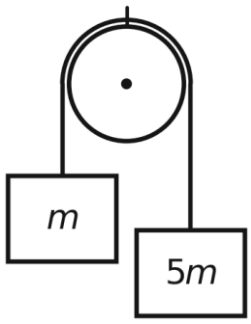
More Two-Body Systems — Advanced Applications

Draw a separate free-body diagram for each object. Show force equations and calculations, including directions and units. Assume massless, inextensible ropes and frictionless pulleys.

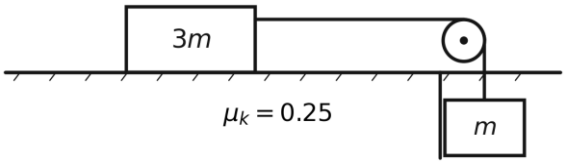
Mild

1. Two masses, m and 5m, hang from opposite ends of a rope passing over a pulley.
   a. Choose a value for m between 1.0 kg and 10 kg. State both masses.
   b. Determine the magnitude and direction of the system's acceleration.
   c. Determine the tension in the rope.
   d. Predict how doubling m will affect the acceleration. Calculate to verify.
   e. Predict how doubling m will affect the tension. Calculate to verify.



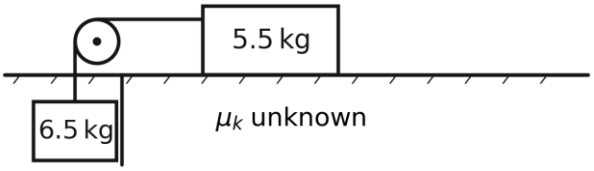
Medium

2. A block of mass 3m is sliding right across a horizontal surface with $\mu_k = 0.25$. It is connected over a pulley to a hanging mass m.
   a. Choose a value for m between 1.0 kg and 10 kg. State both masses.
   b. Determine the kinetic frictional force on the horizontal block.
   c. Determine the magnitude and direction of the system's acceleration.
   d. Determine the tension in the rope.



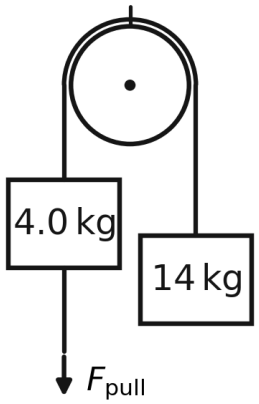
Spicy

3. A 5.5 kg block slides left across a rough horizontal table. A rope passes over a pulley on the left to a hanging 6.5 kg mass. The block accelerates left at $2.0\ \mathrm{m/s^2}$.
   a. Determine the tension in the rope.
   b. Determine the magnitude of the kinetic frictional force.
   c. Calculate the coefficient of kinetic friction between the block and table.



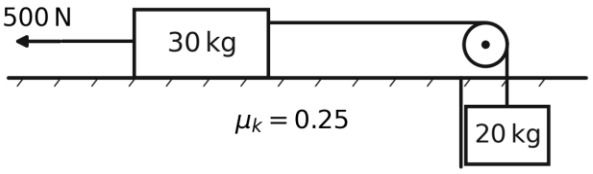
Spicy

4. A 4.0 kg mass and a 14 kg mass hang from the connecting rope over a pulley. A person pulls vertically downward on a separate rope attached below the 4.0 kg mass. The system is initially at rest.
   a. Determine the tension in the rope connecting the masses if they remain stationary.
   b. Determine the minimum downward pulling force required to prevent the 14 kg mass from beginning to descend.



Extra-Spicy

5. A 30 kg block is sliding left across a rough table with $\mu_k = 0.25$. It is connected over a pulley on the right to a hanging 20 kg mass. A person pulls the block left using a separate rope with a force of 500 N.
   a. Determine the magnitude and direction of the system's acceleration.
   b. Determine the tension in the rope connecting the two masses.



6. A 10 kg block is already sliding left on a rough table with $\mu_k = 0.50$. It is connected over a pulley on the left to a hanging 8.0 kg mass. A person pulls the block horizontally right with 180 N using a separate rope.
   a. State the direction of kinetic friction acting on the 10 kg block.
   b. Determine the magnitude and direction of the system's acceleration.
   c. Determine the tension in the connecting rope.
   d. Is the 10 kg block initially speeding up or slowing down? Explain.

