



Answers to the questions given under Competency Based Questions

Chapter-1 Reflection of Light

Case/Source Based Questions ▼

1. (i) Comparison of Plane and Convex Mirrors:

- **Plane Mirror:** Forms virtual, erect images that are of the same size as the object and appear as far behind the mirror as the object is in front of it.
- **Convex Mirror:** Forms virtual, erect and diminished images that are closer to the mirror than the object.

Given: focal length, $f = 20$ cm

object distance, $u = 30$ cm

Using the formula, $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\frac{1}{20} = \frac{1}{v} + \frac{1}{30}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{30}$$

$$= \frac{3}{60} - \frac{2}{60}$$

$$= \frac{1}{60}$$

Image distance, $v = 60$ cm.

Magnification, $m = \frac{v}{u} = \frac{60}{30} = 2$

The image will be virtual, erect and 2 times of the size of the object.

(ii) Convex mirrors are preferred as rear view mirrors because:

- They provide a wider field of view, allowing drivers to see more of the area behind them.
- They always form diminished images, ensuring that a large area is visible in the mirror.

(iii) The angle of incidence is given as $i = 90^\circ - 40^\circ = 50^\circ$

By the law of reflection,

$$\text{angle of reflection} = \text{angle of incidence}$$

$$r = i = 50^\circ$$

2. (i) The mirror formula relates the focal length (f), object distance (u) and image distance (v) as $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

Given: $f = 15$ cm, $u = 30$ cm (negative as the object is on the left side of the mirror).

Using the formula,

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

$$\frac{1}{15} = \frac{1}{v} + \frac{1}{30}$$

$$\frac{1}{v} = \frac{1}{15} - \frac{1}{30}$$

$$= \frac{2}{30} - \frac{1}{30}$$

$$= \frac{1}{30}$$

or $v = 30$ cm.

Magnification, $m = \frac{v}{u} = \frac{30}{30} = 1$

The image is real, inverted and of the same size as the object.

(ii) When the object is placed at the focal point of the concave mirror, the reflected rays become parallel and the image is formed at infinity. The image is real, highly magnified and inverted.

(iii) For a concave mirror with a focal length of 15 cm, parallel rays converge at the focal point. The rays will meet at a distance of 15 cm from the mirror on the principal axis.

Value Based Questions ▼

1. Rahul uses the principle of reflection to tilt the rear view mirror, which directs the light from the approaching vehicle away from his eyes. This reduces glare and ensures a safer driving experience. This action demonstrates responsible behaviour and concern for road safety, highlighting the importance of quick thinking and applying basic science in real-life situations.
2. Convex mirrors provide a wider field of view, making it easier for drivers to see oncoming vehicles around sharp turns. Ravi's action shows social responsibility and concern for community safety. By installing these mirrors, Ravi helps prevent accidents and ensures safer roads for everyone.

Assertion & Reason Type Questions ▼

1. (a), 2. (a), 3. (b), 4. (d), 5. (c).

Chapter-2

Refraction and Total Internal Reflection of Light

Case/Source Based Questions ▼

1. (i) Given: angle of incidence, $i = 45^\circ$
 refractive index of water, $n_2 = 1.33$
 refractive index of air, $n_1 = 1.0$
 Using Snell's law,

$$\begin{aligned} n_1 \sin i &= n_2 \sin r \\ \sin r &= \frac{n_1}{n_2} \sin i = \frac{1.0}{1.33} \sin 45^\circ \\ &= \frac{1.0}{1.33} \cdot \frac{1}{\sqrt{2}} = \frac{1.0}{1.33 \cdot 1.414} \\ &= \frac{1}{1.88} = 0.53 \end{aligned}$$

Angle of refraction $r = \sin^{-1}(0.53)$

- (ii) The speed of light in water is given by $v = \frac{c}{n}$

where c is speed of light in air and n is the refractive index of water.

$$v = \frac{3 \times 10^8}{1.33} = 2.26 \times 10^8 \text{ m/s}$$

- (iii) The wavelength of light in water

$$\begin{aligned} \lambda_{\text{water}} &= \frac{\lambda_{\text{air}}}{n} \\ \lambda_{\text{water}} &= \frac{600}{1.33} = 451 \text{ nm.} \end{aligned}$$

- (iv) The refractive index (n) of a medium affects both the speed and wavelength of light as it moves from one medium to another. The speed of light in a medium is given by the equation $v = \frac{c}{n}$, where c is the speed of

light in a vacuum and n is the refractive index. As the refractive index increases, the speed of light decreases. This means that light travels slower in media with higher refractive indices (e.g., water or glass) compared to those with lower refractive indices (e.g., air or vacuum).

When light enters a new medium, its frequency remains constant, but its wavelength changes. The relationship between the speed, wavelength and frequency of light is given by $v = \lambda \nu$, where λ is the wavelength and ν is the frequency. Since, the speed of light decreases in a medium with a higher refractive index, the wavelength also shortens. Conversely, in a medium with a lower refractive index, the speed and wavelength of light increase. Therefore, light has a shorter wavelength in denser media (higher n) and a longer wavelength in less dense media (lower n).

