Chapter 04 : Newton's Laws

HW04-15 : A 14.0 kg bucket is lowered vertically by a rope in which there is 132 N of tension at a given instant. What is the acceleration of the bucket? Is it up or down?

Suppose we change the mass to 12 kg but change nothing else. What is the acceleration of the bucket now? Is it up or down?

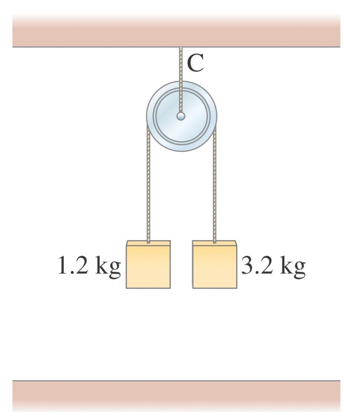
(Note: this is a good example emphasizing how the direction of motion tells you nothing about the sign of the acceleration. The bucket may be travelling downward and speeding up downward, or may be travelling downward but slowing down.)

HW04-34 : One 3.2 kg paint bucket is hanging by a massless cord from another 3.2 kg paint bucket, also hanging by a massless cord, as shown in the figure. (a) If the buckets are at rest, what is the tension in each cord? (b) If the two buckets are pulled upward with an acceleration of 1.45 m/s^2 by the upper cord, calculate the tension in each cord.

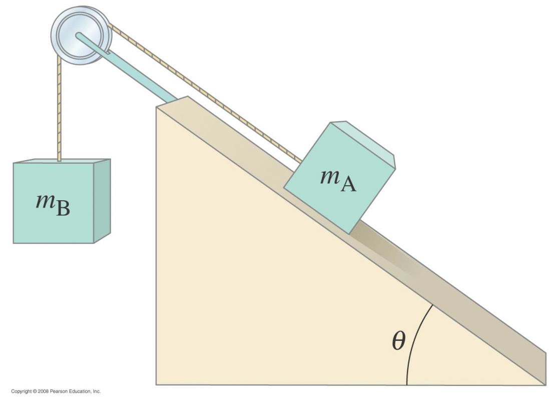
(Hint: remember to apply Newton's Laws separately to each object.)

HW04-52 : A 450 kg piano is being unloaded from a truck by rolling it down a ramp inclined at 15^o (with respect to the horizontal direction). There is negligible friction and the ramp is 4.0 m long. Two workers slow the rate at which the piano moves by pushing with a combined force of 1020 N parallel to the ramp. If the piano starts from rest, how fast is it moving at the bottom of the ramp?

HW04-58 : Suppose the pulley in the figure is suspended by a cord C. Determine the tension in that upper cable C after the masses are released (but before either hits the ground). Ignore the mass of the pulley and cords.
(Take note of what they're asking for here: the tension in that upper cable, not in the cable that's connecting the two masses, although you'll need that to determine the tension in the upper cable. Remember Newton's Laws apply separately to each object. What object is involved in determining the tension in cord C?)



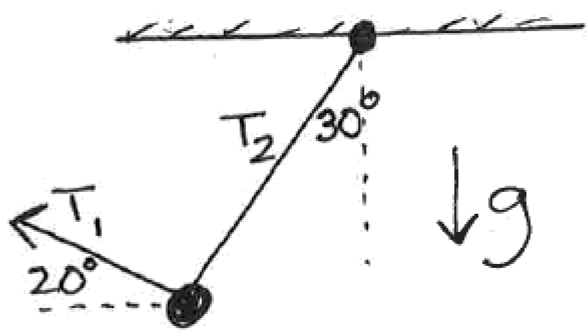
HW04-77 : A block (of mass $m_A = 1.00\ kg$) lying on a fixed frictionless inclined plane (with $\theta = 38^o$) is connected to an identical block (of mass $m_B = 1.00\ kg$) by a cord passing over a pulley. (a) What will be the acceleration of the system? (b) How much tension will there be in the cable?



(c) What **different** mass for block B would allow the system to remain at rest? (d) How much tension will there be in the cable in this case?

(Hint: remember to apply Newton's Laws separately to each object.)

[Another recent test problem.] : We occasionally do a demonstration in class where a bowling ball is hung on a cable from the ceiling to illustrate pendulums, energy and other things. Here though, we're just looking at the forces involved. Suppose that another cable is being used to pull the ball over to the side. In the figure, the ball is hanging motionless, the cable connecting the ball to the ceiling makes a 30^o angle relative to the vertical, and the cable going off to the left is making a 20^o angle relative to the horizontal.



