Physics
Optics: Reflection

Science and Mathematics Education Research Group

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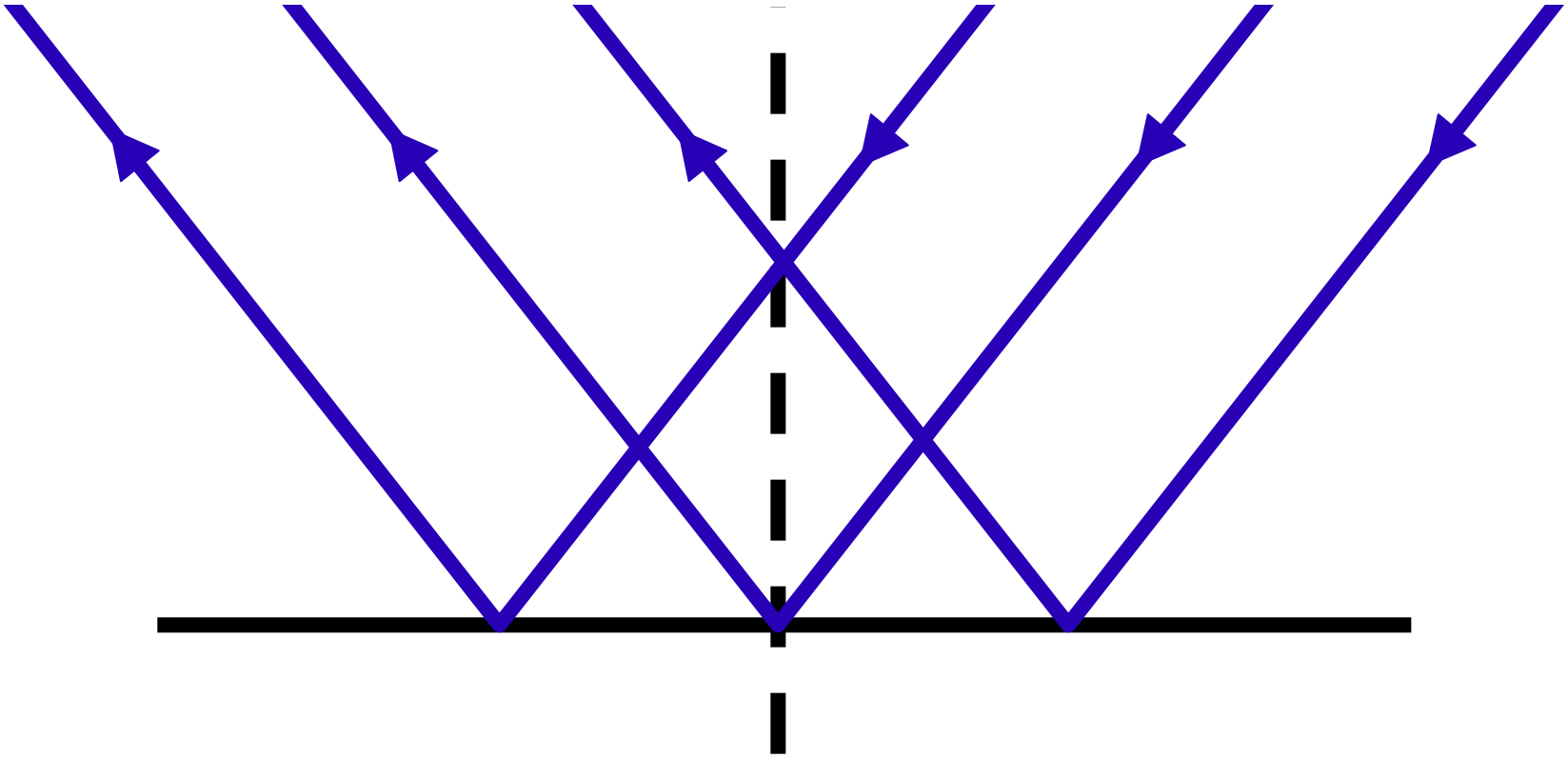
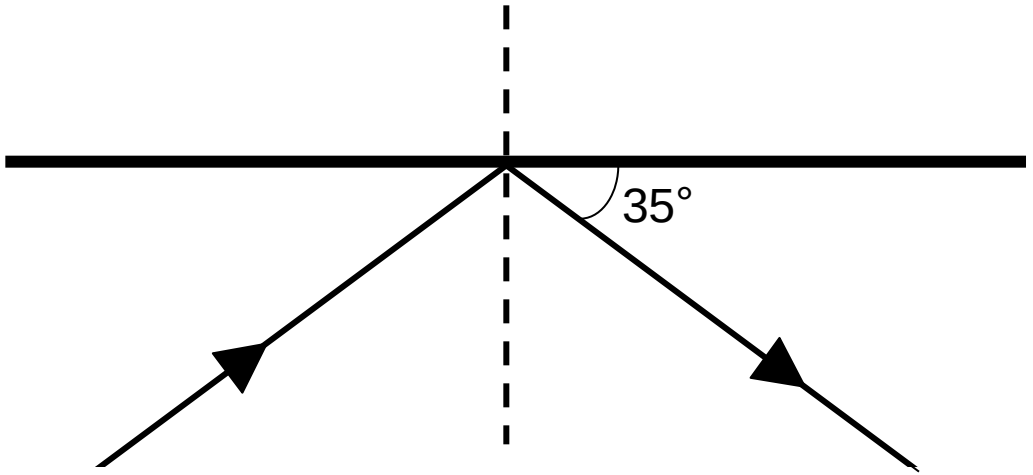
Reflection



