5th Grade Unit 4
9 weeks

Space Systems

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Essential Questions

How do mass and distance affect the force of gravity between two objects?

What causes the cycle of day and night?

How do lengths and directions of shadows or relative lengths of day and night change from day to day?

Why do the sun, stars, and planets appear to move across the sky?

How does the appearance of some stars change in different seasons?

Space Systems

Students who demonstrate understanding can:

5-PS2-1 Support an argument that the gravitational force exerted by Earth on objects is directed down.
[Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.] [Assessment Boundary: Assessment does not include mathematical representation of gravitational force.]

5-ESS1-1 Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.
[Assessment Boundary: Assessment is limited to relative distances rather than sizes of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, or stage).]

5-ESS1-2 Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.
[Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and select stars that are visible only in particular months.] [Assessment Boundary: Assessment does not include causes of seasons.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. (5-ESS1-2) **Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model. (5-PS2-1, 5-ESS1-1)	**PS2.B: Types of Interactions** • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1) **ESS1.A: The Universe and its Stars** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	**Patterns** • Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena. (5-ESS1-2) **Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change. (5-PS2-1) **Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large. (5-ESS1-1)

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Background knowledge videos:

PS2B - Types of Interactions (gravitational force ideas)

ESS1A - The Universe & Its Stars

ESS1B - Earth & the Solar System

These videos are designed to assist in providing background knowledge with the associated DCI. The information in the videos follows the progression through high school.

Prior to 5th grade, students should have knowledge, understanding of, and experiences with the following ideas:

- ★ When objects touch or collide, they push one another and can change motion.
- ★ Objects in contact exert forces on each other.
- ★ Each force acts on one particular object and has both a strength and direction.
- ★ An object at rest typically has multiple forces acting on it by they add to give zero net force on the object.
- ★ The sizes of the forces in each situation depend on the properties of the objects and their distances apart or their relative orientation to each other.
- ★ The patterns of an object's motion in various situations can be observed and measured; when the past motion exhibits a regular pattern, future motion can be predicted from it.
- ★ Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.
- ★ Seasonal patterns of sunrise and sunset can be observed, described, and predicted.

With the implementation of new standards, students may not have had opportunities to engage in these foundational understandings and ideas before 5th grade. You may need to provide opportunities for students to experience these ideas as you move forward.

- How do mass and distance affect the force of gravity between two objects?
- What causes the cycle of day and night?
- How do lengths and directions of shadows or relative lengths of day and night change from day to day?
- Why do the sun, stars, and planets appear to move across the sky?
- How does the appearance of some stars change in different seasons?

Big Ideas

★ The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.

★ The sun is a star that appears larger and brighter than other stars because it is closer to Earth.

★ Stars range greatly in their distance from Earth.

★ The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its *North* and *South* poles, cause observable patterns.

These patterns include:

- Day and night
- Daily changes in the length and direction of shadows
- Different positions of the sun, moon, and stars at different times of the day, month, and year

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Students who demonstrate understanding can:

5-PS2-1: Support an argument that the gravitational force exerted by Earth on objects is directed down.

[Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.]

[Assessment Boundary: Assessment does not include mathematical representation of gravitational force.]

Disciplinary Core Ideas

PS2.B: Types of Interactions

- The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)

Identify and CLARIFY the STANDARDS

Possible student misconceptions about Gravity:

Misconception: There is no gravity in space.

The force of gravity acts between all objects in the universe.

Misconception: Gravity increases with height.

Gravity is the force of attraction between two objects. The greater the masses of the objects and the smaller the distance between them, the greater is the gravitational pull between them.

Misconception: Gravity affects light objects differently.

The reason that many lighter objects take longer to fall to the ground is because of the effect of air resistance, and not weight.

Misconception: Gravity is caused by Earth's rotation or a push from above.

Mass and distance determine the force of gravity.

Misconception: Astronauts in orbit around Earth are weightless.

Astronauts in orbit are not weightless. The sensation of weightlessness occurs because the astronauts are in constant free fall. They never hit the ground because their orbital speed matches their rate of fall, which causes them to stay in orbit. The orbiting astronauts still have weight because they remain within Earth's gravitational field.

Misconception: Gravity is the same as magnetism or static electricity.

Although gravity and electromagnetism are both fundamental forces, they are quite different in nature. Electromagnetism can attract or repel objects, but only with objects with certain specific properties. Gravity is only an attractive force that acts between any two objects that have mass.

Space Systems

Students who demonstrate understanding can:

5-ESS1-1: Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.

