K-12 Educator's Guide

AN INCREDIBLE JOURNEY

This K-12 Educator's Guide includes supplemental information and activities to help extend the learning experience associated with watching *To Space & Back.*

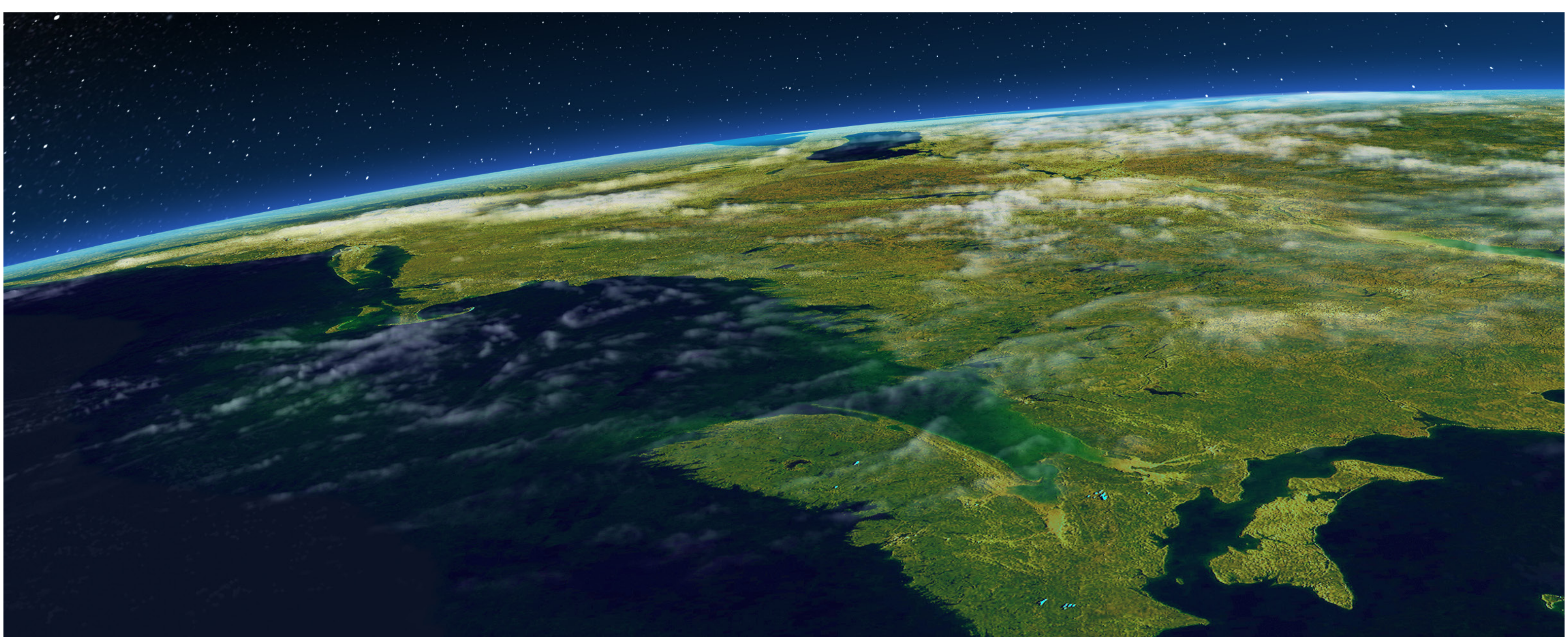
Space exploration, our greatest adventure, is having a big impact on our lives. It is helping us to discover a universe of unimaginable scale and beauty, and it is reaching down into our world and influencing the way we live.

To Space & Back takes audiences on an incredible journey from the far reaches of our known universe to our own planet. It is an extraordinary story of human ingenuity and incredible engineering, describing how the technology that transports us through space is paving the way for the devices and apps we use every day. What is happening above is coming back down to Earth!

This Guide includes ideas for how to engage students with the themes presented in *To Space & Back*. You will also find a complete presentation of how the film can be used to support classroom learning in context with the National Science Education Standards.

Learning Goals for K-12 Students:

- Space research and exploration enable understanding of the universe while also producing new technologies that directly impact daily life.
- Many of the technologies that we take for granted resulted from the human desire to understand the universe.
- The human eye provides a magnificent vision of the world, but technologies enable us to see things that the human eye cannot.



GLOSSARY

galaxy – a large system of stars held together by mutual gravitation and isolated from similar systems by vast regions of space.

geostationary orbit – a circular orbit around the Earth having a period of twenty-four hours, enabling a satellite to remain in a fixed position above the Earth.

gravity – the force of attraction that tends to move bodies towards the center of a celestial body like a planet or a moon.

infrared telescope – a device that uses infrared light to look for objects in the universe.

optical telescope – a device that uses lenses and mirrors to gather and focus visible light in order to magnify images of distant objects.