Reflection I

What is the angle of incidence?



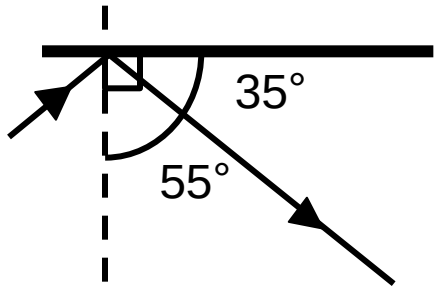
A. 35°
B. 55°
C. 110°
D. 145°
E. Not enough information

Solution

Answer: B

Justification: The angle of incidence and angle of reflection are measured from the normal. The normal is the imaginary line perpendicular to the reflective surface at the point of contact (dotted line in diagram). The normal and incident and reflected rays are always in the same plane.

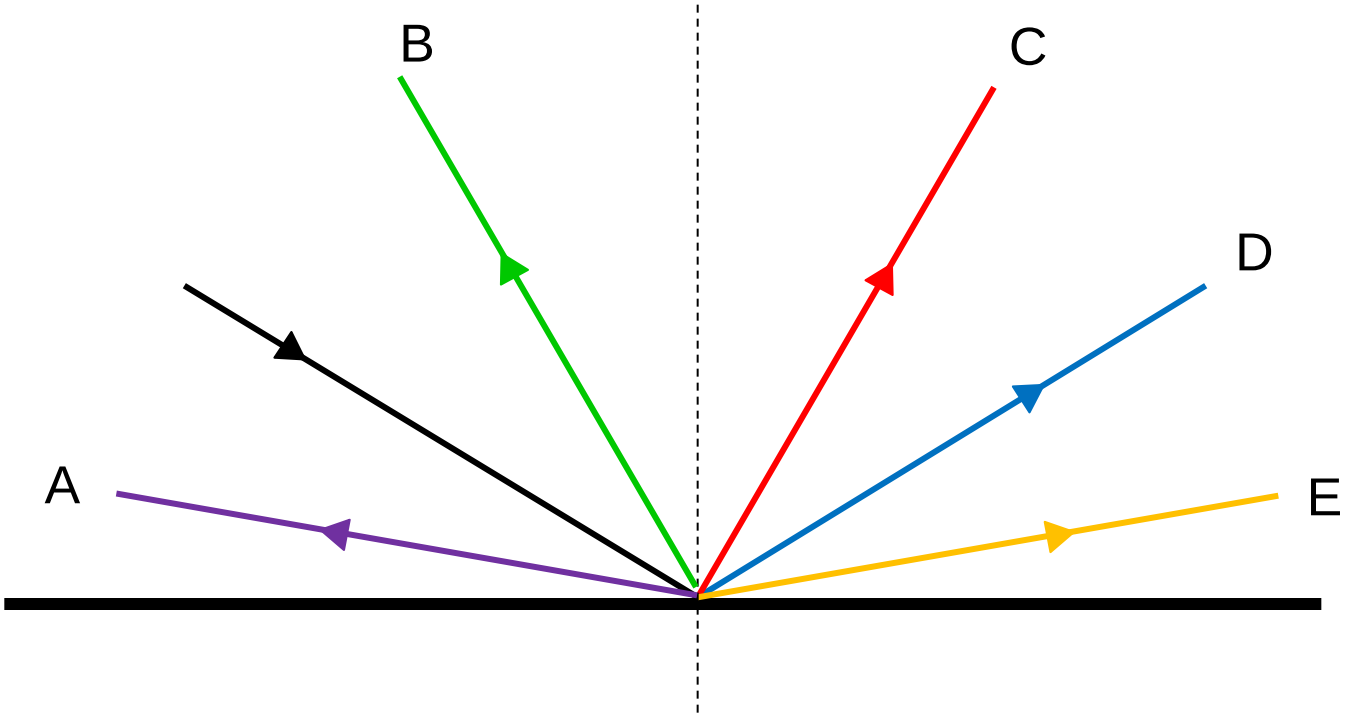
In the diagram, the angle between the reflected ray and the surface is 35°. The normal is perpendicular to the surface, so the angle of reflection and the angle between the reflected and the surface and up to 90°. The angle of reflection is 90° – 35° = 55°.



