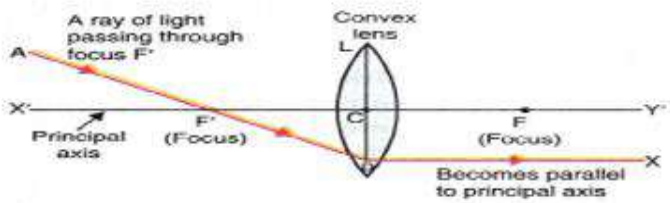


fig (i)



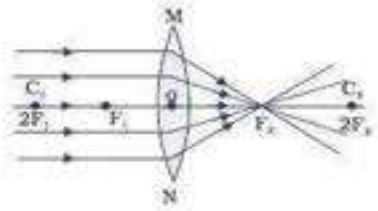
fig(ii)



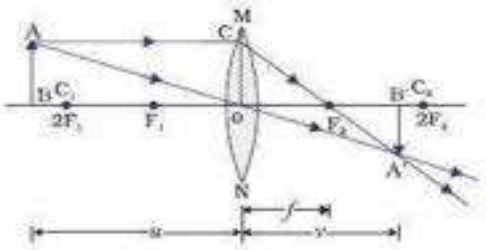
fig(iii)

IMAGES FORMATION OF CONVEX LENS FOR VARIOUS POSITIONS OF OBJECT

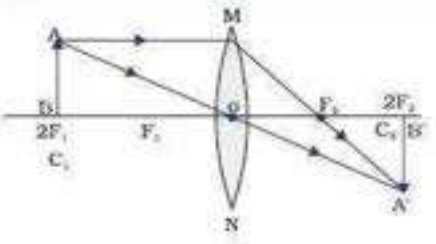
Position of the object	Position of the image	Position of the image	Nature of the image
1) At infinity	Focal point	Highly diminished	Real and Inverted **(fig i)**
2) beyond centre of curvature (C_1)	Between $F_2 and C_2$	Point size diminished	Real and Inverted **(fig ii)**
3) At the centre of curvature (C_1)	At C_2	Same size	Real and Inverted **(fig iii)**
4) between centre of curvature and focal point ($C_1 and F_1$)	Beyond centre of curvature	Magnified	Real and Inverted **(fig iv)**
5) At focal point F_1	At infinity	Highly Magnified	We can't say about size and nature of image **(fig v)**
6) Between focal pointF_1 and optic centre (O)	On the same side of the lens of the object	Magnified	Virtual and erect **(fig vi)**



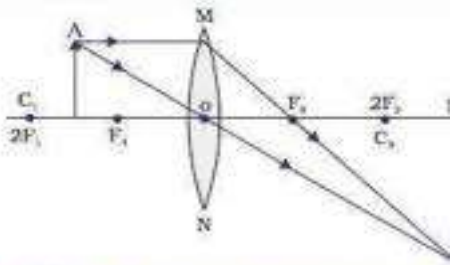
Case (i) Object at infinity



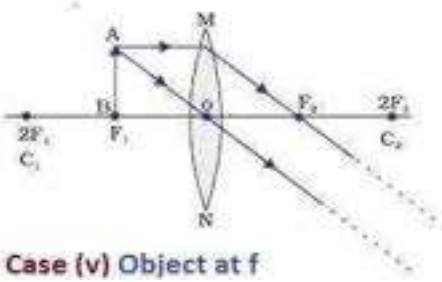
Case (ii) Object at beyond 2f



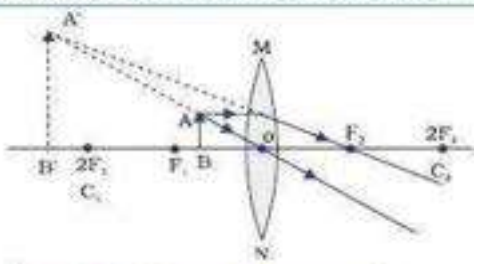
Case (iii) Object at 2f



Case (iv) Object in between f and 2f



Case (v) Object at f



Case (vi) Object distance < f

IMAGES FORMATION OF CONCAVE LENS FOR VARIOUS POSITIONS OF OBJECT

Position of the object	Position of the image	Position of the image	Nature of the image
At infinity	At F_2	Highly diminished and point size	virtual and erect
Between optical centre and infinity	Between optical centre and F_2	Diminished	virtual and erect

LENS FORMULA:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

Where u= object distance, v= image distance and f= focal length.

- **Magnification(m):**

It is expressed as the ratio of the height of the image to the height of the object.

$$m = \frac{Height\ of\ the\ image\ (h^1)}{Height\ of\ the\ object(h)}$$

The magnification m is also related to the object distance (u) and image distance (v).

$$\text{Magnification (m)} = \frac{h^1}{h} = -\frac{v}{u}$$

Power of lens:

- It is reciprocal of focal length of the lens i.e,
- $P = \frac{1}{f} = \frac{100}{f(cm)}$
- It is positive for a convex lens and negative for a concave lens.
- S.I unit of power is **dioptre(D).**
- Convex lens are used **as magnifying glasses** in cameras, spectacles and microscopes etc.
- Concave lenses are sometimes combined with other lenses **in telescopes** to produce clear images of distant objects. They are also used in microscopes and eye glasses.
- The net power (P) of the lenses placed in contact is given by the algebraic sum of the individual powers P_1, P_2, P_3, ... as

$$P = P_1 + P_2 + P_3 + \ldots\ldots\ldots\ldots$$

MULTIPLE CHOICE QUESTIONS

1. Kerosene is optically ..... than water
(a) rarer (b) denser (c) dilute (d) higher

2. If the relative index of the medium is high then the speed of light is
(a) 0 (b) 1 (c) very High (d) low

3. The angle of incidence at which light ray does not undergo refraction is
(a) 45^0 (b) 90^0 (c) 0^0 (d) 120^0

4. When light ray travels denser to rarer medium them if i and r be angle of incidence and refraction
(a) r > i (b) r < i (c) r =i (d) None

5. The velocity of light in a diamond with refractive index is "2"
(a) 3×10^8 m/s (b) 2×10^8 m/s (c) 1.5×10^8 m/s (d)10^8 m/s

6. Refractive index of ice is .....
(a) 1.31 (b) 1.44 (c) 1.52 (d) 2.42

7. Refractive index of the medium depends upon
(a) Nature of the material (b) Wavelength of the light
(c) Both a & b (d) None

8. Refractive index of a medium is directly proportional to
(a) Optical density of the medium (b) frequency of the light ray
(c) Mass of the medium (d) All the above

9. Relative refractive index n_{21}= .....
(a) v_1/v_2 (b) v_2/v_1 c) n_1/n_2 (d) c/v

10. Snell's law says
(a) $n_1 \sin i = n_2 \sin r$ (b) $n_1 \sin r = n_2 \sin i$ (c) $n_1/n_2 = \sin i.\sin r$ (d) $\sin i / \sin r = n_1.n_2$

11. The focal length of a lens depends on .....
(a) Radius of curvature (b) Material of the lens
(c) Medium in which the lens is placed (d) All the above

12. An air bubble inside water behaves as a ..... lens
(a) Bi convex lens (b) Plano convex lens (c) Bi concave lens (d) Plano concave lens

13. ..... lens always forms a diminished and erect image of an object.
(a) Bi convex (b) Bi concave (c) a& b (d) none

14. The ratio of the size of the image to the size of object is called .....
(a) Magnification (b) Power (c) Transformation ratio (d) focal length

15. The image formed by a convex lens is virtual erect and larger than the object. The position of the object must be .....
(a) at F (b) between F & 2F (c) at 2F (d) beyond 2F

16. A real, inverted enlarged image is formed by a convex lens when the object is placed.
(a) at F (b) between F & 2F (c) at 2F (d) beyond 2F

17. If the object is moved towards a convex lens the size of its image .....
(a) Decreases (b) Increases
(c)First decrees and then increases (d) Remains the same

18. The image formed by a concave lens is .....
(a) Always virtual and diminished (b) Always virtual and enlarge
(c) Always real (d) Sometimes real and sometimes virtual

19. A real image formed by a convex lens is always .....
(a) On the same side of the lens as the object (b) Erect
(c) inverted (d)Smaller than the object

