Name____ Date________________ Per_______

Collision Helping Quadrant

Part A: **Think About It (Independent)**

Thinking Questions:

1. What is a collision?
2. In paragraph 2, The article says, "The motion of the balls changes in different ways because of their initial velocity and the direction of the force on them." What is meant by this?
3. If you collide with someone in a bumper car with the same mass, what will happen to BOTH of you?
4. In paragraph 4, why do you only get pushed back a little bit, and why does you brother go flying across the floor?
5. Why do some objects that collide have different effects from the equal forces that occur due to the collisions??

Annotate the Text

1. Highlight, or underline important information.
2. Write at least 2 comments or questions about the text in the margin.
3. Circle words you don't understand
3. Use symbols to mark the text

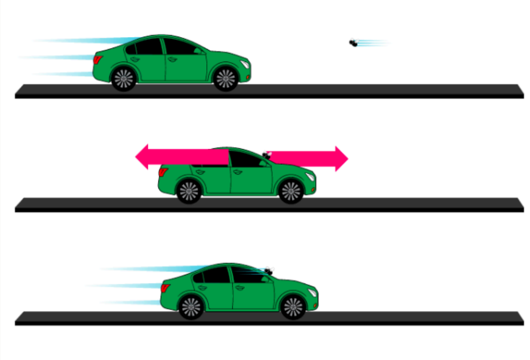
!	This is INTERESTING.
?	This is CONFUSING.
*	This is IMPORTANT

Criteria for Success: A LEVEL 4 will do the all of the following

- Annotations (underlines and symbols) are found throughout the reading, equaling at least 1 per paragraph.
- At LEAST 2 additional questions/interactions with the text are written in the margins/empty spaces
- All thinking questions are answered correctly
- All prepped responses are written neatly, are detailed, and written in own words.
- All group responses are answered correctly using evidence from the text, or from prior learning

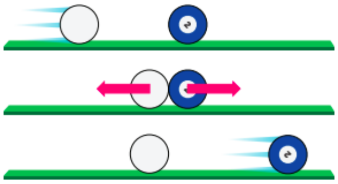
Crash!: Forces in Collisions

Say you're in a car driving down the highway at 60 miles per hour, and...SPLAT! Your car hits a bug. It probably seems like all the **force** of that **collision** acted on the bug. After all, the bug is splattered across your windshield, but you and the car probably didn't feel a change. However, not all collisions result in such different results. When two bugs that are about the same size fly into each other, the effect on both bugs is similar: they're both bumped off course by about the same amount. How can some collisions affect objects the same way (like the two bugs) and other collisions have vastly different effects (like the bug splattered on the car windshield)? The world is full of things running into each other, and what happens as a result of those collisions depends on the physics of **force, mass**, and **velocity**.



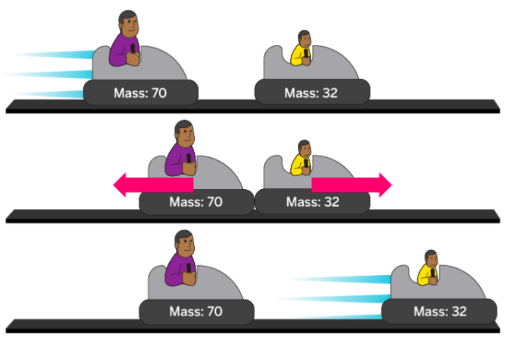
When a car hits a bug, both the car and the bug experience the same forces. However, those same forces have a much greater effect on the bug because its mass is so much less than the mass of the car.

In a game of pool, also known as billiards, you hit a white cue ball with a long stick called a cue. You want the cue ball to knock other balls, sitting stationary on the pool table, into the pockets on the edges of the table. However, you don't want the cue ball to follow them into the pockets. Hitting the cue ball can be risky! Whether they know it or not, pool players use physics to their advantage: if they set up the **collision** just right, the white cue ball comes to a complete stop after the **collision,** while the colored ball starts moving. How does that work? During the collision, both balls experience the ***same force,*** but in ***opposite directions***. When a moving object collides in a straight line with an object of the same mass that's sitting still, both objects experience the same amount of force. However, the motion of the balls changes in different ways because of their initial velocity and the direction of the force on them. The moving object changes its velocity by going from motion to rest, while the still object goes from rest to motion with the *same velocity* the moving object *used* to have. Since the force is experienced by both balls, but in different directions, the colored ball moves across the table while the cue ball stops.



When two pool balls collide, both balls experience the same amount of force, but in opposite directions. Because they have the same mass, the ball that is moving stops, while the ball that is sitting still begins to move.