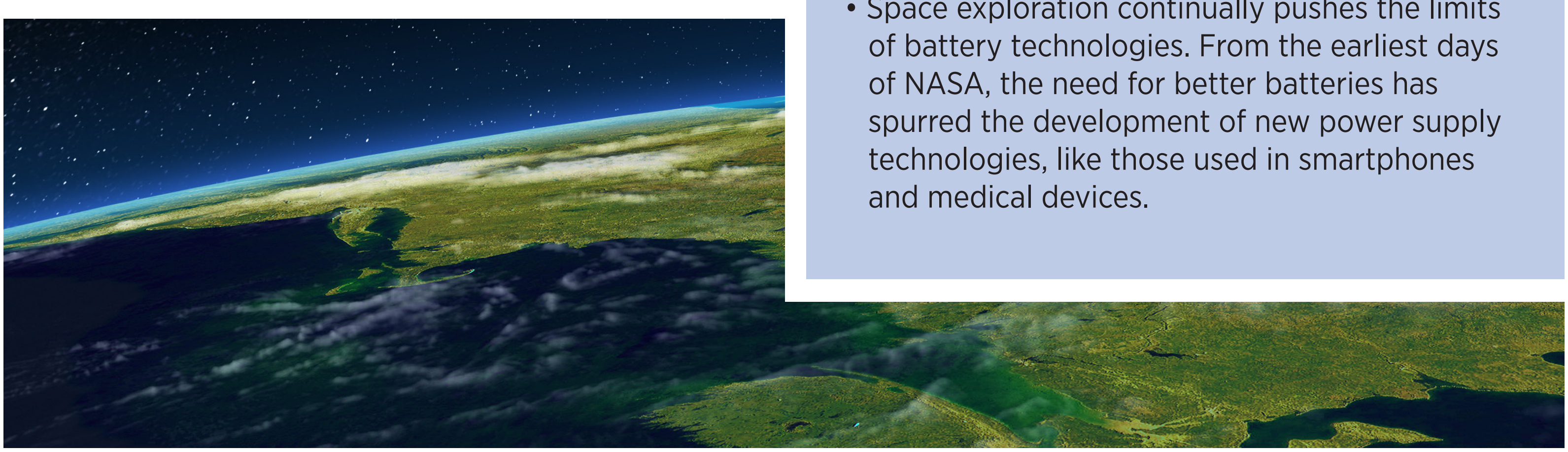
orbit – the curved path, usually elliptical, of an object's movement around a celestial body.

satellite – an object, whether natural or man-made, that orbits a celestial body.

telescope – a device that aids in the observation of remote objects.

FAST FACTS!

- Temper Foam often seen in Memory Foam products like mattresses originated at NASA.
- NASA did not invent Tang, Velcro, or Teflon!
- NASA invented the nanoceramic material used in many flat-irons and blow dryers used for hair styling.
- Transparent ceramics research for NASA led to the development of invisible braces—improving smiles while straightening teeth here on Earth.
- Science fiction author Arthur C. Clarke was the first person to imagine a fleet of communication satellites orbiting Earth. He wrote about the idea long before our age of space exploration actually began.
- Early advances in wireless telemetry made by NASA helped medical scientists develop the programmable pacemaker, enabling doctors to adjust heart pacing without need for repeated surgeries.
- Space exploration continually pushes the limits of battery technologies. From the earliest days of NASA, the need for better batteries has spurred the development of new power supply technologies, like those used in smartphones and medical devices.



TRY THIS! SATELLITE TRACKING:

Some might say that the International Space Station is responsible for more advances in technology than any other construction project in human history! First, the planning, design, construction, and deployment of the station all required the engineering and development of new technologies. Then, once the station became operational, it became the site of many scientific research studies that have generated important results to advance human understanding here on Earth. The station is so much more than just an orbiting satellite—it is a symbolic representation of the countless contributions that space exploration and research have made to civilization.

Did you know that the International Space Station is often visible in the sky?

Consider planning a viewing event at your school for students and their families when the world's largest artificial satellite is passing overhead. Or, encourage students to go outside at home and track its passage.

PLAN AHEAD

Find out when the International Space Station will be visible over your location.
Go to: spaceflight.nasa.gov/realdata/sightings

Select your country from the list and then continue selecting locations until you find your town. If you do not see your exact location listed, select a nearby town. The sighting opportunities will be the same, or vary by just a second or two. The listings will be for the next week or two, depending on your location. The best opportunities, of course, are those with the longest durations. Those that say < 1 minute will be the most challenging.

Note: You will also need to pay attention to the weather forecasts in your area. Cloud cover will prevent you from seeing the satellite.

WHAT TO DO

When you know that the satellite will be passing overhead and the sky will be clear, go outside and be ready to look to the sky.

Note: No special equipment is needed. You will be able to see the International Space Station just by looking. Of course, binoculars will enhance your view. Telescopes are actually not practical because of the satellite's speed.

