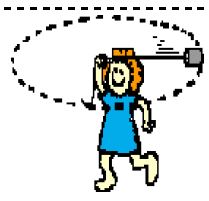


Force
Newton's Laws
Newton's Second Law

Essential Questions
1. How can one plus one not equal two?
2. What makes objects move the way they do?
3. How can we describe forces without words and numbers?

Enduring Understanding - A net force is required to change an object's velocity; no force is required to explain constant velocity.

Learning Targets: 7, 8, 10, 11

Recall
An UNBALANCED force is required to change an object's motion. An UNBALANCED Force is also called the NET force and is equal to the sum of all forces, ΣF.

UNBALANCED Force = NET Force = ΣF (sum of forces)

Σ is the capital Greek letter sigma and means to sum or add up. In the case of ΣF it means to add up all the forces acting on an object.

1. Describe the motion of an object experiencing an UNBALANCED force.

ΣF

Summation

Newton's Second Law of Motion
The acceleration of an object is proportional to the net force applied to the object and inversely proportional to the object's mass.

2. Express Newton's Second Law as a mathematical proportion.

acceleration is proportional (α) to the net force applied to the object	acceleration is inversely proportional to the object's mass
$a \alpha \frac{F}{m}$	$a \alpha \frac{1}{m}$

3. Express Newton's Second Law as a mathematical equation.

$$\Sigma F = ma$$

How do we know if we have an unbalanced force and if so in what direction is it acting? The solution to this problem is the construction of **F**ree-**B**ody **D**iagrams or FBDs.

Free-Body Diagram Construction
A free body diagram (FBD) is a vector drawing of all OUTSIDE (external) forces acting on an object.

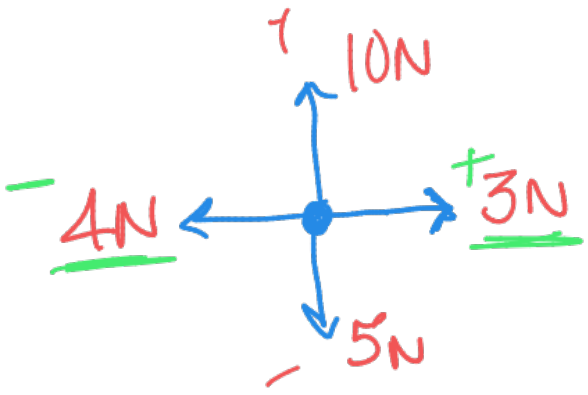
Guidelines for drawing FBD's
- Forces are vectors and must include magnitude and direction.
- Force vectors are drawn from the center of the object and always point away from the object to indicate the effect the force has on the object.
- Each vector must be labeled with the type of force it represents.

For the following scenarios, use the following:

W or F_g = Force of Gravity
$F_{Lift} = F_L$ = force of lift
$F_{Thrust} = F_T$ = force of thrust
$F_{drag} = F_d$ = Frictional force that opposes motion, air resistance

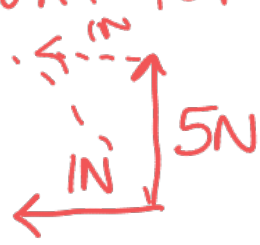
force from engine
force from air
friction from air

Horizontal and Vertical Forces
Draw the weight vector equal to 2 cm.



