

Elastic and inelastic collisions with centre of mass

AP Physics 1 (algebra-based) · Lab

Name: _____ Date: _____ Class: _____

When two carts stick together, how much momentum and how much kinetic energy is left? You time a cart over a fixed distance before and after it hooks onto a stationary one, convert the times to speeds, and compare momentum and energy for three trials with different starting speeds.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 4

Aim

To test whether momentum is conserved and to measure the fraction of kinetic energy retained when a moving dynamics cart sticks to a stationary one.

Equipment

- Two dynamics carts of masses 0.50 kg and 0.25 kg, one with a hook-and-loop strip on each facing end
- Level track at least 1.5 m long
- Timer with two light gates, or a phone video and a stopwatch app
- Card of length 0.040 m, balance, metre rule

Safety

Safety

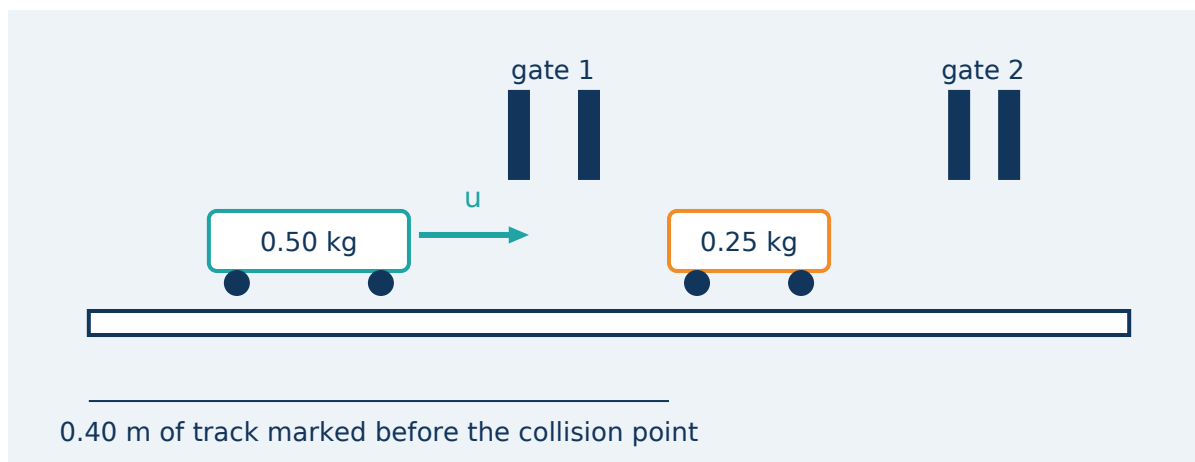
Stop the carts with your hand before they reach the end of the track so they cannot fall to the floor. Keep fingers away from the gap between the carts when they meet, and keep feet clear of the floor below the track.

Method

1. Measure the mass of each cart. Level the track by checking that a cart placed at rest does not drift.
2. Place the 0.25 kg cart at rest at the collision point, hook-and-loop strip facing the incoming cart.
3. Push the 0.50 kg cart so that it crosses a marked 0.40 m stretch in front of the collision

point. Record the time t before for this stretch.

4. After the carts stick, record the time t after for the pair to cover the next 0.40 m.
5. Repeat for three different push speeds and calculate the speeds u and v .



The moving cart is timed over 0.40 m before and the joined carts over 0.40 m after.

Results

Sample measurements (0.40 m timed each time):

Trial	t before (s)	t after (s)	u (m/s)	v (m/s)
1	0.50	0.76	0.800	0.526
2	0.40	0.61	1.000	0.656
3	0.32	0.49	1.250	0.816

Analysis questions

Question 1 Momentum before and after

Using the sample table, calculate the momentum before and after for each trial.

Question 2 Percentage difference

Calculate the percentage difference between p_{after} and p_{before} for each trial and state whether momentum is conserved within a reasonable uncertainty.

Question 3 Energy retained

Calculate the kinetic energy before and after for each trial, and the fraction retained. Compare with the theoretical value $m_1 \div (m_1 + m_2)$.

Question 4 Graph of momentum

Describe the graph of p_{after} against p_{before} and say what gradient you expect. Explain what the

intercept should be.

Question 5 Timing uncertainty

The timer has an uncertainty of ± 0.01 s. Calculate the percentage uncertainty in u for trial 1 and in the momentum before.

Question 6 Why is p after slightly low?

Suggest a systematic error that makes p_{after} slightly smaller than p_{before} and explain how to reduce it.

Question 7 Centre of mass check

Calculate the velocity of the centre of mass of the two carts before the collision in trial 1 and compare it with the measured speed after the collision.