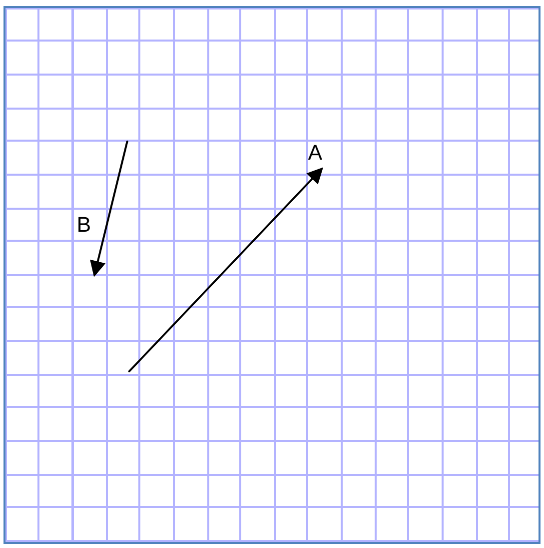
Chapter 2

Section 2.2

1. Vector Addition – Graphical

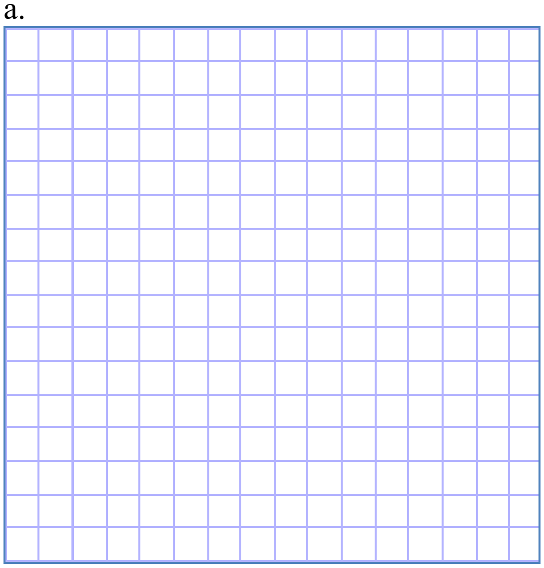
Consider the 2 force vectors given below. Each square on the grid is equal to 10N.



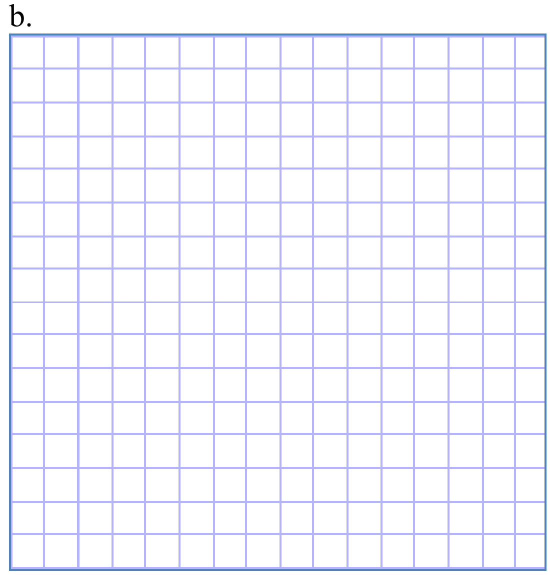
a. Draw $\vec{A}+\vec{B}$

b. Draw $\vec{A}-\vec{B}$

a.



b.



2.Vector Addition

Given: **A**= (10 m, 0^{o}), **B** = 10 m, 45^{o}), **C** = 10 m. 270^{o})

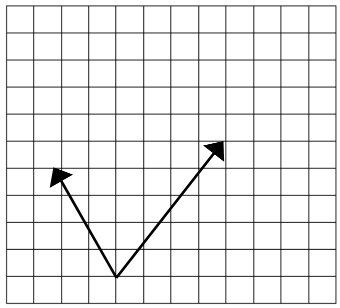
Use the tip-to-tail method to find:

a. **A + B**
b. **A – B**
c. **B – A**
d. **B + C**

a.	b.
c.	d.

