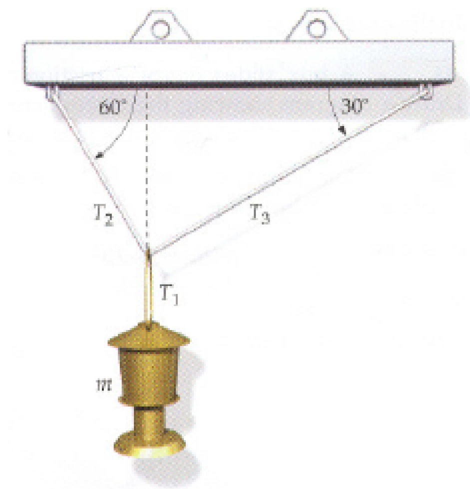
Name: ____ **Assignment Due Date: December 12, 2011**

AP Physics: Newton's Laws 2

Multiple Choice

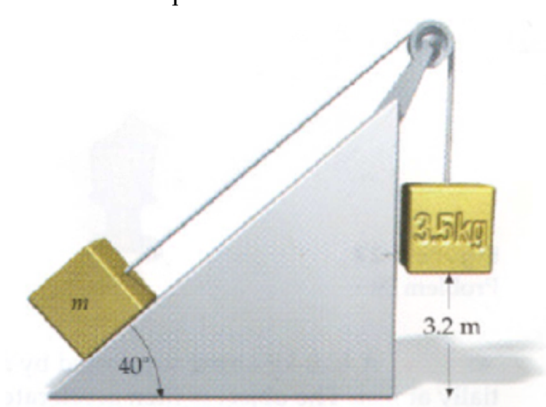
Identify the choice that best completes the statement or answers the question.

____ 1. A lamp with a mass m = 42.6 kg is hanging from wires as shown in the figure below. The tension T_1 in the vertical handle is



a. 209 N.
b. 418 N.
c. 570 N.
d. 360 N.
e. 730 N.

____ 2. The system shown in the figure below is in equilibrium. It follows that the mass m is



a. 3.5 kg.
b. 3.5 sin 40° kg.
c. 3.5 tan 40° kg.
d. none of the above.

____ 3. An object is suspended from the ceiling of an elevator that is descending at a constant speed of 9.81 m/s. The tension in the string holding the object is

a. equal to the weight of the object.
b. less than the weight of the object but not zero.
c. greater than the weight of the object.
d. zero.

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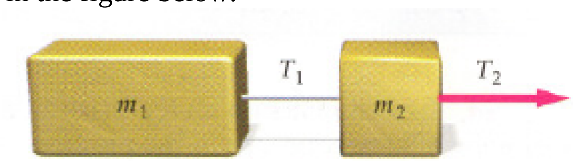
____ 4. Two boxes of mass m_1 and m_2 connected together by a massless string are accelerated uniformly on a frictionless surface, as shown in the figure below.



The ratio of the tensions T_1/T_2 is given by

a. m_1/m_2.

b. m_2/m_1.

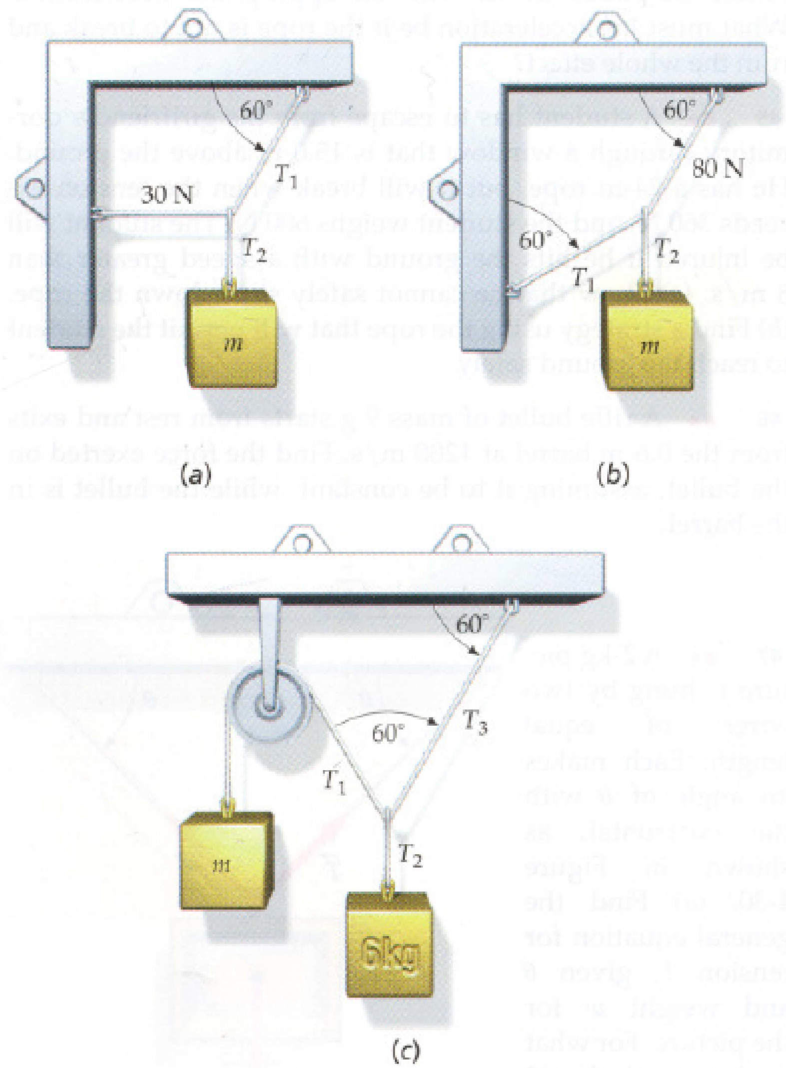
c. $(m_1 + m_2)/m_2$.

