Exercise

DIRECTIONS : This section contains multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) out of which only one is correct.

1. Rays from the sun converge at a point 15 cm in front of a concave mirror. Where should an object be placed so that size of its image is equal to the size of the object?
   (a) 15 cm in front of the mirror
   (b) 30 cm in front of the mirror
   (c) between 15 cm and 30 cm in front of the mirror
   (d) more than 30 cm in front of the mirror.
2. Under which of the following conditions a concave mirror can form an image larger than the actual object?
   (a) When the object is kept at a distance equal to its radius of curvature
   (b) When object is kept at a distance less than its focal length
   (c) When object is placed between the focus and centre of curvature
   (d) When object is kept at a distance greater than its radius of curvature
3. For an object at infinity, a concave mirror produces an image at its focus which is
   (a) enlarged
   (b) virtual
   (c) erect
   (d) real, inverted and diminished
4. According to the laws of reflection
   (a) angle i = angle r
   (b) sine i = sine r
   (c) sine i / sine r = constant
   (d) All of these
5. An inverted image can be seen in a convex mirror,
   (a) under no circumstances
   (b) when the object is very far from the mirror

(c) when the object is at a distance equal to the radius of curvature of the mirror
(d) when the distance of the object from the mirror is equal to the focal length of the mirror

6. 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 dipotre power having a focal length 0.25 m
(d) A concave lens has – 4 dioptre power having a focal length 0.25 m

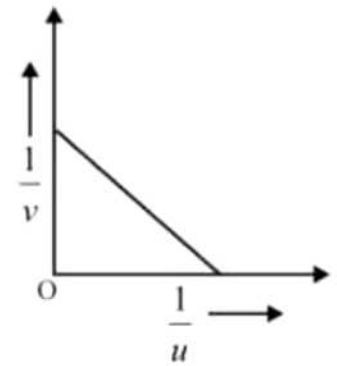
7. In case of a concave mirror, when the object is situated at the principal focus, the image formed is
(a) real and inverted
(b) of infinite size
(c) lies at infinity
(d) All of these

8. An object placed at F of a concave mirror will produce an image
(a) at infinity
(b) highly enlarged
(c) real and inverted
(d) All of these

9. The relation between u, v and R for a spherical mirror is
(a) $R = \frac{2uv}{u+v}$
(b) $R = \frac{2}{u+v}$
(c) $R = \frac{2(u+v)}{(uv)}$
(d) None of these

10. A 10 mm long awlpin is placed vertically in front of a concave mirror. A 5 mm long image of the awl pin is formed at 30 cm in front of the mirror. The focal length of this mirror is
(a) – 30 cm
(b) – 20 cm

(b)



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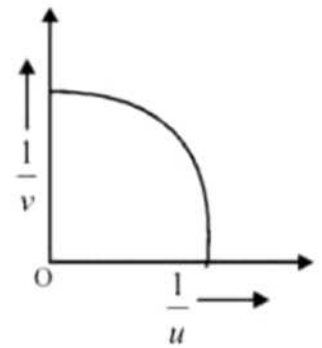

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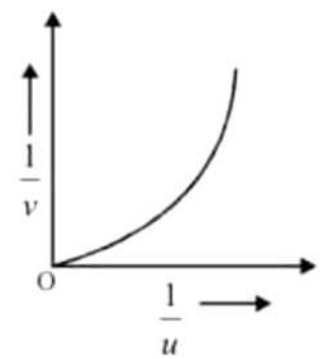
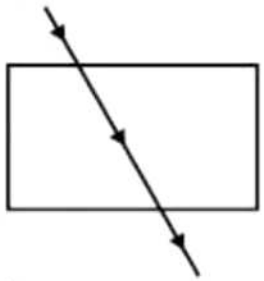


15. Magnification produced by a rear view mirror fitted in vehicles
    (a) is less than one
    (b) is more than one
    (c) is equal to one
    (d) can be more than or less than one depending upon the position of the object in front of it.
16. An object placed at F of a convex mirror will produce an image
    (a) Behind the mirror
    (b) Diminished
    (c) Virtual and erect
    (d) All of these
17. When a ray of light passes from an optically denser medium to a rarer medium, it
    (a) goes undeviated
    (b) bends away from the normal
    (c) bends towards the normal

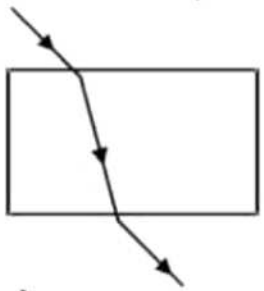
(d) None of these

18. The path of a ray of light coming from air passing through a rectangular glass slab traced by four students are shown as 1, 2, 3 and 4 in the figure. Which one of them is correct?

