Optics JEE Main PYQ - 1

Total Time: 25 Minute **Total Marks:** 40

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

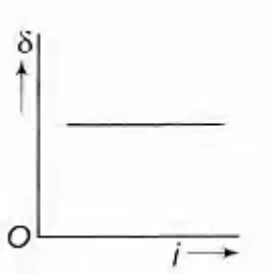
Optics

1. The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by **(+4, -1)**

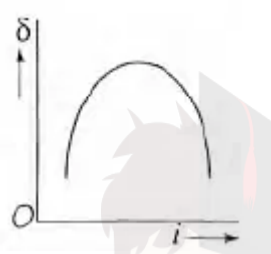
[2013]

Click Here for Solution

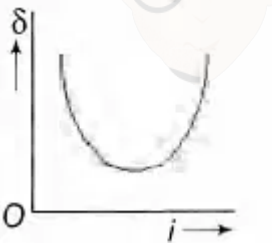
a.



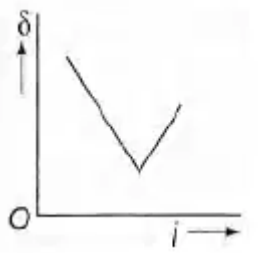
b.



c.



d.



---

2. Diameter of a plano-convex lens is $6\,cm$ and thickness at the centre is 3 mm. If speed of light in material of lens is 2×10^8 m/s, the focal length of the lens is **(+4, -1)**

[2013]

a. $15\,cm$

Click Here for Solution

b. $20\,cm$

c. $30\,cm$

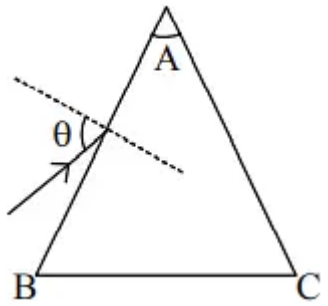
d. $10\,cm$

---

3. Monochromatic light is incident on a glass prism of angle A. If the refractive index of the material of the prism is u, a ray incident at an angle θ, on the face AB would get transmitted through the face AC of the prism provided **(+4, -1)**

[11 Jan. 2019 II]

Click Here for Solution



a. $\theta < cos^{-1}\left[\mu sin\left(A + sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

b. $\theta < sin^{-1}\left[\mu\, sin\left(A - sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

c. $\theta > cos^{-1}\left[\mu\, sin\left(A + sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

d. $\theta > sin^{-1}\left[\mu\, sin\left(A - sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

---

4. A vessel of depth $2\,h$ is half filled with a liquid of refractive index $2\sqrt{2}$ and the upper half with another liquid of refractive index $\sqrt{2}$ The liquids are immiscible. The apparent depth of the inner surface of the bottom of vessel will be : **(+4, -1)**

[9 Jan. 2020 I]

Click Here for Solution

a. $\frac{h}{\sqrt{2}}$

b. $\frac{3}{4}h\sqrt{2}$

c. $\frac{h}{3\sqrt{2}}$

d. $\frac{h}{2\left(\sqrt{2}+1\right)}$

---

5. An object is located in a fixed position in front of a screen. Sharp image is obtained on the screen for two positions of a thin lens separated by $10\,cm$. The size of the images in two situations are in the ratio 3 : 2. What is the distance between the screen and the object ? **(+4, -1)**

April 11, 2014

Click Here for Solution

a. $124.5\,cm$

b. $144.5\,cm$

c. $65.0\,cm$

d. $99.0\,cm$

---

6. A concave mirror has radius of curvature of $40\,cm$. It is at the bottom of a glass that has water filled up to $5\,cm$ (see figure). If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d is close to : (Refractive index of water $= 1.33$) **(+4, -1)**

12 Apr. 2019 I

Click Here for Solution

a. $8.8\,cm$

b. $11.7\,cm$

c. $6.7\,cm$

d. $13.4\,cm$

---

7. A convergent doublet of separated lenses, corrected for spherical aberration, has resultant focal length of $10\,cm$. The separation between the two lenses is $2\,cm$. The focal lengths of the component lenses are : **(+4, -1)**

