

Topic: Forces in a Newtonian World

Duration: 11 lessons

Composite: Unit test

Key vocabulary:

Core knowledge Components and Powerful knowledge components (P) crucial to commit to long term memory

Links to previous and future topics

- Force
- Newton
- Speed
- Velocity
- Distance
- Displacement
- Vector
- Scalar
- Acceleration
- Direction
- Gradient
- Area
- Mass
- Weight
- Centripetal
- Gravitational Field Strength
- Balanced
- Unbalanced
- Initial
- Final
- Friction
- Resultant
- Magnitude
- Braking
- Stopping
- Thinking
- Momentum
- Light gate
- Motion

Year 10 Forces and Motion (Page 1)

Core and Powerful (P) knowledge questions


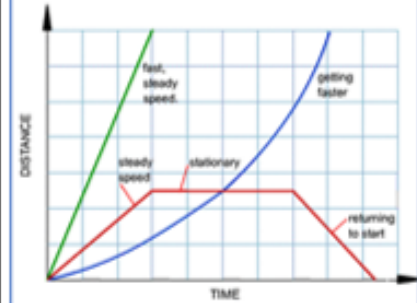
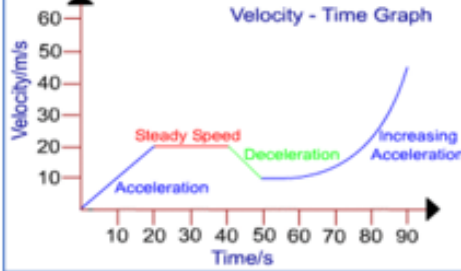

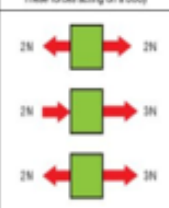
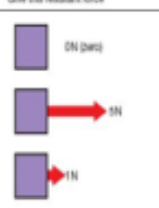


What is the difference between a scalar and a vector quantity? (P)
A vector quantity has size and direction.
A Scalar quantity has size only

Scalars	Vectors
direction	displacement
speed	velocity
mass	force (including weight)
temperature	acceleration
energy	momentum

State some everyday speeds:

- Walking 1.5m/s
- Running 3 m/s
- Cycling 6m/s
- Car 25m/s
- Train 50m/s
- Plane 250m/s

What are the units for distance, speed, acceleration, force, mass, time and momentum?

Distance, m	Speed, m/s	Acceleration, m/s ²	Force, N	Mass, kg	Time, s	Momentum kgm/s
<p>What equation links velocity, distance and time? (P)</p> $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$ 	<p>How do we interpret a distance time graph? (P)</p> 	<p>How do we interpret a velocity time graph? (P)</p> 	<p>What is the equation that links acceleration with change in velocity and time? (P)</p> $a = \frac{(v - u)}{t}$ 			
<p>Which equation links acceleration with change in velocity and distance travelled?</p> $v^2 - u^2 = 2 \times a \times x$	<p>What happens to an object if there is a resultant force acting on it? (P) The object moves in a straight line at a steady speed</p> <p>What happens to an object if there is no resultant force acting on it? (P) The object accelerates</p>	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>These forces acting on a body</p>  </div> <div style="text-align: center;"> <p>Give this resultant force</p>  </div> </div>	<div style="display: flex; align-items: center;">  <div style="background-color: yellow; padding: 5px; font-weight: bold; text-align: center;"> <p>Required practical: Watch again: Investigating force, mass and acceleration</p> </div> </div> 			

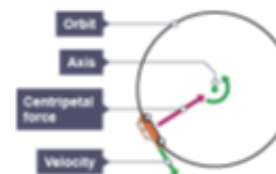
- KS2: Forces & Magnets, Forces
- Y7: Forces & Space
- Y9 Forces in a Newtonian World
- Y9 Motion and Pressure in a Newtonian World
- KS4: Forces and Matter
- KS4: Forces and their effects
- KS4: Forces and Work

Year 10 Forces and Motion (Page 2)

Core and Powerful (P)
knowledge questions

What is the name of the type of force that keeps an object moving in a circle? (H)
Why is an object moving in a circle constantly accelerating? (H)

Objects travelling in a circular motion are prevented from moving off in a straight line by **centripetal force**. This resultant force pulls objects toward the centre of the circle, continually changing the direction that an object is travelling in to keep it in circular motion.



What does Newton's First Law of Motion State?

An object remains in the same state of motion unless a resultant force **acts** on it. If the resultant force on an object is zero, this means:

- a stationary object stays stationary
- a moving object continues to move at the same velocity (at the same speed and in the same direction)

What does Newton's Second Law of Motion State?

The law can be described by this equation which shows that the acceleration of an object is:

$$F = m \times a$$

- proportional to the resultant force on the object
- inversely proportional to the mass of the object

In other words, the acceleration of an object increases if the resultant force on it increases, and decreases if the mass of the object increases

What is the equation that links force, mass and acceleration? (P)

$$F = m \times a$$



What is weight?

What is the difference between mass and weight?

Mass and weight are not the same!

- **Mass** is the amount of matter in an object and is measured in **kilograms**. Mass is not a force.

Mass will have the same value anywhere in the Universe, including space.

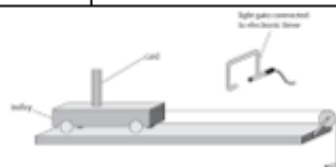
- **Weight** is a force and is caused by the pull of gravity acting on a mass. Like other forces, weight is measured in **newtons** and has both magnitude and direction.

What does Newton's Third Law of Motion State?

Whenever two objects interact, they exert equal and opposite forces on each other

How do light gates work?

A **light gate** is connected to a device that measures the time the light is blocked when the card passes through it.