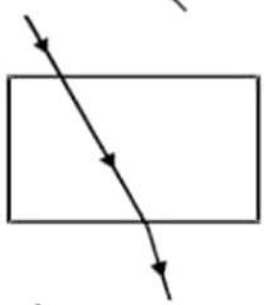
(a)



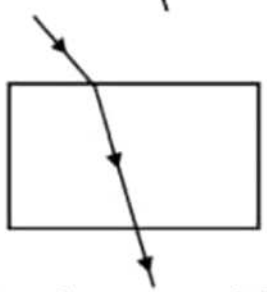
(b)



(c)



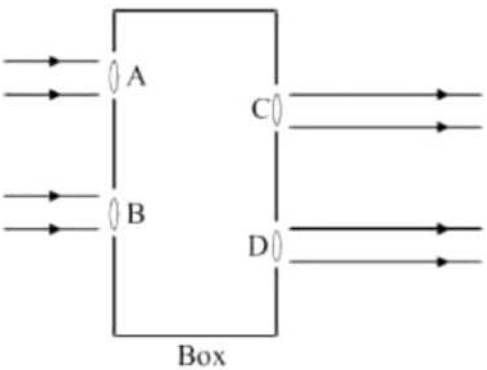
(d)



19. 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 centre of curvature of the reflector
20. An object placed at 2F of a convex lens will produce an image
    (a) at 2F
    (b) same size

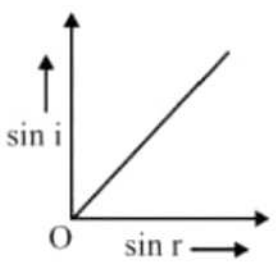
(c) real and inverted
(d) All of these

21. Beams of light are incident through the holes A and B and emerge out of box through the holes C and D respectively as shown in the figure. Which of the following could be inside the box?



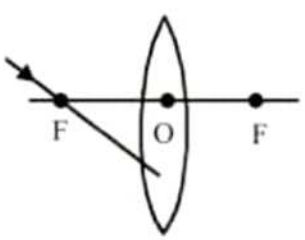
(a) A rectangular glass slab
(b) A convex lens
(c) A concave lens
(d) A prism

22. A straight line graph is obtained by plotting sine of angle of incidence versus sine of angle of refraction. The slope of this graph represents

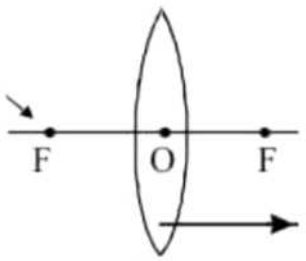


(a) velocity of light
(b) refractive index
(c) gravitational constant
(d) None of these

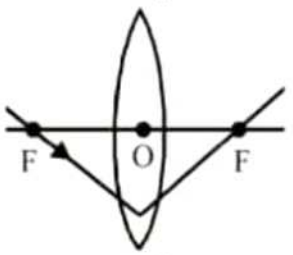
23. Which of the following ray diagrams is correct for the ray of light incident on a lens shown in Fig ?



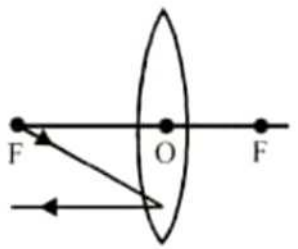
(a)



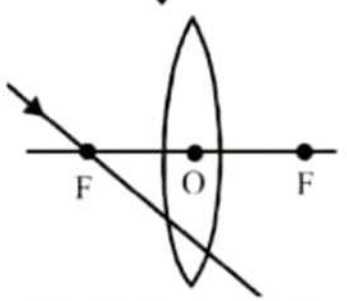
(b)



(c)



(d)



24. An object placed between F and 2F of a convex lens will produce an image
    (a) beyond 2F
    (b) enlarged
    (c) real and inverted
    (d) All of these

25. A swimming pool looks shallower than it really is, when seen by a person standing outside near it, because of the phenomenon of
    (a) refraction of light
    (b) reflection of light
    (c) dispersion of light
    (d) None of these

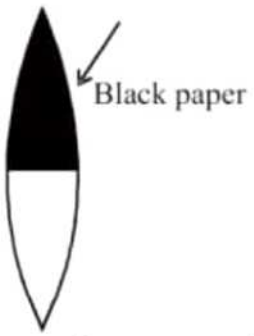
26. How will the image formed by a convex lens be affected if the upper half of the lens is wrapped with a black paper?

    (a) The size of the image is reduced to one-half

(b) The upper half of the image will be absent

(c) The brightness of the image is reduced

(d) There will be no effect



27. The middle vascular coat that darkens the eye chamber and prevents refraction by absorbing the light rays is

(a) choroid

(b) sclera

(c) retina

(d) cornea

28. Refractive index of a substance is

(a) speed of light in vacuum / speed of light in the medium

(b) speed of light in water / speed of light in the medium

(c) speed of light in the medium / speed of light in air

(d) All of these

29. The eyelens ..... light rays to form real, inverted and highly diminished image on the .....

(a) converges, retina

(b) diverges, retina

(c) converges, pupil

(d) diverges, pupil

30. The surface of retina has about 125 million light sensitive

(a) rods only

(b) cones only

(c) rods and cones

(d) neither rods nor cones

31. While looking at nearby objects, the ciliary muscles ..... the eyelens so as to ..... its focal length.

(a) contract, increase
(b) contract, decrease
(c) expand, increase
(d) expand, decrease

32. Negative value of focal length of a spherical mirror indicates that it is
(a) Concave mirror
(b) Convex mirror
(c) Plane mirror
(d) None of these