WHERE TO LOOK

Younger students will need an adult to point to the satellite's position in the sky. Older students can be challenged to "read" the sky for themselves. The satellite tracking data for your location will include the local date/time, duration, maximum elevation, approach, and departure. For example, your result might look like the table at the bottom of this page.

This means that the International Space Station will be visible overhead on Tuesday, November 14 from 6:22AM to 6:26AM. It will come into view from the southwestern sky and pass out of view from the northeastern sky. The maximum elevation means that the satellite will never be higher than 66 degrees above the horizon. (90 degrees is directly overhead.) When it first comes into view, it will appear low in the sky, just 10 degrees above the horizon. It will climb as high as 66 degrees and then descend to 31 degrees before passing from view.

EXTENSION IDEAS

If you are going to track the International Space Station in the sky, you may want to use an Astrolabe to help locate it. On the following page, you will find instructions to make your own Astrolabe.

Older students can access live tracking data for the International Space Station online. Challenge them to read the map and name the location currently below.
Go to: www.isstracker.com

The crew's view is also available online. See what the astronauts are looking down on right now.
Go to: external.jsc.nasa.gov/events/ISSPhotos

This is particularly fun to do while students are waiting to go outside and see the satellite pass overhead. They will see it coming into range over your continent and then get to go outside and see it in the sky.

SATELLITE	LOCAL DATE/TIME	DURATION (minutes)	MAX ELEV (degrees)	APPROACH (degrees/direction)	DEPARTURE (degrees/direction)
ISS	Tue Nov 14 06:22 AM	4	66	10 above WSW	31 above NE

TRY THIS! D.I.Y. ASTROLABE:

An astrolabe is a classical instrument used to locate and predict the position of objects in the sky.

In this simple activity, students will construct their own astrolabe. The activity can be used at almost any grade level by increasing the complexity of the observation challenges. For K-6 students, simply having them record one angle of elevation in sunlight is sufficient. For 7-12 students, identification of objects in the night sky is appropriate.

Depending on your classroom circumstances, it may be acceptable to have students share the astrolabes, in which case you would need fewer supplies. However, if you want to challenge your students to use their astrolabes to observe the nighttime sky at home, they will each need their own. For young children, consider using brightly colored string or thread which will be easier for them to manipulate.

Note: The materials for this activity are inexpensive and readily available in your local discount store's school supply and hardware aisles.

MATERIALS

One straight plastic straw (not the flexible kind)

One protractor

Fine string or thick thread

cut to 12 inch length

One weight such as a bolt or fishing sinker

Scotch tape

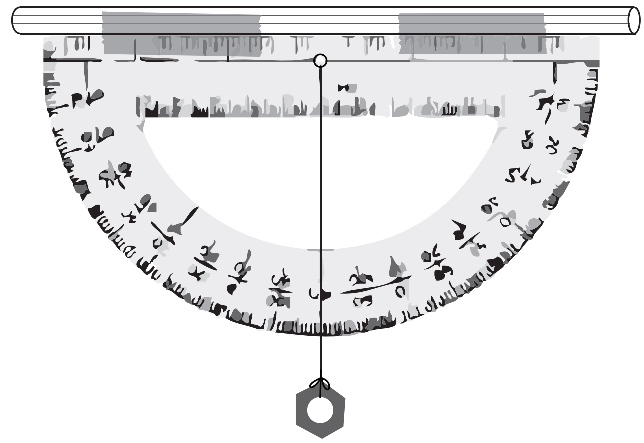
Notebooks/pencils for recording observations

PROCEDURE

Locate the hole at the center of the protractor's straight edge. Loop one end of the thread through the hole and tie it securely, using as little of the thread as possible. There should be about 10 inches left hanging.

At the other end of the string, attach the weight, again being careful not to waste too much length.

When you hold the protractor level, the weight should hang down with the string passing alongside the 90 degree mark on the arc of the protractor.



Using scotch tape, carefully attach the plastic straw to the straight edge of the protractor. Be sure that the string is not caught in the tape. The string needs to move freely.

Now, look through the straw to observe a tall object like a tree or rooftop. As you tilt the astrolabe up, the weight will move to measure the degree of your angle of observation. Work with a partner and take turns reading each other's angles. Record your data.

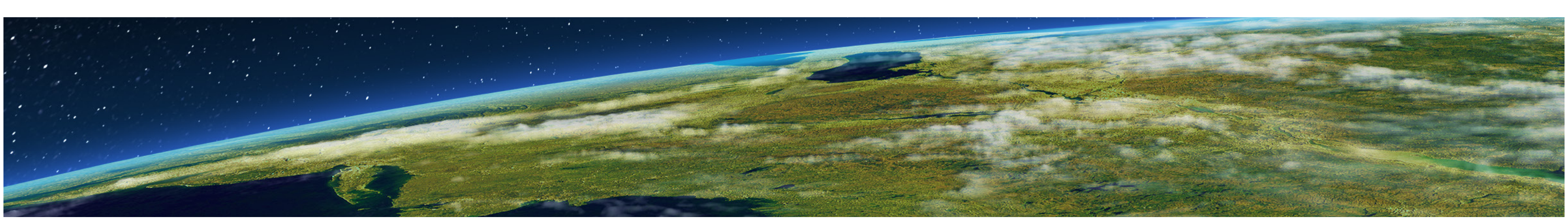
Once students know how to use the astrolabe, they can use it to locate and track satellites based on their predicted elevation.

