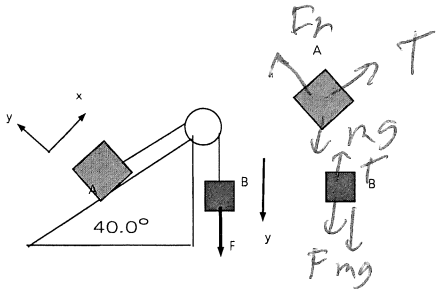
Your Name: _____

PHY203

Exam #2
Chapters 5-8
~~10/20/22~~
3/24/23

Solutions



1. Blocks A and B are connected by a light string and attached over a massless pulley and are initially held at rest. Assume masses m_A and m_B. A vertical force, F, is applied to block B as shown. The blocks are released and start to move. The ramp under block A is frictionless and makes an angle of 40.0° with respect to the horizontal.

a. Draw free body diagrams of the blocks on the figures above and to the right. **5**

b. Write out Newton's 2nd Law for both blocks in the x- and y-directions as they are moving. **15**

A: Σx: $T - m_A g \sin 40^\circ = m_A a$

Σy: $F_N - m_A g \cos 40^\circ = 0$

B: Σy: $F + m_B g - T = m_B a$

Assume that m_A =6.50 kg, m_B = 8.00 kg, and F = 75.0 N.

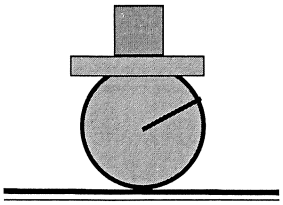
c. Find the magnitude of the acceleration of the blocks. **10**

Combine # equations!

$F + m_B g - m_A g \sin 40^\circ = (m_A + m_B) a$

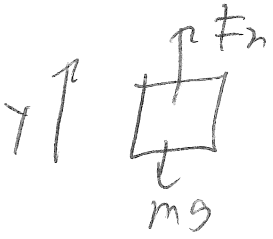
$a = \frac{1}{14.5}\left[75 + g(8.00 - 6.50 \sin 40^\circ)\right]$

$= 7.74 \text{ m/s}^2$



2. A 2.50 kg block is resting on a force scale that is sitting on the floor of an elevator.

a. First assume the elevator is <u>ascending</u> with a constant speed of 25.0 m/s. Draw a free body diagram of the block, choose a coordinate system (y-direction), write down Newton's 2nd Law for the block, and find the reading on the scale. **15**

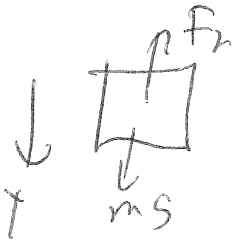


y: $F_n - mg = ma = 0$

$F_n = mg = 25.0$

$= 24.5$ N

b. Now assume the elevator is <u>descending</u> with a constant downward acceleration of 4.50 m^2/s in magnitude. Draw a free body diagram of the block, choose a coordinate system (y-direction), write down Newton's 2nd Law for the block, and find the reading on the scale. **15**

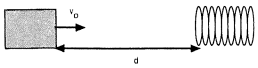


y: $mg - F_n = ma$

$F_n = m(g - a)$

$= 25.0(9 - 4.50)$

$= 13.3$ N



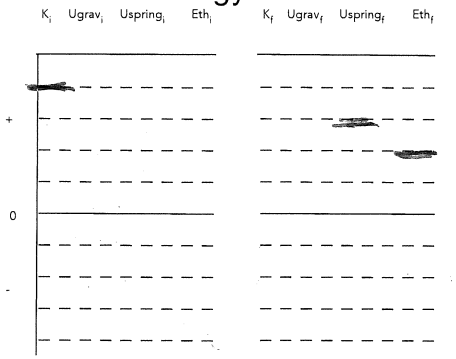
3. A block of mass M=4.50 kg is initially at rest on a smooth horizontal table as shown. The block is given a push which gives it an initial speed of 3.50 m/s. The block travels on the frictionless surface for 5.00 m before hitting the end of an uncompressed spring with a spring constant of 70.0 N/m. The spring is resting on a rough surface with kinetic coefficient of 0.300.

a. The initial situation is shown above. Sketch the final situation below, once the block has come to rest (momentarily): **5**

b. ~~List the forms of energy that are non-zero at the beginning of the problem when the block has just started moving: **5**~~ K

c. List the forms of energy ~~that are~~ non-zero just as the block ~~comes to rest~~ after sliding a distance, ~~d,~~ on the rough surface: **5** U_{spring}, E_{th}

d. Create energy bar charts: **10**



e. Find d, the maximum compression of the spring. ~~**15**~~ 25

$$\frac{1}{2}mv^2 = \frac{1}{2}kd^2 + \mu_k mgd$$

$$27.6 = 35d^2 + 13.2d$$

$$0 = 35d^2 + 13.2d - 27.6$$

$$d = \frac{-13.2 \pm \sqrt{13.2^2 + 4 \cdot 35 \cdot 27.6}}{70}$$

$$= 0.719\ m$$

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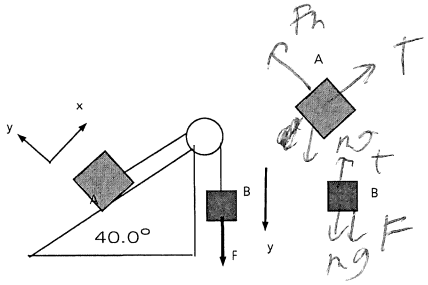


