

Your Name: \_\_\_\_\_

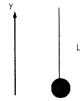
PHY203  
Exam #2  
Chapters 5-8

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FR, March 22, 2024

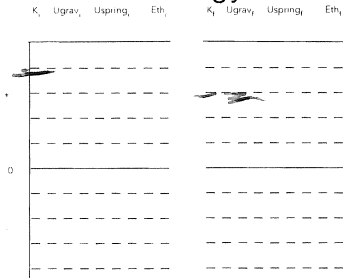
Solutions





2. A ball of mass 2.50 kg is attached to the end of a string of length  $L=1.50$  m and is given a push so that it swings around in a vertical circle. The speed of the ball at the bottom of the circle is 9.50 m/s. We want to find the speed of the ball at the top of the circle and the tension in the string. Take  $y=0$  at the bottom of the swing.

a. Create energy bar charts: 5



b. Find the speed of the ball at the top of the circle. 10

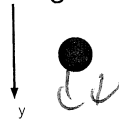
$$\frac{1}{2} m v_B^2 = \frac{1}{2} m v_T^2 + 2mg r$$

$$v_T^2 = v_B^2 - 4g r$$

$$= 9.5^2 - 4(9.8)(1.5)$$

$$v_T = 5.40 \text{ m/s}$$

c. On the figure below, draw a free body diagram of the ball at the top of the circle. 5



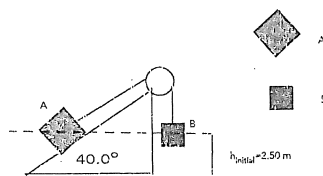
d. Write out Newton's 2<sup>nd</sup> Law in the y-direction for the ball at the top of the circle and find the magnitude of the tension in the string. 10

$$T + mg = \frac{m v^2}{r}$$

$$T = m \left( \frac{v^2}{r} - g \right)$$

$$= 2.50 \left( \frac{5.4^2}{1.5} - 9.8 \right)$$

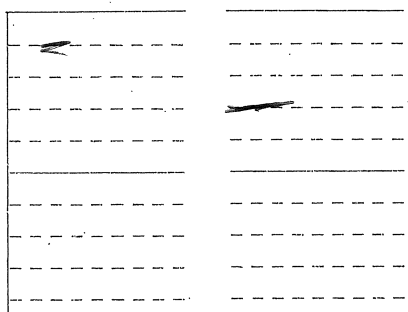
$$= 27.8 \text{ N}$$



3. Blocks A and B are connected by a light string and attached over a massless pulley and are initially at rest at a height of 2.50 m. Assume a frictionless surface under block A and masses  $m_A$  and  $m_B$ . The ramp under block A is inclined at  $40.0^\circ$ , as shown above. The blocks are released and start moving. We want to find the speed of the blocks after they have moved 2.00 m.

a. Create energy bar charts: 5

$K_i$   $U_{grav_i}$   $U_{spring_i}$   $E_{th_i}$      $K_f$   $U_{grav_f}$   $U_{spring_f}$   $E_{th_f}$



$$\begin{aligned} & \frac{2.5}{\sin 40^\circ} \approx 2.50 \sin 40^\circ \\ & = 1.62 \text{ m} \\ & 1.29 \end{aligned}$$

Assume that  $m_A = 6.50 \text{ kg}$ ,  $m_B = 8.00 \text{ kg}$ , and the initial height of both blocks is 2.50 m.

b. Find the initial energy of the blocks before they start moving. 5

3. Block A and B are connected by a light string and attached over a massless pulley and are initially at rest at a height of 2.50 m. Assume a frictionless surface under block A and masses  $m_A$  and  $m_B$ . The ramp under block A is inclined at  $40.0^\circ$ , as shown above. The blocks are released and start moving. We want to find the speed of the blocks after they have moved 2.00 m.

c. Using Conservation of Energy, find the speed of the blocks after they have moved 2.00 m. 20

$$\begin{aligned} 350 &= \frac{1}{2} (6.50 + 8.00) v^2 + g (8.00 \cdot 0.50 + 6.50 (1.29 + 3.50)) \\ &= 7.25 v^2 + g (281) \\ &= 7.25 v^2 + 281 \end{aligned}$$

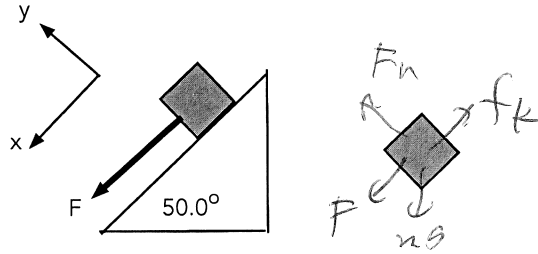
Assume that  $m_A = 6.50 \text{ kg}$ ,  $m_B = 8.00 \text{ kg}$ , and the initial height of both blocks is 2.50 m.

b. Find the total energy of the blocks before they start moving. 5

$$v = 3.22 \text{ m/s}$$

c. Using Conservation of Energy, find the speed of the blocks after they have moved 2.00 m. 20

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1. A rope is attached to a block on a rough ramp and pulled with a force,  $F$ , parallel to the ramp.
  - a. Above and to the right draw a free body diagram of the block while it is sliding down the ramp. 5
  - b. Write out Newton's 2nd Law for the block in both directions. 20

$$x: F + mg \sin 50^\circ - \mu_k F_n = ma$$

$$y: F_n - mg \cos 50^\circ = 0$$

Assume  $m=3.50$  kg,  $F = 30.0$  N, and  $\mu_k = 0.300$ .