33. A student sitting on the last bench can read the letters written on the blackboard but is not able to read the letters written in his textbook. Which of the following statements is correct?
(a) The near point of his eyes has receded away
(b) The near point of his eyes has come closer to him
(c) The far point of his eyes has come closer to him
(d) The far point of his eyes has receded away

34. A person cannot see distinctly objects kept beyond 2 m. This defect can be corrected by using a lens of power
(a) + 0.5 D
(b) – 0. 5 D
(c) + 0. 2 D
(d) – 0. 2 D

35. Which of the following statement is correct?
(a) A person with myopia can see distant objects clearly
(b) A person with hypermetropia can see nearby objects clearly
(c) A person with myopia can see nearby objects clearly
(d) A person with hypermetropia cannot see distant objects clearly

36. A ray of light propagates from an optically denser medium to an optically rarer medium.
(a) It will bend towards the normal after refraction.

(b) It will bend away from the normal after refraction.

(c) It will continue to go on the same path after refraction.

(d) It will refract making an angle of refraction = angle of incidence.

37. Which of the following statements is correct regarding the propagation of light of different colours of white light in air?

(a) Red light moves fastest

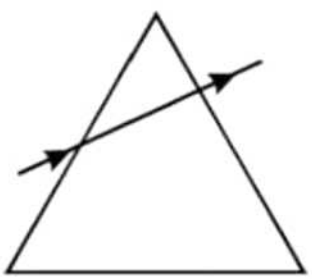
(b) Blue light moves faster than green light

(c) All the colours of the white light move with the same speed

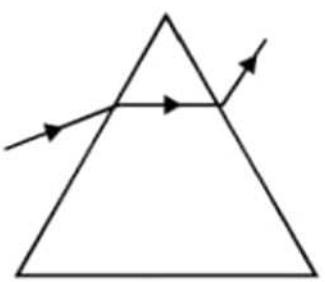
(d) Yellow light moves with the mean speed as that of the red and the violet light

38. Which of the following figures correctly shows the bending of a monochromatic light inside the prism?

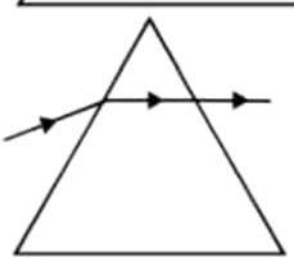
(a)

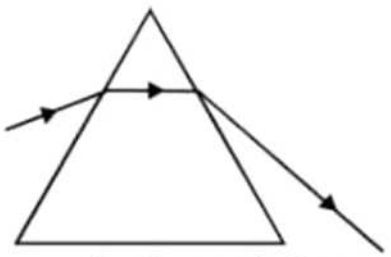


(b)

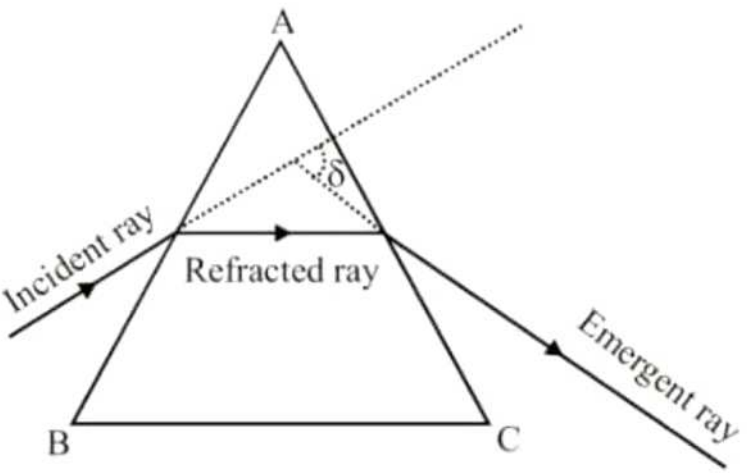


(c)



(d) 

39. At a particular minimum value of angle of deviation, the refracted ray becomes
    (a) parallel to the base of the prism
    (b) perpendicular to the base of the prism
    (c) inclined at 45° w.r.t. base of the prism
    (d) None of these
40. The distance between a spherical lens and the image is – 15 cm. The lens is
    (a) concave lens
    (b) convex lens
    (c) either of the two irrespective of the object distance
    (d) either concave lens or convex lens with object between O and F.
41. Which of the following phenomena of light are involved in the formation of a rainbow?
    (a) Reflection, refraction and dispersion
    (b) Refraction, dispersion and total internal reflection
    (c) Refraction, dispersion and internal reflection
    (d) Dispersion, scattering and total internal reflection
42. A ray of light passes through a prism as shown in the figure given below:



The angle δ is known as

(a) angle of deviation
(b) angle of dispersion
(c) angle of emergence
(d) angle of refraction

43. The clear sky appears blue because

(a) blue light gets absorbed in the atmosphere
(b) ultraviolet radiations are absorbed in the atmosphere
(c) violet and blue lights get scattered more than lights of all other colours by the atmosphere
(d) light of all other colours is scattered more than violet and blue colour lights by the atmosphere