2. (i) Given: $n_{\text{air}} = 1.0, n_{\text{glass}} = 1.5$

The critical angle is given by

$$\sin c = \frac{n_{\text{air}}}{n_{\text{glass}}} = \frac{1.0}{1.33} = 0.751$$

$$c = \sin^{-1}(0.751) = 48.6^\circ$$

- (ii) The incident angle 60° is greater than the critical angle 48.6° , so total internal reflection will occur. The light will be completely reflected inside the prism and will not refract into the air.
- (iii) Since the angle of incidence 70° exceeds the critical angle, total internal reflection will occur and no refraction will take place.
- (iv) Total internal reflection occurs when the angle of incidence is greater than the critical angle. If the refractive index of the prism increases, the critical angle decreases, making total internal reflection more likely at smaller angles of incidence. The relationship between the critical angle and the refractive index is inversely proportional—higher refractive indices lower the critical angle.

Value Based Questions ▼

- The straw appears bent at the point where it enters the iced tea due to refraction. Refraction occurs when light changes speed and direction as it passes from one medium to another with a different refractive index. In this case, light moves from air into iced tea. As light slows down when entering the denser iced tea, it bends toward the normal, creating the illusion that the straw is bent, even though it's perfectly straight. This observation teaches us the value of curiosity and appreciation for the natural world. It also reminds us that things are not always as they seem at first glance. There may be deeper explanations behind what we perceive, encouraging critical thinking. Additionally, the example highlights the importance of attention to detail and the value of observing and reflecting on even the simplest occurrences.
- Yes, Sarah should be suspicious. In a real diamond, any light hitting the surface at an angle greater than the critical angle (24.4°) from the normal should undergo total internal reflection and not exit the diamond. Since the light beam at 30° is refracting out instead of totally reflecting, this stone cannot be a genuine diamond. Sarah

demonstrates attention to detail and critical thinking, applying her knowledge of diamond properties to verify the authenticity of the stone. She also displays professional integrity by carefully assessing the stone to ensure accurate and reliable inspection results.

Assertion & Reason Type Questions ▼

1. (c), 2. (a), 3. (c) 4. (d) 5. (c).

Chapter-3

Refraction of Light at Spherical Surfaces: Lens

Case/Source Based Questions ▼

1. (i) From formula, $\frac{1}{f} = \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$.

Since, $R_2 = -30 \text{ cm}$, $R_1 = 10 \text{ cm}$, $f = 30 \text{ cm}$

$$\frac{1}{30} = \left(\frac{1}{10} - \frac{1}{-30} \right)$$

$$\frac{4}{3} = 1.33$$

(ii) From formula,

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{30} = \frac{1}{20} + \frac{1}{f_2}$$

$f_2 = 60 \text{ cm}$

(iii) By the lens maker's formula,

$$\frac{1}{f} = \left(\frac{\mu - 1}{R} \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

For biconvex lens, R_1 is positive and R_2 is negative.

Now, $\frac{1}{R/2} = \left(\frac{\mu - 1}{R} \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$ ($R_1 = R_2 = R$)

$$\frac{2}{R} = \left(\frac{\mu - 1}{R} \right) \left(\frac{1}{R} + \frac{1}{R} \right)$$

$$2 = 2(\mu - 1)$$

(iv) From formula,

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{60} = \frac{1}{20} + \frac{1}{f_2}$$

$f_2 = 30 \text{ cm}$

2. (i) Focal length of combination

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{80} + \frac{1}{20} = \frac{3}{40}$$

$f_2 = \frac{80}{3} \text{ cm} = 26.7 \text{ cm}$.

(ii) (a) Refractive index of air bubble $\mu_a = 1$
 Refractive index of glass $\mu_g = 1.5$
 $\mu_g > \mu_a$

Although air bubble is convex in shape but embedded in a medium of greater refractive index hence will behave as a concave lens.

- (b) Single convex lens
 (c) Between F and optical centre

(iii) For real image,

Given, $m = 3$

$$\therefore m = \frac{v}{u}$$

$$\frac{v}{u} = 3 \quad v = 3u$$

by lens formula, $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\frac{1}{20} = \frac{1}{3u} + \frac{1}{u}$$

$$\frac{1}{20} = \frac{4}{3u}$$

$$u = \frac{4 \times 20}{3} = \frac{80}{3} = 26.66 \text{ cm}$$

Value Based Questions ▼

- The convex lens in the magnifying glass refracts sunlight, converging the parallel rays to a point called the focal point. At this point, the concentrated energy causes the paper to burn. This situation teaches responsibility and careful handling of scientific tools. It also highlights the importance of using science for constructive purposes rather than causing harm.
- The power of the lens is:

$$P = \frac{100}{f(\text{cm})} = \frac{100}{50} = 2\text{D}$$

This initiative reflects empathy, inclusivity and the role of science in social responsibility by improving the quality of life for underserved communities.

Assertion & Reason Type Questions ▼

1. (b), 2. (c), 3. (a), 4. (d), 5. (a).

