

Formative Assessment Exemplar - 7.1.5

Introduction:

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS A LESSON FOR STUDENTS.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

General Format:

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

Accommodation Considerations:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

References:

Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

Teacher Facing Information

Standard: 7.1.5

Assessment Format: Printable or Online Format (Does not require students to have online access)

Phenomenon	
Jupiter has gained the nickname “vacuum cleaner of the solar system” and is known to change to flight path of asteroids, comets, and debris as they fly through space.	Proficient Student Explanation of Phenomenon: The mass of Jupiter increases its gravity, making it more likely to affect the inertia of objects that come near it and can either deflect them away from Earth or send them toward Earth.
Cluster Task Statement	
(Represents the ultimate way the phenomenon will be explained or the design problem will be addressed) Using the information provided, engage in argument from evidence about the effect of Jupiter’s mass on objects moving toward Earth.	
Supporting Information	
Figure 1 - Jupiter 2021 Impact and Video 1  00h39mn 23s environ Heure locale 00h39mn 31s environ Copyright Jean-Paul ARNOULD 54-Villey-le-sec FRANCE - membre de la Société Lorraine d'Astronomie C11 + Barlow x2 + ADC + ZWO 120 MMC-S extrait d'une vidéo de 1000 images à 45 i/s	
This eight-image sequence and video shows the September 13, 2021 event of an object striking Jupiter	

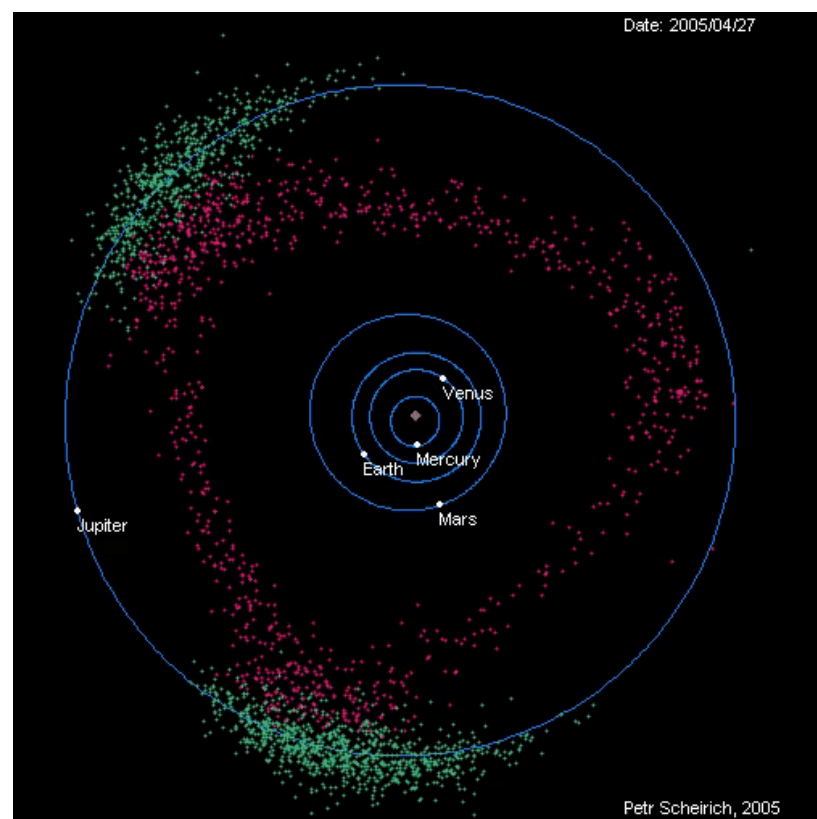
and leaving a temporary mark. From the first image to the last image in this sequence, a total of eight seconds have elapsed. No further effects or consequences have subsequently been observed. (Credit: Jean-Paul Arnould, 54-Villey-le-ssec, France/Societe Lorraine d'Astronomie.)

