

# **FORCES**

## **Newton's 2<sup>nd</sup> and 3<sup>rd</sup> Law**

# A new era of physics

- *Aristotle (384-322 BC) thought that objects were naturally at rest, would always stop themselves and a force was needed for any motion.*
- *Descartes (1596-1650) thought that some unseen vortex was constantly pushing on things to make them stay in motion.*
- *Galileo (1564-1642) realized that the Greeks weren't accounting for forces such as friction.*
- *Newton summarized Galileo's thoughts and others through his three laws of motion.*

# objectives

*You will be able to*

- describe how mass, force and acceleration are related to each other.
- describe the consequences of Newton's 2<sup>nd</sup> Law.
- graph data to find a relationship between variables.

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# Newton's 2<sup>nd</sup> Law

- Newton's 2<sup>nd</sup> law describes how a mass behaves when forces act on it.
- We can guess these forces will produce a change in motion but how are they related?

# Newton's 2<sup>nd</sup> Law

- How does acceleration relate to force?
- Lets do a little experiment together as a class to find out.

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# Newton's 2<sup>nd</sup> Law

- How does this acceleration relate to the force?
- The acceleration will be in the same direction as the force.
- The magnitude of the acceleration increases as the force increases
- The magnitude of the acceleration decreases as the mass of the object increases
- Lets try it out! [Phet Simulation](#)

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# Newton's 2<sup>nd</sup> Law

- In mathematical terms
  - $a = \Sigma F/m$
  - **acceleration = net force / mass**  
or more commonly written
  - **Force (net) = mass · acceleration**
  - $\Sigma F = m \cdot a$
- And since **force** and **acceleration** are vectors, they will be in the same direction.

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# MEASURING FORCES

- The unit of force is the Newton {N}
- It is derived from its effect.
- $F = m \cdot a \rightarrow [\text{kg}] \cdot [\text{m}/\text{s}^2]$
- $1 \text{ N} = 1 \text{ kg} \cdot \text{m}/\text{s}^2$
- 1 N is defined as the amount of force required to accelerate 1 kg at a rate of  $1 \text{ m}/\text{s}^2$ .

# objectives

*Can you*

- describe how mass, force and acceleration are related to each other.
- describe the consequences of Newton's 2<sup>nd</sup> Law.
- graph data to find a relationship between variables.
  - [Jump to Post Lab](#)

# How things interact

- ⇒ *When you hit a wall with your fist what happens?*
- ⇒ *When a bug splats on your windshield what happens?*
- ⇒ *How about when you push a couch across a floor?*
- ⇒ *How do you interact with these objects ... how do they interact with you?*

# Results of ILD 2.1

A bug splats on your windsheild as you are driving. What feels a bigger force?

A) The bug does

B) The windshield does

C) They feel the same force

D) Neither feel any force

Time (s)

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# Newton's 3<sup>rd</sup> Law

- ~~➔ For every action there is an equal and opposite reaction~~
- ➔ Forces always occur in equal magnitude and opposite direction pairs.
- ➔ Forces only exist during interactions.
- ➔ One of the pair forces acts on one object, and the other pair force acts on the other object
- ➔ The 3<sup>rd</sup> law is often called the law of action-reaction (even though I don't like it)

# Newton's 3<sup>rd</sup> Law

- ⇒ *Why are people so often tricked. Why do we think the bug feels a greater force than the windshield, when in reality they feel the same?*
- ⇒ Although the forces are the same the effect of the force on each object is different. That force on the bug squishes it, but the same force on your windshield only gives you something to clean.

# Newton's 3<sup>rd</sup> Law Examples

Take a few minutes and write down how you think Newton's 3<sup>rd</sup> law applies to these situations. Describe what objects are interacting, and what is the effect of these interactions.

- ⇒ You are swimming thru a pool of water
- ⇒ Car driving on flat ground
- ⇒ A gun shoots a bullet and recoils
- ⇒ Punching a wall or paper
- ⇒ You jump out a window and fall to the ground

# Objectives summary

Do you...

*Understand the idea of force*

⇒ Forces are vector pushes or pulls which have a magnitude and direction

*Be able to Categorize forces into the two main types of force*

⇒ Contact and At a Distance Forces

*Be able to Recognize when forces exist*

⇒ Forces **only** exist during interactions between objects

*Be able to use Newton's 3<sup>rd</sup> Law to describe how objects interact.*

⇒ Forces occur during interactions and are equal in size on each object but opposite in direction.

# Newton's 3<sup>rd</sup> Law Examples

Identify at least 6 pairs of 3<sup>rd</sup> Law forces in the situation below ...

