**Speed and Acceleration Inquiry Lab**

GPS S8P3a: Determine the relationship between velocity and acceleration.

**Motion Introduction**

1. How is motion defined in science?
2. Describe an original example that shows how frame of reference influences the perception of motion.

**Purpose**: Creating and interpreting Distance vs. Time graphs and Velocity vs. Time Graphs

**Question**: Will your object travel at a constant speed once it reaches the bottom of the ramp?

**Hypothesis**: ***Answer the above question as your hypothesis. If the object travels 4 meters down a ramp then…***

**Materials:**

Hot Wheels Track

Marble or Hot Wheels Car

Textbook

Timing Devices

Meter Sticks

Tape

**Procedure:**

1. Mark track and floor at one meter marks for four meters. Mark the spots out on the chart below with the tape
2. Tape end of track to top of one textbook
3. Timer Testing:
	1. Place the appropriate number of books at starting point and attach the ramp.
	2. Select a person to be the starter and agree upon a “Starting Phrase”. (ie. Ready, Set, Go)
	3. Assign positions to each of your timers.
4. All timers should start their watches at the starting phrase, when the car is released.
5. Release object and have all timers stop at their appropriate marks.
6. Collect and record data in the table below in the Group column. Write down the time it takes to get to that spot.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distance | Time at 2 Books | Time at 4 Books | Time at 6 Books | Time at 8 Books |
|  | Trial 1 | Trial 2 | Ave | Trial 1 | Trial 2 | Ave | Trial 1 | Trial 2 | Ave | Trial 1 | Trial 2 | Ave |
| 50 cm |  |  |  |  |  |  |  |  |  |  |  |  |
| 100 cm |  |  |  |  |  |  |  |  |  |  |  |  |
| 150 cm |  |  |  |  |  |  |  |  |  |  |  |  |
| 200 cm |  |  |  |  |  |  |  |  |  |  |  |  |
| 250 cm |  |  |  |  |  |  |  |  |  |  |  |  |
| 300 cm |  |  |  |  |  |  |  |  |  |  |  |  |
| 350 cm |  |  |  |  |  |  |  |  |  |  |  |  |
| 400 cm |  |  |  |  |  |  |  |  |  |  |  |  |
| 450 cm |  |  |  |  |  |  |  |  |  |  |  |  |
| 500 cm |  |  |  |  |  |  |  |  |  |  |  |  |

1. Add a book to the stack.
2. Repeat Steps 5 - 7. Collect data at four different book heights.
3. Using a different color for each book height, graph the Distance vs. Time Data. Make sure that you create a key.
4. Using a pencil (yes a pencil), draw a constant speed line on your graph that roughly makes a 45⁰ angle with the x axis. (\*\*Hint the graph will be divided diagonally into two)
5. Calculate the average speed for each interval (from point to point) for your final set of data. Average speed is calculated by using the following formula:

$$Average Speed= \frac{Change in distance }{Change in time}$$

1. Record the Average Speeds using your average trial for your 8 books in the following chart:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Interval: | 0-50 cm | 50-100 cm | 100-150 cm | 150-200 cm | 200-250cm | 250-300 cm | 300-350 cm | 350-400 cm | 400-450 cm | 450-500 cm |
| Average Speed (cm/s) |  |  |  |  |  |  |  |  |  |  |
|   |   |   |   |   |   |   |   |   |   |  |

1. Graph the above data on a Speed vs. Time Graph.

**Distance v. Time**



**Speed v. Time**



**Conclusion**: Using complete sentences, answer the following questions

1. Identify a reference point where the car appears to be in motion.
2. Identify a reference point where the car does not appear to be in motion.
3. Revisit your hypothesis. Use your data to discuss whether you accept or reject your hypothesis. Explain why you accept or reject your hypothesis.
4. What’s the relationship between the slope of your line and the velocity of your car?
5. What are possible sources of error? (What could have prevented you from getting accurate results?)
6. How would you describe the lines on the Distance vs. Time graph?
7. How would you describe the line on the Speed vs. Time graph?
8. Discuss a possible application of your data in the real world.
9. Acceleration is defined as a change in speed over time or a change in direction. How does the car demonstrate acceleration?
10. Calculate the acceleration for the car with 8 books from 40 cm to 120 cm. Use the following formula:

$$a =\frac{(v\_{f}-v\_{i})}{∆t}$$

 $a=acceleration$

 $v\_{i} =initial velocity$

 $v\_{f}=final velocity$

 $∆t=change in time$

1. What does the equation above tell you about acceleration if the velocity remains constant?
2. How does the change in time affect the value for acceleration?
3. Is it possible to have $∆t$ = 0 and $v\_{f}\ne v\_{i}$? Why or Why not?
4. **Bonus**:
	1. Draw a line tangent to one of the curves on your Distance vs. Time graph. See drawing below for an example. Using your graph estimate the slope of this line. What does the slope of this line represent?
	2. What force(s) cause the object to start moving?
	3. What force(s) oppose the movement of the object?

