

4.3.84 Core Practical 10 — analysing 2D collisions with ICT

In this practical you record a video of two small spheres colliding on a flat surface, then use video-analysis software to measure their positions frame-by-frame. The aim is to test whether linear momentum is conserved in two dimensions.

Method

1. Set up a smooth horizontal surface (e.g. an air table or glass plate) with a scale bar visible in the frame. Mark a reference grid on the surface.
2. Mount a camera directly above the surface (top-down view) to avoid parallax. Set the camera to a high frame rate (at least 60 fps).
3. Place one sphere at rest. Flick the second sphere towards it at an angle that will produce a clear glancing collision.
4. Record video. Import into tracking software (<https://simpliphys.com/alevel/simulations/collision>).
5. For each sphere, step through the video frame by frame and mark the position. The software outputs (x, y) coordinates against time.
6. Calculate velocity components from the gradients of the x–t and y–t graphs, just before and just after the collision.
7. Compute total momentum in each direction before and after, using $p = m v$ for each sphere. Compare.

Why ICT?

Video analysis measures two components of position simultaneously — perfect for 2D problems.

Frame timing is precise (1/60 s or better), so velocities are measured with low timing uncertainty.

Data is archived — you can re-analyse a single collision many times without re-running the experiment.

Evaluation points

A top-down camera removes perspective distortion. The scale bar in the frame lets you convert pixel measurements to metres. Friction and spin mean the 'conservation' check is never exact — expect agreement to a few percent, not perfect equality. Repeat with spheres of different masses to test that the result does not depend on the choice of objects.

4.3.84 Practice — Core Practical 10

1 Explain why the camera must be mounted vertically above the surface, not at an angle. [2]

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2 A student measures the velocity components of two spheres before and after a collision. The table below shows the results. Determine whether momentum is conserved in the x direction.

[3]

Sphere A: mass 0.050 kg, v_x before = +0.80 m s⁻¹, v_x after = +0.30 m s⁻¹

Sphere B: mass 0.070 kg, v_x before = 0, v_x after = +0.35 m s⁻¹

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3 Explain one source of random uncertainty and one source of systematic error in this experiment.

[4]

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4 State one advantage of using video analysis rather than light gates for this type of experiment. [1]

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