15 The Science of Stunts

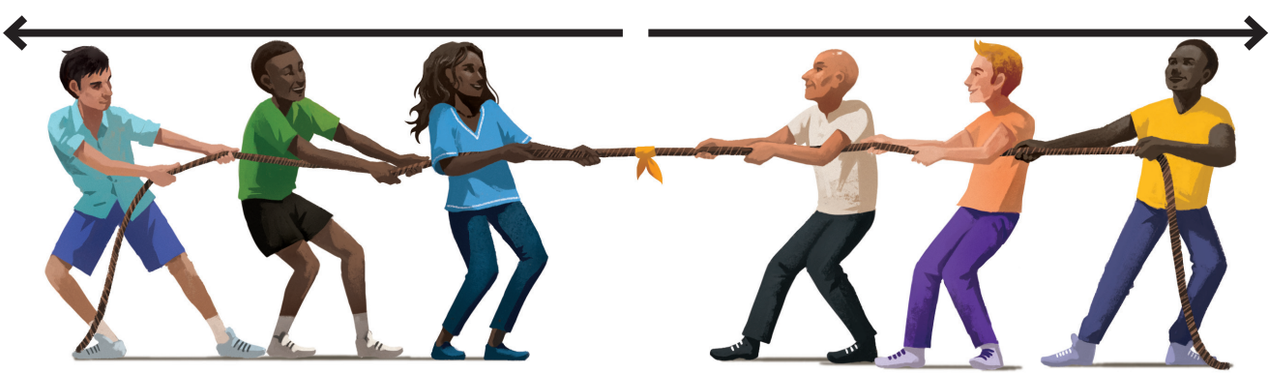
There's nothing more exciting than a good stunt. Stunts can make audiences gasp in wonder or scream in fright! But behind every death-defying stunt, there are several forces at work. In this unit we will explore the science of stunts.

Keywords force balanced forces gravity mass gravitational pull lever pivot fulcrum see-saw teeterboard friction air resistance drag

Forces

All stunts involve one or more forces. A **force** is a push or a pull on an object. It can make the object move or speed up. It might also change its direction or shape. Forces can't be seen but they are at work all around us. They are needed to lift, turn, move, open and close objects. When you throw a ball, you are using force to make the ball move through the air.

When two forces are the same strength but act in opposite directions, they are called **balanced forces**. For example, in a tug of war, if the teams on each side of the rope are pulling with the same strength but in opposite directions, the forces are balanced. There is no movement. However, if one team is stronger than the other, the forces are unbalanced and one team will be pulled forwards.



In this tug of war, the forces are balanced.

Most people don't really think about how or why forces work the way they do. However, these laws of physics are fundamental to our understanding of how the universe works. They are also a critical factor when it comes to stunts!

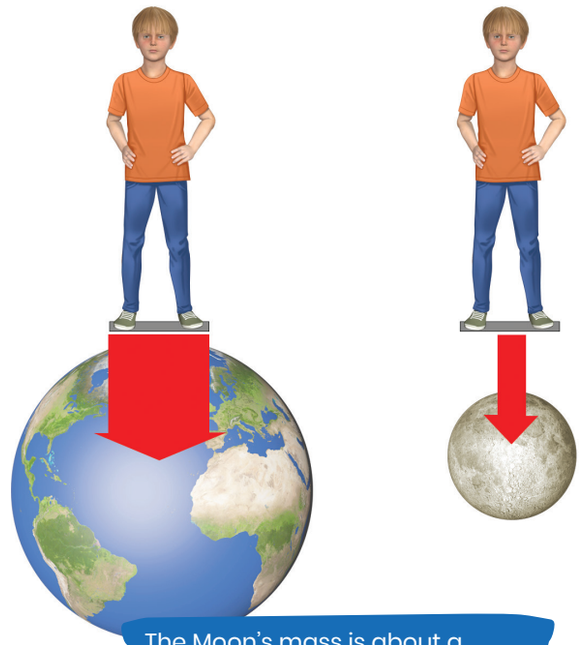
Fact File

Forces are measured in newtons, after Isaac Newton. He developed the principles of modern physics and is considered one of the greatest scientists of all time.

