Teacher's Supplement

MAGAZINE ARTICLES

Contents

Teachers' Guide for *MUSE: 100 Years of General Relativity*

OVERVIEW

In this magazine, readers will learn how general relativity affects daily life as well as projects possibilities for the future. ***Muse: 100 Years of General Relativity*** *includes information about Albert Einstein's theory of relativity, time travel and explores how perception ultimately influences reality.*

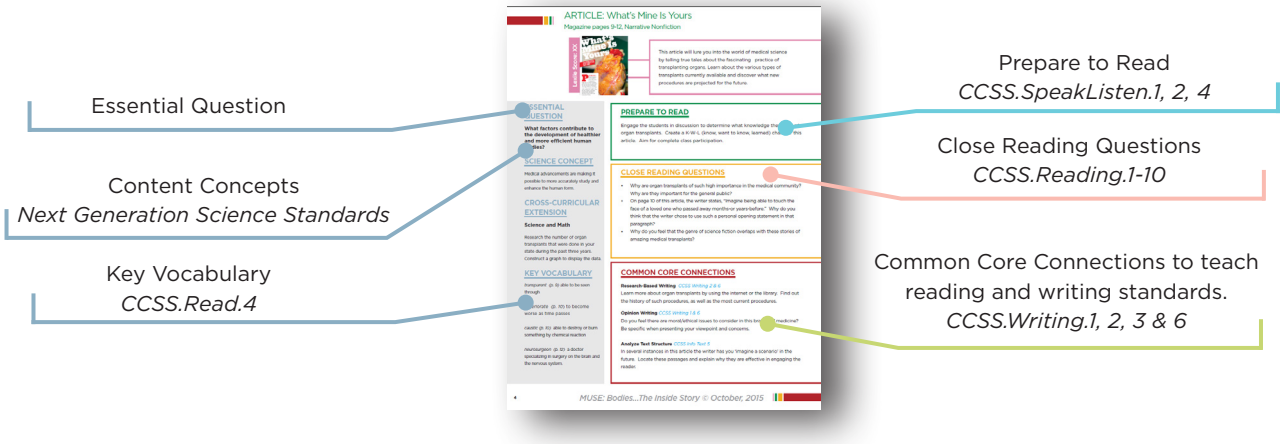
ESSENTIAL QUESTION:

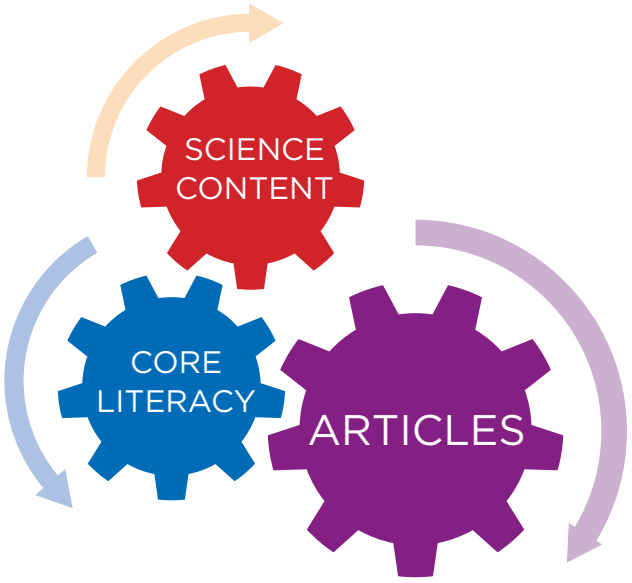
How does general relativity affect you and your perception of the world?

We invite you to use this magazine as a flexible teaching tool, which is ideal for interdisciplinary learning of social studies and science content and core literacy concepts. Find practical advice for teaching articles individually or utilize a mini-unit that helps your students' make cross-text connections as they integrate ideas and information.

READ MULTIPLE ARTICLES PAGES 4 – 8

Each article in this magazine is well-suited for teaching Common Core literacy concepts and content area knowledge. For each individual article page in this guide, you'll find the following:





TEACH A MINI-UNIT PAGES 10 – 12

Magazine articles can be easily grouped to make cross text connections and comparisons. Our Common Core mini-unit guides students to read and discuss multiple articles and integrate ideas and information. (CCSS.Reading InfoText.9) Discussing multiple articles (CCSS.SpeakListen.1, 2, 4) prepares students to write informational texts to share and publish in a variety of ways. (CCSS.Writing.2)

READING

Core literacy concepts, such as the ones found in the Common Core State Standards, help students access social studies and science content. Integration of both literacy thinking and content study offers students a great way to become experts in reading informational text and literature for content knowledge. This guide provides questions to cover many core literacy concepts.

