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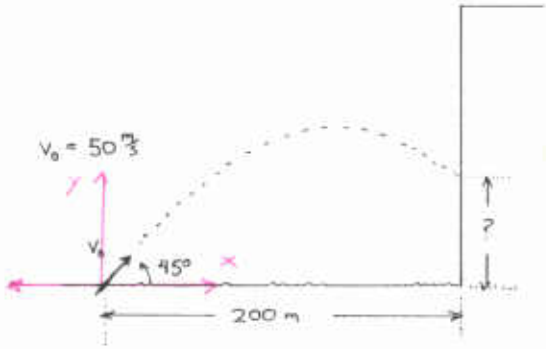
Phys 221 (Section 8)
Quiz #2

1. A projectile is fired from ground level, with an initial speed $v_0 = 50\frac{\text{m}}{\text{s}}$, directed at 45° above the horizontal. It is fired toward a tall building; the launcher is 200 m from its base. (See figure).



a) How long does it take the projectile to strike the building? Use the x equation of motion:

$x = (50\frac{m}{s})(\cos 45°)t = (35.4\frac{m}{s})t$

The projectile strikes the building when $x = 200$ m. Solving for t,

$200\text{ m} = (35.4\frac{m}{s})t \implies$ **$t = 5.66$ s**

b) At what height will the projectile strike the building?

Use the y equation of motion:

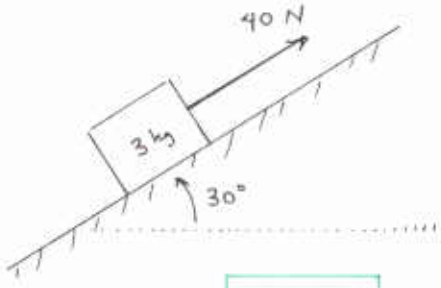
$y = (50\frac{m}{s})(\sin 45°)t - \frac{1}{2}gt^2 = (35.4\frac{m}{s})t - \frac{1}{2}gt^2$

Find the value of y at $t = 5.66$ s (time of impact)

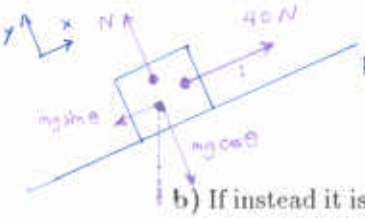
$y = (35.4\frac{m}{s})(5.66\text{s}) - (4.9\frac{m}{s^2})(5.66\text{ s})^2 =$ **43.0 m**

This is the height at which the projectile strikes the building.

2. A 3.0 kg mass is pulled up a 30° inclined surface by a force of 40 N. (This force is directed parallel to the incline.)



a) If the surface is smooth (*i.e.* frictionless) what is the acceleration of the mass? Forces on the block are as shown. The components perp to the slope must sum to zero but the components par. to the slope give



$F_{x,\text{net}} = 40\text{N} - mg\sin\theta$

$= 40\text{N} - (3\text{ kg})(9.8\frac{m}{s^2})\sin 30° =$ **25.3 N**

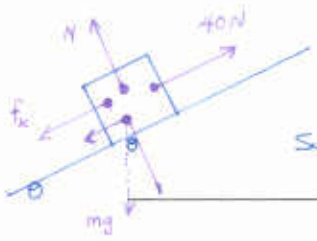
$= ma_x \implies a_x = \frac{25.3\text{ N}}{m} = \frac{25.3\text{ N}}{3\text{ kg}} =$ **$8.43\frac{m}{s^2}$**

Here, x axis runs up the slope

b) If instead it is a *rough* inclined surface and the acceleration is found to be $a = 5.9\frac{\text{m}}{\text{s}^2}$, what is the coefficient of kinetic friction for the block and surface?

Now there is an additional friction force, of magnitude $f_k = \mu_k N$ and directed opposite the motion, i.e. down the slope. Again, the perpendicular forces sum to zero so

$N - mg\cos\theta = 0 \implies N = mg\cos\theta = (3\text{ kg})(9.8\frac{m}{s^2})\cos 30° =$ **25.5 N**



The net force parallel to the surface is

$(40\text{ N}) - mg\sin\theta - f_k = (40\text{ N}) - 14.7\text{ N} - \mu_k(25.5\text{ N}) = ma_x = (3\text{ kg})(5.9\frac{m}{s^2})$

$= 17.7$ N

Solving for μ_k, **$\mu_k = 0.298$**

$x = x_0 + v_0t + \frac{1}{2}at^2 \qquad v = v_0 + at \qquad v^2 = v_0^2 + 2a(x - x_0) \qquad x = x_0 + \frac{1}{2}(v_0 + v)t$

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