



Scalar Quantities



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Quantities that only have a **magnitude**, not a direction.

Examples include speed, distance, time, mass, and

energy

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Vector Quantities



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Quantities that have both a **magnitude and direction**. They are represented by an arrow. Examples include velocity, displacement, acceleration, force, and momentum

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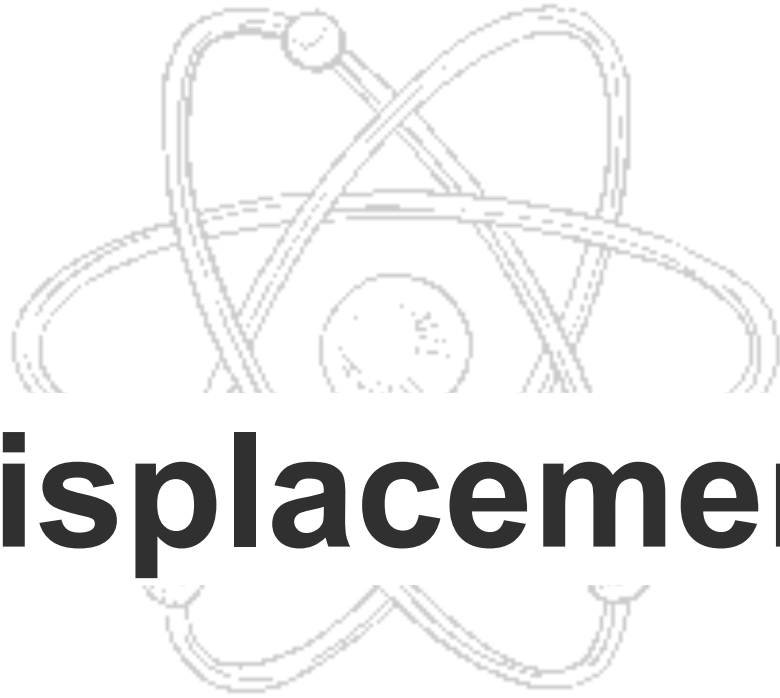
Distance

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A measure of how far an object moves. It doesn't depend on direction and is therefore a **scalar quantity**

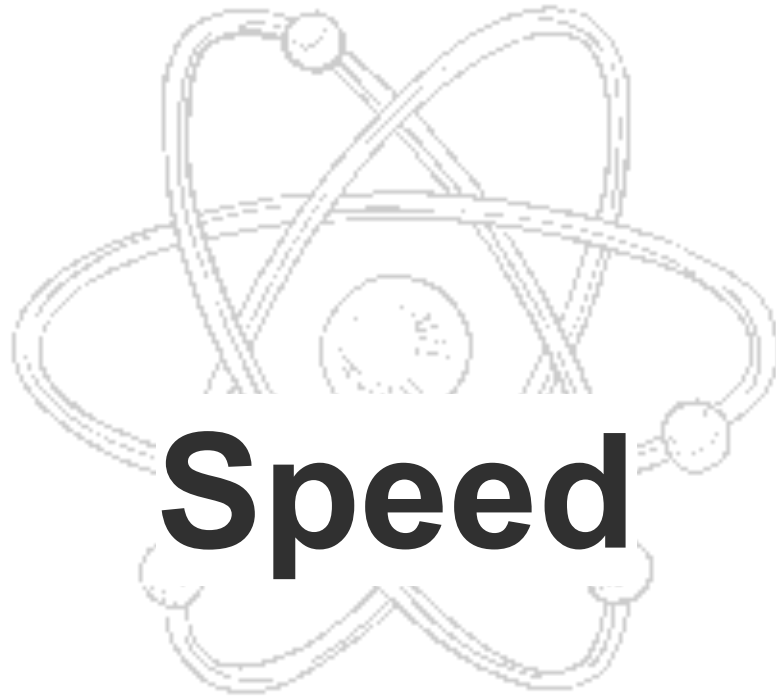
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Displacement