The angle of incidence is equal to the angle of reflection, so the angle of incidence is also 55°.

Reflection II

Given the incident ray, in black, which is the correct reflected ray?



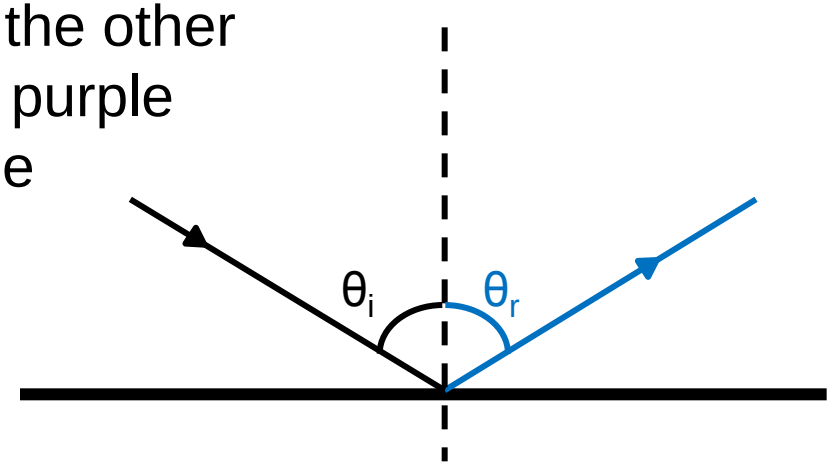
Solution

Answer: D

Justification: From the law of reflection, we know that the angle of incidence is equal to the angle of reflection.

The blue reflected ray in the diagram is the same distance from the normal as the black incident ray.

It is important to remember that light will never reflect backwards, it will always move to the other side of the normal. Therefore, the purple and green reflected rays cannot be correct in this case.



Reflection III

At what angle of incidence do the incident ray and the reflected ray travel along the same path?

A. 0°

B. 45°

C. 90°

D. 180°

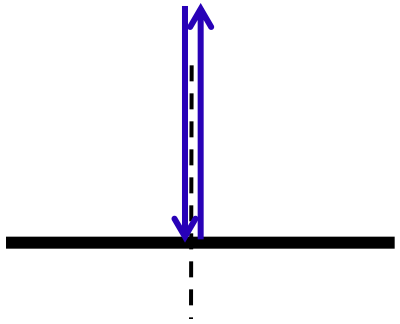
E. Never

Solution

Answer: A

Justification: Remember: the angles of incidence and reflection are each measured from the normal, not the reflective surface.