[Assessment Boundary: Assessment is limited to relative distances rather than sizes of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, or stage).]

Disciplinary Core Ideas

ESS1.A: The Universe and its Stars

- The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1)

Identify and CLARIFY the STANDARDS

Possible student misconceptions about the Sun:

Misconception: The Sun travels across the sky throughout the day.

The Sun only appears to move this way because the Earth is rotating on its axis.

Misconception: The Sun has a solid surface.

The Sun is made mostly of hydrogen and helium gases and has no solid surface.

Misconception: The Sun does not rotate.

Like Earth, the Sun rotates on an invisible axis. Galileo discovered the Sun's rotation when he observed sunspots moving across the face of the Sun. It takes the Sun about 27 days to make a full rotation.

Misconception: It is not harmful to look directly at the Sun.

Looking directly at the Sun is very dangerous and can result in permanent eye damage or blindness.

Possible student misconceptions about stars and constellations:

Misconception: Confuse astronomy with astrology.

Astronomy is a science: astronomers study objects in space. Astrology is a pseudoscience: astrologers believe that the positions of celestial bodies affect people.

Misconception: Stars appear to move in the night sky because of the stars' movement.

The stars appear to move because of Earth's rotation and orbit around the Sun. It's like turning in a circle. The objects around you appear to move, but it's actually you who is moving.

Misconception: The stars in a constellation are close to one another.

They may be hundreds of light years apart.

Misconception: All stars are the same distance from Earth.

They are all at varying distances from Earth.

Misconception: All stars are the same size and color.

There are stars smaller than the Sun and some much more massive. Stars may be different colors, including yellow, red, and blue.

Misconception: The North Star is the brightest star in the sky.

Actually, the North Star is not particularly bright and can be easily overlooked.

Misconception: Stars and constellations appear in the same place in the sky every night.

Due to the revolution of Earth in its orbit around the Sun, we see different stars and constellations in the night sky as the weeks and months pass.

Disciplinary Core Ideas

ESS1.A: The Universe and its Stars

- The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1)

Identify and CLARIFY the STANDARDS

Space Systems

Students who demonstrate understanding can:

5-ESS1-2: Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. [Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and select stars that are visible only in particular months.] [Assessment Boundary: Assessment does not include causes of seasons.]

Disciplinary Core Ideas

ESS1.B: Earth and the Solar System

- The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)

Possible Student Misconceptions about the day/night cycle:

Misconception: If it's daytime where we live, it's daytime everywhere else on Earth.
As Earth rotates, about half of the planet experiences day while the other half experiences night.

Misconception: Earth's revolution around the sun cause day and night to occur.
It is Earth's rotation on its axis every 24 hours that causes day and night to occur.

Possible Student Misconceptions about the Seasons:

Misconception: Earth's changing seasons are caused by the changing distance between Earth and the Sun.
The seasons change because the Earth's axis remains tilted in one direction in space as it orbits the Sun. When a hemisphere is tilted toward the Sun, it has summer and when a hemisphere is tilted away from the Sun, it has winter.

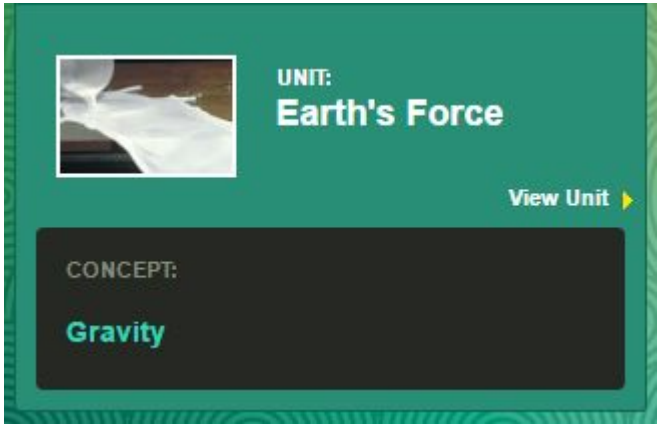
Misconception: Every place on Earth has the same season at the same time.
The Northern and Southern hemispheres have opposite seasons.

