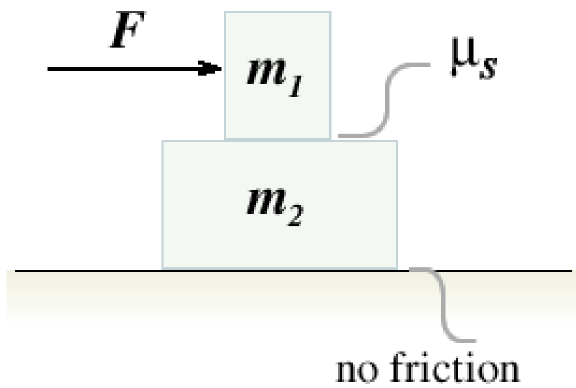
Problem Set 2

1. **Stacked Blocks**

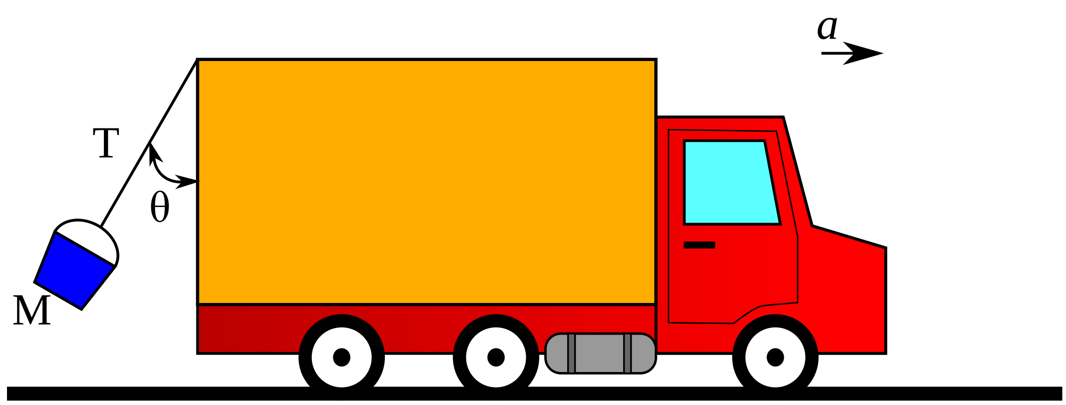


Consider two blocks that are resting one on top of the other. The lower block has mass $m_2 = 4.8$ kg and is resting on a frictionless table. The upper block has mass $m_1 = 2.2$ kg. Suppose the coefficient of static friction between the two blocks is given by $\mu_s = 0.5$.

A force of magnitude F is applied as shown. What is F_{max}, the maximum value of F for which the upper block can be pushed horizontally so that the two blocks move together without slipping? Please give your answer in Newtons.

2. **Accelerating Truck and Suspended Bucket**

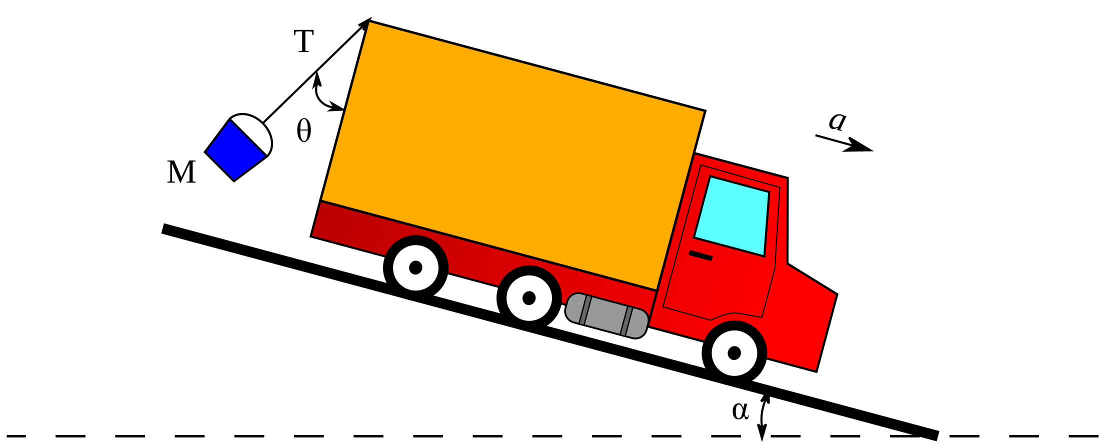
A truck is traveling in a straight line on level ground, and is accelerating uniformly with an acceleration of magnitude a. A rope (that can be considered massless and inextensible) is tied to the back of the truck. The other end of the rope is tied to a bucket of mass M. The bucket tosses wildly when the truck starts to accelerate, but later on it stays at a fixed position at a fixed distance behind the truck, with the rope hanging straight at a fixed angle, as shown in the diagram.



