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Discussion 3: Force

Objective

- State and apply the relationship between force and motion.

Summary

Newton's laws of motion

1. $\left(\sum \vec{F} = \vec{0}\right) \Leftrightarrow \left(\vec{a} = \vec{0}\right)$
2. $\vec{a} = \sum \vec{F}/m$
3. $\vec{F}_{1\to 2} = -\vec{F}_{2\to 1}$

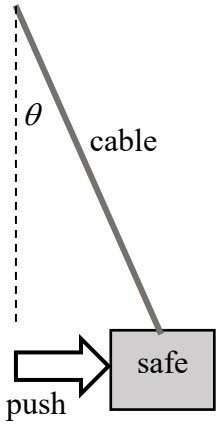
Problems

There is not room on this worksheet for your work. Use scratch paper.

1. A 2880-kg elevator suspended by a steel cable accelerates upward at a rate of 1.0 m/s^2. Find the tension $\vec{F}_T$ in the cable using the following procedure.
   a. Draw a diagram of the situation. Indicate your coordinate axes and origin.
   b. List the forces acting on the elevator. Make a free body diagram for the elevator.
   c. Find the weight $\vec{F}_g$ of the elevator (magnitude and direction).
   d. Complete the table below. Use Newton's second law and the rules for addition of vectors to find the formulas.

vector	*x*	*y*
$\vec{F}_g$	$mg_x = 0$	$mg_y =$
$\vec{F}_T$		
$\sum \vec{F}$	$ma_x = 0$	$ma_y =$
$\vec{a}$	0	1.0 m/s^2

2. A 225-kg safe carried by a crane hangs from a cable. A worker installing the safe pushes the safe horizontally, so that the safe is motionless with the cable at an angle of $\theta = 20°$ from vertical. What is the magnitude of the worker's push F_P? What is the tension F_T in the cable?



   a. Draw a diagram of the situation. Include coordinate axes in the diagram. Here, I'll ask that you make *x* horizontal and *y* vertical.

   b. Draw a labeled free body diagram for the safe.

   c. Decompose the cable tension vector $\vec{F}_T$ into its *x* and *y* components by identifying and applying the appropriate trigonometric functions of the angle θ.

   $F_{Tx} =$ F_T _____ θ $\qquad$ $F_{Ty} =$ F_T _____ θ

   d. Complete the table below to find the magnitudes of F_P and F_T. Signs matter! Make sure they are consistent with your coordinate axes.

vector	*x*	*y*
$\vec{F}_g$	$mg_x = 0$	$mg_y =$
$\vec{F}_P$	$F_P =$	0
$\vec{F}_T$	$F_{Tx} =$	$F_{Ty} =$
$\sum\vec{F}$	0	0

3. Two tugboats push a large (5.0×10^6 kg) tanker ship to dock. The first tugboat pushes with a force of 50,000 N due north (0°), and the second pushes with a force of 100,000 N 50° east of north (50°).

   a. Find the magnitude and direction of the ship's resulting acceleration. Assume that momentarily the water does not apply any drag to the ship. Feel free to use tools and techniques from the previous problems.

   b. Under what condition(s) would it be reasonable to assume that momentarily the water does not apply any drag to the ship?