Identify and CLARIFY the STANDARDS

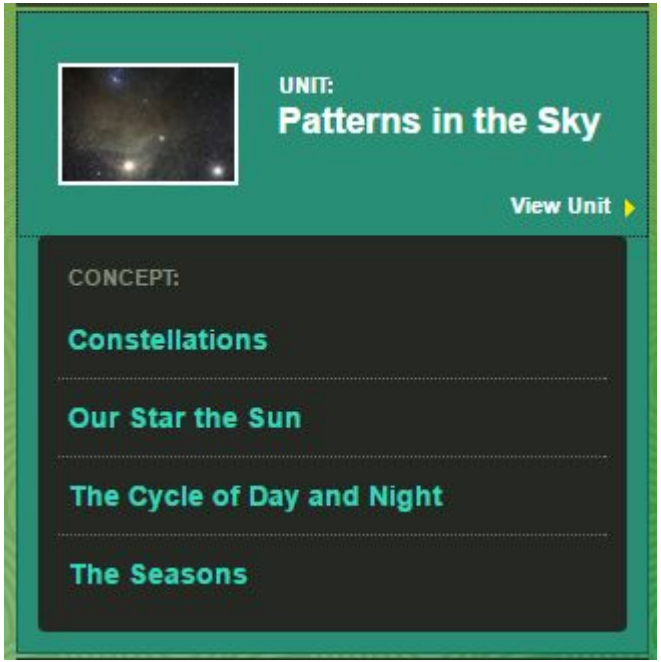
Discovery Education
Science Techbook Units

Gather and study the RESOURCES

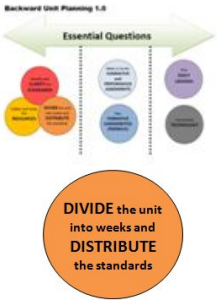
Physical Science



Earth and Space Science



Week 1 & 2



Foundation Standards:
- **An object at rest typically has multiple forces acting on it by they add to give zero net force on the object.**
- **The sizes of the forces in each situation depend on the properties of the objects and their distances apart or their relative orientation to each other.**
- **Each force acts on one particular object and has both a strength and direction.**
- **When objects touch or collide, they push one another and can change motion.**
- **Objects in contact exert forces on each other.**

Grade Level Standard:
- **5-PS2-1 Support an argument that the gravitational force exerted by Earth on objects is directed down.**

[Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.]
[Assessment Boundary: Assessment does not include mathematical representation of gravitational force.]

Instruction

Foundational Questions:

How do force and motion interact?

A. What effect does a force have on the motion of an object?
B. What effect do balanced forces have on the motion of an object?
C. What effect do unbalanced forces have on the motion of an object?

Grade-Level Questions:

A. How do mass and distance affect the force of gravity between two objects? (CER on following slide)

*See common misconceptions about gravity on slide 6

Foundational Resources

Formative Assessment Probe: Force and Motion Ideas (pre-assessment) *intranet password required*
5 Crash Course Videos about Gravity
Forces and Motion DE Video
Slippery Design 5E DE Hands-On Lesson

Grade-Level Resources

Gravity 5E DE Lesson
Universal Gravity DE Hands-On Lesson
Universal Gravity Student
Shooting More Marbles DE Hands-On Activity

Vocabulary: Gravity, gravitational force, force, object, motion, distance, directions, strength, pattern

Possible SCIENTIFIC EXPLANATION

Guiding Question: How do mass and distance affect the force of gravity between two objects?

CLAIM Statement about the results of an investigation

* One-sentence answer to the question you investigated.
* It answers, what can you conclude?
* It should not start with yes or no.
* It should describe the relationship between dependent and independent variables.

EVIDENCE Scientific data used to support the claim

* Evidence must be:
  - Sufficient: use enough evidence to support the claim
  - Appropriate: use data that support your claim
  - Qualitative (using the senses),quantitative (numerical), or a combination of both

REASONING Ties together the claim and the evidence

* Shows how or why the data count as evidence to support the claim
* Proves the justification for why this evidence is important to this claim
* Includes one or more scientific principles that are important to the claim and evidence..

The greater the mass of two objects, the greater the gravitational pull. The smaller the distance between the two objects, the greater the gravitational pull. The bowling ball dropped to the ground quicker than the feather. When the moon is closer to the Earth, the moon's gravitational force makes the ocean's tide rise. Newton's law states that gravitational force is constant, but air resistance is a force that plays an important role.

DIVIDE the unit into weeks and **DISTRIBUTE** the standards

Weeks 3 & 4

Standard: 5-ESS1-1: Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth. [Assessment Boundary: Assessment is limited to relative distances rather than sizes of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, or stage).]

Instruction

Weeks 3-4 Questions:

A. How does distance affect the size and brightness of stars?
B. Why does the sun appear brighter and larger than other stars?
C. How does the Sun make it possible for life on Earth to exist?