When angle of incidence is zero, the incident light ray is in line with the normal. The angle of reflection is also zero, and thus the reflected ray is also in line with the normal. The two rays travel along the same path, but in opposite directions.



Reflection IV

As the angle of incidence increases, the angle between the incident and reflected rays goes to

A. 0°

B. 45°

C. 90°

D. 180°

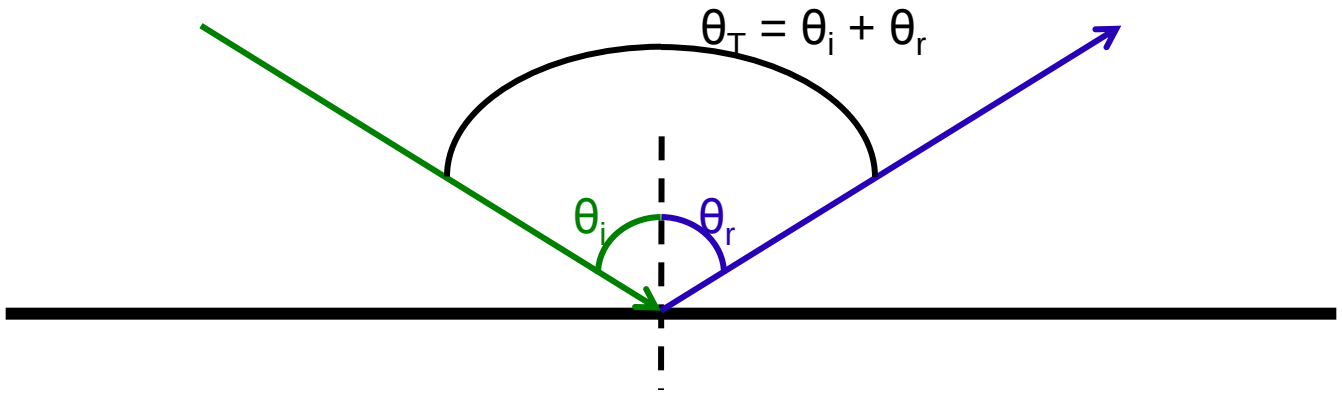
Press for hint

The angle of incidence goes to 90°.