20. Reciprocal of focal length in meters is .....
(a) Focus (b) Power (c) Four Point (d) Radius of Curvature

21. S.I unit of power of the lens is .....
(a) Dioptre (b) cm (c) m (d) Watt

22. A convex lens has a focal length 50cm its power is .....
(a) 2D (b) 5D (c) 0.5D (d) 0.02D

23. Magnification of a concave lens is .....
(a) Always less than unity (b) Always equal to unity
(c) Always greater than unity (d) None of these

24. A doctor has prescribed Corrective lens of power + 1.5 D. The focal length of the lens is .....
(a) 56cm (b) 66cm (c) 33cm (d) 42cm

25. A convex lens has focal length of 20cm. At What distance from the lens should be place. So that the image is formed at 40cm on the other side of the lens
(a) – 20cm (b) +20cm (c) 40cm (d) -40cm

26. Lens formula is given by
(a) $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ (b) $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ (c) $f = \frac{uv}{u+v}$ (d) None of these

27. The magnifying glass forms .....
(a) A real and Diminished image (b) A real and magnified image
(c) A virtual and magnified image (d)) A virtual and Diminished image

28. A convex lens of focal length 20cm is cut in to two halves along principal axis then focal length of each part will be .....
(a) 20cm (b) 10cm (c) 40cm (d) 60cm

29. If focal length of lens is doubled then the power of lens will be .....
(a) The power gets halved (b) The power gets doubled
(c) The power will remain unchanged (d) None of these

30. The rays from distant object falling on the convex lens pass through .....
(a) Centre of curvature (b) Principal focus (c) Optical centre (d) None of these

KEY

1.a	**2.d**	**3. b**	**4.a**	**5.c**	**6.a**	**7.c**	**8.a**	**9.c**	**1O.a**
11.d	**12.c**	**13. b**	**1 4.a**	**15.c**	**16.b**	**17.b**	**18.a**	**1 9.a**	**2O.b**
21.a	**22.a**	**23. a**	**24.b**	**25.d**	**26.a**	**27.c**	**28.a**	**29.a**	**3O.b**

PREVIOUS POLYCET QUESTIONS

1. The number of focal points ,that every lens has
(a) 4 (b) 3 (c) 2 (d) 1

2. a convex lens is placed in water.the focal length will
(a) Remains same (b) decreases (c) increases (d) none of the these.

3. If 40cm each is the object and image distance respectively for a convex lens,then the focal length is….
(a) 80cm (b) 40cm (c) 20cm (d) 25cm

4. Which one of the following material can be used to make lens?
(a) iron (b) plastic (c) glass (d) clay

5. Irrespective position of the object on principal axis, a concave lens given an image of nature
(a) real, inverted (b) real, erected (c) virtual, inverted (d) virtual, erected

6. Watch maker uses to repair.
(a) Convex mirror (b) concave mirror (c) concave lens (d) convex lens

7. Pick the correct answer from the following two answers
(1) Focal length of a lens depends on the surrounding medium.
(2) Focal length of a lens changes with object distance.
(a) both (1) and (2) are true (b) both (1) and (2) are false
((c) Only (1) is true (d) Only (2) is true

8. On heating a liquid the refractive index generally:
(a) Increases (b) Decreases (c) Does not change
(d) Increases or decreases depending upon rate of heating

9. A lens of focal length 12 cm forms an erect image, three times the size of the object. The distance between the object and image is:
(a) 8 cm (b) 16 cm (c) 24 cm (d) 36 cm

10. A ray of light passes from a medium X to another medium Y. No refraction of light occurs if the ray of light hits the boundary of medium Y at an angle of:
(a) 120^o (b) 90^o (c) 45^o (d) 0^o

11. A ray of light is travelling in a direction perpendicular to the boundary of a parallel glass slab. The ray of light:
(a) Is refracted towards the normal (b) Is refracted away from the normal
(c) Is reflected along the same path (d) Does not get refracted

12. Power of the lens is -4D, its focal length is
(a) 4m (b) -40m ((c) -0.025m (d) -25m

13. Which of the following statements is true?
(a) A convex lens has 4 dioptre power having a focal length 0.25 m
(b) A convex lens has -4 dioptre power having a focal length 0.25 m
(c) A concave lens has 4 dioptre power having a focal length 0.25 m
(d) A concave lens has -4 dioptre power having a focal length 0.25 m.

14 . A lens has a power of +0.5D. It is:
(a) A concave lens of local length 5 m (b) A convex lens of focal length 2 m
(c) A convex lens of focal length 5 m (d) A concave lens of focal length 2 m

15. A parallel beam of light is incident on a converging lens parallel to its principal axis. As we move away from the lens on the other side on its principal axis the intensity of light
(a) Remains constant (b) Continuously increases
(c) Continuously decreases (d) First increases and then decreases

16. You are given water, mustard oil, glycerine and kerosene. In which of these media a ray of light incident obliquely at same angle would bend the most?
(a) Kerosene (b) Water (c) Mustard oil (d) Glycerin

17. When white light moves through vacuum
(a) Violet has greater speed than red (b) Red has greater speed than violet
(c) All colours have the same speed
(d) Different colours have different random speeds

18. Spherical air bubble in water will act as :
(a) A concave lens (b) A convex lens (c) Plane-concave lens (d) Plane glass plate

19. Refractive index of glass relative to water is 9/8. What is the refractive index of water relative to glass?
(a) 9/8 (b) 8/9 (c)1/9 (d)None

20. The angle of deviation produced by glasss lab is
(a) 0^0 (b) 20^0 (c) 90^0
(d) Depends on the light ray and normal to slab.

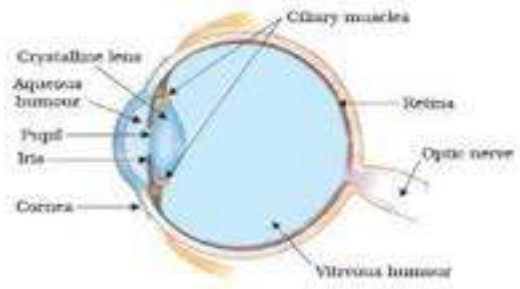
KEY

1.b	**2.c**	**3. c**	**4.c**	**5.d**	**6.d**	**7.c**	**8.b**	**9.b**	**10.b**
11.d	**1 2.c**	**13. a**	**14.b**	**15.d**	**16.d**	**17.c**	**18.a**	**1 9.b**	**20.a**

3. HUMAN EYE AND THE COLOURFUL WORLD

CHAPTER AT A GLANCE

- Human eye is an organ that enables us to see the world around us.
- Human eye works similar to that of a camera, its lens system forms an image on retina. The lens system of eye is made up of tissues.



The main parts of the human eye are the following.

1. **Cornea:** It is the transparent thin membrane on the front surface of the eyeball through which the light enters into the eye. The refraction of light occurs at the outer surface of the cornea.
2. **Eyeball**: It is spherical in shape with a diameter of 2.3 cm.
3. **Lens**: Behind the cornea, the space filled with a transparent liquid called aqueous humour and behind this a crystalline lens.
   - It is the central part of the eye that provides the image formation. This provides the adjustment of focal length required to focus the objects at different distances.
   - The eye lens composed of a fibrous, jelly- like materials. The eye lens forms a real and inverted image of the object on the retina of the eye.
4. **Ciliary muscles**: The curvature of the eye lens can be modified by ciliary muscles. The ciliary muscles are also useful to hold the position of eye lens.
   - Ciliary muscles contract when the human eye looking the closer objects. This causes increase in the curvature of the eye lens and it becomes thicker and the focal length of the eye lens decreases.
   - Ciliary muscles expands when the human eye looking the distant objects. These causes decrease in the curvature of the eye lens and it becomes thinner and the focal length of the eye lens increases.
5. **Accommodation**: The ability of the eye lens to adjust its focal length to see the objects clearly is called the accommodation.
   - The minimum distance (near point) to see the objects without strain is called the least distance of vision. For a normal eye it is about **25 cm.**
   - The maximum distance (far point) upto which the eye can see the objects clearly is called far point and it is infinity for a normal eye.
   - When the eye is looking the near objects eye lens becomes more convex.

- Hence a normal eye can able to see the objects clearly between 25 cm and infinity distance. Hence, the power of accommodation for a young adult is about **4 D.**
- The eye loses its power of accommodation at old age.
- As the age of human increases the eye lens becomes milky and cloudy. This leads to partial or complete loss of vision. This problem is called cataract. With a cataract surgery this problem can be cleared.

