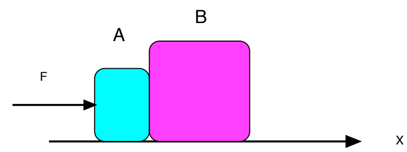
Your Name: ______________________________

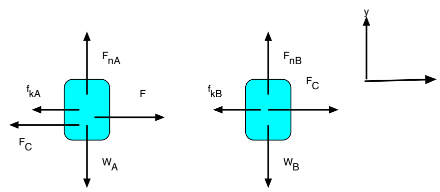
PHY203
Exam #2
Chapters 4,5,11
Fri., 10/15/13

Solutions



1. Block A above has a mass of 5.00 kg and a kinetic frictional coefficient of 0.250. Block B has a mass of 8.00 kg and a kinetic frictional coefficient of 0.350. Block A is pushed along the table with a horizontal force of F = 55.0 N.

a. Draw free-body diagrams (sketch and label all the forces on the blocks) for the blocks. Include a coordinate system.



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b. Find the magnitude of the normal forces on the blocks.
y-direction:

$$F_n - mg = 0$$
$$F_n = mg$$
$$F_{nA} = (5.00)(9.81) = 49.0\,N$$
$$F_{nB} = (8.00)(9.81) = 78.5\,N$$

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c. Find the magnitude of the frictional forces on the blocks.

$$f_k = \mu_k F_n$$
$$f_{kA} = (0.250)(49.0N) = 12.2N$$
$$f_{kB} = (0.350)(78.5N) = 27.5N$$

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d. Find the magnitude of the acceleration of the blocks and the magnitude of the contact force.
y-direction:

$$A: -f_{kA} - F_c + F = m_A a$$
$$B: -f_{kB} + F_c = m_B a$$
$$Combine:$$
$$-f_{kA} - f_{kB} + F = (m_A + m_B)a$$
$$a = \frac{-12.2 - 27.5 + 55.0}{5.00 + 8.00} = 1.18 m/s^2$$
$$F_c = m_B a + f_{kB} = (8.00)(1.18 m/s^2) + 27.5$$
$$= 36.9N$$

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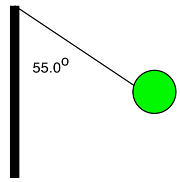
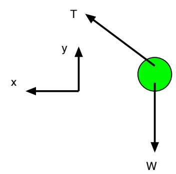


2. A 0.500 kg ball is swung around a vertical pole at an angle of 55.0°, as shown. The length of the string is 1.50 m.

a. Draw a free-body diagram (sketch and label all the forces on the ball). Include a coordinate system.



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b. Find the magnitude of the tension in the string.

$$y: T\cos\theta - mg = 0$$

$$T = \frac{mg}{\cos\theta} = \frac{(0.500)(9.81)}{\cos 55^o} = 8.55N$$

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c. Find the magnitude of the centripetal force.

$$x: F_c = T\sin\theta$$

$$= (8.55N)\sin 55^o = 7.00N$$

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d. Find the speed of the ball.

$$F_c = 7.00N = \frac{mv^2}{r} = \frac{mv^2}{L\sin\theta}$$

$$= \frac{(0.500)v^2}{(1.50)\sin 55^o}$$

$$v = 4.15m/s$$

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e. Find period of the ball's motion.

$$T = \frac{2\pi r}{v} = \frac{2\pi L\sin\theta}{v}$$

$$= \frac{2\pi(1.50)\sin 55^o}{4.15m/s} = 1.86s$$

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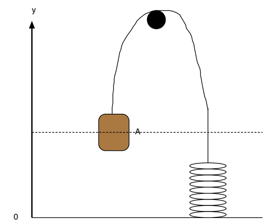

3. A 4.50 kg block is attached to a massless string, which is attached to a spring, as shown. Initially, the block is held at position A, at a position of y = 0.250 m. The string is tight but the spring is not compressed or extended. The spring coefficient is 500 N/m.

a. If the block is slowly lowered until it stops, use work and energy to find the maximum extension of the spring.

$$E = mgh_A = mgh_{\mathbf{B}} + \frac{1}{2}kx^2$$

$$h_A - h_{\mathbf{B}} = x \quad so$$

$$mgx = \frac{1}{2}kx^2 \quad mg = \frac{1}{2}kx$$

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$$x = \frac{2mg}{k} = \frac{2(4.50)(9.81)}{500} = 0.177m$$

b. If instead the block is released at point A and allowed to fall freely, use work and energy to find the speed of the block after it has fallen to y = 0.200 m.

$$E = mgh_A = mgh_{\mathbf{B}} + \frac{1}{2}kx^2 + \frac{1}{2}mv^2$$

$$mgx = \frac{1}{2}kx^2 + \frac{1}{2}mv^2 \quad mg = \frac{1}{2}kx$$

$$v^2 = \frac{2mgx - kx^2}{m} = \frac{2(4.50)(9.81)(0.0500) - (500)(0.0500)^2}{4.50}$$

