SATELLITES AND REFLECTION

SENDING SIGNALS (E.G. TV, TELEPHONE, INTERNET) ACROSS LONG DISTANCES

Equipment:

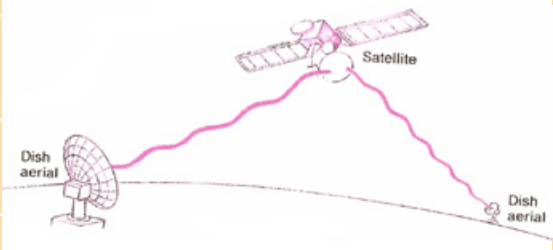
1. Ball, floor or wall on which a ball can bounce, another person
2. Plane (*i.e. flat*) mirror, white A4 paper, small torch (*one with single bulb gives a better single ray of light than halogen type with multiple bulbs*), cardboard, scissors, protractor, pencil, book or other object to prop up mirror.
3. For follow-up activity: Concave mirror, piece of plain A4 paper, sun or torch or light of any sort.

Suggested Class Level:

5th- 6th

Preparation:

Darkened room if possible for Activity 2.



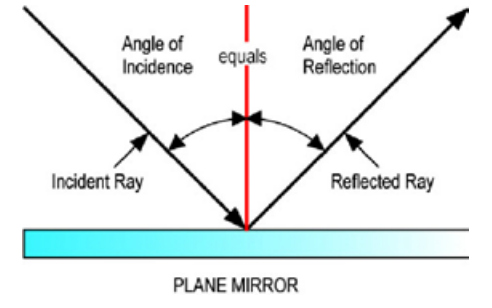
Background information:

REFLECTION OF LIGHT

Light bounces off a flat shiny surface in the same way a ball bounces off the ground.

When light hits a surface at a certain angle (*called the angle of incidence*) it bounces off the surface at the same angle (*called the angle of reflection*).

(*See DPS activity 'Make a Periscope' for similar concept*).



SATELLITES

A satellite is something which orbits a planet.
The Moon is a natural satellite of the Earth. There are now thousands of man-made satellites which orbit the Earth.

The first man-made satellite was launched by the Soviet Union in 1957. It was called Sputnik 1 and it studied the atmosphere.

Since then thousands of satellites have been launched into space for lots of different reasons: for communications (*TV, radio, telephone and Internet - the signals are sent up to the satellites, they are 'reflected' off the satellites at a different angle like light off a mirror or a ball off a wall, and are received back down in another part of the world*), weather forecast, studying the Earth itself, looking at plant cover and the effects of climate change, etc.

GEOSTATIONARY SATELLITES

Many signals (*e.g. from mobile phones*) are sent from one mast to another directly via waves in straight lines. But if the signals are to be sent over very long distances across the world, then the masts would have to be extremely high to allow for the curvature of the earth (*e.g. nearly 2 km high for transmission between Europe and the USA!*).

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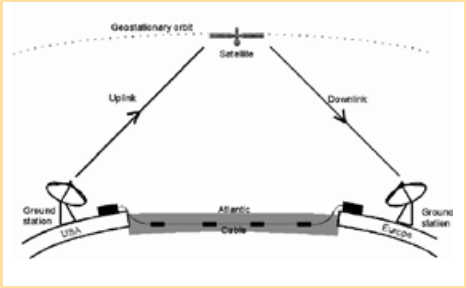


However, if a kind of mirror for the waves is put in a 'fixed' position well above the earth, large distances can be overcome (*a bit like seeing around a corner using a traffic mirror*). Because the Earth is rotating this' mirror' has to rotate also, and exactly in time with the earth. This is called a Geostationary satellite, i.e. it appears to be fixed but is actually rotating.

Very large amounts of communications (*telephone, Internet and TV*) are also sent long distances along very fine glass cables called **fibre optics.** These go along the ground and under the sea. They have largely replaced the old copper cables.

Trigger questions:

If you throw a ball straight against a wall or onto the ground, what happens?
(*It bounces back straight at you*).

If you throw a ball at an angle against the wall or on the ground, what happens?
(*It bounces off the wall or ground at an angle in the opposite direction from you*).

What way does the ball bounce off the table in table tennis, or off the side of a snooker table?

What are the different ways that radio, TV, telephone and Internet communications travel across various distances? (*Wires, fibre optic (i.e. very fine glass) cables, invisible waves through the air.*)

What is a SAT NAV?
(*A piece of electronic equipment in a car. It can tell you which way you need to go by using information received from a satellite*).

