Physics 231: General Physics I **Names:**________________________
Lab 5 – Feb. 19, 2004 ________________________

Conservation of Energy

A car must have a minimum speed to make it around a loop without losing contact with the track. If the car starts from rest, it will need to have a minimum height in order to have enough speed at the top of the loop. We will test this with a set of "Hot Wheels" cars. The car will begin a certain height up a ramp and at the bottom of the ramp go into a loop.

A. Prediction

1. Minimum speed at top of loop – This will be found using dynamics.

1. **Pre-lab** Draw and label a free-body diagram for the car at the top of the loop.

2. **Pre-lab** What direction is the acceleration at the top of the loop?

3. **Pre-lab** Write down Newton's second law for the car at the top of the loop in symbolic form.

4. **Pre-lab** Find a symbolic expression for the minimum speed (v_{min}) of the car at the top of the loop. Your answer may be in terms of the mass of the car (m), the radius of the loop (r), and the acceleration of gravity (g). (Hint: The normal force gets smaller as the speed gets smaller.)

5. Measure the radius of the loop and calculate a numerical prediction for the minimum speed in m/s.

r =________________

v_{min} =______________

2. **Minimum starting height** – The lowest starting height above the table to achieve the minimum speed at the top of the loop will be found assuming that mechanical energy is conserved.
    1. **Pre-lab** Draw a picture showing the initial and "final" (at the top of the loop) situation of the car. Label everything you know about its height and speed initially and finally. Call initial height above the ground "y_i" because it is unknown.

    2. **Pre-lab** Apply the conservation of mechanical energy and solve for the minimum starting height (y_i) <u>in symbolic form</u>.

    3. Calculate a numerical value for the minimum starting height in meters.

y_i = ________________

B. Measurement – Check your predictions. What is the lowest starting height for which the wheels of the car stay in contact with the loop?

h = ________________

C. Conclusions

1. How does your measurement compare to your prediction?

2. Choose a system. What are the objects in the system?

3. What are the forces internal to the system?

4. What are the forces external to the system?

5. Is mechanical energy conserved?

6. If not, what formula should you have used and why?

7. What other quantity would you need to know in order to apply this formula?

8. Is there an experimental way to find this quantity using the equipment at hand? Explain. Solve for the value of this quantity as a function of measurable quantities.

Pre-lab Name:___________________________

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2. **Pre-lab** What direction is the acceleration at the top of the loop?

3. **Pre-lab** Write down Newton's second law for the car at the top of the loop <u>in symbolic form</u>.

4. **Pre-lab** Find a <u>symbolic</u> expression for the <u>minimum</u> speed (v_{min}) of the car at the top of the loop. Your answer may be in terms of the mass of the car (m), the radius of the loop (r), and the acceleration of gravity (g). (Hint: The normal force gets smaller as the speed gets smaller.)

1. **Pre-lab** Draw a picture showing the initial and "final" (at the top of the loop) situation of the car. Label everything you know about its height and speed initially and finally. Call initial height above the ground "y_i" because it is unknown.

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