Suppose we know that the tension in cable 1 is 25 N. Use this information to determine the tension in the other cable and the mass of the bowling ball.

(Hint: what are **all** the vector forces acting on the bowling ball here?)

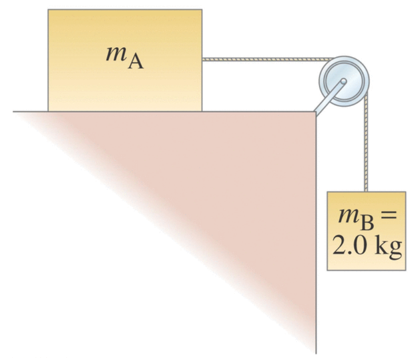
Chapter 05 : friction (kinetic and static); circular motion

HW05-02 : A (horizontal) force of 35 N is required to start a 4.0 kg box moving across a horizontal concrete floor. (a) What is the coefficient of static friction between the box and the floor? (b) If the 35.0 N force continues, the box accelerates at 0.60 m/s^2. What is the coefficient of kinetic friction?

HW05-06 : A 25.0 kg box is released on a 27^o incline and accelerates down the incline at 0.36 m/s^2. Find the friction force impeding its motion. What is the coefficient of kinetic friction?

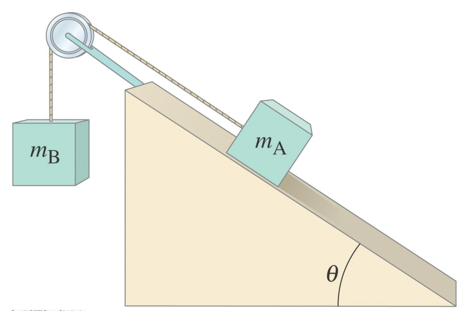
(Start from Newton's Laws; don't use specialized equations you won't be able to use on the test.)

HW05-23 : The coefficient of static friction between mass m_A and the table is 0.40, whereas the coefficient of kinetic friction is 0.30. (Ignore masses of the cord and pulley.)
(a) What minimum value of m_A will keep the system from starting to move?
(b) If the blocks are moving, what value of m_A will allow the blocks to continue to move at a constant speed?



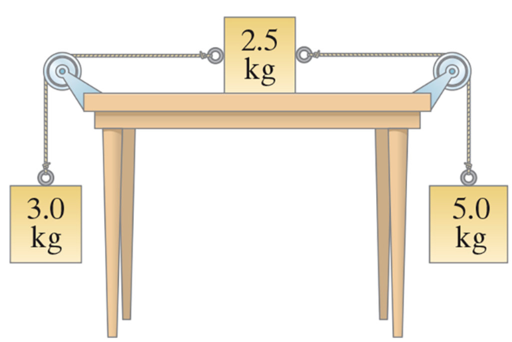
(The usual hint for connected objects: Newton's Laws apply separately to each object.)

HW05-28 : (a) Suppose the coefficient of kinetic friction between m_A and the ramp in $\mu_k = 0.15$ and that $m_A = m_B = 2.7$ kg. As m_B moves down, determine the magnitude of the acceleration of m_A and m_B when $\theta = 34^o$. (Are the masses speeding up or slowing down?)
(b) What value of μ_k will keep the system from accelerating?

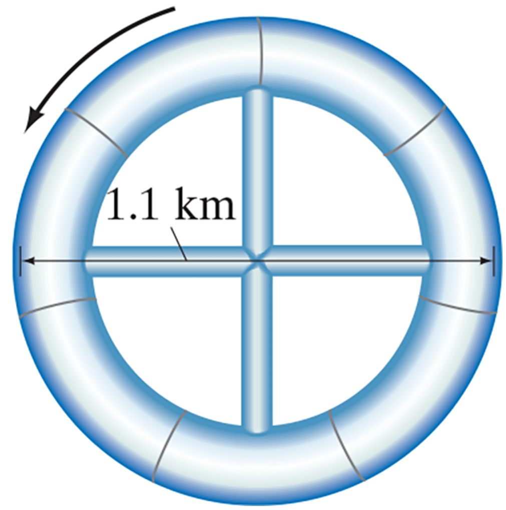


(And again - Newton's Laws apply separately to each object.)

