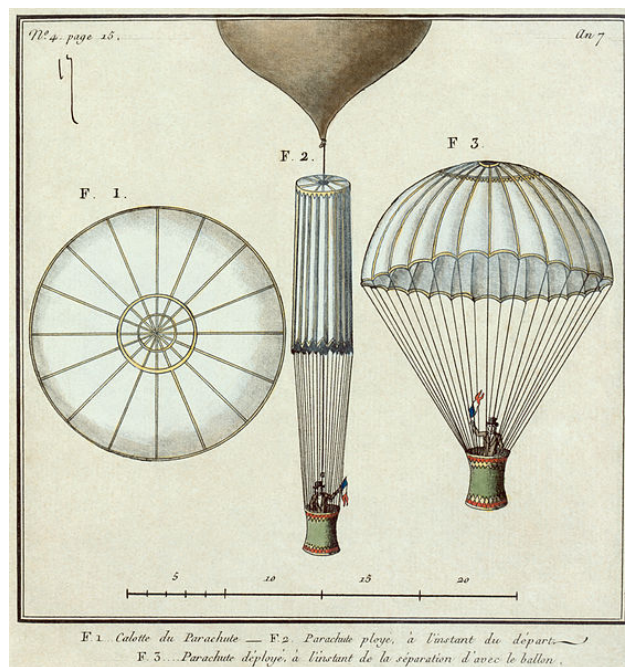


## Crashing, Jumping, Falling



What happens when two cars collide on the highway? Obviously we know what a car accident looks like. While slowly riding past in our own vehicle, we have seen the dented doors, the crumpled hood, and the shattered glass glittering on the asphalt. But what kind of physical processes are responsible for the ways these unfortunate cars look?

The physics of a car accident is fairly simple. Two cars are driving towards one another at a certain speed. For a legitimate accident to take place, rather than a simple fender bender, one or both of the cars must be traveling at a certain speed. If neither of the cars is traveling above a few miles an hour when they come in contact, an accident will not result.

For example, if two cars are moving at 30 miles per hour when they collide, this will result in an accident. In such a case, each car is exerting 30 miles per hour worth of force on the other. The combined effect of such a crash would be equivalent to a car slamming into a brick wall at 60 miles per hour. In both cases, energy is transferred from one object to the other — between the two cars, or between the car and the wall.

Clearly, the faster a car is traveling, the more energy it will transfer to the object — be it a car, a brick wall, or a guardrail. The exchange of energy between two cars that crash into each

other at high speeds is often great enough to bend steel as if it were thin plastic. Formerly impenetrable brick walls will crumble upon coming into contact with a rogue vehicle driving at 60 or 70 miles per hour.

But different types of forces exist between objects. If you are trying to park, for example, and your car slides against another car in the next spot, a frictional force is created. Frictional force can become heat, the way rubbing your hands together when it's cold out tends to warm your hands up.

Still, objects don't have to be touching in order to exert force on one another. Magnetic, gravitational and electric fields can exist between two objects that are not in contact.

Take a wrecking ball, for example, which construction workers use to tear down old buildings to make room for new ones. When lying on the ground, the wrecking ball exerts the force of its own weight onto the ground. But when a crane operator lifts the wrecking ball into the air, the gravitational field between the ball and the ground changes. The higher the crane operator lifts the wrecking ball, the more potential energy is stored inside that ball. The higher the ball is raised, that is, the more damage it will do to the ground when it is dropped.

Similarly, once the wrecking ball is attached to a pendulum-like chain, the higher it is raised, the more damage it will do to the building's wall. When the energy contained inside the ball has exerted its force against the wall enough times, the wall will eventually come crashing down.

The same idea goes for skydiving. When you are standing on the ground, the most force you can exert on it would be through jumping or falling. The situation changes when you're lifted into the air on an airplane. When the skydiver goes up into the plane at 20,000 feet, a certain amount of potential energy is stored inside him. When he jumps from the plane, that energy is then converted into motion, known as kinetic energy.

At 20,000 feet, of course, the amount of kinetic energy generated by a falling skydiver poses a risk to his life. A parachute, which slows the skydivers fall by creating air resistance, is required to reduce the kinetic energy the skydiver generates as he falls. Consequently, once the parachute has opened, the skydiver makes a gentle impact with the ground when he lands.

Bungee jumping, although similar to skydiving, involves a different kind of stored energy. Like the skydiver, the bungee jumper is a vessel of potential energy when he stands on the edge of a bridge. Also like the skydiver, that potential energy is transformed into kinetic energy when he jumps. But in the bungee jumper's case, that energy is then transformed once more into what is called tensional energy.

When the bungee jumper reaches the end of the cord, he briefly stops moving. By this point, the kinetic energy produced by his fall has been fully transformed into tensional energy inside the cord. This energy then exerts its force on the bungee jumper himself, sending him bouncing back toward the bridge. In a traditional bungee jump, the same process occurs several times. Finally, once the kinetic and tensional energy have both been expended, the jumper is pulled back up to the bridge.

The relationship between energy and forces applies to less extreme activities as well. Baseball, in which the batter attempts to hit a round ball with a bat, demonstrates how energy can be transferred between objects colliding at high speeds.

When a pitch is thrown, the batter swings the bat in a pendulum arc. The point at which the bat makes contact with the ball determines where and how far the ball will travel. If the ball connects too high or too low on the bat, vibrations will reduce the amount of energy transferred between the bat and the ball.

