

How momentum is conserved in collisions

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

Does the total momentum of two trolleys stay the same when one hits the other and they couple? You will time a trolley before and after a collision, calculate the momenta, and compare them, including the effect of friction and timing uncertainty. It can be done with toy cars at home.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS2-2, HS-PS2-3

Aim

To test whether the total momentum of two trolleys is the same before and after they couple together.

Equipment

- Two dynamics trolleys or toy cars with Velcro or plasticine on the ends
- Smooth, level runway at least 1.5 m long
- Kitchen scale or balance (to 0.01 kg)
- Metre rule and masking tape
- Phone with slow-motion video, or a stopwatch
- Spare masses to add to a trolley

Safety

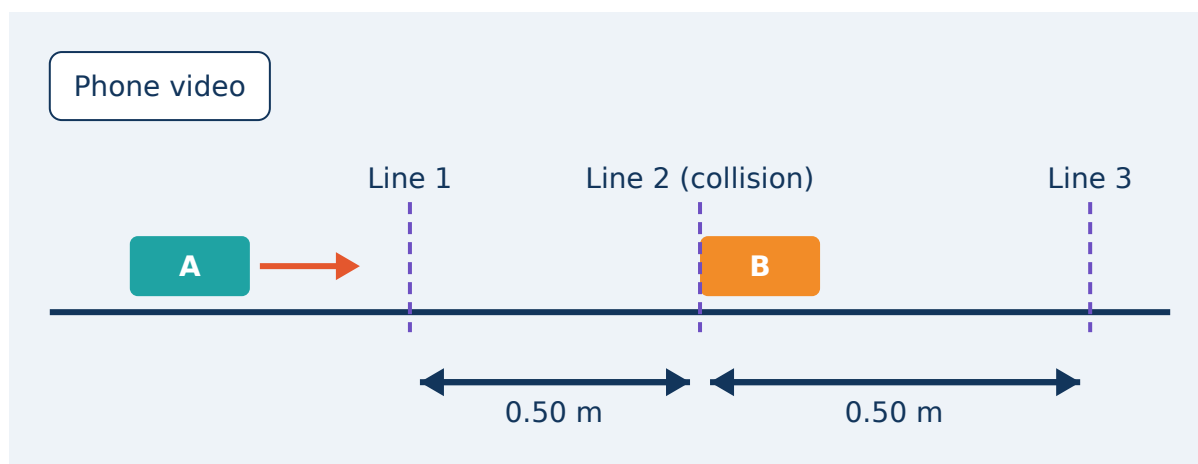
Safety

Keep trolleys away from the table edge, catch them with a soft stop at the end of the runway, and keep feet clear of the floor path.

Method

1. Measure the mass of each trolley and add masses where needed.
2. Stick three tape lines on the runway: line 1, line 2 and line 3, each 0.50 m apart.
3. Place trolley B at rest on line 2.
4. Push trolley A so it moves steadily through line 1 and hits B.
5. Film the run and read the time A takes from line 1 to line 2 (time before).
6. Read the time the coupled pair takes from line 2 to line 3 (time after).

7. Repeat with different masses and speeds, and record every run.



Set-up: time A between lines 1 and 2, then time the coupled pair between lines 2 and 3.

Results

Sample measurements (distance for each timed section 0.50 m, time read to ± 0.02 s).

Run	Mass A (kg)	Mass B (kg)	Time before (s)	Time after (s)
1	0.50	0.50	0.40	0.84
2	0.50	0.50	0.55	1.14
3	0.50	1.00	0.45	1.40
4	1.00	0.50	0.45	0.70

Analysis questions

Question 1 Speeds in run 1

1. Calculate speed before and after for run 1.
2. Repeat for run 3.

Question 2 Momentum before and after

Calculate the total momentum before and after the collision for each of the four runs.

Question 3 Percentage retained

Calculate the percentage of the initial momentum found after the collision in each run, and the mean.

Question 4 Conclusion

State whether the results support conservation of momentum. Use the percentages to justify

your answer.

Question 5 Why less than 100 %

Explain why every run gives slightly less momentum after the collision.

Question 6 Timing uncertainty

The time is read to ± 0.02 s. Calculate the percentage uncertainty in the time before for run 1 and in the time after for run 1.

Question 7 Improving the lab

Suggest two changes that would improve the accuracy of the results.