EXTENSION IDEAS

Challenge older students to use their astrolabe at home to observe planets and stars in the nighttime sky. You can make your own observation the night before and challenge them the next night to tell you what they see at certain angles of elevation. Or, you can use one of the many online stargazing information websites to identify what they should be able to see in your town on a certain night. Don't forget, though, that cloud cover will interfere with this activity, so make sure the weather forecast calls for clear skies.

Here are two websites that offer daily sky charts by zip code.

Weather Underground:
www.wunderground.com/sky/index.asp
Sky and Telescope:
www.skyandtelescope.com/observing/skychart

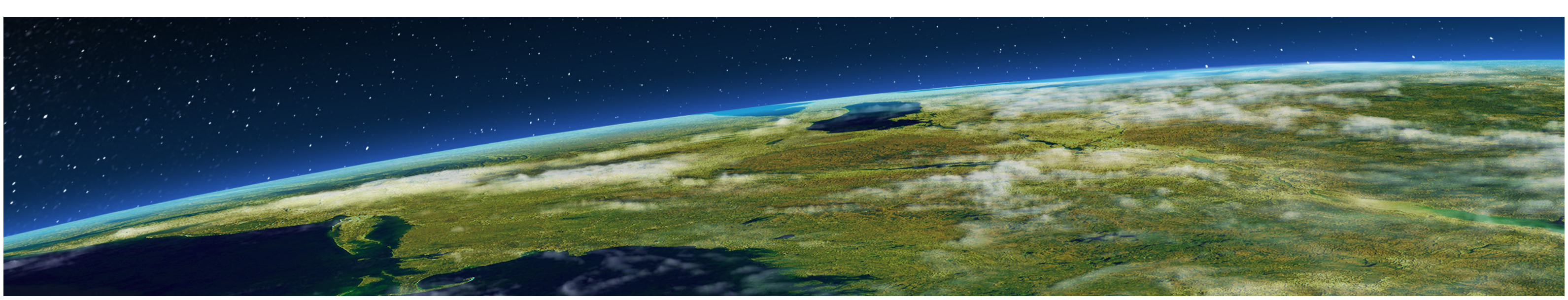


TRY THIS!

WORD SEARCH

N	Z	S	Z	J	G	A	E	Z	E	A	A	G	L	X
K	O	C	V	P	Z	X	O	P	Y	Q	A	D	G	V
A	A	I	Z	W	T	K	O	X	W	L	T	Y	B	J
N	B	E	T	Y	M	C	E	H	A	P	Q	S	A	V
Y	C	N	D	A	S	Y	T	X	N	G	D	Q	J	Q
P	T	C	B	E	R	G	Y	Q	M	T	G	T	H	D
X	K	E	L	V	E	O	R	B	S	V	O	V	S	H
D	N	E	R	L	A	L	L	E	C	A	P	S	G	T
T	T	P	J	A	G	O	L	P	S	S	I	G	R	R
A	Z	I	N	I	T	N	F	J	X	E	J	I	Z	Y
F	J	H	V	J	M	H	I	Z	L	E	A	B	Q	I
W	S	C	T	E	Y	C	U	N	I	V	E	R	S	E
F	L	K	T	O	C	E	P	Z	R	U	W	K	C	X
W	L	K	V	F	B	T	X	T	Q	P	F	I	O	H
Z	O	T	C	K	Q	X	B	P	G	Y	O	L	Q	Z

EXPLORATION
GALAXY
RESEARCH
SCIENCE
SPACE
TECHNOLOGY
TELESCOPE
UNIVERSE



TRY THIS!

