Physics Workshop Teacher's Notes

Car & Ramp: Gravity & Motion

Main Topic	Forces
Subtopic	Gravity
Learning Level	High
Technology Level	Photogates
Activity Type	Student

Description: Test the effect of two variables, mass and slope, on the acceleration of a car on an inclined plane

Required Equipment	Workshop Stand, Ramp, Car, Bolt, Hooked Masses, EasySense Datalogger, 2 Photogates, Balance (electronic or triple-beam).
Optional Equipment	

Educational Objectives

- To investigate the effects of changes in mass and slope on the car's acceleration.

Key Question

- What variables can affect the acceleration of a car on an inclined plane?

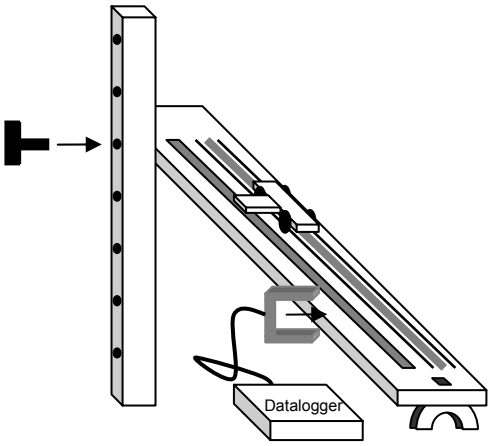
Concept Overview

Students will test the effect of two variables, mass and slope, on the acceleration of a car on an inclined plane. They should find that changing the mass has little effect on the acceleration, while changing the slope has a predictable effect.

Lab Tips

Assembly:

1. Push the attachment bolt through the Workshop Stand at the desired height of the top of the ramp.



2. Screw the bolt into the side of the ramp, tightening the ramp against the side of the stand.
3. Push the "foot" up through the hole in the bottom of the ramp.
4. Place the car on the ramp so that the wheels rest in the grooves and the rubber bumper extends down through the hole between the grooves. The bumper is designed to stop the car at the bottom of the ramp without allowing it to fall off.
5. Orient the car so that the side flag extends over the wide hole, toward the printed scale. This flag will block a photogate beam so that students can find its speed at different points on the ramp.
6. The car is designed to accommodate the 500g and 200g masses from the Hooked Mass Set. Secure the masses by stretching the rubber band through the two top hooks and over the mass.

7. Arrange photogates so that the beam goes through the wide hole and will capture the motion of the car's flag as it moves. Support photogates with ring stands or by clamping them directly on the ramp.
8. The angle of the ramp can be adjusted simply by attaching it to different heights on the stand. Angles greater than 45° are not recommended due to possible damage to the car or ramp at the end of the trip.

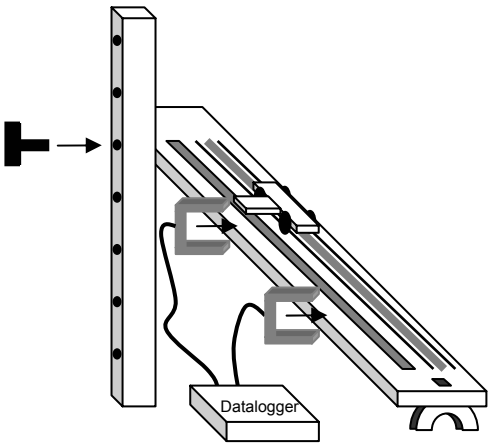
Car & Ramp: Gravity and Motion

Objective: To investigate the effects of changes in mass and slope on the car's acceleration.

Materials: Workshop Stand, Ramp, Car, Bolt, Hooked Masses, EasySense Datalogger, 2 Photogates, Balance (electronic or triple-beam).

Procedure:

1. Push the attachment bolt through the Workshop Stand, using the 5th hole from the bottom.



2. Screw the bolt into the side of the ramp, tightening the ramp against the side of the stand.
3. Push the "foot" up through the hole in the bottom of the ramp.
4. Place the car on the ramp so that the wheels rest in the grooves and the rubber bumper extends down through the hole between the grooves.
5. Orient the car so that the side flag extends over the wide hole, toward the printed scale.

Changing Mass

6. Predict what you will observe as the car's mass changes. As the car's mass increases, its speed at a constant point on the ramp will _____.
7. Measure and record the mass of the car. _____
8. Position one photogate at 30cm and another one at 70cm.
9. Program the datalogger to find the car's speed at each of the two gates.
10. Hold the car at the top of the ramp and release it. Record the speed at 30cm _____ and at 70cm _____.
11. Place a 200g mass on the car and secure it with a rubber band. Repeat the experiment and record the results in the table below.
12. Repeat with a 500g mass added.

Trial #	Added Mass	Total Mass	30cm speed	70cm speed
1	0			
2	200g			
3	500g			

13. Find the percent change in the car's mass between trials 1 and 3.

$$\%change = \frac{trial\_3\_mass - trial\_1\_mass}{trial\_1\_mass} * 100\% =$$

14. Find the percent change in the car's speed at 30cm between trials 1 and 3.

$$\%change = \frac{trial\_3\_speed - trial\_1\_speed}{trial\_1\_speed} * 100\% =$$

15. Find the percent change in the car's speed at 70cm between trials 1 and 3.

$$\%change = \frac{trial\_3\_speed - trial\_1\_speed}{trial\_1\_speed} * 100\% =$$

16. Compare the percent changes in mass and speed. Does mass seem to have a significant effect on the car's speed?

17. On a separate sheet (or using a computer), make a graph of the car's speed (y-axis) vs. the total mass (x-axis). Use different colors or symbols for the two locations.
18. Use your graph to predict the car's speed at 70cm when the added mass is 100g. _____
19. Measure the car's actual speed at 70cm when the added mass is 100g. _____
20. How accurate was your prediction? Explain.

_____
_____
_____

Changing Slope

21. Predict what you will observe as the ramp's slope changes. As the ramp's slope increases, the car's speed at each point down the ramp will _____.
22. With the ramp attached to the 5th hole from the bottom, place photogates at 30cm and 70cm.
23. Program the datalogger to find the car's speed at each of those points. Release the car and record the result in the table below.
24. Repeat the experiment for the 6th-9th holes in the stand and record the results.

Hole #	30cm speed	70cm speed
5		
6		
7		
8		
9		

25. As the slope of the ramp increases, the car's speed _____.
26. On a separate sheet (or using a computer), make a graph of the car's speed (y-axis) vs. the hole number (x-axis). Use different colors or symbols for the two locations.
27. Use your graph to predict the car's speed at 70cm when the ramp is attached to:
    a. The 3rd hole. _____
    b. The 10th hole. _____
28. Measure the car's actual speed at 70cm when the ramp is attached to:
    a. The 3rd hole. _____
    b. The 10th hole. _____
29. How accurate were your predictions? Explain.

_____
_____
_____