Chapter-4

Refraction and Dispersion of Light through Prism

Case/Source Based Question ▼

- (i) (a) Violet colour will suffer greatest dispersion.
 (b) Given, $A = 60^\circ$, $b = 53^\circ$, $y = 51^\circ$ and $r = 52^\circ$

Dispersive power of prism $\frac{b - r}{y}$

$$= \frac{53 - 52}{51} = 0.0196$$

(ii) The refractive index of prism angle A and angle of minimum deviation m is given by $n \sin \frac{(A+m)}{2} = \sin \frac{A}{2}$

According to the question $m = A$
Substituting the value, we have;

$$n \frac{\sin A}{\sin \frac{A}{2}} = \sin \frac{A}{2}$$

$$n \frac{2 \sin \frac{A}{2} \cos \frac{A}{2}}{\sin \frac{A}{2}} = 2 \cos \frac{A}{2}$$

For the given value of refractive index,

$$\cos \frac{A}{2} = \frac{\sqrt{3}}{2}$$

$$\cos \frac{A}{2} = \cos 30^\circ$$

Or $\frac{A}{2} = 30^\circ$
 $A = 60^\circ$

Thus, the angle of prism is 60°

(iii) Refractive index of prism,

$$n \sin \frac{(A+m)}{2} = \sin \frac{A}{2}$$

$$\sqrt{2} \frac{\sin \frac{(60+m)}{2}}{\sin \frac{60}{2}} = \sin \frac{60}{2}$$

$$\frac{1}{\sqrt{2}} \sin \frac{(60+m)}{2} = \sin \frac{60}{2}$$

$$\sin 45^\circ = \sin \frac{(60+m)}{2}$$

$$45^\circ = \frac{(60+m)}{2}$$

Or $m = 30^\circ$
Angle of incidence, $i = \frac{(60+30)}{2} = 45^\circ$

Value Based Questions ▼

1. The rainbow occurs when sunlight is refracted, dispersed and reflected by water droplets, splitting the light into its different colours. Ravi and his sibling show curiosity and appreciation for nature. They also learn about the beauty of science and the diversity of colours in life.

2. Prisms are designed in specific triangular shapes to refract and disperse light effectively. They are made from materials with high transparency and specific refractive indices, like glass or quartz, to achieve the desired optical effects. This question encourages students to explore material science and geometry. It fosters curiosity about why certain designs are better suited for particular purposes. It instills a mindset of innovation. It motivates students to apply scientific Principles to solve practical challenges and design better tools for the future.

Assertion & Reason Type Questions ▼

1. (c), 2. (c), 3. (a), 4. (b), 5. (a) .

Chapter-5 Optical Instruments

Case/Source Based Questions ▼

1. (i) A microscope consists of two lenses and we know focal length of a lens depends on the refractive index of the lens which itself depends on the wave length or colour of the light used. Therefore, we can say the magnifying power of a microscope depends on the colour of the light used.

(ii) Given,

$$f_o = 1.25 \text{ cm}$$

$$f_e = 5 \text{ cm and } m = 30$$

Magnification of compound microscope

$$m = m_o \cdot m_e = \frac{L}{f_o} \cdot 1 + \frac{D}{f_e}$$

$$30 = \frac{L}{1.25} \cdot 1 + \frac{25}{5}$$

$$30 - 1.25 = \frac{6L}{1.25}$$

$$L = \frac{30 - 1.25}{6} = 5 - 1.25$$

$$6.25 \text{ cm}$$

(iii) Given, $f_o = 1.0 \text{ cm}, f_e = 2.0 \text{ cm}, L = 20 \text{ cm}.$

$$\text{Magnifying power, } m = \frac{L}{f_o} \cdot 1 + \frac{D}{f_e}$$

$$\frac{20}{1.0} \cdot 1 + \frac{25}{2.0}$$

$$20 + \frac{27}{2} = 270$$

2. (i) When the image is formed at infinity, we can see it with minimum strain in the ciliary muscles of the eye.

Chapter-6

Wave Theory of Light

Case/Source Based Question ▼

- (ii) The multi-component lenses are used for both objective and the eyepiece to improve image quality by minimising various optical aberrations in lenses.
- (iii) Difference between a compound microscope and astronomical telescope are given below:
- The compound microscope is used to observe minute nearby objects whereas the astronomical telescope is used to observe distant objects.
 - In compound microscope, the focal length of the objective is lesser than that of the eyepiece whereas in astronomical telescope, the focal length of the objective is larger than that of the eyepiece.
- (iv) Two advantages of a reflecting type telescope over a refracting type telescope are given below:
- The image formed by reflecting type telescope is brighter than that formed by refracting telescope.
 - The image formed by the reflecting type telescope is free from chromatic aberration.

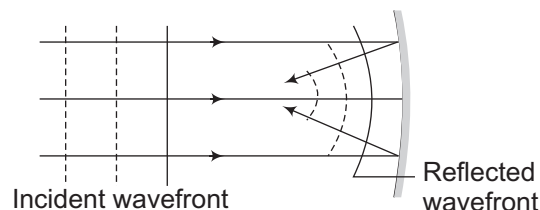
Value Based Questions ▼

- A microscope works on the principle of magnification and resolution using a combination of convex lenses. It allows tiny objects, like cells, to be viewed clearly by enlarging their image and resolving finer details. By using the microscope, Aryan helps his classmates identify plant cells, demonstrating his understanding of optical instruments. He shows helpfulness by assisting his classmates, teamwork by working collaboratively and patience while guiding them through the observation.
- To increase the magnification of the telescope, the astronomer can use an eyepiece with a shorter focal length. The magnifying power of a telescope is determined by the ratio of the focal length of the objective lens to the focal length of the eyepiece. By decreasing the focal length of the eyepiece, the magnification increases. However, the astronomer must also ensure that the image remains clear, as excessive magnification may blur the image. This situation reflects values such as curiosity and a desire to explore the unknown, as the astronomer seeks to understand distant galaxies. It also highlights critical thinking and responsibility as the astronomer considers both the magnification and image clarity.

