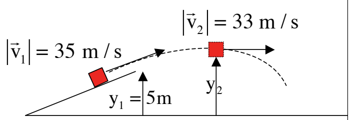
Problem 5.25

Motorcycle leaves a 30° ramp 5 meters above the ground moving at 35 m/s. If its speed is 33 m/s at the top, what must his height be at the top?



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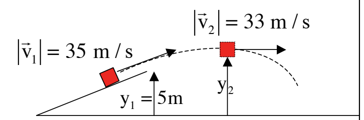

What you were asked to do, though, was to approach the problem without using kinematics or the work/energy theorem. The only other way to do it is to use the re-jiggering of the work/energy theorem that comes in the form of the conservation of energy. Doing that yields (note that the masses cancel):

$$\sum KE_1 + \sum U_1 + \sum W_{extraneous} = \sum KE_2 + \sum U_2$$

$$\frac{1}{2}mv_1^{\,2} + (mgy_1) + \quad 0 \quad = \frac{1}{2}mv_{top}^{\,2} + (mgy_{top})$$

$$\Rightarrow \quad y_{top} = \frac{\frac{1}{2}v_1^{\,2} + (gy_1) - \frac{1}{2}v_{top}^{\,2}}{g}$$

$$\Rightarrow \quad y_{top} = \frac{\frac{1}{2}(35\text{ m/s})^2 + (9.8\text{ m/s}^2)(5\text{ meters}) - \frac{1}{2}(33\text{ m/s})^2}{(9.8\text{ m/s}^2)}$$

$$\Rightarrow \quad y_{top} = 11.94\text{ meters}$$

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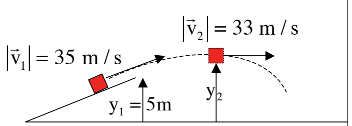

If you wanted to use the work/energy theorem, you would have to determine the amount of work gravity did as the motorcycle went from y_1 = 5m to y_2 = unknown meters. In fact, you'd be trying to determine the unknown y. Noting the m's cancel:

$$W_{net} = \Delta KE$$

$$W_{gravity} = \frac{1}{2}mv_{top}^{\,2} - \frac{1}{2}mv_1^{\,2}$$

$$\Rightarrow \quad mg(y_{top} - y_1)\cos 180^\circ = \frac{1}{2}mv_{top}^{\,2} - \frac{1}{2}mv_1^{\,2}$$

$$\Rightarrow \quad y_{top} = \frac{\frac{1}{2}v_{top}^{\,2} - \frac{1}{2}v_1^{\,2} - gy_1}{-g}$$

$$\Rightarrow \quad y_{top} = \frac{\frac{1}{2}(33\text{ m/s})^2 - \frac{1}{2}(35\text{ m/s})^2 - (9.8\text{ m/s}^2)(5\text{ meters})}{-(9.8\text{ m/s}^2)}$$

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