6. **Pupil**: It is the small central hole in the iris which becomes smaller in brighter light and becomes larger in dim light conditions.
7. **Iris**: The opaque/dark circular diaphragm that controls the size of the pupil is called iris. Iris makes the pupil to act as a variable aperture for the light to enter into the eye.
8. **Retina**: It is light sensitive membrane on the back wall of the eyeball on which the images are formed and transmitted to brain through optic nerves is called retina.
   - The distance between the lens and retina is about 2.5 cm. The image distance if fixed and is 2.5 cm for any object we can see for a normal eye.
   - The retina consists of 125 million rectors (light sensitive cells) and generate electrical signals namely "rods" and "cones" which receives the light signals **Rods identify the intensity of light where as the cones identify the colour.**
   - Images of the object are formed on retina by successive refractions at the cornea, the aqueous humour, lens and the vitreous humour respectively.
9. **Optic nerves**: The information of the object that we see can be transmitted to human brain are called optic nerves.
10. **Sclera:** Its is an opaque, fibrous, protective out layer of the human eye containing the collagen and elastic fibre. It is also known as the white part of the eye.
11. **Blind spot**.: The point at which the optic nerve leas the eye. At this point no rods or cones are present, so if any image formed at blind point cannot be seen (visualized) by human brain.
12. **Aqueous humour**: The space behind the cornea the space filled with a transparent liquid called aqueous humour
13. **Vitreous Humour**: The space between the lens and the retina in the eye is filled with a clear, gel-like substance called vitreous humour. Behind this crystalline lens is present.

Defects of Vision and their correction:

The vision becomes blurred due to the refractive defects of the eye. There are mainly three common refractive defects of the vision. They are

(i) Myopia or near sightedness
(ii) Hypermetropia or farsightedness and
(iii) Presbyopia.

(i). Myopia:

- It is also called near sightedness. A person with this defect can see nearby objects clearly but cannot see the distinctly.
- A person with this defect has the far point nearer than infinity. For the people suffering with myopia the focal length of eye lens is < 2.5 cm.
- **Reason:** In this defect the image of the distant object is formed in front of the retina and not at the retina. This is due to excessive curvature of the eye lens or elongation of the eyeball.
- **Remedy:** This defect can be correct by using a concave lens of suitable power.

Figure:2. Myopic eye

Figure:3. Correction of myopia

(ii) Hypermetropia:

- It is also called far-sightedness. A person with hypermetropia can see the distant objects clearly but cannot see the nearby objects clearly.
- The near point, for the person is farther away from the normal near point (25 cm). Such a person has to keep a reading book or material much beyond 25 cm from the eye for a comfortable reading. This is because the light rays from a close object are focussed at a point behind the retina.
- For these people, focal length of the lens is > 2.27 cm.
- **Reason**: This defect arises because the focal length of the eye lens is too long, or the eyeball has become small.
- **Remedy:** This defect can be corrected by using a convex lens of appropriate power. Eye-glasses with converging lenes provide additional focussing power for the formation of the image on the retina.

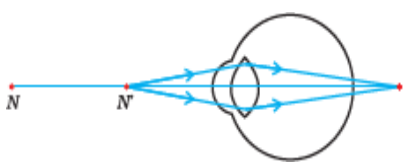


Figure:4. Hypermetropia eye

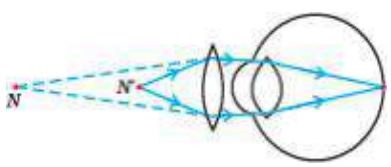


Figure:5. Correction of hypermetropia

(iii) Presbyopia:

- The accommodation power of the human eye decreases with the ageing. As a result, the near point gradually recedes away. So, it become difficult to see nearby objects comfortably without corrective eye-glasses. This defect is called Presbyopia.

- **Reason:** It arises due the gradual weaking of the ciliary muscles and diminishing flexibility of the eye lens. Some times a person may have both myopia and hypermetropia.
- **Remedy:** This defect can be corrected by using bi-focal lens. It generally contains both concave and convex lens. The upper portion is concave and lower portion is of convex les.
- Now a days the refractive defects can be cured with contact lenses or surgery.

Other Defects of Vision and their correction:

(iv) Astigmatism:

- The defect in which the eye can not focus objects both in horizontal and vertical lines clearly.
- **Reason**: Due to imperfect shape of cornea or the lens or both
- **Remedy**: This defect can be cured by using cylindrical lens.

(v) Colour blindness:

- In this defect eye can not distinguish between certain colours.
- **Reason:** It may be due to genetics, injury or disease.
- **Remedy**: No permanent cure, but special glasses and contact lens are useful to treat this defect.

MULTIPLE CHOICE QUESTIONS

1. **The distance between eye-lens and retina in a human eye is around** [ ]
   (a) 25 mm (b) 2.5 mm (c) 25 cm (d) 40 cm
2. **In hypermetropia defect, the image is formed** [ ]
   (a) On the retina (b) Behind the retina (c) Before the retina (d) None.
3. **The power of a lens of focal length 20 cm is** [ ]
   (a) 5 D (b) 4 D (c) 10 D (d) 2 D
4. **Usually Doctors, after testing for defects of vision, prescribe the corrective lens indicating their** [ ]
   (a) radius of curvature (b) Refractive index
   (c) Mass (d) power
5. **Far sightedness is also called as** [ ]
   (a) myopia (b) Hypermetropia (c) Colour blinded ness (d) Presbyopia
6. **In case of myopic defect, the image is formed** [ ]
   (a) On the retina (b) Behind the retina (c) Before the retina (d) None
7. **The part of the human eye which helps the eye lens to change its focal length, is** [ ]
   (a) ciliary muscle (b) Retina (c) Cornea (d) iris
8. **The power of a lens is 2.5 D, its focal length** [ ]
   (a) 4 cm (b) 40 mm (c) 40 cm (d) 0.4 cm
9. **Bifocal lenses are used to correct which defect of the vision** [ ]
   (a) presbyopia (b) Myopia (c) Hypermetropia (d) cataract

10. Diaptre is the unit of …..the lens [ ]
(a) Focal length (b) Power (c) Radius of curvature (d)none.

11. For the children below the age of 10 years, the value of least distance of distinct vision is about [ ]
(a) 7-8 cm (b) 1 m (c) 2 m (d) 1-2 m

12. The transparent layer in a human eye is called…. [ ]
(a) eye ball (b) Lens (c) Corena (d) pupil

13. The defect of vison in which the people can not see the objects beyond far point is called [ ]
(a) presbyopia (b) Myopia (c) Hypermetropia (d) None

14. For a health eye, the accommodation of eye lens will be in the range of [ ]
(a) 2.5 cm to 25 cm (b) 25 cm to 100 cm
(c) 2.5 to 2.27 cm (d) 2.25 cm to 2.5 cm

15. A person can not see the objects placed between near point and the point of least distance of distinct vision. His defect of vision can be corrected by using [ ]
(a) bi-concave lens (b) Bi-convex lens (c) Bi-focal lens (d) Concavo-convex lens

16. For a person with myopia defect, the maximum focal length of the eye- lens is [ ]
(a) less than 2.5 cm. (b) Greater than 2.5 cm (c) Equal to 2.5 cm (d) None

17. The sensation of vision on the retina is carried to the brain by [ ]
(a) ciliary muscle (b) optic nerve (c)rods and cones (d) Aqueous humour

18. A person can not see objects clearly beyond 40 cm. The power of the lens to correct the vision is [ ]
(a)*+2.5D convex lens* (b).*-4 D concave lens*
(c)*-2.5D concave lens.* (d).*+4 D convex lens*

19. When an object is placed at a distance of 5 cm from a human eye, the image is formed at a distance of ____: [ ]
(a) 2.25 cm (b) 2.5 cm (c) 1 cm (d) Can not form a clear vision.

20. Pick the false statement [ ]
(a) Eye lens form a real image (b) Image is formed on retina
(c) cornea contains rods and cones. (d) Distance between the lens and retina is 2.5 cm.

21. When we enter a cinema hall, we can't see properly for a short time. This is because of [ ]
(a) eye-lens become opaque (b) pupil does not open
(c) ciliary muscles do not react (d) adjustment of size of pupil takes time.

