Name: _____ Date: _____

The Slingshot That Saves Rocket Fuel

Circle group

A spacecraft that goes to the far planets has a problem. Rocket fuel is heavy. The farther a ship goes, the more fuel it needs. Engineers found a clever way to save some. They let a planet give the ship a push.

This is called a gravity assist. Planets pull on everything near them with gravity. When a spacecraft flies close to a planet, it is pulled in and swings around, like a runner swinging around a pole. When it leaves, it can be going faster and in a new direction. The planet gives the ship a little of its own motion around the sun.

Does the planet slow down? It does, but the change is far too small to notice. A planet is much, much heavier than a spacecraft.

Gravity assists let ships reach places that need too much fuel by engine alone. The Voyager spacecraft used the pull of the giant planets to go from one to the next. Planners must aim with great care. Too far from a planet gives little help. Too near could be dangerous. When it works, a planet is a free boost.

Questions

1. Why is a lot of rocket fuel a problem?

_____

_____

2. What is it called when a planet pushes a spacecraft?

_____

_____

3. What does a spacecraft get from a gravity assist?

_____

_____

4. Why does the planet not seem to slow down?

_____

_____

5. Why must planners aim with care?

_____

_____

6. Which spacecraft used the pull of the giant planets?

_____

_____

Words to know

engineers: people who design and build machines and tools
gravity: the force that pulls objects toward each other
boost: a push that helps something go faster

Talk together (every group has these)

1. Find one fact that every group read. How did your sheet say it?
2. What did your sheet tell you that you think another group's did not? Ask them.
3. What is one question about this topic that none of the sheets answered?

Name: _____ Date: _____

The Slingshot That Saves Rocket Fuel

Triangle group

A spacecraft that heads for the far planets has a problem. Rocket fuel is heavy, and the farther a ship needs to go, the more fuel it needs to carry. Engineers found a clever way to save some. They let a planet give the spacecraft a push.

The method is called a gravity assist. Planets pull on everything near them with gravity. When a spacecraft flies close to a planet, it is pulled toward it and swings around it, much like a runner swinging around a pole. As the spacecraft leaves, it can be moving faster and heading in a new direction. The planet gives the ship a little of its own motion along its path around the sun.

Does the planet slow down? It does, but the change is far too small to notice, because a planet is enormously heavier than a spacecraft. The spacecraft gains speed, and the planet hardly changes at all.

Gravity assists let spacecraft reach places that would take too much fuel to get to by engine alone. The Voyager spacecraft used the pull of the giant planets to travel from one to the next. Mission planners must aim very carefully, because passing too far from a planet gives little help, and passing too near could be dangerous. When it works, a planet becomes a free boost on a long journey.

Questions

1. Why is carrying a lot of rocket fuel a problem?

_____

_____

2. What is the method called that uses a planet to push a spacecraft?

_____

_____

3. What does a spacecraft gain from a gravity assist?

_____

_____

4. Why does the planet not seem to slow down?

_____

_____

5. Why must planners aim carefully?

_____

_____

6. Which spacecraft used the pull of the giant planets?

_____

_____

Words to know

engineers: people who design and build machines and tools
gravity: the force that pulls objects toward each other
enormously: to a very great degree
boost: a push that helps something go faster
mission: a special job or trip with a goal

Talk together (every group has these)

1. Find one fact that every group read. How did your sheet say it?
2. What did your sheet tell you that you think another group's did not? Ask them.
3. What is one question about this topic that none of the sheets answered?

Name: _____ Date: _____

The Slingshot That Saves Rocket Fuel

Square group

A spacecraft bound for the distant planets confronts a serious difficulty. Rocket fuel is extremely heavy, and the farther a ship must travel, the more fuel it is required to carry. Engineers devised an ingenious method of saving some of it: they allow a planet to give the spacecraft a push.

The technique is known as a gravity assist. Planets pull on everything in their vicinity through the force of gravity. When a spacecraft passes close to a planet, it is drawn toward the planet and swings around it, much like a runner whipping around a pole. As the spacecraft departs, it may be traveling faster and heading in an entirely new direction, because the planet has transferred a small portion of its own motion along its path around the sun.

Does the planet slow down as a result? It does, but the change is far too tiny to detect, since a planet is immensely heavier than any spacecraft. The ship gains speed, while the planet is scarcely affected.

Gravity assists enable spacecraft to reach destinations that would demand too much fuel if they relied on engines alone. The Voyager spacecraft used the pull of the giant planets to travel from one to the next. Mission planners must aim with remarkable precision, because passing too far from a planet provides little help, and passing too near could be hazardous. When everything goes well, a planet becomes a free boost on a long journey.

Questions

1. Why is carrying a large amount of rocket fuel a difficulty?

_____

_____

2. What is the technique called in which a planet pushes a spacecraft?

_____

_____

3. What does a spacecraft gain from a gravity assist?

_____

_____

4. Why does the planet scarcely slow down?

_____

_____

5. Why must mission planners aim with precision?

_____

_____

6. Which spacecraft used the pull of the giant planets?

_____

_____

Words to know

engineers: people who design and build machines and tools
gravity: the force that pulls objects toward each other
boost: a push that helps something go faster
mission: a special job or trip with a goal

Talk together (every group has these)

1. Find one fact that every group read. How did your sheet say it?
2. What did your sheet tell you that you think another group's did not? Ask them.
3. What is one question about this topic that none of the sheets answered?

For the teacher: The Slingshot That Saves Rocket Fuel

Each student sheet carries a shape, not a level. The same topic and facts, written three ways.

Circle: The Slingshot That Saves Rocket Fuel

Easier · 189 words · Flesch-Kincaid grade 3.9

1. Fuel is heavy, and a ship that goes farther needs more.
2. A gravity assist.
3. Speed and a new direction.
4. A planet is much heavier than a spacecraft, so the change is too small to see.
5. Too far gives little help, and too near could be dangerous.
6. The Voyager spacecraft.

Triangle: The Slingshot That Saves Rocket Fuel

This passage · 226 words · Flesch-Kincaid grade 6.6

1. Fuel is heavy, and a ship that goes farther needs more of it.
2. A gravity assist.
3. Speed and a new direction.
4. A planet is enormously heavier than a spacecraft, so the change is too small to notice.
5. Passing too far gives little help, and passing too near could be dangerous.
6. The Voyager spacecraft.

Square: The Slingshot That Saves Rocket Fuel

Harder · 243 words · Flesch-Kincaid grade 9.5

1. Fuel is extremely heavy, and a ship that travels farther must carry more of it.
2. A gravity assist.
3. Speed and a new direction.
4. A planet is immensely heavier than a spacecraft, so the change is too tiny to detect.
5. Passing too far gives little help, and passing too near could be hazardous.
6. The Voyager spacecraft.