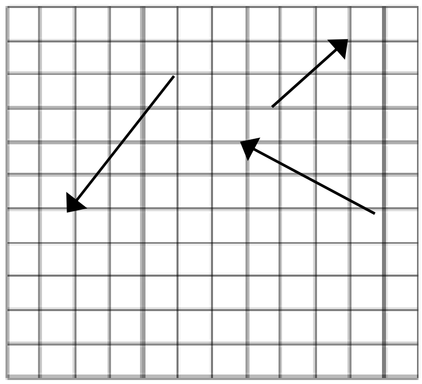
3. Calculating Net Force - Graphical

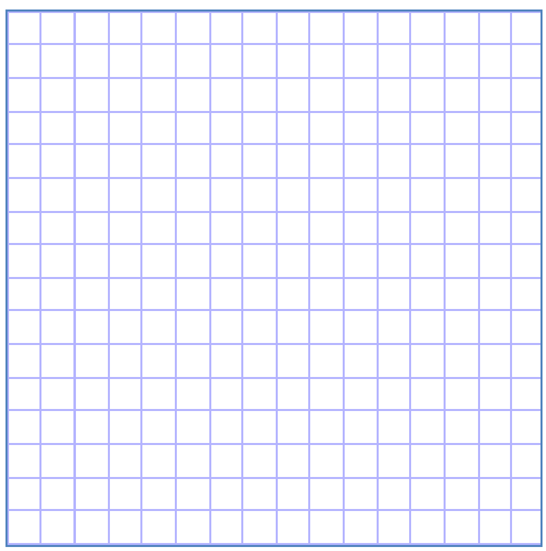
The arrows in the figure represent the forces acting on an object. Draw an arrow to represent the *net* force.



4. Calculating Net Force - Graphical

The arrows in the figure represent the forces acting on an object. Draw an arrow to represent the *net* force.



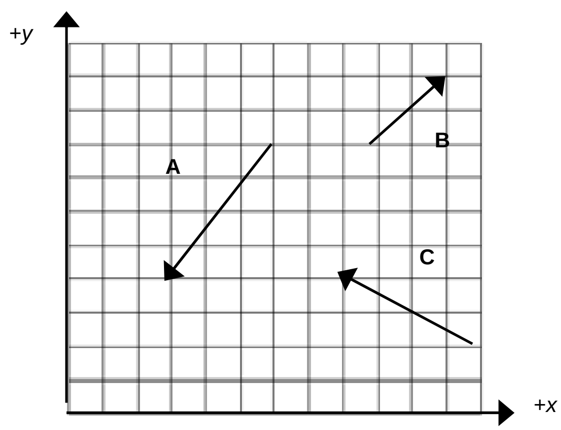


Section 2.3

5. Calculating Force Components - Graphical

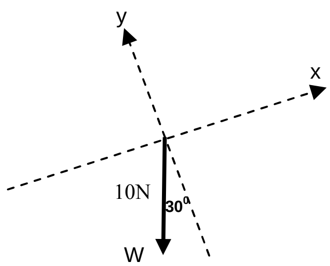
The arrows in the figure represent the forces acting on an object. For each force, determine the signs (+ or –) of the *x*- and *y*-components.

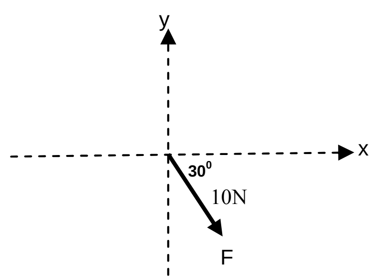
Force	**Sign of *x*-component**	**Sign of *y*-component**
A		
B		
C		

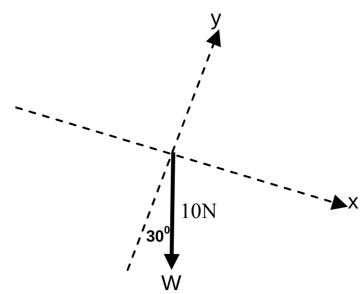


6. Force Components - Trigonometry

Find the x- and – y component of the three vectors shown below.







