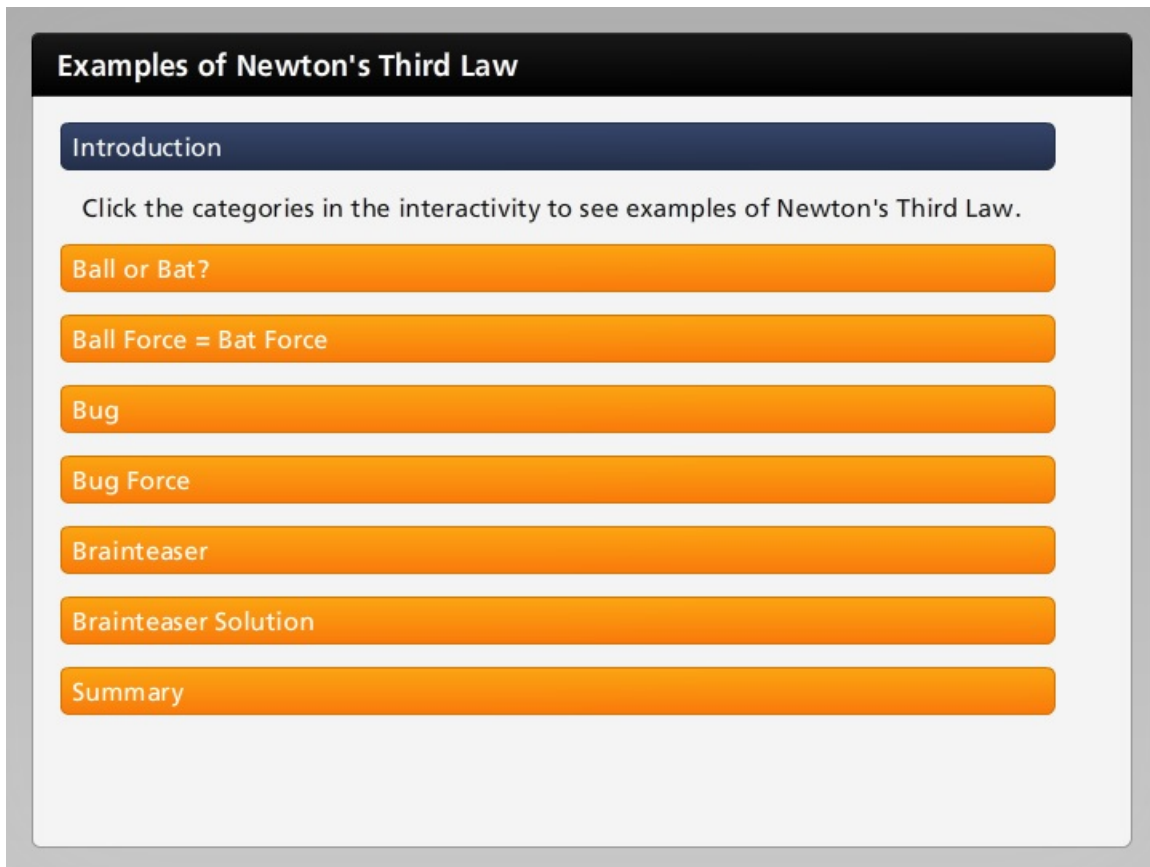


# Module 5: Impulse and Momentum

## Topic 2 Content: Examples of Newton's Third Law

### Introduction



The screenshot shows a digital interface with a dark grey header bar containing the text "Examples of Newton's Third Law" in white. Below the header is a list of eight orange buttons with white text, arranged vertically. The first button is dark blue and contains the word "Introduction". The remaining seven buttons are orange and contain the following text from top to bottom: "Ball or Bat?", "Ball Force = Bat Force", "Bug", "Bug Force", "Brainteaser", "Brainteaser Solution", and "Summary".

Click the categories in the interactivity to see examples of Newton's Third Law.