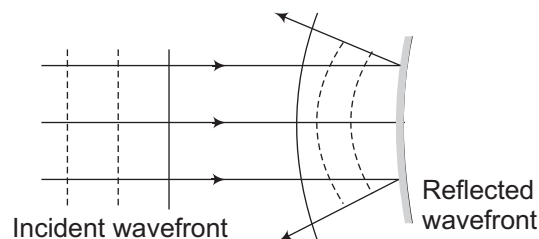
Assertion & Reason Type Questions ▼

1. (c). 2. (b). 3. (a). 4. (c). 5. (d).

- A wavefront is defined as a surface of constant phase. It is the continuous locus of points having the same phase of oscillation. When a plane wave passes through a convex lens, the geometrical shape of the wavefront that emerges would be converging spherical.
 - According to Huygens principle, each point of the wavefront is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions with the speed of the wave. These wavelets emanating from the wavefront are usually referred to as secondary wavelets and if we draw a common tangent to all these spheres, we obtain the new position of the wavefront at a later time.
 - (a) Reflected wavefront from a concave mirror:



- Reflected wavefront from a convex mirror:



- Given, velocity of sound in first medium, $v_1 = 332$ m/s
wavelength of sound waves in first medium, $\lambda_1 = 1.5$ m
and velocity of sound in second medium, $v_2 = 1500$ m/s
Frequency of sound waves in first medium,

$$f_1 = \frac{v_1}{\lambda_1} = \frac{332}{1.5} = 221.33 \text{ Hz}$$

Now, we know that, when a wave goes from one medium to another medium, its frequency does not change. Therefore frequency of sound waves in second medium, $f_2 = f_1 = 221.33$ Hz.

Now, wavelength of sound waves in second medium,

$$\lambda_2 = \frac{v_2}{f_2} = \frac{1500}{221.33} = 6.78 \text{ m.}$$

Value Based Questions ▼

1. Huygens demonstrated perseverance, intellectual courage and a commitment to truth. These values are crucial in any field where innovation and progress are desired. In science, perseverance is essential for conducting long-term research and overcoming setbacks. Intellectual courage is needed to challenge existing paradigms and propose new ideas. A commitment to truth drives scientists to seek accurate and reliable explanations of natural phenomena. These values are equally important in other areas of life, such as in pursuing personal goals, overcoming adversity and advocating for social justice.

Assertion & Reason Type Questions ▼

1. (b), 2. (d), 3. (a), 4. (b), 5. (c).

Chapter-7 Interference

Case/Source Based Questions ▼

1. (i) Given, $I_1 = 10 \text{ W/m}^2$ and $I_2 = 25 \text{ W/m}^2$
- $$\frac{I_1}{I_2} = \frac{a_1^2}{a_2^2} = \frac{10}{25} = \frac{a_1^2}{a_2^2} \Rightarrow \frac{a_1}{a_2} = \frac{3.16}{5}$$
- $$a_1 = \frac{3.16}{5} a_2 = 0.6324 a_2$$
- $$\frac{I_{\max}}{I_{\min}} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2} = \frac{[0.6324 a_2 + a_2]^2}{[0.6324 a_2 - a_2]^2}$$
- $$= \frac{0.6324 a_2 + a_2}{0.6324 a_2 - a_2} = \frac{1.6324}{-0.3676} = 19.724$$

- (ii) The condition for possible interference maxima on the screen is, $d \sin \theta = n \lambda$

where d is slit separation and λ is the wavelength.

As $d \sin \theta = n \lambda$ (given)

$$2 \sin \theta = n$$

or $2 \sin \theta = n$

For number of interference maxima to be maximum.

$$\sin \theta = 1$$

$$n = 2$$

The interference maxima will be formed when

$$n = 0, 1, 2$$

Hence, the maximum number of possible maxima is 5.

- (iii) Given, $y_1 = a \sin \left(t - \frac{x}{3} \right)$ and $y_2 = a \sin \left(t - \frac{x}{3} \right)$

Resultant amplitude,

$$A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2 \cos \phi}, \text{ where } \phi = \frac{x}{3} \text{ and}$$

$$a_1 = a_2 = a$$

$$\sqrt{a^2 + a^2 + 2aa \cos \frac{x}{3}} = \sqrt{3} a$$

2. (i) Monochromatic light, which consists of a single wavelength, is used to produce clear and stable interference patterns. Using light with multiple wavelengths would result in overlapping patterns, making it difficult to observe distinct fringes.