Draw Inferences *(CCSS. InfoText.1)*
Describe Relationships *(CCSS.InfoText.3)*
Analyze Text Structure *(CCSS.InfoText.5)*
Interpret Visual Information *(CCSS.InfoText.7)*

Summarize *(CCSS.InfoText.2)*
Determine Word Meaning *(CCSS.InfoText.4)*
Understand Author's Point of View *(CCSS.InfoText.6)*
Explain Reasons and Evidence *(CCSS.InfoText.8)*

FOCUS STANDARD: CCSS. InfoText 9: Integrate Ideas and Information:
Have students read multiple articles from this magazine on the same topic, build knowledge, and make cross-text comparisons.

SPEAKING AND LISTENING

Use the articles in this magazine to spark meaningful discussions in person and online. Encourage deeper discussions where students can become topic experts. *(CCSS.SpeakListen.1, 2, 4)*

DISCUSSION OPTIONS—IN CLASS OR ONLINE

Article Clubs: Form small reading groups of students reading the *same* article. Have students discuss the content, share ideas, and critically evaluate the text.

Jigsaw Clubs: Form small reading groups of students reading *different* articles. Invite students to share information and resources with each other.

Whole Class: Launch with an essential question. Encourage students to find and share evidence from different articles building a greater understanding of the question.

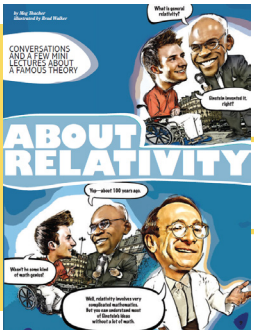
WRITING

Use the articles in this magazine to prompt **informative/explanatory writing** *(CCSS.Writing.2).* Have students use evidence from the texts to share information about social studies, language arts, or science content in the articles. See the **Mini-Unit** section of this guide (pages 9 – 12) as well as the **article pages** (pages 4 - 8) for ways to incorporate writing into your instruction.

ARTICLE: A General Introduction to Relativity

Magazine pages 9 - 11, Script/Play

Lexile Score: 720



Try out different roles in this interactive script as you learn about the concept of general relativity. Gather new scientific information as the perspective of each character is revealed.

ESSENTIAL QUESTION

How does general relativity affect you and your perception of the world?

SCIENCE CONCEPT

Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system.

CROSS-CURRICULAR EXTENSION

Science and History

Research the life and accomplishments of Albert Einstein. Consider his contributions across the many disciplines. Construct a simple chart to display your data.

KEY VOCABULARY

***cosmic* (p. 10)** relating to the universe or outer space

***gravity* (p. 11)** natural force causing physical things to move towards each other

***relativity* (p. 10)** how objects/events are viewed in relation to each other

***warped* (p. 11)** twisted or bent

PREPARE TO READ

Engage the students in discussion to determine what prior knowledge they have concerning general relativity. Create a K-W-L chart (know, want to know, learned) for this article. Aim for complete class participation.

CLOSE READING QUESTIONS

- Reread the article and take note of the different responses to the identical question, "What is general relativity?" Do you think that the ages of the people being questioned has an effect on their answer? Why or why not?
- On page 10 of this article, the 'scientist' explains the mathematics that determine the speed of light. Following his formula, write your own example to explain this phenomenon.
- How might this same information be organized in an informational article? Choose how you would organize the information and what headings you would use.

COMMON CORE CONNECTIONS

Research-Based Writing *CCSS Writing 2 & 6*

Learn more about general relativity by using the internet or the library. Find out how Einstein's theory was received when he first presented it and how this theory has wholly affected our understanding of time and space.

Apply Information, Describe Relationships *CCSS Info Text 3*

On page 10 of this article, the 'scientist' explains the mathematics that determines the speed of light. Following his formula, write your own example to explain this phenomenon.

Summarize Main Ideas *CCSS Info Text 2*

Summarize the main idea of this script in paragraph format.

ARTICLE: Relativity: Painting the Picture

Magazine pages 17 - 19, Expository Nonfiction

Lexile Score: 1140

Examine space and time through the world of art. Learn how Einstein's theory of relativity influenced the work and lives of many of the world's great artists.

ESSENTIAL QUESTION

How does general relativity affect you and your perception of the world?

SCIENCE CONCEPT

Throughout history, artists have created numerous works of art inspired by general relativity.

