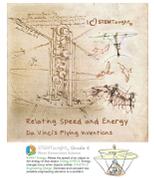


These pages were taken from the G4 "Relating Speed and Energy" journal.



Objects at rest remain at rest

An object that is at rest will remain at rest until some force acts upon it. This is true for all objects everywhere!



These sitting stones are at rest.



A parked car is at rest.



A jar on the shelf is at rest.



A sleeping puppy is at rest.

All of these objects will stay right where they are until they are moved by something. It takes energy to do the work needed to move something.



The fact that objects at rest stay at rest is useful. The people of ancient Rome built structures by shaping and stacking stones. Structures such as the Coliseum are not held together by cement or glue. Rather, these stones were carefully set down and balanced to form magnificent pillars and arches.



The fact that objects at rest stay at rest can help us solve mysteries. How did this large boulder get into this flat field? Something must have moved it here!



Scientists found evidence that the rock was carried here by flowing glacial ice long ago. The ice has now melted, but the rock remains in place.

Objects in motion remain in motion

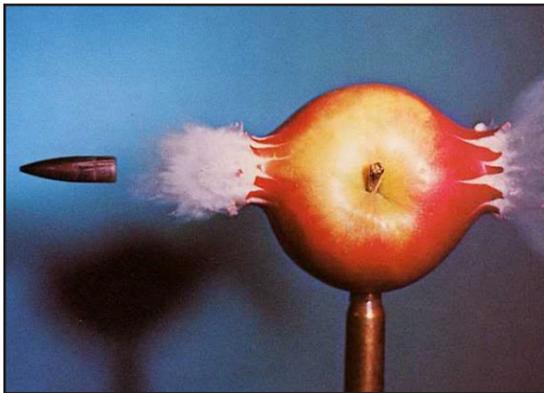
An object in motion will continue moving at the same speed and in the same direction until another force acts on it. This is true for all objects everywhere! The faster an object moves, the more energy it has.



This car is in motion.



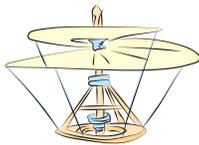
This ball is in motion.



This bullet is in motion.



The Moon is in motion as it orbits the Earth.



Think,
Pair,
Share

Do these objects move in a straight line at a constant speed? How do you know?



Objects in motion remain in motion

Based on your experiences, you may know that a car, a ball, a bullet and the Moon do not move in straight lines or at a constant speed. Moving objects commonly speed up, slow down, follow curved paths and can even bounce off of other things. What forces cause these motions?

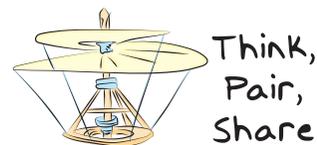
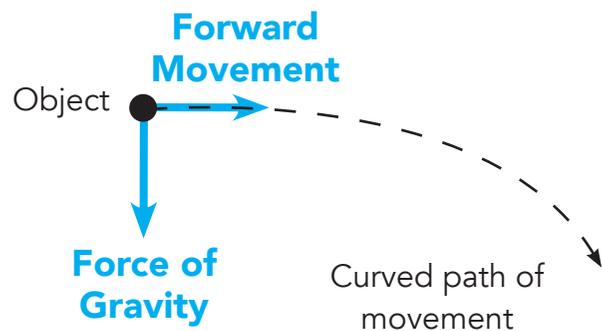


The skateboarder follows a curved path through the air.



The ball follows a curved path when passed.

Gravity pulls objects toward the Earth. Falling objects speed up because of gravity's continuous pull. An object going up into the air slows down because of the pull of gravity. An object moving forward and falling at the same time follows a curved path.



Have you observed a curved path of motion? Describe what you saw.

Objects in motion remain in motion

In addition to gravity's pull, collisions with other things commonly prevent objects from moving at a constant speed forever.



The dog's ears flap in the oncoming air as it looks outside the moving car.

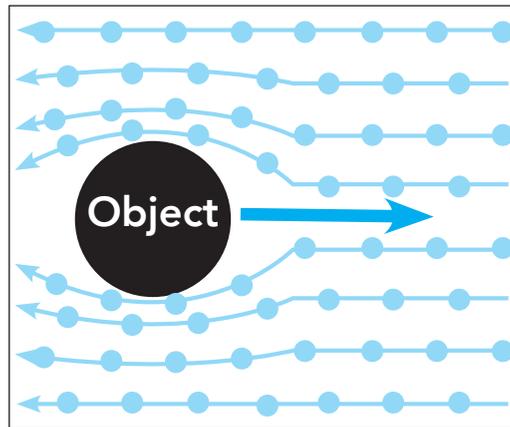


The parachuter safely floats to the ground because of air resistance.

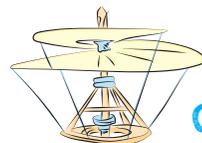
Objects lose energy and slow down when they bump into other things. When something moves through air, it bumps into millions of microscopic air particles. When something slows down after colliding with air particles we call it **air resistance**.