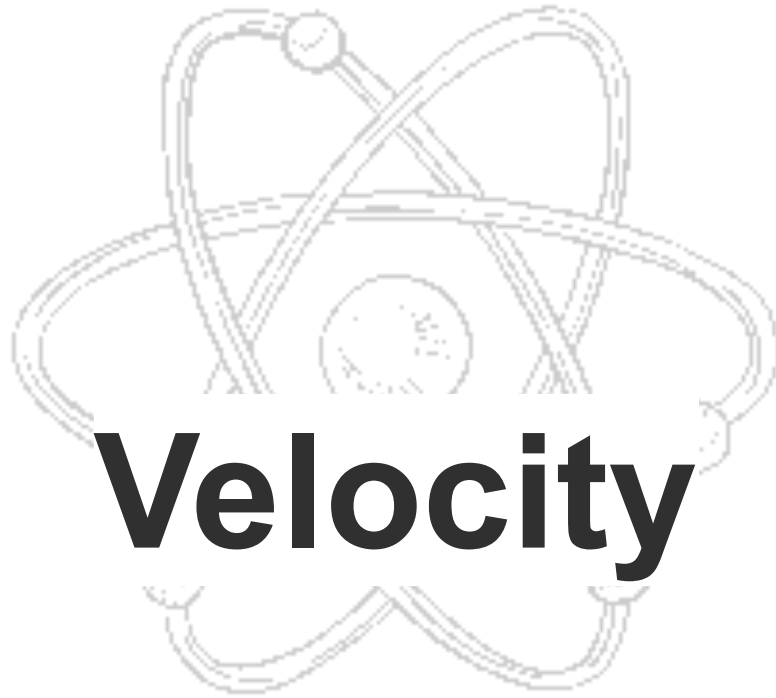
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A measure of how far an object moves in a **given direction**. It is the straight line between the starting and finishing points and is a **vector quantity**



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A **scalar quantity** that is a measure of the **rate of change of distance**. Average speed is calculated by dividing the distance travelled by the time taken



Velocity

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A vector quantity that is a measure of the rate of change of displacement. It is the speed in a given direction.

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Acceleration



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The rate of change of velocity. It can be calculated from the gradient of a velocity-time graph

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Acceleration due to Gravity (g)

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The acceleration experienced by an object travelling in **free-fall**. Its value at the surface of Earth is **10 m/s^2**

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Distance-Time Graph



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The **gradient** of the graph at any point equals the object's **speed**. A horizontal line means the object is **stationary**.

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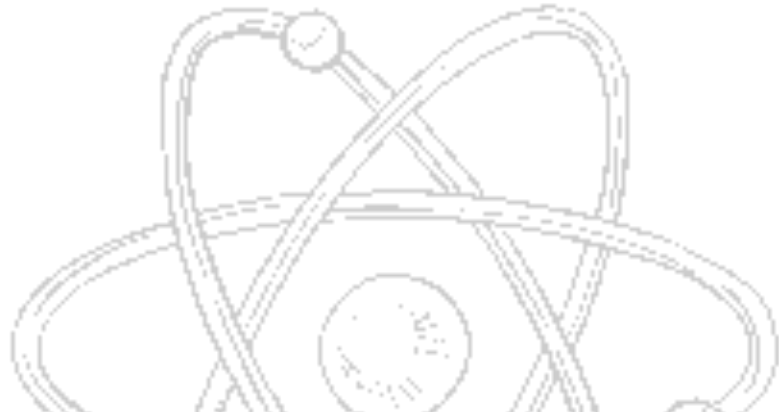
Velocity-Time Graph

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The **gradient** at any point equals the object's **acceleration**. The **area under the graph** equals the object's **displacement** (distance travelled)

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Human Reaction Time



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The time it takes for the brain to react to a stimulus. Typical times are in the range of
0.2–0.9 seconds

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Stopping Distance



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The sum of the **thinking distance** and the **braking distance**

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Thinking Distance



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The distance a vehicle travels during the driver's **reaction time**. This is affected by tiredness, drugs, or alcohol.

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Braking Distance



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The distance a vehicle travels under the braking force. Affected by adverse road/weather conditions, and the condition of the vehicle (e.g., bald tyres)

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Braking Distance and Speed

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Braking distance is **proportional to the initial velocity squared** ($d \propto u^2$). The work done to stop the vehicle equals its initial Kinetic Energy

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Weight

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The **force** acting on an object due to gravity. It is equal to the product of the object's mass and the gravitational field strength. Measured in Newtons (N) using a Newton Meter