44. Dispersion of light by a glass prism takes place because of

(a) difference in wavelengths of the constituents of light
(b) difference in speeds of various constituents of white light.
(c) scattering of light by the surface of the glass prism

(d) only b and a are correct

45. The danger signals installed at the top of tall buildings are red in colour. These can be easily seen from a distance because among all other colours, the red light
(a) is scattered the most by smoke or fog
(b) is scattered the least by smoke or fog
(c) is absorbed the most by smoke or fog
(d) moves fastest in air

46. Which of the following phenomena contributes significantly to the reddish appearance of the sun at sunrise or sunset?
(a) Dispersion of light
(b) Scattering of light
(c) Total internal reflection of light
(d) Reflection of light from the earth

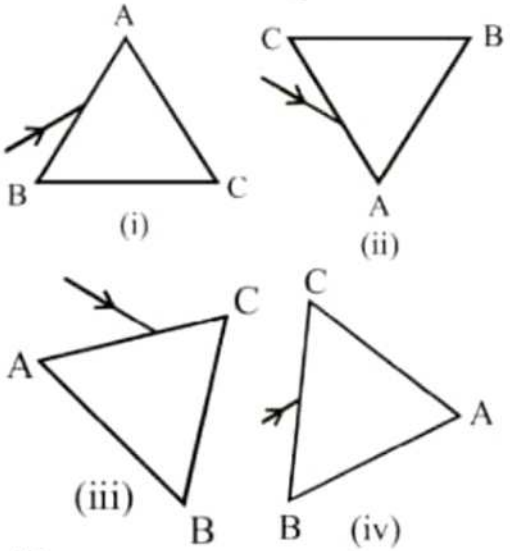
47. The bluish colour of water in deep sea is due to
(a) the presence of algae and other plants found in water
(b) reflection of sky in water
(c) scattering of light
(d) absorption of light by the sea

48. The colour of an object is determined by
(a) the colour of light reflected by it
(b) the colour of light absorbed by it
(c) the colour of light incident on it only
(d) None of the above

49. 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) Glycerine

50. A prism ABC (with BC as base) is placed in different orientations. A narrow beam of white light is incident on the prism as shown in Fig. In which of the following cases, after disper-

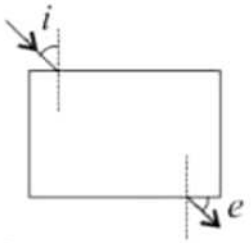
sion, the third colour from the top corresponds to the colour of the sky?



(a) (i)
(b) (ii)
(c) (iii)
(d) (iv)

51. A student does the experiment on tracing the path of a ray of light passing through a rectangular glass slab for different angles of incidence. He can get a correct measure of the angles of incidence and angle of emergence by following the labelling indicated in figure.

(a)



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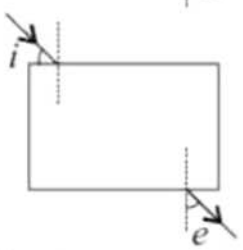

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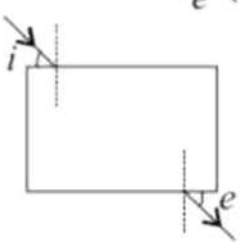
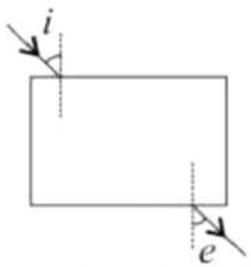
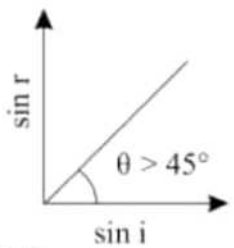


(d) 

52. Human eye is one of the most valuable and sensitive organ that
(a) enables us to see the wonderful world and colours around us
(b) can identify the objects
(c) is like a camera
(d) All of these

53. A ray of light travels from medium I to medium II. The figure given shows the variation of sin of angles of incidence (sin i) in medium I with sin of angle of refraction (sin r) in medium II.



Consider the following statements
(a) Speed of light in medium I > Speed of light in medium II.
(b) Speed of light in medium I < Speed of light in medium II.
(c) Light travels from denser medium to rarer medium.

Which of the statement given above is/are correct ?
(a) (a) only
(b) (b) only
(c) (a) and (c)
(d) (b) and (c)

54. Three student measured the focal length of a convex lens using parallel rays from a distant object. All of them measured the distance between the lens and the inverted image on the screen.

Student A saw a sharp image on the screen and labelled the distance as f_1.

Student B saw a slightly larger blurred image on the screen and labelled the distance as f_2.

Student C saw slightly larger blurred image on the screen and labelled the distance as f_3.

The relation between the three measurement would most likely be :

(a) $f_1 = f_2 = f_3$

(b) $f_1 < f_2$ and f_3

(c) $f_1 < f_2$ and $f_1 = f_3$

(c) None of these

55. A person is suffering from myopia. He is advised to use concave lens but by mistake the optician give him spectacle having convex lens which of the following ray diagram correctly shows the image formation in his eye.