CROSS-CURRICULAR EXTENSION

Art in Science

Further explore the concept of art in Science. Research the various ways in which artists use scientific concepts to create unique and thought provoking works of art.

KEY VOCABULARY

***abstract* (p. 18)** relating to general ideas/qualities rather than specific/ tangible objects

***kinetic* (p. 18)** relating to the movement of physical objects

***perspective* (p. 18)** the angle or direction which is used to view an object or idea

***property* (p. 18)** a special quality or characteristic of something

PREPARE TO READ

Introduce "Relativity: Painting the Picture" by showing photographs or images of some of the great artwork discussed in this article. Have students make specific observations about the paintings and exhibits presented.

CLOSE READING QUESTIONS

- According to the article, why do many scholars believe that Salvador Dali's "The Persistence of Memory" was inspired by Einstein's theory of relativity? Find evidence for your answer in the article.
- Examine the sequence of the topics in this article. Why did the author organize the topic this way? How is sequence important in presenting these ideas?
- Locate an example of cause/effect in this article. Share with a partner how an event or new information effected how people view the world.

COMMON CORE CONNECTIONS

Describe Relationships *CCSS Info Text 3*

The main idea of this article is to allow readers to explore the relationship between art and nature. Arrange the class into small groups to discuss this idea. Allow all groups to share their thoughts.

Draw Inferences *CCSS Info Text 1*

Peruse other artwork created by the artists discussed in this article. Work with a partner to apply the theory of relativity to other works of art. Support your inferences with details.

Opinion Writing *CCSS Writing 1 & 6*

Is Science a powerful force in the art world? Write an essay explaining your viewpoint. Use proper form and support your opinion.

ARTICLE: Rings, Arcs, Crosses, and Twins

Magazine pages 20 - 23, Expository Nonfiction

Lexile Score: 1250

In this article, you will take a journey into space to study a phenomenon known as gravitational lensing. Learn how looking up at the stars can give us information about our past, as well as possible hints about our future.

ESSENTIAL QUESTION

How does general relativity affect you and your perception of the world?

SCIENCE CONCEPTS

General relativity helps to explain some of the amazing images we see in the sky.

CROSS-CURRICULAR EXTENSION

Science Vocabulary

Reread the article and extract all of the key science terms. Create a flow chart or web to demonstrate the inter- connectedness of the terms.

KEY VOCABULARY

***distort* (p. 21)** to change something so that it is no longer true or accurate

***mirage* (p. 22)** something that appears to be real, but is not actually there

***phenomenon* (p. 20)** someone or something that is very impressive or popular especially because of an unusual ability or quality

PREPARE TO READ

Introduce the article by having the students view the various photographs placed within the text. Instruct the class to use the titles and pictures throughout the article to formulate predictions regarding the content.

CLOSE READING QUESTIONS

- What challenges did the author have explaining this topic? Find examples of how the author tried to make a complex topic easier to understand.
- Why do we have so little information about 'dark matter' and 'dark energy'? What methods are scientists using to gather more information? Find information from the text to support your answers with key details.
- If you could only choose one image, which one do you think best illustrates the main topic of this article?

COMMON CORE CONNECTIONS

Explain Reasons and Evidence *CCSS Info Text 8*

What evidence does the writer of the article provide to help the reader understand that events and objects are often not as they truly appear to be?

Describe Relationships *CCSS Info Text 3*

Describe the relationship between perception and reality in paragraph form. Next, simplify your information and rewrite it in more general terms so that you would be able to educate students at a lower level.

Interpret Visual Information *CCSS Info Text 7*

Discuss the photographs that appear in the article with a partner. Explain how images aid in the understanding of the written content.

ARTICLE: Traveling Through Time

Magazine pages 29 - 31, Expository Nonfiction

Lexile Score: 1160


Traveling Through Time

CAN RELATIVITY PUNCH YOUR TICKET TO THE PAST AND FUTURE?

by Alice-Andrée Clark

You pass through the gleaming silver doors. You reach for the lever. All of history and all of history-to-come are at your fingertips. Pull up, and you could come face-to-face with a triceratops. Push down, and ring in the year 3000 with your descendants. Has relativity, with its varying clock speeds and curving space-time fabric, given us the clues we need to build the first time machine?

Growing Apart

29

Would you like to be a time traveler? This article discusses the possibility of time travel to distant places and points in time. Has the understanding of general relativity given us the clues we need to build a time machine?

ESSENTIAL QUESTION

How does general relativity affect you and your perception of the world?

SCIENCE CONCEPT

Understanding and utilizing the concept of time dilation could be the key to time travel.

