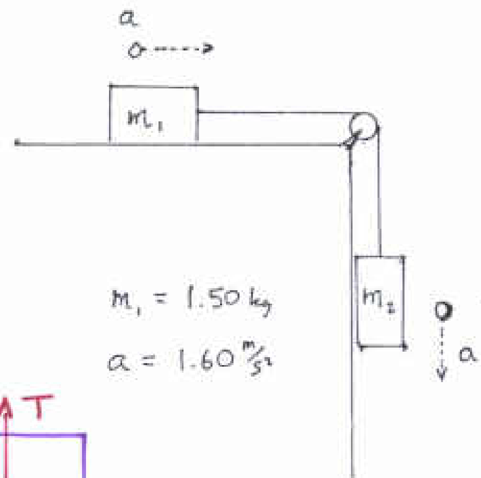
Name Units? Units?

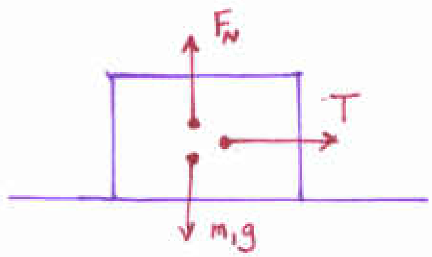
Phys 121
Quiz #2 — Spring 2001



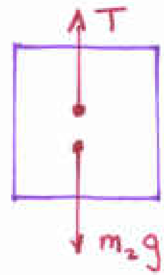
1. Two masses are connected by a string which passes over an ideal pulley. One mass slides on a level frictionless surface and the other hangs vertically from the string. The acceleration of the masses is $1.60\frac{m}{s^2}$. The mass which moves horizontally is $m_1 = 1.50$ kg.

a) Draw ("free–body") diagrams showing all the forces acting on each of the two masses. *These diagrams will be of use to you for questions about the forces...*

m_1:

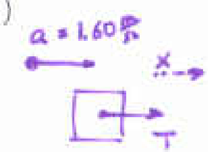


m_2:



b) Find the tension in the string. (The force diagram for m_1 will help here.)

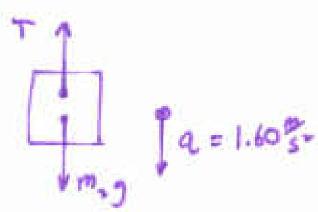
Newton's 2nd Law (for x-direction, m_1) gives:



$$T = m_1 a = (1.50\text{ kg})(1.60\tfrac{m}{s^2}) = \boxed{2.4\ N}$$

c) Find the value of the hanging mass, m_2. (The force diagram for m_2 will help here.)

For simplicity take "down" as the + direction for m_2. Then N's 2nd Law gives:



$$m_2 g - T = m_2 a$$

m_2 is unknown; solve for m_2!

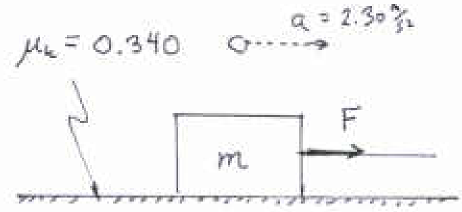
$$m_2 g - m_2 a = T$$

$$m_2 (g - a) = T$$

$$\rightarrow \quad m_2 = \frac{T}{(g-a)} = \frac{2.4\ N}{(9.80\frac{m}{s^2} - 1.60\frac{m}{s^2})} = \boxed{0.293\text{ kg}}$$

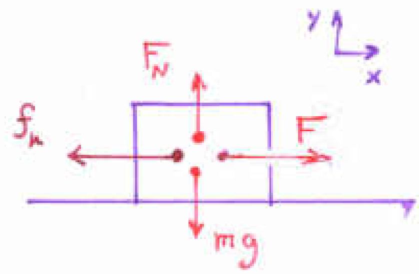
2. A 22.0 kg box is dragged over a level floor by an applied horizontal force F. The coefficient of kinetic friction (for box and floor) is 0.340.

The box moves with constant acceleration $2.30\frac{\text{m}}{\text{s}^2}$. What is F? *A diagram of the forces acting on the box may help you...*



No net force in y direction, so

$F_N = mg = (22.0\text{ kg})(9.80\frac{m}{s^2}) = 216\text{ N}$



N's 2nd law for dir gives:

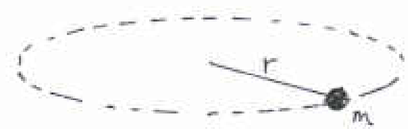
$F - f_k = ma$. But $f_k = \mu_k F_N = \mu_k mg$, so

$F - \mu_k mg = ma$, and then

$F = ma + \mu_k mg = m(a + \mu_k g) = (22.0\text{ kg})\left(2.30\frac{m}{s^2} + (0.340)(9.80\frac{m}{s^2})\right) = \boxed{124\text{ N}}$

3. A 1.70 kg mass is swung in a horizontal circle at the end of a 1.30 m–long string. It makes one revolution every 0.300 s.

a) Find the speed of the mass.



$v = \frac{2\pi r}{T} = \frac{2\pi(1.30\text{ m})}{(0.300\text{ s})} = \boxed{27.2\frac{m}{s}}$

$r = 1.30\text{ m}$

$T = 0.30\text{ s}$

$m = 1.70\text{ kg}$

b) Find the tension in the string.

Tension in the string is equal to the centripetal force on the mass, so

$T = F_c = \frac{mv^2}{r} = \frac{(1.70\text{ kg})(27.2\frac{m}{s})^2}{(1.30\text{ m})} = \boxed{969\text{ N}}$

You must show all your work and include the right units with your answers!

$$g = 9.8\,\frac{\text{m}}{\text{s}^2} \qquad 1\text{ m} = 100\text{ cm} \qquad 1\text{ kg} = 1000\text{ g}$$

$$v = v_0 + at \qquad x = v_0 t + \tfrac{1}{2}at^2 \qquad v^2 = v_0^2 + 2ax \qquad x = \tfrac{1}{2}(v_0 + v)t$$

$$\mathbf{F} = m\mathbf{a} \qquad a_c = \frac{v^2}{r} \qquad F_c = \frac{mv^2}{r} \qquad C = 2\pi R$$

$f_k = \mu_k F_N$