April 15, 2018

Click Here for Solution

a. 10 cm, 12 cm

b. 12 cm, 14 cm

c. 16 cm, 18 cm

d. 18 cm, 20 cm

---

8. A convex lens is put $10\,cm$ from a light source and it makes a sharp image on a screen, kept $10\,cm$ from the lens. Now a glass block (refractive index 1.5) of $1.5\,cm$ thickness is placed in contact with the light source. To get the sharp image again, the screen is shifted by a distance d. Then d is : **(+4, -1)**

9 Jan. 2019 I

a. $0.55\,cm$ away from the lens

Click Here for Solution

b. $1.1\,cm$ away from the lens

c. $0.55\,cm$ towards the lens

d. 0

---

9. A thin cylindrical rod of length $10\,cm$ is placed horizontally on the principle axis of a concave mirror of focal length $20\,cm$ The rod is placed in a such a way that mid point of the rod is at $40\,cm$ from the pole of mirror The length of the image formed by the mirror will be $\frac{x}{3}cm$ The value of x is _____ **(+4, -1)**

1-Feb-2023 Shift 1

Click Here for Solution

---

10. In an experiment for estimating the value of focal length of converging mirror, image of an object placed at $40\,cm$ from the pole of the mirror is formed at distance $120\,cm$ from the pole of the mirror These distances are measured with a modified scale in which there are 20 small divisions in $1\,cm$ The value of error in measurement of focal length of the mirror is $\frac{1}{K}cm$ The value of K is _____ **(+4, -1)**

30-Jan-2023 Shift 1

Click Here for Solution

Answers

1. **Answer: c**

Explanation:

We know that the angle of deviation depends upon the angle of incidence.