## Module 5: Impulse and Momentum

### Topic 2 Content: Examples of Newton's Third Law

#### Ball or Bat?

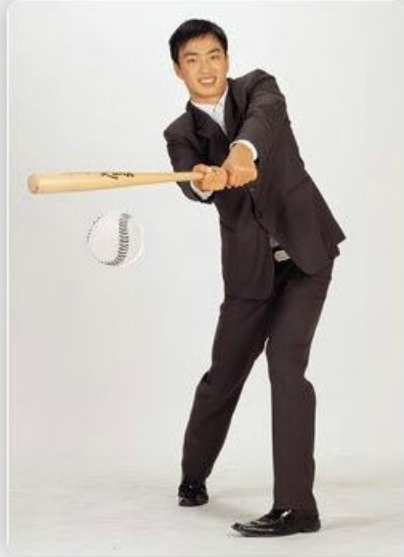
#### Examples of Newton's Third Law

Introduction

#### Ball or Bat?

With Newton's third law in mind, let's answer the following question:

A baseball is pitched towards the batter. When the ball and bat come into contact, which experiences a greater force, the ball or the bat?

A photograph of a man in a dark suit and white shirt, captured in the middle of a baseball swing. He is holding a wooden baseball bat horizontally, and a baseball is visible in the air just in front of the bat's tip. The background is a plain, light-colored wall.

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## Module 5: Impulse and Momentum

### Topic 2 Content: Examples of Newton's Third Law

#### Ball Force = Bat Force

#### Examples of Newton's Third Law

Introduction

Ball or Bat?

**Ball Force = Bat Force**

Your first instinct might be that since the ball is being hit by the bat, it must feel the greater force. But now that you know Newton's third law, you know that the magnitude of the force of the baseball bat on the ball is exactly the same as the magnitude of the force of the ball on the bat.

Bat pushes ball left      Ball pushes bat right

Bug

Bug Force

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# Module 5: Impulse and Momentum

## Topic 2 Content: Examples of Newton's Third Law


### Bug

#### Examples of Newton's Third Law

- Introduction
- Ball or Bat?
- Ball Force = Bat Force
- Bug**
- Bug Force
- Brainteaser
- Brainteaser Solution
- Summary

How about an extreme example.

An unlucky bug finds its way in front of a speeding Ferrari. The bug gets squashed on the windshield. Which experienced the greater force, the bug or the windshield?



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# Module 5: Impulse and Momentum

## Topic 2 Content: Examples of Newton's Third Law

### Bug Force

**Examples of Newton's Third Law**

Introduction

Ball or Bat?

Ball Force = Bat Force

Bug

**Bug Force**

The answer, of course, is that they experience exactly the same magnitude force, in opposite directions.

$F_N$  ← ● →  $F_N$

Bug pushes windshield left      Windshield pushes bug right

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# Module 5: Impulse and Momentum

## Topic 2 Content: Examples of Newton's Third Law

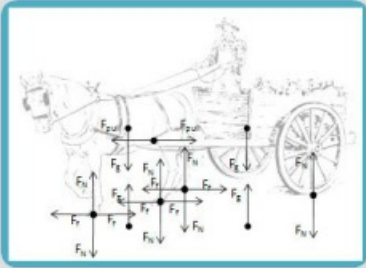
### Brainteaser

#### Examples of Newton's Third Law

- Bug
- Bug Force
- Brainteaser**

A classic physics brainteaser involves a horse harnessed to a cart.

If the horse pulls on the cart, Newton's third law tells us that the cart will pull equally back on the horse. If all forces result in an equal and opposite paired force, then how can the horse ever get the cart to move?



The diagram shows a horse pulling a cart. Various force vectors are labeled:  $F_{pull}$  (horse pulling cart),  $F_{cart}$  (cart pulling horse),  $F_g$  (gravity),  $F_N$  (normal force),  $F_f$  (friction), and  $F_{fr}$  (friction between wheels and ground).

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## Module 5: Impulse and Momentum

### Topic 2 Content: Examples of Newton's Third Law

#### Brainteaser Solution

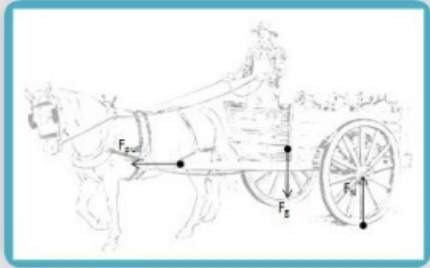
#### Examples of Newton's Third Law

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#### Brainteaser Solution

The solution to this puzzle is that while force pairs are equal and opposite, they are acting on different objects. To determine if an object will accelerate, you need to not focus on all the forces that exist, only those that act on the one object. These forces are often unbalanced.

The cart is pulled forward with a significant force by the horse, is pushed up by a normal force and is pulled down with an equal gravitational force. The unbalanced force is the force of the horse's pull which accelerates the cart.



