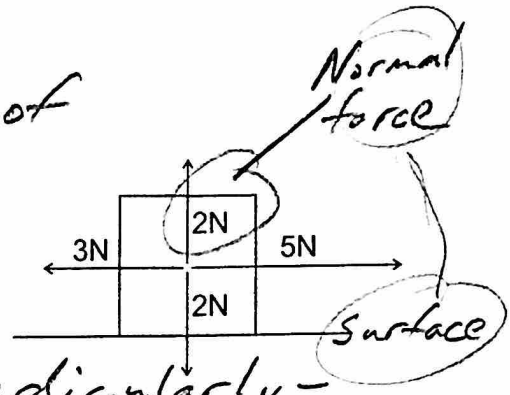
Physics 200 (Stapleton)
Newton's Laws in 1 Dimension
Notes: 1st and 2nd Laws

Name: Key

Net force (F_{net}): The sum (resultant) of all of the force vectors acting on an object.

ΣF



What is the net force that is acting on the box to the right?

$\Sigma F = 2N$ rightward

Normal Force: The force exerted perpendicularly outward by a surface

Newton's 1st Law:

- Usual version: Objects in motion remain in motion in a straight line and at a constant speed, and objects at rest stay at rest, unless they are acted upon by an outside (or unbalanced) force.
- Simpler version: Objects have zero acceleration unless they experience a net force.

If there is no net force acting on an object (i.e. any applied forces are balanced), what might that object be doing? What are the options?

- motionless
- constant velocity

$\Rightarrow \Sigma F = 0$

What are the options for what an object might be doing if there is a net force acting on an object?

- Slowing down
- Speeding up
- Changing direction

$\Rightarrow \Sigma F \neq 0$

Newton's 1st Law is called the "Law of Inertia." Inertia is:

- Resistance to Acceleration

What kinds of objects have the most inertia?

Massive objects

The basic metric unit of force is the Newton. 1 N ≈ 0.224 pounds.

Newton's 2nd Law: $\sum F = ma$ (m: mass, a: acceleration, $\sum F$: Net force)

Mass: A measure of inertia

The unit we will use for Mass = kilogram **, which is abbreviated** kg

On Earth, a 1kg mass weighs about 9.8 Newtons or about 2.2 pounds.

Weight: Force of gravity (usually exerted by a planet)

$\sum F = ma \Rightarrow W = mg$ (W: weight, g: acceleration due to gravity)

Primary strategy for solving problems in this unit:

1. Write $\sum F$ = vector sum of forces
2. Write $\sum F = ma$
3. Substitute Vector sum of forces $= ma$
4. Solve.

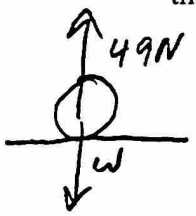
Calculating forces using Newton's 2nd law:

1. A 91N net force is applied to an object. If the object accelerates at a rate of $8 m/s^2$, what is the object's mass?

$\sum F = ma \quad 91N = m(8 m/s^2)$

$m = 11.4 kg$

3. A bowling ball is sitting motionless on the ground. The ground is applying a 49N upward force to the bowling ball. What is the bowling ball's mass?



$\sum F = ma = m(0 m/s^2) = 0$

$\sum F = 49N - w$

$49N - w = 0 \Rightarrow w = 49N$

$W = mg$

$49N = m(9.8 m/s^2)$

$m = 5 kg$

2. A 1,200kg car is being acted upon by two forces. The car's motor is providing a 1,000N rightward force, and friction is providing a 300N leftward force. What is the car's acceleration?

$\sum F = (-300N) + (1000N) = 700N$

$\sum F = 1200kg(a)$

$700N = 1200kg(a)$

$a = 0.58 m/s^2$