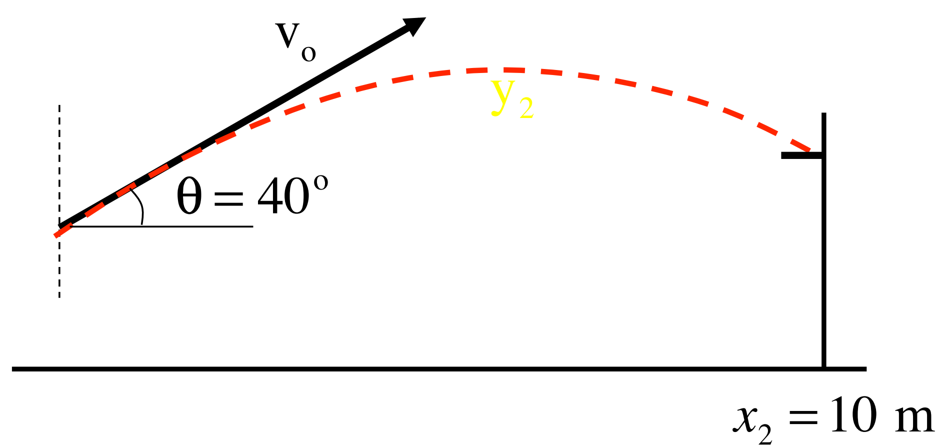
Problem 3.58

A basketball is shot 2.0 meters above floor level at an angle of $\theta = 40^{o}$. It goes through the basket 10.0 meters away where the basket is 3.05 meters above the court. How fast must the ball initially be moving?



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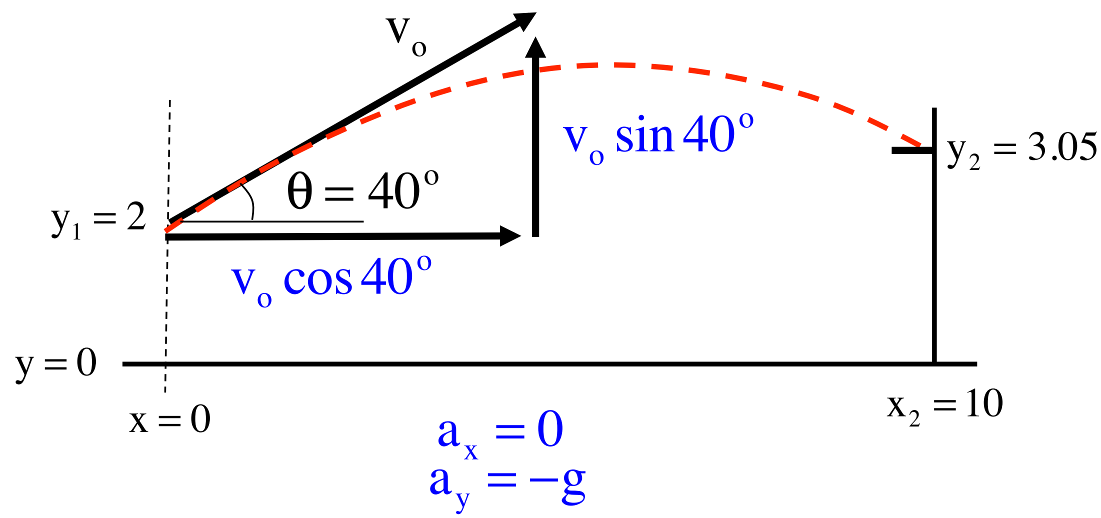
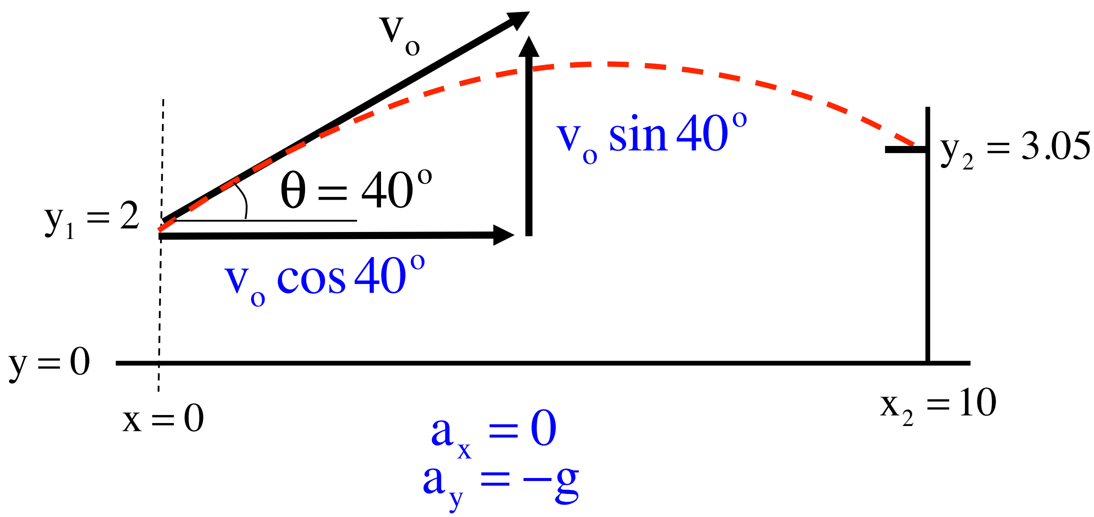




