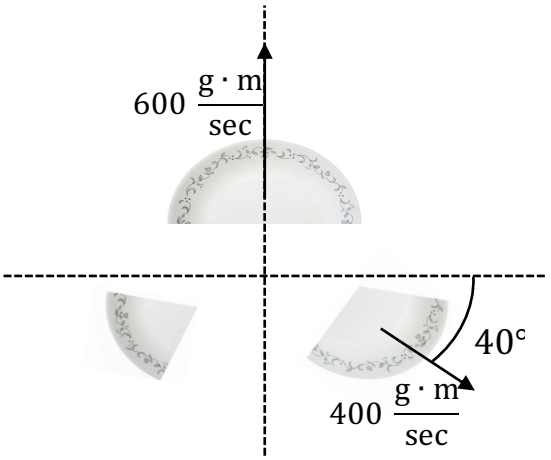
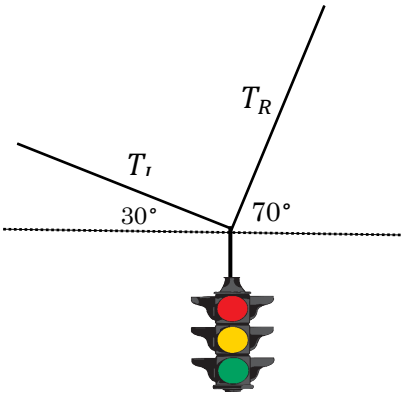
Mastering Physics Prerequisites
Manipulating Vectors
Problems 1-5

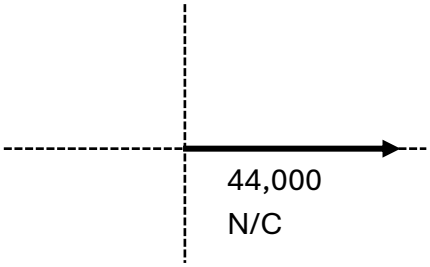
1. A plate is dropped straight downward and breaks on the floor. The initial momentum of the plate in the plane of the floor is zero, so the final momentum of the pieces of the plate must be zero as well. The plate breaks into three pieces. One piece has a momentum of $600\ \mathrm{g \cdot m/sec}$ straight up in the diagram and a second has a momentum of $400\ \mathrm{g \cdot m/sec}$ at an angle of $40°$ below the horizontal. What is the direction of the velocity of the third piece?

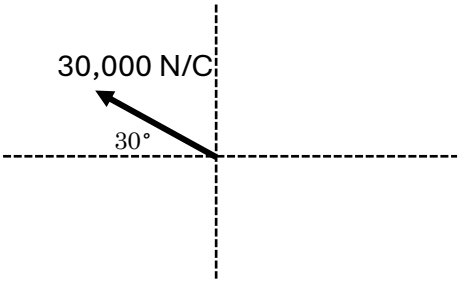


2. A 100-lb stoplight is suspended from two cables, the mass of which can be ignored. The cable on the right, T_R, makes an angle of 70° with the horizontal and the cable on the left, T_L, makes an angle of 30° with the horizontal. What is the tension in each cable? Give your answers in units of pounds.

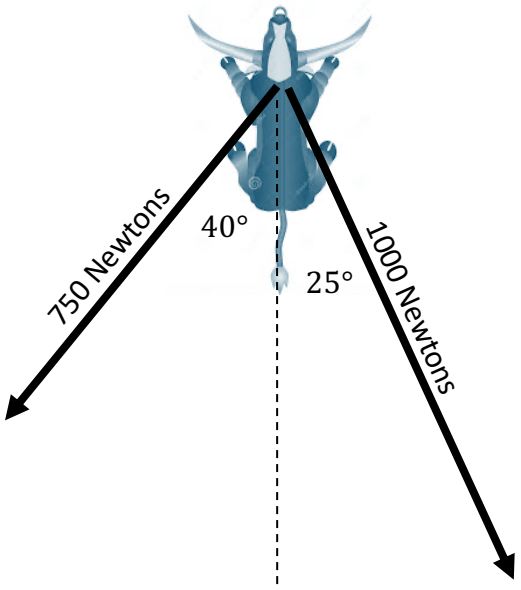


3. An electric charge is placed at some point in a plane. As a result, the electric field at the origin is 44,000 N/C in the positive x direction. Now a second charge is added to the coordinate system and now the electric field is 30,000 N/C in a direction that is $30°$ above the negative x axis. Now the first charge is removed. What is the electric field at the origin of the coordinate system?





4. Two cowboys have roped a bull and are pulling on it with the forces and directions shown. Nonetheless, the bull is motionless. What is the force the ground is exerting on the bull?



5. A well-known artifact from the battle of Gettysburg shows a Union 3-ring Minie ball fused with a Confederate 2-ring bullet after a mid-air collision. Similar fused pairs from the Civil War have been excavated. Let's make some assumptions about the trajectories of the bullets and calculate their trajectory immediately after they fused. Assume that the Union bullet had a mass of 500 grains and a speed of 800 ft/sec immediately before the collision and that the Confederate bullet had a mass of 450 grains and a speed of 1200 ft/sec immediately before the collision. If the bullets were traveling in the directions shown, what if the direction of travel of the bullets immediately after they fused?