Key:

- Air Particles
- ➔ Forward Movement
- Moving Object



Objects slow down as they pass through particles of air.



GUIDING QUESTION

Have you observed air resistance? Describe what you saw or felt.

These objects do not move in a straight line or at a constant speed because other forces are involved in their motion.

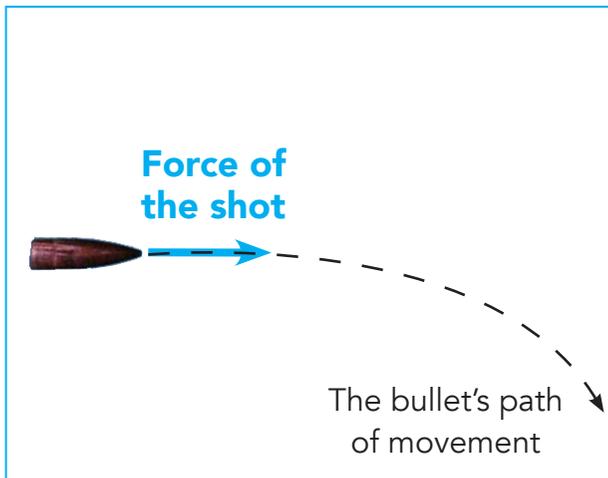
Try answering the blue questions with a group. Then cut and fold the flap for the answer.



Fold Line

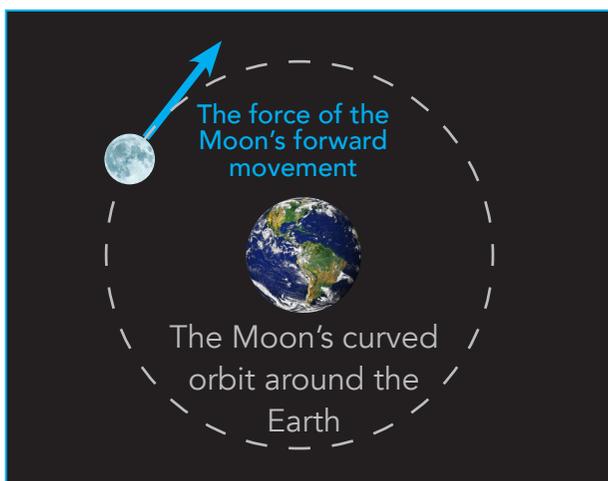
When kicked, the soccer ball quickly goes up into the air, then it comes back down. It follows a curved path of movement.

Why does the ball follow a curved path of movement?



The bullet moves forward at 3,000 feet per second. The bullet quickly slows down to 2,200 feet per second and drops toward the ground on a curved path of movement.

Why does the bullet slow down and follow a curved path of movement?



The moon orbits the Earth at a constant speed of 2,288 miles per hour in outer space where there is no air.

Why does the Moon never slow down?

Once an object is in motion, for it to change direction or speed another force must be involved.

The pull of gravity causes the ball to move on a curved path.



Why does the ball follow a curved path of motion?

The bullet experiences air resistance and slows down. It follows a curved path because of gravity.

Why does the bullet slow down after it is shot?

There is no air in space. Because there is no air resistance in space the Moon will travel at a constant speed forever.

Why does the Moon move at a constant speed?

There is no air resistance in space

In the emptiness of space there is no air between planets and stars. For this reason, objects moving through space experience no air resistance. In space, objects are free to move at a constant speed forever. Although these objects experience no air resistance, the force of gravity can be felt everywhere in space. Large objects such as planets and stars create a gravitational pull that causes smaller objects zooming through space to follow curved paths of motion.



As seen from space, the Hubble space telescope circles the Earth.



Space is a place of extremes

When a crewed spacecraft is launched to the International Space Station, the gleaming white rocket soars into space. When the spacecraft docks to the space station, it is still a glittering white.



The SpaceX Crew Dragon space capsule is about to dock at the international space station.

To come back to Earth the crew's capsule must reenter the Earth's atmosphere. Traveling thousands of miles per hour (faster than a speeding bullet) the capsule experiences extreme air resistance.



Millions of tiny air particles collide with the capsule causing it to heat up and burst into flames.

After 20 minutes of falling, the crew returns to Earth with a smooth splashdown in the ocean.



Elon Musk 
@elonmusk · [Follow](#)



Atmospheric entry at 17,000 mph is like a meteor & will vaporize steel. Burn marks below are on cold side. Main heatshield on bottom.



SpaceX  @SpaceX

Crew Dragon is on SpaceX's recovery vessel—completing the spacecraft's first test mission!

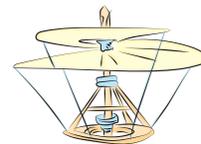


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Now, the crew is back, and the spacecraft doesn't look so new anymore. When it is picked up by the recovery ship, the space capsule with the crew inside looks a bit like a burnt marshmallow!



Think,
Pair,
Share

What causes the space capsule to heat up during reentry?