Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Hour\_\_\_\_\_\_\_\_\_\_\_\_\_

**Conservation: It’s the Law!!**

**Essential Question: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Part 1, Directions: With your table partner read the below information. Please talk to the text (make connections, or one sentences summaries for each paragraph)**

**Background Information:** Car collisions can illustrate and help students discover the concept of energy. Energy is defined as the ability to do work. And work is the ability to apply force (push or pull) over a distance.

All energy can be considered either kinetic energy, which is the energy of motion; potential energy, which is stored energy due to its relative position or condition; or energy contained by a field, such as a light or radio waves. Underlying every car crash are two conservation laws of physics: the law of conservation of energy and the law of conservation of momentum. The conservation of energy law states that energy cannot be created or destroyed; it may be transformed from one form to another, but the total amount of energy never changes. The conservation of momentum law states that the total quantity of momentum of a group of objects does not change unless acted on by an outside force.

Like energy, momentum can transfer from one object to another. Newton’s Third Law of Motion describes how all forces occur in equal pairs bit in opposing directions. Consider a marble rolling along a track and hitting motionless but identical marble. Upon colliding each marble experiences the same force but in opposite directions. The force of the first ball transfers to the second. Along with a transfer of forces is a transfer of momentum. Since one marble loses in momentum the other ball gains (and the system’s total momentum is unchanged). The observable phenomenon of maintaining and transferring momentum equally is called the law of conservation of momentum.

Momentum is vector quantity, which means the direction it is traveling is also important. Vector quantities can cancel out if they are of the same magnitude but in opposite directions! Energy is not a vector quantity, it cannot be canceled, it must go somewhere! In a crash of a well-designed car, crash energy does the work that crushes the car’s crumple zones. Some of the energy also becomes heat and sound generated by the crash.

**Ms. Murphy Check in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Must get Ms. Murphy’s approval before raising your hand for the supplies.**

Materials:

-pipe insulation track 3 ft -7 marbles -Masking tape 30cm

-ruler -books 3-5

**Part 2, Procedure: Check mark each step as you complete them**

\_\_\_\_1. Using books as support, tape one end of the track to a height of 25-30 cm. using two more pieces of tape, create a flat, straight 60cm rollway.

\_\_\_\_2. Using small pieces of tape and a ruler measure and mark the following heights on the upward curve of the track: 5cm, 10cm, and 15cm (measured straight up from the surface of the desk, not along the curve of the track).

\_\_\_\_3. Place six marbles in the groove of the track. Allow about 15 cm between the end of the slope and the first marble in the line of six.

\_\_\_\_4. Push the marbles together so they all touch.

\_\_\_\_5. Place the last or seventh marble at the 5cm mark on the upward slope.

\_\_\_\_6. Release the marble and allow it to roll down the track and collide with the row of marbles. Observe what happens! How many marbles roll away from the row? Record your observations in Data Table 1.

\_\_\_\_7. Place the marbles back in a row, making sure they all touch.

\_\_\_\_8. Repeat step 6 from 10cm and 15cm using one marble.

\_\_\_\_9. Repeat steps 6 and 7, with two, three and four marbles.

\_\_\_\_10. Record results in Data Table 1

\_\_\_\_11. Next, place the marbles back in a row, again making sure they all touch.

\_\_\_\_12. Place one marble in the 5 cm mark and release it.

\_\_\_\_13. Try and compare the speed of the released marble just before it collides with the row to the speed of the marble knocked away from the row (qualitative speed descriptions: slow, medium, fast)

\_\_\_\_14. Repeat step 13 at 10 cm, and 15 cm. With one marble

\_\_\_\_15. Repeat step 6 & 7, with two and three marbles.

\_\_\_\_16. Record your observations in Data Table 2.

