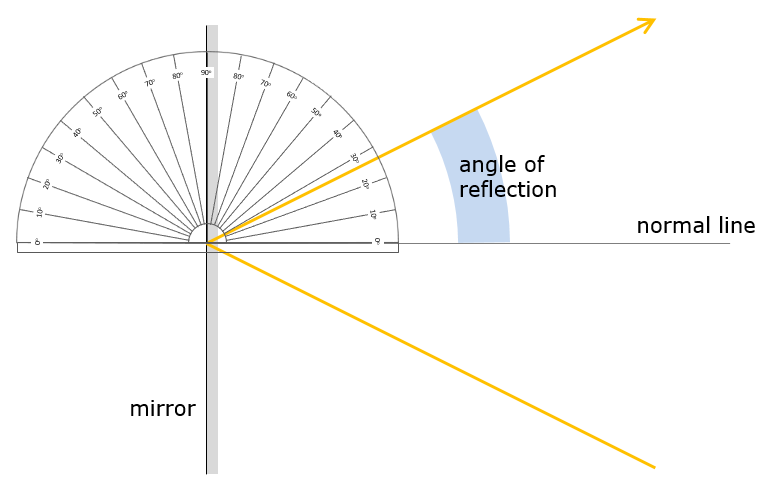
**Reflecting angles**

A protractor measures angles.

It can be used to measure how light reflects off a mirror.



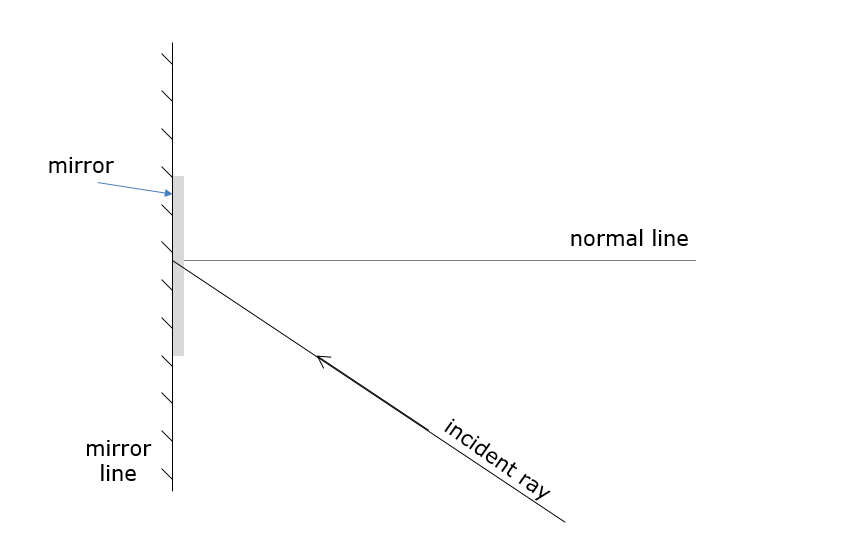
**Apparatus and materials**

* mirror
* ray lamp
* slit for ray lamp
* lab pack
* ruler
* sharp pencil
* protractor

**Procedure**

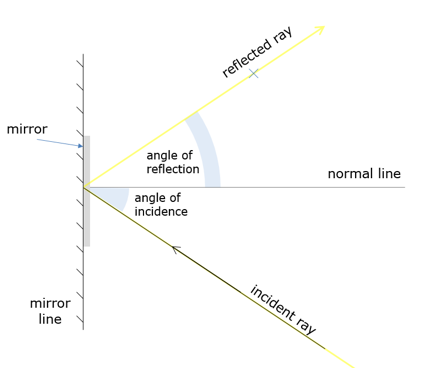
1. Put the back of the mirror on the mirror line
2. Put the slit into the ray lamp and turn it on
3. Aim the ray of light along the incident ray
4. Draw a small cross in the centre of the reflected ray
5. Take away the mirror
6. Use a ruler to join the cross to the mirror to show the reflected ray
7. Use the protractor to measure the angle of incidence and the angle of reflection
8. Repeat with different incident rays

Measurement sheet for reflecting angles



**Reflecting angles**

A protractor can be used to measure how light reflects off a mirror.



**Predict**

How do you think the angle of reflection will compare to the angle of incidence?

**Explain**

Why do you think this will happen?

|  |
| --- |
| **Now take a set of measurements** |

**Observe**

Record all of your measurements.

**Explain**

Did you predict the right pattern? ……………………………………………………………………………..

Describe the pattern you got.

Explain why you think this happens with a flat mirror.

*Physics > Big idea PSL: Sound, light and waves > Topic PSL1: Sound and light > Key concept PSL1.2: Characteristics of light*

|  |
| --- |
| **Response activity** |
| **Reflecting angles** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Light is reflected from all surfaces, and off a flat mirror it is reflected in a single direction. |
| Observable learning outcome: | Predict the direction in which flat mirrors reflect light.  Draw a ray diagram to show how light reflects off a flat mirror.  Accurately measure angles of incidence and angles of reflection. |
| Activity type: | Predict, explain, observe, explain - practical/demonstration |
| Key words: | Incident ray, reflected ray, angle of incidence, angle of reflection, normal line, mirror, ray, protractor |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: Which way?
* Diagnostic question: Angle of reflection
* Diagnostic question: Measuring angles

**What does the research say?**

When light reflects off a mirror Anderson and Smith (1986) found that, out of 125 ten and eleven year olds, just under half correctly predicted that the angle it reflects at is the same as the angle it hits the mirror, 28% thought light reflected at a different angle and 7% that more than one ray is reflected.

Anecdotal evidence suggests significant numbers of students continue to mix up which angle is which in ray diagrams and they do not always use a protractor to measure angles accurately.

Students following the national curriculum of England are likely to learn how to draw given angles, and measure them in degrees (o) when they are aged nine or ten (DFE, 2013).

This activity gives students the opportunity to practise their practical skills and to investigate the law of reflection.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict *what* they think will happen, and then to explain *why* they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

Students now carry out the practical, or watch a demonstration. You will need to decide whether it is better for each group to carry out the practical and risk some unexpected observations, or to demonstrate the activity so that everyone *observes* the same thing.

After the practical each group should be given the opportunity to change, or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their *explanations* and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Equipment**

For each student/pair/group:

* mirror
* ray lamp
* slit for ray lamp
* lab pack
* measurement sheet
* ruler
* sharp pencil
* protractor

**Technician notes**

* A small plane mirror is necessary and it needs to be held vertically on the table – e.g. glued to a small wooden block.
* A collimating lens in the ray lamp is helpful, but not necessary.
* Black-out is not necessary, a dimmed room with blinds closed is adequate.

**Health and safety**

Mains electricity is used and the lab packs may be heavy.

Bulbs may become hot enough to burn.

A visual scan to check for damaged plugs or sockets and loose wires on the lab packs is necessary. Lab packs need to be placed away from the edge of a desk, with no trailing wires.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

The angle of reflection is the same size as the angle of incidence.

With careful measurement students will be able to achieve accurate values for all of their results. Errors of a degree or two are most likely to be caused by the mirror not being lined up exactly, or by measurement errors.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: UYSEG

**References**

Anderson, C. W. and Smith, E. L. (1986). Childrens' conceptions of light and colour: developing the concept of unseen rays. *Annual meeting of the American Educational Research Association.* Montreal, Canada.

DFE (2013). Mathematics programmes of study: key stages 1 and 2 National curriculum in England. Department for Education.