- (ii) Given, $d = 0.28 \text{ mm} = 0.28 \times 10^{-3} \text{ m}$

$$D = 1.4 \text{ m}$$

Distance of m th bright fringe from central bright fringe is $x = m \frac{D}{d}$

For $m = 4$, $x = 1.2 \text{ cm} = 1.2 \times 10^{-2} \text{ m}$.

$$1.2 \times 10^{-2} = 4 \frac{1.4}{0.28 \times 10^{-3}}$$

$$\frac{1.2 \times 10^{-2} \times 0.28 \times 10^{-3}}{4 \times 1.4}$$

$$0.06 \times 10^{-5} \text{ m} = 6000 \text{ \AA}$$

$$\text{Fringe width, } W = \frac{D}{d} \lambda$$

$$= \frac{1.4 \times 0.06 \times 10^{-5}}{0.28 \times 10^{-3}} = 3 \times 10^{-3} \text{ m}$$

$$= 3 \text{ mm}$$

- (iii) Given, $6000 \text{ \AA} = 6000 \times 10^{-10} \text{ m}$, $d = 0.05 \text{ cm} = 0.05 \times 10^{-2} \text{ m}$, $D = 1 \text{ m}$

Distance between first dark and first bright fringe

$$\frac{D}{2d} = \frac{6000 \times 10^{-10} \times 1}{2 \times 0.05 \times 10^{-2}} = 0.6 \text{ mm.}$$

Value Based Question ▼

1. Those colourful patterns are due to "thin-film interference." The oil forms a thin film on the water and light reflecting off the top and bottom surfaces of this film interferes, creating the colour. Different thicknesses of oil create different colours. Environmentally, oil spills are a disaster. They harm marine life, disrupt entire ecosystems and pollute water sources.

Assertion & Reason Type Questions ▼

1. (d), 2. (b), 3. (c), 4. (c), 5. (b).

Chapter-8

Diffraction

Case/Source Based Question ▼

- (i) The width of the central maxima is directly proportional to the wavelength, therefore if the wavelength of light is increased, then width of central maxima also increases.
- (ii) Condition for first minima due to a single slit, $a \sin \theta = \lambda$, where, a = width of slit.
- (iii) Bending of waves by obstacles by a large angle is possible when the size of the obstacle is comparable to the wavelength of the waves. On the one hand, the wavelength of light waves is too small in comparison to the size of the wall. Thus, the diffraction angle will be very small. Hence, the students are unable to see each other. On the other hand, the size of the wall is comparable to the wavelength of the sound waves. Thus, the bending of sound waves takes place at a large angle. Hence, the students are able to hear each other.

Value Based Question ▼

- During a family dinner, Rohit notices that when candlelight passes through the fine threads of a muslin cloth covering a window, a spectrum of colours appears on the wall. This phenomenon occurs due to the diffraction of light. The muslin cloth's fine threads create narrow slits, acting as a diffraction grating. When white light from the candle passes through these slits, it bends around the threads, causing the different wavelengths to spread out and form a colourful spectrum on the wall. Rohit's observation demonstrates his keen sense of curiosity and attentiveness to natural phenomena. By questioning and seeking to understand the underlying cause of the colourful display, he exhibits a scientific mindset and a desire to learn, which are commendable values.

Assertion & Reason Type Questions ▼

- (d), 2. (a), 3. (c), 4. (a), 5. (c).

Chapter-9

Polarisation of Light

Case/Source Based Question ▼

- (i) The student observes that as the analyser is rotated relative to the polariser, the transmitted light intensity decreases. This behaviour is described by Malus's law,

which states that the intensity of light transmitted through a polariser-analyser system is given by $I = I_0 \cos^2 \theta$, where I_0 is the initial intensity of the polarised light incident on the analyser and θ is the angle between the transmission axes of the polariser and analyser.

- (ii) When unpolarised light passes through a polariser, its intensity is reduced by half, so the intensity after the polariser is

$$I_p = \frac{I_0}{2}$$

Now, applying Malus law for $\theta = 60^\circ$

$$I_{\text{final}} = I_p \cos^2 \theta = \frac{I_0}{2} \cos^2 60^\circ = \frac{I_0}{2} \left(\frac{1}{2}\right)^2 = \frac{I_0}{8}$$

Therefore, the intensity of transmitted light is $\frac{I_0}{8}$.

- (iii) The angle between the polariser and analyser significantly affects the transmitted light intensity. According to Malus law, the transmitted intensity is proportional to $\cos^2 \theta$. As θ increases from 0° to 90° , the transmitted intensity decreases from its maximum value to zero. At $\theta = 0^\circ$, the axes are aligned and maximum intensity passes through. At $\theta = 90^\circ$, the axes are perpendicular and no light passes through.

Value Based Question ▼

- Polarised sunglasses contain a special polarising filter that blocks horizontally polarised light. When sunlight reflects off horizontal surface like water or roads, it becomes horizontally polarised. The polarising filter in the sunglasses absorbs this horizontally polarised light, reducing glare and enhancing visual clarity. This principle is based on the phenomenon of polarisation, where light waves oscillate in specific planes. By filtering out horizontally polarised light, the sunglasses improve contrast and reduce eye strain. By observing and understanding this phenomenon, Rahul demonstrates curiosity and an appreciation for how scientific principles, such as light polarisation are applied in everyday life to enhance quality of life.

