PLTW Launch

# Project 1.4 Energy Transfer in Collisions Answer Key

## Introduction

CRASH! BANG! BOOM! These are the sounds you hear inside a bumper car track as cars collide with each other.

A **collision** occurs when two objects collide or bump into each other. A collision causes an exchange or transformation of energy.

In the case of bumper cars, the exchange of energy causes cars to bounce off of each other. The sound you hear during a collision is also an exchange of energy, as some of the kinetic energy from the cars is converted to sound.

Not all collisions are the same. **Elastic Collisions** are collisions with no loss of kinetic energy. **Inelastic Collisions** are collisions in which part of the kinetic energy is changed into another form of energy. Inelastic collisions may result in objects "sticking together," as in the case of a large truck colliding with a small car and pushing it over a distance.

In this project you will document an investigation into elastic and inelastic collisions and describe how energy is conserved and transferred in a collision.

## Equipment

- VEX IQ® Equipment
  - 2 assembled cars from Activity 1.3 Speed and Energy
  - Additional parts
    - 4x Pitch shaft (2)
    - Rubber shaft collar (4)
    - Small wheel hub (4)
    - 200mm Travel rubber tire (4)
- Poster board sheets (2)
- Masking tape
- Launch Log
- iPad® tablet
- Tablet applications
    - Ubersense Coach: Slow Motion Video Analysis
    - Canvas by Instructure

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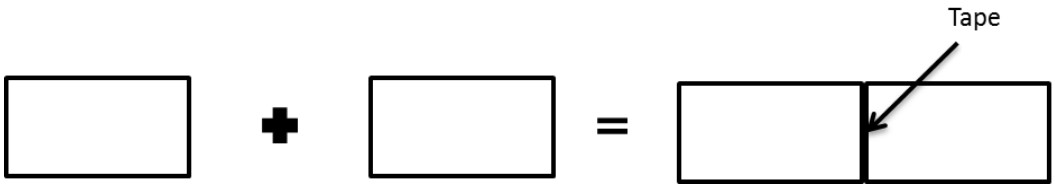
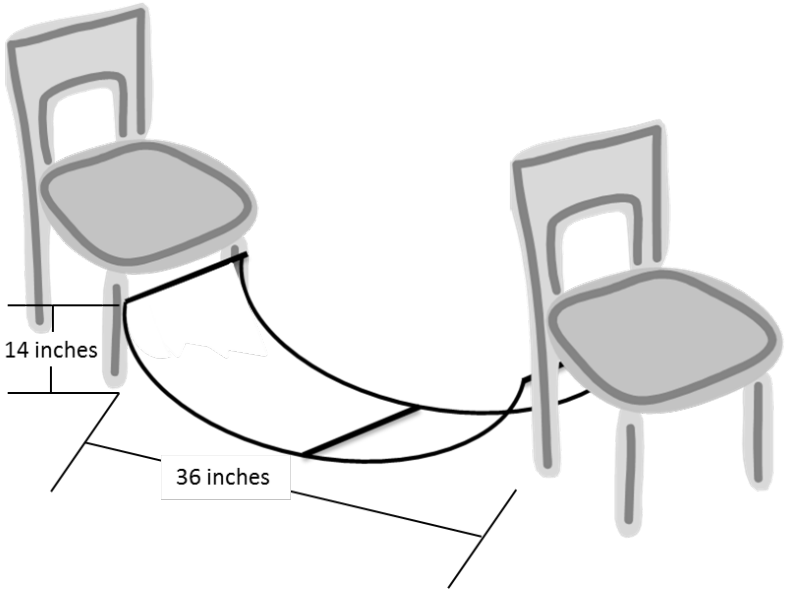
## Procedure

1. Prepare the half-pipe ramp out of poster board by following the steps below:
    a. Tape two pieces of poster board together as shown below.




    b. Tape the poster board to two chairs or another surface so the top of the poster board is about 14 inches from the floor and the chairs are about 36 inches from each other.




2. To test collisions between the two cars, you will hold a car on opposite sides of the ramp and let them go at the same time. If the cars are in line with each other, they will collide.
3. In addition to observing the collisions as they are happening, you may record the collisions with the tablet app Ubersense Coach: Slow Motion Video Analysis. This app allows you to record the collisions as they are happening and then play them back in slow motion to analyze the resulting motion.
4. Repeat the collision with the cars at different heights on the ramp and record your results in your Launch Log. You may wish to copy the following chart into your Launch Log before beginning the trials.

