5-Series Problem

5.1) An acceleration of $\vec{a} = \left(2.00\hat{i} + 5.00\hat{j}\right)$ m/s^2 is applied to a 3.00 kg mass.

a.) What is the resulting force acting on the mass?
b.) What is the magnitude of the resulting force acting on the mass?

5.3.) A 4.00 kg puck is found to have a velocity of $\left(3.00\hat{i}\right)$ m/s as it moves over a flat, horizontal, frictionless surface. Its velocity is $\left(8.00\hat{i} + 10.0\hat{j}\right)$ m/s eight seconds later. Assuming the applied force is constant:

a.) Determine the components of the applied force, and
b.) Determine the magnitude of the applied force.

5.5) The force of gravity on a baseball is $mg = 2.21\,N$ directed downward. If a pitcher accelerates the ball from rest for 170 milliseconds along a straight, horizontal line:

a.) Through what distance does the pitcher accelerate the ball?
b.) Determine the net magnitude and force on the ball due to the pitch.

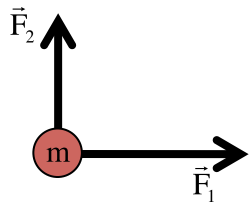
5.7) Over a 5.00 cm distance, an electron (mass $9.11\text{x}10^{-31}$ kg) accelerates from $3.00\text{x}10^{5}$ m/s to $7.00\text{x}10^{5}$ m/s. Assuming the motion is straight-line:

a.) What is the force exerted on the electron?
b.) How does this force compare to the electron's weight?

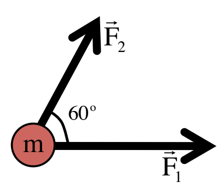
5.13) A force $\vec{F}_1 = 20.0N$ and $\vec{F}_2 = 15.0N$ act on a 5.00 kg mass as shown in the sketches. Determine the acceleration:

a.) For sketch a.
b.) For sketch b.

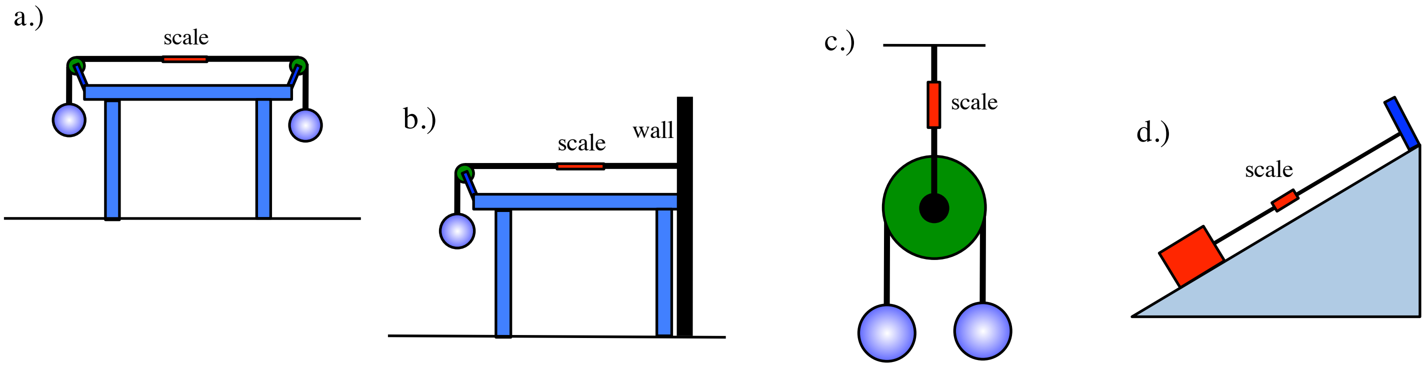
a.)

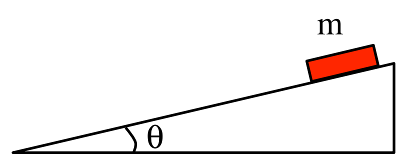


b.)