Assertion & Reason Type Questions ▼

- (a), 2. (d), 3. (c), 4. (b), 5. (a).

Chapter-10

Dual Nature of Radiation and Matter

Case/Source Based Questions ▼

1. (i) Assuming potentiometer circuit as independent the current in wire PQ is $I = \frac{E}{r + R} = \frac{16}{2 + 8} = 1.6 \text{ A}$

P.D. across wire PQ, $V = IR = 1.6 \times 8 = 12.8 \text{ V}$

Equivalent resistance of tube

$$R = \frac{V}{I} = \frac{12.8}{2 \times 10^{-6}} \quad (I = 2 \text{ A} = 2 \times 10^{-6} \text{ A})$$

$$6.4 \times 10^6 \quad 6.4 \text{ M}$$

- (ii) $I = 2 \text{ A}$ is saturation current.

If n be the number of electrons emitted per second (number of photons falling per second), then

$$I = ne \text{ and } p = \frac{nhc}{\lambda}$$

$$\frac{p}{I} = \frac{hc}{e\lambda} \text{ or } \frac{hcl}{pe}$$

$$\frac{(2 \times 10^6)(6.6 \times 10^{-34})(3 \times 10^8)}{(4 \times 10^6)(1.6 \times 10^{-19})}$$

$$\frac{9.9}{1.6} \times 10^{-7} \text{ m} = \frac{9900}{1.6} \text{ \AA} = 6187.5 \text{ \AA}$$

which is in the range of orange light.

- (iii) The range of wavelength for red light is beyond the wavelength of incident light.

- (iv) Stopping potential, $V_s = \frac{12.8}{2} = 6.4 \text{ V}$

and $KE_{\max} = eV_s$
 $KE_{\max} = 6.4 \text{ eV}$

2. (i) Maximum kinetic energy,

$$K_{\max} = h\nu - \phi_0 = \frac{hc}{\lambda} - \phi_0$$

$$= \frac{(6.6 \times 10^{-34})(3 \times 10^8)}{(300 \times 10^{-9})} - 3.3 \times 1.6 \times 10^{-19}$$

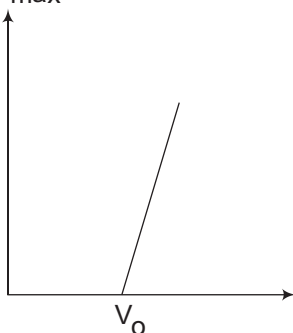
$$= 6.6 \times 10^{-19} - 3.3 \times 1.6 \times 10^{-19}$$

$$= 3.3 \times 10^{-19}(2 - 1.6) = 1.32 \times 10^{-19} \text{ J}$$

- (ii) We know, $K_{\max} = h\nu - \phi_0$, when $\nu = \nu_0$, $K_{\max} = 0$

$$0 = h\nu_0 - \phi_0 \text{ or } \phi_0 = h\nu_0$$

If $\nu < \nu_0$ then K_{\max} is negative i.e., no photoelectric emission takes place. The variation of maximum kinetic energy (K_{\max}) of the emitted photoelectron with frequency (ν) is shown in figure.



- (iii) Each graph cuts the $\frac{1}{\lambda}$ axis at $\frac{1}{\lambda_0}$.

For metal 1, $\frac{1}{\lambda_0} = 0.001 \text{ nm}^{-1}$

For metal 2, $\frac{1}{\lambda_0} = 0.002 \text{ nm}^{-1}$

For metal 3, $\frac{1}{\lambda_0} = 0.004 \text{ nm}^{-1}$

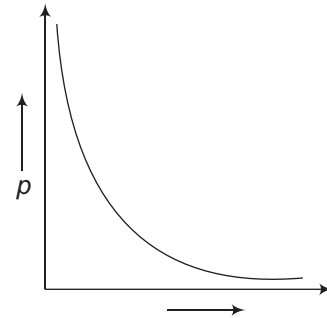
Now $\frac{hc}{\lambda_0} = (hc) \frac{1}{\lambda_0} = \phi_0$

$(\phi_0)_1 : (\phi_0)_2 : (\phi_0)_3 = 0.001 : 0.002 : 0.004$
 $1 : 2 : 3 = 1 : 2 : 4$

- (iv) de-Broglie wavelength

$$\frac{h}{p}, \text{ i.e., } \frac{1}{p}$$

So, the graph between $\frac{1}{\lambda}$ and p is shown in figure.



Value Based Questions ▼

- The photoelectric effect is the emission of electrons from a material when light incident on it. The work function is the minimum energy required to liberate an electron from the material. A material with a lower work function is preferable because it requires less energy (lower frequency/longer wavelength light) to cause electron emission, making the solar panel more efficient across a wider range of the solar spectrum. Values important in space exploration include efficiency, reliability, innovation and the pursuit of scientific discovery.
- The Davisson-Germer experiment demonstrated the wave nature of electrons by showing that they can be diffracted, a characteristic of waves. The observed interference pattern provided evidence for the de-Broglie hypothesis, which states that matter has wave-like properties. The teacher's dedication to clear explanation reflects values like education, mentorship and a commitment to fostering scientific understanding in the next generation.