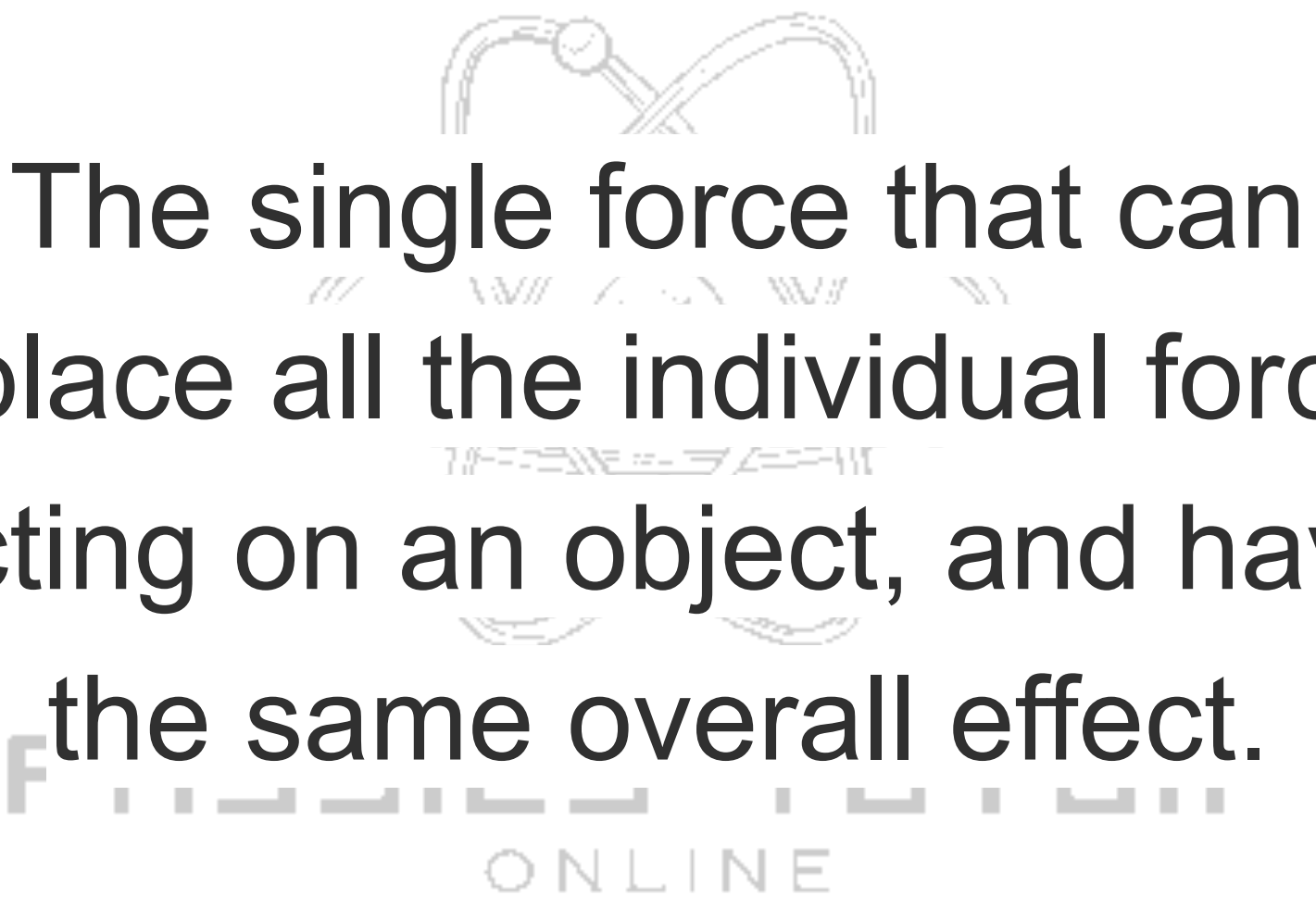
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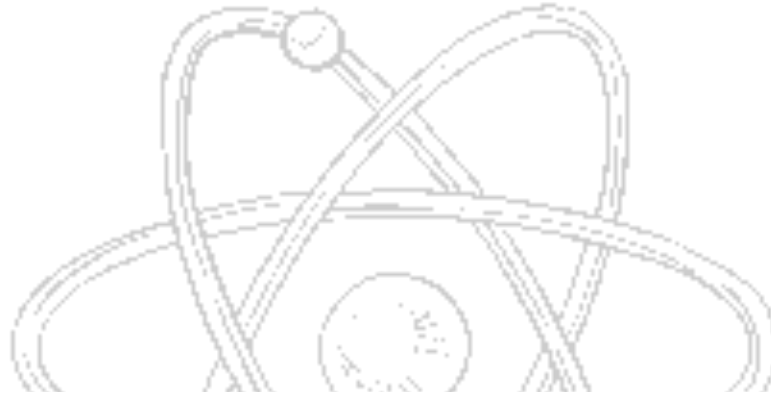
Resultant Force



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The single force that can
replace all the individual forces
acting on an object, and have
the same overall effect.