22. The function of the 'rods' of the retina is to [ ]
(a) colour of the light (b) identify the intensity of light.
(c) To focus the light (d)to form image on retina

23. The maximum and minimum focal lengths of the eye-lens respectively are [ ]
(a) 2.5 cm to 25 cm (b) 25 cm to 100 cm
(c) 2.5 to 2.27 cm (d) 2.25 cm to 2.5 cm

24. Which part of the human eye is called 'variable aperture' [ ]
(a) iris (b) Pupil (c) Cornea (d) Ciliary muscle

25. Which of the following changes takes place when you walk out of bright sunshine into a poorly light room [ ]
(a) The pupil becomes larges (b) The lens becomes thicker
(c) The ciliary muscle relaxes (d) The pupil becomes smaller.

26. Which part of the human eye contains 'rods' and 'cones' to receive the light signals [ ]
(a)retina (b) Cornea (c) Lens (d) iris

27. The minimum focal length of the eye lens for the person of hypermetropia is
(a) less than 2.27 cm (b) greater than 2.27 cm
(c) Equal to 2.27 cm (d) None of the above

28. The pupil of the eye changes in size adjust for
(a) Different colours (b) objects at different distances
(c) Different amounts of light (d) Objects of different sizes.

29. When light rays enter the eye, most of the refraction occurs at the [ ]
(a) At the lens (b) outer surface of cornea (c) At retina (d) None

30. Colour blindness is due to the absence [ ]
(a) rod cells in retina. (b) Cone cells in retina
(c) Retina (d) None

31. In the eye the position of the image on the retina as adjusted by change the
(a) Focal length of the lens. (b) Position of the lens
(c) Length of the eye ball (d) Diameter of the pupil

32. A person can not see the objects clearly beyond 50 cm. The power of the lens to correct the vision is [ ]
(a) -2 D. (b) +2 D. (c) -4 D. (d) +4 D.

33. The change in focal length of the eye lens is *not* caused by the action of the [ ]
(a) Ciliary muscles (b) Iris (c) Pupil (d) retina

34. If the far point of an eye is at 4 m then the eye is [ ]
(a) myopic and needs -0.25 D lens (b) myopic and needs +0.25 D lens
(c) hypermetropic and needs +0.25 D lens (d) hypermetropic and needs -0.25 D lens

35. The image formed by the eye-lens on retina is [ ]
(a)Real (b) Inverted (c)Diminished (d) All of the above

36. Pick the false statement from the following [ ]
(a) Eye lens forms real image (b) Image is formed on retina
(c) cornea contains rods and cones. (d) Distance between lens and retina is about (b)5 cm

37. To correct one's myopia, the selected lens should form an image at [ ]
(a) Near point (b) Far point
(c) Both near and far points (d) None of the above.

ANSWERS

1-a,	**2-b,**	**3-a,**	**4-d,**	**5-b,**	**6-c,**	**7-a,**	**8-c,**	**9-a,**
10-b,	**11-a,**	**12-c,**	**13-b ,**	**14-c,**	**15-b**	**16-a,**	**17-b,**	**18-c,**
19-d ,	**20-c,**	**21-d,**	**22-b,**	**23-c,**	**24-b,**	**25-a,**	**26-a,**	**27-b,**
28-c,	**29-b,**	**30-b**	**31-d,**	**32-a,**	**33-b**	**34-a,**	**35-d,**	**36-c,**
37-b.								

4. REFRACTION OF LIGHT THROUGH A PRISM

CHAPTER AT A GLANCE

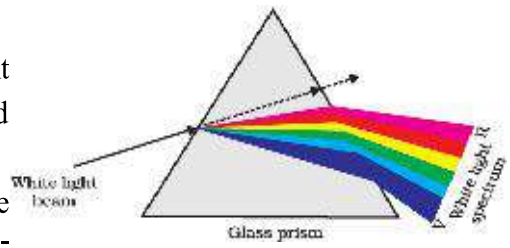
Prism: A prism is a transparent refracting medium bounded by two plane surfaces inclined to each other at certain angle.

Angle of prism: The angle between the two lateral faces of prism is called angle of prism(A)

A prism can be used to observe the dispersion of light rays.

Dispersion of white light by a glass prism:

The splitting of the white light into its component colours when it passes through a prism is called "dispersion of light"

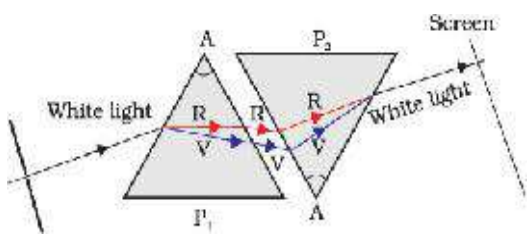


- The bands of seven colours obtained are in the name **VIBGYOR** from bottom to top V-Violet, I-Indigo, B-Blue, G-Green, Y-Yellow, O-Orange, R-Red.
- **Reason for dispersion**:
  Refraction is the reason for dispersion of light rays.
- When light rays are travelling in different media due to variation in the densities of the two media the velocity of light rays will be changed, due to this bending of light rays takes place at different angles that leads to the formation of the colour spectrum.
- The band of distinct colours that we see is called spectrum and it is as shown in the Figure.
- **Angle of deviation**: It is the angle made by the emergent ray with the incident ray and it depends on the material of prism.
- Newton was the first person to use a glass prism to get the spectrum of white light. He also shown that white light contains seven constituent colours using newton's colour wheel rotation.
- Red colour has the maximum wave length and violet colour has the minimum wave length in visible light.
- The refractive index for red is minimum and for violet it is maximum
- The angle of deviation of violet is maximum and minimum for red colour.
- Also, the velocity of red colour is more and violet is minimum hence, red colour travels faster than any other colour hence it deviates least and violet deviates most

Recombination of white light:

Newton placed a second identical prism in an inverted position with respect to the first prim as shown in Figure .

- He found a beam of white light emerging from the other side of the second prism. This observation gives the idea that the sun light is made up of sun light.



Rainbow:

A rainbow is a natural spectrum appearing in the sky after a rain shower as shown in Figure. In a rainbow red colour appear on the upper side and violet on the lower side.

Reason:

- The dispersion of sun light by tiny water droplets in the atmosphere.
- A rainbow is always found opposite to the Sun. Here, the water droplets will act like small prisms. They refract and disperse the sun light, then reflect it internally and finally refract it again when it comes out of the rain drop as shown in Figure
- Due to dispersion of light and internal reflection, different colours reach the observer's eye.
- We can also see a rainbow on a sunny date when we look at the sky through a water fall or a water fountain with the Sun behind us.

Atmospheric Refraction:

- The atmosphere of the earth is not uniform, its density changes as we move up and down. Hence, refraction of light through atmosphere occurs.

  Example **1: Twinkling of stars**
- The stars are very far away from the Earth. When the star light enters into the atmosphere, it continuously undergoes refraction causing to twinkling of stars.
- But the planets are much closer to Earth and they can be seen as extended sources while the stars look like point sources. Hence, the twinkling effect is nullified.

  Example 2 : **advanced sunrise and delayed sunset.**
- The time difference between actual sun rise and sun set is about 2 minutes.
- Also, the apparent flattening of the Sun's disc at sunrise and sunset is also due to the atmospheric refraction.

Scattering of light:

- The reflection of light from an object in all directions is called the scattering of light.
- The process of re-emission of absorbed light in all directions with different intensities by atoms or molecules, is called "**scattering of light".**

  Examples:
  1. The blue colour of the sky
  2. colour of water in deep sea
  3. The reddening of the sun at sun rise and sun set are the examples for scattering of light.
- **Tyndal effect** is also an example for scattering of light.
- The scattering of light by particles in a colloid or suspension is called **Tyndal effect.**
- The intensity of the scattered light depends on the density of the particles and frequency of the incident light.

- Blue light scatters more than the red light because of its shorter wave length.
- Tyndall effect can also be observed when a fine beam of sun light enters a smoke-filled room through a small hole. The scattering of light makes the particles visible.
- The colour of scattered light depends on the size of the scattering particles. Small particles scatter blue light and larger size particles scatter light of longer wave lengths.
- The blue colour of the sky is due to scattering of sun light in the atmosphere by the gas molecules (mainly due to N_2 and O_2) present in the atmosphere, which have small sizes than the wave length of the visible light.
- Sometimes very large size of scattering particles causes appearance of white light.
- One more thing to remember is the red colour is least scattered by fog or smoke; hence **red colour is used in danger signal lights**.
- If earth has not had atmosphere the **sky appears to be dark**.
- The astronauts see the sky in dark colour due to the absence of atmosphere.

