Example force problems

1. An advertisement claims that a particular automobile can "stop on a dime." What net force would actually be necessary to stop a 850 kg automobile traveling initially at 45.0 km/h in a distance equal to the diameter of a dime, which is 1.8 cm. *Hint: watch the units!*

2. A block of mass $m = 5.00\,\mathrm{kg}$ is pulled along a horizontal frictionless floor by a cord that exerts a force of magnitude $F = 12.0\,\mathrm{N}$ at an angle of 65° with respect to horizontal. **(a)** What is the magnitude of the block's acceleration? **(b)** The force magnitude F is slowly increased. What is its value just before the block is lifted off the floor?

3. NOTE: you should draw free-body diagram for a mass on an inclined plane to show that $a = -g\sin\theta$. They should know this, but need to see the vector components work out.

A block is projected up a frictionless inclined plane with an initial speed of $v_o = 2.50\,\mathrm{m/s}$. The angle of incline is $\theta = 17.0°$. (a) How far up the plane does the block go? (b) How long does it take to get there? (c) What is its speed when it gets back to the bottom?

4. In the figure below, three ballot boxes are connected by cords, one of which wraps over a pulley having negligible friction on its axle and negligible mass. The three masses are $m_a = 30.0\,\mathrm{kg}$, $m_b = 40.0\,\mathrm{kg}$, and $m_c = 10.0\,\mathrm{kg}$. When the assembly is released from rest, **(a)** what is the tension in the cord connecting B and C, and **(b)** how far does A move in the first 0.250 s (assuming it does not reach the pulley)? The table may be assumed to be frictionless.

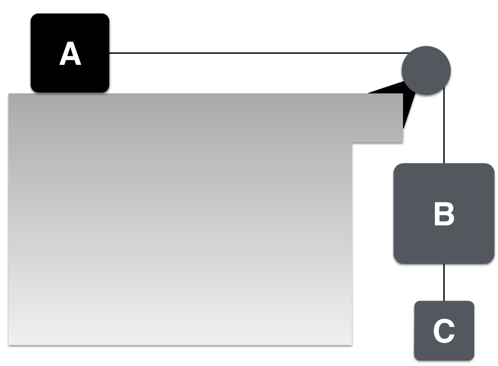


Figure 1: *Three boxes connected by cords, one of which wraps over a pulley.*

5. A projectile is launched with initial velocity $\vec{\mathbf{v}}_i$ from the start of a ramp, with the ramp making an angle φ with respect to the horizontal. The projectile is launched with an angle $\theta > \varphi$ with respect to the horizontal. At what position along the ramp does the projectile land?

6. A 3.00 kg object is moving in a plane, with its x and y coordinates in meters given by $x(t) = 5t^2 - 1$ and $y(t) = 3t^3 + 2$, where t is in seconds. What is the magnitude of the net force acting on this object at $t = 2.00\,\mathrm{s}$?

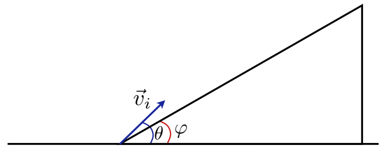
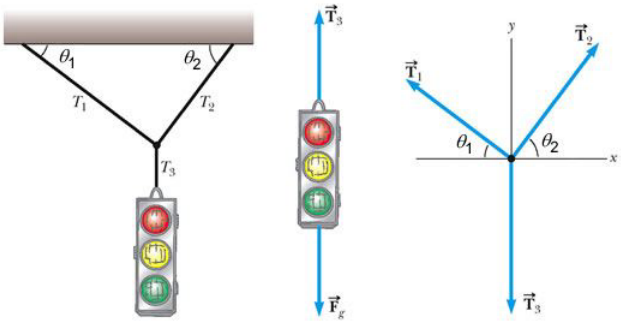
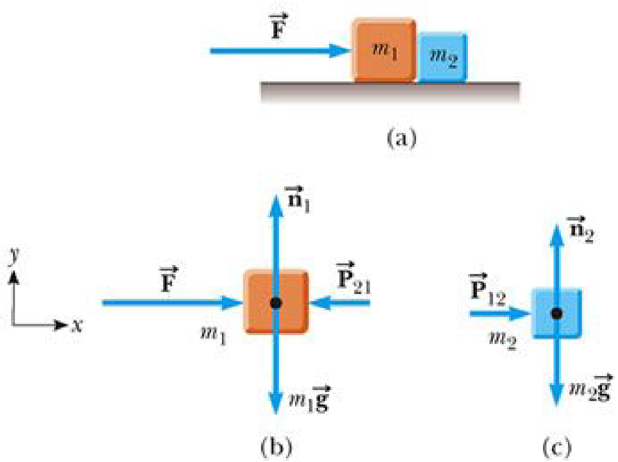


Figure 2: *A projectile is launched onto a ramp.*

7. A traffic light weighing $mg = 123\,\mathrm{N}$ hangs from a cable tied to two other cables fastened to a support, as in the figure below. The upper cables make angles of $\theta_1 = 40°$ and $\theta_2 = 50°$ with the horizontal. Find the magnitudes of $\vec{\mathbf{T}}_1$, $\vec{\mathbf{T}}_2$, and $\vec{\mathbf{T}}_3$.



8. Two blocks of masses m_1 and m_2 ($m_1 > m_2$) are placed in contact on a horizontal, frictionless surface, as shown in the figure below. A constant horizontal force of $\vec{\mathbf{F}} = 115\mathrm{N}$ is applied to m_1 as shown. Find the magnitude of the acceleration of the two blocks.



9. *HRW 6.30* A toy chest and its contents have a combined weight of $180\,\mathrm{N}$. The coefficient of static friction between toy chest and floor is $\mu_s = 0.42$. A child attempts to move the chest across the floor by pulling on an attached rope. (a) If the rope makes an angle of $\theta = 42°$ with the horizontal, what is the magnitude of the force $\vec{\mathbf{F}}$ that the child must exert on the rope to pull the chest on the verge of moving? (b) Write an expression for the magnitude F required to pull the chest on the verge of moving as a function of the angle θ. Determine the value of θ for which F is (c) a minimum and

(d) a maximum magnitude.

10. *HRW 5.57* A block of mass $m_a = 3.70\,\text{kg}$ on a frictionless plane inclined at an angle $\theta = 30.0°$ is connected by a cord over a massless, frictionless pulley to a second block of mass $m_b = 2.30\,\text{kg}$ (figure below). What are (a) the magnitude of the acceleration of each block, (b) the direction of the acceleration of the hanging block, and (c) the tension in the cord?