W_x = __________ N
W_y = __________ N

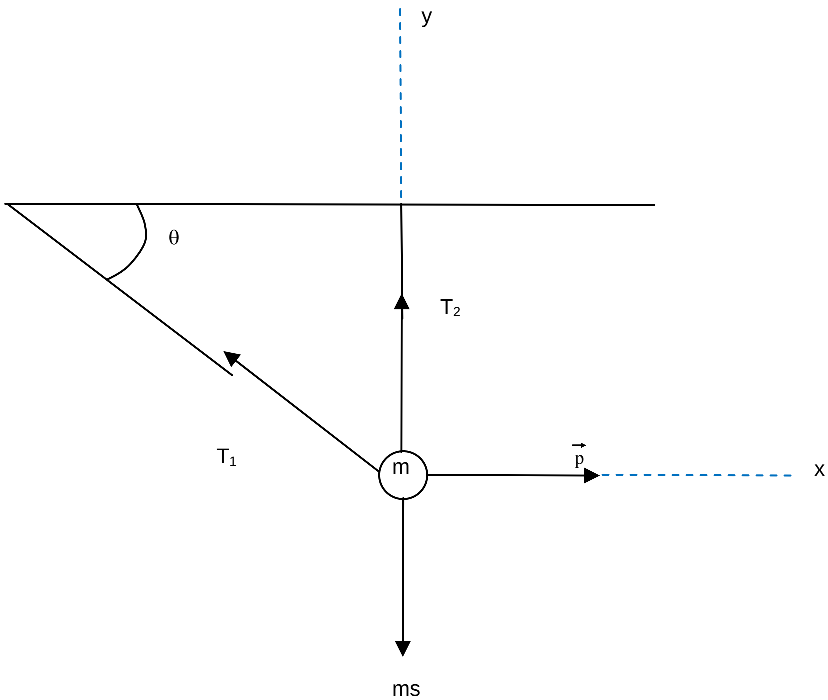
W_x = __________ N
W_y = __________ N

W_x = __________ N
W_y = __________ N

Section 2.4

7. Force Components

Use the given xy-coordinate system to determine the x-component and y-component of the individual forces shown on the force diagram shown below. Use the symbols provided to complete the table.

