Optics JEE Main PYQ - 2

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. A convex lens (of focal length $20\,cm$) and a concave mirror, having their principal axes along the same lines, are kept $80\,cm$ apart from each other. The concave mirror is to the right of the convex lens. When an object is kept at a distance of $30\,cm$ to the left of the convex lens, its image remains at the same position even if the concave mirror is removed. The maximum distance of the object for which this concave mirror, by itself would produce a virtual image would be : **(+4, -1)**

8 Apr. 2019 II

a. $20\,cm$

b. $10\,cm$

Click Here for Solution

c. $25\,cm$

d. $30\,cm$

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2. A diverging lens with magnitude of focal length $25\,cm$ is placed at a distance of $15\,cm$ from a converging lens of magnitude of focal length $20\,cm$. A beam of parallel light falls on the diverging lens. The final image formed is : **(+4, -1)**

a. real and at a distance of 40 cm from convergent lens

Click Here for Solution

b. virtual and at a distance of 40 cm from convergent lens

c. real and at a distance of 40 cm from the divergent lens

d. real and at a distance of 6 cm from the convergent lens

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3. A light ray falls on a square glass slab as shown in the diagram. The index of refraction of the glass, if total internal reflection is to occur at the vertical face, is equal to : **(+4, -1)**

April 23, 2013

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

Click Here for Solution

b. $\sqrt{\frac{5}{2}}$

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

d. $\sqrt{\frac{3}{2}}$

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4. A plano-convex lens (focal length f_2, refractive index μ_2, radius of curvature R) fits exactly into a plano-concave lens (focal length f_1, refractive index μ_2, radius of curvature R). Their plane surfaces are parallel to each other. Then, the focal length of the combination will be : [12 Jan. 2019 II **(+4, -1)**

a. $f_1 - f_2$

b. $f_1 + f_2$

Click Here for Solution

c. $\frac{R}{\mu_2 - \mu_1}$

d. $\frac{2f_1 f_2}{f_1 + f_2}$

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5. A plano convex lens of refractive index μ_1 and focal length f_1 is kept in contact with another plano concave lens of refractive index μ_2 and focal length f_2. If the radius of curvature of their spherical faces is R each and $f_1 = 2f_2$, then μ_1 and μ_2 are related as : [10 Jan. 2019 I **(+4, -1)**

a. $\mu_1 + \mu_2 = 3$

b. $2\mu_1 - \mu_2 = 1$

Click Here for Solution

c. $2\mu_2 - \mu_1 = 1$

d. $3\mu_2 - 2\mu_1 = 1$

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6. A printed page is pressed by a glass of water. The refractive index of the glass and water is 1.5 and 1.33 , respectively. If the thickness of the bottom of glass is $1\,cm$ and depth of water is $5\,cm$, how much the page will appear to be shifted if viewed from the top ? April 25, 2013 **(+4, -1)**

a. $1.033\,cm$

b. $3.581\,cm$

Click Here for Solution

c. $1.5cm$

d. $1.90\,cm$

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7. A thin convex lens made from crown glass $\left(\mu = \frac{3}{2}\right)$ has focal length f. When it is measured in two different liquids having refractive indices $\frac{4}{3}$ and $\frac{5}{3}$, it has the focal lengths f_1 and f_2 respectively. The correct relation between the focal lengths is **(+4, -1)**

2014

a. $f_1 - f_2$

b. $f_2 > f$ and f_2 becomes negative

Click Here for Solution

c. $f_2 > f$ and f_1 becomes negative

d. f_1 and f_2 both become negative

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8. A thin convex lens of focal length ' f' is put on a plane mirror as shown in the figure. When an object is kept at a distance ' a ' from the lens-mirror combination, its image is formed at a distance $\frac{a}{3}$ in front of the combination. The value of ' a ' is **(+4, -1)**

