

Physics Year 11 Week 4

Forces

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Forces can't be seen, but the effects of a force can be seen.

They are measured in Newtons — N.

They usually act in pairs.

They always act in a certain direction.

A newton meter is used to measure forces.

Forces can Make Objects do Five things

1) Speed up

— like kicking a football.



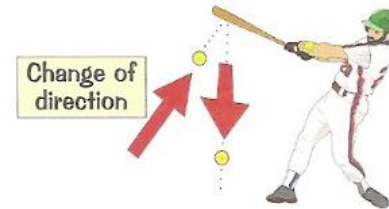
2) Slow down

— like drag or air resistance.



3) Change Direction

— like hitting a ball with a bat.



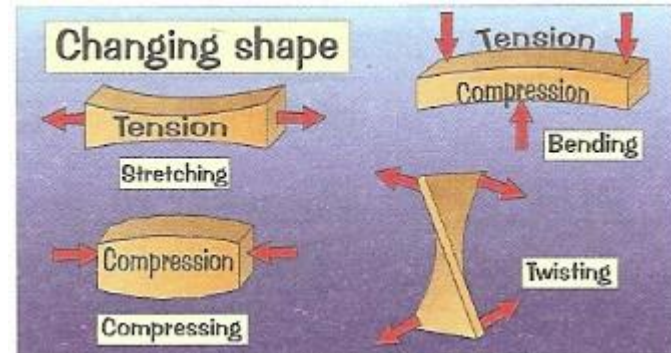
4) Turn

— like turning a spanner.

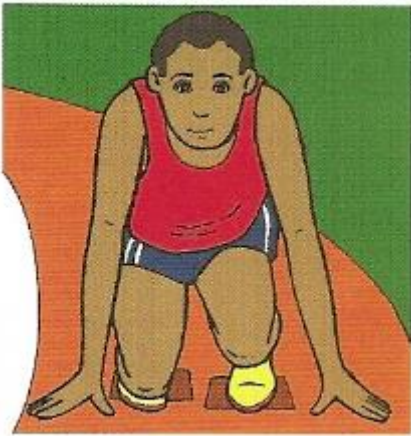


5) Change Shape

— like stretching, twisting, compressing, bending.



Recognising Forces



pushing off the blocks



pulling the grass roller



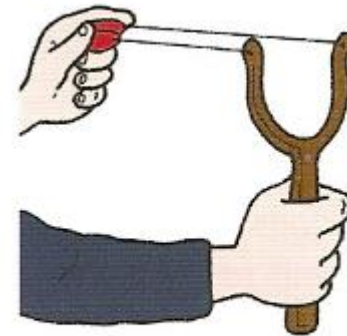
compressing the spring



twisting the bottle



lifting the bag

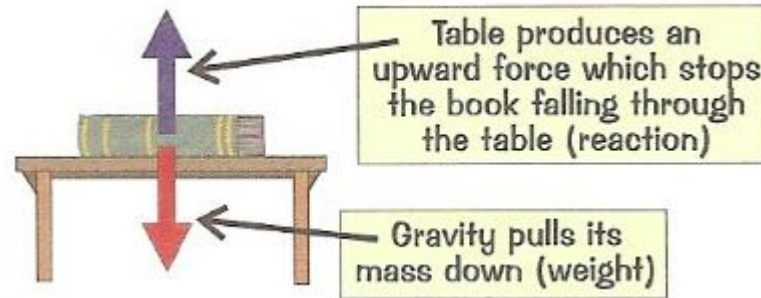


stretching the catapult

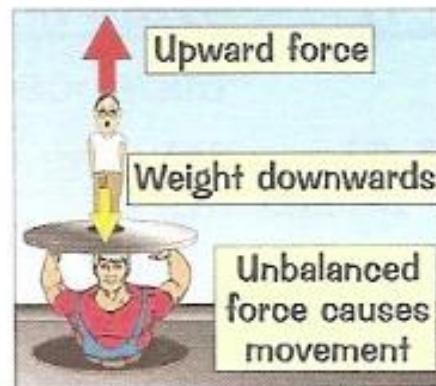
Types of Forces

- Contact Force – Forces that act through direct contact between two objects
 - Applied Forces, Friction
- Long Range Forces – Forces that can act over distances
 - Gravity, Electromagnetic Force (EMF)

Balanced Forces produce No Change in Movement

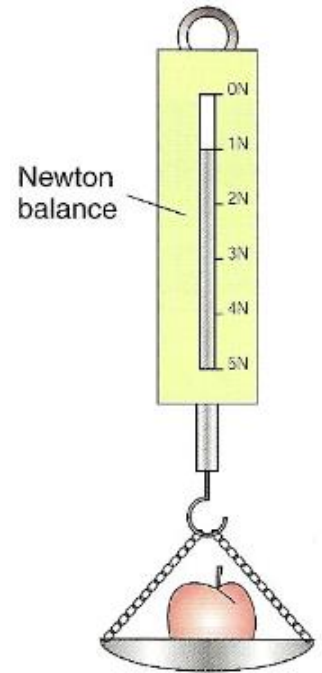


Unbalanced Forces Change the Speed and or Direction of Moving Objects



S.I. Unit For Force

- The Unit for Force is a Newton (N)
 - $1\text{N} = 1\text{kg m/s}^2$
 - A Newton (N) is defined as the amount of force required to accelerate 1 kg of mass at a rate of 1 m/s^2 .