x direction: 4N - 3N = 1N ←

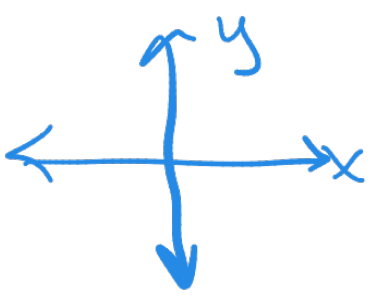
y direction: 10N - 5N = 5N ↑

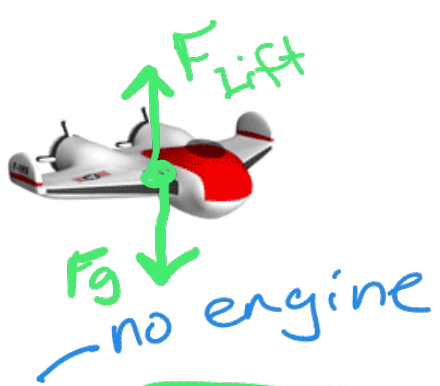


$\Sigma F = \sqrt{(5N)^2 + (1N)^2}$

$\Sigma F = \sqrt{26}\ N$

→





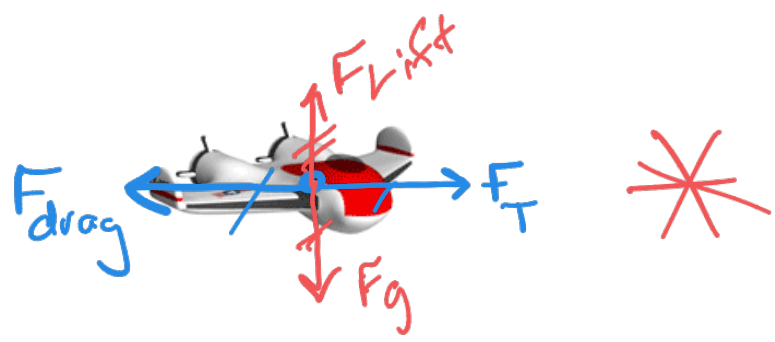
A jet plane is gliding at a constant elevation at a constant velocity. Draw the Free-Body Diagram of the forces acting on the plane.
NO air resistance
Circle the correct term in each statement.

The forces are **balanced / unbalanced** along x axis

Newton's **1st / 2nd** law applies to the x axis.

The forces are **balanced / unbalanced** along y axis

Newton's **1st / 2nd** law applies to the y axis.



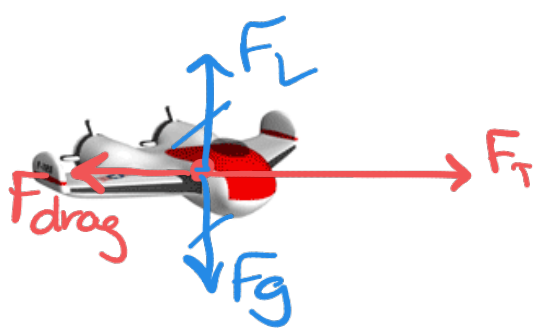
A jet plane is flying at a constant elevation at a constant velocity. Draw the Free-Body Diagram of the forces acting on the plane.
Consider Air Resistance.
Circle the correct term in each statement.

The forces are **balanced / unbalanced** along x axis

Newton's **1st / 2nd** law applies to the x axis.

The forces are **balanced / unbalanced** along y axis

Newton's **1st / 2nd** law applies to the y axis.



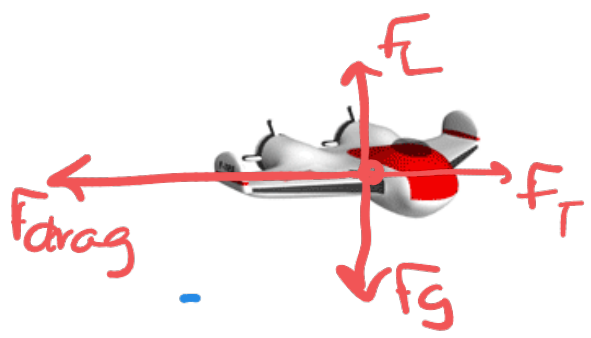
A jet plane is flying at a constant elevation with an increasing velocity. Draw the Free-Body Diagram of the forces acting on the plane. Consider Air Resistance.
Circle the correct term in each statement.

The forces are **balanced / unbalanced** along x axis

Newton's **1st / 2nd** law applies to the x axis.

The forces are **balanced / unbalanced** along y axis

Newton's **1st / 2nd** law applies to the y axis.



A jet plane is flying at a constant elevation with a decreasing velocity. Draw the Free-Body Diagram of the forces acting on the plane. Consider Air Resistance.

Circle the correct term in each statement.

The forces are **balanced / unbalanced** along x axis

Newton's **1st / 2nd** law applies to the x axis.

The forces are **balanced / unbalanced** along y axis

Newton's **1st / 2nd** law applies to the y axis.

What is the relationship between net force and acceleration?

↑F → ↑a Same direction

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