<https://www.youtube.com/watch?v=MgoLgmojwMA>

https://www.missionjuno.swri.edu/origin?show=hs_origin_story_jupiters-influence

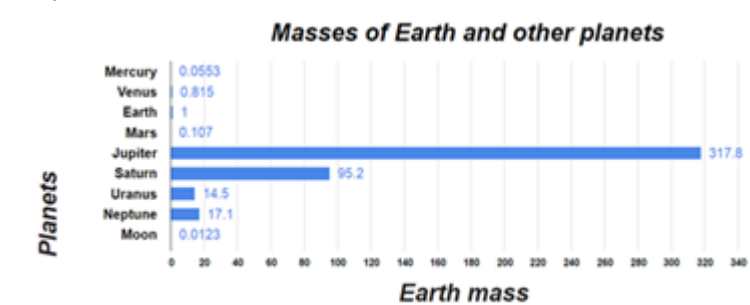
<https://bigthink.com/starts-with-a-bang/does-jupiter-protect-earth-or-endanger-it/>

Animation 1 - Asteroid Belt



This animation shows the asteroid belt and planets orbiting around the sun. The red and green dots are asteroids that maintain different orbits. <https://www.ngssphenomena.com/#/jupiter-asteroids/>

Graph 1 - Masses of Earth and Other Planetes



This graph shows how many Earth’s it would take to make up the mass of each planet.

Cluster Questions

Cluster Question # __1__

Question Type: Highlighting Text
Addresses:

__x__ DCI (MS-PS2-4): Types Of
Interactions

__x__ SEP (evaluating evidence)
____ CCC

Answer:

In our solar system, Jupiter can eat up any asteroid or comet that ventures near, earning the nickname “vacuum cleaner of the solar system.” The asteroid belt in between the orbits of Mars and Jupiter is another example of the gas giant’s influence. Its gravity likely prevented the asteroids from combining into a planet.

Jupiter can also radically alter the orbits of small bodies that stray close, hurling them on long orbits that take hundreds or even thousands of years for those bodies to return. We think this is how comets got the extreme orbits that carry them to the far-flung reaches of the solar system.

While Jupiter often protects Earth and the other inner planets by deflecting comets and asteroids, sometimes it sends objects on a collision course straight toward the inner planets. Earlier in the solar system’s history, when there were more objects flying around, the increased amount of impacts would have brought to Earth water and other ingredients for life. Of course,

Question 1:

Read the following passage. Highlight the three sentences from the passage that explains how Jupiter’s gravity can change the direction of objects that get near it.

In our solar system, Jupiter can eat up any asteroid or comet that ventures near, earning the nickname “vacuum cleaner of the solar system.” The asteroid belt in between the orbits of Mars and Jupiter is another example of the gas giant’s influence. Its gravity likely prevented the asteroids from combining into a planet.

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(from:

https://www.missionjuno.swri.edu/origin?show=hs_origin_story_jupiters-influence)

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Reason: Cluster Question # <u> 2 </u> Question Type: Multiple Choice Addresses: <u> X </u> DCI (MS-PS2-4): Types Of Interactions <u> x </u> SEP (evaluating evidence) <u> X </u> CCC (Systems) Answer: b. The gravity of Jupiter is attracting the asteroids and sending them in different directions	Question 2: The small unlabeled dots in Animation 1 show asteroids between Jupiter and the Sun. Which answer best explains why are there no asteroids around Jupiter? - The force of gravity of Jupiter is repelling the asteroids and sending them into space - The force of gravity of Jupiter is attracting the asteroids and sending them in different directions - The force of gravity of the inner planets are attracting the asteroids and pulling them away from Jupiter - The force of gravity of the sun is attracting the asteroids and pulling them away from Jupiter
Reason: Cluster Question # <u> 3 </u> Question Type: Multiple Choice Addresses: <u> X </u> DCI (MS-PS2-4): Types Of Interactions <u> X </u> SEP (use a model) <u> X </u> CCC (Systems) Answer: a. The force of gravity of Jupiter is less because it is farther away so it can't pull them in.	Question 3: The small unlabeled dots in Animation 1 show asteroids between Jupiter and the Sun. Which answer best explains why the asteroids start appearing when they are about the same distance away from Jupiter? - The force of gravity of Jupiter is less because it is farther away so it can't pull them in. - The force of gravity of Jupiter is greater because it is farther away so pushes them to that location. - The force of gravity of Jupiter is greater because it is farther away so it can't pull them in. - The force of gravity of Jupiter is less because it is farther away so pushes them to that location.
Reason: Cluster Question # <u> 4 </u> Question Type: Addresses: <u> X </u> DCI (MS-PS2-4): Types Of Interactions <u> X </u> SEP (develop a model) <u> X </u> CCC (Systems) Answer: Models will vary, but should	Question 4: Create a model showing how Jupiter's gravity affects flying debris in our solar system to make them fly towards the Earth, destroyed or sent away. Your model should contain the system of Jupiter and surrounding comets. - Show Jupiter interacting with more than one comet - Use arrows to show forces acting on the objects - Write a description, or different colored arrows, to show the motion for each object - Label the objects

