MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Physics

Physics 8.01X Fall Term 2002

STROBE A FALLING BALL

The **direction** of the acceleration vector of gravity is **down**. What is its **magnitude**?

In class on Friday, Mark dropped the ball as a strobe light flashed on it and a photographic exposure was taken of the ball's drop.

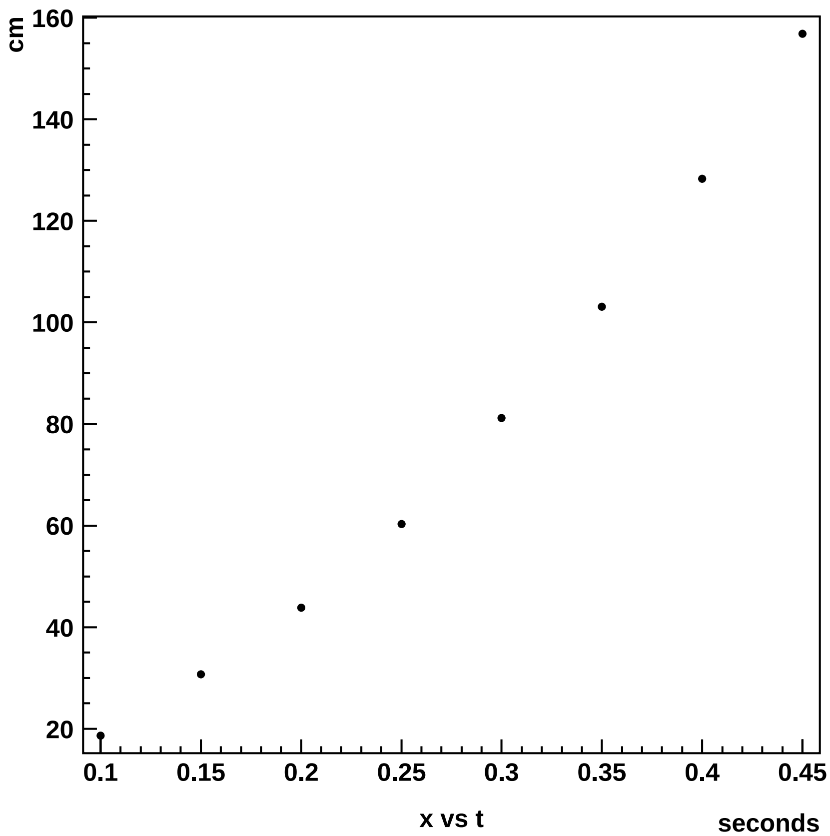
The frequency of the strobe was 20 Hertz, or 20 times per second. Therefore the time between flashes was $1/20 = 0.05$ seconds. The distance between the white lines on the background board was 25 cm. We now have enough information to calculate the magnitude of the acceleration of gravity from the photograph!

First, we choose a coordinate system with positive x going down. The first column in the table is the time t, starting at zero near the top. (Does it matter where we choose zero for x? For t?).

t s	Δt s	x cm	Δx cm	$v_{avg} = \frac{\Delta x}{\Delta t}$ cm/s
0.05	0.05	18.6	8.7	175
0.1	0.05	30.7	12.1	241
0.15	0.05	43.9	13.2	263
0.2	0.05	60.3	16.5	329
0.25	0.05	81.2	20.8	417
0.3	0.05	103.1	21.9	439
0.35	0.05	128.3	25.2	505
0.4	0.05	156.8	28.5	572

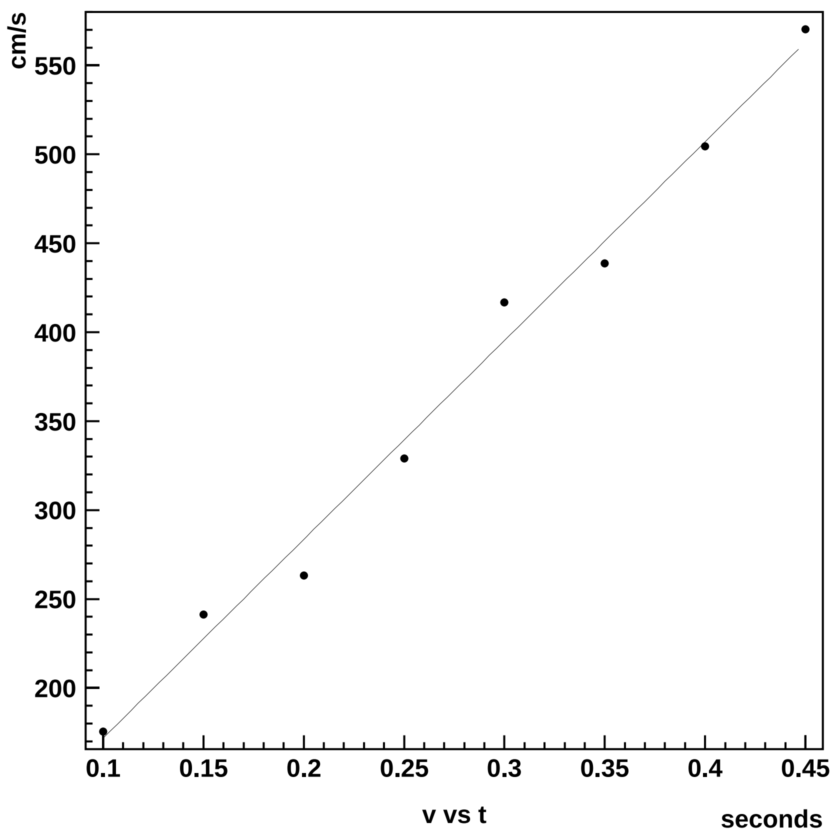
The next column is Δt, the time difference since the last flash. The next column, x, is filled by measuring with a ruler the distance from the top of the board of the ball's image on the photograph, and then converting to cm knowing that 1 division is 25 cm. Δx is the displacement in the interval, and then $v_{avg} = \frac{\Delta x}{\Delta t}$ is the average velocity for the past interval.

The following plot shows x vs t: a parabola.



The next plot shows v_{avg} vs t: a straight line.

The slope of this line should give roughly the magnitude of the acceleration of gravity. (Note that v_{avg} for the preceding interval is an approximation to the instantaneous velocity at time t.) I did a fit to this straight line using a computer: the slope of it is 1120 cm/s^2, which is rather more than 10% off the known value of 980 cm/s^2. That's probably reasonable within expected error for this rough data and analysis. What sources of error can you think of? Do you think we have under or overestimated g with this method? Can you think of a more accurate way to get g from the same data?



In your "Falling Object" experiment of next week you will use a slightly different method to calculate the magnitude of $\vec{g}$, and you will do a more careful analysis, including error estimates.