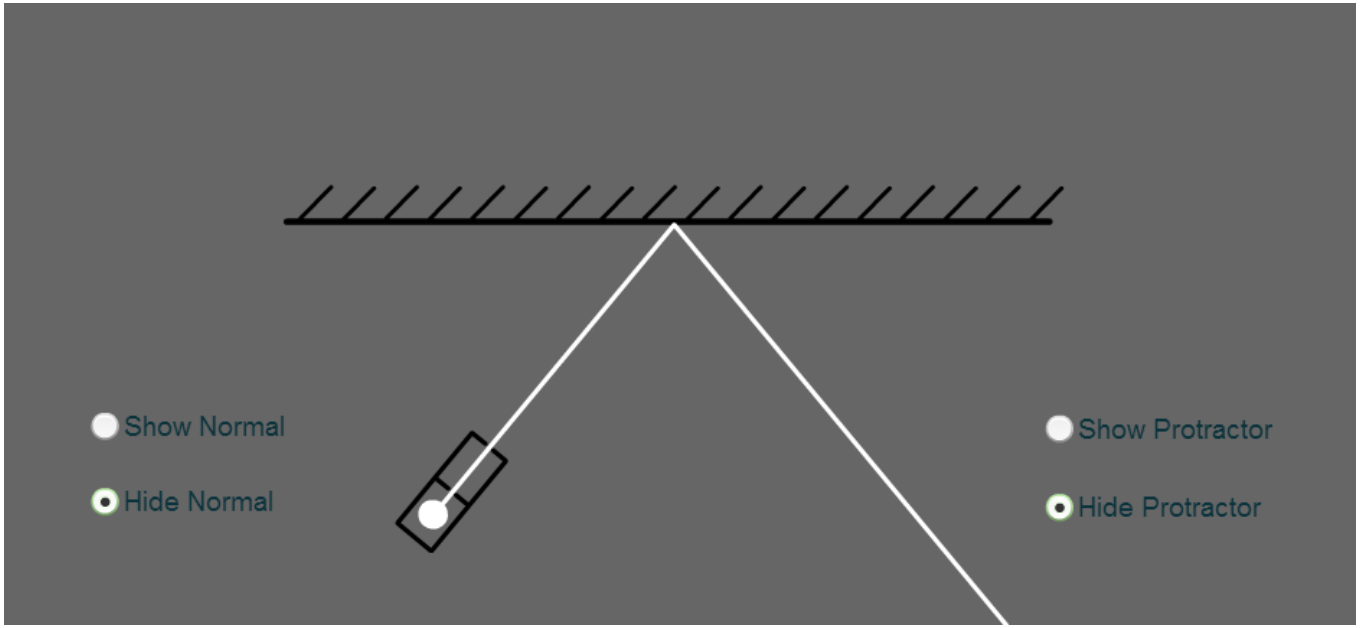
Solution

Answer: D

Justification: The angle of incidence is the angle between the incident ray and the normal. As this angle approaches 90°, the reflected ray also approaches a 90° angle with the normal. Adding these together, the angle between the incident and reflected ray approaches 180°. In this case, the light would be parallel to the surface, and would not actually reflect.



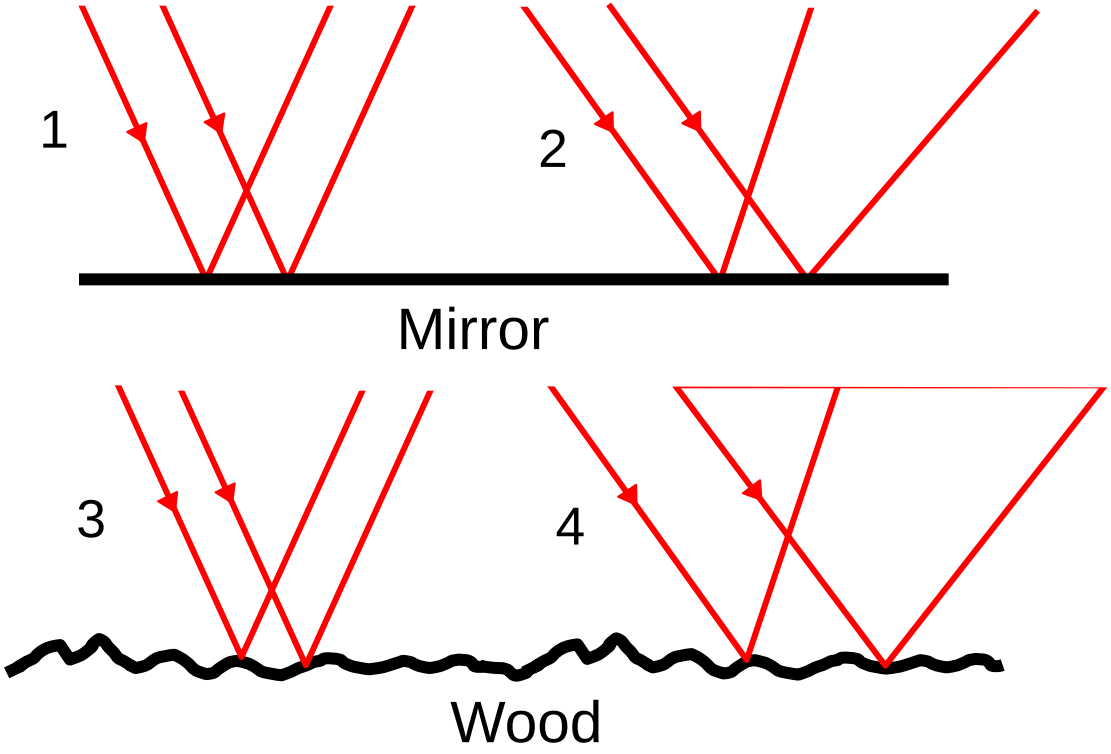
Extend Your Learning: Simulation



Reflection V

Two parallel light rays reflect off a mirror and a wood table.

Which diagrams accurately represent the resulting reflecting rays and the respective types of reflection?