include comets being attracted to Jupiter with the interaction causing varying trajectories.			
Communicate: Cluster Question #__5__ Question Type: Addresses: __X__ DCI (MS-PS2-4): Types Of Interactions __X__ SEP (construct an explanation) __X__ CCC (Cause and effect) Answer: Jupiter is affecting the comets and asteroids more than other planets. Its gravity attracts them more strongly because its mass gives it a stronger gravitational pull.	Question 5: Using the evidence in Graph 1 and the other sources in the passage, construct an explanation of why Jupiter is affecting the comets and asteroids more than other planets.		
Communicate: Cluster Question #__5__ Question Type: Addresses: __X__ DCI (MS-PS2-4): Types Of Interactions __X__ SEP (Argue from Evidence) __X__ CCC (Cause and effect) Answer: Answers will vary based on evidence used.	Question 6: Engage in argument from evidence about how the gravity and mass of Jupiter is either helping or harming the Earth. Additional scaffolding (optional): Possible Claims - ● The gravity of Jupiter is helping the Earth ● The gravity of Jupiter is harming the Earth Evidence - 1. 2. 3. Reasoning - (connect your evidence to your claim)		
Proficiency Scale			
Proficient Student Explanation: The mass of Jupiter increases its gravity making it more likely to affect the inertia of objects that come near it and can either deflect them away from Earth or send them toward Earth.			
Level 1 - Emerging	Level 2 - Partially	Level 3 - Proficient	Level 4 - Extending

	Proficient		
SEP: Does not meet the minimum standard to receive a 2.	SEP: Compare and refine arguments based on an evaluation of the evidence presented. Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation. Construct and/or support an argument with evidence, data, and/or a model. Compare and refine arguments based on an evaluation of the evidence presented. Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation. Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem	SEP: Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system, based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.	SEP: Extends beyond proficient in any way.

CCC: Does not meet the minimum standard to receive a 2.	CCC: A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. A system can be described in terms of its components and their interactions.	CCC: Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.	CCC: Extends beyond proficient in any way.
DCI: Does not meet the minimum standard to receive a 2.	DCI: Objects in contact exert forces on each other. The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	DCI: Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.	DCI: Extends beyond proficient in any way.

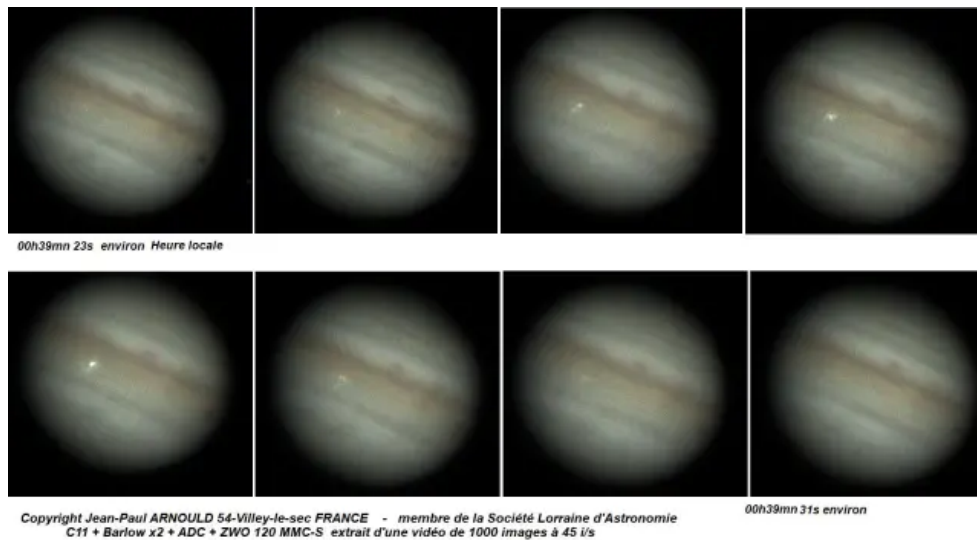
(Student Facing Format on following page)