1. Blocks A and B are connected by a light string and attached over a massless pulley and are initially held at rest. Assume masses m_A and m_B. A vertical force, F, is applied to block B as shown. The blocks are released and start to move. The ramp under block A is frictionless and makes an angle of 40.0° with respect to the horizontal.

a. Draw free body diagrams of the blocks on the figures above and to the right. **5**

b. Write out Newton's 2nd Law for both blocks in the x- and y-directions as they are moving. **15**

$A: +\nearrow \quad T - m_A g \sin 40^\circ = m_A a$

$y: \quad F_n - m_A g \cos 40^\circ = 0$

$B: y: \quad F + m_B g - T = m_B a$

Assume that m_A =7.50 kg, m_B = 6.00 kg, and F = 65.0 N.

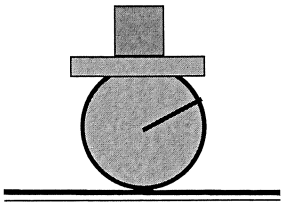
c. Find the magnitude of the acceleration of the blocks. **10**

combine A: x and B: y:

$F + m_B g - m_A g \sin 40^\circ = (m_A + m_B) a$

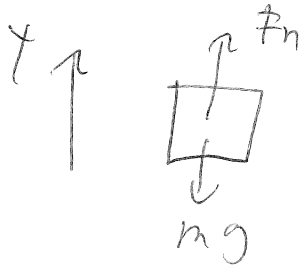
$a = \frac{1}{13.5}\left[6 - 7.50 \sin 40^\circ\right] g + \frac{65.0}{13.5}$

$= 5.42 \text{ m/s}^2$



2. A 3.00 kg block is resting on a force scale that is sitting on the floor of an elevator.

a. First assume the elevator is <u>ascending</u> with a constant speed of 35.0 m/s. Draw a free body diagram of the block, choose a coordinate system (y-direction), write down Newton's 2nd Law for the block, and find the reading on the scale. **15**

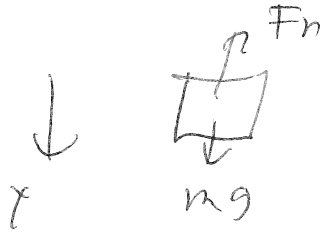


$y: \quad F_n - mg = ma = 0$

$F_n = 3.00g$

$= 29.4\ N$

b. Now assume the elevator is <u>descending</u> with a constant downward acceleration of 3.50 m^2/s in magnitude. Draw a free body diagram of the block, choose a coordinate system (y-direction), write down Newton's 2nd Law for the block, and find the reading on the scale. **15**

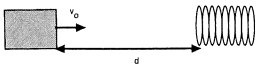


$y: \quad mg - F_n = ma$

$F_n = m(g-a)$

$= 3.00(g - 3.50)$

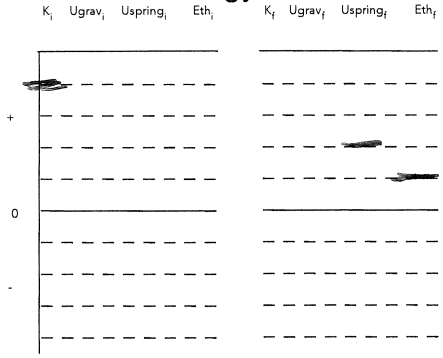
$= 18.9\ N$



3. A block of mass M=5.50 kg is initially at rest on a smooth horizontal table as shown. The block is given a push which gives it an initial speed of 3.50 m/s. The block travels on the frictionless surface for 5.00 m before hitting the end of an uncompressed spring with a spring constant of 80.0 N/m. The spring is resting on a rough surface with kinetic coefficient of 0.300.

a. The initial situation is shown above. Sketch the final situation below, once the block has come to rest (momentarily): **5**

\b. Create energy bar charts: **10**



c. Find d, the maximum compression of the spring. **25**

$$\frac{1}{2}mv^2 = \frac{1}{2}kd^2 + \mu_k F_n d$$

$$= \frac{1}{2}kd^2 + \mu_k mgd$$

$$33.7 = 40d^2 + 16.2d$$

$$40d^2 + 16.2d - 33.7 = 0$$

$$d = \frac{-16.2 \pm \sqrt{16.2^2 + 4 \cdot 40 \cdot 33.7}}{80}$$

$$= 0.737\,m$$