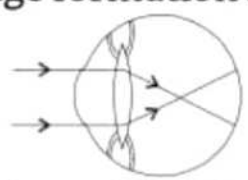
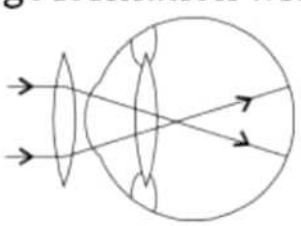
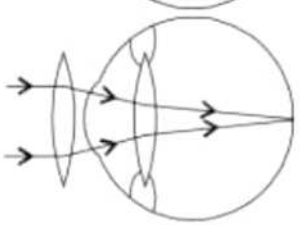


Image formation without using lens

(a)



(b)



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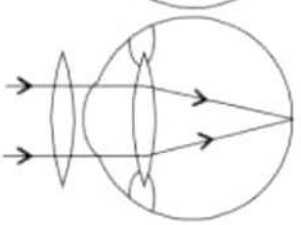
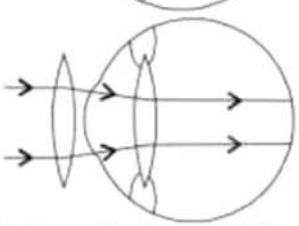


(d)



56. Which of the following does not describe working of the human eye?

(a) The lens system forms an image on a light sensitive screen called the retina.

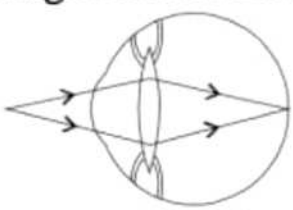
(b) Light enters the eye through a thin membrane called the cornea

(c) Rainbow is formed due to splitting of white light

(d) Iris is a dark muscular diaphragm that controls the size of the pupil for regulating the amount of light entering into the eye

57. Which of the following ray diagram is correct for image formation in a hypermetropic eye ?

(a)



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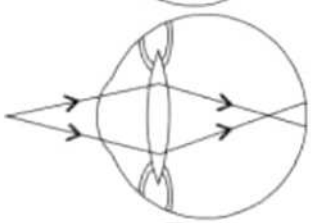
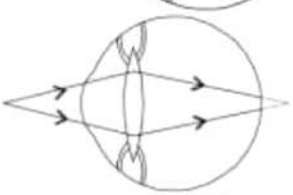
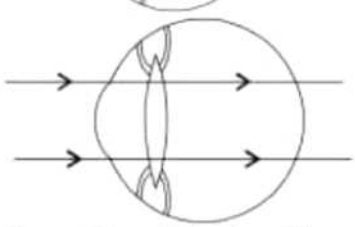


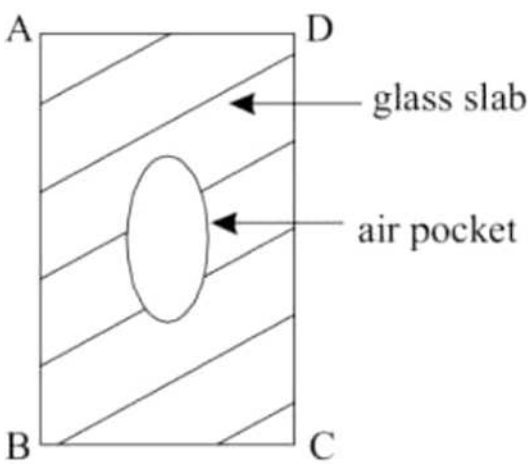
(c)



(d)



58. During the fabrication of a glass slab an air pocket is left in the slab as shown in fig.



For a parallel beam of light incident on face AB of slab the emergent beam through face CD will be a :

(a) Parallel beam
(b) Converging beam
(c) Diverging beam
(d) None of these

59. Light sensitive cells get activated on
(a) illumination
(b) seeing the different colours
(c) facing opaque objects
(d) receiving message from the brain

60. Iris contracts the pupil
(a) In bright light
(b) To allow less light to enter
(c) In darkness
(d) Only (a) and (b)

61. A person is not able to see near objects clearly, because
(a) image is formed behind the retina
(b) focal length of the eye lens is too great
(c) use of convex lens has been ignored, though it was advised
(d) All of the above

62. Hypermetropia is also known as far sightedness because
(a) the person is not able to see clearly the distant objects, but can see near objects clearly
(b) the person is able to see clearly the distant objects, but not near objects
(c) the person is not able to see clearly the distant or near objects
(d) the person is able to see clearly the distant or near objects

63. Presbyopia can be corrected by
(a) Using bifocal lenses
(b) Using microscopes
(c) Using binoculars
(d) Using sunglasses

64. The shape of the triangular prism
(a) Makes the emergent ray bend at angle to the direction of the incident ray

(b) Angle of deviation is the angle between the incident ray produced and the emergent ray produced
(c) Both (a) and (b)
(d) Neither (a) nor (b)

65. Dispersion of white light takes place because
(a) different colours of light bend through different angles with the incident ray
(b) the red light bends the least and the violet light bends the most
(c) both (a) and (b)
(d) refractive index of glass is not uniform in the prism

66. Placement of another identical prism in an inverted position with respect to the first and allowing the colours of spectrum to pass through it will
(a) change the spectrum into white light
(b) change the spectrum into a black band
(c) keep the spectrum as before
(d) split into more colours

