AIMING FOR AWESOME

1918 2018

Satellite age

Teacher's Guide

ROYAL ACADEMY OF ENGINEERING

RAF 100

The aim of this resource is to give students the opportunity to investigate the impact of science, technology, engineering and mathematics (STEM) on satellite communications.

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Curriculum links

England

Activity	Key Stage	Subject	National Curriculum
Time to investigate	KS2	*Science*	**Light:** recognise that light appears to travel in straight lines.
Time to investigate	KS3	*Science*	**Working scientifically:** experimental skills and investigations.

Scotland

Activity	Subject	Topic	Experiences and outcomes
Time to investigate	*Sciences*	Vibrations and waves	SCN 2-11b
Stretch and challenge	*Sciences*	Vibrations and waves	SCN 2-11b

Wales

Activity	Key Stage	Subject	National Curriculum
Time to investigate	KS2	*Science*	**How things work:** how light travels and how this can be used. **Skills:** communication, enquiry.
Time to investigate	KS3	*Science*	**Skills:** communication, enquiry.

Northern Ireland

Activity	Key Stage	Subject	National Curriculum
Time to investigate	KS3	*Science*	Develop a range of practical skills, including the safe use of science equipment. **Learn about:** Sound and light.

Preparation

- Ensure all materials and equipment needed are available well in advance of the session. See the resource list below for essential materials and components.
- A full risk assessment should be conducted prior to the session.
- This session is expected to last 60 minutes.
- Ensure technology is available to project the relevant video materials.

This resource has been linked to the Engineering Habits of Mind (EHoM). For more information about the EHoM please see the information sheet provided or www.raeng.org.uk/ltbae.

Resource list

For this activity, you will need the following per group:

- LED torch, with paper to create a single beam
- Plane mirror
- Protractor
- Paper
- Pencil

The following specific components may not be readily available in schools and other educational establishments. Therefore, it may be necessary to order these items.

Description	Product code	Pack size	Supplier
Plane mirror	52-0094	10	www.rapidonline.com
LED Torch	86-9527	1	www.rapidonline.com

Skynet

In the 1960s, satellites became an increasingly important way for military to communicate with squadrons abroad. However, only two countries used satellites for signals and military intelligence: the USA and the Soviet Union.

Consequently, the UK created Skynet as its own military communications satellite. The Skynet satellite also provided secure and encrypted facilities for all three of the British armed forces.

The first Skynet satellite, Skynet 1A, was launched in November 1969 but was quickly replaced by Skynet 1B in 1970 following a fault. Unfortunately, Skynet 1B was placed in a geostationary transfer orbit and had to be abandoned in transfer orbit because of a failure of the Thiokol Star 37D apogee kick motor.