What is the equation that links momentum, mass and velocity? (H)

$$p = m \times v$$

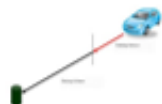


What equation links change in momentum to force? (H)

$$F = \frac{(mv - mu)}{t}$$

How is overall stopping distance linked to braking and thinking distance? (P)

Stopping distance = Thinking distance + Braking distance



Which different factors affect thinking and braking distance? (P)



Thinking distance	Braking distance
Speed of car	Speed of car
Drugs and alcohol	Road conditions
Tiredness	Condition of tyres
Medication	Condition of brakes

Impressive reading

Impressive speaking

Impressive writing

Resilience

Employability via:

Various careers available in engineering, design and sports science that demand an understanding of forces and how they affect motion.

CULTURE CAPITAL: Rocket Science: How do we get a satellite into orbit? Newtons cannonball theory: <https://www.youtube.com/watch?v=ALRdYPMpqQs> . Isaac Newton postulated many years before humans made it into space how something could get into orbit

SEND

- Opening activity/theme is Knowledge Recall to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge using Knowledge Recall.
- Multi-sensory approach using reading, listening, watching, doing practicals, talking, observing demonstrations...
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary
- Skills ordered logically and sequenced with an increase in complexity

- Links to prior learning explicitly highlighted to support non-verbal reasoning – then, now, next
- Activities are scaffolded with over-learning of previous content to encourage independence

Topic: Energy - Forces Doing Work	Duration: 2 Lessons	Composite: Unit test
--	----------------------------	-----------------------------

Key vocabulary:	Core knowledge Components Powerful knowledge components crucial to commit to long term memory (IN RED BOX)	Links to previous and future topics
------------------------	---	--

Energy
Work
Power
System
Watt
Sankey
Chemical
Thermal
Gravitational
Kinetic
Radiation
Conservation

ENERGY – FORCES DOING WORK

Systems

- A system is an object or group of objects being studied that are energy stores
- A closed system is a system which experiences no external forces
 - E.g. a circuit, or a skydiver
- In a closed system, the total energy remains the same at all times

Work Done

- Measured in Joules (J)
- The term used to describe the energy involved when an external force transfers energy to a system (e.g. a person pushing a ball up a hill)
- Have to have a force moving an object

Power

- Power is the rate of energy transfer.
- Measured in Watts (W)
- 1 Watt = 1 Joule of energy transferred in 1 second

Energy Stores & Transfers

- Useful energy is energy that has been transferred to a desired store
- Wasted energy is energy that has not been transferred to a useful store
- Mechanical processes are wasteful when they get hot (usually due to friction)
 - Energy is dissipated as heat, causing a rise in temperature
 - So the energy is lost to the surrounding
- Sankey diagrams show: the input and output energy stores; state useful and wasted energies; state amounts of energy
- Efficiency is a measure of how good a machine is at transferring energy into useful stores.

Energy Transfer Diagram for Filament Lamp

Sankey diagram: e.g. washing machine

Principle of the Conservation of Energy: Energy cannot be created or destroyed but can be transferred from one store to another.

- Gravitational Potential Energy = energy involved when an object changes height**

Potential Energy

$E_p = mgh$

KINETIC ENERGY

Objects that are moving have kinetic energy, equation:

Kinetic energy (J) = 1/2 x mass (kg) x speed² (m/s²)

$E_k = \frac{1}{2}mv^2$

- Energy Stores: Chemical, Thermal, Kinetic, Gravitational Potential, Elastic Potential, Nuclear, Magnetic, Electrostatic**
- Energy transfers: transfer energy from one store to another:**
 - Electrical – through electric currents
 - Mechanical – through forces or particles
 - Heating – through differences in temperature from hotter to colder
 - Radiation – as electromagnetic waves e.g. visible light, ultraviolet, infrared etc.

W
Joules
Work Done

F
Newtons
Force

d
meters
Distance

E
Joules
Energy

P
Watts
Power

T
seconds
Time

Y7: Energy

Y8: Heating & Cooling

Y9: Energy, Force in a Newtonian World, Motion

KS4: Conservation of Energy, Forces, Forces and their Effects

KS5 Physics: Forces in Action, Work, Energy and Power

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
In this experiment, students follow written instructions calculate their own work done and power in a simple timed lifting exercise. Students lift the object and return it to the floor 20 times, to allow a reasonable period for timing purposes.	Explain ways of reducing unwanted energy transfer through lubrication.	Ask students, in small groups, to write down any equations or definitions they already know for forces and/or energy, and their units. The groups should classify their ideas into 'definitely correct' and 'hopefully correct'	Determine own work done using practical work and calculations.	Heating Engineers, Product Design, Mechanical and Aeronautical Engineering, Manufacturing, Environmental Science and Design

CULTURAL CAPITAL: <https://www.youtube.com/watch?v=G8yKFVPOD6o&:text=http%3A%2F%2Fwww.ted.com,found%20in%20a%20library%20book>. William Kamkwamba – 14 year old boy from Malawi – designed and built windmill from spare parts (links to following topic on Forces and Effects also due to short length of topics).

SEND

- Opening activity/theme paired/groups equation recall from previous topics to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge via starter activity and knowledge recall slides
- Multi-sensory approach using video, practical work, teacher explanation, calculations
- William Kamkwamba case study chosen to support cultural capital at KS4/KS5
- William Kamkwamba case study chosen as relatable
- William Kamkwamba case study chosen as it shows life skills to support the pathway into adulthood
- William Kamkwamba case study chosen due to cross curricular links with Geography and DT
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary
- Skills ordered logically and sequenced with an increase in complexity
- Links to prior learning explicitly highlighted to support non-verbal reasoning