67. Twinkling of a star is due to
(a) atmospheric refraction of sunlight
(b) atmospheric refraction of starlight
(c) lightening in the sky
(d) none of these

68 The path of light passing through a clear solution is not visible, but becomes visible through a colloid
(a) because light is scattered by relatively larger particles
(b) because light is getting refracted
(c) because light is getting refracted as well reflected
(d) All of these

69. The sky appears blue because
(a) molecules of air and other particles in the atmosphere are smaller than wavelength of visible light
(b) light of shorter wavelengths at the blue end are scattered more than the red light whose wavelength is 1.8 times

(c) the scattered blue light enters our eyes
(d) All of these

Hints & SOLUTIONS

1. **(b)**
2. **(c)**
3. **(d)**
4. **(a)** Angle of incidence is equal to the angle of reflection.
5. **(a)**
6. **(a)**
7. **(d)**
8. **(d)** An object placed at F of a concave mirror produces a highly enlarged, real & inverted image at infinity.
9. **(a)**
10. **(b)**
11. **(c)**
12. **(d)** A point-sized object placed at infinity of a concave mirror will produce a real & inverted, highly diminished image at its focus.
13. **(a)**
14. **(b)**
15. **(a)**
16. **(d)** A convex mirror always produces a diminished, virtual and erect image behind the mirror.
17. **(b)**
18. **(b)**
19. **(b)**
20. **(c)** A convex lens will produce a diminished, real and inverted image between F and 2F if the object is placed at 2F.
21. **(a)**
22. **(b)**
23. **(a)**
24. **(c)** A convex lens will produce an enlarged, real and inverted image beyond 2F if the object is placed between F and 2F.
25. **(a)**
26. **(c)**
27. **(a)**
28. **(a)** Absolute refractive index of a medium = speed of light in vacuum / speed of light in the medium.

29. **(a)**
30. **(c)**
31. **(a)**
32. **(a)** Focus of a concave mirror is towards the left, so focal length is negative.
33. **(a)**
34. **(a)**
35. **(c)**
36. **(b)** A ray of light traveling from optically denser to the optically rarer medium will bend away from the normal.
37. **(c)**
38. **(d)**
39. **(a)**
40. **(d)** Negative value of image distance signifies that the image is formed on the same side of the object. It is possible only when the image formed is virtual and erect. Such image is formed when the object is between focus and optical center in case of convex or any position of the object in case of concave lenses.
41. **(c)**
42. **(a)** 43. **(c)**
44. **(d)** Different constituents of white light have different wavelengths. So, they travel with different speeds after refraction, though they are traveling with the same speed in air.
45. **(b)** 46. **(b)** 47. **(c)**
48. **(a)** Colour of an object is determined by the colour of light reflected by it. The reflected light causes the sensation of the colour in the eye.
49. **(d)**
50. **(b)**
51. **(d)**
52. **(d)** Working of the human eye as a camera makes it one of the most valuable and sensitive organ of the body. It is only because of the eye that we are able to see the wonderful world and colours around us.
53. **(d)**
54. **(b)**
55. **(a)**

56. **(c)** Atmospheric refraction cause splitting of white sunlight when refracting through water droplets.

57. **(c)**

58. **(c)**

59. **(a)** Light sensitive cells get activated on illumination enabling formation of image.

60. **(d)** Iris is the muscle that contracts the pupil in bright light so as to allow less light to enter.

61. **(d)** The focal length of the eye lens is too great or the eye ball has shrunk. The image is formed behind the retina and the person faces difficulty in seeing the near objects clearly. Use of convex lens is advised for correcting the defect.

62. **(b)** Hypermetropia is also known as far sightedness because the person is able to see clearly the distant objects, but not near objects.

63. **(a)** Presbyopia is a condition in which a person is suffering from both myopia and hypermetropia. It can be corrected by using bifocal lenses in which upper portion is a concave lens and the lower portion is a convex lens.

64. **(c)** The inclined surfaces of the triangular prism makes the emergent ray bend at angle to the direction of the incident ray. The angle between the incident ray produced and the emergent ray produced is called the angle of deviation.

65. **(c)** Dispersion of white light takes place because different colours of light travel with different speeds in the same medium. They bend at different angles with the incident ray. The red light bends the least and the violet light bends the most.

66. **(a)** Placement of another identical prism in an inverted position with respect to the first and allowing the colours of spectrum to pass through it will change the spectrum into white light.

67. **(b)** The star is considered to be a point source of light for its distance from the earth. Apparent change in position of its image due to atmospheric refraction causes twinkling of stars.

68. **(a)** The path of light passing through a clear solution is not visible because of small particle

size do not come its way. But the path of light becomes visible through a colloid because light is scattered by relatively larger particles.

69. **(d)** The sky appears blue because molecules of air and other particles in the atmosphere are smaller than wavelength of visible light. Light of shorter wavelengths at the blue end are scattered more than the red light whose wavelength is 1.8 times. The scattered blue light enters our eyes.

Chapter 6

Electricity and Its Magnetic Effects

ELECTRICITY

Charge is something associated with matter due to which it produces and experiences electric and magnetic effects.