$\theta_4=\sin^{-1}n\sin(\theta_3)$

$A+\delta=\theta_1+\theta_4$, which suggests that

$A=\theta_2+\theta_3$

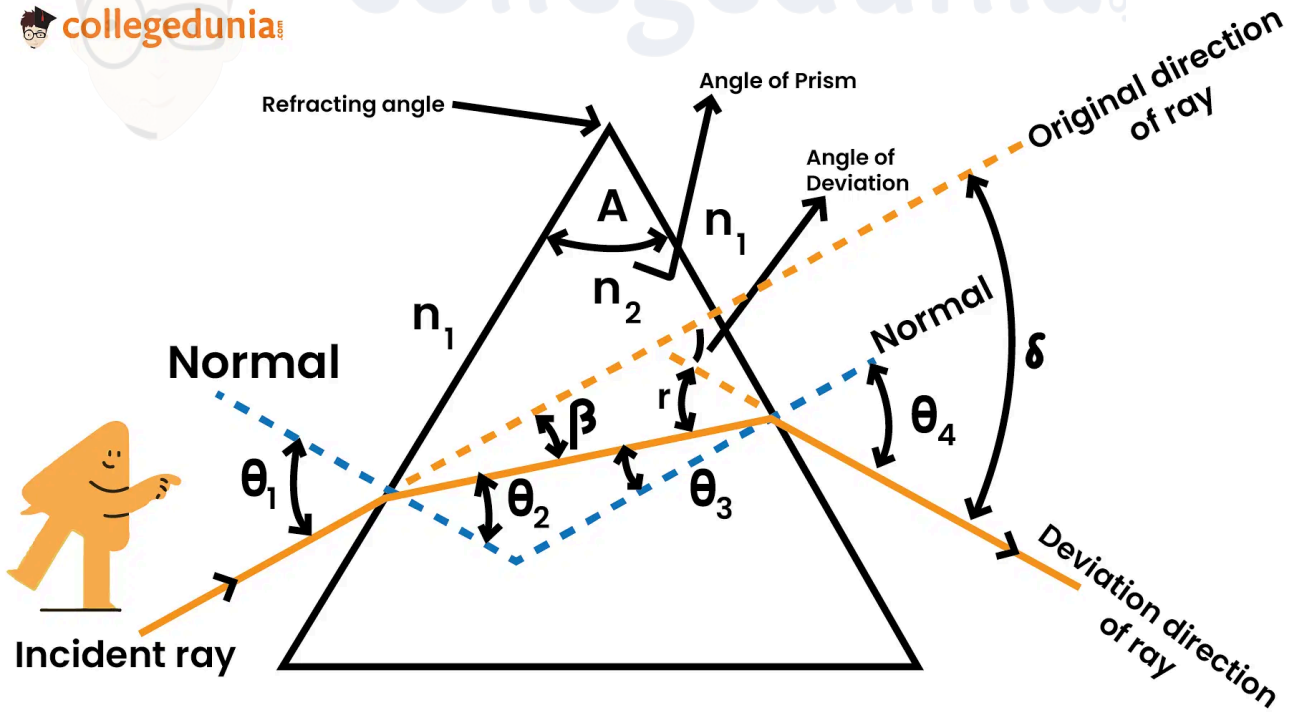
substituting the value of θ_4,

$\delta=\theta^1+\sin^{-1}n\sin(\theta_3)-A$

then the value of δ is

$\delta=\theta_1+\sin⁡ n\sin(A-\sin⁡ (\sin(\theta 1/n))) -A$

Plot this on the graph. The curve should be continuous and non-linear. Also, minimum deviation takes place at only value 1 of angle incidence.



Therefore, The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by Option C).

The graph between the angle of deviation (δ) and the angle of incidence (i) for a triangular prism is not a simple linear relationship.

- It is a non-linear curve that can be represented by a sine function.
- The angle of deviation (δ) is the angle between the incident ray and the emergent ray after passing through the prism.
- The angle of incidence (i) is the angle between the incident ray and the normal to the surface of the prism.
- As the angle of incidence (i) increases, the angle of deviation (δ) also changes.
- Initially, the angle of deviation increases slowly with the angle of incidence, but as the angle of incidence increases further, the angle of deviation starts to increase more rapidly.

This non-linear relationship is due to the refraction of light as it passes through the prism. The refractive index of the prism material and the geometry of the prism play a crucial role in determining the angle of deviation for a given angle of incidence.

To accurately represent the graph between δ and i for a triangular prism, a mathematical equation based on the principles of optics and trigonometry is used. The equation involves the refractive index of the prism material, the apex angle of the prism, and the angle of incidence.

> *Read more from chapter: Angle of minimum deviation*

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called **Refraction**.

Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments

---

2. Answer: c

Explanation:

By Pythagoras theorem

$R^2 = (3)^2 + (R - 0.3)^2 \Rightarrow \ R \approx$ 15 cm

Refractive index of material of lens $\mu = \frac{c}{v}$

Here c = speed of light in vacuum = 3 x 10^8 m/s

v = speed of light in material of lens = 2 x 10^8 m/s

$\hspace55mm =\frac{3 \times 10^8}{2 \times 10^8}=\frac{3}{2}$

From lens maker's formula

$\hspace25mm \frac{1}{f}=(\mu-1) \big(\frac{1}{R_1}-\frac{1}{R_2}\big)$

Here, $R_1 = R and R_2 = \infty$ (For plane surface)

$\hspace25mm \frac{1}{f}=\big(\frac{3}{2}-1\big) \big(\frac{1}{15}\big)$

$\Rightarrow \hspace25mm f=$30 cm

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called Refraction.

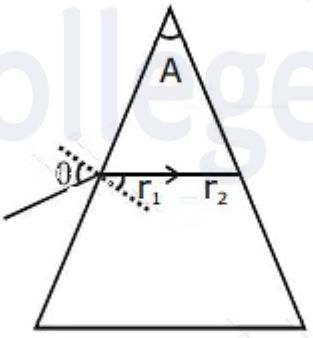
Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments

---

3. **Answer: d**

Explanation:



$r_{2}

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called Refraction.

Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments

---

4. **Answer: b**

Explanation:

For near normal incidence,

$h_{app} = \frac{h_{actual}}{\left(\frac{\mu_{in}}{\mu_{ref.}}\right)}$

$\therefore h_{apparent} = \frac{\frac{h}{\left(\frac{2\sqrt{2}}{\sqrt{2}}\right)}+h}{\frac{\sqrt{2}}{1}} = \frac{3h}{2\sqrt{2}} = \frac{3}{4}h\sqrt{2}$

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called Refraction.

Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments

---

5. Answer: d

Explanation:

$\frac{m_1}{m_2} = \frac{3}{2} = \left(\frac{D+10}{D-10}\right)^2$

$D = 99\,cm$

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called Refraction.

Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments

---

6. **Answer: a**

Explanation:

Light incident from particle P will be reflected at mirror $u = -5cm, f = -\frac{R}{2} = -20cm$
$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$
$v_1 = +\frac{20}{3}cm$
This image will act as object for light getting refracted at water surface
So, object distance $d = 5 + \frac{20}{3} = \frac{35}{3}cm$ below water surface.
After refraction, final image is at
$d' = d\left(\frac{\mu_2}{\mu_1}\right)$
$= \left(\frac{35}{3}\right)\left(\frac{1}{4/3}\right)$
$= \frac{35}{4} = 8.75cm$
$\approx 8.8cm$

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called Refraction.

Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments

---

7. Answer: d

Explanation:

For a convergent doublet of separated lens, we have

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

where d is separation between two lens, f_1 and f_2 are focal lengths of component lenses,

f is resultant focal length. Therefore, E (1) becomes

$\frac{1}{10} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{2}{f_1 f_2} \Rightarrow \frac{1}{10} = \left(\frac{f_2 + f_1 - 2}{f_1 f_2}\right)$

$\Rightarrow f f_2 = 10 f_2 + 10 f_1 - 20$

$\Rightarrow 10 f_1 + 10 f_2 - f f_2 = +20$

For $f = 18\,cm$ and $f_2 = 20\,cm$, the above equation satisfies.

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called Refraction.

Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments

8. **Answer: a**

Explanation:

$\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{10}-\frac{1}{-10}=\frac{1}{f} \Rightarrow f=5cm$
Shift due to slab = $t\left(1-\frac{1}{\mu}\right)$ n the direction of incident ray
$=1.5\left(1-\frac{2}{3}\right)=0.5$
again, $\frac{1}{v}-\frac{1}{-9.5}=\frac{1}{5}$
$\Rightarrow \frac{1}{u}=\frac{1}{5}-\frac{2}{19}=\frac{9}{95}$
$\Rightarrow v=\frac{95}{9}=10.55\,cm$

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called Refraction.

