Name: ____________________

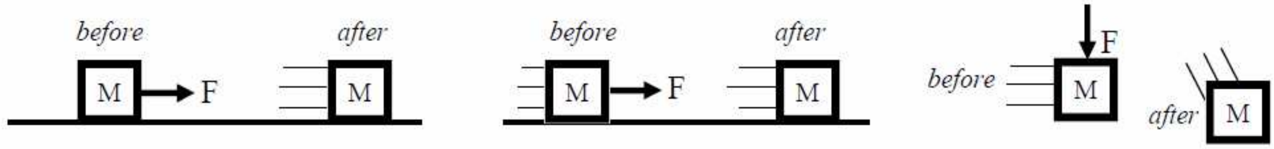
Period: ____________________

Forces and Newton's First Law of Motion

3.1

A force is any push or pull. Force is measured in Newtons (N). Forces are vectors, so the direction of the force matters.

A force can cause an object to move, *to change speed,* *or to change direction.*



You should remember that if an object changes speed or direction it is accelerating. **Forces cause accelerations!**

Net Force (F_{net})

The net force (F_{net}) is the result of all of the forces acting on an object. There can be many forces, but the object will act as if there is only one force: the net force.

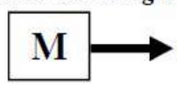
Net Force Sum of all Forces

$$F_{net} = \Sigma F$$

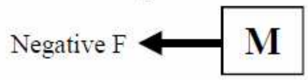
$$\Sigma F = F_1 + F_2 + \ldots$$

Add up all of the individual forces

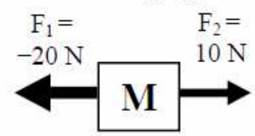
Forces to the right and up are +.



Forces to the left and down are −.



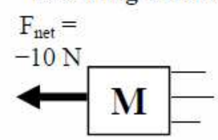
Finding F_{net}



$F_{net} = \Sigma F = F_1 + F_2$

$\Sigma F = -20 + 10 = -10$ N

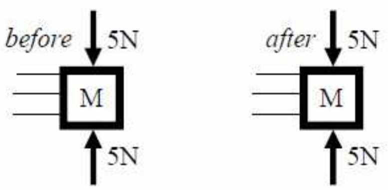
Resulting Motion



The object accelerates left since F_{net} is left.

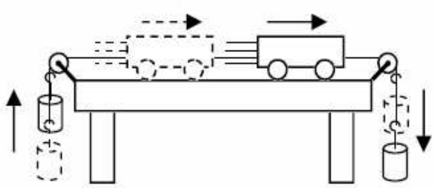
Balanced Forces

If balanced forces act on an object it doesn't change speed or direction. **It is at equilibrium.**



If there are balanced (equal and opposite) forces, the object doesn't change direction.

If there are balanced forces the object stays at constant speed.



At Equilibrium:
Forces are balanced
(= and opposite)
$F_{net} = 0$ N
No acceleration ($a = 0$)
At constant velocity ($\Delta v = 0$)
(No change of direction; no change of speed)

Inertia

Objects need forces to change direction or speed. This tendency to not change motion is called inertia and is dependent only on the object's mass (measured in kilograms).

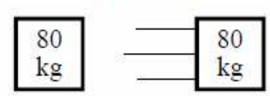
Object's with more mass have more inertia and are harder to push.

Object's with less mass have less inertia and are easier to push.

Once an object is moving, inertia keeps it moving. This is why heavy moving objects are hard to stop.

Velocity doesn't matter: a massive object is hard to push whether it is stopped or moving.

Same mass = same inertia!



Newton's First Law

Sir Isaac Newton (1642-1727) was an English physicist and mathematician. Before the age of 30 he formulated the laws of motion and invented calculus.

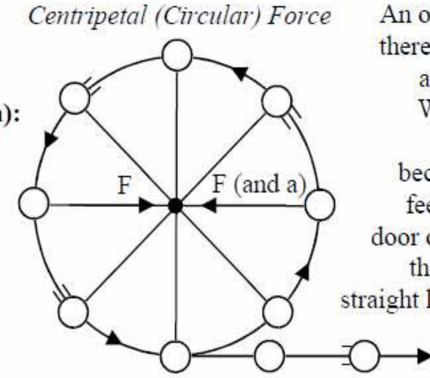
From what you have learned about forces, so far, we know how forces change motion and proven

Newton's First Law of Motion (The Law of Inertia):

An object at rest will remain at rest and an object in motion will stay in motion at constant speed and in a straight line unless acted on by an unbalanced (net) force. OR if there is no net force ($F_{net} = 0$) the object will continue at constant velocity.