Gravity

Gravity is the invisible force that keeps our feet on the ground and stops us floating off into space. Everything that has **mass** is affected by gravity. Mass is the amount of matter within an object. The greater the mass of an object, the stronger its **gravitational pull**. Because Earth has a lot of mass, it pulls us towards it. However, the Moon is smaller than Earth and its gravitational pull is much weaker. You could jump much higher on the Moon than you can on Earth.

Think About It: Do you think the gravitational pull on Jupiter is greater or less than that of Earth?



The Moon's mass is about a quarter of the Earth's mass, so its gravitational pull is much weaker.

High-wire Hijinks

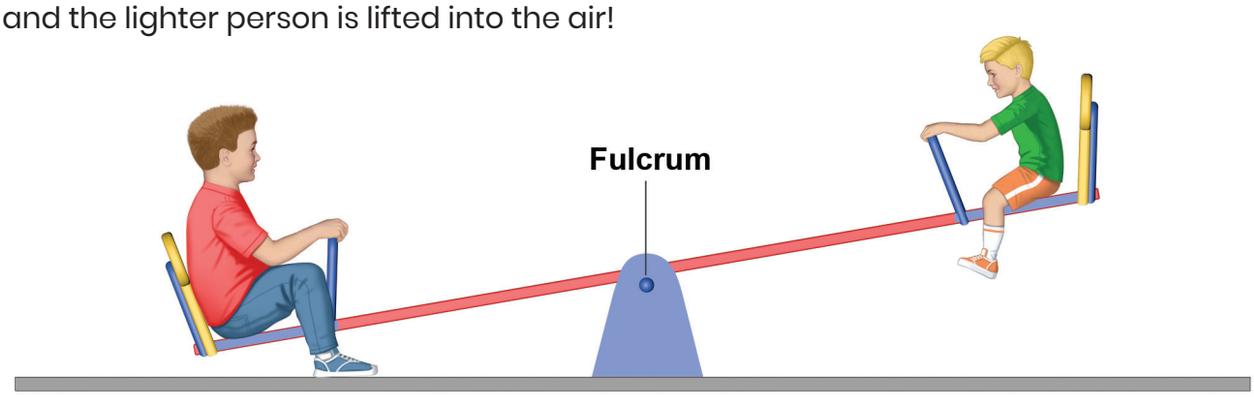
Gravity is what makes some stunts so challenging and so exciting. In 1974, Philippe Petit walked on a high wire between the Twin Towers of the World Trade Center in New York City. The wire was suspended between the two towers more than 400 m in the air. The force of gravity was pulling Petit towards the ground. The only thing preventing him from plunging to his death was the force of the wire pushing back against his body. Petit also used a pole to help him balance the forces acting on him.

Philippe Petit spent six years planning his high-wire walk between the Twin Towers. He was arrested after completing the stunt but released shortly afterwards.

Levers

A **lever** is an object that can be used to apply or transfer forces. It consists of a rigid rod on a fixed hinge called a **pivot** or **fulcrum**. When the fulcrum is between the ends of the rod, a downward force on one side can be used to apply an upward force on the other side. For this reason, levers are very useful for lifting heavy objects.

A playground **see-saw** is a great example of a lever. When two people who weigh the same sit on either end of a see-saw, the see-saw doesn't move. This is because the forces are balanced. However, if a heavier person sits on one end of the see-saw, the forces are now unbalanced and the lighter person is lifted into the air!



A see-saw is a type of lever.

Teeterboard Tricks

The **teeterboard** is a popular circus stunt that relies on a see-saw. One performer stands on one side of the see-saw. Their partner jumps from a height to land on the other side. The force of gravity pulls them towards the ground. When they land, their force is transferred by the see-saw, pushing their partner up into the air.

The greater the height from which the performer jumps, the stronger the force created and the higher the other performer is pushed into the air.

Fact File

Archimedes was a Greek mathematician and scientist who lived in the third century BC. He wrote: 'Give me a lever long enough and a fulcrum on which to place it, and I shall move the world.'

Think About It: Research the following household objects and find out why they are levers; scissors, tin opener, wheelbarrow, nail clippers.