April 11, 2015

a. f

b. $2f$

Click Here for Solution

c. $3f$

d. $\frac{3}{2}$f

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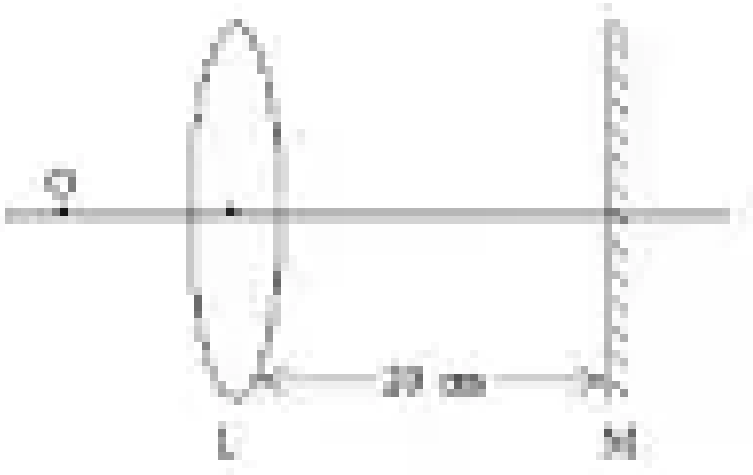
9. An object is placed on the principal axis of convex lens of focal length $10cm$ as shown A plane mirror is placed on the other side of lens at a distance of $20cm$ The image produced by the plane mirror is $5cm$ inside the mirror The distance of the object from the lens is $\_\_\_cm$ **(+4, -1)**

