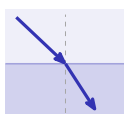


Geometric Optics

AP Physics 2 ■ Unit 13

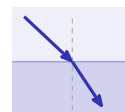
AP Physics 2



Geometric Optics

What we will cover

- 1 Reflection
- 2 Images formed by mirrors
- 3 Refraction and Snell's law
- 4 Images formed by lenses



1 Reflection

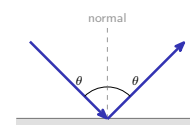
Geometric Optics

└ Reflection

Reflection

Model light as a **ray** 光线. The **law of reflection** 反射定律: the angle of incidence equals the angle of reflection (from the **normal**).

- **specular** 镜面反射 – smooth surface, a clear image
- **diffuse** 漫反射 – rough surface, scattered rays



2 Mirrors

Geometric Optics

└ Mirrors

Images formed by mirrors

Mirror equation

$$\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}, \quad m = -\frac{s_i}{s_o}$$

- **real** 实像 ($s_i > 0$): can be projected on a screen
- **virtual** 虚像 ($s_i < 0$): only appears behind the mirror
- $m < 0$ inverted; $|m| > 1$ enlarged

Worked example

Object 30 cm, concave $f = 10$ cm:

$$\frac{1}{30} + \frac{1}{s_i} = \frac{1}{10} \Rightarrow s_i = 15 \text{ cm}$$

$$m = -\frac{15}{30} = -0.5$$

Real, inverted, half size.

3 Refraction

Geometric Optics
└ Refraction

Refraction and Snell's law

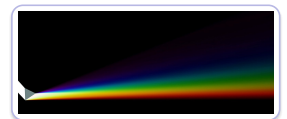
Crossing into a new medium, light changes speed and bends:

Snell's law

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

index 折射率 $n = c/v$; higher n bends light more.

Past the **critical angle** 临界角 ($\sin \theta_c = n_2/n_1$): **total internal reflection** 全内反射 – fibre optics.



Refraction bends light at boundaries

4 Lenses

Geometric Optics
└ Lenses

Images formed by lenses

A **converging lens** 会聚透镜 (convex) bends parallel rays to a focus; a **diverging lens** 发散透镜 spreads them.

Thin-lens equation

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

Same form as the mirror equation; a camera and the eye cast a real image.



Lenses form real and virtual images

5 Recap

Geometric Optics
└ Recap

Unit 13 – key takeaways

1 Reflection

angle in = angle out from the normal

2 Mirrors

$$1/s_o + 1/s_i = 1/f, m = -s_i/s_o$$

3 Refraction

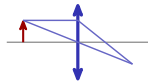
$n_1 \sin \theta_1 = n_2 \sin \theta_2$; TIR past the critical angle

4 Lenses

same thin-lens equation; converging casts a real image

Check yourself

- 1 A ray hits a mirror at 25° to the normal – at what angle does it leave?
- 2 A negative magnification means the image is...?
- 3 Light enters a denser medium – does it bend toward or away from the normal?
- 4 What effect makes fibre-optic cables work?



Answers 1. 25° 2. inverted 3. toward the normal 4. total internal reflection