

Work, kinetic energy and the net-work theorem

AP Physics 1 (algebra-based) · Lab

Name: _____ Date: _____ Class: _____

A hanging mass pulls a cart along a track and a light gate measures its speed. By comparing the work done on the system with its gain in kinetic energy over several distances, you test whether the net work equals the change in kinetic energy.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 3

Aim

Test the work-energy theorem by comparing the work done on a cart-and-mass system with its gain in kinetic energy.

Equipment

- Dynamics cart (mass 0.500 kg) and a level track with a pulley at one end
- Hanging mass of 0.050 kg on a light string
- Light gate and timer, or a phone recording at 120 frames per second
- Metre rule, balance, small wooden block to tilt the track

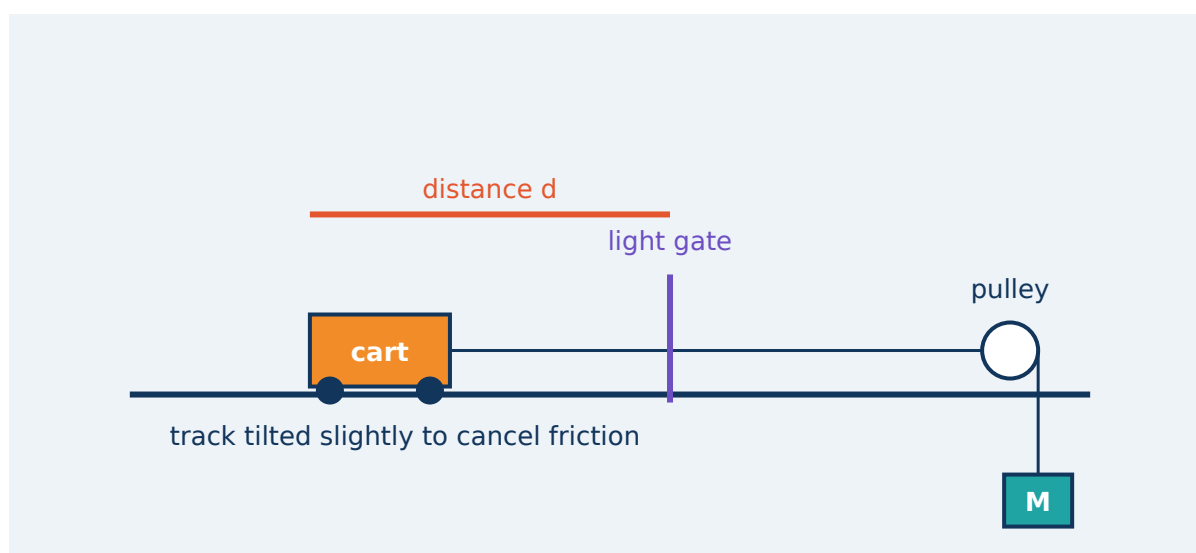
Safety

Safety

Place a soft stop at the pulley end of the track and keep feet away from the falling mass. Do not let the cart hit the pulley or fall off the bench.

Method

1. Raise the far end of the track a little until the cart, given a gentle push, rolls with constant speed. This cancels friction.
2. Connect the string over the pulley to the 0.050 kg hanging mass.
3. Release the cart from rest. Place the light gate at $d = 0.20$ m and record the speed through the gate.
4. Repeat for $d = 0.40, 0.60, 0.80$ and 1.00 m, with three trials each, and keep the average.
5. Calculate the work done on the system, $M g d$, and its kinetic energy $\frac{1}{2} (m + M) v^2$.



Set-up: the hanging mass M pulls the cart; a light gate records its speed after distance d .

Results

Sample averages (cart 0.500 kg, hanging mass 0.050 kg, $g = 9.81 \text{ N/kg}$):

Distance d (m)	Speed v (m/s)	Work $M g d$ (J)	Kinetic energy $\frac{1}{2}(m+M)v^2$ (J)	$K \div W$
0.20	0.59	0.098	0.096	0.98
0.40	0.85	0.196	0.199	1.01
0.60	1.03	0.294	0.292	0.99
0.80	1.19	0.392	0.389	0.99
1.00	1.32	0.491	0.479	0.98

Analysis questions

Question 1 Check one row

Show how the last two columns were found for $d = 0.60 \text{ m}$.

Question 2 Why the total mass

Explain why the mass in the kinetic energy is $m + M$ and not m alone.

Question 3 Plotting

Plot kinetic energy (vertical axis) against work (horizontal axis) and describe the graph.

Question 4 Gradient

Calculate the gradient through the origin and state what the theorem predicts.

Question 5 Percentage uncertainty

The speed is uncertain by ± 0.02 m/s at $d = 0.20$ m. Find the percentage uncertainty in K there.

Question 6 Friction effect

Predict, with a reason, what the $K \div W$ values would be if the track were not tilted.

Question 7 Improvement

Suggest one improvement that would allow a better test over a wider range.