AP Physics – Newton's Laws – 6 ans

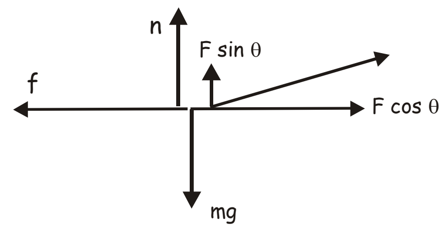
1. A small weather rocket weighs 15.7 N.

   a. What is the rocket's mass? $w = mg$ $m = \frac{w}{g} = \frac{15.7 \frac{kg \cdot m}{s^2}}{9.8 \frac{m}{s^2}} = \boxed{1.60\ kg}$

   b. The rocket (the one up above) fires its engine when it is dropped from a balloon at high altitude. If the rocket has a thrust of 109.2 N, what is the acceleration on the rocket?

$$\sum F_y = ma \qquad ma = F_T - w \qquad a = \frac{F_T - w}{m} = \left(109.2 \frac{kg \cdot m}{s^2} - 15.7 \frac{kg \cdot m}{s^2}\right)\left(\frac{1}{1.60\ kg}\right) = \boxed{58.4 \frac{m}{s^2}}$$

2. A boy pulls a 47.5 kg crate with a rope. The rope makes an angle of 28.0° to the horizontal. The coefficient of kinetic friction for the crate and the deck is 0.300. The boy exerts a force of 185 N. What is the acceleration of the crate?



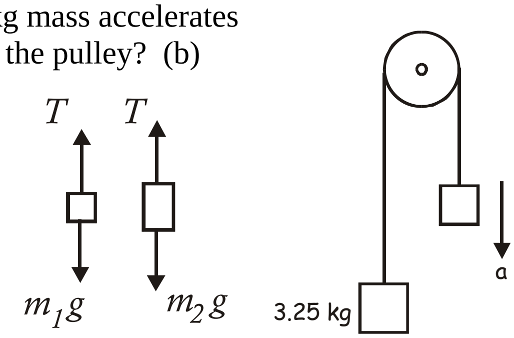
$$n + F \sin\theta - mg = 0 \qquad n = mg - F \sin\theta$$

$$n = 47.5\ kg\left(9.8 \frac{m}{s^2}\right) - 185\ N\left(\sin 28.0^\circ\right) = 378.6\ N$$

$$\sum F_x = ma \qquad F \cos\theta - f = ma \qquad a = \frac{F \cos\theta - f}{m}$$

$$a = \frac{185 \frac{kg \cdot m}{s^2} \cos 28.0^\circ - (0.300)\left(378.6 \frac{kg \cdot m}{s^2}\right)}{47.5\ kg} = \boxed{1.05 \frac{m}{s^2}}$$

3. Two of these here masses are connected by a very light weight string that passes over your basic very low friction pulley. The mass on the left is 3.25 kg. The 3.25 kg mass accelerates upward at 0.345 m/s^2. (a) What is the mass on the other side of the pulley? (b) what is the tension in the string?



(a) $m_1 a = T - m_1 g$ $\qquad m_2 a = m_2 g - T$

Add 'em up:

$$m_1 a + m_2 a = T - m_1 g + m_2 g - T$$

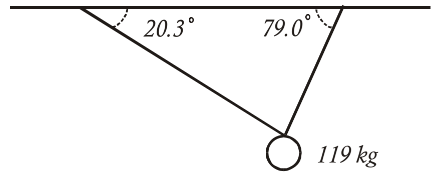
$$m_1 a + m_2 a = m_2 g - m_1 g \qquad m_1 a + m_1 g = m_2 g - m_2 a$$

$$m_1 a + m_1 g = m_2 (g - a) \qquad m_2 = \frac{m_1 a + m_1 g}{(g - a)}$$

$$m_2 = \frac{3.25\ kg\left(0.345 \frac{m}{s^2}\right) + 3.25\ kg\left(9.8 \frac{m}{s^2}\right)}{\left(9.8 \frac{m}{s^2} - 0.345 \frac{m}{s^2}\right)} = \frac{32.97\ kg}{9.455} = \boxed{3.49\ kg}$$

(b) $m_1 a = T - m_1 g$ $\qquad T = m_1 a + m_1 g = 3.25\ kg\left(0.345 \frac{m}{s^2}\right) + 3.25\ kg\left(9.8 \frac{m}{s^2}\right) = \boxed{33.0\ N}$

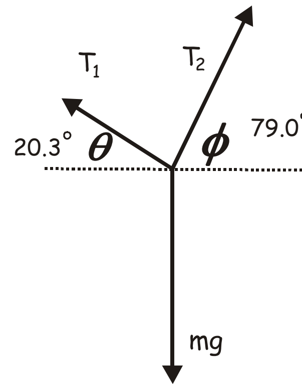
4. A disturbing weight hangs suspended as shown in the drawing. Find the tensions in the two strings.