The study of charges at rest is called **static electricity** or **electrostatics** while the study of charges in motion is called **current electricity**. There are two types of electric charge:

(i) *Positive charge* and (ii) *Negative charge*

The magnitude of elementary positive or negative charge is same and is equal to 1.6×10^{-19} C.

Charge is a scalar quantity and its **SI unit** is **ampere second** or **coulomb** (C).

Basic properties of electric charge

(1) *Similar charges repel and opposite charges attract each other.*

(2) *A charged body attracts light uncharged bodies.*

(3) *Accelerated charge radiates energy.*

(4) Quantization of charge i.e., Q = + ne ; n = 1, 2, 3 ....

(5) Charge is conserved.

Types of Electricity

There are two types of electricity

(i) Static electricity (ii) Current or dynamic electricity

Static electricity causes physical effects due to the charge at rest. *Current electricity* causes physical effects due to the moving charge.

Conductors

It is a material which allows the current (charge) to pass through it, e.g. Aluminium, Copper, Silver (best).

Insulators

It is a material which does not allow the current (charge) to pass through it, e.g. Rubber, Wood, Plastic.

ELECTRIC CURRENT AND CIRCUIT

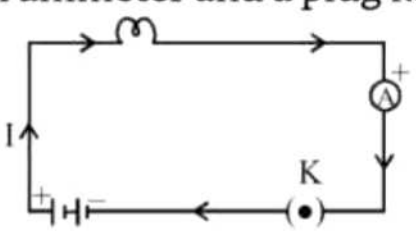
Electric current is the rate of flow of charge.

The magnitude of electric current in a conductor is the amount of charge flowing through it in one second.

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 $I = \frac{Q}{t}$

The SI unit of electric charge is coulomb (C),

- An instrument called ammeter measures electric current in a circuit. It is always connected in series in a circuit through which the current is to be measured shows the schematic diagram of a typical electric circuit comprising a cell, an electric bulb, an ammeter and a plug key.



One ampere is the amount of current when 1 coulomb of charge flows for 1 second, that is 1A = 1C/s.

Electric Potential and Potential Difference

When a unit test charge is placed outside an electric field which is produced by another charge it does not experience any force. When this test charge is brought inside the field, some work is done because the unit positive charge experiences a force which becomes more and more when the test charge moves near to the given charge. This amount of work done is known as electric potential.

Potential difference is the difference between electric potentials of two distinct points inside an electric field. A and B are two considered points

inside an electric field. When a unit positive test charge moves from A to B, some work is done. This amount of work done is known as *potential difference*.

It is represented by V.

Therefore, $V = \frac{W}{Q}$

One volt:

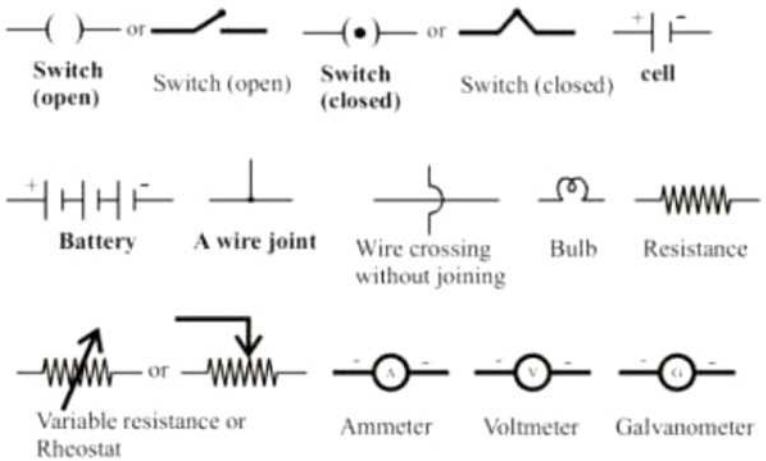
It is the potential difference when 1 joule of work is done to move a charge of one coulomb from one point to another inside an electric field.

$\therefore$ 1 volt = $\frac{1 \text{ joule}}{1 \text{ coulomb}}$, or $1V = 1JC^{-1}$.

Circuit Diagram

It is a closed conducting path containing a source of potential difference or electric energy and a device utilizing the electric energy.

Symbols of commonly used electrical components



RESISTANCE

Ohm's law

According to Ohm's Law, *"Electric current is directly proportional to the potential difference between the two ends of a conductor at constant temperature"* i.e.

$I \propto V$ or $V \propto I$ or $V = RI$

where R is constant of proportionality which is known as Resistance. It is measured in *ohm* represented by Ω.

One Ohm :- We know that $R = \frac{V}{I}$

$$1\ \Omega = \frac{1V}{1A} = 1V/A\ .$$

Resistance of a conductor is said to be 1 ohm if a potential difference of 1 volt across the ends of the conductor makes a current of 1 ampere to flow through it.

$1\ k\Omega = 1$ Kilo Ohm $= 10^3\ \Omega$

$1\ M\Omega = 1$ Mega Ohm $= 10^6\ \Omega$

Cause of Resistance

A conductor has large number of free electrons. When a potential difference is maintained across the ends of a conductor, the free electrons drift from one end to the other end of the conductor. During their movement, they collide with each other. These collisions oppose the movement of free electrons from one end to the other end of the conductor. This opposition to the flow of free electrons due to the collisions is called resistance. More is the collision suffered more is the resistance.