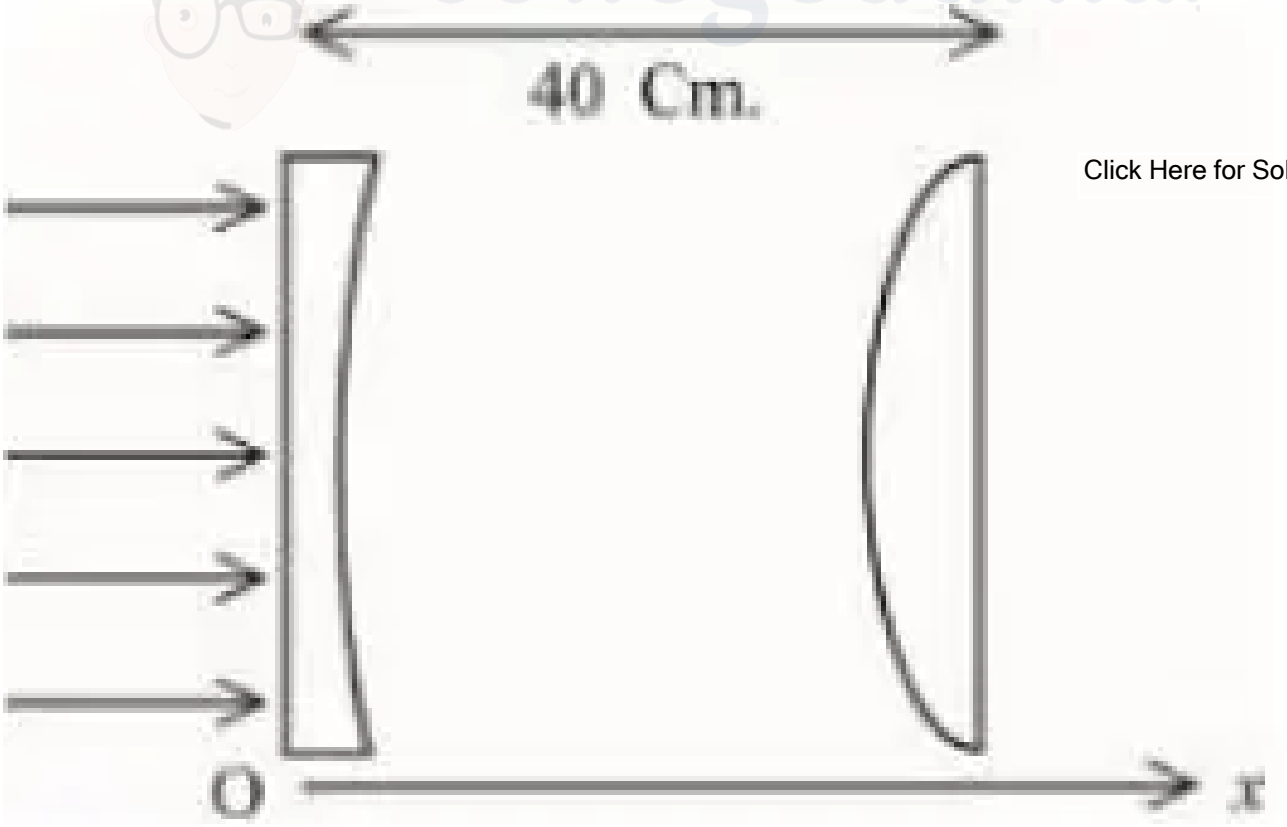
[25-Jan-2023 Shift 2

Click Here for Solution



10. As shown in the figure, a combination of a thin plano concave lens and a thin plano convex lens is used to image an object placed at infinity The radius of curvature of both the lenses is $30\,cm$ and refraction index of the material for both the lenses is 175 Both the lenses are placed at distance of $40\,cm$ from each other Due to the combination, the image of the object is formed at distance $x =$ __ cm, from concave lens. **(+4, -1)**

24-Jan-2023 Shift 1



Click Here for Solution

Answers

1. **Answer: b**

Explanation:

Image formed by lens

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

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

$v = +60\,cm$

If image position does not change even when mirror is removed it means image formed by lens is formed at centre o f curvature of spherical mirror.

Radius of curvature of mirror = $80 - 60 = 20\,cm$

$\Rightarrow$ focal length of mirror $f = 10\,cm$ for virtual image, object is to be kept between focus and pole.

$\Rightarrow$ maximum distance of object from spherical mirror for which virtual image is formed, is $10\,cm$.

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

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2. **Answer: a**

Explanation:

For converging lens
$u = -40$ cm which is equal to $2f$
$\therefore$ Image will be real and at a distance of 40 cm from convergent lens.

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3. **Answer: d**

Explanation:

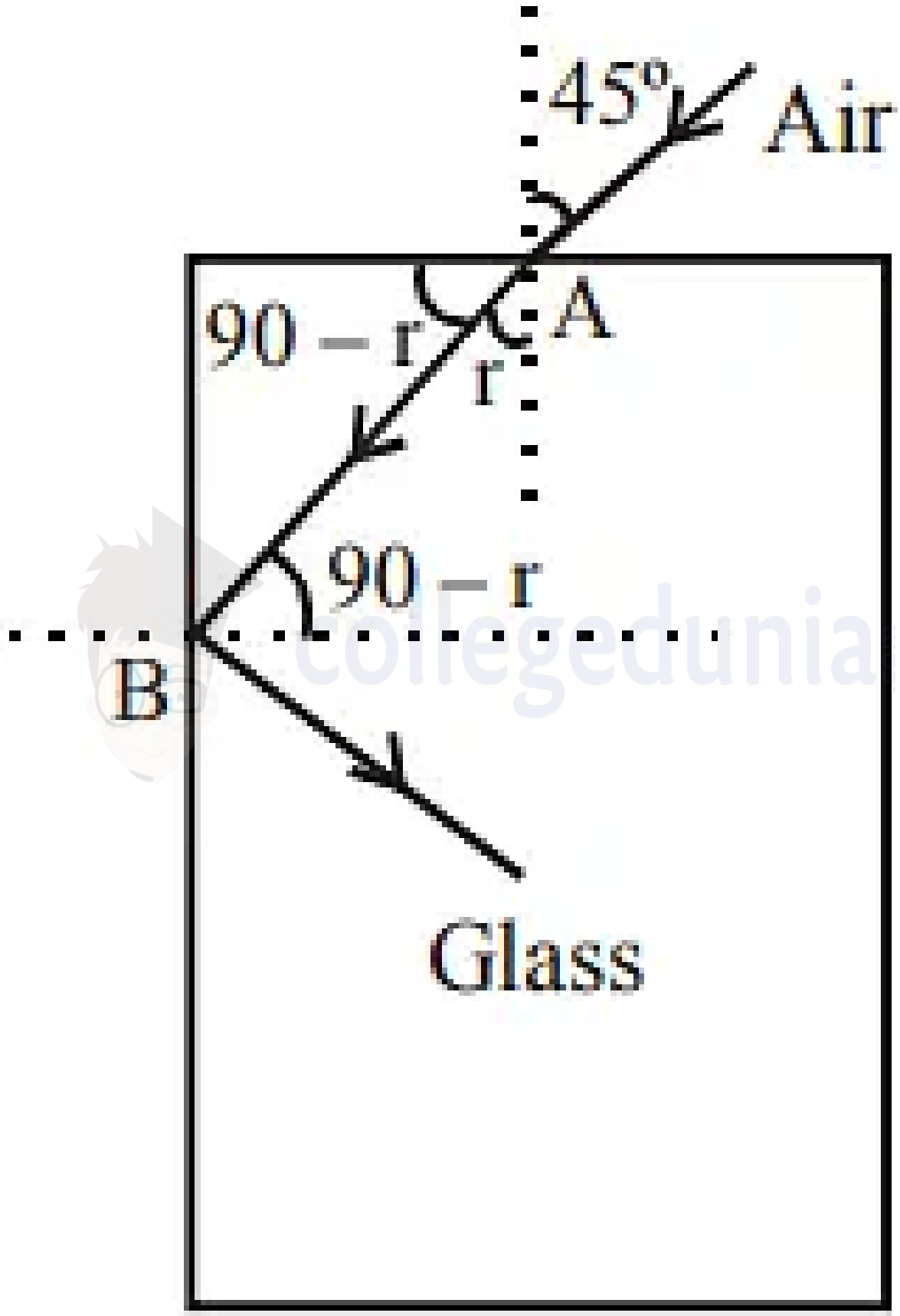
The correct answer is (D) : $\sqrt{\frac{3}{2}}$

