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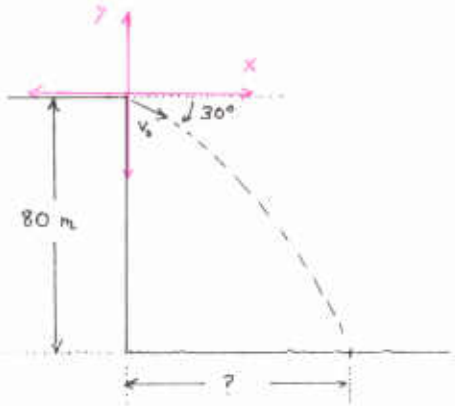
Phys 221 (Section 6)
Quiz #2



1. A projectile is fired from a height of 80 m at an angle of 30° downward from the horizontal. It hits the ground 1.5 s later.

a) What was the initial speed (v_0) of the projectile?

Use the y equation of motion. If the projectile starts at the origin, then $y = (-v_0 \sin 30°)t - \frac{1}{2}gt^2 = -0.5\,v_0 t - \frac{1}{2}(9.8\,\frac{m}{s^2})t^2$

We know that $y = -80$ m when $t = 1.5$ s, so

$-80\text{ m} = -0.5\,v_0(1.5\text{s}) - (4.9\,\frac{m}{s^2})(1.5\text{s})^2$

$\rightarrow$ $(0.5)v_0(1.5\text{s}) = 69.0$ m $\rightarrow$ $\boxed{v_0 = 92.0\,\frac{m}{s}}$

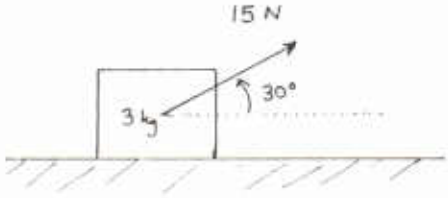
b) What horizontal distance did the projectile travel during its flight?

Use the x equation of motion:

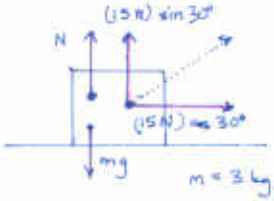
$x = (v_0 \cos 30°)t = (92.0\,\frac{m}{s})(\cos 30°)\,t = (79.6\,\frac{m}{s})\,t$

At $t = 1.5$ s (time of impact), $x = (79.6\,\frac{m}{s})(1.5\text{s}) = \boxed{119\text{ m}}$, the "horizontal distance" traveled.

2. A 3.0 kg block is pulled over a horizontal surface by a 15 N force directed at 30° above the horizontal.



a) If the surface is smooth (*i.e.* frictionless) what is the acceleration of the block?

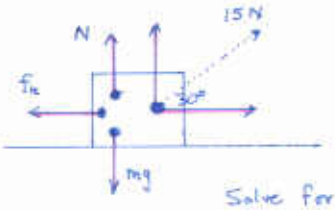


Forces on the block are as shown here with the 15 N force resolved into components. There is no net vertical force, only a net horizontal force, which is

$F_{x,\text{net}} = (15\text{ N})(\cos 30°) = 13.0\text{ N} = ma_x$

So the acceleration is $a_x = \frac{(13.0\text{ N})}{m} = \frac{(13.0\text{ N})}{(3\text{ kg})} = \boxed{4.33\,\frac{m}{s^2}}$

b) If instead it is a *rough* surface and the acceleration is found to be $a = 2.6\frac{\text{m}}{\text{s}^2}$, what is the coefficient of kinetic friction for the block and surface?



Now there is an additional frictional force on the block, of magnitude $f_k = \mu_k N$ which is directed opposite to the motion. Again there is no net vertical force so

$N + (15\text{ N})(\sin 30°) - mg = 0$

So $N = (3\text{ kg})(9.8\,\frac{m}{s^2}) - (15\text{ N})\sin 30° = 21.9$ N, normal force between block & surface.

The net horizontal force is

$(15\text{ N})\cos 30° - f_k = (15\text{ N})\cos 30° - \mu_k N = ma_x = (3\text{ kg})(2.6\,\frac{m}{s^2}) = 7.8$ N

Solve for μ_k: $-\mu_k(21.9\text{ N}) = 7.8\text{ N} - (15\text{ N})\cos 30° = -5.19$ N $\rightarrow$ $\boxed{\mu_k = 0.237}$

$x = x_0 + v_0 t + \frac{1}{2}at^2$ $\quad v = v_0 + at$ $\quad v^2 = v_0^2 + 2a(x - x_0)$ $\quad x = x_0 + \frac{1}{2}(v_0 + v)t$

$g = 9.8\,\frac{\text{m}}{\text{s}^2}$ $\quad \mathbf{F} = m\mathbf{a}$ $\quad f_k = \mu_k N$ $\quad$ **Show your work!**