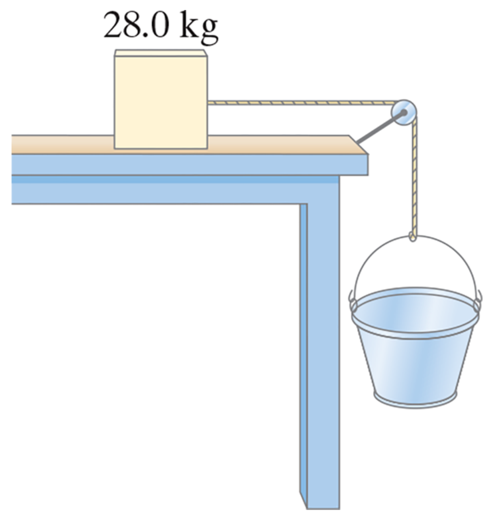
HW05-31 A 2.5 kg block is placed on a table as shown in the figure. The coefficient of kinetic friction between the block and the table is $\mu_k = 0.35$. The block is connected by massless ropes over pulleys (whose mass and friction can be ignored) to a 5.0 kg block on the right, and a 3.0 kg block on the left. (a) Find the acceleration of the block on the table if at this instant it's moving to the right. (b) Find the tensions in the two ropes.



HW05-54 A proposed space-station consists of a circular tube that will rotate about its center (like a tubular bicycle tire). The circle formed by the outer edge of the tube has a diameter of 1.1 km. What must be the rotation speed (in revolutions per **day**) if an effect nearly equal to gravity at the surface of the earth, 0.9 g, is to be felt by astronauts standing inside?
(For this to happen, basically they'll need to stand so their feet are planted on the inner surface of the outer edge of the tube. That normal force will 'feel' like the same normal force they'd feel if their feet were on the Earth.)

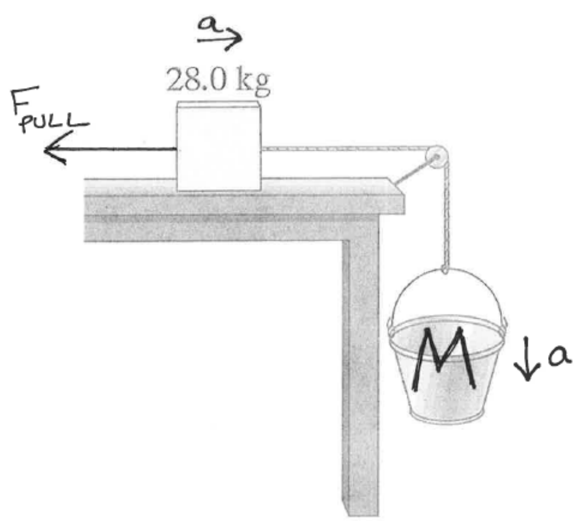


HW05-95 A 28.0 kg block is connected to an empty 2.0 kg bucket by a cord running over a frictionless pulley. The coefficient of static friction between the table and the block is 0.42 and the coefficient of kinetic friction is 0.34.
Sand is gradually added to the bucket until the system just starts to move. (a) Calculate the mass of sand we had to **add** to the bucket. (b) Calculate the resulting acceleration of the system.



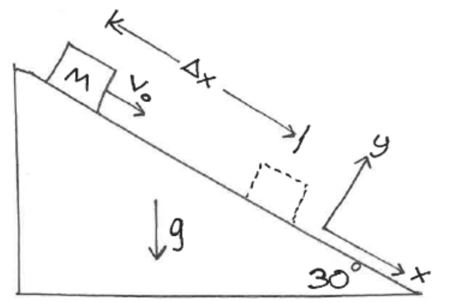
HW05-XX A 28.0 kg block is connected to a filled bucket by a cord running over a frictionless pulley. There is **no friction** here, but someone is **pulling** the block to the left with $F_{pull} = 100\ N$. As a result, the bucket is seen to be accelerating downward with $|a| = 0.5\ m/s^2$, and the block on the table is accelerating to the right at $|a| = 0.5\ m/s^2$.

(a) What must the mass of the hanging object be?



