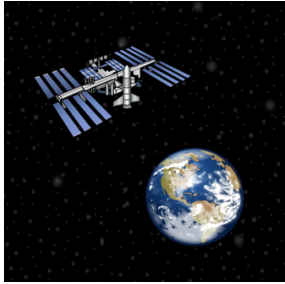
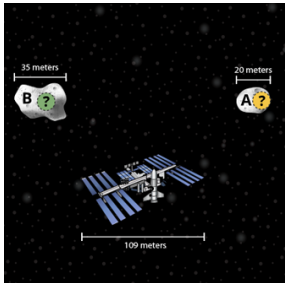


CONTEXT	SCREEN	QUESTION	POINTS SCORED
	2	An asteroid is 400 kilometers from Earth. Show the forces of gravity.	SCORE 286 012
	3	Explain the motion of the asteroid when it is 400 kilometers from Earth.	SCORE 187 012
	5	The table shows data from the Onboard Simulator. Read the data and describe the force for each trial.	SCORE 088 012
	6	Plan an investigation to learn how the force of different rockets moves asteroids with different mass.	SCORE 6523 0123
	8	The astronaut can repeat two trials. Describe the trials to repeat.	SCORE 1132 012
	9	Use the data from Screen 7 to estimate the mass of the asteroids.	SCORE 106 01
	10	Use the data to explain the change in motion of the asteroids.	SCORE 385 012
	11	The asteroids move near the Space Station. Show the forces of gravity between the Space Station and the asteroids.	SCORE 754 012
	12	Show the forces of gravity between the asteroids.	SCORE 0124 012

Science Concepts

Gravity exists between any two masses. On the screens that showed Earth, the Space Station, or asteroids against the backdrop of space, this task required students to show these understandings about gravity: (i) it is a force that exists between any two objects; (ii) the amount of force varies with the mass of the object; (iii) the force is always attractive and pulls an object toward the center of mass.

Some students may NOT understand that the force of gravity:

- exists between any two objects. **[13%]**
- varies with the mass of the object. **[19%]**
- causes two objects in space to move toward each other. **[6%]**

Some students may have the misconception that gravity:

- is a force between an object and space. **[44%]**
- is a force inside or around an object. **[6%]**
- is the same as energy or friction. **[19%]**

Change in motion depends on the sum of the forces on the object and the mass of the object. On the rocket investigation screens, students were required to show these understandings: (i) a change in motion requires an unbalanced force; (ii) balanced forces result in NO change in motion; (iii) the mass of an object determines the amount of force required to move / change the motion of the object; and (iv) the amount of force on an object determines the amount of motion / change in motion of the object.

Some students may not understand that an object:

- with more mass requires more force to move. **[64%]**

Some students incorrectly used the terms:

- 'internal force' or 'energy' to describe what causes an object to move. **[50%]**
- 'no force', 'stop moving', or 'start moving' to describe objects in space. **[13%]**

Science and Engineering Practices

Construct an Explanation. On Screens 3 and 10:

Some students did not successfully explain that:

- mass or force affect the movement of objects in space. **[19%]**
- objects in space move due to an outside force on the object. **[6%]**
- objects in space move toward the center of mass of another object. **[50%]**
- the distance an object moves in space is related to the mass of the object. **[31%]**
- the distance an object moves in space is related to the force on the object. **[13%]**

Analyze and Interpret Data. On the rocket and asteroid investigation screens:

Some students left two or more screens blank. There is not enough information to describe their skills related to this practice. **[38%]**

Some students did not:

- identify the trials with large measurement error. These trials should be repeated. **[44%]**
- examine the data, calculate the mean, and then use that information to make a prediction. **[44%]**
- use the available tools to organize the data in the table. Organizing data in different ways can help emphasize patterns in the data. **[63%]**

Plan and Carry out investigations. On screens 6 and 8:

Some students left one or both screens blank. There is not enough information to describe their skills related to this practice. **[44%]**

Some students did not:

- use all of the available variables in controlled combinations to plan their investigation. **[31%]**
- include the appropriate number of trials in their investigation. A strong investigation repeats each trial at least 3 times. **[69%]**

Some students did not correctly revise their investigation. They did not:

- identify all trials with data outside the range of acceptable error. **[44%]**
- use the same variables as the original trial. **[25%]**

Crosscutting Concepts

Systems and Models. On screens 2, 11, and 12:

These students used a system model to represent how forces of gravity act on objects in space. **[31%]**

Cause and Effect. Across this task:

Some students did not consistently link cause and effect to show that:

- gravity is the force that causes an object to move toward the center of mass of another object. **[56%]**

- unbalanced forces cause a change in motion while balanced forces cause NO change in motion. **[50%]**
- an object with greater mass requires greater force to move. **[63%]**
- the amount of force and the amount of mass both affect how far an object will move. **[69%]**

Patterns. This task required students to look for patterns in data and observations and use those patterns to inform their answers.

Across this task, some students did not look for or use patterns:

- in the mass of objects to describe changes in gravitational force. **[44%]**
- to set up a controlled investigation. **[31%]**
- in data to identify measurement error. **[25%]**
- in data to describe mass of the asteroids, or the movement of the asteroids. **[75%]**

Across this task, these students looked for and used Science patterns to inform their answers. They used patterns:

- in the asteroid motion to describe balanced and unbalanced force. **[25%]**