MULTIPLE CHOICE QUESTIONS

1. **Blue colour of the sky is due to the scattering of light by the molecules of ……in air**. [ ]
   (a) N_2 and O_2 (b) H_2 and H_2O (c) $H_2$and N_2 (d) $H_2$and O_2
2. **Which of the following statements on red colour light is true** [ ]
   (a) It has low refractive index and suffers high deviation
   (b) It has low refractive index and suffers low deviation
   (c) It has high refractive index and suffers high deviation
   (d) It has high refractive index and suffers low deviation.
3. **If i_1 and i_2 are the angle of incidence and angle of emergence due to a prism respectively, then at the minimum deviation** [ ]
   (a) $i_1=i_2$ (b) $i_1> i_2$ (c) $i_1< i_2$ (d) None
4. **When we sit at a camp fire, objects beyond the fire are seen swaying. The principle involved in it is** [ ]
   (a) Reflection (b) Refraction (c) Diffraction (d) Interference
5. **Pick the correct answer from the following two statements**
   1) In VIBGYOR, wave length increases from violet to red
   2). In VIBGYOR, refractive index increases from violet to red
   (a) Only (1) is true (b) Only (2) is true
   (c) Both (1) and (2) are true. (d) Both (1)&(2) false
6. **The sun does not appear red during noon hours, because all colours scattered on reaching the eye,** [ ]
   (a) all colours reach our eye with out much scatering
   (b) all colours get scattered on reaching the eye.
   (c) red colour only gets scattered
   (d) red colour only does not scattered.
7. **The scientific work of C.V. Raman is on** [ ]
   (a) scattering of light. (b) Reflection of light
   (c) Diffraction of light (d) Total internal reflection of light

8. A lemon kept in a glass of water appears to be bigger than its actual size. This is due to [ ]
(a) Reflection (b) Refraction. (c) Total internal reflection (d) Dispersion

9. A cut diamond sparkles because of its [ ]
(a)high refraction of diamond. (b) Low refraction of diamond
(c) Both (1)&(2) (d)None

10. During the refraction which of the following quantity does not change? [ ]
(a) Wave length (b) Speed of light (c) Frequency (d) None

11. If earth had no atmosphere, the sky would have appeared [ ]
(a) White (b) Blue (c) dark. (d) yellow

12. To see a dark blue sky, we have to see with an angle of ….with the sun rays. [ ]
(a) 0^0 (b) 90^0 (c) 45^0 (d)30^0

13. During the sun set the sun seems to be [ ]
(a) lower than it really is (b) higher than it really is.
(c) equal to it really is (d) None

14. Which among the following colours has the maximum angle of deviation [ ]
(a) Red (b) Blue (c) Green (d) Violet

15. The phenomenon involved in the formation of a rainbow are: [ ]
(a) Refraction, (b)Total internal reflection (c) dispersion. (d) All of the above

16. Pick the correct statement [ ]
1). Red colour has the shorter wave length
2) Formation of rainbow is due to dispersion
(a) Only (1) is true (b) Only (2) is true
(c) Both (1)& (2) are true (d) Both (1) & (2) are false.

17. Scattering of light involves the process of [ ]
(a) Bending of light at the interference of two media (b) Splitting of light into different colours
(c) convergence of light rays at the focus (d) re-emission of absorbed light

18. The number of surfaces bound a prism are…… [ ]
(a) 4 (b) 6 (c)5 (d) 9

19. The formation of rain bow is due to the dispersion of sun light by the [ ]
(a) dust particles (b) Water droplets (c) N2 molecules (d) Inert gas molecules.

20. A beam of white light is incident on a glass prism, then the light can not be…. [ ]
(a) Deviated (b) Dispersed (c) Focussed (d) Refracted.

ANSWERS

1-a	**2-b**	**3-a**	**4-b**	**5-a**	**6-b**	**7-a**	**8-b**	**9-a**	**10-c**
11-c	**12-b**	**13-b**	**14-d**	**15-d**	**16-b**	**17-d**	**18-c**	**19-b**	**20-c**

5. ELECTRICITY

CHAPTER AT A GLANCE

Electric Current:

- If a net charge Q, flows across any cross section of a conductor in time t, then the current I, through the cross-section is

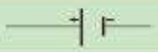
  I = Q/t
- The SI unit of electric charge is **coulomb (C)**
- electron possesses a negative charge of 1.6×10^{-19} C. The electric current is expressed by a unit called **ampere (A)**
- An instrument called ammeter measures electric current in a circuit.
- Ammetre is always connected in series in a circuit through which the current is to be measured.

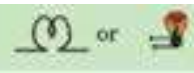
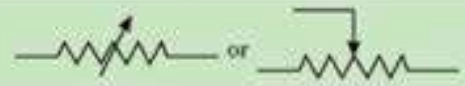
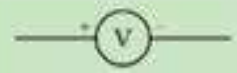
Potential Difference:

- It is defined as the workdone in moving single unit positive charge from infinite to that point in electric field
- Potential difference (V) between two points = Work done (W)/Charge(Q

  V = W/Q
- The SI unit of electric potential difference is **volt (V)**
- Potential difference between the two ends is said to be 1 Volt if one joule of work is done to move one coloumb of charge from one point to other.
- $1\ V = 1\ JC^{-1}$
- The potential difference is measured by means of an instrument called the **voltmeter**.
- voltmeter is always connected in parallel across the points between which the potential difference is to be measured.

Symbols of some commonly used components in circuit diagrams:

Sl. No.	Components	Symbols
1	An electric cell	
2	A battery or a combination of cells	
3	Plug key or switch (open)	
4	Plug key or switch (closed)	
5	A wire joint	
6	Wires crossing without joining	

7	Electric bulb	
8	A resistor of resistance R	
9	Variable resistance or rheostat	
10	Ammeter	
11	Voltmeter	

Ohm's Law:

At constant temperature, The potential difference, V, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it

$V \alpha I$

$V/I = \text{constant} = R$

$V = IR$

- R is a constant for the given metallic wire at a given temperature and is called its resistance.
- Resistance is the property of a conductor to resist the flow of charges through it.
- SI unit of resistance is **ohm (.Ω)**
- If the potential difference across the two ends of a conductor is 1V and the current through it is 1A, then the resistance R, of the conductor is 1Ω.
- If v=1 volt and I= 1ampere then R= 1 Ω.
- A component used to regulate current without changing the voltage source is called **variable resistance.**
- In an electric circuit, a device called **rheostat** is often used to **change the resistance** in the circuit.
- All metallic conductors obeys ohm's law are called ohmic conductors
- The V-I graph of ohmic conductors is a straight line
- Non ohmic conductors like semi conductors and electrolytes does not obey ohm's law.
- The V-I graph of non ohmic conductors is Non linear.

The resistance of the conductor depends

(i) on its length,

(ii) on its area of cross-section, and

(iii) on the nature of its material.

$$R \alpha l/A$$

$$R = \rho\ l/A$$

where ρ(rho) is a constant of proportionality and is called the **electrical resistivity** of the material of the conductor.

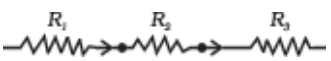
- The SI unit of resistivity is Ohm-metre(**Ω m).**

Electrical resistivity of some substances at 20°C

	Material	Resistivity (Ω m)
Conductors	Silver	1.60×10^{-8}
	Copper	1.62×10^{-8}
	Aluminium	2.63×10^{-8}
	Tungsten	5.20×10^{-8}
	Nickel	6.84×10^{-8}
	Iron	10.0×10^{-8}
	Chromium	12.9×10^{-8}
	Mercury	94.0×10^{-8}
	Manganese	1.84×10^{-6}
Alloys	Constantan (alloy of Cu and Ni)	49×10^{-6}
	Manganin (alloy of Cu, Mn and Ni)	44×10^{-6}
	Nichrome (alloy of Ni, Cr, Mn and Fe)	100×10^{-6}
Insulators	Glass	$10^{10} - 10^{14}$
	Hard rubber	$10^{13} - 10^{16}$
	Ebonite	$10^{15} - 10^{17}$
	Diamond	$10^{12} - 10^{13}$
	Paper (dry)	10^{12}

Resistors in series:

- Two or more resistors are said to be connected in series when the **same amount of current flows through all the resistors. In such circuits, the voltage across each resistor is different**



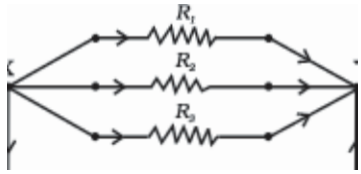
- The equivalent resistance of several resistors in series is equal to the sum of their individual resistances.

$$R_S = R1+R2+R3+\ldots\ldots$$

Where $I = I_1 = I_2 = I_3$ and $V = V_1 + V_2 + V_3$

Resistors in parallel :

- Two or more resistors are said to be connected in parallel when the **same amount of voltage across each resistor. In such circuits, the total current is equal to the sum of all individual currents**



- The equivalent resistance of several resistors in parallel is equal to the sum of reciprocal of their individual resistances.