Name: _____ Date: _____

Stimulus

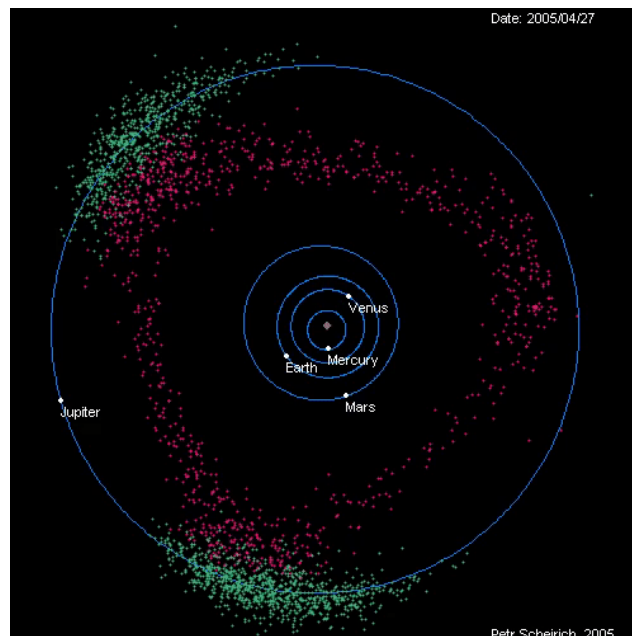
Jupiter has gained the nickname “vacuum cleaner of the solar system” and is known to change the flight path of asteroids, comets, and debris as they fly through space.

Figure 1 - Jupiter 2021 Impact and [Video 1](#)



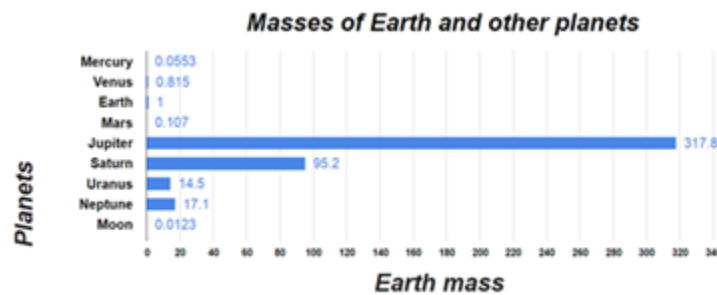
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Animation 1 - Asteroid Belt



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Graph 1 - Masses of Earth and Other Planets



This graph shows how many Earth's it would take to make up the mass of each planet.

Your Task

In the questions that follow, you will use the information provided, you will engage in argument from evidence about the effect of Jupiter's mass on objects moving toward Earth.

Question 1

Read the following passage and highlight the three sentences from the passage that explains how Jupiter's gravity can change the direction of objects that get near it.

In our solar system, Jupiter can eat up any asteroid or comet that ventures near, earning the nickname "vacuum cleaner of the solar system." The asteroid belt in between the orbits of Mars and Jupiter is another example of the gas giant's influence. Its gravity likely prevented the asteroids from combining into a planet.

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Question 2

The small unlabeled dots in Animation 1 show asteroids between Jupiter and the Sun. Which answer best explains why are there no asteroids around Jupiter?

- The force of gravity of Jupiter is repelling the asteroids and sending them into space
- The force of gravity of Jupiter is attracting the asteroids and sending them in different directions
- The force of gravity of the inner planets are attracting the asteroids and pulling them away from Jupiter
- The force of gravity of the sun is attracting the asteroids and pulling them away from Jupiter

Question 3

The small unlabeled dots in Animation 1 show asteroids between Jupiter and the Sun. Which answer best explains why the asteroids start appearing when they are about the same distance away from Jupiter?

- a. The force of gravity of Jupiter is less because it is farther away so it can't pull them in.
- b. The force of gravity of Jupiter is greater because it is farther away so pushes them to that location.
- c. The force of gravity of Jupiter is greater because it is farther away so it can't pull them in.
- d. The force of gravity of Jupiter is less because it is farther away so pushes them to that location.

Question 4

Create a model showing how Jupiter's gravity affects flying debris in our solar system to make them fly towards the Earth, destroyed or sent away. Your model should contain the system of Jupiter and surrounding comets.

- Show Jupiter interacting with more than one comet
- Use arrows to show forces acting on the objects
- Write a description, or different colored arrows, to show the motion for each object
- Label the objects

Question 5

Using the evidence in Graph 1 and the other sources in the passage, construct an explanation of why Jupiter is affecting the comets and asteroids more than other planets.

Question 6

Engage in argument from evidence about how the gravity and mass of Jupiter is either helping or harming the Earth.

Possible Claims -

- The gravity of Jupiter is helping the Earth
- The gravity of Jupiter is harming the Earth

Evidence -

1.

2.

3.

Reasoning - (connect your evidence to your claim)