- c. Find the magnitude of the normal force on the block. 5

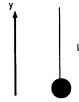
$$F_n = (3.50)g \cos 50^\circ = 22.1 \text{ N}$$

- d. Find the magnitude of the acceleration of the block. 10

$$a = \frac{1}{m} [ F + mg \sin 50^\circ - \mu_k F_n ]$$

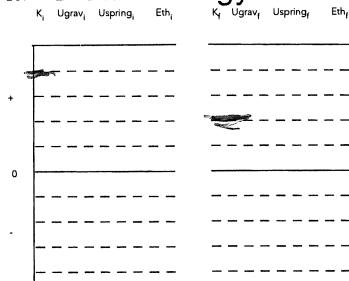
$$= \frac{1}{3.50} [ 30.0 + 3.50g \sin 50^\circ - 0.300(22.1) ]$$

$$= 14.2 \text{ m/s}^2$$



2. A ball of mass 3.00 kg is attached to the end of a string of length  $L=1.75$  m and is given a push so that it swings around in a vertical circle. The speed of the ball at the bottom of the circle is 11.5 m/s. We want to find the speed of the ball at the top of the circle and the tension in the string. Take  $y=0$  at the bottom of the swing.

a. Create energy bar charts: 5



b. Find the speed of the ball at the top of the circle. 10

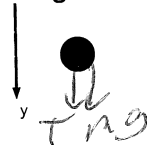
$$\frac{1}{2} m v_B^2 = \frac{1}{2} m v_T^2 + m g h$$

$$v_T^2 = v_B^2 - 2 g h$$

$$= 11.5^2 - 2 g (3.50)$$

$$v_T = 7.97 \text{ m/s}$$

c. On the figure below, draw a free body diagram of the ball at the top of the circle. 5



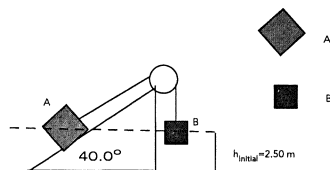
d. Write out Newton's 2<sup>nd</sup> Law in the y-direction for the ball at the top of the circle and find the magnitude of the tension in the string. 10

$$T + mg = ma = \frac{m v^2}{r}$$

$$T = m \left( \frac{v^2}{r} - g \right)$$

$$= 3.00 \left( \frac{7.97^2}{1.75} - g \right)$$

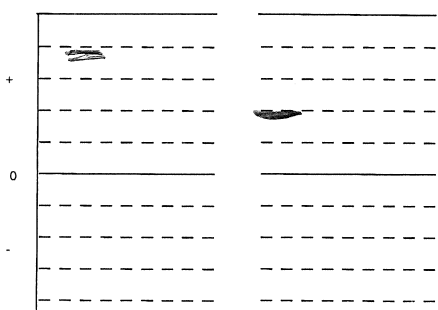
$$= 79.6 \text{ N}$$



3. Blocks A and B are connected by a light string and attached over a massless pulley and are initially at rest at a height of 2.50 m. Assume a frictionless surface under block A and masses  $m_A$  and  $m_B$ . The ramp under block A is inclined at  $40.0^\circ$ , as shown above. The blocks are released and start moving. We want to find the speed of the blocks after they have moved 1.50 m.

a. Create energy bar charts: 5

$K_i$   $U_{grav,i}$   $U_{spring,i}$   $E_{th,i}$      $K_f$   $U_{grav,f}$   $U_{spring,f}$   $E_{th,f}$



$$\begin{aligned} & \text{1.5 m} \\ & \text{40}^\circ \\ & h = 1.5 \sin 40 \\ & = 0.964 \end{aligned}$$

Assume that  $m_A = 7.50$  kg,  $m_B = 6.00$  kg, and the initial height of both blocks is 2.50 m.

b. Find the initial energy of the blocks before they start moving. 5

$$U = (7.50 + 6.00)g(2.50) = 331 \text{ J}$$

c. Using Conservation of Energy, find the speed of the blocks after they have moved 1.50 m. 20

$$\begin{aligned} 331 &= \frac{1}{2} (m_A + m_B) v^2 + m_B g (1.00) + m_A g (2.50 + 0.964) \\ &= \frac{1}{2} (13.5) v^2 + g [6.0 + 7.50 (3.464)] \\ &= 6.75 v^2 + 312 \text{ J} \end{aligned}$$

$$v = 1.60 \text{ m/s}$$