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Where $I_1 = V/R_1$, $I_2 = V/R_2$ and $I_3 = V/R_3$

Joule's law of heating Effect of Electric current:

The law implies that heat produced in a resistor is

(i) directly proportional to the square of current for a given resistance,

(ii) directly proportional to resistance for a given current, and

(iii) directly proportional to the time for which the current flows through the resistor.

- The amount of heat H produced in time t is given by

$$H = I^2 Rt$$

Examples of joule heating effect

The electric laundry iron, electric toaster, electric oven, electric kettle and electric heater are some of the familiar devices based on Joule's heating.

- The electrical energy dissipated in a resistor is given by

$$W = V \times I \times t$$

$$W = I^2Rt$$

$$W = \frac{V^2}{R}t$$

Electric Power :

The rate at which work is done by an electric current is called electric power

$$P = W/t$$

$$P = V\,Q/t$$

$$P = VI = I^2R = V^2/R$$

- The unit of electric power is **watt** (W).
- One watt of power is consumed when 1 A of current flows at a potential difference of 1 V.
- The commercial unit of electrical energy is kilowatt hour (kWh). 1 kW h = 3,600,000 J = 3.6×10^6 J

Fuse:

An electric fuse is a device which is used in series to limit current in electric circuit

- In our house hold circuits when the current drawn from the mains exceeds the maximum safe limit over heating occurs and may cause of fire. This is called over loading
- To prevent damages due to over loading, electic fuse is connected to house holds

SOLVED PROBLEMS

1. A current of 0.5 A is drawn by a filament of an electric bulb for 10 minutes. Find the amount of electric charge that flows through the circuit.

Sol: We are given, I = 0.5 A; t = 10 min = 600 s.

we have Q = It = 0.5 A × 600 s

= 300 C

2. How much work is done in moving a charge of 2 C across two points having a potential difference 12 V?

Sol: W = VQ = 12 V × 2 C = 24 J

3. The potential difference between the terminals of an electric heater is 60 V when it draws a current of 4 A from the source. What current will the heater draw if the potential difference is increased to 120 V?

Sol: We are given, potential difference V = 60 V, current I = 4 A.

According to Ohm's law, R = V/I = 60/4 = 15 Ω

When the potential difference is increased to 120 V the current is given by

Current I = V/R = 120/15 = 8 A

The current through the heater becomes 8 A.

4. A wire of given material having length l and area of cross-section A has a resistance of 4 Ω. What would be the resistance of another wire of the same material having length l/2 and area of cross-section 2A?

Sol: For first wire $R_1 = \rho\ I/A = 4\Omega$

Now for second wire $R_2 = \rho\ I/2/2A$

$= ¼\ R_1 = 1\Omega$

5. Find the effective resistance If the resistors $R_1 = 10\ \Omega$, $R_2 = 40\ \Omega$, $R_3 = 30\ \Omega$, are connected in

(i) series (ii) Parallel

Sol: i) For series combination $R_s = R_1+R_2+R_3+\ldots\ldots$

$= 10 + 40 + 30 = 80\ \Omega$

ii) For parallel combination $1/R_p = 1/R_1 + 1/R_2 + 1/R_3$

$= 1/10 + 1/40 + 1/30$

$R_p = 6.3\ \Omega$

6. 100 J of heat is produced each second in a 4 Ω resistance. Find the potential difference across the resistor.

Sol: H = 100 J, R = 4 Ω, t = 1 s, V = ?

we have the current through the resistor as $I = \sqrt{(H/Rt)} = \sqrt{[100\ J/(4\ \Omega \times 1\ s)]} = 5\ A$

Thus the potential difference across the resistor, $V = IR = 5\ A \times 4\ \Omega = 20\ V$

7. An electric bulb is connected to a 220 V generator. The current is 0.50 A. What is the power of the bulb?

Solution : $P = VI = 220\ V \times 0.50\ A = 110\ J/s = 110\ W$

8. An electric refrigerator rated 400 W operates 8 hour/day. What is the cost of the energy to operate it for 30 days at Rs 3.00 per kW h?

Sol: The total energy consumed by the refrigerator in 30 days would be

400 W × 8.0 hour/day × 30 days = 96000 W h = 96 kW h

Thus the cost of energy to operate the refrigerator for 30 days is

96 kW h × Rs 3.00 per kW h = Rs 288.00

MULTIPLE CHOICE QUESTIONS

1. A piece of wire of resistance R is cut into five equal parts. These parts are then connected in parallel. If the equivalent resistance of this combination is R^1, then the ratio R/R^1 is

(a) 1/25 (b) 1/5 (c) 5 `(d) 25

2. Which of the following terms does not represent electrical power in a circuit?

(a) I^2R (b) IR^2 (c) VI (d) V^2/R

3. **An electric bulb is rated 220V and 100W. When it is operated on 110V, the power consumed will be**
   (a) 100W (b) 75W (c) 50W (d) 25W
4. **Two conducting wires of the same material and of equal lengths and equal diameters are first connected in series and then parallel in a circuit across the same potential difference. The ratio of heat produced in series and parallel combinations would be –**
   (a) 1 : 2 (b) 2 : 1 (c) 1 : 4 (d) 4:1
5. **When a 12 V battery is connected across an unknown resistor, there is a current of 2.5 mA in the circuit. The value of the resistance of the resistor is _____ ohm.**
   (a) 4.8 (b) 4800 (c) 48 (d) 30
6. **A battery of 9 V is connected in series with resistors of 0.2 Ω, 0.3 Ω, 1.0 Ω , 1.5 Ω and 12 Ω, respectively. How much current would flow through the 12 Ω resistor?**
   (a) 108 A (b) 1.33 A (c) 0.6 A (d) 0.75 A
7. **A battery of 10 V is connected in parallel with resistors of 3 Ω and 6 Ω, respectively. How much current would flow in the circuit ?**
   (a) 5 A (b) 3 A (c) 6 A (d) 10 A
8. **An electric heater of resistance 8 Ω draws 15 A from the service mains 2 hours. The electrical energy consumed by the heater is**
   (a) 120 J (b) 15 J (c) 8 J (d) 1 J

Key: 1) c 2) b 3) d 4) c 5) b 6) c 7) a 8) d

PREVIOUS POLYCET QUESTIONS

1. **The sum of two resistors is 6Ω and their equivalent resistance when connected in parallel is 1.5 Ω . The product of the two resistances is**
   (a) 4Ω (b) 9Ω (c) 7.5Ω (d) 4.5Ω
2. **6 J / 2 C =**
   (a) 3 Ω (b) 3 V (c) 3 A (d) 3 W
3. **The relation between the potential difference and current is established by the scientist**
   (a) Ampere (b) Oersted (c) Kirchhoff (d) Ohm
4. **The resistance of a wire of length 1 m and cross-sectional area 1 mm² is 1 Ω . The specific resistance is**
   (a) 1 Ω-m (b) 10^{-6} Ω-m (c) 10^{-3} Ω-m (d) 0.1 Ω-m

5. A charge of 6 C is flowing through a point in a circuit for 2 minutes. The current in the circuit is

(a) 3 A (b) 8 A (c) 0.05 A (d) 12 A

6. The electrical energy (in kWh) consumed in operating a bulb of 60 W for 10 hours is

(a) 0.6 J (b) 6 J (c) 36 J (d) 12 J

7. Electric Power is the product of current and

(a) resistance (b) charge (c) velocity (d) potential difference

8. If R is the resistance of conductor of length l

(a) $R \alpha l^3$ (b) $R \alpha l$ (c) $R \alpha l^2$ (d) R is independent on l

9. 6 watt x second =

(a) 6 J (b) 6 A (c) 6 Ω (d) 6 V

10. Ohm's law is applicable to

(a) insulators (b) semi-conductors (c) conductors (d) all of the above

Key: 1) b 2) b 3) d 4) b 5) c 6) b 7) d 8) b 9) a 10) c

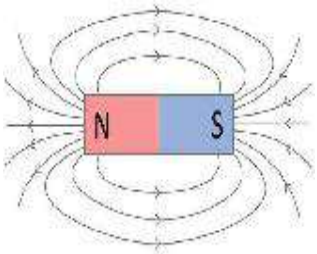
* * *

6. MAGNETIC EFFECTS OF ELECTRIC CURRENT

CHAPTER AT A GLANCE

- H.C. Oersted first observed that magnetic compass needle is deflected by current carrying conductor.
- Oersted concluded that electricity and magnetism are related phenomena.
- The unit of magnetic induction field strength is named as 'Oersted' in his honour.

