

## Measuring Momentum and Position II

### Apparatus

marbles, slide, web cam or light gate or other passive detector

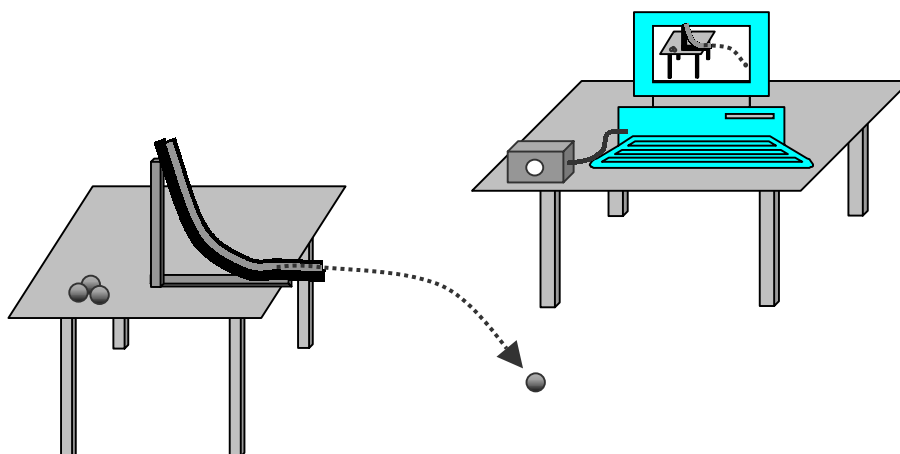
The slide is mounted on a table such that a marble released at the top slides down and is ejected horizontally from the end of the slide. The camera is used to take a picture when the marble reaches a certain height, or a light gate or some other sort of sensor which uses light to tell when the marble reaches a particular height.

### Action

The students release the marbles from the top of the slide, and using the sensor can calculate the momentum and position of the marble at a given point.

### 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 at a time  $t = (\frac{2h}{g})^{1/2}$  after it leaves the end of the slide it has fallen a distance  $h$ . Knowing the horizontal distance it has traveled in this time, we can find both the marble's momentum and position. In this case the measurement has not significantly affected the momentum, however if the object were an electron, the scattering the light used to make the measurement would have had a significant effect.



### Accompanying sheet:

## Measuring Momentum and Position II

Use the apparatus to measure the time at which the marble passes a given point.

What effect has your measurement had on the marble's position and momentum?

Do you need to take the uncertainty principle into account in this experiment?

How would it be different if you were measuring the momentum of an electron using this sort of apparatus?