Newton's First Law

WHS Physics

Facts about Force

- Unit is the NEWTON(N)
- Is by definition a push or a pull
- Can exist during physical contact (Tension, Friction, Applied Force)
- Can exist with NO physical contact, called FIELD FORCES (gravitational, electric, etc)

Newton's First Law – The Law of Inertia

- INERTIA – a quantity of matter, also called MASS. Italian for *"LAZY"*. Unit for MASS = kilogram.
- Weight or Force due to Gravity is how your MASS is effected by gravity.

$$W = mg$$

NOTE: MASS and WEIGHT are NOT the same thing. MASS never changes When an object moves to a different planet.

What is the weight of an 85.3-kg person on earth? On Mars (g=3.2 m/s/s)?

$$W = mg \rightarrow W = (85.3)(9.8) = 835.94N$$

$$W_{MARS} = (85.3)(3.2) = 272.96N$$

Newton's First Law

An object in motion remains in motion in a straight line and at a constant speed OR an object at rest remains at rest, UNLESS acted upon by an EXTERNAL (unbalanced) Force.

There are TWO conditions here and one constraint.

Condition #1 – The object CAN move but must be at a CONSTANT SPEED
Condition #2 – The object is at REST
Constraint – As long as the forces are BALANCED!!!!! And if all the forces are balanced the SUM of all the forces is ZERO.

The bottom line: There is NO ACCELERATION in this case AND the object must be at EQILIBRIUM (All the forces cancel out).

$$acc = 0 \rightarrow \sum F = 0$$

Scalar

A **SCALAR** is ANY quantity in physics that has MAGNITUDE, but NOT a direction associated with it.

Magnitude – A numerical value with units.

Scalar Example	**Magnitude**
Speed	20 m/s
Distance	10 m
Age	15 years
Heat	1000 calories

Vector

A **VECTOR** is ANY quantity in physics that has BOTH MAGNITUDE and DIRECTION.

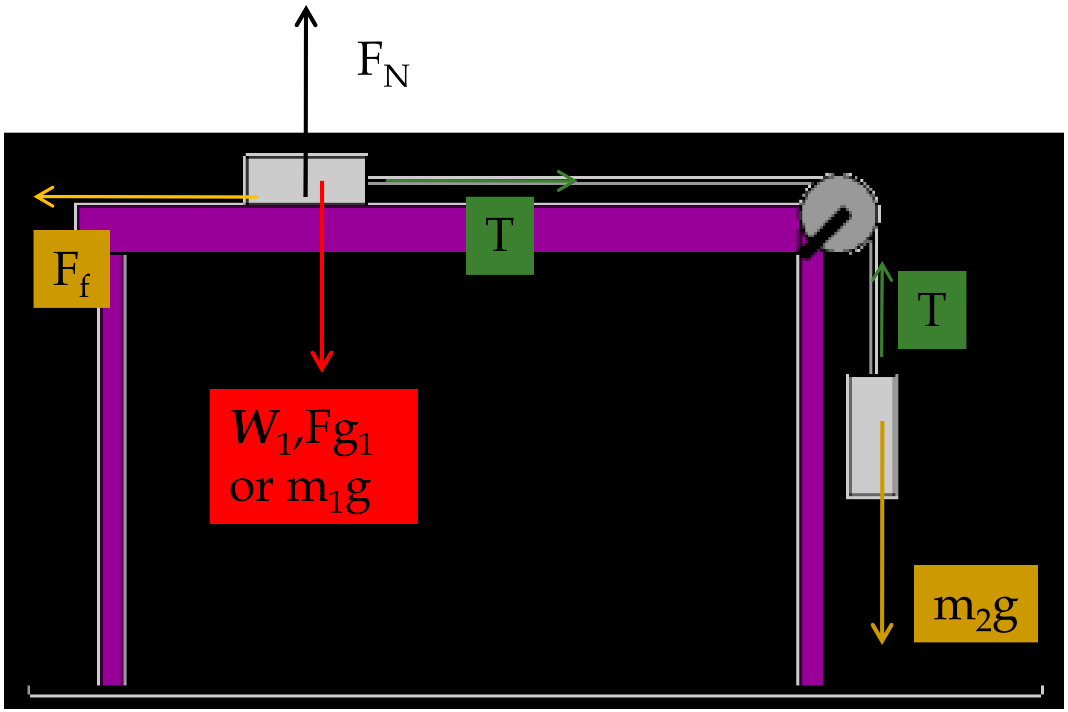
Vector	Magnitude & Direction
Velocity	20 m/s, N
Acceleration	10 m/s/s, E
Force	5 N, West

$$\vec{v}, \vec{x}, \vec{a}, \vec{F}$$

Vectors are typically illustrated by drawing an ARROW above the symbol. The arrow is used to convey direction and magnitude.

