Optics JEE Main PYQ - 3

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. An observer looks at a distant tree of height $10\,m$ with a telescope of magnifying power of 20. To the observer the tree appears : **(+4, -1)**

2016

a. 10 times taller.

b. 10 times nearer.

Click Here for Solution

c. 20 times taller.

d. 20 times nearer.

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2. If we need a magnification of 375 from a compound microscope of tube length $150\,mm$ and an objective of focal length $5\,mm$, the focal length of the eye-piece, should be close to : **(+4, -1)**

[7 Jan. 2020 I]

a. $22\,mm$

b. $12\,mm$

Click Here for Solution

c. $33\,mm$

d. $2\,mm$

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3. In an experiment a convex lens of focal length $15\,cm$ is placed coaxially on an optical bench in front of a convex mirror at a distance of $5\,cm$ from it. It is found that an object and its image coincide, if the object is placed at a distance of $20\,cm$ from the lens. The focal length of the convex mirror is : **(+4, -1)**

April 9, 2017

a. $27.5\,cm$

b. $20.0\,cm$

Click Here for Solution

c. $25.0\,cm$

d. $30.5\,cm$

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4. In an experiment for determination of refractive index of glass of a prism by $i - \delta$, plot, it was found that a ray incident at angle 35°, suffers a deviation of 40° and that it emerges at angle 79°. ?n that case which of the following is closest to the maximum possible value of the refractive index ? [2016 **(+4, -1)**

a. 1.5

b. 1.6

Click Here for Solution

c. 1.7

d. 1.8

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5. Light is incident from a medium into air at two possible angles of incidence $(A)20^\circ$ and $(B)40^\circ$. In the medium light travels $3.0\,cm$ in $0.2\,ns$. The ray will : April 9, 2013 **(+4, -1)**

a. suffer total internal reflection in both cases (A) and (B)

b. suffer total internal reflection in case (B) only

Click Here for Solution

c. have partial reflection and partial transmission in case (B)

d. have 100% transmission in case (A)

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6. What is the position and nature of image formed by lens combination shown in figure? (f_1, f_2 are focal lengths) 12 Jan. 2019 I **(+4, -1)**

a. $70\,cm$ from point B at left; virtual

b. $40\,cm$ from point B at right; real

Click Here for Solution

c. $20/3\,cm$ from point B at right , real

d. $70\,cm$ from point B at right, real

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7. You are asked to design a shaving mirror assuming that a person keeps it $10\,cm$ from his face and views the magnified image of the face at the closest comfortable distance of $25\,cm$. The radius of curvature of the mirror would then be : April 10, 2015 **(+4, -1)**

a. $60\,cm$

b. $24\,cm$

Click Here for Solution

c. $-60\,cm$

d. $-24\,cm$

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8. One plano-convex and one plano-concave lens of same radius of curvature $'R'$ but of different materials are joined side by side as shown in the figure. If the refractive index of the material of 1 is μ_1 and that of 2 is μ_2, then the focal length of the combination is : **(+4, -1)**

10 Apr. 2019 I

a. $\frac{R}{2-(\mu_1-\mu_2)}$

b. $\frac{2R}{\mu_1-\mu_2}$

Click Here for Solution

c. $\frac{R}{2(\mu_1-\mu_2)}$

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

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9. A convex lens of refractive index 15 and focal length $18\,cm$ in air is immersed in water. The change in focal length of the lens will be_____ cm (Given refractive index of water $=\frac{4}{3}$) **(+4, -1)**

Click Here for Solution

24-Jan-2023 Shift 2]

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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: d

Explanation:

Magnification of a telescope is given by:

$M = \frac{\theta_i}{\theta_o}$

$20 = \frac{h/d_i}{h/d_o}$

$20 = \frac{d_0}{d_i}$

Distance of image, $d_i = \frac{d_o}{20}$

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.