Newton's First Law



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If the **resultant force is zero**, a stationary object remains stationary, or a moving object continues to move at a **constant velocity** (same speed and direction).

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Newton's Second Law



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An object's **acceleration** is directly **proportional to the resultant force** acting on it, and inversely proportional to the object's mass. Formula: $F=ma$

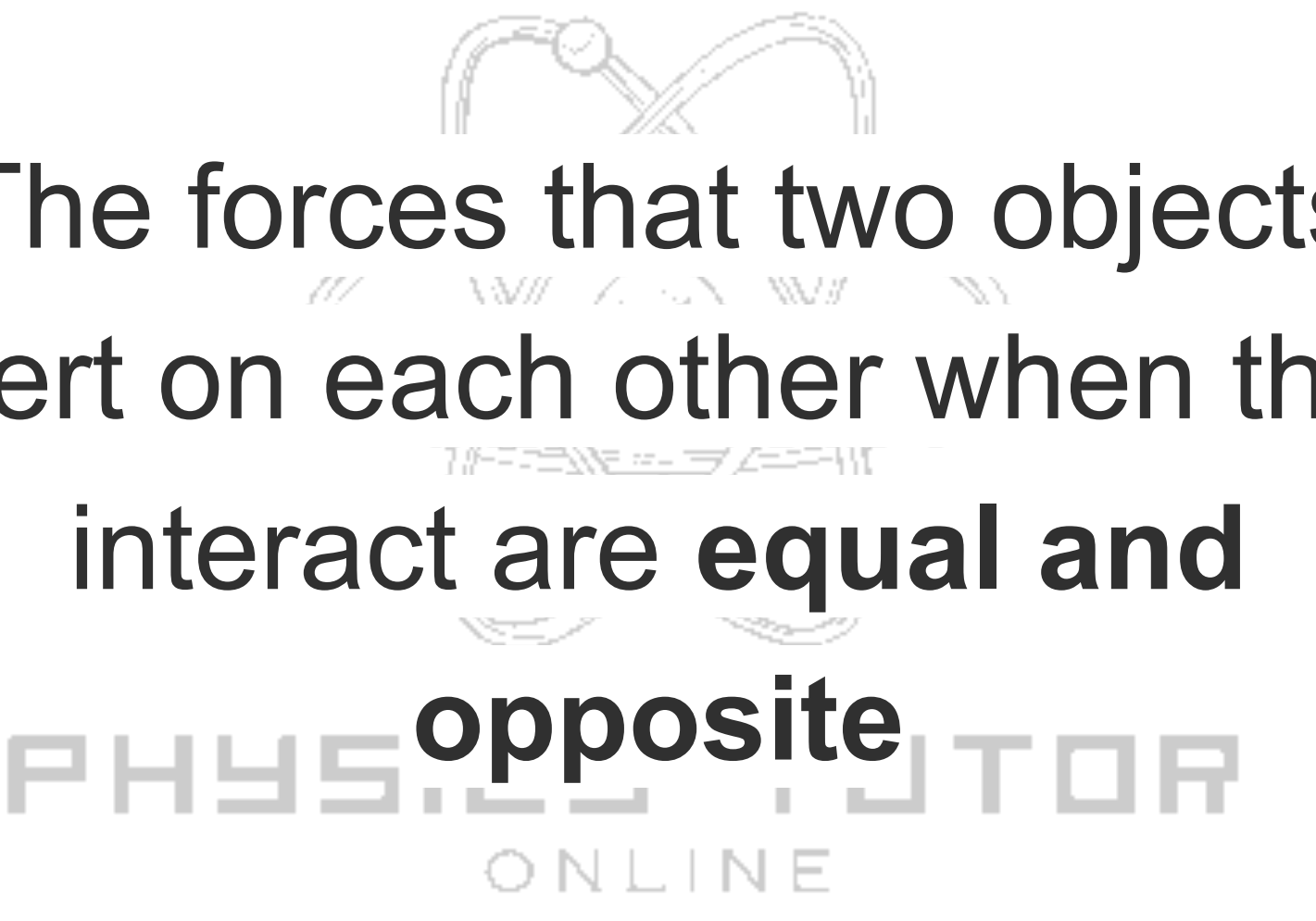
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Newton's Third Law