WORD SEARCH

O	H	Y	Q	W	T	T	J	E	N	O	Z	E	Z	E	A	Q	Z	K	S	P	G	J	T	T
P	E	C	D	G	I	B	P	R	G	O	I	N	V	E	N	T	I	O	N	A	K	R	J	W
V	W	N	R	K	R	O	G	O	W	B	I	E	C	A	P	S	K	G	L	T	Q	P	U	F
M	A	O	Z	A	C	A	I	E	J	G	U	T	L	X	T	S	F	A	C	E	M	M	V	R
Q	N	I	M	S	E	M	V	L	L	P	W	N	A	A	Z	I	X	Y	X	L	A	U	F	F
F	F	G	E	G	R	S	E	I	A	K	B	Y	O	R	A	Y	B	D	A	E	O	P	A	Y
J	P	L	Y	N	A	Z	E	S	T	Y	C	O	R	E	O	Z	M	R	I	M	F	D	V	F
Q	E	C	G	F	J	C	T	R	V	Y	X	E	E	J	G	L	I	I	O	E	I	E	H	T
T	O	K	B	M	Q	R	O	P	T	I	C	A	L	T	S	C	P	P	V	T	W	R	P	C
D	K	Q	I	W	O	F	N	X	S	J	D	C	G	O	N	N	H	X	P	R	D	A	U	P
N	Y	O	W	N	P	J	Q	X	T	R	W	A	C	K	N	Z	B	N	E	Y	L	R	O	H
A	L	D	O	F	W	Q	V	N	V	G	M	E	C	T	K	P	Q	Y	Q	X	E	F	O	L
O	C	M	D	Z	M	Z	V	G	Y	A	T	I	A	Y	R	V	I	B	L	L	V	N	O	P
D	Y	G	F	Z	Y	R	A	N	O	I	T	A	T	S	O	E	G	D	X	L	C	I	T	H
F	I	F	C	W	T	E	G	H	O	A	Y	R	P	G	P	I	U	L	R	D	J	Y	W	Y
X	G	S	Z	D	C	G	Z	X	E	S	G	D	C	V	I	E	S	R	E	V	I	N	U	S
Y	X	W	C	N	G	G	Y	B	U	N	O	X	K	M	H	B	R	S	W	Q	B	H	E	I
A	K	J	E	O	W	F	F	W	T	W	L	L	P	K	I	A	I	D	U	A	L	Z	C	C
V	G	I	H	K	V	S	M	D	I	P	O	Y	L	I	B	N	Z	D	P	H	U	S	D	S
A	C	U	I	U	Y	E	T	T	X	O	N	I	A	H	Z	O	D	U	H	L	E	Y	I	V
S	O	E	P	P	W	V	R	L	A	H	H	X	M	I	A	Q	M	V	M	T	B	T	V	K
C	X	Y	Y	C	B	H	S	Y	W	C	C	K	T	N	Z	N	L	R	E	F	T	W	J	P
D	I	F	P	O	V	Q	R	Q	A	B	E	L	G	T	H	V	I	X	A	N	V	D	J	I
Y	K	B	E	T	B	C	E	V	X	Q	T	V	K	U	E	S	O	E	X	H	S	G	J	A
L	W	K	N	L	K	D	K	X	A	M	W	X	A	W	Y	F	P	X	U	I	W	R	C	S

ASTRONOMY
DISCOVERY
EXPLORATION
GALAXY
GEOSTATIONARY
GRAVITY
INFRARED
INVENTION
OPTICAL
ORBIT
PHYSICS
RESEARCH
SCIENCE
SPACE
TECHNOLOGY
TELEMETRY
TELESCOPE
UNIVERSE

RECOMMENDED RESOURCES

Websites

Spinoff: NASA Technologies Benefit Society
spinoff.nasa.gov
Complete collection of technologies resulting from NASA research and exploration.

International Space Station
www.nasa.gov/station
Home for everything related to the ISS.

Hubble Space Telescope
www.nasa.gov/hubble
Clearinghouse for Hubble information and images.

NASA Space Operations Learning Center
solc.gsfc.nasa.gov
Kids Zones 1 and 3 feature satellite information for K-6. Advanced Space Communications features activities for 7-12.

U.S. Space Objects Registry
www.usspaceobjectsregistry.state.gov
Searchable database of space objects.

Keck Observatory
keckobservatory.org
Home of the world's largest optical and infrared telescopes.

Recommended Reading for Children and Young Adults

Grades K-3

I Fall Down
by Vicki Cobb. ISBN 0688178421

National Geographic Little Kids First Big Book of Space
by Catherine D. Hughes. ISBN 1426310145

Newton and Me
by Lynne Mayer. ISBN 9781607180678

Sputnik: The First Satellite
by Heather Feldman. ISBN 082396244X

Grades 4-8

How the Future Began: Communications
by Anthony Wilson. ISBN 0753451794

Space, Stars, and the Beginning of Time: What the Hubble Telescope Saw by Elaine Scott. ISBN 0547241895

Space Station Science: Life in Free Fall
by Marianne J. Dyson. ISBN 0590058894

Scientific American: Inventions from Outer Space: Everyday Uses for NASA Technology by David Aaron Baker. ISBN 0375409793

The International Space Station
by Franklyn M. Branley. ISBN 0060287020

This Is Rocket Science: True Stories of the Risk-taking Scientists who Figure Out Ways to Explore Beyond Earth
by Gloria Skurzynski. ISBN 1426305974

Grades 9-12

Close Encounters: Exploring the Universe with the Hubble Space Telescope
by Elaine Scott. ISBN 0786821205

Something New Under the Sun: Satellites and the Beginning of the Space Age by Helen Gavaghan. ISBN 0387949143

Sputnik: The Shock of the Century
by Paul Dickson. ISBN 0802779514

Space Research by Peggy J. Parks. ISBN 1601521111

The Seven Secrets of How to Think like a Rocket Scientist
by James Longuski. ISBN 1441921591

NATIONAL SCIENCE EDUCATION STANDARDS

To Space & Back and the accompanying activities suggested in this guide can be used to support K-12 student learning as called for by the National Science Education Standards.