*Readworks.org has several passages that support these questions (free account required)

*Betterlesson.com has several lessons supporting these questions (free account required)

Resources for Question A:

Formative Assessment Probe: Is the Sun a Star?
intranet password required

Brightness and Distance of Stars (DE Hands-On Activity)

Resources for Question B:

DE Video- "Stars" why the sun appears closer
Size of the Sun Image

Resources for Question C:

DE Our Star the Sun
Crash Course Kids: Here Comes the Sun

Vocabulary

Sun, Stars, Distance, Position

Weeks 5 & 6

Standard: 5-ESS1-2: Represent data in graphical displays to reveal patterns of daily changes in length and **direction of shadows, day and night**, and the seasonal appearance of some stars in the night sky. [Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and select stars that are visible only in particular months.] [Assessment Boundary: Assessment does not include causes of seasons.]

Instruction

Weeks 5-6 Question:

A. What causes the cycle of day and night?
B. How do lengths and directions of shadows change during the course of the day?

Examples of patterns you can incorporate include:

- Over the course of a day, chart shadows and explain patterns Example Lesson
- Draw conclusions and predict future phases of the moon (Note: relate this to Question B - This is not formal instruction of the phases of the moon.)

*APK possibility: when illustrating the rotation and revolution of the earth, compare the Earth to the way the cars on the “teacup ride” rotate and revolve. (Teacup = Earth; Teapot = Sun) Teacup Ride (Start 0.42)

Resources for Question A:

Formative Assessment Probes:
intranet password required
What Causes Night and Day?
Darkness at Night

Resources for Question B:

Formative Assessment Probe: Me and My Shadow *intranet password required*
DE Hands On: Investigating Shadows Over the Course of a Day
DE Hands On: Rotate Versus Revolve
Crash Course Kids: Earth's Rotation & Revolution
DE Hands On: Shedding Light on Sundials

Vocabulary

Rotate and Revolve DE: Skill Builder

Weeks 7 & 8

Standard: 5-ESS1-2: Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the **seasonal appearance of some stars in the night sky.**
[Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and select stars that are visible only in particular months.] [Assessment Boundary: Assessment does not include causes of seasons.]

Instruction

Weeks 7-8 Question:

A. How do relative lengths of day and night change over time? (KLEWS chart and CER on following slides)
B. Why do the sun, stars, and planets appear to move across the sky? (reinforce using resources from Weeks 5-6)
C. How does the appearance of some stars change in different seasons?

Examples of patterns you can incorporate include:

- Draw conclusions and explain how the lengths of day and night changes over time
- Calendar for moon phases and day length
- Calendar for moon phases and sunrise/set

Resources for Question A:

Formative Assessment Probe: Shorter Days in Winter *intranet password required*
DE explanation of day and night changing over time
DE Solstice Video - Changes in Seasons and Lengths of Days

Resources for Question C:

DE The Seasons
Crash Course Kids: Seasons and the sun
DE Constellations Exploration
Formative Assessment Probe: Where Do Stars Go? *intranet password required*

Vocabulary

Phase, sun, moon, rotate, revolve, axis, equator, hemisphere

Possible KLEWS Chart

Essential Question: How do relative lengths of day and night change over time?

K	L	E	W	S
Varies from class to class	The Earth takes 365 ¼ days to orbit the sun. The Earth spins around its axis. The Earth's axis is not upright, it is slightly tilted. As Earth is rotating the tilt of the North Pole changes in relation to the sun.	The tilt in the Earth's axis causes different amounts of sunlight through the year this causes seasons. The day the North Pole is closest to the sun is the summer solstice, longest day The day the North Pole is farthest from the sun is the winter solstice, shortest day of the year	Varies from class to class	Earth's axis Summer solstice Winter solstice Spring equinox Autumn equinox

Possible SCIENTIFIC EXPLANATION

Essential Question: How do relative lengths of day and night change over time?

CLAIM Statement about the results of an investigation

* One-sentence answer to the question you investigated.
* It answers, what can you conclude?
* It should not start with yes or no.
* It should describe the relationship between dependent and independent variables.

EVIDENCE Scientific data used to support the claim

* Evidence must be:
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REASONING Ties together the claim and the evidence

* Shows how or why the data count as evidence to support the claim
* Proves the justification for why this evidence is important to this claim
* Includes one or more scientific principles that are important to the claim and evidence.