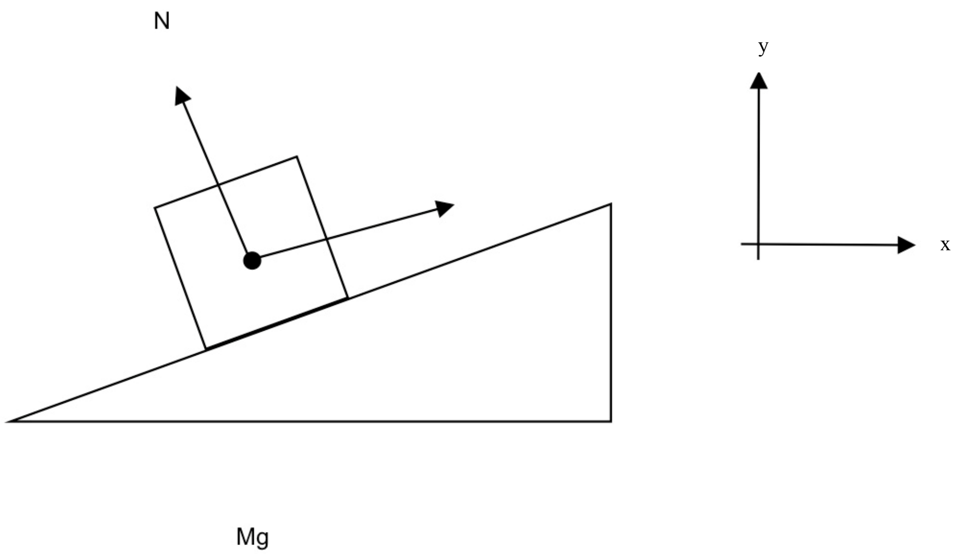


Force	Formula for x-component	Formula for y-component
T_1		
T_2		
Mg		
P		

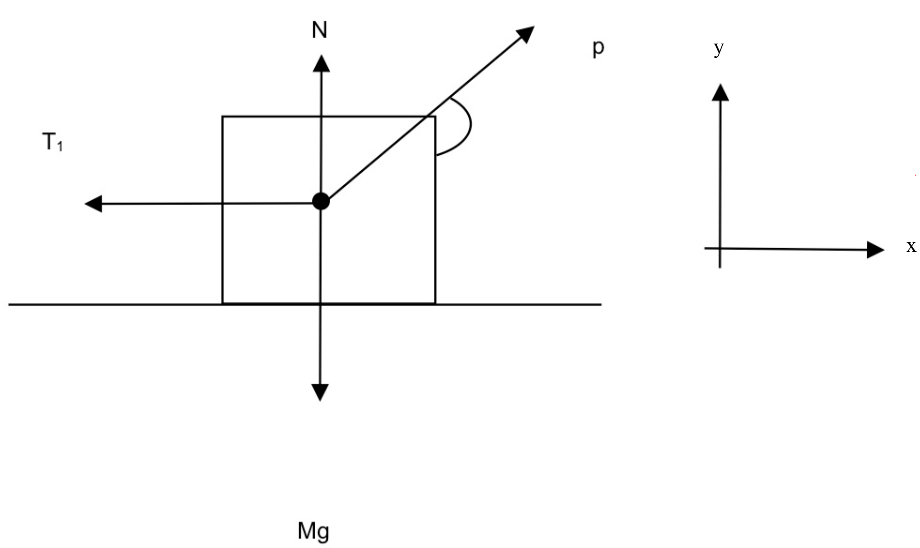
8. Calculating Net Force

Use the symbols provided in the diagrams below to write an expression for the net force acting on the object in the direction requested.

a.



b.

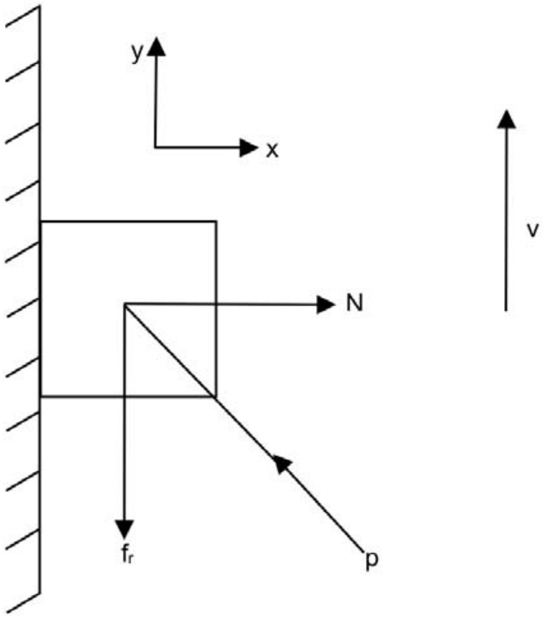


Case	$F_{net,x}$	$F_{net,y}$
a		
b		

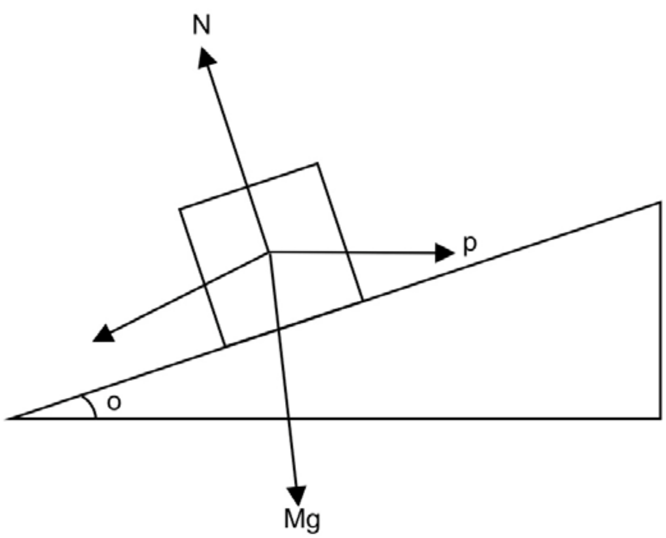
9. Dynamic Equilibrium

Force diagrams for two objects in dynamic equilibrium are shown below. Use Newton's 2nd Law and the provided symbols to write the equilibrium conditions in each direction

a.



b.

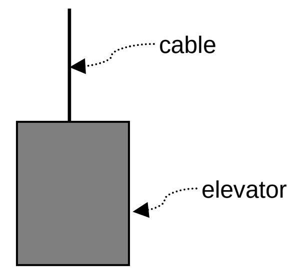


Case	x-direction	y-direction
a.		
b.		

