**Conservation of Energy**

**Directions**:

1. Read the procedure and basic design of the lab shown in the handout.
2. You will measure time of travel as well as distance traveled so that you can *derive* (calculate) speed
3. You will complete 3 trials for 3 different ramp heights and 3 trials for 3 different masses in the car

**Background**

1. Read and complete the questions on the HMH handout
2. Please use complete and detailed sentences to answer the following (3 points each)
3. How can you tell whether an object is in motion? You can tell whether an object is in motion by a reference point.
4. What two measurements are needed to calculate speed? The measurements that are needed to calculate speed are time and distance.
5. How do you determine the amount of kinetic energy of an object? You determine it by mass times velocity.
6. What two factors affect the potential energy of an object? The two factors that affect the potential energy of an object are Height and Mass.
7. What is the law of conservation of energy? Will all of the car's potential energy convert to kinetic energy? Why or why not (where is it "lost"?) The car’s potential energy will convert to kinetic energy but some of it will be lost to friction. The law of conservation of energy is energy can not be created nor destroyed.

**Purpose:** the purpose of this activity is to investigate the relationship between gravitational potential energy and kinetic energy of a car rolling down a ramp.

**Questions**

*What is the effect of ramp height on the speed of a car sent down the ramp?* Gravity pulls the car down to make it go very fast.

*What is the effect of mass on the speed of a car sent down a ramp?* Mass makes more joules.

**Predictions**

*-complete the statements by adding increase or decrease (1 point each)*

If the height of the ramp increases, then the speed of the car will increase.

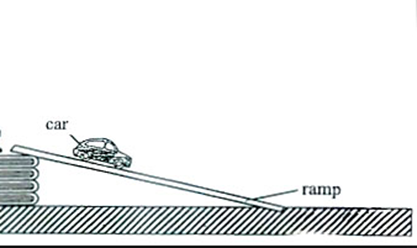
If the mass of the car increases, then the speed of the car will increase.

**Hypotheses**

*-create a hypothesis by added increase or decrease AND a reason for this guess (5 points each)*

As ramp height increases, the speed of a car sent down the ramp will increase, because the more gravity pulls on it makes the velocity increase.

As the mass of the car increases, the speed of a car will stay the same, because gravity doesn’t change.



**Data and Observations (10 points per table)**

**Part 1. Effect of Ramp Height on Speed of a Car**

| **Ramp Height**  **(# of books)** | **Trial** | **Total Travel Time** | **Distance Traveled**  **(cm)** | **Speed**  **(d/t)** | **Average Speed**  **cm/s** |
| --- | --- | --- | --- | --- | --- |
| **1 book** | 1 | **5.51** | **257** | **46.64** | **44.79** |
| 2 | **4.9** | **200** | **40.81** |
| 3 | **3.75** | **176** | **46.93** |
| **2 books** | 1 | **5.30** | **195** | **36.79** | **35.19** |
| 2 | **5.59** | **182** | **34.4** |
| 3 | **5.29** | **182** | **34.4** |
| **3 books** | 1 | **5.35** | **89** | **16.63** | **18.18** |
| 2 | **4.78** | **89** | **18.61** |
| 3 | **4.76** | **92** | **19.32** |

**Speed = distance divided by time**

**Average = add all speeds for the ramp height and divide by 3**

**Calculate the Potential and Kinetic Energy of the Car at each height on the next page!**

**Part 1. Calculate the Potential Energy of the Car at each height:**

**(weight should be the SAME for all three)**

| **Ramp Height (meters)** | **Mass of Car (kilograms)** | **Weight of Car in Newtons (mass x 10)** | **Potential Energy ( PE = wh)** |
| --- | --- | --- | --- |
| **00.5 m** | **0.056kg** | **0.56 N** | **0.028 J** |
| **0.10 m** | **0.056kg** | **0.56 N** | **0.056 J** |
| **0.15 m** | **0.056kg** | **0.56 N** | **0.084 J** |

**Part 1. Calculate the Kinetic Energy of the Car at each height:**

| **Height** | **Mass of Car** | **Average Speed** | **Kinetic energy (KE = ½ mv2)** |
| --- | --- | --- | --- |
| **1** | **0.056kg** | **4.469** | **55.92** |
| **2** | **0.056kg** | **3.519** | **34.67** |
| **3** | **0.056kg** | **1.818** | **9.25** |

**Part 1. Compare PE and KE for Part 1**

| **Height** | **Potential Energy** | **Kinetic Energy** | **Where is the missing Energy?** |
| --- | --- | --- | --- |
| **1** | **0.028 J** | **55.92** | **When the car flies off the ramp some of the energy is missed and leaves the car while in flight.** |
| **2** | **0.056 J** | **34.67** | **When the car flies off the ramp some of the energy is missed and leaves the car while in flight.** |
| **3** | **0.084 J** | **9.25** | **When the car flies off the ramp some of the energy is missed and leaves the car while in flight.** |

**Part 2. Effect of Mass on Speed of a Car**

| **Mass ((kilograms))** | **Trial** | **Total Travel Time** | **Distance Traveled**  **(cm)** | **Speed**  **(d/t)** | **Average Speed**  **cm/s** |
| --- | --- | --- | --- | --- | --- |
| **Empty Car** | 1 | **4.88** | **242** | **49.59** | **45.8** |
| 2 | **5.23** | **219** | **41.87** |
| 3 | **3.22** | **148** | **45.96** |
| **Car +100 grams** | 1 | **5.12** | **309** | **60.35** | **57.04** |
| 2 | **5.31** | **279** | **52.54** |
| 3 | **5.03** | **293** | **58.25** |
| **Car + 200 grams** | 1 | **4.94** | **263** | **53.23** | **55.12** |
| 2 | **5.00** | **269** | **53.8** |
| 3 | **4.37** | **255** | **58.35** |

