13 Reflection and refraction – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	**Write it 3 times** (English)		
Geometric optics			
law of reflection			
angle of incidence			
angle of reflection			
refraction			
index of refraction			
Snell's law			
total internal reflection			

Recall

You have watched light behave in these ways:

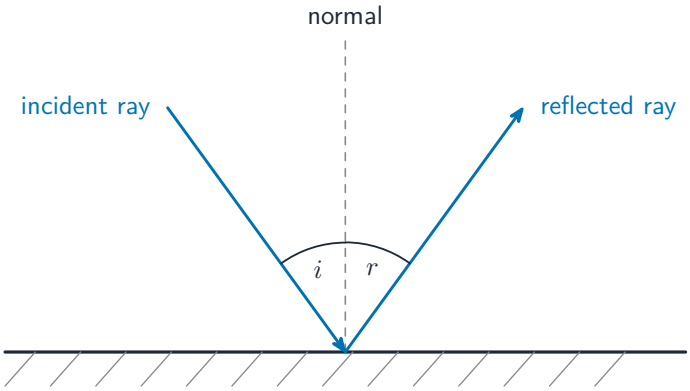
- A mirror bounces light back – you see your reflection.
- A straw in a glass of water looks bent where it enters the water.
- Fibre-optic cables carry light for long distances.

This sheet gives these effects exact laws. Each idea has a worked example.

New ideas

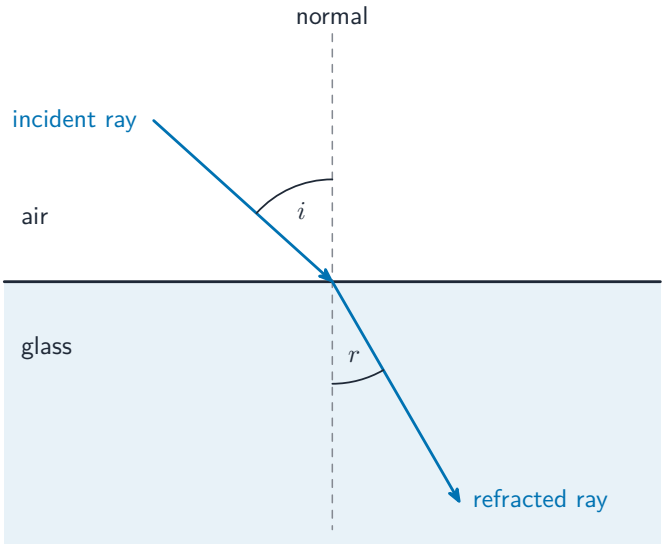
1 Reflection

Geometric optics treats light as straight rays. The **law of reflection** says the **angle of incidence** equals the **angle of reflection**, both measured from the **normal** (the line at right angles to the surface).



2 Refraction

When light passes from one material into another its speed changes, so it bends – **refraction**. Each material has an **index of refraction** $n = \frac{c}{v}$ (how much it slows light). Light entering a denser material (larger n) bends **toward** the normal.



■ 3 Snell's law

The bending follows **Snell's law** :

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

Worked example. A ray in air ($n_1 = 1.00$) enters water ($n_2 = 1.33$) at 40°: $\sin\theta_2 = \dfrac{1.00}{1.33}\sin 40° = 0.483$, so $\theta_2 = 29°$ – it bends toward the normal, as expected going into the denser medium.

■ 4 Total internal reflection

When light tries to leave a dense material at a steep enough angle, it reflects **entirely** back inside – **total internal reflection** . This is how optical fibres trap light and carry it for kilometres.

Watch out: all these angles are measured from the **normal**, not from the surface. Measuring from the surface is the most common error in optics.

Practice

Try these in order. The methods are all above.

2.1 A ray hits a mirror at 30° to the normal. State the angle of reflection. [1]

2.2 State what happens to the direction of light entering a denser material (bends toward or away from the normal). [1]

2.3 A ray in air ($n_1 = 1.00$) enters glass ($n_2 = 1.50$) at 30° to the normal. Use Snell's law to find the angle in the glass. [3]

2.4 Glass has an index of refraction of 1.5. Find the speed of light in the glass ($c = 3.0 \times 10^8$ m/s). [2]

2.5 State what total internal reflection is used for, and why it works. [2]

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