Factors Affecting Resistance of a Conductor

There are four factors on which resistance of a conductor i.e., wire depends :

(1) Length of wire or conductor.
(2) Area of cross-section.
(3) Nature of material of wire.
(4) Temperature.

Resistivity and Specific Resistance

Resistance of a conductor depends on length of wire and area of cross-section i.e.

$$R \propto L;\ R \propto \frac{1}{A} \text{ i.e., } R \propto \frac{L}{A} \Rightarrow R = \frac{\rho L}{A}$$

ρ is a constant. This constant of proportionality is known as resistivity, which is represented by ρ (rho).

Therefore, $\rho = \frac{RA}{L}$

Resistivity of a conductor is measured in 'ohm meter' or 'Ω m'.

Resistivity, which is also known as specific resistance is also defined as the resistance offered by a conductor of length 1 m having area of cross-section 1 m^2.

Resistivity of a material does not depend on length or area of cross-section. Infact, it depends on the nature of materials. For a particular material (conductor) resistivity is constant, e.g., resistivity of silver is 1.6×10^{-8} Ω m.

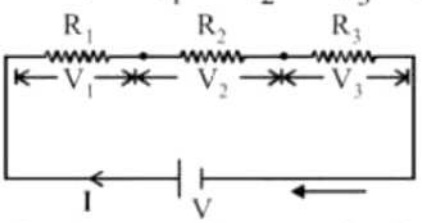
Resistance of Alloys

It is found practically that the resistance of alloys is more than the resistance of its constituent metals. It means alloys have higher resistivity than their constituent metals e.g., nichrome which is an alloy of nickel and chromium has very high resistivity than its constituent metals i.e., Nickel and Chromium.

Resistance of a System of Resistors

(i) **Combination of resistances in series :** When two or more resistances are connected end to end, they are said to be in series. When two or more resistances are connected in series, then current flowing in the circuit remains same i.e., it is equal in each and every resistance but PD gets distributed among these resistances. It means the sum of PDs or voltage across the different resistances is equal to the total voltage given to the circuit i.e.

$$V = V_1 + V_2 + V_3 + ...$$



The equivalent resistance is given by,

$$R = R_1 + R_2 + R_3 + ...$$

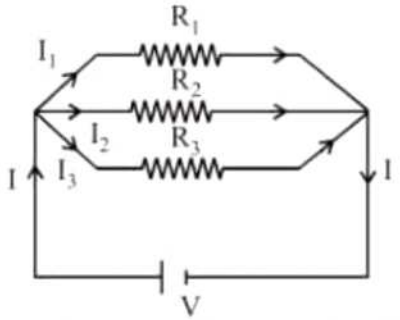
(ii) **Combination of resistances in parallel : -** If two or more resistances are connected to the

same end, they are said to be in parallel. When resistances are connected in parallel and put in a circuit with a battery of voltage 'V' volt which supplies a current of 'I' ampere, then :

(a) The PD across these resistances remain same i.e., 'V' volt.

(b) Current gets divided into parts in such a way that the total current in the circuit is equal to the sum of the currents flowing through each resistance.

$$I = I_1 + I_2 + I_3 + ...$$



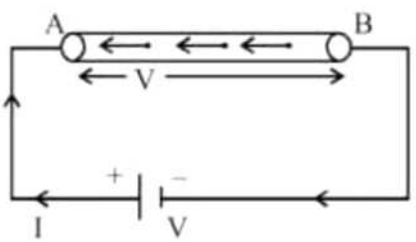
The equivalent resistance is given by,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$$

HEATING EFFECT OF ELECTRIC CURRENT

When the electric current is passed through a conductor then conductor gets heated, this effect is known as the heating effect of current.

Consider a conductor AB connected to a cell of potential difference V. If W be the work done to carry the charge q from one end to another end of the conductor,



Then, $V = \frac{W}{q}$

$$W = Vq \qquad .....(1)$$

If I be the amount of current flowing through the conductor, then

$q = I.t$

$W = VIt$; from (1)

This work done is equal to heat (H) produced in a conductor.

$$\boxed{H = VIt}$$

But according to Ohm's law

$V = IR$

Then, $\boxed{H = I^2Rt}$ and $I = \frac{V}{R}$

Then, $\boxed{H = \frac{V^2}{R}t}$

i.e., $\boxed{H = VIt = I^2Rt = \frac{V^2}{R}t}$

Joule's Law of Heating Effect

It states that the amount of heat produced in a conductor is

(i) directly proportional to the square of current passing through it,

$H \alpha I^2$ .... (1)

(ii) directly propotional to the resistance of conductor,

$H \alpha R$ .... (2)

(iii) Directly proportional to the time for which current passed ,

$H \alpha t$ .... (3)

Combining (1), (2) and (3).

$H \alpha I^2 Rt.$

Here, constant of proportionality is 1.

$$\boxed{H = I^2Rt \text{ joule}}$$

Practical Applications of Heating Effect of Current