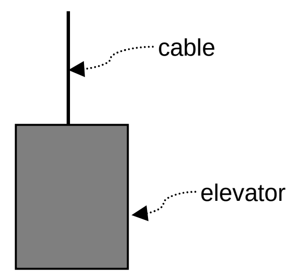
10. Net Force

Draw force diagrams for the following object. Before drawing the force diagram draw the x-and-y coordinate axis. In each force diagram, indicate the direction of the Net force acting on the object.

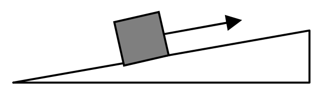
a. Elevator shown to the right is moving down at a constant speed.



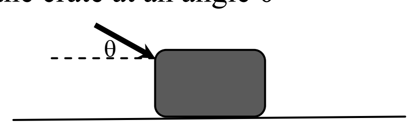
b. Now the same elevator is slowing down while moving down.



c. A box is being pulled up a ramp at a constant speed. Friction between the box and the incline cannot be ignored.



d. A man pushes a crate across a rough concerete flow by push on the crate at an angle θ^0 below the horizontal. The crate is moving at a constant speed.



Section 2.5

11. Forces

A crate containing a new water heater weighs 800 N. The crate rests on the basement floor. Tim pushes horizontally on it with a force of 600 N, but it doesn't budge.

a. Identify all the forces acting on the crate. Describe each as: *(type of force)* exerted on the crate by *(object)*.

b. Identify the interaction partner of each force acting on the crate. Describe each partner as: *(type of force)* exerted on ______ by ______.

c. Draw a force diagram for the crate. Are any of the interaction partners identified in (b) shown on the force diagram?

d. What is the *net* force acting on the crate? Use your answer to determine the magnitudes of all the forces acting on the crate.

e. If there are pairs of forces on the force diagram that are equal in magnitude and opposite in direction, are these *interaction pairs*? Explain.

12. Newton's 3rd Law

A car traveling on a straight section of highway is acted upon by the following forces:

Force	Magnitude	Direction
Weight	10,000 N	Down
Air drag	2000 N	Left
Road friction	1000 N	Right
Normal Force	10,000 N	up

Complete the following table stating the interaction partner for each of these forces, its magnitude, and its direction.

Force	Interaction Partner	Magnitude	Direction
Weight			
Air drag			
Road friction			
Normal Force			

13. Newton's 3rd Law

State in words the interaction partner to the given force.

a. The weight of a car.

b. The normal force on a car.

c. The air resistance on a car moving at a constant speed.

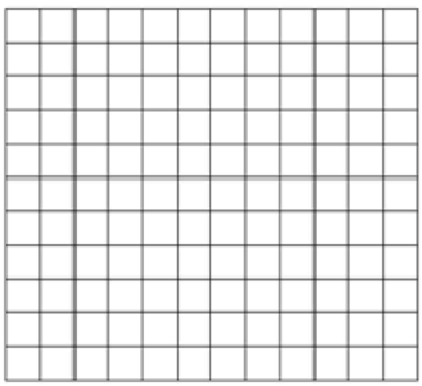
d. The force of friction by the car tires on the road.

Section 2.6

14. Force of Gravity

The magnitude of the gravitational force exerted by Earth on a satellite is given by $F = GMm/r^2$, where M and m are the masses of Earth and the satellite, respectively, G is a constant, and r is the distance from Earth's *center* to the satellite.

a. Sketch a graph of F as a function of r, from $r = R_E$ (Earth's mean radius) to $r = 4R_E$.



b. If the weight of the satellite on the surface is 1200 N, what is its weight at $r = 4R_E$ (*i.e.* when in orbit at a height of $3R_E$ above the surface)?

Section 2.7

15. Frictional Forces

A crate weighing 600N is lying on a horizontal surface. The coefficients of static and kinetic friction between the crate and the surface are $\mu_s = 0.8$ and $\mu_k = 0.3$, respectively.

a. The friction force acting on the crate is:

1. Exactly 0N
2. Exactly 180N
3. more than 0N but less than 480N
4. Exactly 480N
5. Not enough information to determin the friction force.

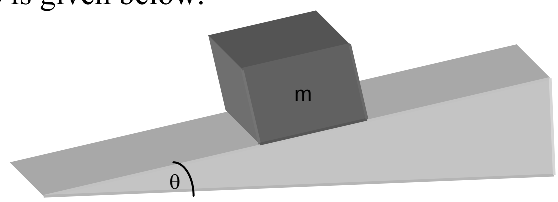
b. Now, the crate is pushed with a 600N horizontal force, but the crate is still not moving. The friction force acting on the crate is:

1. Exactly 0N
2. Exactly 180N
3. more than 0N but less than 480N
4. Exactly 480N
5. Not enough information to determin the friction force.