d. $m_1/(m_1 + m_2)$.

e. $m_2/(m_1 + m_2)$.

Problem

5. For the systems in equilibrium shown below, find the unknown tensions and masses.



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6. In the figure below, the objects are attached to spring balances calibrated in newtons. Give the readings of the balances in each case, assuming that the strings are massless and the incline is frictionless.

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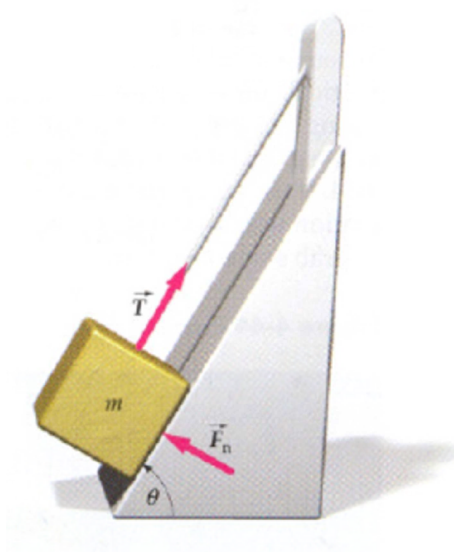
7. A box is held in position by a cable along a frictionless incline as shown in the figure below. *(a)* If $\theta = 60°$ and $m = 50$ kg, find the tension in the cable and the normal force exerted by the incline. *(b)* Find the tension as a function of θ and *m,* and check your result for $\theta = 0$ and $\theta = 90°$.



8. A 60-kg girl weighs herself by standing on a scale in an elevator. What does the scale read when *(a)* the elevator is descending at a constant rate of 10 m/s; *(b)* the elevator is descending at 10 m/s and gaining speed at a rate of 2 m/s^2; *(c)* the elevator is ascending at 10 m/s but its speed is decreasing by 2 m/s in each second?

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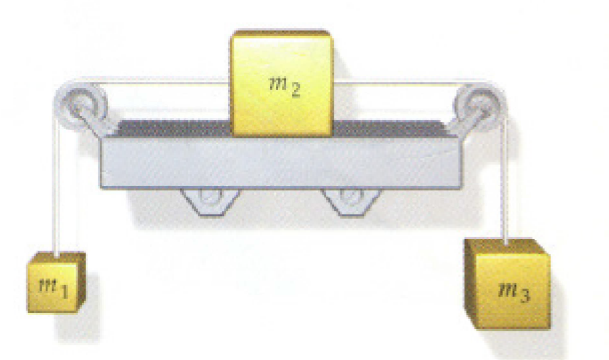
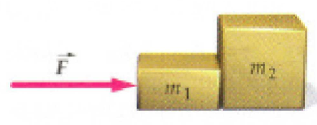
9. A box of mass m_2 = 3.5 kg rests on a frictionless horizontal shelf and is attached by strings to boxes of masses m_1 = 1.5 kg and m_3 = 2.5 kg, which hang freely, as shown in the figure below. Both pulleys are frictionless and massless. The system is initially held at rest. After it is released, find *(a)* the acceleration of each of the boxes, and *(b)* the tension in each string.



10. Two blocks are in contact on a frictionless, horizontal surface. The blocks are accelerated by a horizontal force $\vec{F}$ applIed to one of them (see below). Find the acceleration and the contact force for *(a)* general values of F, m_1, and m_2, and *(b)* for F = 3.2 N, m_1 = 2 kg, and m_2 = 6 kg.



