 NAME: ____________________

Lab 9-2: **Hot Wheels**

Purpose:
1. To define and determine the efficiency of a Hot Wheels track.
2. To determine the height from which a Hot Wheels car must be released to have it just make it around the loop-the-loop track.

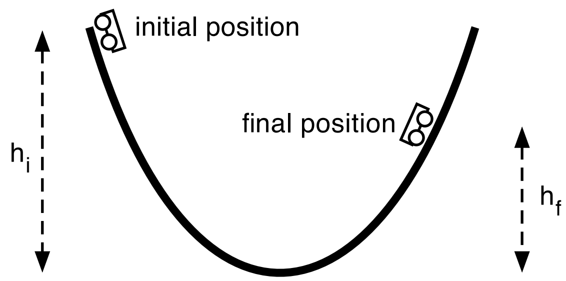

Diagram 1

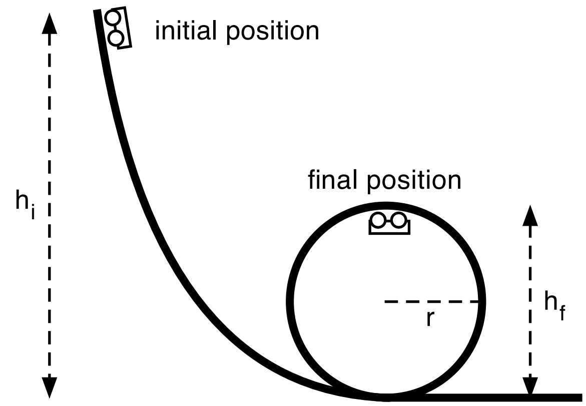

Diagram 2

Procedure:
Finding energy efficiency of track
Hot Wheels tracks don't result in perfect "potential energy turns into kinetic energy" problems as there are a lot of other kinds of energy involved. We will try and take that into account by defining the tracks effeciency.

1. Set up the Hot Wheels track in the shape of a rounded "v" as shown above in Diagram 1. Use two pieces of track and the ramp connectors. Release the car from the top of the track and determine how high up on the other side the car goes. Measure to the <u>middle</u> of the car. Record the heights below.

initial height = ____________ m   final height = ____________ m

2. Why is the final height less than the initial height?

3. In terms of energy, where else does the initial potential energy of the car go?

4. Determine the fraction of energy the car kept (i.e. the efficiency of the system) by dviding the final height by the initial height.

efficiency = ____________

5. Why did you <u>not</u> need to know the mass of the car?

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Finding minimum speed to just barely make the loop
First we will do some math and circular motion concepts to figure out how fast the car has to be moving to just barely make the loop.

6. Set up the Hot Wheels track to make a loop-the-loop (Diagram 2.) Secure the track with some tape and a stand. When it is all put together, measure the radius of the loop.

radius of loop = ____________ m

7. Now we (meaning you) have to do some algebra. When the car is at its hhighest point on the loop it is upside down. There are two forces acting on the car at that point - draw a labeled force diagram that shows those two forces.

8. In what direction is the net force and on the car at its highest point on the loop? How do you know?

9. There are two ways you can figure out the net force (combining question 7 and question 8 with your knowledge of the net force when an object is moving in a circle.) Write it out below as an equation.

10. Hopefully your answer to question 9 says something like the weight of the car plus the normal force on the car equals the centripetal force on the car. Here is an important idea: what is the normal force on the car at the top of the loop if the car just barely makes the loop?

11. So what happens to your equation from question 9? Write it out below.

12. If you did everything correctly, your equation in step 11 should say the weight of the car (mg) equals the centripetal force on the car (mv^2/r). Plug in radius of your loop, the acceleration due to gravity and solve the speed. This is the speed the car needs to have at the top of the loop to just barely make the loop.

speed at top of loop = _________________ m/s

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Finding minimum release height for car to make the loop
Now we will use energy ideas to figure out where the car needs to be released so that the car makes the loop.

13. Using letters, what would be the initial energy of the car while you are holding it up on the ramp?

14. Using letters, what would be the final energy of the car when it is at the top of the loop? (*Hint: there are two types of energy!*)

15. Since energy is conserved, combine your answers to 13 and 14 into an equation.

16. Notice the mass of the car cancels out. What is the height of the car when it is at the top of the loop?

height at top of loop = _____________ m

17. Now plug in the height at the top of the loop, the speed at the top of the loop and the acceleartion due to gravity and solve for the initial height of the car.

theoretical minimum release height = _____________ m

Let's do it!

18. Release the car from that theoretical minimum height. What happens?

19. Thinking about energy, why do you think the car did not make the loop?

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20. The car didn't make the loop because it "lost" a lot of the potential energy it had at the start to other forms of energy. We didn't take into account the efficiency of the track. So let's fix that now by using the following to more accurately predict the minimum height so that the car makes the loop:

    theoretical minimum height = efficiency of system x predicted minimum height

    (You calculated at theefficiency at the start of this lab.)

predicted minimum release height = _____________ m

21. Release the car from that predicted height. What happens?

22. Finally, experimentally figure out the minumum release height so that the car just barely makes the loop.

actual minimum release height = _____________ m

23. Did physics work?