16. Friction and Newton's 2nd Law

Six identical boxes are at rest on inclined planes. Assume the coefficients of friction for each case to be the same. The angle of inline for each case is given below.

a. $\theta = 10^0$	b. $\theta = 30^0$
d. $\theta = 25^0$	c. $\theta = 55^0$
e. $\theta = 5^0$	f. $\theta = 65^0$



a. Rank the boxes from largest to smallest based on the normal force acting on them.

b. Rank the Boxes from largest to smallest based on the friction force acting on them.

17. Frictional Forces and Newton's 2nd Law

In each of the situations described, determine the direction of the frictional force (or state that it is zero) and explain your reasoning. If the given information is insufficient to determine the direction of the frictional force, explain why. Also state whether the frictional force is static or kinetic.

a. A child slides down a slide in a playground. The frictional force on the child is ___________.

b. A woman stands on an airport's moving sidewalk and moves at constant velocity. The frictional force on the woman is ___________.

c. A toolbox sits in the bed of a truck that is initially stopped at an intersection. The truck darts forward and the box starts to slide toward the back of the truck. The frictional force on the toolbox while it is sliding is ___________.

d. A toolbox sits in the bed of a truck that is initially stopped at an intersection. The truck darts forward and the box starts to slide toward the back of the truck. The frictional force on the *bed of the truck due to the toolbox* while the toolbox is sliding is ___________.

18. Friction and Newton's 2^{nd} Law

A crate containing a new water heater weighs 800 N.

a. The crate rests on the basement floor. Tim pushes horizontally on it with a force of 400 N, but it doesn't budge. What can you conclude about the coefficient of static friction: $\mu_s = 0.5$, $\mu_s \geq 0.5$, or $\mu_s \leq 0.5$, or is not enough information given to draw a conclusion? Explain.

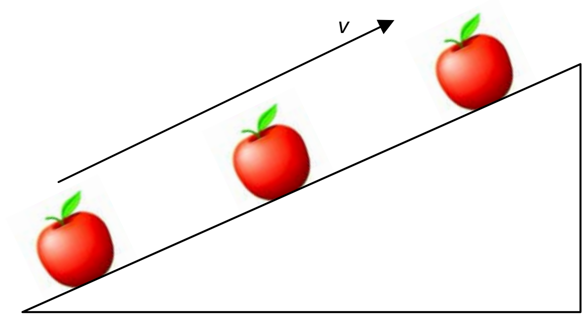
b. Tim and a friend push on the water heater with a force of 600 N as it slides across the floor with constant velocity. What can you conclude about the coefficient of kinetic friction: $\mu_k = 0.75$, $\mu_k \geq 0.75$, or $\mu_k \leq 0.75$, or is not enough information given to draw a conclusion? Explain.

19. Static and Kinetic Friction

A conveyor belt carries apples up an incline to a cider press. The apples do not either slide or rolling as they move up the incline.

a. Is it a *static* or *kinetic* frictional force that the belt exerts on an apple? Explain.

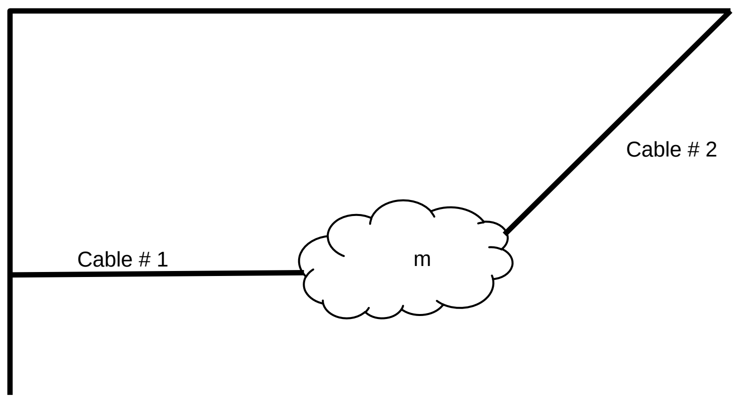
b. Draw the direction of the frictional force identified in previous part on the diagram below.