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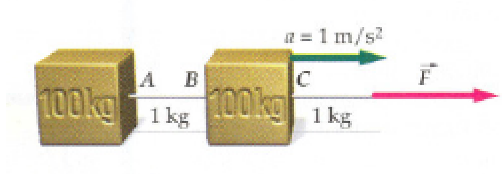
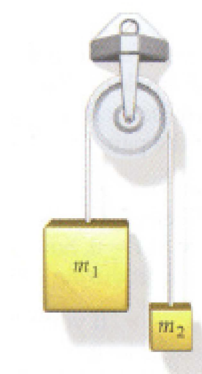
11. Two 100-kg blocks are dragged along a frictionless surface with a constant acceleration of 1.6 m/s^2, as shown in the figure below. Each rope has a mass of 1 kg. Find the force *F* and the tension in the ropes at points *A*, *B*, and C.



12. The apparatus in the figure is called an *Atwood's machine* and is used to measure the acceleration due to gravity *g* by measuring the acceleration of the two blocks. Assuming a massless, frictionless pulley and a massless string, show that the magnitude of the acceleration of either body and the tension in the string are

$$a = \frac{m_1 - m_2}{m_1 + m_2} g \text{ and } T = \frac{2m_1 m_2 g}{m_1 + m_2}$$



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13. If one of the masses of the Atwood's machine in the figure below is 1.2 kg, what should the other mass be so that the displacement of either mass during the first second following release is 0.3 m?

14. A simple accelerometer can be made by suspending a small object from a string attached to a fixed point on an accelerating object-to the ceiling of a passenger car, for example. When there is an acceleration, the object will deflect and the string will make some angle with the vertical. *(a)* How is the direction in which the suspended object deflects related to the direction of the acceleration? *(b)* Show that the acceleration a is related to the angle θ that the string makes by $a = g \tan \theta$; *(c)* Suppose the accelerometer is attached to the ceiling of an automobile that brakes to rest from 50 km/h (13.89 m/s) in a distance of 60 m. What angle will the accelerometer make? Will the object swing forward or backward?

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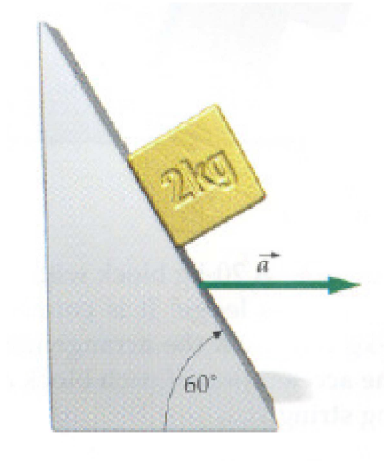
15. A 2-kg body rests on a frictionless wedge that has an inclination of 60° and an acceleration a to the right such that the mass remains stationary relative to the wedge (see figure below). *(a)* Find *a*. *(b)* What would happen if the wedge were given a greater acceleration?



AP Physics: Newton's Laws 2
Answer Section

MULTIPLE CHOICE

1. ANS: B REF: Tipler4thed.p.106#39
2. ANS: D REF: Tipler4thed.p.108#54
3. ANS: A REF: Tipler4thed.p.109#59
4. ANS: D REF: Tipler4thed.p.109#67

PROBLEM

5. ANS:

In each case, consider the junction of the three strings.

(*a*) Set $\Sigma F_x = 0$, $\Sigma F_y = 0$	$30 \text{ N} = T_1 \cos 60^\circ$; $T_1 \sin 60^\circ = T_2$
Solve for T_1 and T_2	$T_1 = 60$ N, $T_2 = 52$ N
$M = T_2/g$	$M = 5.3$ kg
(*b*) Proceed as in part (*a*)	$T_1 \sin 60^\circ = 80 \cos 60^\circ$ N; $T_1 \cos 60^\circ + T_2 = 80 \sin 60^\circ$ N
	$T_1 = (80 \text{ N})/\tan 60^\circ = 46.2$ N; $T_2 = 46.2$ N
	$M = (46.2/9.81)$ kg $= 4.71$ kg
(*c*) Proceed as in part (*a*); note that $Mg = T_1$	$T_1 \sin 30^\circ = T_3 \sin 30^\circ$; $T_1 = T_3$;
	$2T_1 \cos 30^\circ = T_2 = 6 \times 9.81$ N
	$T_1 = T_3 = 34$ N; $M = (34/9.81)$ kg $= 3.46$ kg

REF: Tipler4thed.p.108#51

6. ANS:

• In Figure 4-34, the objects are attached to spring balances calibrated in newtons. Give the readings of the balances in each case, assuming that the strings are massless and the incline is frictionless.
(*a*) and (*b*) $F = 98.1$ N. (*c*) F(per spring balance) $= 49$ N. (*d*) $F = (98.1 \sin 30^\circ)$ N $= 49$ N.