Content:

SCIENCE: Energy and Forces – Light

MATHS: Lines and Angles
Data: Representing and Interpreting Data
SPHE: Myself and the wider world – Environmental care

Skills:

Investigating and Experimenting, Observing, Measuring, Recording, Analysing

Cross-curricular Links:

Geography:

Human Environment – Transport and Communications
Natural Environment – Planet Earth in Space

SATELLITES AND REFLECTION

SENDING SIGNALS (E.G. TV, TELEPHONE, INTERNET) ACROSS LONG DISTANCES

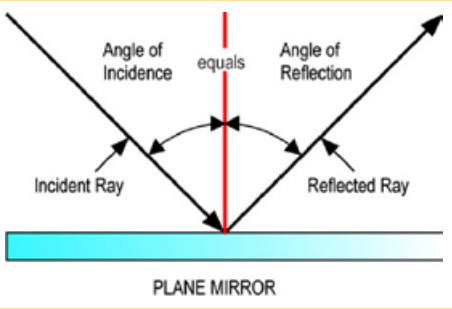
Activity:

1. Bouncing a ball at an angle to the ground.

- Stand some distance away from the other person.
- Can you throw the ball against a wall, or onto the ground, at an angle so that the ball reaches the other person exactly?
- What do you notice about the angle at which the ball hits the ground, and comes off the ground?

2. Reflecting light off a plane mirror.

- Make a very narrow slit from the edge, and at right angles, into a piece of cardboard.
- Put a sheet of plain white paper onto the table.
- Prop up the mirror into a vertical position (*against a book or something similar*) on the paper.
- Draw a line along the back of the mirror.
- Shine the torch through the vertical slit in the cardboard, to give a narrow beam of light coming through the cardboard. (*Does the distance between the torch and cardboard make any difference to the width of the beam of light?*).
- Direct the narrow beam at right angles to the mirror. What happens to the reflected beam?
- Now shine the narrow beam of light at an angle to the mirror. In what direction does the reflected beam go?
- Can you draw along the incident ray and the reflected ray? (*See diagram*).
- Take away the torch and draw a right angle where the light hit the mirror.
- With your protractor measure the angle between the incident ray and the perpendicular (*angle of incidence*).
- Then measure the angle between the reflected ray and the perpendicular (*angle of reflection*).



Record these angles. Are they acute or obtuse?

- Repeat this activity a number of times, with the light hitting the mirror at different angles.
- What conclusion do you come to? Is there any connection between the two angles?

ANGLE OF INCIDENCE	ANGLE OF REFLECTION

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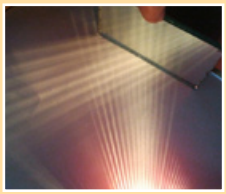
Safety:

Do not shine torches into eyes, or look directly into the sun. It is very bad for eyes.

Follow-up activities:

1.

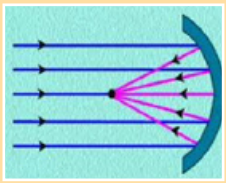
- Shine a beam of light through the teeth of a comb, at an angle to a plane mirror.
- What do you notice about the pattern which is formed?



2.

- Hold a curved (*concave*) mirror towards the sun or a light, with the hollow shiny side facing the sun or light.
- With your other hand can you move the piece of paper to a position where you get a clear sharp image of the sun or light on the piece of paper?
- Can you think what the mirror is doing to the rays of light?

(*The mirror brings them together to a point - called the focus. Small curved satellite dishes on many houses pick up TV signals from the air, focus them to a point from where they are sent into the houses*).



More Maths:

The following data was taken from the NASA (*American Space Agency*) website: www.spacemath.gsfc.nasa.gov

"The Declining Arctic Ice Cap during September"

The minimum ice cap area for the Arctic during the month of September was measured using satellites.
The results for the following years were:

- Draw a graph from this data, using a suitable scale.
- Can you give a rough prediction of the area of ice in 2020 and 2030 if the present trend continues?
- Why do you think the area of ice is getting smaller?
- What do you think will be the effect on the environment if this global warming continues?

Year	Ice area in millions of square kms
1980	7.9
1985	6.9
1990	6.2
1995	6.1
2000	6.3
2005	5.6
2010	4.9