The lengths of day and night on Earth change predictably over the year. The length of the day is longer and the night is shorter during the summer. The length of the day is shorter and the night is longer during the winter. Due to the orbit of the Earth around the Sun, the Earth's tilt towards and away from the Sun causes the amount of daylight to increase or decrease along with the seasons.

DIVIDE the unit into weeks and **DISTRIBUTE** the standards

Plan
DAILY
LESSONS

Incorporate
TECHNOLOGY

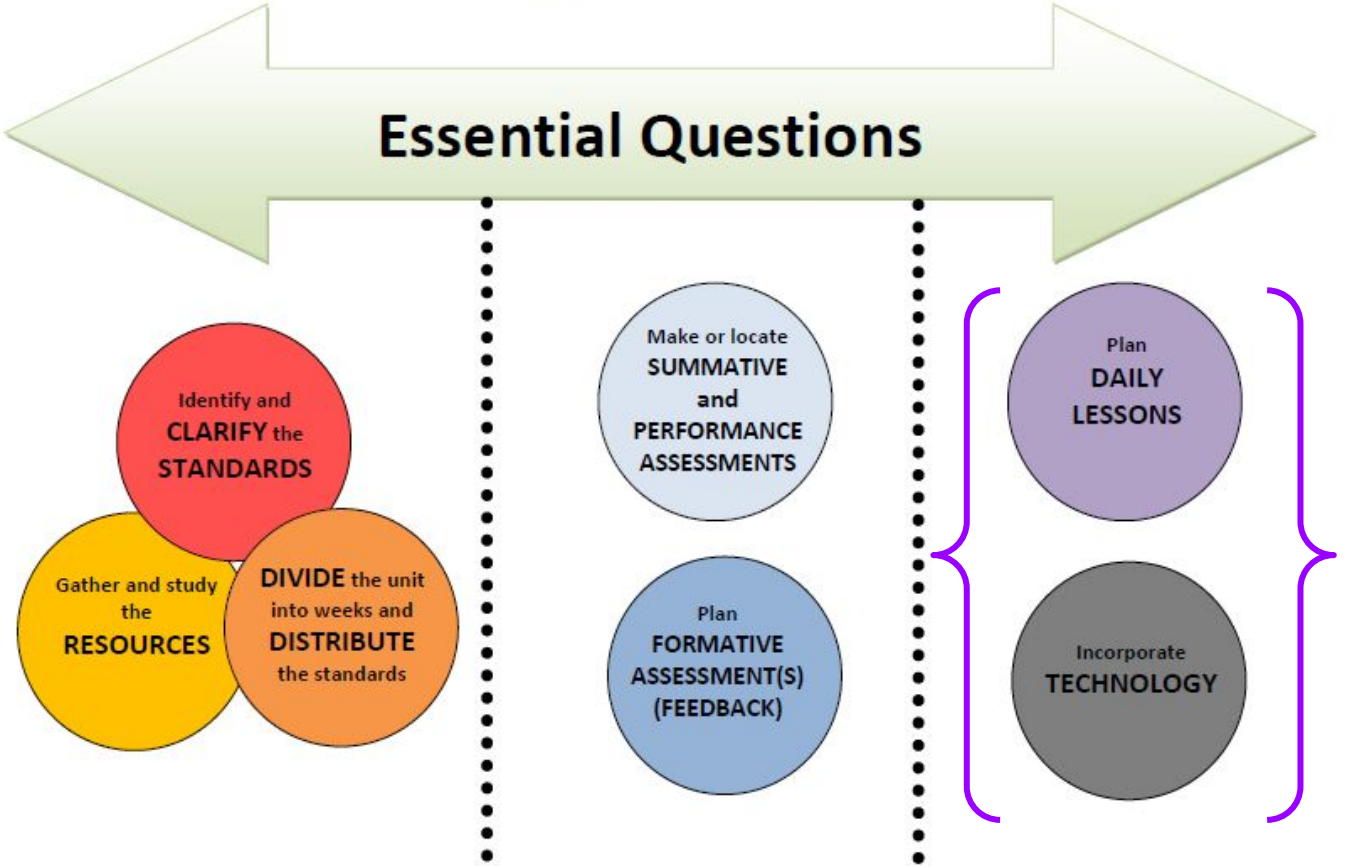
Additional Resources:

Uncovering Student Ideas in Science Assessment probes

*any assessment probes mentioned in plan are available on our website

Assessment Probes for 5th Grade WebPage *-intranet password protected*

Backward Unit Planning 1.0



Now you're ready to plan your daily lessons!