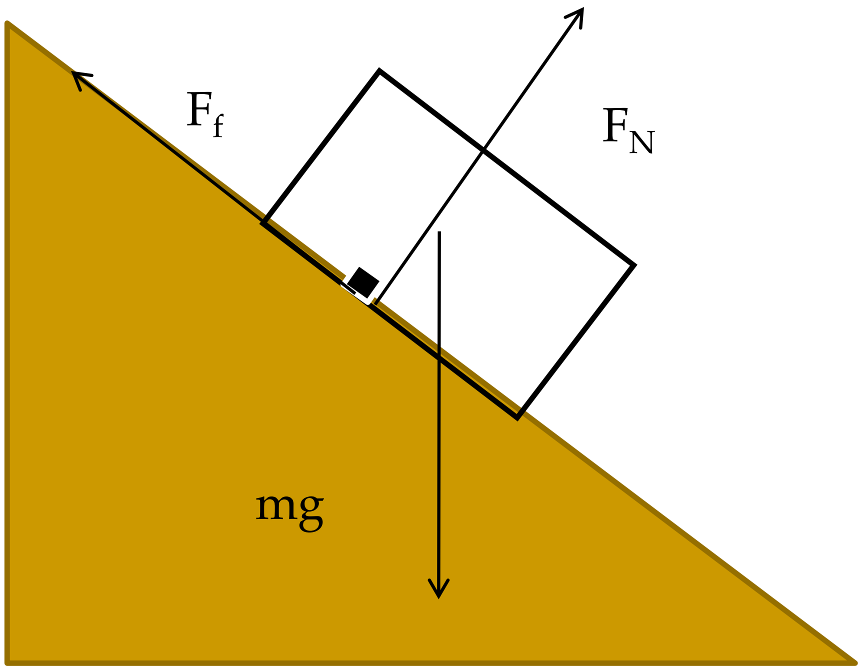
Free Body Diagrams

A pictorial representation of forces complete with labels.



- Weight(mg) – Always drawn from the center, straight down
- Force Normal(F_N) – A surface force always drawn perpendicular to a surface.
- Tension(T or F_T) – force in ropes and always drawn AWAY from object.
- Friction(Ff)- Always drawn opposing the motion.

Free Body Diagrams



Newton's First Law – The Law of "EQUILIBRIUM"

Since the $F_{net} = 0$, a system moving at a constant speed or at rest MUST be at "EQUILIBRIUM".

TIPS for solving problems

- Draw a FBD
- Resolve anything into COMPONENTS
- Write equations of equilibrium
- Solve for unknowns

Example

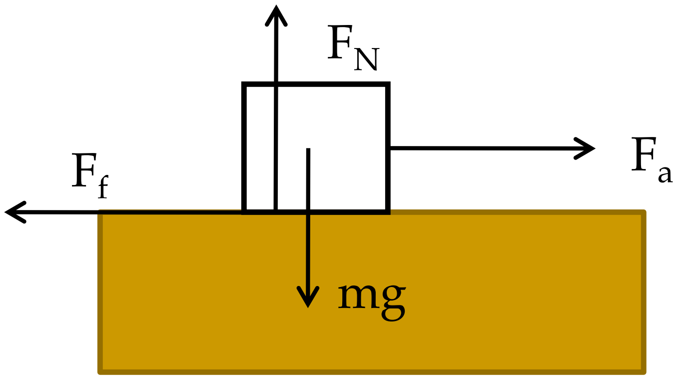
A 10-kg box is being pulled across the table to the right at a constant speed with a force of 50N.

a) Calculate the Force of Friction

$$F_a = F_f = 50N$$

a) Calculate the Force Normal

$$mg = F_n = (10)(9.8) = 98N$$



Example

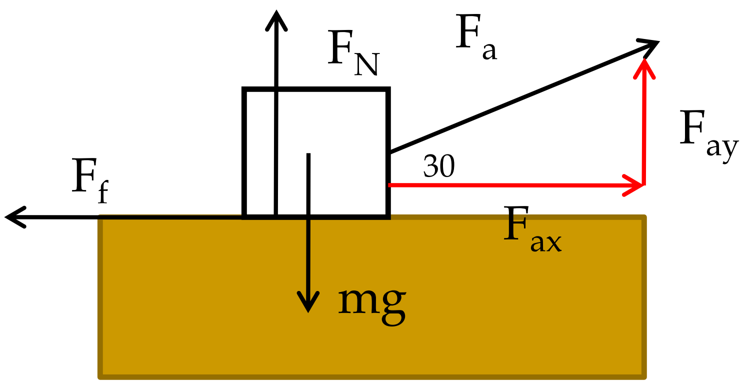
Suppose the same box is now pulled at an angle of 30 degrees above the horizontal.