CROSS CURRICULAR EXTENSION

Science and Math

Research the passage of time on each of the planets. Calculate the differences in the length of days, months and years compared with Earth.

KEY VOCABULARY

descendants (p. 29) plant/animal that is related to a plant/animal that lived long ago

dilation (p. 29) to become larger or wider

infinite (p. 31) having no limits

speculate (p. 31) to think about something and make guesses about it

PREPARE TO READ

Search online for various science fiction clips of movies depicting time travel. View as a class and have the students discuss the common threads in these clips. Encourage the students to notice recurrent themes and ideas that seem to represent time travel in movies/books.

CLOSE READING QUESTIONS

- Look for clues in the article about the relationship between time and energy forces? Share your discoveries with a partner.
- The author invites you to use your imagination in several places in this article. Locate one of these and explain how the author is helping you understand a concept by using your power of imaginative thinking.
- Locate a science concept word in this article that is new to you. Share the context clues that help you understand the word's meaning.

COMMON CORE CONNECTIONS

Research-Based Writing *CCSS Writing 2 & 6*

Choose one of the scientific phenomena discussed in this article and use the Internet and the library to learn more. Write an informative essay and share your findings with the class.

Opinion Writing *CCSS Info Text 3*

Do you think that time travel currently exists? Support your answer with details. If time travel DOES exist, where are all the time travelers? If it does not exist, when/how might this become possible?

Summarize Main Ideas *CCSS Info Text 2*

Reread the article and search for the biggest ideas presented in the text. Share a summary of the article with a partner.

ARTICLE: Twins Again

Magazine pages 32 - 36, Science Fiction

Lexile Score: 740

Experience a complex and fascinating journey through time and space. Join two sets of twins on the adventure of a lifetime!

ESSENTIAL QUESTION

How does general relativity affect you and your perception of the world?

SCIENCE CONCEPT

General relativity allows for significant differences in the passage of time as we know it.

CROSS CURRICULAR EXTENSION

Science and Genetics

Twin research is considered a key component in the study of behavioral genetics. Why are twins such a valuable source for observation in many branches of science?

KEY VOCABULARY

decelerate (p. 34) to lose speed.

disembark (p. 36) to leave a ship or airplane

interstellar (p. 34) existing or occurring between the stars

trajectory (p. 34) a curved path through which something moves through space/air

vouch (p. 36) to say something is true/authentic

PREPARE TO READ

Build background by discussing what it means to be a twin. Ask: What might happen if one twin sibling went to space, and the other stayed back on Earth? Can the effects of time and space alter the physiology and psychology of being a twin?

CLOSE READING QUESTIONS

- Explain the fictional time experiment the two sets of twins are taking part in. Use details from the text to support your experiment description.
- Why was it that the time slippage wasn't very noticeable when Tara was close to Earth? How did the time/age difference become more extreme? Provide text evidence for your answer.
- What is the structure of this story? In what ways does the author help you understand the concept of time and travel?

COMMON CORE CONNECTIONS

Draw Inference *CCSS Info Text 1*

This article is written from Tara's point of view. Using statements from the article infer what this experiment might feel like for her twin, Macha. Draw on the sentiments of Tara to reach a reasonable conclusion.

Author's Point of View *CCSS Info Text 6*

This article is written from a fictional first-person point of view. Locate several sentences that use the pronouns I and we. Discuss with a partner how the article would be different if it was written as an informational text.

Opinion Writing *CCSS Writing 1 & 6*

Would you like to be one of the characters in the story? Explain why with reasons from the story.

CROSS-TEXT CONNECTIONS WITH MULTIPLE ARTICLES

COMPARE ARTICLES

SYNTHESIZE: Guide students to compare articles they read. Help students find the connections between pieces of information in multiple texts. Use prompts, such as the following examples, to have students work together to **Integrate Ideas and Information** *(CCSS.Reading.9)*:

- The articles "Traveling Through Time" and "Twins Again" use very different writing styles to explore the concept of time travel. List the positive and negative attributes of each style and discuss which you think is more effective. Why would an author choose a particular style depending on the topic?

- Refer back to the articles and locate the various types of scientists (physicists, astronomers, psychologists, etc.) who are studying and applying the theory of general relativity to their work. Discuss the importance of relativity in each field, and compare their various approaches to learning more.

- Imagine that you have lived for thousands of years. Use information from the feature articles to discuss how Einstein's theory of general relativity has altered the way that humans understand the world. Use a journal format to record your observations.

