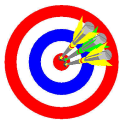
Vectors as Forces (7.1)
Day One

Math Learning Target:



"Using vector diagrams, I can determine resultant and equilibrant forces. I can compose forces and I can resolve any force. I can apply what I have learned in familiar and unfamiliar settings."

Force

A **force** is a push or pull upon an object in a given direction resulting from its interaction with another object. The standard unit of measure for its magnitude (push or pull) is the Newton (N), named after Sir Isaac Newton; 1 N is the force required to give a 1 kg mass an acceleration of 1 m/s per s, in a given direction.

Newton's 2nd Law of Motion

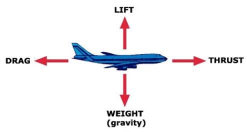
$\vec{F} = m\vec{a}$ where $\vec{F}$ is the force applied, m is the mass of the object, and $\vec{a}$ is the acceleration of the object. It can also be shown that:

$$|\vec{F}| = m|\vec{a}|$$

Weight

The **force of gravity** is the attractive force that results with any two objects with mass. This is otherwise known as **weight.**

equilibrium



An object is in a state of **equilibrium** when it is:

- at rest and stays at rest, or
- in motion and continues in motion at a constant velocity.

When an object is in equilibrium then the forces are balanced. This means the magnitude of the net force is zero.

Groups
(Small Response Boards)

a) Using any two collinear geometric vectors with unique magnitudes, create a third vector to produce a state of equilibrium.
b) Repeat part a) for *non*-collinear vectors.

Newton's First Law of Motion

An object at rest stays at rest, and an object in motion stays in motion with the same speed and direction unless acted upon by an unbalanced force.

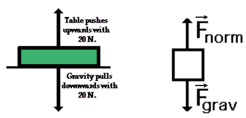
Recall:
(Physics)

A **free body diagram (FBD)** is a diagram to show the relative magnitude and direction of all forces acting upon an object. The length of each vector shows its relative magnitude.

For example,

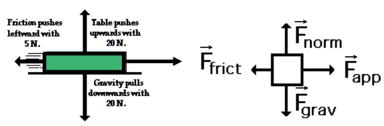
a book at rest on a tabletop

system diagram FBD



a book slides across a tabletop by a rightward force with rightward acceleration

system diagram FBD



In this course, as we have seen, we construct **vector diagrams.**

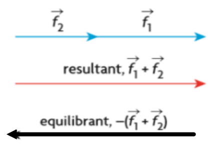
resultant

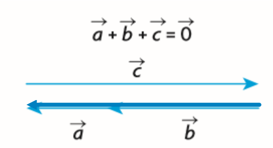
The combined net effect of all forces acting on an object is a single force called **resultant** $\vec{F}$. The individual forces that create the resultant are the **components** of the resultant. The process of determining this single force is called **composition.**

equilibrant

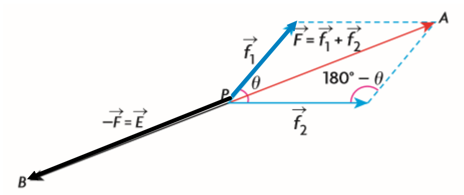
The single force that opposes the resultant force of an object is the **equilibrant**. When it is applied to an object, the object is in a state of equilibrium.

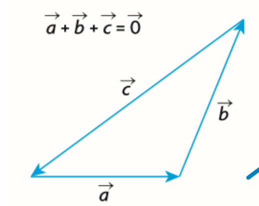
when vectors are collinear and in a state of equilibrium

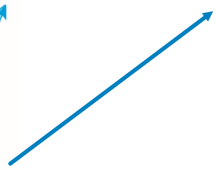




when vectors are noncollinear and in a state of equilibrium







When an object is in a state of equilibrium, the resultant of <u>all</u> forces (including the equilibrant) acting on the object is $\vec{0}$.

<u>Example</u>

Find the resultant and equilibrant of two forces of 13N and 5N acting on an object at 40° with each other. Round all values to nearest tenth.

<u>Groups</u>

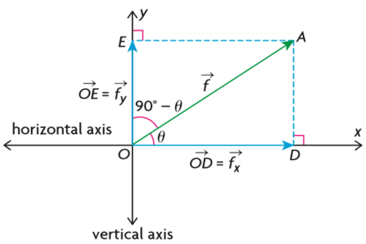
<u>(Small Response Boards)</u>

a) Given only two non-collinear (non-zero) vectors, how many unique parallelograms can be created using the Parallelogram Law?

b) Given only one resultant, how many unique parallelograms can be created?

<u>resolution</u>

In many situations involving forces we are interested in a process that is the inverse of composition. Taking a single force, and decomposing it into two single forces is called **resolution**.



Usually, we are only interested in the **horizontal component** and the **vertical component**.

<u>Example</u>

While pulling a wagon, Terri exerts a force of 50 N at 30 degrees with the horizontal. Determine the force, to nearest tenth, that pulls the wagon forward along the horizontal and the force that is applied vertically.

May the force be with you...Page 362...#1, 2, 3, 4, 5b, 8, 9, 11*, 12, 13, 14. *More questions from this section will be assigned next class.*
*there are three possible answers for a) and b)