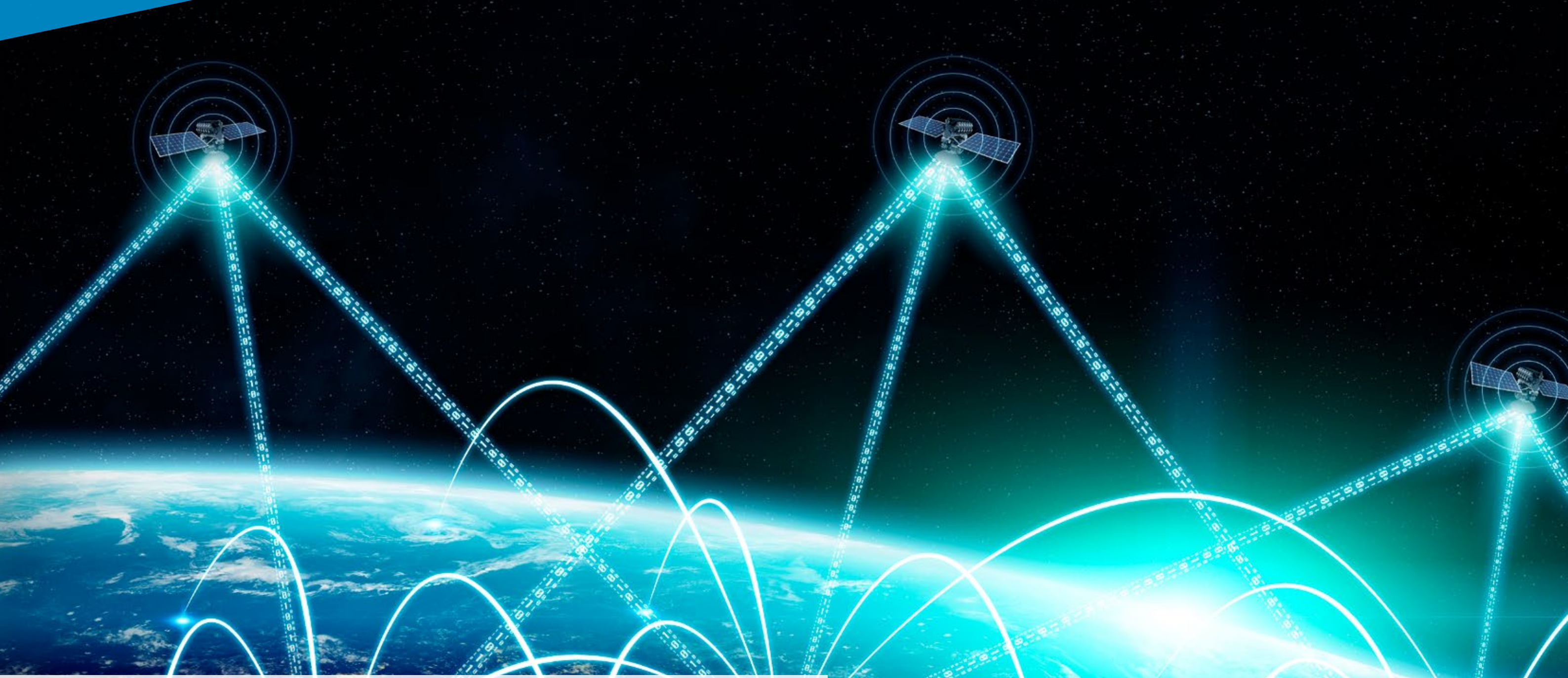
Despite the issues faced with Skynet 1A and 1B, engineers persisted with Skynet and launched Skynet 2A in January 1974 and Skynet 2B in November 1974. The Skynet 2 system was very successful for its time, and remained in service for several years beyond the timeframe originally planned.

Satellites

Satellites use radio waves and microwaves depending on the type of communication the satellite is being used for.

Microwaves are used for mobile phones while radio waves are used to transmit television and radio programmes.

Satellites are needed to allow communication over long distances. A signal is sent from a transmitter, such as a TV station, to a satellite. The satellite receives the signal and transmits a receiver, such as a TV dish.



TIME TO DEMONSTRATE

Demonstrate how an event is broadcast around the world using satellites.