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| Collision Description | Sketch starting position | Describe the movement of the cars during the collision |
|---|---|---|
| Both cars at the top of the ramp | | Trial 1: |
| | | Trial 2: |
| Both cars 8 inches from the top of the ramp | | Trial 1: |
| | | Trial 2: |
| Car 1 at the top of the ramp, car 2 8 inches from the top of the ramp | | Trial 1: |
| | | Trial 2: |
| Car 1 stopped at the bottom of the ramp, car 2 at the top of the ramp | | Trial 1: |
| | | Trial 2: |
| Car 1 stopped at the bottom of the ramp, car 2 halfway down the ramp | | Trial 1: |
| | | Trial 2: |

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5. The car that was assembled in Activity 1.2 will be slightly modified for this project. Follow the steps below for both cars.
6. Attach the 4x shaft in the middle of the base of the car and hold it in place with rubber shaft collars as shown. For Step 6 tires may be stacked on the shaft to hold the tires in place during the collisions.

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7. Repeat the collision with a tire as a mass on the car held in place by the shaft and record your results below. Both cars will start at the top of the ramp each for each trial.

| Trial | Collision Description | Sketch | Describe the movement of the cars during the collision |
|---|---|---|---|
| 1 | Both cars with 1 tire | | |
| 2 | Both cars with 2 tires | | |
| 3 | Car 1 with 1 tire, car 2 without any tires | | |
| 4 | Car 1 with 2 tires, car 2 without any tires | | |
| 5 | Car 1 with 2 tires, car 2 with 1 tire | | |

8. Follow your teacher's instructions to design and run two collisions not described above. Document the collisions below.

| Collision Description | Sketch starting position | Describe the movement of the cars during the collision |
|---|---|---|
| | | |
| | | |

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## Conclusion

1. Why do bumper cars have a rubber bumper around each of the cars as shown here? Explain.

   Student answers may vary. One explanation is that the rubber bumpers absorb some of the energy of the collision and allow the bumper cars to bounce off of each other instead of damaging the cars.


2. How do your hands create sound when you clap? What two objects are colliding in this example?

   Student answers may vary. Students may answer that when two hands collide, the air is heated so quickly that sound is produced. At this level is it also acceptable for students to answer that the kinetic energy is converted to sound energy during the collision of the two hands. The objects colliding in this example are hands.

3. Defend the statement that bumper car collisions are inelastic collisions.

   Bumper car collisions are inelastic collisions because some of the kinetic energy produced is converted into sound. The cars also do not bounce back as far as they did when they initially collided.

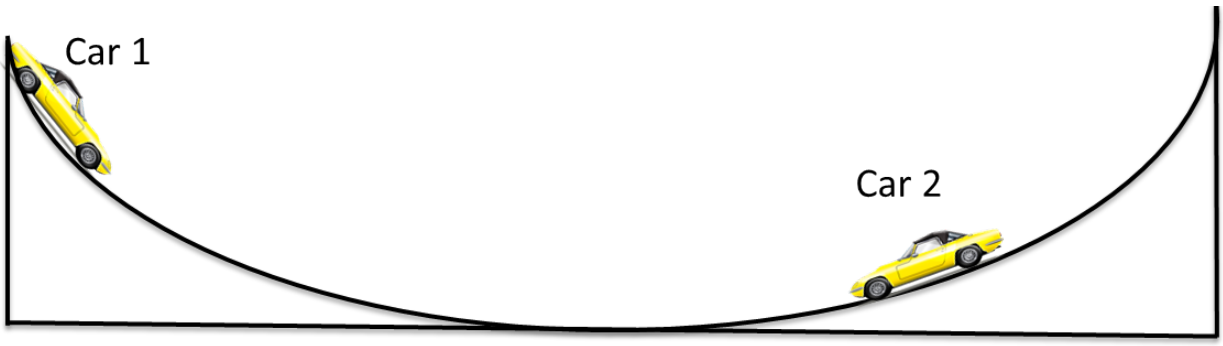
4. Look at the figure below with the toy cars on a ramp and answer the following questions.

   a. Which car has more potential energy? Why?

      Car 1 has more potential energy because it is higher up on the ramp.

   b. Predict the movement of the cars during the collision.

      Student answers may vary. During the collision car 1 will have more kinetic energy and will cause car 2 to roll backward up the ramp. Students may state that car 1 will follow up the ramp or that car 1 will stop after the collision.

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