If you've ever driven a bumper car at a carnival or fair, you've already studied your fair share of collisions. After all, bumping into other cars is the whole point of bumper cars—it's right there in the name! If you and your bumper car bump into a car carrying a friend who's about the same size as you are, you might expect that both of you would experience equal forces. You have about the same amount of mass and are about the same size, so if you're both already moving, you bounce away from each other to about the same distance. But what if you bump into somebody with a different mass? Say you bump into your little brother, who has less mass than you do. You bounce back just a little bit, but your brother and his bumper car go zooming across the floor. Would you believe that the forces you experienced during the collision are still exactly the same? They are! Your brother moved far away from you because he has less mass than you do—the amount of force you both experienced was enough to send him flying at high speed. You didn't travel as far as he did because you have more mass. The effect of that same amount of force was only enough to change the velocity of your mass a small amount.



When a bumper car carrying a person with a lot of mass collides with a bumper car carrying a person without much mass, both bumper cars and both people experience the same forces. However, those forces have stronger effect on the person with less mass, sending him or her zooming across the floor.

The distribution of forces in a collision between your car and a bug isn't so different from the forces in a collision between your bumper car and your brother's—in both collisions, both objects (or people) experience *equal forces*. ***However, it's the difference in the masses of the objects or people that makes the effects of the collisions dramatically different***. Since the bug is so tiny, the effect of the collision with the windshield is large enough to suddenly change its velocity by a lot—so much that it ends up exploding into a pile of goo on the windshield. Nothing *that* terrible happens to your brother in the bumper car when you run into him, because your mass and his mass aren't very different, so the effects of the equal forces your collision produces affect you only slightly differently.

Name______________________________ Date______________ Per______

Part B: **Share What You Learned (Groups of 4, but first prepare your own responses before you share with your partners)**

My Prepped Responses – These are open ended and there are multiple acceptable responses.

1. When two objects collide, the objects experience **different / equal** forces in opposite directions because ____.

2. When two objects of equal mass collide, their change in velocity is **different / the same.** For example, ____.

3. When two objects of different masses collide, the object with less mass is affected **more than / less than / the same as** the object with more mass because it receives the same amount of force as the object with more mass. For example____.

Next: As a group, determine the BEST answers for the prepped response questions above. This may be from one person's paper, OR a combination of your group's answers. Then find the BEST text evidence that supports the answer (write it out)

1. When two objects collide, the objects experience **different / equal** forces in opposite directions because…

This is supported in the text in paragraph ______ where it states,

2. When two objects of equal mass collide, their change in velocity is **different / the same.** For example …

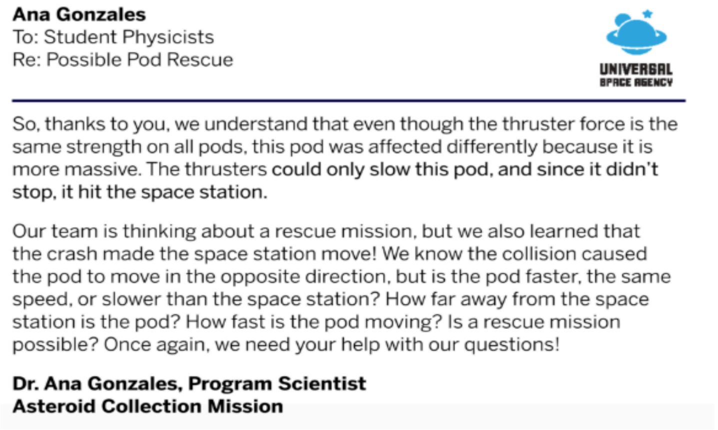
This is supported in the text in paragraph ______ where it states,

3. When two objects of different masses collide, the object with less mass is affected **more than / less than / the same as** the object with more mass because it receives the same amount of force as the object with more mass. For example…

This is supported in the text in paragraph ______ where it states,

As a group, use what you learned in the article to answer the following questions:

READ BEFORE ANSWERING:



Ana Gonzales
To: Student Physicists
Re: Possible Pod Rescue

So, thanks to you, we understand that even though the thruster force is the same strength on all pods, this pod was affected differently because it is more massive. The thrusters could only slow this pod, and since it didn't stop, it hit the space station.

Our team is thinking about a rescue mission, but we also learned that the crash made the space station move! We know the collision caused the pod to move in the opposite direction, but is the pod faster, the same speed, or slower than the space station? How far away from the space station is the pod? How fast is the pod moving? Is a rescue mission possible? Once again, we need your help with our questions!

Dr. Ana Gonzales, Program Scientist
Asteroid Collection Mission

1. Because we know that the pod and the space station collided, do you think the space station was also affected by the collision? Why or why not?

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2. If the space station has much more mass than the pod, which object is moving faster after the collision? The pod, or the space station? Why?

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Name____ Date____________________ Per_________