Section 2.8

20. Tension

A hanging sculpture in the Museum of Modern Art in New York City is supported by several strong cables as shown below.

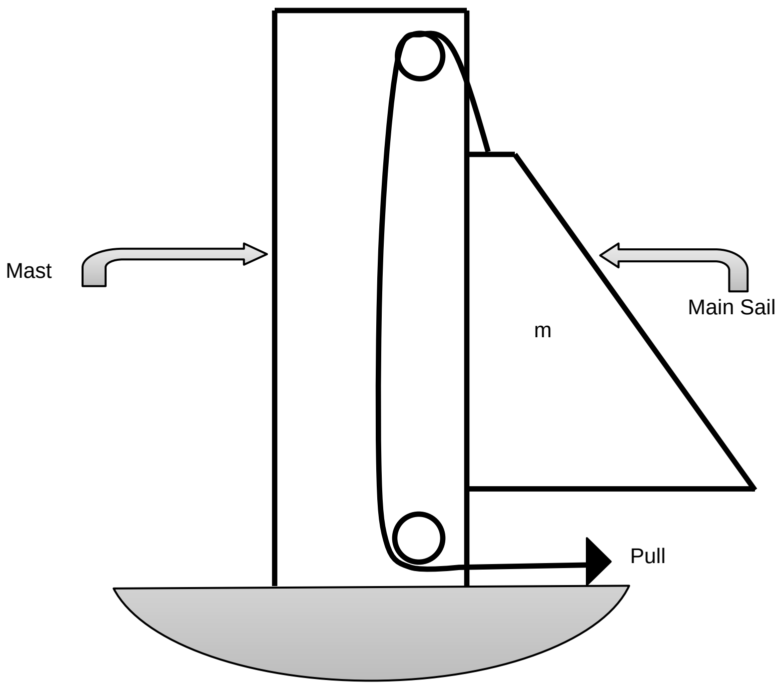


a. Construct a force diagram for the sculpture.

b. Rank the tension in each cable and the weight of the sculpture from greatest to least if cable 2 makes a 30^{o} angle with the horizontal. Explain.

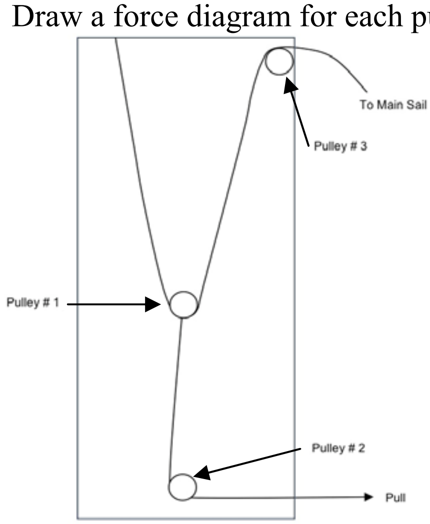
21. Tension

Systems of ropes and pulleys are used on sailboats to raise and lower the sails. A pulley system used on a large 20 m long racing boat is shown below.



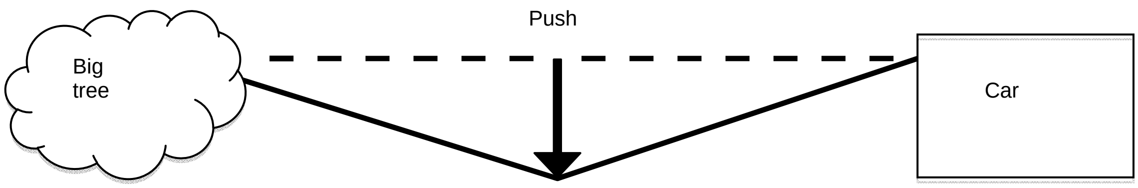
a. If the mainsail has a mass, m, and the pulleys are ideal (mass less and frictionless) how much pulling force must a crewmember exert to raise the mainsail at a constant speed? Explain.

b. Repeat the analysis from part a) for the following arrangement of pulleys inside the mast. (Hint: Draw a force diagram for each pulley.)



22. Tension

An old-fashion method for moving a car stuck in snow or a farm tractor stuck in mud is shown below as seen from above.



Find the tension in the cable if a sideways force of 1000 N causes a 5^{o} deflection.