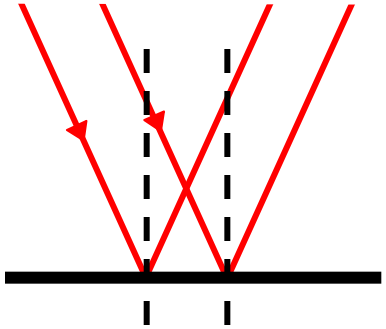
	Specular Reflection	Diffuse Reflection
A	1	2
B	2	3
C	3	4
D	1	4

Solution

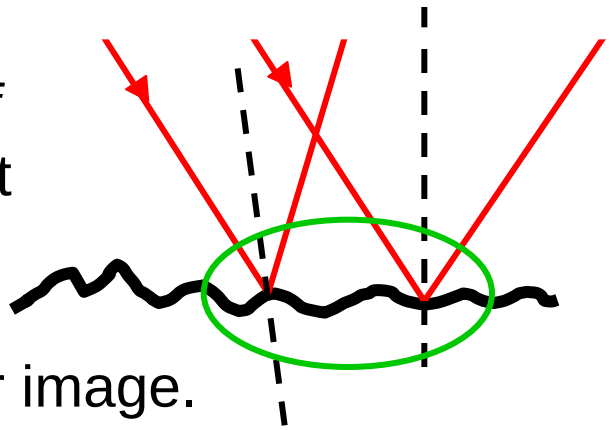
Answer: D

Justification: 1 = specular reflection, 4 = diffuse reflection

If a reflective surface is smooth, all normals are parallel to each other. As a result, parallel incident rays will always generate parallel reflected rays. This is why we see a clear image formed in a mirror.



When two parallel light rays hit an uneven surface, the normals are not parallel to each other, but are perpendicular to the surface *at the point of reflection.* Parallel incident rays may not reflect parallel to each other, however each angle of reflection is equal to its angle of incidence. This is why you might see a glare, but no clear image.



Reflection VI

Household paint comes in a variety of finishes, ranging from non-gloss to eggshell to high-gloss.

Why does non-gloss paint give a softer, more pleasing effect than high-gloss paint?

A. More light is absorbed by the non-gloss paint

B. More light is absorbed by the high-gloss paint

C. Light rays reflected off non-gloss paint diverge (spread out)

D. Light rays reflected off high-gloss paint diverge (spread out)

Solution

Answer: C

Justification: The amount of light absorbed by the paint depends only on the colour of the paint. The wall will only reflect light that is the same colour as the paint, all other colours will be absorbed.

The surface of the non-gloss paint is not as smooth as that of the high-gloss paint. As a result, when light rays that are parallel at the **macroscopic** level hit the surface, they are not all incident at the same angles at a **microscopic** level. As a result, the reflected rays are not parallel.

Remember: each individual ray will still respect the law of reflection, as discussed in the previous question.

Reflection VII

Magazines usually have glossy pages. This effect is achieved by filling in the usual microscopically rough surface of paper to make the surface smoother.

Do you suppose that it would be easier to read from glossy or rough pages?

A. Glossy

B. Rough

C. No difference

Solution

Answer: B

Justification: Glare off surfaces occurs when light is strongly reflected into the eyes. This occurs most often in the form of specular reflection, which is commonly more intense than diffuse reflection.

It is much easier to read from rough pages which provide diffuse reflection. The light reflected off the pages diverges, and no clear image of the light source is formed.

Glossy pages are covered with a coating that fills empty space in the paper to create a smooth surface. The result is specular reflection and glare. It is common for the reader to see an image of the light bulb which illuminates the page.

Reflection VIII

The reflection of a full Moon in a smooth lake is almost perfectly circular.

What would happen to the image if a wind came up and the water became rough?

A. The image would disappear
B. The image would become distorted
C. The image would become dimmer
D. The image would become brighter
E. Nothing

Solution

Answer: B

Justification: When the Moon is reflecting off the smooth lake, the surface of the water acts like a mirror and we observe near-perfect specular reflection and the image is almost perfectly circular.

When the water begins to move, the surface changes and is no longer smooth, and we begin to observe some diffuse reflection. Because water is still reflective, we still observe the reflection.

Because water is clear, no light is absorbed, and the brightness of the image does not change.