- Gather information across texts to generate a list of Albert Einstein's contributions to the world. Give reasons to support the notion that Einstein has influenced many different disciplines of study.

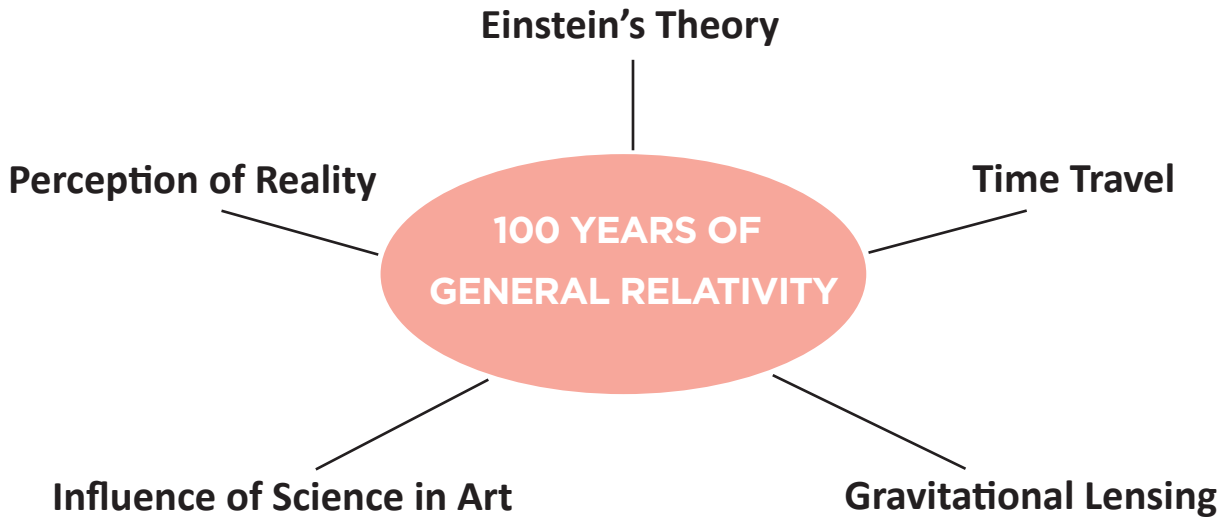
- Using information from the articles "Relativity: Painting the Picture" and "Rings, Arcs, Crosses, and Twins" compare and contrast how differently the theory of relativity is explained and applied. Explain how science and art can be interrelated.

EXPLORATORY LEARNING - FLEXIBLE MINI-UNIT DESIGN

The mini-unit is designed as a flexible teaching tool. The order in which the material is not of importance, since each article can stand alone. You may want to gauge the interest level of the students when determining your focus.

ENGAGE | **READ AND COMPARE** | **APPLY**

ENGAGE: Engage students in the topic of the general relativity. Have students page through the magazine, read article titles and look at the pictures to gain prior knowledge of the material to be read. Supplement with engaging video clips to depicting perception and time travel to achieve a high level of motivation for the content of this magazine. Create an idea or concept web to tap into background knowledge.



Share the essential question:

How does general relativity affect you and your perception of the world?

READ AND COMPARE ARTICLES: Begin with a focus article as a base for building content knowledge and model how to work through the text.

1) READ ALOUD: Use "A General Introduction to Relativity" on pages 9 - 11 as a focus article, or choose a different article that works well for your teaching goals. Share the article summary on page 4 of this guide. Students can read using their own copies of the article and use sticky notes to mark places they find interesting or have questions about.

2) DISCUSS THE ARTICLE: After reading, guide the students to turn and talk about the article. See the Article Pages for Close Reading Questions.

3) READ NEW ARTICLES: Help students choose additional articles to read based on their inquiry questions or what they wonder. Refer to the Article Pages for summaries of each article within "100 Years of General Relativity".

4) COMPARE ARTICLES: After students have read multiple articles, guide them to make cross-text connections. Refer to page 9 to Compare Articles using prompts that help students integrate ideas and information.

CHOOSE A PURPOSE FOR READING

CLOSE READ: *CCSS.Reading Info Text.1* Mark the text, noting important details and highlighting what interests, surprises, or confuses you.

UNDERSTAND MAIN IDEAS TO DEVELOP EXPERTISE: *CCSS.Reading Info Text.2* Record the main ideas in a second article. Note how these main ideas build on the main ideas from the focus article, or other readings. How is your topic knowledge growing?