**Calculate the Potential and Kinetic Energy of the Car at each height on the next page!**

**Part 2. Calculate the Potential Energy of the Car for each mass:**

**(height should be the SAME for all 3)**

| **Ramp Height (meters)** | **Mass of Car (kilograms)** | **Weight of Car in Newtons (mass x 10)** | **Potential Energy ( PE = wh)** |
| --- | --- | --- | --- |
| **0.15 m** | **0.056 kg** | **0.56 N** | **0.084 J** |
| **0.15 m** | **0.256 kg** | **2.56 N** | **0.384** |
| **0.15 m** | **.456 kg** | **4.56 N** | **0.684 J** |

**Part 2. Calculate the Kinetic Energy of the Car at each height:**

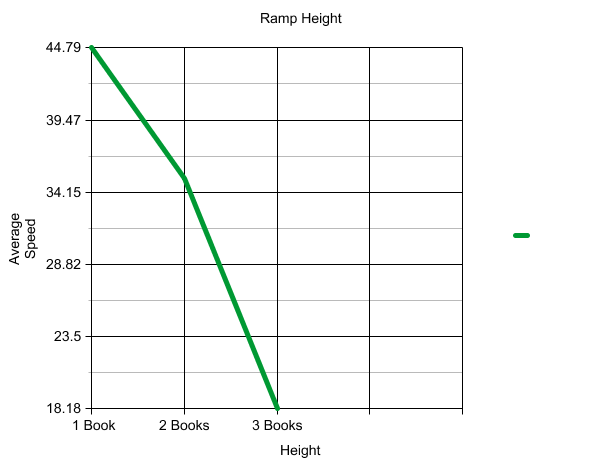
| **Height** | **Mass of Car (kilograms)** | **Average Speed** | **Kinetic energy (KE = ½ mv2)** |
| --- | --- | --- | --- |
| **1** | **0.056 kg** | **45.8** | **53.73** |
| **2** | **0.256 kg** | **57.04** | **416.45** |
| **3** | **0.456 kg** | **55.12** | **692.17** |

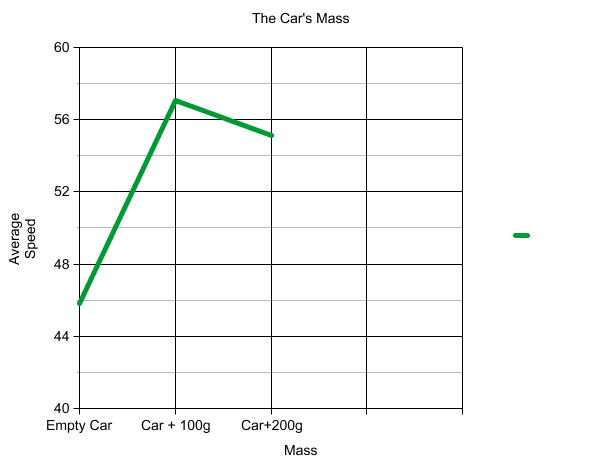
**Part 2. Compare PE and KE for Part 2**

| **Height** | **Potential Energy** | **Kinetic Energy** | **Where is the missing Energy?** |
| --- | --- | --- | --- |
| **1** | **0.084 J** | **53.73** | **When it is at the bottom of the ramp.** |
| **2** | **0.384** | **416.45** | **When it is at the bottom of the ramp.** |
| **3** | **0.684 J** | **692.17** | **When it is at the bottom of the ramp.** |

**Create Two Graphs**

1. **Height vs. speed: height on X axis and AVERAGE speed on Y axis** (you are graphing 3 heights and 3 speeds)
2. **Mass vs. speed: mass on X axis and AVERAGE speed on Y axis** (you are graphing 3 masses and 3 speeds)

*Part 1 Graph*

*Part 2 Graph*

*Graph Grading:*

*Title (2 points); axes labels with units (2 points each); no data labels (2 points); data entered and graphed correctly (9 points) both graphs =30 points)*

**Conclusion Paragraph (25 points)**

* *Sentence 1: Start your paragraph with your hypothesis. Explain your hypothesis. (4 points)*
* *In 2-3 sentences: Explain how potential energy and kinetic energy were involved. Explain how speed is measured and calculated. (5 points)*
* *In 2-3 sentences: Describe how you tested your hypothesis without using "I" (we, our is better) (5 points)*
* *In 2-3 sentences: Describe whether your procedure was effective and successful. How could the experiment be improved? What errors occurred? (3 points)*
* *In 3-5 sentences: Summarize your results and what the results show. (4 points)*
  + *Which had more of an impact on speed- height or mass? Support with data.*
  + *Was energy conserved? Did all the PE convert to KE? Why or why not?*
* *In 1-2 sentences: state that you proved or disproved your hypothesis. (2 points)*
* *End sentence: state the relationship between the independent variable (manipulated) and the dependent variable (responding) as shown by your data. (2 points)*

**Describe** means you should explain and support your statements.