At point A by Snell's law

$\mu = \frac{sin\,45^\circ}{sin\,r} \Rightarrow r = \frac{1}{\mu\sqrt{2}} \ldots (i)$

At point B, for total internal reflection,

$sin\,i_1 = \frac{1}{\mu}$



From figure, $i_1 = 90^? - r$

$\therefore (sin\,90^? - r) = \frac{1}{\mu}$
$\Rightarrow cos\,r = \frac{1}{\mu} \ldots (ii)$
Now $cos\,r = \sqrt{1 - sin^2\,r} = \sqrt{1 - \frac{1}{2\mu^2}}$
$\sqrt{\frac{2\mu^2-1}{2\mu^2}}$
Squaring both sides and then solving, weget
$\mu = \sqrt{\frac{3}{2}}$

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4. Answer: c

Explanation:

$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1-\mu_1}{R} + \frac{\mu_2-1}{R}$

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5. Answer: b

Explanation:

$\frac{1}{2f_2} = \frac{1}{f_1} = (\mu_1 - 1)\left(\frac{1}{\infty} - \frac{1}{-R}\right)$
$\frac{1}{f_2} = (\mu_2 - 1)\left(\frac{1}{-R} - \frac{1}{\infty}\right)$
$\frac{(\mu_1 - 1)}{R} = \frac{(\mu_2 - 1)}{2R}$
$2\mu_2 - \mu_2 = 1$

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6. **Answer: c**

Explanation:

Real depth = $5\,cm + 1\,cm = 6\,cm$
Apparent depth- $\frac{d_1}{\mu_1} + \frac{d_2}{\mu_2} + \ldots$
$= \frac{5}{1.33} + \frac{1}{1.5}$
$\simeq 3.8 + 0.7 \simeq 4.5\,cm$
$\therefore$ Shift $= 6cm - 4.5cm \cong 1.5cm$

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7. Answer: b

Explanation:

By Lens maker's formula

$\frac{1}{f_1} = \left(\frac{3/2}{4/3} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f_2} = \left(\frac{3/2}{5/3} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\Rightarrow f_1 = 4f \,\&\, f_2 = -5f$

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8. Answer: b

Explanation:

The combination acts like a silvered lens

$\frac{1}{f_{eq}} = \frac{2}{f_e} + \frac{1}{f_m} = \frac{2}{f} + \frac{1}{\infty}$

$f_{eq} = \frac{f}{2}$ (Combination behaves as a concave mirror as object and image lie on the same side.)