REVIEW GRAPHIC FEATURES: *CCSS.Reading Info Text.7* Examine graphic features within this issue and describe how the graphic feature enhances your understanding of the content. (Use Graphic Features printable, p.19)

APPLY: GENERAL RELATIVITY

Explore the manner in which the theory of general relativity has altered our perception of the past, present and the future. Divide the class into different groups to discuss and study different facets of this question. Use the activities below to further immerse your students in the material presented in this issue of MUSE.

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Group One: Using Explore the manner in which the theory of general relativity has altered our perception of the past, present and the future. Divide the class into different groups to discuss and study different facets of this question. Use the activities below to further immerse your students in the material presented in this issue of MUSE.
- 

Group Two: Reread the article "Relativity: Painting the Picture" and closely study the representations of the artwork within the text. Use the Venn Diagram located within the printables section of this guide to depict the relationship between science/nature and art. Work with your group to collectively create a work of art that demonstrates the theory of general relativity within your masterpiece.
- 
Group Three: Reexamine and annotate the two articles, "Traveling Through Time" and "Twins Again". What could be some of the realistic benefits and disasters of time traveling? Discuss the ethical issues and divide the group to debate both sides of the topic. Be sure to create well-formed and reasonable arguments.

WHOLE CLASS: After groups present their information, find common threads to link all of the articles.

