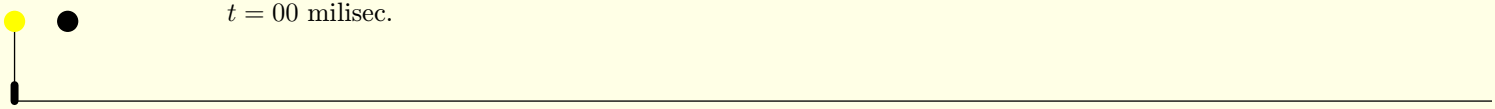
Lamp and shadow of falling ball

A strong light shines from the top of a pole 15 m high. A ball is dropped from the same height from a point 10 m away from the light. How fast is the shadow of the ball moving along the ground 1/2 sec later? Assume that the ball falls a distance $s = 5t^2$ meters in t seconds.



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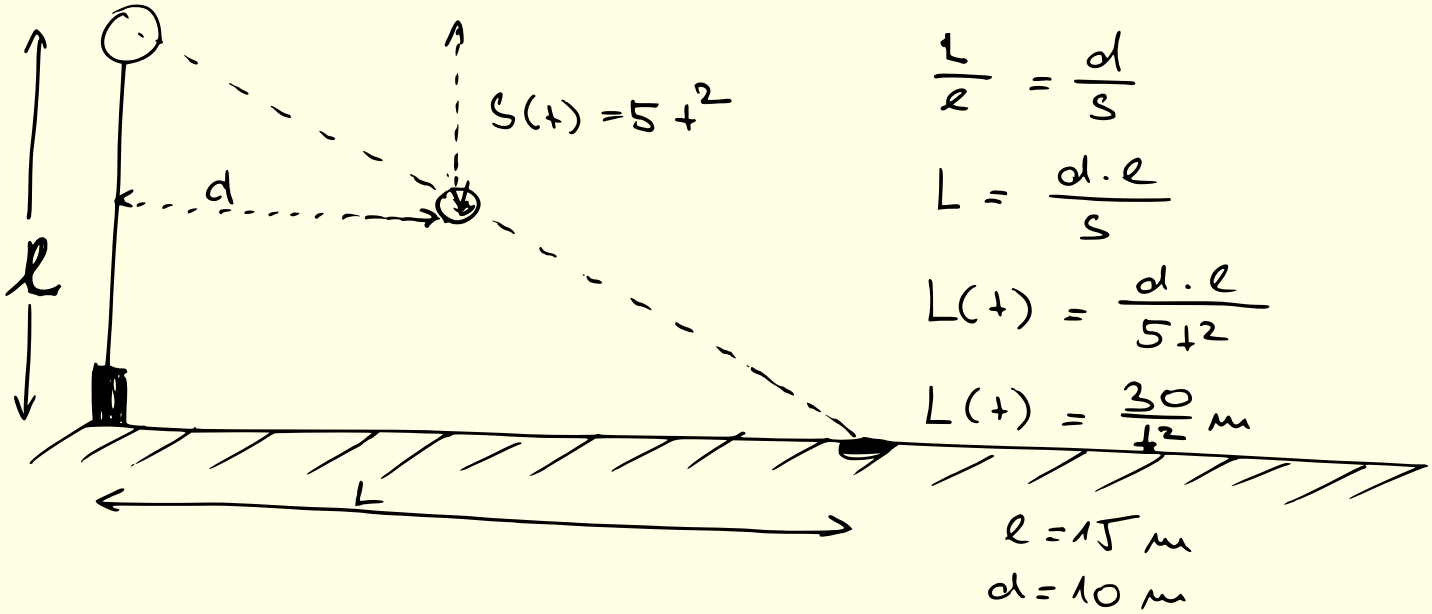
Delay .9

Positions of the shadow at the time 500 miliseconds and 510 miliseconds give a rough estimate of the velocity of the shadow. Estimate this velocity from the animation and then continue on the next page.



From rigth triangles we find the distance L between the pole and the shadow as a functino of time: $L(t) = \dfrac{30}{t^2}$ m. The shadows moves by velocity

$$\frac{dL}{dt} = -2\frac{30}{t^3} = -\frac{60}{t^3}.$$

The velocity in time $1/2$ sec is

$$\left.\frac{dL}{dt}\right|_{t=0.5} = -\frac{60}{0.125} = -480\,\mathrm{ms}^{-1}.$$