**Data Table 1**

|  |  |  |
| --- | --- | --- |
| Number of marbles released | Height of release | Number of marbles knocked away from the row |
| 1 | 5 cm               10 cm               15 cm | \_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | 5 cm               10 cm               15 cm |  |
| 3 | 5 cm              10 cm              15 cm |  |
| 4 | 5 cm              10 cm             15 cm |  |

Blue

Data Table 2

|  |  |  |  |
| --- | --- | --- | --- |
| Height of release | Number of Marbles | Speed of released marbles before impact (slow, medium, fast) | Speed of released marbled knocked away (slow, medium, fast) |
| 5cm | 1             2             3 | \_\_\_\_\_ |  |
| 10 cm | 1             2             3 |  |  |
| 15cm | 1             2             3 |  |  |
| 20 cm | 1            2            3 |  |  |

**Comprehension Questions: Complete using complete sentences and a restate on a separate piece of paper.**

1. Describe your results in Data Table 1 (3 sentences)
2. Describe your results in Data Table 2 (3 sentences)
3. Reviewing Data Table 1, how do the number of marbles and their release height affect the marbles energy and momentum?
4. What conclusions can you make from Data Table 1 regarding the total energy of released marbles and the total energy of the marbles knocked away from the row?
5. What conclusions can you make from Data Table 2 regarding the momentum of the released marbles just before impact and the momentum of the marbles knocked away from the row?
6. Describe the collision pictured below in terms of momentum, if the truck has four times the momentum of the car before the collision. (What is going to happen with the momentum?)
7. Describe the collision pictured below in terms of energy, if the truck has four times the energy of the car before the collision. (What is going to happen to the energy)
8. Imagine there is a head-on collision with cars of the same speed but different masses. The car with more mass is hit by the car with less mass. You are in the car with more mass.

A. What happens to your car?

B. What direction will your car move after the crash?

C. What are you hoping protects you during this crash?

9. When two balls in the swinging-balls apparatus are released and collide with the remaining row of balls, why doesn’t one ball emerge with twice the speed at the other end? (Use words such as momentum and energy)

Yellow

Data Table 2

|  |  |  |  |
| --- | --- | --- | --- |
| Height of release | Number of Marbles | Speed of released marbles before impact (slow, medium, fast) | Speed of released marbled knocked away (slow, medium, fast) |
| 5cm | 1             2             3 | \_\_\_\_\_ |  |
| 10 cm | 1             2             3 |  |  |
| 15cm | 1             2             3 |  |  |
| 20 cm | 1            2            3 |  |  |

**Comprehension Questions: Complete using complete sentences and a restate.**

1. Reviewing Data Table 1, how does the number of marbles affect the marbles energy and momentum?

2. Reviewing Data table 1, how does the release height affect the marbles energy and momentum?

3. How does the release height affect the number of marbles that get knocked away from the row?

4. Consider the picture below. If the truck has a mass of 4 tons and the car has a mass of 2 tons, but they have the same speed. If the two vehicles crash what direction would the cars go?

-The truck would go \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

-The car would go \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

5. Now consider the truck and car have the same mass as mentioned above but the truck has a lot more energy than the car.

A. What would happen to the car?

B. What would happen to the energy?

Purple

Data Table 2

|  |  |  |  |
| --- | --- | --- | --- |
| Height of release | Number of Marbles | Speed of released marbles before impact (slow, medium, fast) | Speed of released marbled knocked away (slow, medium, fast) |
| 5cm | 1             2             3 | \_\_\_\_\_ |  |
| 10 cm | 1             2             3 |  |  |
| 15cm | 1             2             3 |  |  |
| 20 cm | 1            2            3 |  |  |

**Comprehension Questions: Complete using complete sentences and a restate.**

1. Describe your results in Data Table 1 (3 sentences)

2. Describe your results in Data Table 2 (3 sentences)

3. Reviewing Data Table 1, how do the number of marbles and their release height affect the marbles energy and momentum?

4. What conclusions can you make from Data Table 1 regarding the total energy of released marbles and the total energy of the marbles knocked away from the row?

5. What conclusions can you make from Data Table 2 regarding the momentum of the released marbles just before impact and the momentum of the marbles knocked away from the row?

6. Describe the collision pictured below in terms of momentum, if the truck has four times the momentum of the car before the collision. (What is going to happen with the momentum?)

7. Describe the collision pictured below in terms of energy, if the truck has four times the energy of the car before the collision. (What is going to happen to the energy?)