The diagram shows a horse pulling a cart. A force vector  $F_{\text{horse}}$  points from the horse towards the cart. A force vector  $F_{\text{g}}$  points downwards from the cart, representing gravity. A force vector  $F_{\text{n}}$  points upwards from the cart, representing the normal force from the ground. The cart is shown moving to the right.

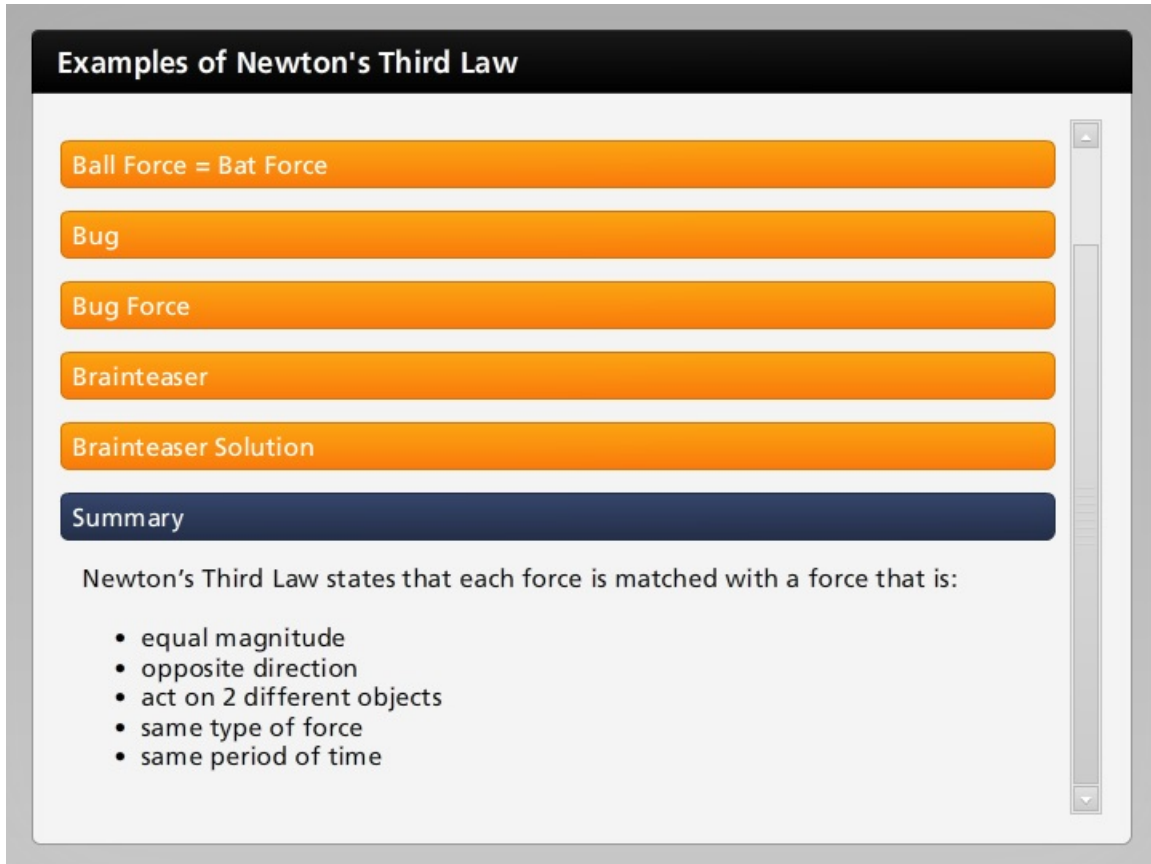
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## Module 5: Impulse and Momentum

### Topic 2 Content: Examples of Newton's Third Law

#### Summary



The screenshot shows a presentation slide with a black header bar containing the title "Examples of Newton's Third Law". Below the header, there are several orange horizontal bars with white text: "Ball Force = Bat Force", "Bug", "Bug Force", "Brainteaser", and "Brainteaser Solution". At the bottom, there is a dark blue bar with the word "Summary" in white. Below this bar, the text reads "Newton's Third Law states that each force is matched with a force that is:" followed by a bulleted list of five characteristics: equal magnitude, opposite direction, act on 2 different objects, same type of force, and same period of time. A vertical scrollbar is visible on the right side of the slide.

Newton's Third Law states that each force is matched with a force that is:

- equal magnitude
- opposite direction
- act on 2 different objects
- same type of force
- same period of time