Some players might suggest that a bigger bat allows you to hit the ball farther. The problem is that a bigger bat is heavier, and therefore harder to swing than a lighter bat. Many professional baseball players use only bats of a certain weight and length, which correspond to the way they swing. Typically, batters prefer lighter bats, but if home runs are what you're looking for, you might consider a bigger bat.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What question is the author attempting to answer in the beginning of the article?
- A** What happens when two cars collide on a highway?
  - B** What speeds are safe for a car to travel at on the highway?
  - C** What kind of physical processes are responsible for the ways cars look after an accident?
  - D** What is frictional force?
2. The author explains the physics involved when objects crash, jump, and fall. How does the author explain this information?
- A** The author lists terms for physical processes and defines those terms.
  - B** The author uses real-world examples to illustrate how different physical processes work.
  - C** The author explains a physical process and then provides diagrams showing what he means.
  - D** The author poses a hypothesis and then supports that hypothesis using evidence from experiments.

3. Below are three pieces of evidence from the text:

1) In both cases, energy is transferred from one object to the other — between the two cars, or between the car and the wall. Clearly, the faster a car is traveling, the more energy it will transfer to the object — be it a car, a brick wall, or a guardrail.

2) The higher the crane operator lifts the wrecking ball, the more potential energy is stored inside that ball. The higher the ball is raised, that is, the more damage it will do to the ground when it is dropped.

3) When the bungee jumper reaches the end of the cord, he briefly stops moving. By this point, the kinetic energy produced by his fall has been fully transformed into tensional energy inside the cord. This energy then exerts its force on the bungee jumper himself, sending him bouncing back toward the bridge.

Which of the following statements are best supported by ALL THREE pieces of evidence from the text?

- A** Jumping, falling and crashing are completely different physical processes and are unrelated.
- B** Jumping, falling and crashing all involve the transference and changing of energy.
- C** Jumping, falling, and crashing have nothing to do with physics.
- D** Jumping, falling, and crashing all demonstrate how “tensional energy” is transferred in a process.

4. What are dented doors, a crumpled hood, and shattered glass examples of?
- A electromagnetic forces being exerted on the cars involved in the accident
  - B the effects of energy being transferred
  - C kinetic energy being changed to potential energy
  - D the effects of potential energy on the cars involved in the accident
5. What is the article "Crashing, Jumping, Falling" mostly about?
- A the physical processes involved in crashing, jumping and falling
  - B the dangers of driving fast, going skydiving and wrecking buildings
  - C how tensional energy affects everything we do
  - D why bigger baseball bats are more effective for hitting homeruns
6. What is an example of "potential energy"?
- A the energy that moves a rollercoaster car as it rolls downhill on the tracks
  - B the energy that is exerted on a brick wall after a car hits it
  - C the energy stored in a wrecking ball after lifting it in the air above the ground
  - D the energy that is used to move a baseball over the fence of a baseball field
7. Choose the answer that best completes the sentence below.
- \_\_\_\_\_ the skydiver jumps from the plane at 20,000 feet, the potential energy stored inside him is converted to kinetic energy.
- A However
  - B When
  - C Although
  - D Before
8. Explain what is happening to a person's energy when they go skydiving. Be sure to explain what happens to the person's energy 1) when they go up in the plane, 2) when they jump from the plane, and 3) when the parachute opens.

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9. What happens to the amount of potential energy stored in a wrecking ball the higher it is raised in the air?

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10. Explain whether the amount of potential energy stored within an object affects the level of impact the object will have on another object when they come into contact. Use at least one example from the text to support your answer.

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## Teacher Guide &amp; Answers

Passage Reading Level: Lexile 1160

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- A What happens when two cars collide on a highway?
- B What speeds are safe for a car to travel at on the highway?
- C **What kind of physical processes are responsible for the ways cars look after an accident?**
- D What is frictional force?

2. The author explains the physics involved when objects crash, jump, and fall. How does the author explain this information?

- A The author lists terms for physical processes and defines those terms.
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Which of the following statements are best supported by ALL THREE pieces of evidence from the text?

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5. What is the article "Crashing, Jumping, Falling" mostly about?

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6. What is an example of "potential energy"?

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7. Choose the answer that best completes the sentence below.

\_\_\_\_\_ the skydiver jumps from the plane at 20,000 feet, the potential energy stored inside him is converted to kinetic energy.

- A However
- B When**
- C Although
- D Before

8. Explain what is happening to a person's energy when they go skydiving. Be sure to explain what happens to the person's energy 1) when they go up in the plane, 2) when they jump from the plane, and 3) when the parachute opens.

**Suggested answer:**

When a skydiver goes up in a plane, potential energy is stored inside him as he rises in the sky with the plane. The potential energy stored inside the skydivers changes to kinetic energy when he jumps from the plane and falls towards the ground. A parachute, which slows the skydivers fall by creating air resistance, is required to reduce the kinetic energy the skydiver generates as he falls.

9. What happens to the amount of potential energy stored in a wrecking ball the higher it is raised in the air?

**Suggested answer:** The amount of potential energy increases.

10. Explain whether the amount of potential energy stored within an object affects the level of impact the object will have on another object when they come into contact. Use at least one example from the text to support your answer.

**Suggested answer:** Students should explain that the amount of potential energy that is stored within an object does affect the level of impact it will have on another object when they come into contact. The more potential energy an object has, the more of that energy can be converted into kinetic energy which will increase the impact that object has on another object when it hits that object. Students can use the example of the wrecking ball to support their answer. The higher the wrecking ball is raised, the more potential energy it has, therefore, the more damage it will do when it is dropped. Any other examples used are acceptable as long as they are from the text and support the students' reasoning.