a) Calculate the Force of Friction

$$F_{ax} = F_a \cos\theta = 50\cos 30 = 43.3N$$
$$F_f = F_{ax} = 43.3N$$

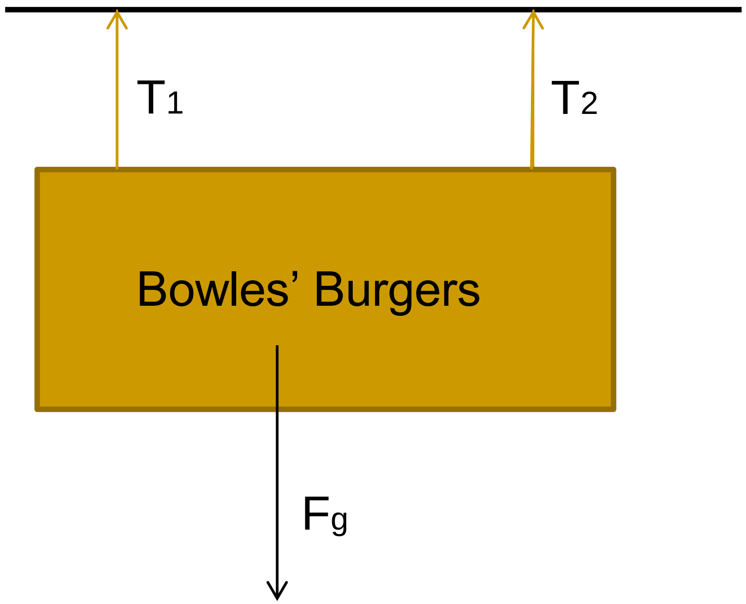
a) Calculate the Force Normal

$$F_N \neq mg!$$
$$F_N + F_{ay} = mg$$
$$F_N = mg - F_{ay} \rightarrow (10)(9.8) - 50\sin 30$$
$$F_N = 73N$$



Example

A cafe sign with a mass of 65.5 kg is being held up by 2 cables as shown in the picture to the left. Calculate the tension in <u>each</u> of the ropes.



$Fg = (mass)(gravity)$

$Fg = (65.5 kg)(9.8 m/s^2)$

$Fg = 642\ N$

$T_1 + T_2 = Fg$

$T_1 + T_2 = 642N$

$T_1 = T_2$

$2\ T = 642\ N$

$T_1 = T_2 = 321N$

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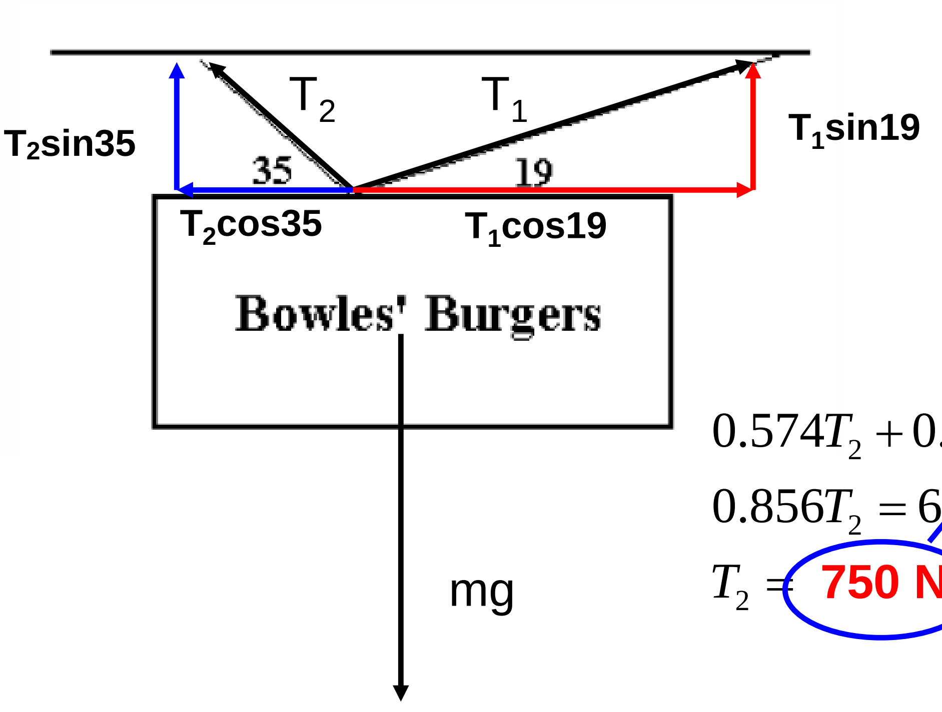

$X - Direction$

$T_2 \cos 35 = T_1 \cos 19$

$T_1 = 0.866 T_2$

$T_2 \sin 35 + T_1 \sin 19 = mg$

$0.574 T_2 + 0.326 T_1 = 642$

$0.574 T_2 + 0.282 T_2 = 642$

$0.856 T_2 = 642$

$T_2 =$ **750 N**　　$T_1 = 650$ N