Unifying Concepts and Processes – K-12

STANDARD: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes:

SYSTEMS, ORDER, AND ORGANIZATION

The natural and designed world is complex; it is too large and complicated to investigate and comprehend all at once. Scientists and students learn to define small portions for the convenience of investigation. The units of investigation can be referred to as "systems." A system is an organized group of related objects or components that form a whole.

EVIDENCE, MODELS, AND EXPLANATION

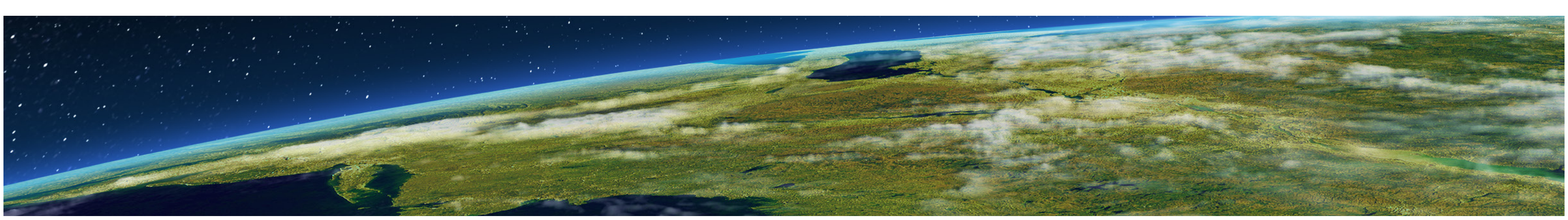
Evidence consists of observations and data on which to base scientific explanations. Using evidence to understand interactions allows individuals to predict changes in natural and designed systems. Models are tentative schemes or structures that correspond to real objects, events, or classes of events, and that have explanatory power. Models help scientists and engineers understand how things work.

CONSTANCY, CHANGE, AND MEASUREMENT

Although most things are in the process of becoming different—changing—some properties of objects and processes are characterized by constancy, including the speed of light, the charge of an electron, and the total mass plus energy in the universe. Changes might occur, for example, in properties of materials, position of objects, motion, and form and function of systems. Interactions within and among systems result in change. Changes vary in rate, scale, and pattern, including trends and cycles.

EVOLUTION AND EQUILIBRIUM

Evolution is a series of changes, some gradual and some sporadic, that accounts for the present form and function of objects, organisms, and natural and designed systems. The general idea of evolution is that the present arises from materials and forms of the past. Although evolution is most commonly associated with the biological theory explaining the process of descent with modification of organisms from common ancestors, evolution also describes changes in the universe.



NATIONAL SCIENCE EDUCATION STANDARDS

CONTENT STANDARD B PHYSICAL SCIENCE

GRADES K-4

POSITION AND MOTION OF OBJECTS

- The position of an object can be described by locating it relative to another object or the background.
- An object's motion can be described by tracing and measuring its position over time.

GRADES 5-8

MOTIONS AND FORCES

- The motion of an object can be described by its position, direction of motion, and speed.

GRADES 9-12

MOTIONS AND FORCES

- Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects.
- Gravitation is a universal force that each mass exerts on any other mass.

CONTENT STANDARD D EARTH AND SPACE SCIENCE

GRADES K-4

OBJECTS IN THE SKY

- The sun, moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described.

CHANGES IN THE EARTH AND SKY

- Objects in the sky have patterns of movement.

GRADES 5-8

EARTH IN THE SOLAR SYSTEM

- Most objects in the solar system are in regular and predictable motion.
- Gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the solar system.

GRADES 9-12

THE ORIGIN AND EVOLUTION OF THE UNIVERSE

- The origin of the universe remains one of the greatest questions in science. The "big bang" theory places the origin between 10 and 20 billion years ago, when the universe began in a hot dense state; according to this theory, the universe has been expanding ever since.

CONTENT STANDARD E SCIENCE AND TECHNOLOGY

GRADES K-4

UNDERSTANDING ABOUT SCIENCE AND TECHNOLOGY

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

GRADES 5-8

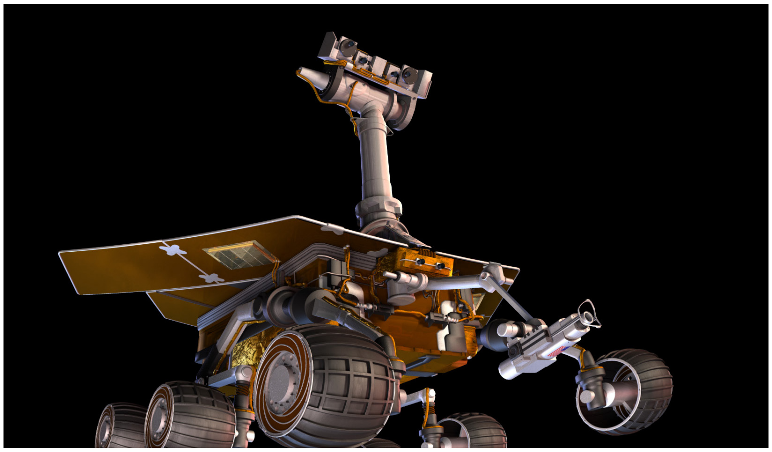
UNDERSTANDINGS ABOUT SCIENCE AND TECHNOLOGY

- Science and technology are reciprocal. Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity, distance, location, size, and speed. Technology also provides tools for investigations, inquiry, and analysis.