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2. Answer: a

Explanation:

Given $M = 375, L = 150\,mm, f_0 = 5\,mm, fe = ?, d = 25\,cm.$
M for a compound microscope is given by
$M = \frac{v_0}{+u_0}\left(1 + \frac{d}{fe}\right)$
focal length of objective lens is small $u_0 \simeq f_0$.
Alos as focal length of eye is small $v_0 \simeq L$
$\therefore M = \frac{L}{+f_0}\left(1 + \frac{d}{f_e}\right)$
$\Rightarrow 375 = \frac{150}{5}\left(1 + \frac{250}{f_e}\right)$
$\Rightarrow \frac{375}{30} = \left(1 + \frac{250}{f_e}\right)$
$\Rightarrow \frac{375}{30} - 1 = \frac{250}{f_e}$
$\Rightarrow \frac{345}{30} = \frac{250}{f_e}$
$\Rightarrow f_e = 2.2\,cm$
$F_e = 22\,mm$

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3. **Answer: a**

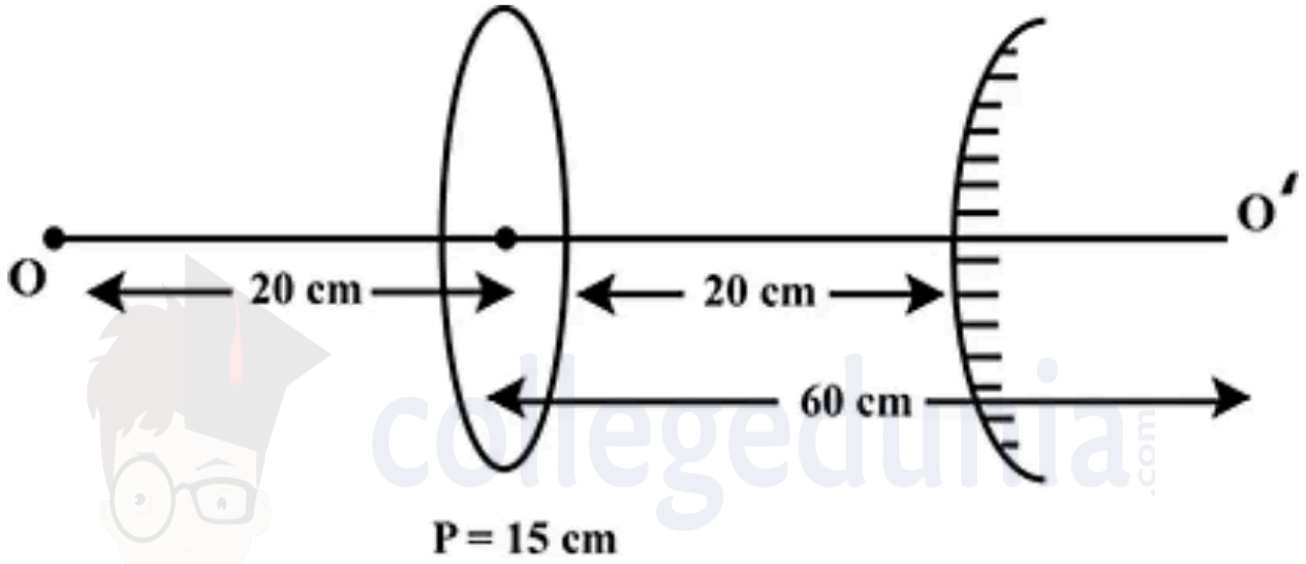
Explanation:

The correct answer is (A) : 27.5 cm

Given: u= -20cm

f= 15 cm

distance (d) of convex lens= 5cm



By substituting the values in equation (1) we get,

$\frac{1}{v}+\frac{1}{20}=\frac{1}{15}$

$\Rightarrow \frac{1}{v}=\frac{1}{15}-\frac{1}{20}$

$\Rightarrow \frac{1}{v}=\frac{5}{300}$

$\Rightarrow v=\frac{300}{5}$

$\Rightarrow v=60\ cm$

Thus, the image will be formed at 60cm to the right of the lens and it will be inverted.

Therefore, distance between lens and mirror will be

d = image distance – radius of curvature of convex mirror

$d=v-2f$

By substituting the values in above equation we get,

$5=60-R$

$\Rightarrow R=55$

But, the radius of curvature (R) is given by,

$R=2f$

$\Rightarrow f=\frac{55}{2}$

$\Rightarrow f = 27.5$

Hence , the focal length of the convex mirror is 27.5cm.

