WOW sheet

Newton's third law

The last of Sir Isaac Newton's three laws of motion, Newton's third law says:

> For every action there is an equal and opposite reaction.

It's actually more accurate to express Newton's third law this way:

> When object X exerts a force on object Y,
> then object Y exerts an equal and opposite force on object X.

What does that mean?

Here's an example

Imagine you are standing very still, with a book on your head. The book is exerting a force on you – it is pressing down on your head. But your head is also exerting a force on the book. That force is pushing the book up.

When object x (the book) exerts a force on object Y (your head), then object Y (your head) exerts an equal and opposite force on object X (the book).

And what if you were in an elevator moving up? It doesn't matter! The book is still exerting a force down on your head and your head is still exerting an equal and opposite force back up on the book.

The two equal and opposite forces that the two objects exert on each other are called the **action-reaction pair**.

Whenever two objects exert force on each other, an action-reaction pair forms. Try this. Take your hand and put your palm on your desk or table. Now push down. The harder you push, the more your palm gets compressed (in other words, squished) in between the desk and the rest of your hand. Your hand is creating an action by pressing down on the desk and the desk is creating a reaction by pushing back up against your hand.

The mass of the objects matters

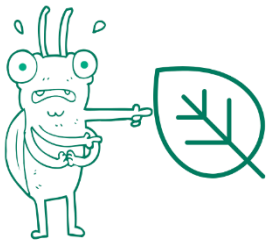
No matter what two objects exert force on each other, the action-reaction pair of forces will be of equal magnitude (size) but in opposite directions. What those forces do to the objects, however, depends on the mass of the objects.

This is because Newton's second law tells us that the greater the mass of an object, the less acceleration a force will cause on that object.

Example: the pushy bug

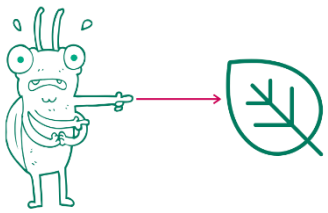
For this example, we will use a bug which has a mass of 10 grams. This bug likes to push on things. And the bug always pushes with the same amount of force: 0.01 newtons (0.01N).

The first thing the bug pushes is a leaf which has a mass of 1 gram.



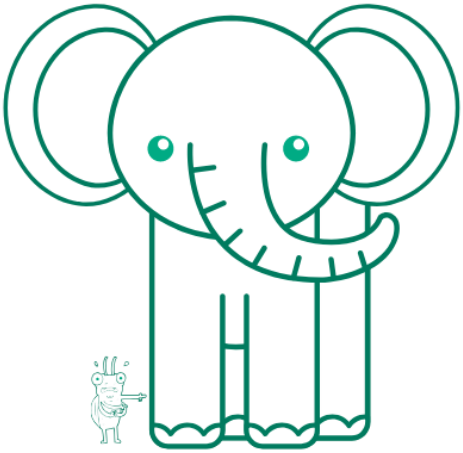
The reaction of the leaf pushing back against the bug has the same force as the bug's action push (0.01N), but in the opposite direction. This reaction force is what causes the bug to feel pressure from the leaf on her front leg.

Because the leaf has very little mass, the force from the bug's push causes a fair amount of acceleration. The result? The leaf is pushed away from the bug.



Next, the bug decides to push on an elephant.

The elephant has a mass of 4,000kg (which is 4,000,000 grams). Once again, the bug pushes with a force of 0.01N. And, once again, there is an instant equal and opposite reaction of 0.01N.



In other words, the surface of the elephant's leg pushes back against the bug with the same force (0.01N) as the bug uses to push on the elephant. This reaction force is equal, but in the opposite direction, and is why the bug feels pressure on her front leg.

But the elephant has a lot of mass.

That means the force of the bug's push only results in a tiny amount of acceleration on the elephant. The bug's push isn't enough to overcome the elephant's inertia. And that means that, unlike the leaf, the elephant doesn't move.