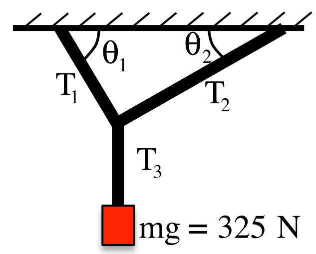
5.20) For each system shown, determine the scale reading. All masses are 5.00 kg; the surfaces are frictionless; ignore scale and string masses and assume the scales read in Newtons.



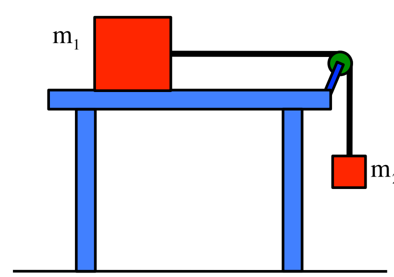


5.21) A block on an incline of length L = 2.00 meters slides from rest down the frictionless incline, whose angle is $\theta = 15^\circ$.

a.) Produce a free body diagram for the forces on the block.
b.) Derive an expression for the acceleration of the block.
c.) Determine the block's speed once it gets to the bottom of the ramp.

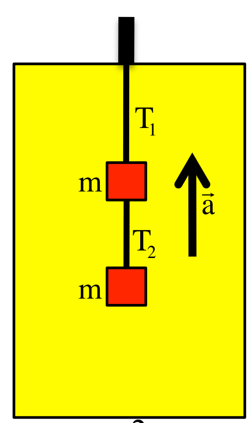


5.24) A backpack is bear-proofed by hanging in a tree by three ropes, as shown in the sketch. If the weight of the pack is 325 N and the angles are $\theta_1 = 60^0$ and $\theta_2 = 40^0$, what are the tensions in the three ropes?



5.28) A mass $m_1 = 5.00$ kg sits on a frictionless table. A stout thread is attached to the mass, threaded over a pulley and attached to a second mass $m_2 = 9.00$ kg.

a.) Generate a free body diagram for both masses.
b.) Derive an expression for the magnitude of the system's acceleration.
c.) Determine the string tension.



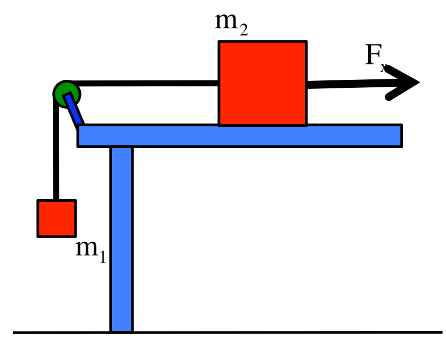
5.31) Two masses $m = 3.50$ kg are strung together and hung in an elevator as shown in the sketch.

a.) What is the tension in each line if the elevator's acceleration is

$$\vec{a} = \left(1.60 \text{ m/s}^2\right)\left(+\hat{j}\right).$$

b.) What acceleration can the elevator experience if the rope can handle only 85.0 N?

5.33) Mass $m_2 = 8.00$ kg is acted upon by a horizontal force F_x as the mass slides over a frictionless table top.

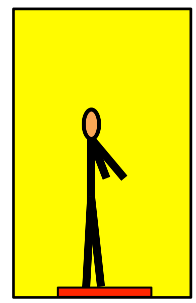


a.) The hanging mass $m_1 = 2.00$ kg will accelerate *upward* under what conditions (that is, what F_x will effect an upward acceleration)?

b.) The tension in the line will be zero under what conditions (that is, what F_x will effect that situation)?

c.) For a range between -100 N and +100 N, plot m_2's acceleration as a function of F_x.