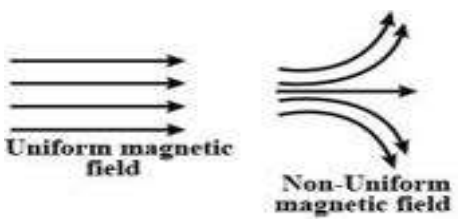
Magnetic field:



- The region (or) space around a magnet where its influence is felt is called "magnetic field".
- The magnetic field varies with the distance from the magnet and is characterized by strength and direction. It exists in all directions i.e., it is three dimensional.

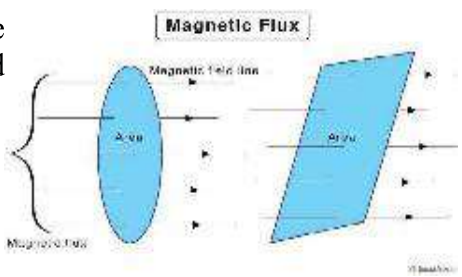
Magnetic field lines/Magnetic lines of force:

- The path traced by a unit north pole in moving it near a magnet is called magnetic field lines (or) magnetic lines of force.
- All magnetic lines of force start at north pole and ends at the south pole outside of a bar magnet
- inside the bar magnet, magnetic lines of force appear at the south pole move towards to the north pole
- magnetic lines of force are continuous and closed loops
- The tangent drawn to the field line at a point gives the direction of the magnetic field.
- The field is strong when the lines are crowded (near the poles of the magnet) and if weak when the lines are apart.
- No two magnetic lines of force can interact to each other.
- The magnetic field is said to be **non-uniform,** when strength or direction changes from point to point.
- The magnetic field is said to be **uniform,** if both strength and direction are constant throughout the field.



Magnetic flux :

- The number of magnetic lines of force passing through the plane of area 'A' perpendicular to the field is called "magnetic flux." It is denoted by 'ϕ'.
- The S.I. unit of magnetic flux is "**weber**"



Magnetic flux density (2):

- It is defined as the magnetic flux passing through unit area taken perpendicular to the field. It is also known as magnetic field induction.

Magnetic flux density = Magnetic flux /Area.

$B = \phi/A$ (or)

$\phi = BA$

If plane makes an angle Θ with field then

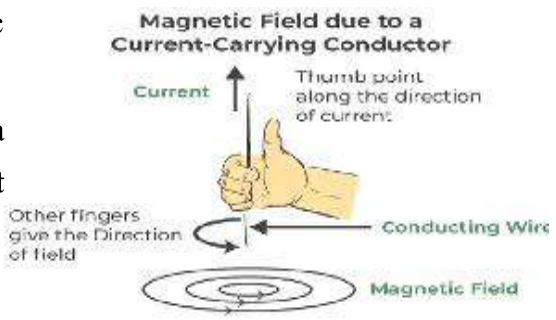
$\phi = BA\cos\Theta = B.A$

where B,A are vector quantities, i.e they have both same direction and magnitude

Unit of magnetic flux density is **weber/(meter)^2 or Tesla.**

Magnetic field due to current carrying straight wire:

- Current carrying in a wire produces magnetic field.
- The direction of the magnetic field, around a current carrying wire is determined by **right hand thumb rule**.
  - (i) Thumb indicates the direction of current.
  - (ii) The curled fingers show the direction of magnetic field.

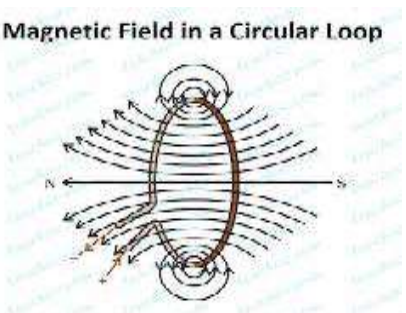


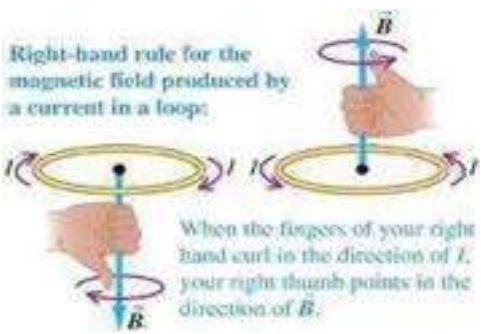
Magnetic field due to current carrying a circular loop:

When a current flows through a circular loop, it generates a magnetic field, which is concentrated inside the loop and has a direction determined by the right-hand rule.

The direction of the field is perpendicular to the plane of the coil.

With Right Hand Thumb rule, the **thumb** points the direction of **magnetic field**, the curled fingers show the **direction of current.**

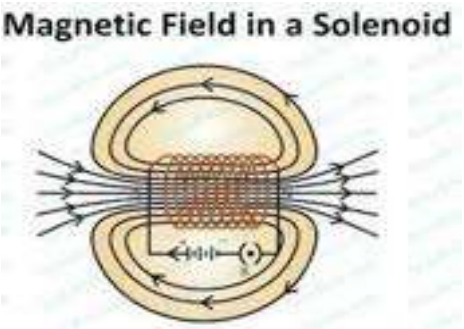




Magnetic field due to a current carrying solenoid:

- A coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder is called a solenoid.

- one end of the solenoid behaves as a magnetic north pole, while the other behaves as the south pole.
- The field lines inside the solenoid are in the form of parallel straight lines.
- This indicates that the magnetic field is the same at all points inside the solenoid. That is, the field is uniform inside the solenoid.



Magnetic force on moving charge ;

If the angle(ɵ) between the velocity direction (V) and magnetic field of direction(2), then the force experienced by the charged particle is given by

$F = q(v \times B)$ $F = qvB\sin\theta$

To find the radius of the path and time period of a charged particle:

We know that $F = qvB$,

r = radius of the circular path, centripetal force = mv^2/r

$qvB = mv^2/r$

then,Time Period of the particle(T)= $2\pi r/v$

The above equation after substitution becomes, **$T = 2\pi m/Bq$**

- **Magnetic force acting on current carrying conductor :**

Magnetic force acting on current carrying conductor place in a magnetic field is given by,

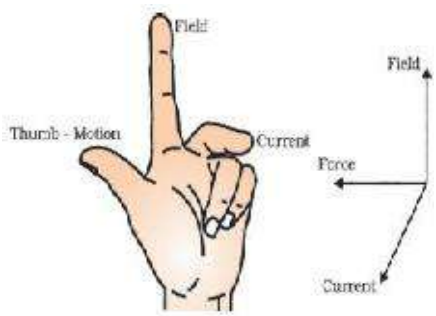
$F = ILB\sin\theta$

$F = ILB$ (where $\theta = 90$ degrees), $\sin\theta = 1$.

where $I = Q/t$ where Q= total charge

I = Current in the wire, L = Length of the wire, B = Strength of uniform magnetic field

- **Fleming's left-hand rule**:
  - According to this rule, stretch the thumb, forefinger and middle finger of your left hand such that they are mutually perpendicular as shown in fig.
  - If the first finger points in the direction of magnetic field and the second finger in the direction of current, then the thumb will point in the direction of motion or the force acting on the conductor.



