

Measuring Momentum and Position I

Apparatus

marbles, slide, carbon paper and paper

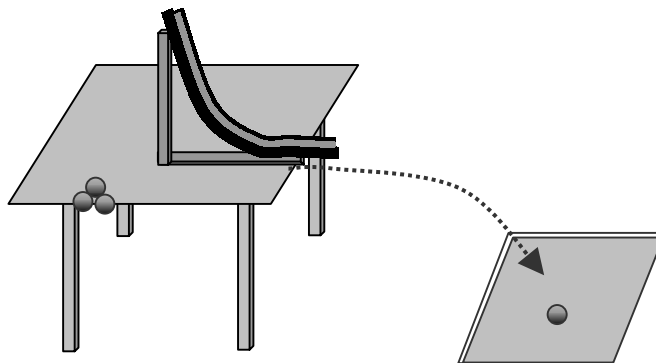
The slide is mounted on a table such that a marble released at the top slides down and is ejected horizontally from the end of the slide. The marble falls and hits the carbon paper, which leaves a mark on the paper beneath it.

Action

The students release the marbles from the top of the slide, and using the mark on the paper from the carbon paper they calculate the horizontal momentum of the marble just prior to the collision. The students need to know the mass of the marble and the height of the desk.

The Physics

When the marble is released from the top of the slide it rolls down, gathering momentum as it falls. As it leaves the end of the slide it has horizontal velocity v . It is accelerated vertically due to gravity, and hits the floor at a time $t = \left(\frac{2h}{g}\right)^{1/2}$ after it leaves the end of the slide, where h is the height of the end of the slide above floor level. The collision with the floor/paper changes the momentum of the marble, hence this measurement is of the position of the marble, and we can infer from it the momentum prior to the measurement, but not during the measurement.



Accompanying sheet:

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Use the apparatus to find the horizontal momentum of the marble during its flight.

How has your measurement affected the position and momentum of the marble?

Do you know both position and momentum simultaneously?
If so, does this contradict the uncertainty principle?