GRADES 9-12

UNDERSTANDINGS ABOUT SCIENCE AND TECHNOLOGY

- Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research.
- Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.



NATIONAL SCIENCE EDUCATION STANDARDS

CONTENT STANDARD F SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

GRADES K-4

SCIENCE AND TECHNOLOGY IN LOCAL CHALLENGES

- People continue inventing new ways of doing things, solving problems, and getting work done. New ideas and inventions often affect other people.

GRADES 5-8

SCIENCE AND TECHNOLOGY IN SOCIETY

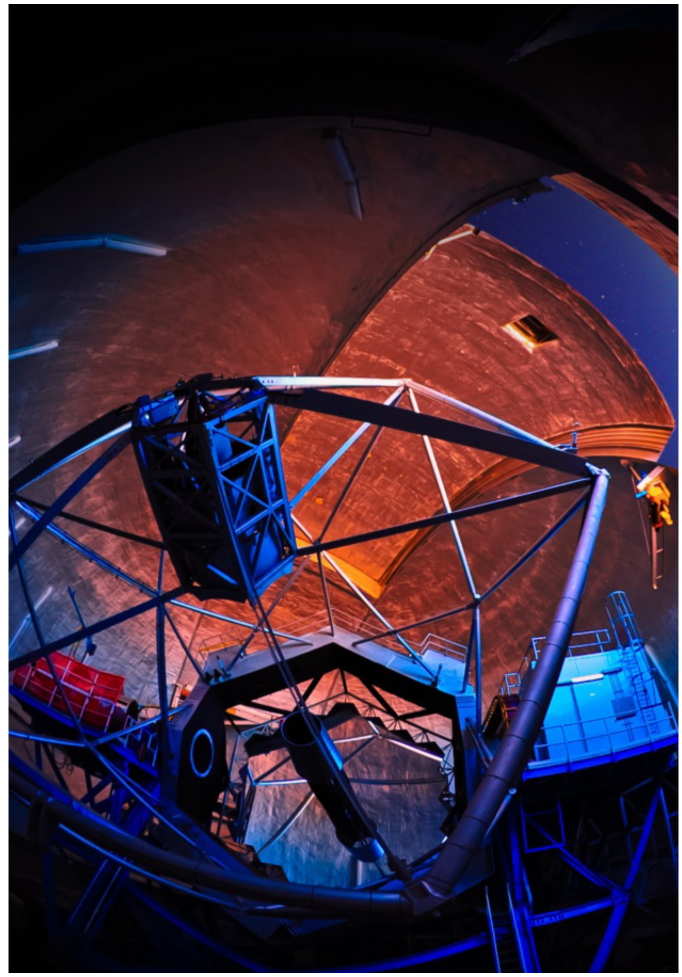
- Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs, attitudes, and values influence the direction of technological development.
- Science and technology have contributed enormously to economic growth and productivity among societies and groups within societies.