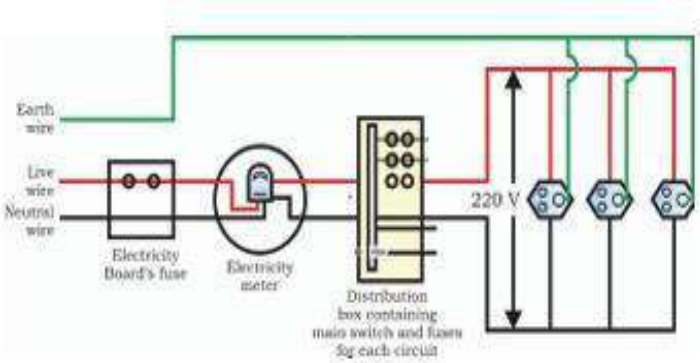
- **Electric motor:**

In an electric motor, electrical energy is converted into mechanical energy.

DOMESTIC ELECTRIC CIRCUITS:

- In our homes, we receive supply of electric power through a main supply (also called mains), either supported through overhead electric poles or by underground cables.
- One of the wires in this supply, usually with red insulation cover, is called live wire (or positive).
- Another wire, with black insulation, is called neutral wire (or negative).

- The earth wire, which has insulation of green colour.
- In our country, the potential difference between the two is 220 V.



Faraday's law:

When there is a continuous change in magnetic flux linked with a closed coil, a current is generated or induced in the coil.

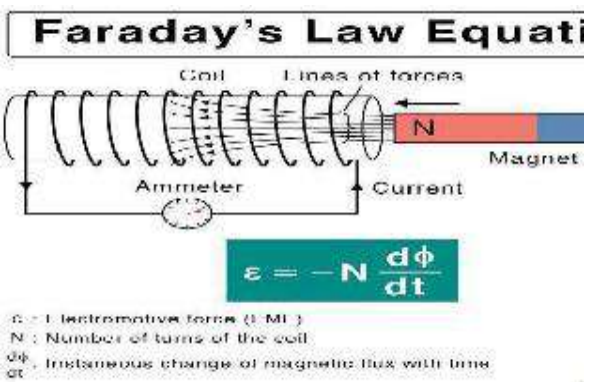
(OR)

"The induced EMF generated in a closed loop is equal to the rate of change in magnetic Flux passing through it".

Induced EMF = Change in magnetic flux/time

$\varepsilon = -N * (d\Phi/dt)$

The consequence of Faraday's law is the conservation of energy



Applications of Faraday's laws of electromagnetic induction:

For security check, Tape recorder, ATM, Induction stove

- In generators, mechanical energy is converted into electrical energy.

Lenz's law:

The law states that "the induced current will appear in such a direction that it always opposes the changes in the flux of the coil."

- **Electric Fues**: Electric fuse is an important component of all domestic circuits. A fuse in a circuit prevents damage to the appliances and the circuit due to overloading.

MULTIPLE CHOICE QUESTIONS

1. Choose the correct option. The magnetic field inside a long straight solenoid-carrying current

(a) is zero. (b) decreases as we move towards its end.

(c) increases as we move towards its end. (d) is the same at all points.

2. A positively-charged particle (alpha particle) projected towards west is deflected towards north by a magnetic field. The direction of magnetic field is

(a) towards south (b) towards east (c) downward (d) upward

3. Which of the following correctly describes the magnetic field near a long straight wire?

(a) The field consists of straight lines perpendicular to the wire.

(b) The field consists of straight lines parallel to the wire.

(c) The field consists of radial lines originating from the wire.

(d) The field consists of concentric circles centred on the wire.

4. Which component is used to avoid the overloading of domestic electric circuits?

(a) Electric fuse (b) Bar magnet (c) solenoid (d) none of the above

5. In domestic electric circuits, the wire with black colour insulation is

(a) live wire (b) neutral wire (c) earth wire (d) none of the above

6. In domestic electric circuits, the wire with red colour insulation is

(a) live wire (b) neutral wire (c) earth wire (d) none of the above

7. In domestic electric circuits, the wire with green colour insulation is

(a) live wire (b) neutral wire (c) earth wire (d) none of the above

8. Electric motor coverts electrical energy to_____ energy

(a) heat (b) light (c) chemical (d) mechanical

Key: 1) d 2) d 3) d 4) a 5) b 6) a 7) c 8) d

PREVIOUS POLYCET QUESTIONS

1. Which converts electrical energy into mechanical energy

(a) Motor (b) Battery (c) Generator (d) Switch

2. Mechanical energy is converted into electrical energy by which device

(a) Generator (b) Motor (c) Battery (d)Switch

3. The magnetic force on a current carrying wire placed in uniform magnetic field if the wire is oriented perpendicular to magnetic field, is

(a) 0 (b) ILB (c) 2ILB (d) ILB/2

4. The scientific demonstration of H.C. Oersted is related to the study of

(a) electric discharge through air

(b) relationship between voltage and current

(c) magnetic effect of current

(d) refraction of light

5. Weber is the S.I. unit of

(a) magnetic pole strength (b) magnetic moment

(c) magnetic flux (d) magnetic flux density

6. An increase in magnetic flux through a coil of 500 turns in 0·1 s is 0·001 Wb. The maximum induced EMF generated in the coil is

(a) 50 V (b) 10 V (c) 0·5 V (d) 5 V

7. The device which contains slip rings to reverse the direction of current through coil is called

(a) resistor (b) battery (c) electric motor (d) solenoid

8. The magnetic force acting on a moving charge is given by the product of three quantities , namely

(a) charge, magnetic flux, magnetic flux density

(b) charge, speed, magnetic flux density

(c) charge, current, magnetic flux density

(d) charge, magnetic flux, emf

9. Which among the following does not involve the electromagnetic induction?

(a) Electric motor (b) Electric generator (c) Electric geyser (d) Induction stove

10. A charge 'q' is moving with a velocity 'v' in magnetic field of induction 'B'. If magnetic force acting on the Charge 'q' is equal to qvB, then

(a) q is moving parallel to B (b) q is moving perpendicular to B

(c) q is moving at an angle of 45^0 to B (d) q is stationary

Key: 1) 1 2) 1 3) 2 4) 3 5) 3 6) 4 7) 4 8) 2 9) 3 10) 2

* * *

POLYCET - 2025

CHEMISTRY

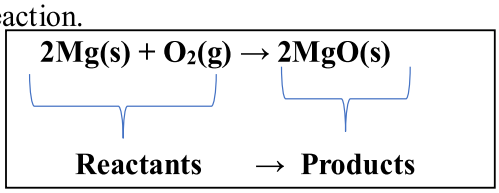
STUDY MATERIAL

Contents

1.CHEMICAL REACTIONS AND EQUATIONS

I. Chemical Reaction

- The transformation of chemical substance into another chemical substance is known as Chemical Reaction. **Ex:** Rusting of iron, the setting of milk into curd, digestion of food, respiration, etc.
- In a chemical reaction, a new substance is formed which is completely different in properties from the original substance, so in a chemical reaction, a chemical change takes place.
  Only a rearrangement of atoms takes place in a chemical reaction.
  Example: The burning of magnesium in the air to form magnesium oxide is an example of a chemical reaction.



- Before burning in air, the magnesium ribbon is cleaned by rubbing with sandpaper.
- This is done to remove the protective layer of basic magnesium carbonate ($MgCO_3$) from the surface of the magnesium ribbon.

Reactant: Substances which take part in a chemical reaction are called reactants.

Ex: Mg and O_2.

Product: New substance formed after a chemical reaction is called a product.**Ex: MgO.**

Characteristics of Chemical Reactions :

(i). Evolution of gas: The chemical reaction between zinc and dilute sulphuric acid is characterised by the evolution of hydrogen gas.

$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)\uparrow$

- **Upward arrow (↑):** Represents a gas escaping from the reaction mixture.

(ii). Change in Colour: When lead nitrate ($Pb(NO_3)_2$) and potassium iodide (KI) are mixed, they react to form lead iodide (PbI_2) and potassium nitrate (KNO_3)

$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) \downarrow + 2KNO_3(aq)$

The colour of lead iodide is yellow

- **Downward arrow (↓):** Indicates a solid precipitate forming in the reaction.

(iii). Change in state of substance: The combustion reaction of candle wax is characterised by a change in state from solid to liquid and gas (because the wax is a solid, water formed by the combustion of wax is a liquid at room temperature whereas, carbon dioxide produced by the combustion of wax is a gas). There are some chemical reactions which can show more than one characteristics.

(iv). Change in Temperature: The chemical reaction between quick lime water to form slaked lime is characterized by a change in temperature (which is a rise in temperature). The chemical