Gravity is the Force of Attraction Between All Masses

Gravity attracts all masses, but you only notice it when one of the masses is really really big, e.g. a planet. Anything near a planet or star is attracted to it very strongly.

On the surface of a planet, it makes all things accelerate towards the ground (all with the same acceleration, g, which is about 10 m/s² on Earth).

It gives everything a weight.

It keeps planets, moons and satellites in their orbits. The orbit is a balance between the forward motion of the object and the force of gravity pulling it inwards.

Weight

- Weight is a Force! It is measured in Newtons.
- Weight = Mass x Acceleration due to Gravity
(Newton's 2nd law)
- $W = mg$
- Weight does change with location! ("g" will change with location)

Mass

Mass depends on the number and type of atoms.

Mass is a scalar – it has only size. No direction.

We measure mass in **kilograms (kg)**.

Weight and Mass are Not the Same

Mass is just the amount of 'stuff' in an object.

Weight is caused by the pull of gravity. In most questions the weight of an object is just the force of gravity pulling it towards the centre of the Earth.

An object has the same mass whether it's on Earth or on the Moon — but its weight will be different. A 1 kg mass will weigh less on the Moon (about 1.6 N) than it does on Earth (about 10 N), simply because the force of gravity pulling on it is less.

Weight is a force measured in newtons. It's measured using a spring balance or newton meter. Mass is not a force. It's measured in kilograms with a mass balance (an old-fashioned pair of balancing scales).

Mass, weight and gravity

'g' actually has two meanings:

- g is the acceleration of free fall (9.81m/s^2)
- g is the gravitational field strength (9.81N/kg)

Mass, weight and gravity

Gravitational field strength is the force experienced by a mass due to gravitational attraction.

Weight is the term we use for the Earth's gravitational force on an object.

Mass, weight and gravity

Weight = mass \times g
(where $g = 10\text{N/kg}$)



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Weight = mass \times g
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$$W = mg$$

$$W = 1000 \times 10$$



Mass, weight and gravity

Weight = mass \times g
(where $g = 10\text{N/kg}$)

$$W = mg$$

$$W = 1000 \times 10$$

$$W = 10,000\text{N}$$



Mass, weight and gravity


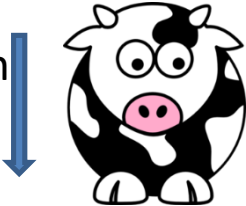
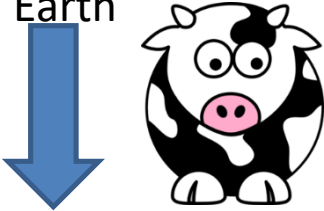
Weight = mass \times g
(where $g = 10\text{N/kg}$)

$$W = mg$$

Remember: mass doesn't change - it's the gravitational force that may change



Mass, weight and gravity

	Mass	Weight
In space 	1000kg	Zero
On the Moon 	1000kg	1,600N
On Earth 	1000kg	10,000N

Gravitational field strength

On earth, the weight of every 1 kg of mass is 10 N.

The weight per unit mass is equal to the gravitational field strength.

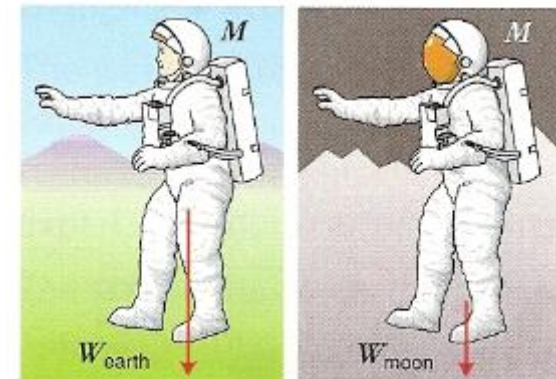
$$g = \frac{W}{m}$$

PLANET	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
g (N/kg)	4	9	10	4	26	11	12	12

The acceleration due to gravity is numerically equal to the gravitational field strength.

On Earth, acceleration, $a = 10 \text{ m/s}^2$ and gravitational field strength, $g = 10 \text{ N/kg}$.

On the Moon, acceleration, $a = 1.6 \text{ m/s}^2$ and gravitational field strength, $g = 1.6 \text{ N/kg}$.



weight loss, but still the same mass!

Relating Mass, Weight & Gravity

weight = mass \times gravitational field strength

$$W = m \times g$$

Mass is in kg, weight is in newtons.

The letter "g" represents the strength of the gravity and its value is different for different planets.
On Earth $g \approx 10 \text{ N/kg}$. On the Moon, where the gravity is weaker, g is only about 1.6 N/kg .

What is the weight, in newtons, of a 5 kg mass, both on Earth and on the Moon?

A force of 1 N will give a mass of 1 kg an acceleration of 1 m/s^2

" $W = m \times g$ ". On Earth: $W = 5 \times 10 = \underline{50 \text{ N}}$ (The weight of the 5 kg mass is 50 N.)
On the Moon: $W = 5 \times 1.6 = \underline{8 \text{ N}}$ (The weight of the 5 kg mass is 8 N.)