

Exercise walk-through

13.4

Images Formed by Lenses

AP Physics 2

You must be able to

- use ray diagrams to locate images from **converging** and **diverging lenses**
- apply the **thin-lens equation** $\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}$ and the magnification relation
- describe the images formed and give an everyday application

1

The method

Method — The thin-lens equation

$$\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}. \text{ A converging lens has } f > 0; \text{ a diverging lens has } f < 0.$$

Exercises 2.1-2.2

2.1 An object is 30 cm from a converging lens of focal length 10 cm. Find the image distance. [2]

2.2 State whether a converging lens has a positive or negative focal length. [1]

Exercises 2.1·2.2

2.1 An object is 30 cm from a converging lens of focal length 10 cm. Find the image distance. [2]

2.1

- thin-lens equation, with $s_o = 30$ cm and $f = 10$ cm:

$$\frac{1}{s_i} = \frac{1}{f} - \frac{1}{s_o} = \frac{1}{10 \text{ cm}} - \frac{1}{30 \text{ cm}} = \frac{2}{30 \text{ cm}}$$

- $s_i = \mathbf{15}$ cm

2.2 State whether a converging lens has a positive or negative focal length. [1]

2.2

- positive

Exercises 2.3-3.1

2.3 Give one everyday use of a converging lens.

[1]

3.1 The thin-lens equation is

[1]

- ☐ **A** $\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}$
- B** $s_o + s_i = f$
- C** $f = s_o s_i$
- D** $m = s_o / s_i$

Exercises 2.3-3.1

2.3 Give one everyday use of a converging lens.

[1]

2.3

- a camera, the eye, or a magnifying glass (any one)

3.1 The thin-lens equation is

[1]

- ☐ **A** $\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}$
B $s_o + s_i = f$
C $f = s_o s_i$
D $m = s_o / s_i$

3.1 A

- $\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}.$

Exercise 3.2

3.2 A converging lens used as a magnifier produces a

[1]

☐

A real, inverted image

B virtual, upright image

C image at the focus

D no image

Exercise 3.2

3.2 A converging lens used as a magnifier produces a

[1]

☐

A real, inverted image

B virtual, upright image

C image at the focus

D no image

3.2 B

- virtual, upright image.

Exercise 3.3 (a)

3.3 An object is placed 15 cm from a converging lens of focal length 10 cm.

(a) Find the image distance.

[3]

Exercise 3.3 (a)

3.3 An object is placed 15 cm from a converging lens of focal length 10 cm.

(a) Find the image distance.

[3]

(a)

- known: $s_o = 15$ cm, $f = 10$ cm (converging, so f is positive)
- thin-lens equation, rearranged for s_i :

$$\frac{1}{s_i} = \frac{1}{f} - \frac{1}{s_o}$$

$$\frac{1}{s_i} = \frac{1}{10 \text{ cm}} - \frac{1}{15 \text{ cm}} = \frac{3 - 2}{30 \text{ cm}} = \frac{1}{30 \text{ cm}}$$

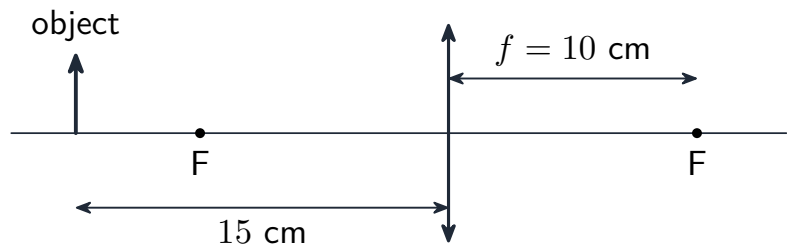
- $s_i = \mathbf{30}$ cm

Exercise 3.3 (b)

3.3 An object is placed 15 cm from a converging lens of focal length 10 cm.

(b) State whether the image is real or virtual.

[1]

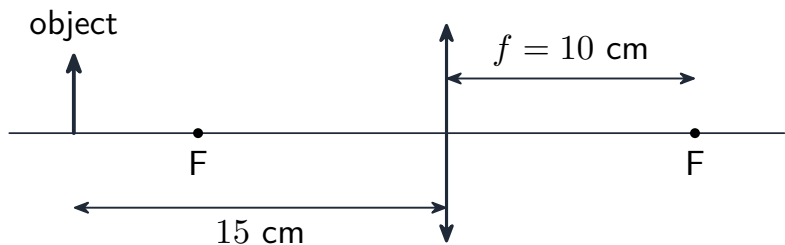


Exercise 3.3 (b)

3.3 An object is placed 15 cm from a converging lens of focal length 10 cm.

(b) State whether the image is real or virtual.

[1]



(b)

- real ($s_i > 0$)