(a) Find the angle θ at which the rope will settle. Express your answers in terms of the given variables M, g, and a as needed.

(b) What will the tension T of the rope be once it settles into this angle? Express your answers in terms of the given variables M, g, and a as needed.

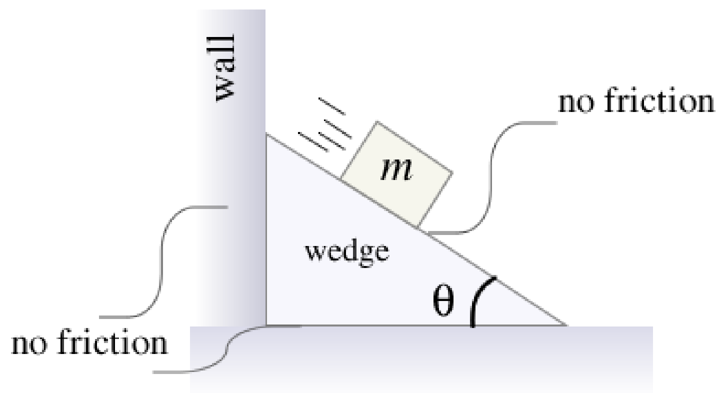
(c) The truck comes to a downhill section of road, at an angle α relative to the horizontal, as shown in the figure. Suppose that the truck continues to accelerate with an acceleration of magnitude a.



Once the rope again settles to a (possibly different) fixed angle θ relative to the truck's back door, what will that new angle be? Express your answer using the given variables M, g, α, and a as needed.

(d) What will the new tension T in the rope be? Express your answers in terms of the given variables M, g, α, and a as needed.

3. **A wedge against a wall**

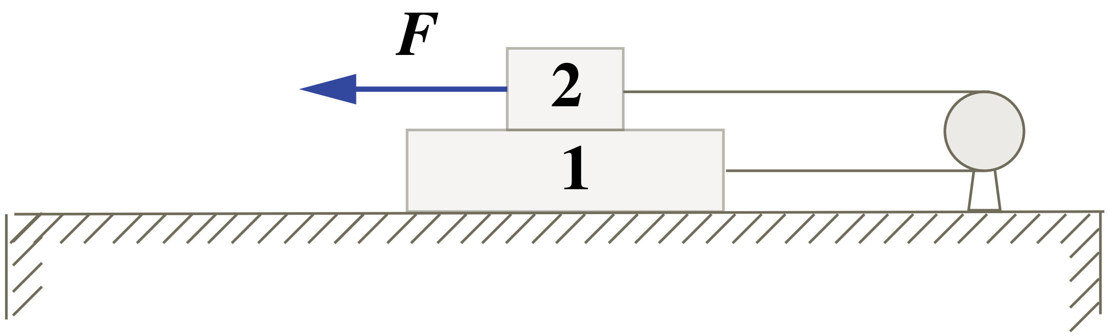


A wedge with an inclination of angle θ rests next to a wall. A box of mass m is sliding down the incline surface, as shown. There is no friction between any of the surfaces, (wedge and the box, wedge and the horizontal surface, wedge and the wall). For the answers below, you can use θ, m and g as needed.

(a) Find F_{total}, the magnitude of the sum of all forces acting on the box.

(b) Find F_{ww}, the magnitude of the force exerted by the wall on the wedge.

