

How light bounces, bends and is absorbed

Grade 7 science (Year 8 · Class 7) · Worksheet answers

Each answer shows the angle or number with its reasoning and the final result in bold. Check that every angle is measured from the normal and that each distance or time carries its unit before you compare your work with the answers.

Level: Grade 7 science (Year 8 · Class 7) · **Curriculum:** MS-PS4-2

Problem 1 Seeing a football

1. No, the football does not make its own light.
2. The **Sun** is the luminous source.
3. Light travels from the Sun to the football, is reflected, and travels from the football into Kofi's eye.

Problem 2 Naming the lines

1. The **normal**.
2. The **incident ray**.
3. The angle of incidence equals the angle of reflection, **$i = r$** .

Problem 3 Angle of reflection

1. $r = i = 25^\circ$.
2. $25^\circ + 25^\circ = 50^\circ$.

Problem 4 Sorting surfaces

1. Regular.
2. Diffuse.
3. Regular.
4. Diffuse, because the crumpled surface has many small faces pointing in different directions.

1 R, 2 D, 3 R, 4 D

Problem 5 Bending towards or away

1. **Towards** the normal.
2. **Away from** the normal.
3. **No bending**, because it travels along the normal.

Problem 6 Reading a mirror diagram

1. The normal is 90° from the surface: $i = 90^\circ - 30^\circ = \mathbf{60^\circ}$.
2. $r = i = \mathbf{60^\circ}$.
3. $60^\circ + 60^\circ = \mathbf{120^\circ}$.

Problem 7 A shallow ray

1. $i = 90^\circ - 20^\circ = \mathbf{70^\circ}$.
2. $r = \mathbf{70^\circ}$.
3. $70^\circ + 70^\circ = \mathbf{140^\circ}$.

Problem 8 Distance to the image

1. Image is 2.0 m behind: $2.0 + 2.0 = \mathbf{4.0\ m}$.
2. $2.0 - 0.8 = \mathbf{1.2\ m}$.
3. $1.2 + 1.2 = \mathbf{2.4\ m}$.

Problem 9 Turning the mirror

1. $30^\circ + 30^\circ = \mathbf{60^\circ}$.
2. $40^\circ + 40^\circ = \mathbf{80^\circ}$.
3. The angle between rays grew from 60° to 80° , so the reflected ray turned through $\mathbf{20^\circ}$.

Problem 10 Why paper shows no face

1. Paper is rough, so reflected rays leave in many directions and cannot form a clear image (diffuse reflection).
2. **Yes:** each ray still obeys $i = r$ at its own small surface, but the surfaces are tilted differently.

Problem 11 Headlights on wet roads

1. A film of water makes the road surface smooth, so more rays are reflected in one direction towards the driver instead of scattering.
2. **Regular reflection.**

Problem 12 Ray entering water

1. **Angle A (45°)** is the angle of incidence.
2. The ray bends **towards** the normal, because B (32°) is smaller than A.
3. Light travels **more slowly** in water than in air.

Problem 13 The broken straw

1. **Refraction.**

2. Light from the part under water changes speed and direction when it leaves the water, so it seems to come from a different place than the true position.

Problem 14 Light through water

1. $t = 0.45 \div (2.25 \times 10^8) = 2.0 \times 10^{-9} \text{ s}$.
2. $t = 0.45 \div (3.0 \times 10^8) = 1.5 \times 10^{-9} \text{ s}$.
3. $2.0 - 1.5 = 0.5 \text{ ns}$.

Problem 15 Find the error

1. She measured the angle from the surface instead of the normal. The law of reflection uses angles from the normal.
2. $i = 90^\circ - 30^\circ = 60^\circ$, so **$r = 60^\circ$** .

Problem 16 Inside a periscope

1. The ray makes 45° with the mirror, so the angle of incidence is $90^\circ - 45^\circ = 45^\circ$.
2. The ray turns through $45^\circ + 45^\circ = 90^\circ$, so it goes down the tube.
3. The lower mirror turns it by another 90° in the same sense, so the ray leaves **parallel to the entering ray, moving in the same direction**.

Problem 17 Two mirrors at right angles

1. $i = 90^\circ - 30^\circ = 60^\circ$.
2. The reflected ray also makes 30° with the first mirror.
3. In the triangle formed with the mirrors, the third angle is $180^\circ - 90^\circ - 30^\circ = 60^\circ$, so the ray makes 60° with the second mirror and $i = 90^\circ - 60^\circ = 30^\circ$.
4. The final ray is **parallel to the original ray but travels in the opposite direction**.

Problem 18 Through a glass block

1. The faces are parallel, so the angle inside at the second face equals the angle of refraction: **31°** .
2. The ray bends away from the normal on leaving: **50°** in air.
3. It is **parallel to the entering ray** but shifted sideways, because the bending on entry is undone on exit.

Problem 19 Checking the law

1. $r - i$: +1, -1, +1, 0, -1, +1 (degrees).
2. Sum = +1, so the mean = $1 \div 6 = 0.17^\circ$.
3. The differences are within about 1° , the reading error of a protractor, so **the results support $i = r$** .

Problem 20 White roof, black roof

1. White absorbs 20 %: $0.20 \times 1000 = \mathbf{200 \text{ W/m}^2}$.
2. Black absorbs 90 %: $0.90 \times 1000 = \mathbf{900 \text{ W/m}^2}$.
3. White: $200 \times 40 = \mathbf{8000 \text{ W}}$. Black: $900 \times 40 = \mathbf{36\,000 \text{ W}}$.
4. $36\,000 - 8000 = 28\,000 \text{ W} = \mathbf{28 \text{ kW}}$. The white roof stays cooler.