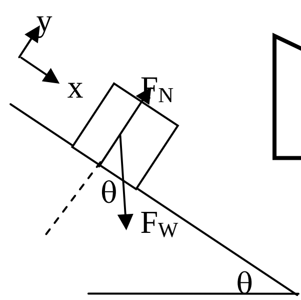
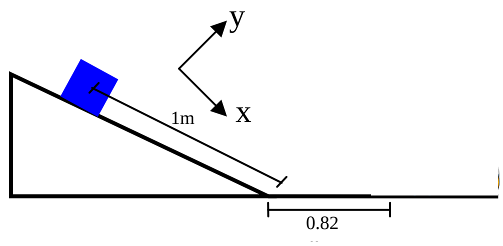
Name______________________________________

Physics 120 Quiz #4, April 27, 2007

1a. A block of mass *2 kg* initially located *1 m* from the bottom of the frictionless ramp inclined at a *30*^{o} angle, as shown below. Using the coordinate system show, and from a carefully labeled free body diagram, what is the acceleration of the block along the ramp? (4)





$$\sum F_x: \quad mg\sin\theta = ma_x \rightarrow a_x = g\sin\theta = 9.8\tfrac{m}{s^2}\times\sin 30 = 4.9\tfrac{m}{s^2}$$

$$\sum F_y: \quad F_N - mg\cos\theta = ma_y = 0 \rightarrow F_N = mg\cos\theta$$

1b. If the block is *launched up the ramp* with an initial speed of *1.5 m/s*, how far from the *bottom of the ramp* will it be when it stops rising? (2)

$$v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x \rightarrow 0 = \left(-1.5\tfrac{m}{s}\right)^2 + 2\times 4.9\tfrac{m}{s^2}\times\left(-d\right) \rightarrow d = 0.23m$$

From bottom of ramp, distance $= 1.23m$.

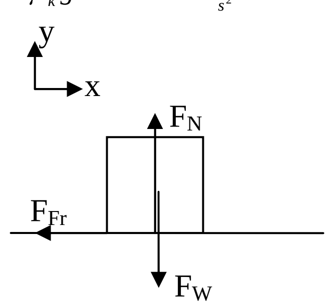
1c. If the speed of the block at the bottom of the ramp is *3.47 m/s* and travels for *0.82 m* along a rough patch along the ground ($\mu_k = 0.31$) what will be the speed of the block as it exits this rough patch? (Hint: You will need to draw a free body diagram for the block on the rough patch and calculate the acceleration of the block across the rough patch.) (4)

$$\sum F_x: \quad -F_{Fr} = ma_x \rightarrow a_x = \frac{-F_{Fr}}{m} = \frac{-\mu_k F_N}{m} = \frac{-\mu_k mg}{m} = -\mu_k g = 0.31\times 9.8\tfrac{m}{s^2} = -3.04\tfrac{m}{s^2}$$

$$\sum F_y: \quad F_N - F_W = ma_y = 0 \rightarrow F_N = F_W = mg$$

$$v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x \rightarrow 0 = \left(3.47\tfrac{m}{s}\right)^2 - 2\times 3.04\tfrac{m}{s^2}\times\left(0.82m\right)$$

$$\therefore v_{fx} = 2.66\tfrac{m}{s}$$



Useful formulas:

Motion in the x, y or z-directions

$r_f = r_0 + v_{0r}t + \frac{1}{2}a_r t^2$

$v_{fr} = v_{ir} + a_r t$

$v_{fr}^2 = v_{ir}^2 + 2a_r \Delta r$

Uniform Circular Motion

$a_r = \frac{v^2}{r}$

$F_r = ma_r = m\frac{v^2}{r}$

$v = \frac{2\pi r}{T}$

$F_G = G\frac{m_1 m_2}{r^2}$

Geometry /Algebra

Circles	*Triangles*	*Spheres*
$C = 2\pi r$	$A = \frac{1}{2}bh$	$A = 4\pi r^2$
$A = \pi r^2$		$V = \frac{4}{3}\pi r^3$

Quadratic equation: $ax^2 + bx + c = 0$,

whose solutions are given by: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Vectors

magnitude of a vector $= \sqrt{v_x^2 + v_y^2}$

direction of a vector $\rightarrow \phi = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

Useful Constants

$g = 9.8\,m/s^2$ $\quad G = 6.67\times10^{-11}\,Nm^2/kg^2$

$N_A = 6.02\times10^{23}\,atoms/mole$ $\quad k_B = 1.38\times10^{-23}\,J/K$

$\sigma = 5.67\times10^{-8}\,W/m^2K^4$ $\quad v_{sound} = 343\,m/s$ $\quad P_{air} = 1.013\times10^5\,N/m^2$

Linear Momentum/Forces

$\vec{p} = m\vec{v}$

$\vec{p}_f = \vec{p}_i + \vec{F}\Delta t$

$\vec{F} = m\vec{a}$

$\vec{F}_s = -k\vec{x}$

$F_f = \mu F_N$

Work/Energy

$K_t = \frac{1}{2}mv^2$

$K_r = \frac{1}{2}I\omega^2$

$U_g = mgh$

$U_S = \frac{1}{2}kx^2$

$W_T = FdCos\,\theta = \Delta E_T$

$W_R = \tau\theta = \Delta E_R$

$W_{net} = W_R + W_T = \Delta E_R + \Delta E_T$

Rotational Motion

$\theta_f = \theta_i + \omega_i t\,\frac{1}{2}\alpha t^2$

$\omega_f = \omega_i + \alpha t$

$\omega^2{}_f = \omega^2{}_i + 2\alpha\Delta\theta$

$\tau = I\alpha = rF$

$L = I\omega$

$\Delta s = r\Delta\theta:\ v = r\omega:\ a_t = r\alpha$

$a_r = r\omega^2$

Simple Harmonic Motion/Waves

$\omega = 2\pi f = \frac{2\pi}{T}$

$T_S = 2\pi\sqrt{\frac{m}{k}}$

$T_P = 2\pi\sqrt{\frac{l}{g}}$

$v = \pm\sqrt{\frac{k}{m}}A\left(1 - \frac{x^2}{A^2}\right)^{\frac{1}{2}}$

$x(t) = A\sin\left(\frac{2\pi t}{T}\right)$

$v(t) = A\sqrt{\frac{k}{m}}\cos\left(\frac{2\pi t}{T}\right)$

$a(t) = -A\frac{k}{m}\sin\left(\frac{2\pi t}{T}\right)$

$v = f\lambda = \sqrt{\frac{F_T}{\mu}}$

$f_n = nf_1 = n\frac{v}{2L}$

$P = \frac{1}{2}\omega^2\mu vA^2$