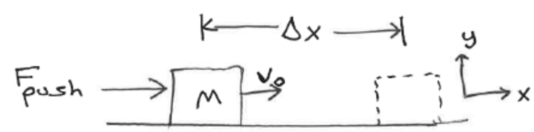
Problems added 25 February:

HW05-YY A 10 kg box is sliding down a rough 30^o incline as shown in the figure. In the upper position, the box is sliding down the incline at 50 cm/s ($v_o = 0.5\ m/s$) but we observe that the box is slowing down and comes to a stop after sliding 50 cm ($\Delta x = 0.5\ m$) along the ramp.



(a) What must the kinetic coefficient of friction be?

HW05-ZZ A box of unknown mass M is sliding across the floor to the right at 1.5 m/s and is being pushed with a constant force of $F_{push} = 200\ N$. The (flat, horizontal) floor is rough, with a coefficient of kinetic friction of $\mu_k = 0.6$ and we observe that the box is slowing down, coming to a stop after travelling 50 cm ($\Delta x = 0.5\ m$).



(a) What must the mass (M) of the box be?

HW04-15 : With $m = 14\ kg$, the acceleration will be $a = 0.3714\ m/s^2$ downward (so the bucket is moving down and speeding up in that direction).

With $m = 12\ kg$, the acceleration will be $a = 1.2\ m/s^2$ upward (so the bucket is moving down, but is slowing down in that direction).

HW04-34 : When $a = 0$, the lower cord has a tension of $31.36\ N$ and the upper cord has a tension of $62.72\ N$.

When the buckets are accelerating upward at $a = 1.45\ m/s^2$, the lower cord has a tension of $36\ N$ and the upper cord has a tension of $72\ N$.

HW04-52 : Applying Newton's laws, find that $a = 0.269759975\ m/s^2$ down along the ramp. After travelling 4 meters, $v = 1.469\ m/s$.

HW04-58 : F_T in cord C will be $34.211\ N$. (Apply Newton's Laws separately to the two hanging objects to find the tension in that lower cable to find the tension in the upper cable.)

HW04-77 : (a) $a = 1.88326\ m/s^2$ (block A accelerating UP along the incline; and block B accelerating vertically downward). (b) In that case, $F_T = 7.917\ N$.

(c) $M_B = 0.61566\ kg$ will allow the system at remain at rest. (d) In that case, $F_T = 6.0335\ N$.

Another recent test problem : $\sum F_x = 0$ will show that $T_2 = 46.9846\ N$. Using that information, $\sum F_y = 0$ results in $M = 5.0245\ kg$.

HW05-02 : (a) $\mu_s = 0.89257$, and (b) $\mu_k = 0.83163$.

HW05-06 : $f_k = 102.2277\ N$; $\mu_k = 0.4683$

HW05-23 : (a) M_A needs to be at least $4.949\ kg$ to keep the blocks in place. (b) M_A needs to be exactly $6.67\ kg$ if the blocks are moving at a constant speed.

HW05-28 : (a) $|a| = 1.551\ m/s^2$, with block A accelerating up the incline, and block B accelerating downward, so each block is speeding up in the same direction they're moving in initially.

(b) Constant speed, so $a = 0$ known now; leads to $\mu_k = 0.5317$

HW05-31 : (a) $a = 1.05\ m/s^2$, to the right (so the objects are speeding up in their directions of motion). (b) The tension in the left rope will be $32.55\ N$ and in the right rope will be $43.75\ N$.

(Hint: 3 objects here so apply Newton's Laws to each. Rearrange the equations for the left and right objects so you can replace the two tension variables present in the equation for the block on the table.)

HW05-54 : (see class notes for 23 Feb)

HW05-95 : (a) We have to **add** $9.76\ kg$ of sand to the $2\ kg$ bucket to produce enough tension in the cable to overcome static friction holding the block in place.

(b) Once things start moving, the acceleration will be $0.5521\ m/s^2$.

HW05-XX : Apply Newton's Laws to each object, using the known acceleration, but leaving the bucket mass as the unknown M. Results in $M = 12.26\ kg$

HW05-YY : Use the given info to find $a_x = -0.25\ m/s^2$; apply Newton's laws (including f_k pointing up along the ramp) to find $\mu_k = 0.607$.

HW05-ZZ : Use the given info to find $a_x = -2.25\ m/s^2$; apply Newton's laws (with f_k to the left, but with M unknown); rearrange to find $M = 55.1\ kg$.