REF: Tipler4thed.p.108#55

7. ANS:

We shall use a coordinate system with x pointing to the right and parallel to the inclined plane, y along $\mathbf{F}_n$.

(*b*) $\Sigma F_x = 0$; $\Sigma F_y = 0$	$T = mg \sin \theta$, $F_n = mg \cos \theta$. For $\theta = 0^\circ$, $T = 0$, $F_n = mg$, and for $\theta = 90^\circ$, $T = mg$ and $F_n = 0$, as should be
(*a*) Use results of (*b*) with $m = 50$ kg, $\theta = 60^\circ$	$T = 508$ N, $F_n = 245$ N

REF: Tipler4thed.p.109#56

8. ANS:

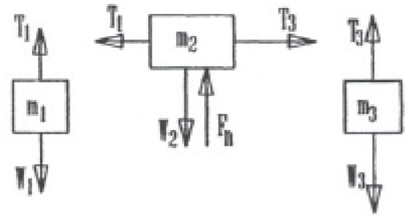
(*a*) $a = 0$; $w = mg = 589$ N. (*b*) $a = -2$ m/s^2; $w = (60 \times 7.81)$ N $= 469$ N. (*c*) Again, $a = -2$ m/s^2 and $w = 469$ N.

REF: Tipler4thed.p.109#64

9. ANS:

Evidently, m_1 will accelerate up, m_2 to the right, and m_3 down, with the same acceleration a.

1. Draw free-body diagrams for each box



(*a*) Write $\Sigma F = m_i a$ for each box — $T_1 - 1.5g = 1.5a$; $T_3 - T_1 = 3.5a$; $2.5g - T_3 = 2.5a$

Add the three equations to find a — $a = (9.81/7.5)$ m/s^2 $= 1.31$ m/s^2

(*b*) Use the three equations to find the tensions — $T_1 = (1.5 \times 11.12)$ N $= 16.7$ N, $T_3 = (2.5 \times 8.5)$ N $= 21.3$ N

REF: Tipler4thed.p.109#68

10. ANS:

(*a*) $a = F/(m_1 + m_2)$ and contact force $F_c = m_2 a$. So $F_c = Fm_2/(m_1 + m_2)$.
(*b*) Substitute numerical values in above expressions. $a = (3.2/8)$ m/s^2 $= 0.4$ m/s^2; $F_c = (3.2 \times 6/8)$ N $= 2.4$ N.

REF: Tipler4thed.p.110#69

11. ANS:

1. Total mass accelerated is 202 kg. $F = ma$ — $F = 323.2$ N
2. Apply $F = ma$ at points A, B, and C — $F_A = 160$ N; $F_B = 161.2$ N; $F_C = 321.6$ N

REF: Tipler4thed.p.110#71

12. ANS:

This is identical to Problem 4-72 with $\theta = 90°$. Setting $\sin\theta = 1$ in the expressions for a and T one obtains the above.

REF: Tipler4thed.p.111#81

13. ANS:

1. Find the acceleration $a = 2s/t^2$ — $a = 0.6\ \text{m/s}^2$
2. Solve for m_1 — $m_1 = m_2[(g + a)/(g - a)] = m_2(10.41/9.21)$
3. Find the second mass for m_2 or $m_1 = 1.2$ kg — $m_1 = 1.356$ kg, or $m_2 = 1.06$ kg

REF: Tipler4thed.p.111#82

14. ANS:

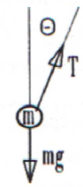
(*a*) The object will swing backward; see figure.

(*b*) $T_x = ma$; $T_y = mg$. $T_x/T_y = \tan\theta = a/g$. $a = g\tan\theta$.

(*c*) The object will swing forward

Find $a = v^2/2s$ — $a = (13.9^2/120)\ \text{m/s}^2 = 1.6\ \text{m/s}^2$

Find $\theta = \tan^{-1}(a/g)$ — $\theta = \tan^{-1}(1.6/9.81) = 9.3°$



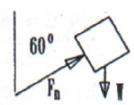
REF: Tipler4thed.p.112#95

15. ANS:

(*a*) Since $a_y = 0$, $\Sigma F_y = 0$ — $F_n\cos 60° = mg$

Find $a = a_x = F_{nx}/m$ — $a = F_n\sin 60°/m$; $a = g$ ~~cot~~ tan $60° = 17\ \text{m/s}^2$

(*b*) For $a > 17\ \text{m/s}^2$ block will move up the plane.



REF: Tipler4thed.p.112#100