Applying Mirror formula, we get

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

$\Rightarrow \frac{1}{-a} + \frac{1}{-a/3} = \frac{1}{-f/2}$

$\Rightarrow \frac{4}{a} = \frac{2}{f}$

$\Rightarrow a = 2f$

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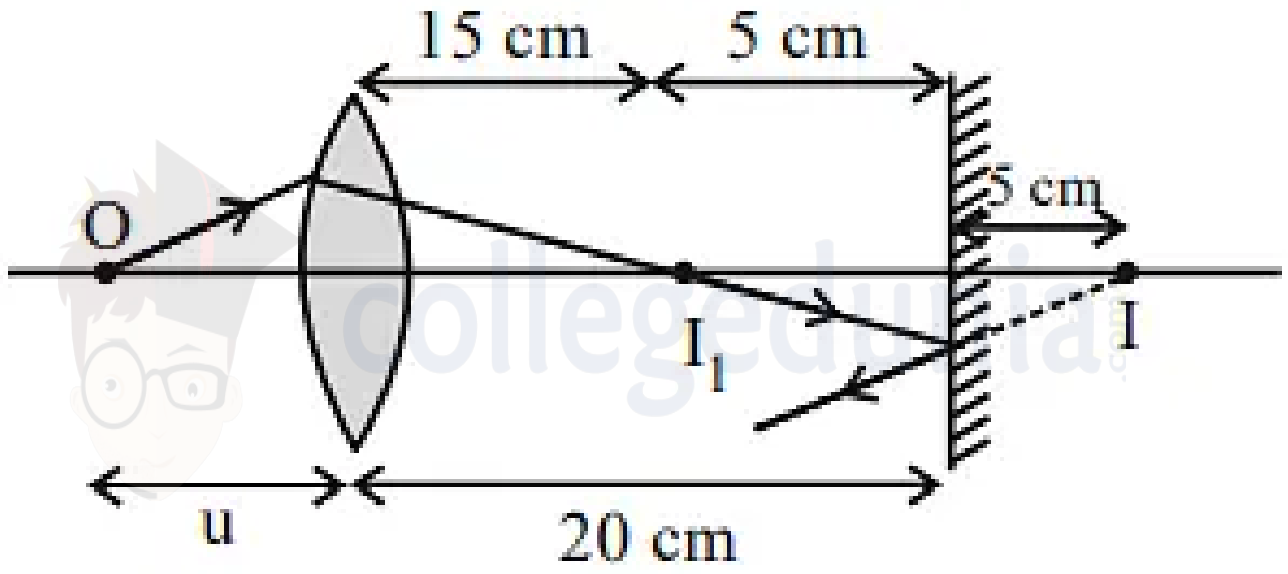
9. **Answer: 30 - 30**

Explanation:

The correct answer is 30.



$f = 10cm$
$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
$\frac{1}{15} - \frac{1}{-u} = \frac{1}{10}$
$\Rightarrow \frac{1}{u} = \frac{1}{10} - \frac{1}{15}$
On solving we get value of u as $30cm$.

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10. **Answer: 120 - 120**

Explanation:

The correct answer is 120.

$\frac{1}{f_1} = (1.75 - 1)\left(-\frac{1}{30}\right)$

$\Rightarrow f_1 = -40\,cm$

$\frac{1}{f_2} = (1.75 - 1)\left(\frac{1}{30}\right) \Rightarrow f_2 = 40\,cm$

Image from L_1 will be virtual and on the left of L_1 at focal length $40\,cm$. So the object for L_2 will be $80cm$ from L_2 which is $2f$. Final image is formed at $80\,cm$ from L_2 on the right.

So $x = 120$

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