5.35) A very tall, 72.0 kg man stands on a scale in an elevator. The elevator begins to move upward from rest accelerating at a constant rate for 0.80 seconds until it reaches a speed of 1.20 m/s. For the next 5.00 seconds, it moves with a constant velocity. It then slows to rest under a constant acceleration for 1.50 seconds.



a.) Before beginning its motion, what does the scale read?

b.) During the 0.80 second period, what does the scale read?

c.) During the 5.00 second period, what does the scale read?

d.) While it is coming to rest, what does the scale read?

5.37) A 12.0 gram bullet moving with velocity $\vec{v} = (260 \text{ m/s})(\hat{i})$ strikes and enters a bag of flour, coming to rest after 23.0 cm. Derive an expression for the frictional force (as a vector) acting on the bullet.

5.39) A 75.0 N force is required to motivate a stationary, 25.0 kg block into motion over a horizontal, frictional surface. A 60.0 N force is required to keep it moving with constant velocity.

a.) What is the coefficient of static friction between the block and the surface?

b.) What is the coefficient of kinetic friction between the block and the surface?

5.42) As of 2010, the fastest quarter mile time any piston-driven car has covered the quarter mile has been 4.43 seconds. Assuming the car pulled a wheelie when making this run (that is, the engine was so powerful that the car's front wheels were pulled off the pavement during the run).

a.) Calculate the minimum possible coefficient of static friction for this situation? (Common sense suggests that the coefficient of static friction will never be greater than 1.00—turns out you can create materials for which that isn't true!)

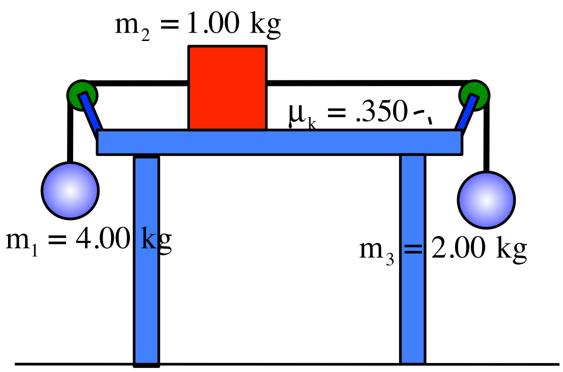
b.) If the engine power was increased over the situation outlined above, all else held constant, how would that affect the elapsed time?

5.46) The coefficient of kinetic friction between the table top and m_2 is .350. The masses are as shown in the sketch with the pulleys ideal (massless and frictionless).

a.) For each mass, draw a free body diagram.

b.) Derive an expression for the acceleration (as a vector) for each mass.

c.) How would the tensions have changed (if at all) if the surface had been frictionless?

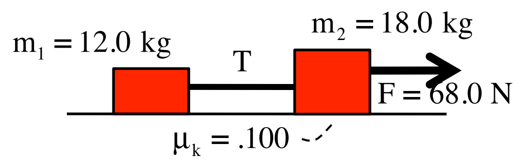


5.47) A 68.0 N force drags two masses connected by a "massless" string. The coefficient of kinetic friction between the blocks and the table top is 0.100.

a.) For each mass, draw a free body diagram.

b.) Derive an expression for the acceleration of each mass.

c.) Derive an expression for the tension in the string.



ADDED THRILL (for those of you who like challenges that are harder than your standard AP question . . .)

5.73) A 2.20 kg block is accelerated over a flat frictional surface by a thin (light) rope threaded over a small pulley that is hung 0.100 meters above the block's top (I've made the pulley look big—it should be really tiny!). The tension in the line is maintained at 10.0 N. If the coefficient of friction between the block and surface is 0.400:

a.) What is the block's acceleration as a function of *x*?

b.) What is the block's acceleration at $x = 0.400$ *meters*?

c.) How does the acceleration behave as you go from a very large *x* to x = 0?

d.) Where is the acceleration maximum, and what is the magnitude of the acceleration at that point?

e.) Where are the acceleration values zero?