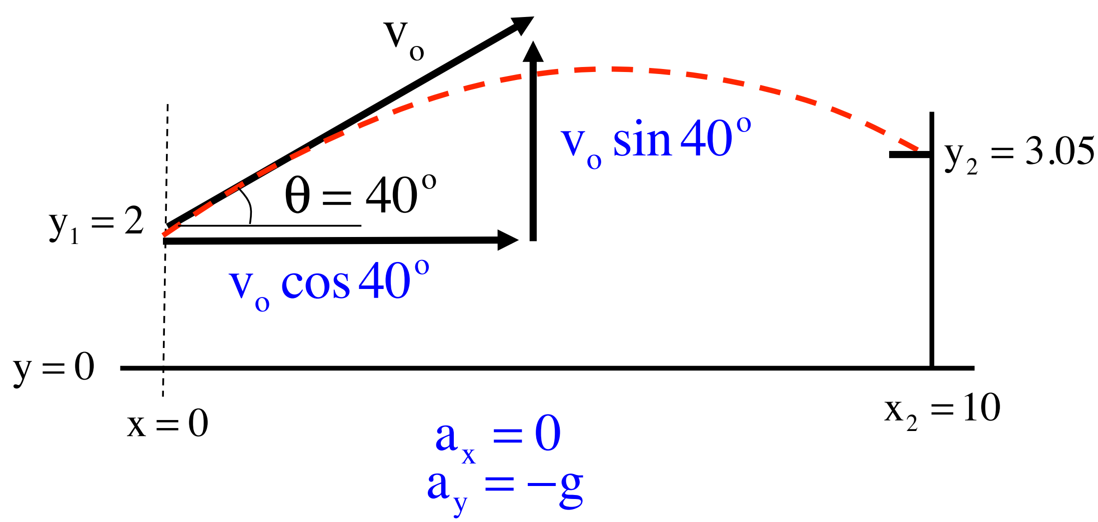
The standard equation for the x-direction in most cases is:

$$x_2 = x_1 + v_{1,x}(\Delta t) + \left(\frac{1}{2}\right)a_x(\Delta t)^2$$

$$= \left(v_0 \cos 40^o\right)t$$

$$\Rightarrow \quad 10 = .766 v_0 t$$

$$\Rightarrow \quad 13.05 = v_0 t$$



The standard equation for the y-direction in most cases is:

$$y_2 = y_1 + v_{1,y}(\Delta t) + \left(\frac{1}{2}\right)a_y(\Delta t)^2$$

$$y_2 = y_1 + \left(v_0 \sin 40^o\right)(\Delta t) + \left(\frac{1}{2}\right)(-g)(\Delta t)^2$$

$$\Rightarrow \quad 3.05 = 2 + (.643v_0)t + \left(\frac{1}{2}\right)(-9.8)t^2$$

$$\Rightarrow \quad 1.05 - .643v_0 t + 4.9t^2 = 0$$

If this was a test problem, deriving the two equations in red (previous pages) would be 90% of the problem. Actually solving in this case is tricky. Noting from the first equation that:

$$13.05 = v_0 t$$

We can substitute that into our second equation getting:

$$1.05 - .643 v_0 t + 4.9t^2 = 0$$

$$\Rightarrow 1.05 - .643(13.05) + 4.9t^2 = 0$$

$$\Rightarrow \quad t = 1.22 \text{ seconds}$$

And with that, we can write:

$$13.05 = v_0 t \quad \Rightarrow \quad v_0 = \frac{13.05}{t} = \frac{13.05}{1.22}$$

$$= 10.7 \text{ m/s}$$