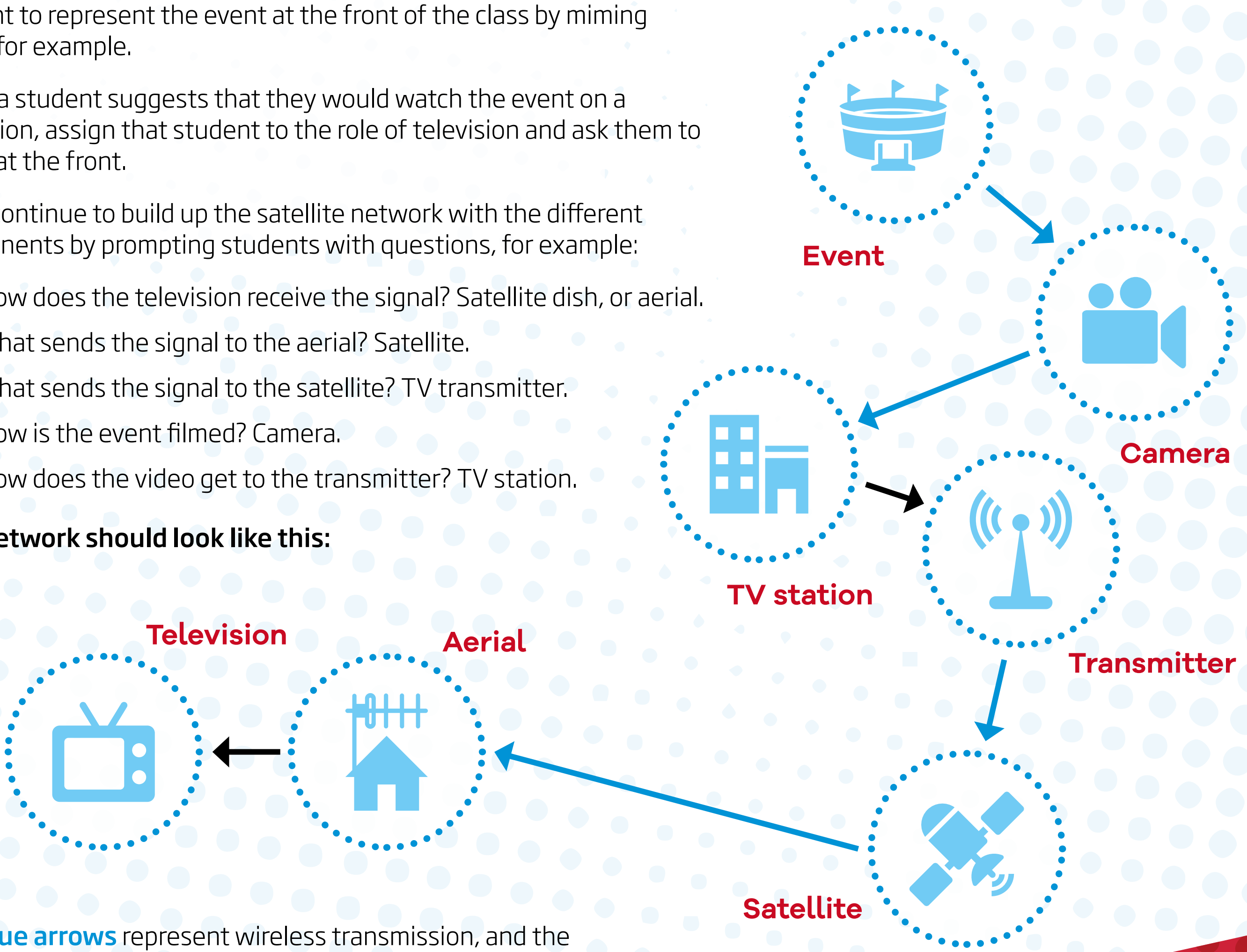
Start by asking students how they would watch an event such as the 2018 Winter Olympics in Pyeongchang County, South Korea. Ask a student to represent the event at the front of the class by miming skiing for example.

When a student suggests that they would watch the event on a television, assign that student to the role of television and ask them to stand at the front.

Then continue to build up the satellite network with the different components by prompting students with questions, for example:

- How does the television receive the signal? Satellite dish, or aerial.
- What sends the signal to the aerial? Satellite.
- What sends the signal to the satellite? TV transmitter.
- How is the event filmed? Camera.
- How does the video get to the transmitter? TV station.

The network should look like this:



The **blue arrows** represent wireless transmission, and the **black arrows** represent cables. You could use students or string to represent cables.

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TIME TO INVESTIGATE

Radio waves and microwaves are types of electromagnetic radiation, like light.

Light travels in straight lines and is reflected by shiny surfaces, like a mirror. Satellite dishes use reflection to receive a signal. The dish reflects the radio or microwave to a small receiver in front of the dish.

Key words

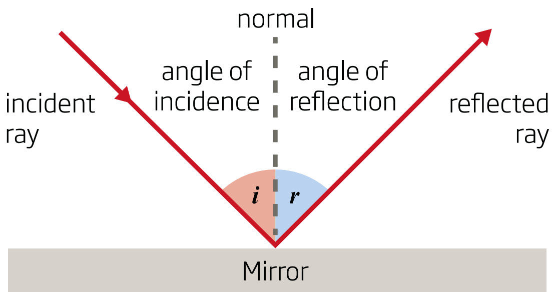
Angle of incidence: the angle between the normal and incident ray