$$\sum F_y = 0 \quad = T_1 \sin\theta + T_2 \sin\phi - w = 0$$

$$\sum F_x = 0 \quad = T_1 \cos\theta - T_2 \cos\phi \qquad T_1 = T_2 \frac{\cos\phi}{\cos\theta}$$

$$T_1 = T_2 \frac{\cos 79^0}{\cos 20.3^0} \quad = \quad 0.2034\, T_2$$

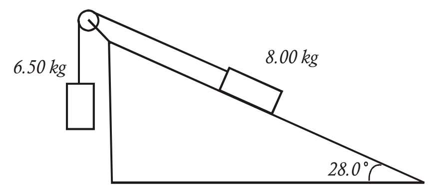


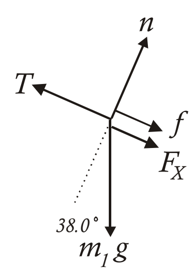
$$T_1 \sin\theta + T_2 \sin\phi = mg \qquad (0.2034\, T_2)\sin\theta + T_2 \sin\phi = mg$$

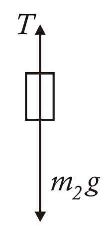
$$T_2 = \frac{mg}{0.2034 \sin\theta + \sin\phi} \quad = \frac{119\, kg \left(9.8 \frac{m}{s^2}\right)}{0.2034 \sin 20.3^0 + \sin 79^0} \quad = \quad \boxed{1110\ N}$$

$$T_1 = 0.2034\, T_2 \quad = 0.2034(1110\ N) \quad = \quad \boxed{226\ N}$$

5. An inclined plane has an 8.00 kg mass resting on it. The plane makes an angle of 28.0° to the horizontal. The coefficient of kinetic friction is 0.342. A low-mass string is attached to the weight and runs over one of them really good low friction pulley deals where it is attached to a 6.50 kg mass.
   (a) What is the tension in the string?
   (b) What is the acceleration of the system?
   (c) Does the 8.00 kg mass go down the ramp or up the ramp?







(b) $m_1 a = T - m_1 g \sin\theta - f \qquad m_2 a = m_2 g - T$

$$m_1 a + m_2 a = \cancel{T} - m_1 g \sin\theta - f + m_2 g - \cancel{T}$$

$$m_1 a + m_2 a = m_2 g - m_1 g \sin\theta - \mu m_1 g \cos\theta$$

$$a(m_1 + m_2) = g(m_2 - m_1 \sin\theta - \mu m_1 \cos\theta)$$

$$a = g \frac{(m_2 - m_1 \sin\theta - \mu m_1 \cos\theta)}{(m_1 + m_2)} \quad = 9.8 \frac{m}{s^2} \left(\frac{6.50\, \cancel{kg} - 8.00\, \cancel{kg}\ \sin 28.0^\circ - 0.342(8.00\, \cancel{kg})\cos 28.0^\circ}{8.00\, \cancel{kg} + 6.50\, \cancel{kg}} \right)$$

$$a = 9.8 \frac{m}{s^2} \left(\frac{0.3285}{14.5} \right) \quad = \quad \boxed{0.222 \frac{m}{s^2}}$$

(a) $m_2 a = m_2 g - T \quad T = m_2(g - a) \quad = 6.25\, kg \left(9.8 \frac{m}{s^2} - 0.222 \frac{m}{s^2} \right) \quad = \quad \boxed{59.9\ N}$

(c) ***Down -- acceleration is positive, so down the ramp.***

6. Two small blocks, each of mass m, are connected by a string of constant length 4 ***h*** and negligible mass. Block ***A*** is placed on a smooth tabletop as shown, and block ***B*** hangs over the edge of the table. The tabletop is a distance 2 ***h*** above the floor. Block B is then released from rest at a distance h above the floor at time ***t*** = 0.

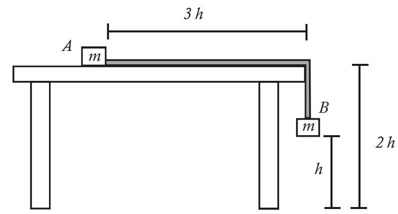
(a) Determine the acceleration of block ***B*** as it descends.

(b) Block ***B*** strikes the floor and does not bounce. Determine the time t_1 at which block ***B*** strikes the floor.

(c) Describe the motion of block ***A*** from time ***t = 0*** to the time when block ***B*** strikes the floor.

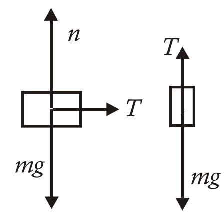
(d) Describe the motion of block ***A*** from the time block ***B*** strikes the floor to the time block ***A*** leaves the table.

(e) Determine the distance between the landing points of the two blocks.



(a) ***Block B***: $ma = mg - T$ ***Acceleration is the same***

Block A: $ma = T$



$ma + ma = mg - T + T \quad a + a = g \quad 2a = g \quad a = \boxed{\frac{g}{2}}$

(b) $y = \frac{1}{2}at^2 \quad t = \sqrt{\frac{2y}{a}} = \sqrt{\frac{2h}{\frac{g}{2}}} = \sqrt{\frac{4h}{g}} = \boxed{2\sqrt{\frac{h}{g}}}$

(c) Accelerate at g/2 till block B hits the deck

(d) Moves at constant speed till it falls off table

(e) $v^2 = v_o{}^2 + 2ay \quad v = \sqrt{2ay} = \sqrt{2\left(\frac{g}{2}\right)h} = \sqrt{gh}$

$y = \frac{1}{2}at^2 \quad t = \sqrt{\frac{2y}{a}} = \sqrt{\frac{2(2h)}{g}} = \sqrt{\frac{4h}{g}}$

$x = vt = \sqrt{gh}\left(\sqrt{\frac{4h}{g}}\right) = \sqrt{\frac{4gh^2}{g}} = \sqrt{4h^2} = \boxed{2h}$