Friction

Friction is a force that slows or stops motion between two surfaces that are touching. Without friction, you would slip and slide on every surface. You wouldn't even be able to hold your pencil between your fingers! Friction exists between any two surfaces that touch. However, there is more friction between two rough surfaces than between two smooth surfaces. This is why it's easier to skate on ice than on concrete!

Smooth surfaces such as ice and glass are much easier to slide over than rough surfaces such as concrete or carpet.

Hair-raising Handbrake Turns

A handbrake turn is a driving technique often used by stunt performers. It involves using the handbrake to slide a car sideways into a skidding turn! All brakes rely on friction. When the handbrake is pulled, the car's brakes grip on the back wheels to slow them down. Of course, if a car is moving very quickly, this creates a lot of friction between the tyres and the rough road. This slows the car down but also generates a lot of heat. When performing a handbrake turn, stunt drivers must be careful that the friction they create doesn't start a fire.

Friction between the car and the tyres causes the rubber on the surface of the tyres to burn slightly, creating smoke and a strong smell.

Think About It: When it's cold, we often rub our hands together for warmth. This is because the friction between our hands creates heat. Can you think of any other instances of friction giving off heat?

Gravity vs Friction: Skydiving!

Skydiving requires a lot of nerve. After jumping from a plane, gravity pulls the skydiver towards the ground. The diver falls faster and faster, accelerating until they are travelling at a maximum speed of about 56 m per second. If they kept going at the same speed, they'd be in trouble! Luckily, skydivers have parachutes that use a type of friction called **air resistance** or **drag** to slow them down. Although air is invisible, it does have mass. Air pushes against the fabric of the parachute. The force of the air resistance is not stronger than the force of gravity, so it doesn't stop the skydiver falling entirely. However, it slows them down enough for a gentle landing.

Think About It: Skydivers can travel faster by adopting a head-down position and tucking their arms in by their bodies. Why do you think this is?

Skydivers generally reach a speed of around 200 km/h before opening their parachutes.

Design and Make: Egg Parachute

1 Explore

Study examples of parachutes.

Useful materials:

- string
- newspaper
- sticky tape
- lollipop sticks
- an egg

2 Plan

Sketch your parachute design.

- What size will the parachute be?
- What will you use to hold your egg?
- What shape will it be?

3 Make

Make your parachute.

4 Evaluate

Test your parachute. If possible, drop your parachute from a first floor window. Did the egg break? Was it protected? What type of parachute was most effective?

Now you know the science behind some common stunts and the forces that are at work all around us. Next time you are on your bike or skateboard, or you kick a ball, see if you can figure out what forces are involved!

Activities

Fact Finding

1. What force on Earth causes objects to fall?
2. What are balanced forces?
3. Name the point on which a see-saw balances.
4. What causes the burning smell when a car does a handbrake turn?
5. What type of friction is at work during a parachute jump?

Explore More

1. Describe how forces behave when a tug of war is won.
2. The greater the height from which the person on one side of a teeterboard jumps, the higher the person on the other side of the board is pushed into the air. Why is this the case?
3. Engineers must consider air resistance, or drag, when designing the shape of many moving objects. Can you say why, and give some examples?
4. Can you explain the forces involved in diving from a great height?
5. Which stunt do you think is the most exciting? Why?

Working as a Scientist: Analysing

1. Many vehicles are powered by an internal combustion engine. The engine contains cylinders which hold the fuel and pistons. The fuel and pistons move up and down rapidly inside the cylinders. If the pistons were not coated with oil, the pistons and cylinders would become so hot that they would melt. What force can explain this? How do you think the oil helps?
2. A typical parachute used by a skydiver has a diameter of about 30 m. Why do you think it needs to be this big?

Working as a Scientist: Investigating and Experimenting

1. Source items that are made from different materials – a newspaper, a leather shoe, a metal spoon, etc. Rub two pieces of the material together. Then touch their surfaces with your finger. What do you notice? Is there a difference in the result for the different materials?
2. Place a metre stick across a whiteboard marker to make a simple see-saw lever. The marker will act as the fulcrum. Place a small book on one end of the metre stick. Then press down on the other end of the lever to raise the book. Repeat the experiment with the marker nearer to the end of the lever with the book, and then nearer to the end that you press down on. Record what happens each time. What did you find about the relationship between the position of the fulcrum (marker) and the force needed to raise the book?