Assertion & Reason Type Questions ▼

1. (b), 2. (a), 3. (b), 4. (a), 5. (a).

Chapter-11

Structure of Atom and Origin of Spectra

Case/Source Based Question ▼

1. (i) On other planet, $mvr = 2n \frac{h}{2} \quad v = \frac{nh}{mr}$

$$\frac{mv^2}{r} = \frac{1}{4} \frac{e^2}{r^2}$$

$$\frac{mn^2h^2}{2m^2r^3} = \frac{1}{4} \frac{e^2}{r^2}$$

Putting $n = 1$, we get $r = \frac{4h^2}{m e^2}$.

(ii) On our planet, $v_0 = \frac{e^2}{2nh}$

On other planet, $v = \frac{e^2}{2(2n)h} = \frac{v_0}{2}$.

(iii) On our planet, $E_n = \frac{13.6}{(n)^2}$

On other planet, $E_n = \frac{13.6}{(2n)^2}$

$$E_n = \frac{E_n}{4} = \frac{13.6}{4} = 3.4 \text{ eV.}$$

(iv) $\frac{13.6}{n^2} \text{ eV}$

Value Based Questions ▼

- Each element has a unique atomic spectrum, a "fingerprint" of specific wavelengths corresponding to electron transitions between energy levels. By comparing the observed spectral lines with known atomic spectra, scientists identify the elements present in the star. The principle governing this is the quantisation of energy levels and the emission/absorption of photons with energies matching the energy differences between these levels. The pursuit of understanding the universe demonstrates curiosity, a thirst for knowledge and a sense of wonder about the cosmos.
- To explain firework colours, the student should use the principles of atomic spectra and electron transitions. Heat from the explosion excites electrons to higher energy levels; when they return to their ground state, they emit photons of specific wavelengths, seen as different colours. Each element has unique energy levels, producing distinct colours (e.g., strontium for red, copper for blue). Flame temperature and chemical reactions also influence colour

intensity. This project fosters scientific inquiry, application of knowledge, creativity, precision, safety awareness and appreciation for the beauty of science.

Assertion & Reason Type Questions ▼

1. (c), 2. (a), 3. (a), 4. (c), 5. (d), 6. (d).

Chapter-12

Structure of Nucleus

Case/Source Based Question ▼

- (i) The nuclear force is of short range and the range of nuclear force is the order of $1.4 \times 10^{-15} \text{ m}$.

(ii) The nature of the force is strong nuclear force.

(iii) Nuclear force is much stronger than the electrostatic force inside the nucleus *i.e.*, at distances of the order of fermi. At 40 \AA , nuclear force is ineffective and only electrostatic force of repulsion is present. This is very high at this distance because nuclear force is not acting now and the gravitational force is very feeble. Thus, $F_{\text{nuclear}} > F_{\text{electrostatic}}$ in this case.

(iv) All the nucleons in an atom are held by nuclear force.

Value Based Question ▼

- The strong nuclear force is essential to counteract the electromagnetic repulsion between protons, allowing them to coexist within the nucleus. It is very strong but short-range force, acting only over distances comparable to the size of the nucleus. Effective teaching demonstrates dedication to education, a passion for sharing knowledge and a commitment to fostering scientific literacy.

Assertion & Reason Type Questions ▼

1. (c), 2. (a), 3. (a), 4. (b).

Chapter-13

Nuclear Energy

Case/Source Based Questions ▼

- (i) As just shown, energy conservation allows us to calculate the third particle's total energy. But we do not know what percentage of that total energy is mass energy.

(ii) According to the given information, subatomic reactions do not conserve mass. So, we cannot find the third particle's mass by setting,

$$m_{\text{neutron}} + m_{\text{proton}} + m_{\text{electron}} = m_{\text{third particle}}$$

The neutron has energy 940.97 MeV. The proton has energy 939.67 MeV + 0.01 MeV = 939.68 MeV. The electron has energy 0.51 MeV + 0.39 MeV = 0.90 MeV. Therefore, the third particle has energy

$$E_{\text{third particle}} = E_{\text{neutron}} + E_{\text{proton}} + E_{\text{electron}} = 940.97 + 939.67 + 0.90 = 1881.54 \text{ MeV}$$

We just found the third particle's total energy, the sum of its mass energy and kinetic energy. Without more information, we cannot figure out how much of that energy is mass energy.

(iii) Yes, but only if the proton has potential energy (due to interactions with other particles).

(iv) Given, $P = 500 \text{ MW} = 5 \times 10^8 \text{ W}$, $t = 1 \text{ h} = 3600 \text{ s}$
Energy produced,

$$E = P t = 5 \times 10^8 \times 3600 = 1.8 \times 10^{11} \text{ J}$$

As $E = mc^2$

$$m = \frac{E}{c^2} = \frac{1.8 \times 10^{11}}{(3 \times 10^8)^2} = \frac{1.8 \times 10^{11}}{9 \times 10^{16}} = 2 \times 10^{-5} \text{ kg}$$

2. (i) Nuclear fission can be explained on the basis of liquid drop model.