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$$v = 0.839m/s$$

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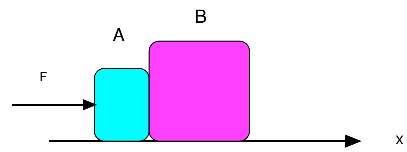
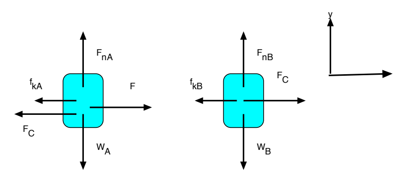


1. Block A above has a mass of 6.00 kg and a kinetic frictional coefficient of 0.250. Block B has a mass of 9.00 kg and a kinetic frictional coefficient of 0.350. Block A is pushed along the table with a horizontal force of F = 75.0 N.

a. Draw free-body diagrams (sketch and label all the forces on the blocks) for the blocks. Include a coordinate system.



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b. Find the magnitude of the normal forces on the blocks.

y-direction:

$$F_n - mg = 0$$
$$F_n = mg$$
$$F_{nA} = (6.00)(9.81) = 58.9\text{N}$$
$$F_{nB} = (9.00)(9.81) = 88.3\text{N}$$

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c. Find the magnitude of the frictional forces on the blocks.

$$f_k = \mu_k F_n$$
$$f_{kA} = (0.250)(58.9N) = 14.7N$$
$$f_{kB} = (0.350)(88.3N) = 30.9N$$

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d. Find the magnitude of the acceleration of the blocks and the magnitude of the contact force.

y-direction:

$$A: -f_{kA} - F_c + F = m_A a$$
$$B: -f_{kB} + F_c = m_B a$$
$$Combine:$$
$$-f_{kA} - f_{kB} + F = (m_A + m_B)a$$
$$a = \frac{-14.7 - 30.9 + 75.0}{6.00 + 9.00} = 1.96 m/s^2$$
$$F_c = m_B a + f_{kB} = (9.00)(1.96 m/s^2) + 30.9$$
$$= 48.5N$$

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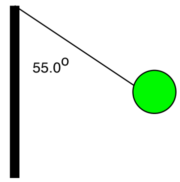
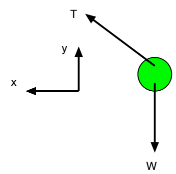


2. A 0.250 kg ball is swung around a vertical pole at an angle of 55.0°, as shown. The length of the string is 0.750 m.

a. Draw a free-body diagram (sketch and label all the forces on the ball). Include a coordinate system.



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b. Find the magnitude of the tension in the string.

$$y: T\cos\theta - mg = 0$$

$$T = \frac{mg}{\cos\theta} = \frac{(0.250)(9.81)}{\cos 55^o} = 4.28N$$

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c. Find the magnitude of the centripetal force.

$$x: F_c = T\sin\theta$$

$$= (4.28N)\sin 55^o = 3.51N$$

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d. Find the speed of the ball.

$$F_c = 3.51N = \frac{mv^2}{r} = \frac{mv^2}{L\sin\theta}$$

$$= \frac{(0.250)v^2}{(0.750)\sin 55^o}$$

$$v = 2.94m/s$$

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e. Find period of the ball's motion.

$$T = \frac{2\pi r}{v} = \frac{2\pi L\sin\theta}{v}$$

$$= \frac{2\pi(0.750)\sin 55^o}{2.94m/s} = 1.31s$$

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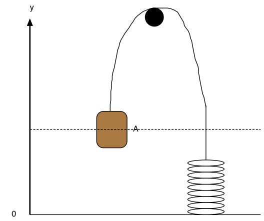

3. A 6.50 kg block is attached to a massless string, which is attached to a spring, as shown. Initially, the block is held at position A, at a position of y = 0.250 m. The string is tight but the spring is not compressed or extended. The spring coefficient is 700 N/m.

a. If the block is slowly lowered until it stops, use work and energy to find the maximum extension of the spring.

$$E = mgh_A = mgh_{\mathbf{B}} + \frac{1}{2}kx^2$$

$$h_A - h_{\mathbf{B}} = x \quad so$$

$$mgx = \frac{1}{2}kx^2 \quad mg = \frac{1}{2}kx$$

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$$x = \frac{2mg}{k} = \frac{2(6.50)(9.81)}{700} = 0.182m$$

b. If instead the block is released at point A and allowed to fall freely, use work and energy to find the speed of the block after it has fallen to y = 0.200 m.

$$E = mgh_A = mgh_{\mathbf{B}} + \frac{1}{2}kx^2 + \frac{1}{2}mv^2$$

$$mgx = \frac{1}{2}kx^2 + \frac{1}{2}mv^2 \quad mg = \frac{1}{2}kx$$

$$v^2 = \frac{2mgx - kx^2}{m} = \frac{2(6.50)(9.81)(0.0500) - (700)(0.0500)^2}{6.50}$$

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$$v = 0.844m/s$$