NAME: _____

Mini-Unit Graphic Organizer

ABC Organizer/Word Study
MUSE: 100 Years of General Relativity

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

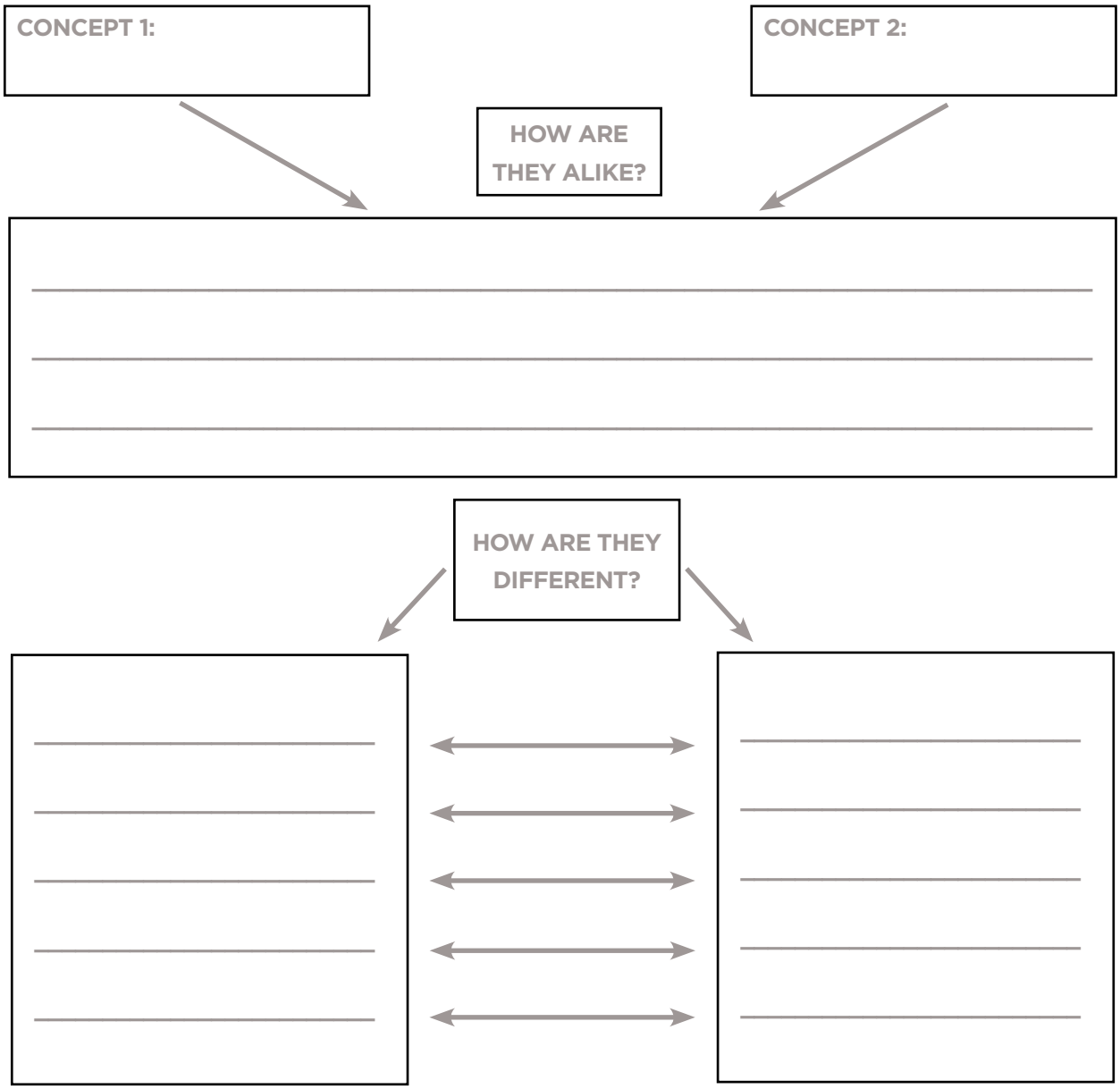
NAME: _____

Mini-Unit Graphic Organizer

Comparing Concepts

DIRECTION: Use this compare/contrast organizer to explore analogous as well as non-analogous characteristics of two concepts related to a give topic.

TOPIC: General Relativity: Reality vs. Perception



NAME: _____

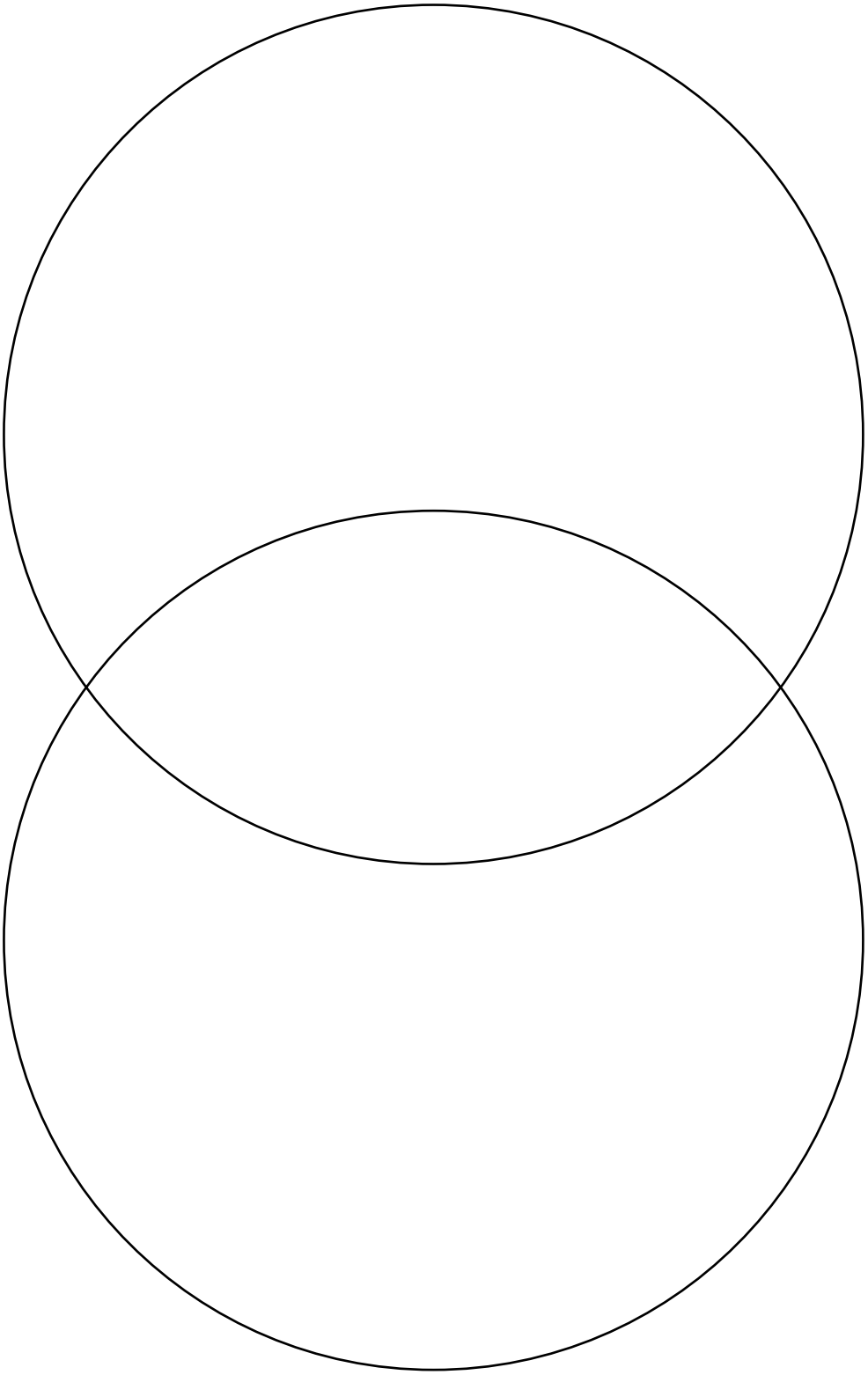
Mini-Unit Graphic Organizer

Venn Diagram

Compare and contrast the world of art and the world of science.