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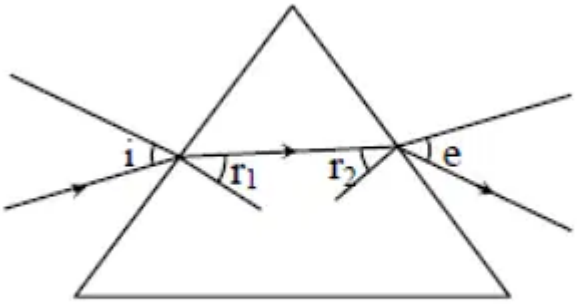
4. Answer: a

Explanation:



$\delta = i + e - A$

$40 = 35 + 79 - A$

$40 = 114 - A$

$A = 114 - 40 = 74 = r_1 + r_2$

From this we get,

$\mu = 1.5$

$\therefore\ \delta_{min} < 40^\circ$

$\mu < \frac{\sin\left(\frac{70+40}{2}\right)}{\sin 37}$

$\therefore\ \mu_{max} = 1.44$

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5. Answer: b

Explanation:

Velocity of light in medium
$V_{med} = \frac{3\,cm}{0.2ns} = \frac{3\times10^{-2}m}{0.2\times10^{-9}s} = 1.5\,m/s$
Refractive index of the medium
$\mu = \frac{V_{air}}{V_{med}} = \frac{3\times10^{8}}{1.5} = 2\,m/s$
As $\mu = \frac{1}{sin\,C}$
$\therefore\ sin\,C = \frac{1}{\mu} = \frac{1}{2} = 30^{\circ}$
Condition of TIR is angle of incidence i must be greater than critical angle. Hence ray will suffer TIR in case of $(B)\,(i = 40^{\circ} > 30^{\circ})$ only.

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6. Answer: d

Explanation:

For first lens

$\frac{1}{V} - \frac{1}{-20} = \frac{1}{5}$

$V = \frac{20}{3}$

For second lens

$V = \frac{20}{3} - 2 = \frac{14}{3}$

$\frac{1}{V} - \frac{1}{\frac{14}{3}} = \frac{1}{-5}$

$V = 70cm$

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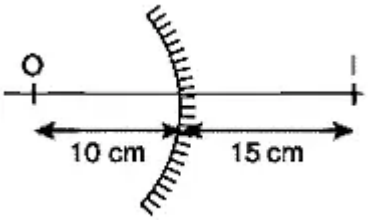
7. **Answer: c**

Explanation:

When object before a concave mirror line within its focal length, its image is virtual, erect and on the other side. Since he wants his image to lie at $25cm$ from him, it is $15cm$ behind the mirror.



$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$
$\Rightarrow \frac{1}{-10}+\frac{1}{15}=\frac{1}{f}$
$\Rightarrow \frac{-3+2}{30}=\frac{1}{f}$
$\Rightarrow f=-30\,cm$ (Concave mirror)
$R=2f=-60\,cm$

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8. Answer: d

Explanation:

For 1st lens $\frac{1}{f_1} = \left(\frac{\mu_1 - 1}{1}\right)\left(\frac{1}{\infty} - \frac{1}{-R}\right) = \frac{\mu_1 - 1}{R}$ for 2nd lens $\frac{1}{f_2} = \left(\frac{\mu_2 - 1}{1}\right)\left(\frac{1}{-R} - 0\right) = -\frac{\mu_2 - 1}{R}$ $\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}$ $\frac{1}{f_{eq}} = \frac{R}{\mu_1 - 1} + \frac{R}{-(\mu_2 - 1)} \Rightarrow \frac{1}{f_{eq}} = \frac{R}{\mu_1 - \mu_2}$ Hence $f_{eq} = \frac{\mu_1 - \mu_2}{R}$

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9. **Answer: 54 - 54**

Explanation:

The correct answer is 54.

$\frac{I}{f_{H_2O}} = \left(\frac{\mu_g}{\mu_{H_2O}} - 1\right)\left(\frac{2}{R}\right)$

$= \frac{1}{8}\left(\frac{2}{R}\right)$

$= \frac{1}{(4f_{air})}$

So, $f_{H_2O} = 4f_{\text{air}} = 72\,cm$

So change in focal length $= 72 - 18 = 54\,cm$

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10. **Answer: 27 - 27**

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

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

$\therefore k=32$

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