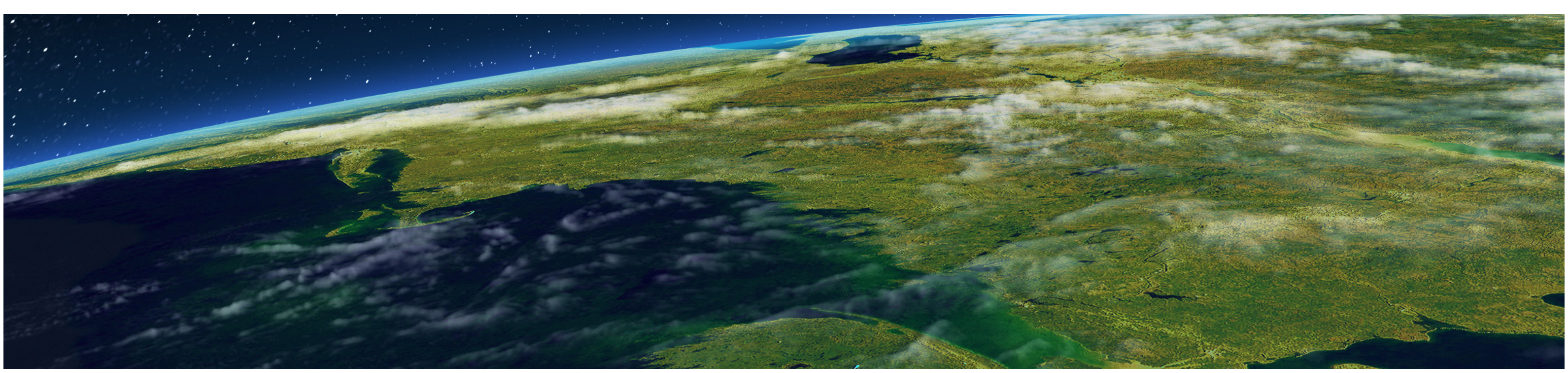
CONTENT STANDARD G HISTORY AND NATURE OF SCIENCE

GRADES 9-12

HISTORICAL PERSPECTIVES

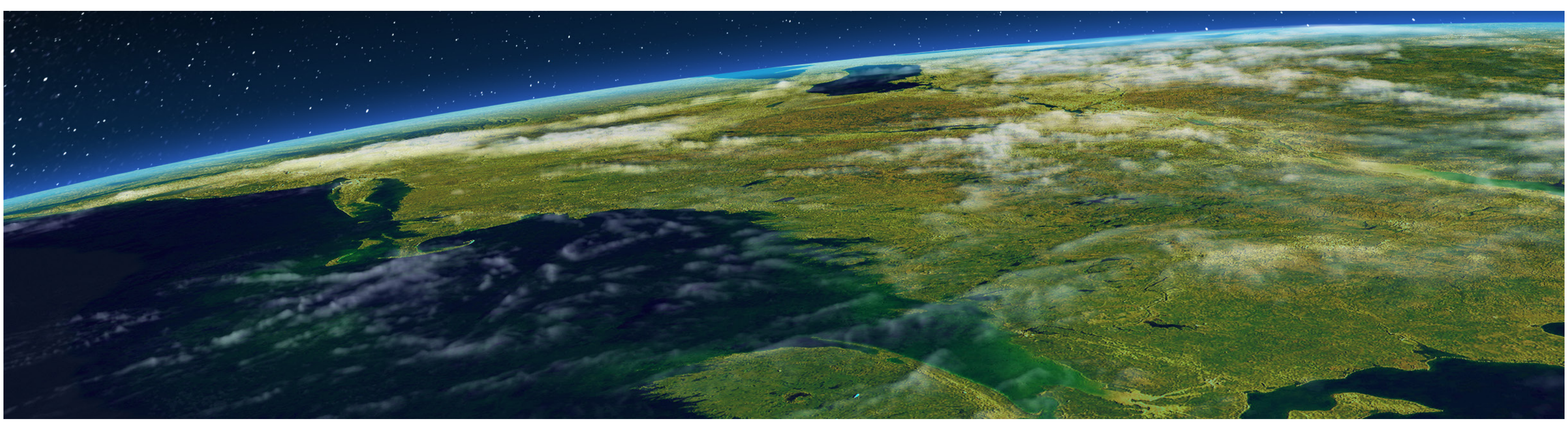
- Usually, changes in science occur as small modifications in extant knowledge. The daily work of science and engineering results in incremental advances in our understanding of the world.





NATIONAL SCIENCE EDUCATION STANDARDS

	K - 4	5 - 8	9 - 12
UNIFYING CONCEPTS & PROCESSES	*Systems, order, and organization. Evidence, models, and explanation. Constancy, change, and measurement. Evolution and equilibrium.*		
PHYSICAL SCIENCE	**POSITION & MOTION OF OBJECTS** *Relative positions, motion over time, change*	**MOTIONS & FORCES** *Object motion, direction, speed*	**MOTIONS & FORCES** *Net force, laws of motion, gravity*
EARTH & SPACE SCIENCE	**OBJECTS IN THE SKY** *Locations, movements* **CHANGES IN THE EARTH & SKY** *Patterns of movement*	**EARTH IN THE SOLAR SYSTEM** *Predictable motion, gravity*	**THE ORIGIN OF THE UNIVERSE** *Big Bang theory, expansion*
SCIENCE & TECHNOLOGY	*Questions about the world, tools to help answer questions*	*Reciprocity between science and technology*	*Process of research, motivations*
SCIENCE IN PERSONAL & SOCIAL PERSPECTIVE	**LOCAL CHALLENGES** *Inventing new ways to address challenges*	**SCIENCE & TECHNOLOGY IN SOCIETY** *Technology influences society*	
HISTORY & NATURE OF SCIENCE			**HISTORICAL PERSPECTIVES** *Incremental advancement*



www.ToSpaceAndBack.com | Follow us! @SkySkan SkySkan

To Space & Back, narrated by James May, explores the way each of us has been changed by the discoveries made by the international space program. From the devices we use every day to the tools that are breaking new ground in medicine and engineering, we can thank space exploration for making our modern lives possible.

To Space & Back is produced by Sky-Skan in association with The Franklin Institute.
This K-12 Educator's Guide is an educational product of The Franklin Institute.