ART

SCIENCE/NATURE



NAME: _____

ANALYZE GRAPHIC FEATURES

GRAPHIC FEATURE	PAGE LOCATION	HOW THIS FEATURE HELPED YOUR UNDERSTANDING

NAME: _____

CONCEPT CHART

Show how reading multiple articles developed your understanding of the essential question or or your own inquiry question.		
ESSENTIAL QUESTION OR INQUIRY QUESTION:		
ARTICLE 1:	ARTICLE 2:	ARTICLE 3:

Glossary

abstract relating to general ideas/qualities rather than specific, tangible objects

*Pereira explained that, for her, **abstract** art made new ideas in math and physics feel real and accessible.(p. 18)*

cosmic relating to the universe or outer space

*It's like a **cosmic** speed limit. (p.10)*

decelerate to lose speed

*The astronomers have detected a likely planet, and we've started to **decelerate**. (p. 34)*

descendants plant/animal that is related to a plant/animal that lived long ago

*Push down, and ring in the year 3000 with your **descendants**. (p.29)*

dilation to become larger or wider

*This strange effect is called time **dilation**. (p. 29)*

disembark to leave a ship or airplane

*Between the workshops on the latest discoveries on our new planet and all the practical details of preparing to **disembark**, I haven't had a minute to myself (p. 36)*

distort to change something so that it is no longer true or accurate

*Some clusters are so big they **distort** more than one galaxy. (p. 21)*

gravity natural force causing physical things to move towards each other

*It's because of **gravity**. (p. 11)*

infinite having no limits

*It would require **infinite** energy to accelerate an object to light speed, so this seems to be the speed limit for every atom in the universe. (p.31)*

interstellar existing or occurring between the stars

*I doubt if anyone is seriously considering this far-fetched idea of **interstellar** telepathy .(p. 34)*

kinetic relating to the movement of physical objects

*Some have used **kinetic** art to portray time passing. (p. 18)*

mirage something that appears to be real, but is not actually there.

*And all that mass causes gravitational lensing, which distorts our view of the universe, like a great cosmic **mirage**. (p. 22)*

perspective the angle or direction which is used to view an object or idea

*The strange geometry of relativity makes **perspective** incredibly important. (p. 18)*

phenomenon someone or something that is very impressive or popular especially because of an unusual ability or quality

*This **phenomenon** is called gravitational lensing. (p. 20)*

property a special quality or characteristic of something

*The theory of general relativity showed us that space and time are not separate **properties**. (p. 18)*

relativity how objects/events are viewed in relation to each other

***Relativity** involves very complicated mathematics. (p. 10)*

speculate to think about something and make guesses about it

*Some scientists **speculate** that the Big Bang left behind infinitely long, massive strings. (p. 31)*

trajectory a curved path through which something moves through space or air

*When astronomers assigned us a new target, engines had to be restarted to correct the **trajectory**. (p. 34)*

A General Introduction to Relativity

- http://www.neok12.com/video/Relativity/zX580f0457675f60454c4159.htm

  This video presents Albert Einstein's theory of relativity and its impact on our everyday life.

Relativity: Painting the Picture

- http://www.npr.org/series/4111499/where-science-meets-art.html

  There is multitude of interesting information on this website exploring the link between science and art.

Rings, Arcs, Crosses, and Twins

- http://www.space.com/17661-theory-general-relativity.html

  This website defines relativity and gravity and provides a useful timeline of various scientific concepts.

Traveling Through Time

- http://www.space.com/21675-time-travel.html

  Interesting website exploring Einstein's theories concerning time travel, as well as other possibilities for jumping through time and space. Website uses much of the same vocabulary as this MUSE article.

Twins Again

- http://www.space.com/21675-time-travel.html
  http://www.nytimes.com/2014/03/25/science/space/a-study-of-twins-separated-by-orbit.html

  These are relevant articles detailing how NASA is currently using twins in their space program.

- https://explorable.com/identical-twins-study

  This is a general article discussing the accuracy and validity of twin studies.