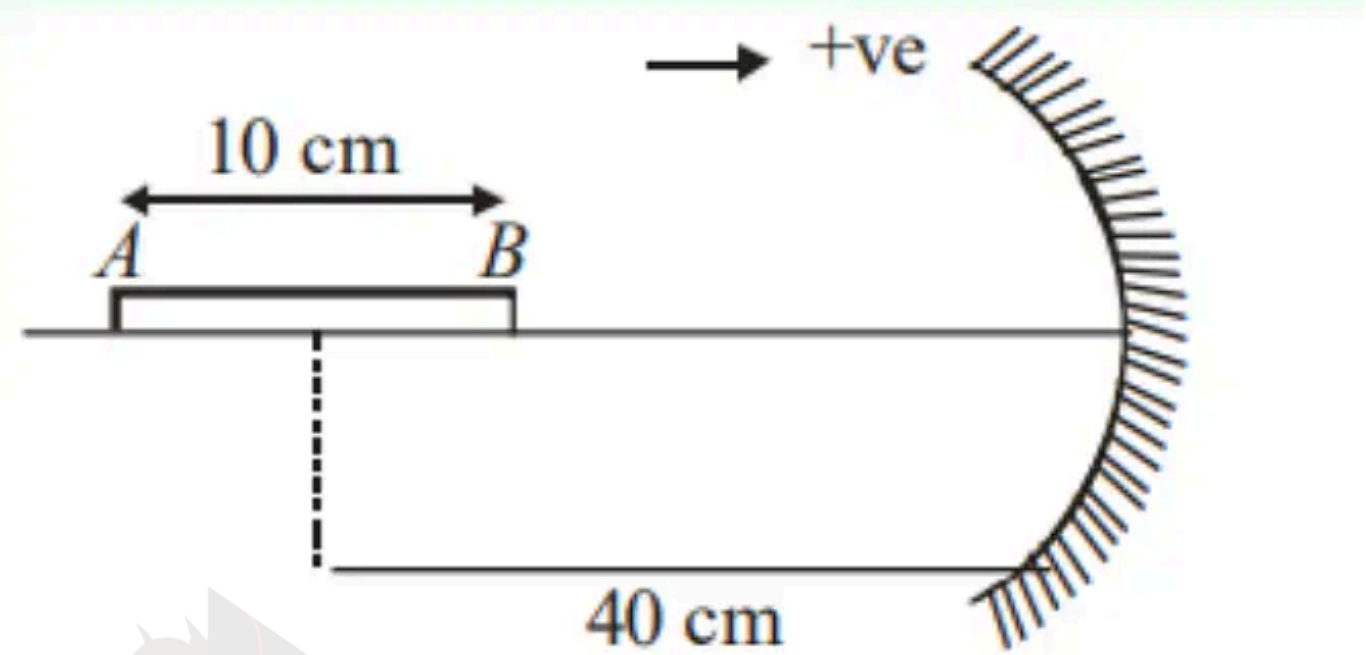
Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments

9. **Answer: 32 - 32**

Explanation:

The correct answer is 32.



$U_A = -45\,cm,\ f = -20\,cm$

$V_A = \frac{-45\times(-20)}{-45-(-20)} = \frac{-900}{25} = -36\,cm$

And $U_B = -35\,cm$

$\therefore V_B = \frac{-35\times(-20)}{-35-(-20)} = \frac{700}{-15}$

$\therefore V_A - V_B =$ length of image

$= \left(-36 + \frac{140}{3}\right)\,cm$

$= \frac{-108+140}{3}\,cm$

$= \frac{32}{3}\,cm$

$\therefore x = 32$

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called Refraction.

Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments

---

10. Answer: 32 - 32

Explanation:

The correct answer is 32.

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

$\frac{-1}{120}-\frac{1}{40}=\frac{1}{f},\ \ f=-30\,cm$

Now,

$\frac{-1}{v^2}dv-\frac{1}{u^2}du=-\frac{1}{f^2}df$

Also $dv=du=\frac{1}{20}cm$

$\therefore \frac{\frac{1}{20}}{(120)^2}+\frac{\frac{1}{20}}{(40)^2}=\frac{df}{(30)^2}$

On solving

$df=\frac{1}{32}\,cm$

$\therefore k=32$

Concepts:

1. Ray Optics and Optical Instruments:

Optics, deals with the determination of behaviour and the properties of light, along with its interactions with the matter and also with the instruments that are used to detect it.

Ray optics is also known as the geometrical optics and it is a branch of science which describes light propagation.

Reflection is the change in direction of light at an interface in-between two different media so that the wave-front returns into a medium from which it was originated.

Speed of light is the rate at which the light travels in free space.

A phenomenal change in image formed when the light is passed from one medium to another which is called Refraction.

Total Internal Reflection is the reflection of light when the light ray enters into a rarer medium from a denser medium and the angle of incidence is higher than the critical angle of incidence then that light ray will be reflected back to the denser medium.

Read More: Ray Optics and Optical Instruments