Practice Quiz 3 Part 2 <Solution> PHYS 1Cb

A cameras zoom lens covers the focal length range from 38mm to 110 mm. You point the camera at a distant object and photograph it first at 50mm and then at 75mm. What's the ratio of the images on the two photos?

D

A) 2.9 B) 4.0 C) 2.0 D) 1.5

Sol. "distant" object $\Rightarrow p \to \infty$, $f_1 = 50\text{ mm}$; $f_2 = 75\text{ mm}$

$$\begin{cases} \frac{1}{p} + \frac{1}{q_1} = \frac{1}{f_1} \\ \frac{1}{p} + \frac{1}{q_2} = \frac{1}{f_2} \end{cases} \Rightarrow \begin{cases} \frac{1}{\infty} + \frac{1}{q_1} = \frac{1}{50} \\ \frac{1}{\infty} + \frac{1}{q_2} = \frac{1}{75} \end{cases} \Rightarrow \begin{cases} q_1 = 50\text{ mm} \\ q_2 = 75\text{ mm} \end{cases}$$

$$\therefore \frac{M_2}{M_1} = \frac{-\frac{q_2}{p}}{-\frac{q_1}{p}} = \frac{q_2}{q_1} = \frac{75}{50} = 1.5 \,/\!\!/$$

A double convex lens with equal curvature radii of 38cm is made from glass with refractive index ranging from 1.51 to 1.54 across the visible spectrum of light (i.e. from red to blue). A white light is placed on the lens axis at a place 95cm away from the lens. Over what range will it's visible image be smeared?

B

A) 2.9cm B) 5.5cm C) 8.3cm D) 9.4cm E) 11.2cm

Sol. For a lens : $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ∵ double convex (biconvex)

$R_1 = -R_2 = 38$

§ Refer to Lecture Note 26B

$$\Rightarrow \frac{1}{f} = (n-1)\cdot\left(\frac{2}{R_1}\right) = \frac{n-1}{19}$$

(1) $n = 1.51 \Rightarrow \frac{1}{f} = \frac{1.51-1}{19} \Rightarrow f = 37.25\text{ cm}$

$$\Rightarrow \frac{1}{p} + \frac{1}{q} = \frac{1}{f} \Rightarrow \frac{1}{95} + \frac{1}{q} = \frac{1}{37.25} \Rightarrow q = 61.28\text{ cm}$$

(2) $n = 1.54 \Rightarrow \frac{1}{f} = \frac{1.54-1}{19} \Rightarrow f = 35.19\text{ cm}$

$$\Rightarrow \frac{1}{p} + \frac{1}{q} = \frac{1}{f} \Rightarrow \frac{1}{95} + \frac{1}{q} = \frac{1}{35.19} \Rightarrow q = 55.89\text{ cm}$$

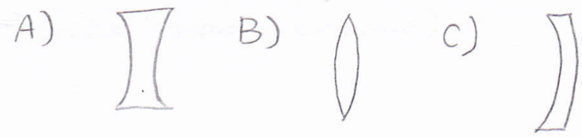
$$\therefore \Delta q = |61.28 - 55.89| = 5.39\text{ cm} \,/\!\!/$$

B) is the closest answer.

You are wearing a corrective lense because you are short sighted. Which of the following describes best the lens that you need?

C A) double concave B) double convex C) concave meniscus

Sol. You need a diverging lens



Best answer is C)

Which of the following statements is incorrect?

A) Virtual images can not be projected.

B) A slide projector produces real images which are upside down on the projection screen.

C) Chomatic aberation is a limitation of lenses due to their geometry.

C D) Spherical aberation is a limitation of lenses due to their geometry.

E) A microscope based on two lenses only will produce an upside down picture.

Sol. Chromatic aberation is a failure of a lens to focus all colors the the same convergence point. It is because the lens has different indices of refraction for different wavelengths of light.

To the unaided eye, the planet jupiter has an angular diameter of 50 arc seconds. What will be its angular size when viewed through a 1m focal length refracting telescope with an eye piece

A whose focal length is 40mm?

A) 1250 arc seconds B) 500 arc seconds

C) 100 arc seconds D) <1 arc seconds

Sol.

#New formula : For a refracting telescope, the angular magnification M_θ is given by :

$$M_\theta = -\frac{f_{ob}}{f_{ey}}$$

f_{ob} ← focal length of objective

f_{ey} ← focal length of eyepiece

$$\therefore M_\theta = -\frac{f_{ob}}{f_{ey}} = -\frac{1}{0.04} = -25$$

$\Rightarrow 50 \times (-25) = -1250$ ∴ the size will be 1250 arc seconds //

What is the focal length of a concave mirror if an object placed 50cm in front of the mirror has a real image 75cm from the mirror?

B A) 15cm B) 30cm C) 45cm D) 60cm

Sol. $p = 50$ cm, $q = 75$ cm (real image)

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \Rightarrow \frac{1}{50} + \frac{1}{75} = \frac{1}{f} \Rightarrow f = 30 \text{ cm} \;//$$

Where on the axis of a concave mirror would you place an object in order to produce an image the same size as the original?

A

A) put the object at twice the focal length from the mirror
B) half way between the focal length and the center of curvature of the mirror.
C) between focal length and mirror
D) further away from the mirror than the center of curvature of the mirror.
E) halfway between the center of curvature and the mirror.

Sol. You should put it at the center of curvature. (Verify this by drawing)

You are projecting 35mm slides onto a wall 2.6m from the projector whose single lens has focal length 12.0cm.
(a) How far should the slides be from the lens?
(b) How big will the image be?

A

A) (a)12.6cm (b) −72cm
B) (a) −12.6cm (b) 72cm
C) (a) 25cm (b) 36cm
D) (a) 25cm (b) −36cm

Sol. (a) $q = +2.6$ m $= 260$ cm, $f = 12$ cm

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \Rightarrow \frac{1}{p} + \frac{1}{260} = \frac{1}{12} \Rightarrow p = 12.6 \text{ cm} \;//$$

(b) $$M = -\frac{q}{p} = -\frac{260}{12.6} = -20.6 = \frac{h'}{h} \Rightarrow \therefore h' = (-20.6)\cdot 35 = -721 \text{ mm} = -72.1 \text{ cm} \;//$$

A converging lense has surfaces with radii R1=80cm and R2=-36cm, and an index of refraction of n=1.63. An emerald that is 2cm tall is placed 15cm to the left of the lense. Where will the image be located?

A

A) Same side as the emerald at a distance 25cm away from the lense.
B) Opposite side of the lense from the emerald at a distance 25cm away from the lense.
C) Same side as the emerald at a distance 20cm away from the lense.
D) Opposite side of the lense from the emerald at a distance 20cm away from the lense.
E) Same side as the emerald at a distance 15cm away from the lense.

Sol. $$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = (1.63-1)\left(\frac{1}{80} - \frac{1}{-36}\right) = 0.025375 \Rightarrow f = 39.4 \text{ cm}$$

$p = 15$ cm $$\Rightarrow \frac{1}{p} + \frac{1}{q} = \frac{1}{f} \Rightarrow \frac{1}{15} + \frac{1}{q} = \frac{1}{39.4} \Rightarrow q = -24.2 \text{ cm} \;//$$

Negative q means the image is at the left of the lens (same side as the object)