(ii) Reactions (a) and (b) represent fission of uranium isotope ${}_{92}^{235}\text{U}$, when bombarded with neutrons that breaks it into two intermediate mass nuclear fragments. However, reaction (c) represents two deuterons fuses together to form the light isotope of helium.

(iii) The energy of the neutron released per fission of the uranium atom is 2 MeV.

(iv) In fission process, when a parent nucleus breaks into daughter products, then some mass is lost in the form of energy. Thus,

Mass of fission products < Mass of parent nucleus.

$$\frac{\text{Mass of fission products}}{\text{Mass of parent nucleus}} < 1$$

Value Based Questions ▼

1. The use of nuclear weapons raises profound ethical questions about the value of human life, the morality of mass destruction and the long-term consequences for humanity and the environment. Scientists have a responsibility to communicate the potential dangers of nuclear weapons and citizens have a responsibility to engage in informed discussions and advocate for peace and disarmament. Values such as human dignity, peace and global responsibility are paramount.

2. Balancing economic development with health and environmental concerns requires careful assessment of risks and benefits, transparent communication with the community and implementation of appropriate safety measures. Scientific research plays a vital role in understanding the potential health effects of radiation exposure and informing policy decisions. Values such as sustainable development, community well-being and evidence-based decision-making are important.

Assertion & Reason Type Questions ▼

1. (b), 2. (a), 3. (c), 4. (a), 5. (c).

Chapter-14 Junction Diode

Case/Source Based Questions ▼

1. (i) Voltage drop across R ,

$$V_R = V_B - V_N = 5 - 0.7 = 4.3 \text{ V}$$

Given, $I_{\text{min}} = 1 \times 10^{-3} \text{ A}$

Maximum value of resistance,

$$R_{\text{max}} = \frac{V_R}{I_{\text{min}}} = \frac{4.3}{1 \times 10^{-3}} = 4.3 \times 10^3 = 4.3 \text{ k}\Omega$$

(ii) Given, $I = 6 \text{ mA} = 6 \times 10^{-3} \text{ A}$;

$$V_R = V_B - V_N = 5 - 0.7 = 4.3 \text{ V}$$

$$R = \frac{V_R}{I} = \frac{4.3}{6 \times 10^{-3}} = 717 \Omega$$

(iii) Total potential, $V_t = V_{bi} + V_R = 0.63 + 6 = 6.63 \text{ V}$

(iv) Given, $V_B = 6 \text{ V}$; $V_N = 0.7 \text{ V}$, $V_R = 6 - 0.7 = 5.3 \text{ V}$

$$\text{Power dissipated, } P = I V_R = (6 \times 10^{-3}) \times 5.3 = 31.8 \times 10^{-3} \text{ W} = 31.8 \text{ mW}$$

2. (i) The rms value of the output voltage at the load resistance,

$$V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$$

In full wave rectifier, the whole cycle is rectified so the value of input voltage will be same as output.

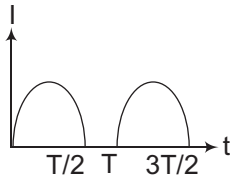
(ii) Output frequency of full wave rectifier is twice the output frequency of half wave rectifier.

Hence,

$$\frac{\text{Frequency of half wave rectifier}}{\text{Frequency of full wave rectifier}} = \frac{1}{2} \quad 1:2$$

(iii) The given circuit works as a half wave rectifier. In this circuit, we will get current through R when p - n junction

diode is forward biased and no current flow when $p-n$ junction diode is reverse biased. Thus, the current (I) through resistor (R) will be shown in the waveform.



(iv) As the output voltage obtained in a half wave rectifier, circuit has a single variation in one cycle of AC voltage, hence the fundamental frequency in the ripple of output voltage would be 50Hz.

Value Based Questions ▼

1. Reshu should not recommend using a PN diode half-wave rectifier for a mobile phone charger. While it's cost-effective and simple, it has significant drawbacks. The half-wave rectifier only uses half of the AC cycle, resulting in poor power efficiency, which can affect the charging performance. This inefficiency may lead to overheating and reducing the product's longevity. Additionally, the unstable DC output could damage sensitive parts of the phone. Ethically, Reshu should prioritize energy efficiency, product reliability, and customer satisfaction over

short-term cost savings. Reshu should demonstrate responsibility, integrity, and a commitment to providing high-quality, durable products that meet safety and performance standards.

2. Doping in semiconductors enhances the efficiency of solar cells by introducing impurities. It creates either extra electrons (in n -type) or extra holes (in p -type), improving the material's electrical conductivity. As a result, the efficiency of energy conversion from sunlight to electricity increases.

Rahul's observation highlights a strong understanding of scientific principles and innovation in improving energy technologies. His concern for energy efficiency reflects his responsibility toward sustainable development. By emphasizing the importance of doping, he demonstrates a commitment to clean energy technologies and the need to minimize energy loss in solar power generation, which is crucial for reducing dependence on non-renewable energy sources.

Assertion & Reason Type Questions ▼

1. (a), 2. (c), 3. (d), 4. (d), 5. (a), 6. (b), 7. (a), 8. (c), 9. (d), 10. (a).