The Law of Inertia: if $F_{net} = 0$, then $a = 0$.

Centripetal (Circular) Force



An object can move in a circle ONLY if there is a inward (centripetal) force (and acceleration) keeping it in the circle. When the centripetal force stops, the object must move in a straight line because of its inertia. This is why you feel yourself being pushed against the door of a car while it is turning. Without the door you would keep moving in a straight line as the car turns away from you.

1. Inertia	A. Any action that can cause motion.
2. Mass	B. When the positive forces are equal to the negative forces.
3. Net force	C. The amount of matter in an object
4. Force	D. Total of all of the forces on an object.
5. Balanced	E. Ability of an object to resist change of motion.

Which has more inertia?

A train or a car?
A ping pong ball or a baseball?
A fast bowling ball or a slow bowling ball?
A 20 kg mass or a 10 kg mass?
A rock on the earth or a rock in space?

Balanced or Unbalanced Forces?

____ An person sitting on a chair?
____ 20 N left and 30 N right?
____ An object at constant speed?
____ An accelerating plane?
____ An object at rest?

___ If $\Delta v = 0$?
___ If $a \neq 0$?
___ If $a = 0$?
___ If $\Delta v \neq 0$?
___ A stopping car?

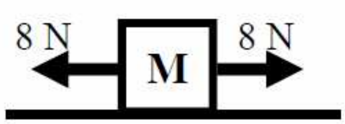
A ball begins in the middle of a cart. The cart is quickly moved and the ball ends up against the right lip of the cart.

A. Which way was the cart moved?

B. Why did the ball end up at the right end of the cart?

If the rope were to break, would the ball move in a straight line or a circle?

What do we call any force pulling toward the center of a circle?

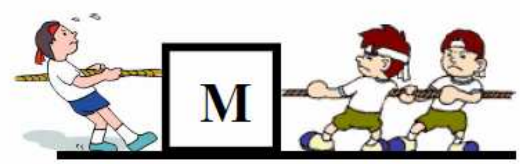


What is the net force on the above object?

Is the object at equilibrium?

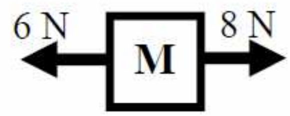
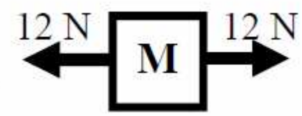
What will be the acceleration of the object?

Is it moving or not?

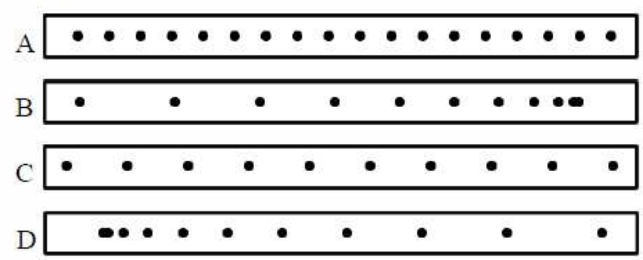


If each of the students above can pull with the same amount of force, which way will the object move?

Why?

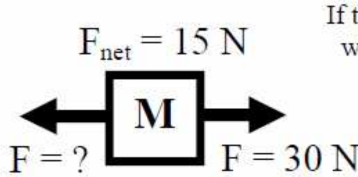
	Calculate the Net Force	Which way will it accelerate?
	________	____
	________	____
	________	____

The tape timers below show the positions of five different objects each second.

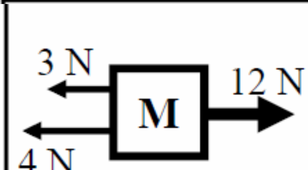


____ Which have $F_{net} = 0$.
____ Which have balanced forces?
____ Which have unbalanced forces?
____ Which have a positive net force?
____ Which have a negative net force?

For each tape timer, if there is a net force, draw its direction.



If the net force on the object is 15 N, what is the magnitude of the force pulling to the left?



What is ΣF (sum of all forces) on the mass?