4. **Dragging two blocks**



Two blocks of masses m_1 and m_2 are connected by a light cord passing around a fixed, frictionless pulley. The coefficient of kinetic friction between all surfaces is μ. Find F, the magnitude of the horizontal force necessary to drag block 2 to the left at constant speed.

5. **Blocks and springs**

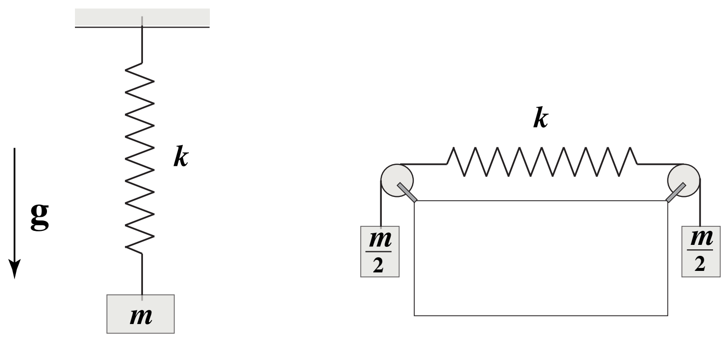
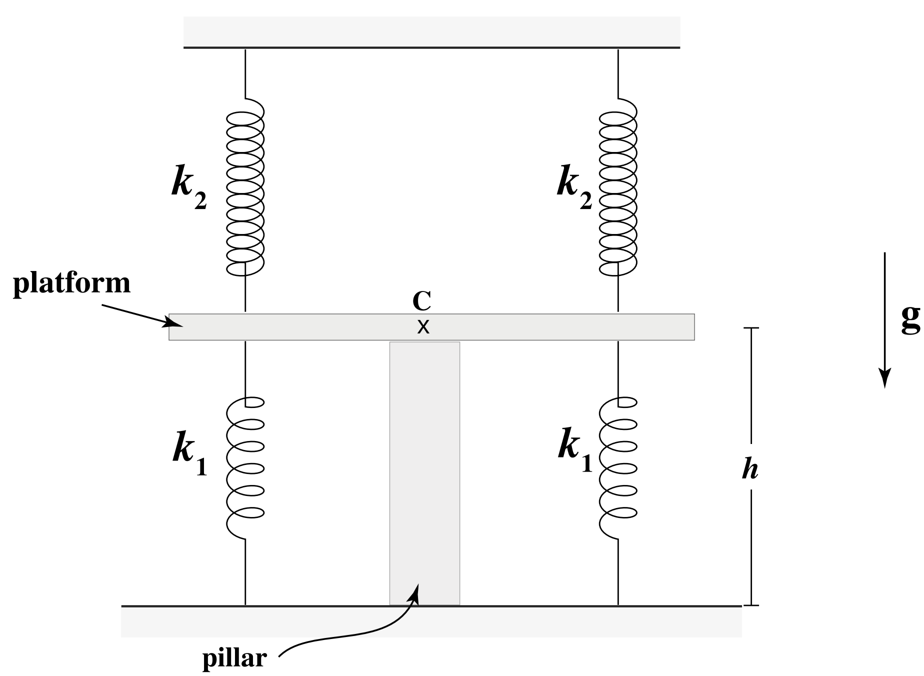


Figure A **Figure B**

(a) In Figure A above, a block of mass m is hanging from a spring attached to the ceiling. In Figure B above, two identical blocks of mass $m/2$ are hanging from two ropes that are attached to a spring that has the same spring constant k. If the spring in Figure A has stretched a distance d from its natural length, what is x, the distance the spring in Figure B has stretched with respect to its natural length?



(b) A platform of mass M and at a height h above the ground is supported by a pillar as shown. The pillar is placed right under the center of the platform, point C in the figure. Two identical springs of spring constant constant k_1 connect the platform to the floor, and a second pair of identical springs of spring constant k_2 connect the platform to the ceiling. The springs are attached to the platform at the same distance from its center, point C. With the support pillar in place, the springs are unstretched.

When the pillar is removed, at what height h_f will the platform come to equilibrium? Express your answer in terms of h, M, g, k_1 and k_2 as needed.