GUIDED INQUIRY HANGING MASS LAB

Goal: Determine how the net force on a cart affects its acceleration.

Materials (per group)

- Physics cart

- Pulley + clamp

- String (non-stretchy)

- Hanging masses (suggested: 25 g, 50 g, 75 g, 100 g, 125 g)

- Stopwatch or photogate timer

- Meter stick / tape measure

- Balance (to measure masses)

- Tape (to mark start & finish lines)

- Safety goggles (recommended)

Setup

1. Put the cart on a smooth, level track or table.

2. Attach the string to the cart and run it over the pulley; hang the masses on the free end.

3. Mark a 1.00 m travel distance along the track (Start → Finish). Use the same start and finish for every run.

4. Measure the mass of the cart (in kg) and write it down. Record the mass of each hanging weight you use (in g and convert to kg for calculations).

Procedure

1. Choose a hanging mass (start with 25 g). Make sure the string is taut, and the hanging mass hangs freely.

2. Pull the cart back so it is at the Start line and release it from rest (no push).

3. Time the run. Start timing when the front of the cart passes the Start line and stop when it passes the Finish line. Record the time as Time 1.

4. Repeat two more times (Time 2, Time 3) with the same hanging mass.

5. Change to the next hanging mass and repeat steps 1-4 until you have data for five different hanging masses. (Suggested masses: 25, 50, 75, 100, 125 g.)

6. For each hanging mass compute average time, acceleration, and force. Fill the Summary table (below).

7. Graph Force (y-axis) vs Acceleration (x-axis) and draw a best-fit line. Use the graph to answer analysis questions.

Data Table 1

Trial	Hanging Mass (g)	Distance d (m)	Time 1 (s)	Time 2 (s)	Time 3 (s)	Average Time (s)
1		1.0				
2		1.0				
3		1.0				
4		1.0				
5		1.0				

Data Table 2: Summary for Graph and Calculations

Trial	Hanging Mass (g)	Hanging Mass m_{hang} (kg)	Cart Mass (kg)	Total mass m_{total} (kg)	Force $F = m_{hang}g$ (N)	Acceleration a (m/s²)
1						
2						
3						
4						
5						

Graphing Instructions

- X-axis: Acceleration a (m/s²): use measured acceleration.

- Y-axis: Force F (N) = $m_{hang}g$.

- Plot all five points and draw a best-fit straight line.

Analysis Questions

1. What relationship between Force and Acceleration do you observe? Does your graph support F=ma? Explain.

2. How does increasing the hanging mass (force) change the acceleration? Give evidence from your data.

3. For a fixed hanging mass, how would adding mass to the cart change the acceleration? (Use data or the a_{theory} equation to support your answer.)

4. Compare measured acceleration to predicted acceleration. What are possible reasons for any differences? (Consider friction, pulley friction, timing errors, human reaction time.)

5. Which source of uncertainty had the largest effect on your results? How could the lab be improved to reduce that uncertainty?