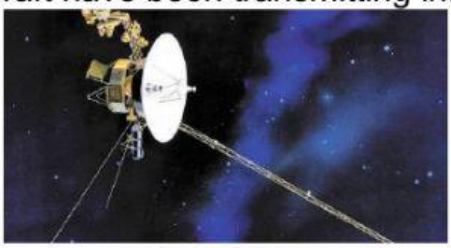
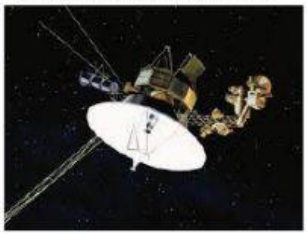
Understanding Gravity and Space Travel

Space ships have traveled to far off destinations in the solar system, but the distance is tiny compared to outer space. **Manned** space ships have traveled a fraction of the distance traveled by **unmanned** missions. Gravity is just one of the many **obstacles** that make space travel so **challenging**.

Two spacecrafts, Voyager 1 and 2, were launched in 1977 and have been traveling ever since. In 2012, Voyager 1 left the solar system and is now traveling through interstellar space (the region between the stars). Throughout their flights both spacecraft have been transmitting information and pictures back to Earth.



VOYAGER 1



VOYAGER 2

The Voyager spacecrafts were launched aboard a Titan-Centaur rocket. This carried the fuel and the rocket engines needed to escape Earth's gravity. It also protected the delicate Voyager craft from air resistance.



TITAN-CENTAUR ROCKET



ROCKET DEPLOYING ITS LOAD

To lift the mass of a rocket from the surface of the earth takes a large and constant force. It has to overcome the pulling force of gravity and the friction caused by **air resistance** in the atmosphere. As the rocket climbs away from earth, the pulling force from earth's gravity gets weaker and eventually drops to zero. Similarly, air resistance also decreases until the rocket has left the Earth's atmosphere then there is no more air resistance.

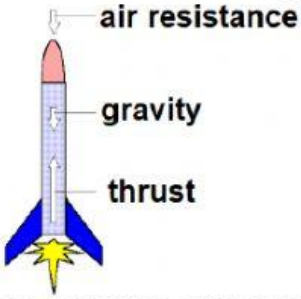
As the Voyager spacecrafts travel through the solar system, they still experience weak gravitational fields from other planets and the Sun. Signals from the scientists on Earth allow Voyager 1 and 2 to be controlled by tiny thrusters that provide enough

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force to keep the spacecrafts heading in the right direction. The thrusters are tiny jet engines that burn fuel, and the waste gases ejected from them provide the pushing force. They use very small amounts of fuel, but because there is no chance of refueling in outer space, Voyager spacecrafts will eventually drift uncontrolled through space.



ROCKET THRUSTERS



FORCES ACTING ON A ROCKET

The Voyager 1 and 2 missions were due to end, after 43 years, in 2020. By this time they will no longer be able to generate enough electrical energy to run the scientific instruments on board. The electrical needs are provided by plutonium and nuclear fuel which is continually **decaying** (breaking down).

Questions

1. How is a manned spaceship different from an unmanned spaceship?

   _____

2. What does the term obstacle mean? _____
3. In what year were the spacecrafts Voyager 1 and 2 launched from planet earth?

   _____

4. What event happened to Voyager 1 in 2012?_____
5. What is the correct location of Voyager 1?_____
6. What two important things do Voyager one and two send back to earth?

   _____

7. What is the name of the rocket that launched the Voyager spacecraft?

   _____

8. What two things did this rocket use to help Voyager 1 and 2 escape the Earth's gravity?_____
9. Along with helping Voyager 1 and escape Earth's gravity, what was the other benefit of carrying them inside of a rocket?_____

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10. What two forces must a rocket leaving the surface of the Earth overcome in order to get into outer space? _____

11. In outer space, what are the value of the forces mentioned in #10 above? _____

12. What would have to happen for a Voyager spacecraft to crash into another planet or into the Sun for? _____

13. What do scientists do in order to keep the Voyager spacecrafts heading in the right direction? _____

14. What are thrusters? _____

15. How do thrusters work? _____

16. Why will thrusters eventually stop working? _____

17. What is the fuel that provided the electricity for the Voyager 1 and 2 space crafts? _____

18. In what year was the Voyager 1 and2 mission supposed to end? _____

19. Please research and find out if the missions have actually ended.

_____

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