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General Physics I, Quiz 2
PHYS10400, Class year 100
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Solutions Q2

Chapter 1-8, Serway; ABSOLUTELY NO CHEATING!
Please write the answers on the blank space or on the back of this paper to save resources.

1. The distances x and y are related to length L and angle θ.

$$x = L\cos\theta$$

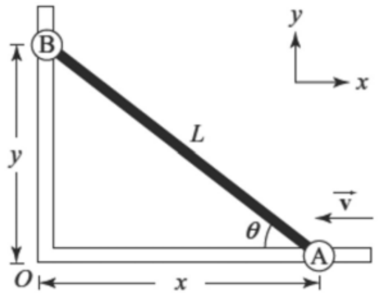
$$y = L\sin\theta$$

where θ has an implicit time dependence.

(a) Differentiating these equations with respect to time, we can write expresses have for the velocities of A and B:

$$v_A = \frac{dx}{dt} = -L\sin\theta\frac{d\theta}{dt} = -v$$

$$v_B = \frac{dy}{dt} = L\cos\theta\frac{d\theta}{dt}$$



ANS FIG. P2.63

where $v_A = -v$ is negative because as θ increases, x decreases.

Using the expression for v_A we solve for $d\theta/dt$ and substitute it into the expression for v_B:

$$-L\sin\theta = \frac{d\theta}{dt} = -v \rightarrow \frac{d\theta}{dt} = \frac{v}{L\sin\theta}$$

$$v_B = L\cos\theta\frac{d\theta}{dt} = +\frac{vL\cos\theta}{L\sin\theta}$$

$$v_B = v\cot\theta$$

(b) As A moves toward the origin, θ goes from $\sim 0^\circ \to 90^\circ$, $\cot\theta$ decreases from a very large value ($\sim\infty$) to zero, so v_B increases from a very large value ($\sim\infty$) to zero. At $\theta = 45^\circ$, $v_B = v$.

2.

(a) $W = F\Delta r\cos\theta = (16.0\text{ N})(2.20\text{ m})\cos 25.0^\circ = 31.9\text{ J}$

(b), (c) The normal force and the weight are both at 90° to the displacement in any time interval. Both do 0 work.

(d) $\sum W = 31.9\text{ J} + 0 + 0 = 31.9\text{ J}$

3.

Forces acting on $m_1 = 2.00$-kg block:

$$T - m_1 g = m_1 a \qquad (1)$$

Forces acting on $m_2 = 8.00$-kg block:

$$F_x - T = m_2 a \qquad (2)$$

(a) Eliminate T and solve for a:

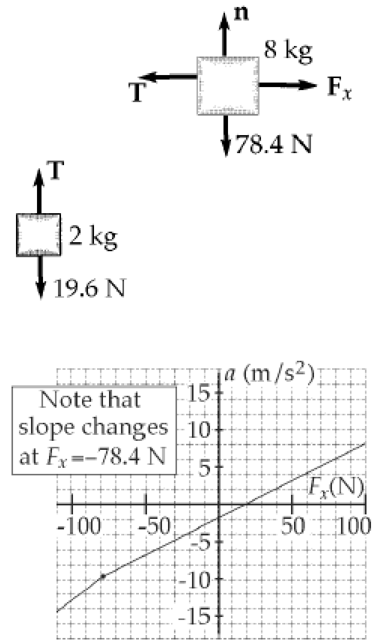
$$a = \frac{F_x - m_1 g}{m_1 + m_2}$$

$$\boxed{a > 0 \text{ for } F_x > m_1 g = 19.6\text{ N}}$$

(b) Eliminate a and solve for T:

$$T = \frac{m_1}{m_1 + m_2}\left(F_x + m_2 g\right)$$

$$\boxed{T = 0 \text{ for } F_x \le -m_2 g = -78.4\text{ N}}$$

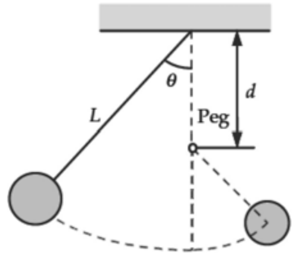


ANS FIG. P5.33

Note that if $F_x < -m_2 g$, the cord is loose, so mass m_2 is in free fall and mass m_1 accelerates under the action of F_x only.

4.

(a) Energy is conserved in the swing of the pendulum, and the stationary peg does no work. So the ball's speed does not change when the string hits or leaves the peg, and the ball swings equally high on both sides.



ANS FIG. P8.67

(b) The ball will swing in a circle of radius $R = (L–d)$ about the peg. If the ball is to travel in the circle, the minimum centripetal acceleration at the top of the circle must be that of gravity:

$$\frac{m\upsilon^2}{R} = g \rightarrow v^2 = g\left(L-d\right)$$

When the ball is released from rest, $U_i = mgL$, and when it is at the top of the circle, $U_i = mg2(L–d)$, where heights is measured from the bottom of the swing. By energy conservation,

$$mgL = mg2\left(L-d\right)+\frac{1}{2}m\upsilon^2$$

From this and the condition on υ^2 we find $d = \frac{3L}{5}$.