Angle of reflection: the angle between the normal and reflected ray

Normal: a line drawn at 90° to the surface of the mirror

Incident ray: the light going towards the mirror

Reflected ray: the light coming away from the mirror



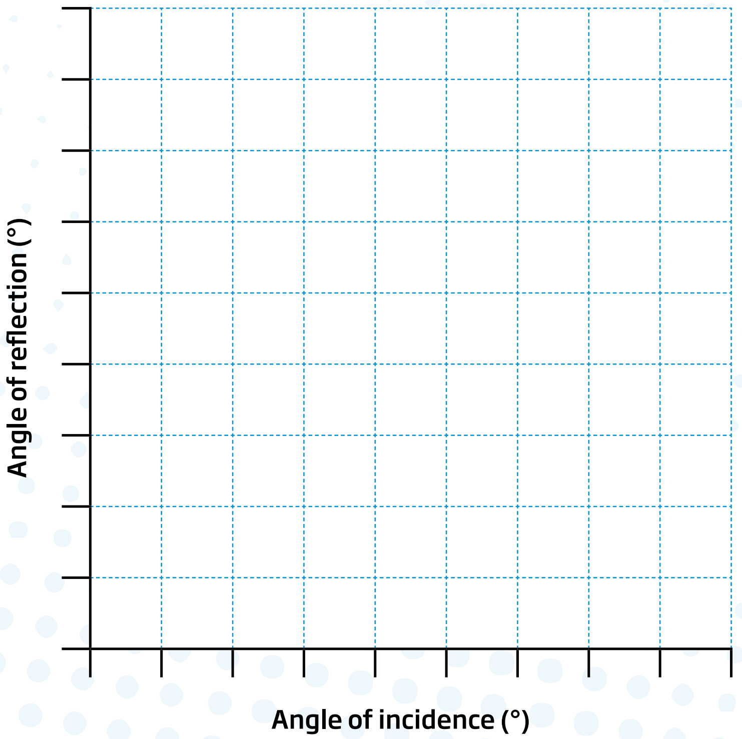
TIME TO INVESTIGATE

In this experiment, you will investigate the relationship between the angle on incidence and the angle of reflection.

1. Draw a line on the paper. Place the mirror on the line and support it so that it does not move.
2. Draw a line at 90° to the mirror; this is the normal line.
3. Shine the beam from the torch towards the mirror. Use the pencil to carefully mark two dots in the centre of the incidence and reflected rays.
4. Move the mirror to one side and use the ruler to join the dots to show the complete path of the ray. Add arrows so that you know what direction the ray travelled.
5. Use the protractor to measure the angle between the normal and the incident ray, and the normal and the reflected ray
6. Repeat three more time with different angles of incidence.

Angle of incidence	Angle of reflection

Complete the graph with your results



Guidance provided to STEM activity leader

This experiment is best conducted in a dark room, and a full risk assessment should be completed before carrying it out. Students should notice that the angle of incidence is the same as the angle of reflection.

Students could represent their results on a straight-line graph to help them explain their findings.

Complete the conclusion below:

From my experiment, I can see that the angle of incidence is .... the angle of reflection.

I can tell this because ....

....

....

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Make the UK the leading nation for engineering innovation

Supporting the development of successful engineering innovation and businesses in the UK in order to create wealth, employment and benefit for the nation.

Address the engineering skills crisis

Meeting the UK's needs by inspiring a generation of young people from all backgrounds and equipping them with the high quality skills they need for a rewarding career in engineering.

Position engineering at the heart of society

Improving public awareness and recognition of the crucial role of engineers everywhere.

Lead the profession

Harnessing the expertise, energy and capacity of the profession to provide strategic direction for engineering and collaborate on solutions to engineering grand challenges.

RAF 100

The RAF 100 Youth & STEM programme has been designed to engage and inspire young people by building their interest in engineering and technical career pathways.

From cyber specialists to aerospace, aviation, electronics and mechanical disciplines, the RAF is committed to using our centenary celebrations to extend opportunity to all and to encourage greater diversity in this critical area of national skills shortages.

Royal Academy of Engineering
Prince Philip House, 3 Carlton House Terrace, London SW1Y 5DG

Tel: +44 (0)20 7766 0600
www.raeng.org.uk

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