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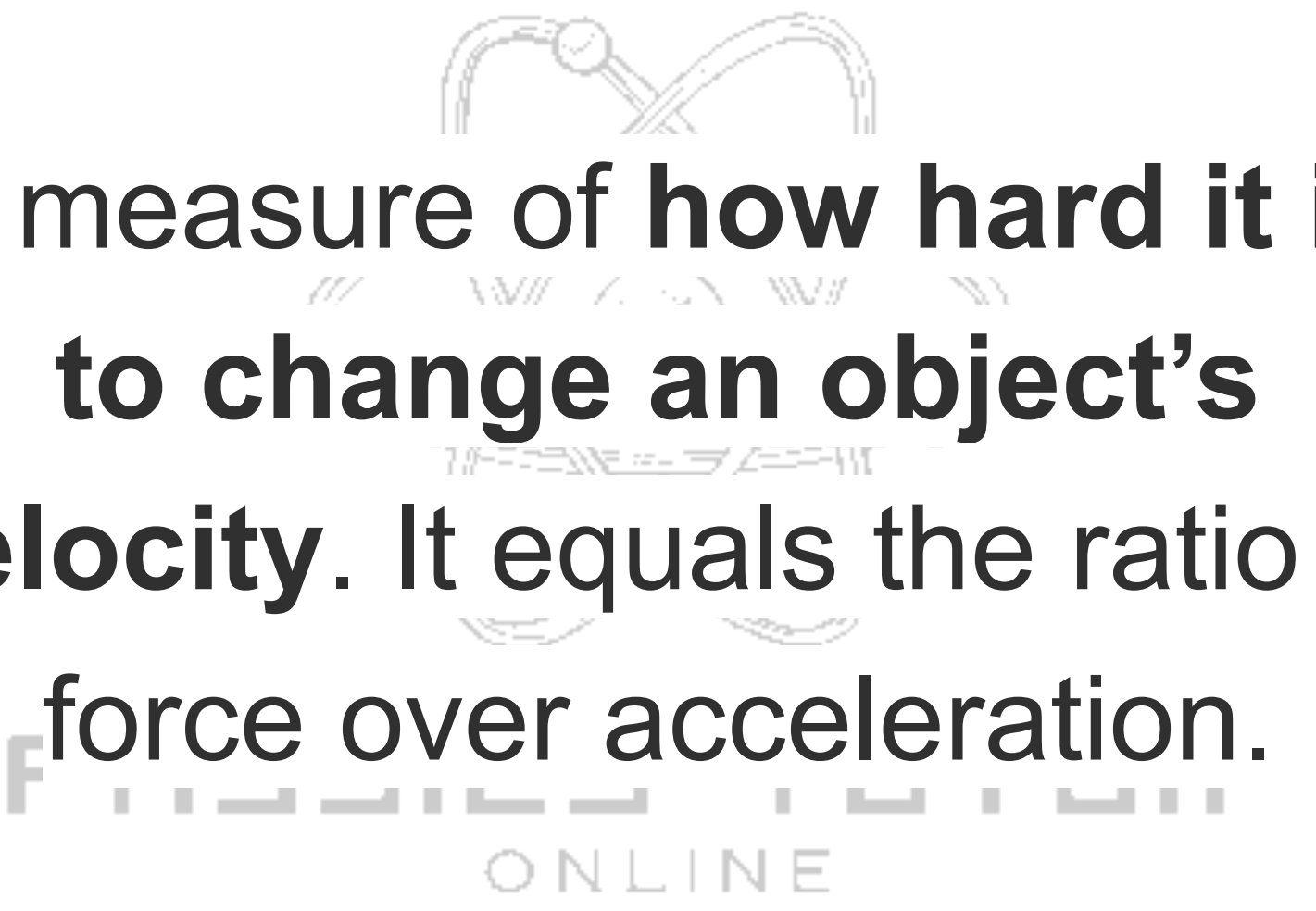
The forces that two objects
exert on each other when they
interact are **equal and
opposite**



Inertial Mass (Higher Tier)



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**A measure of how hard it is
to change an object's
velocity. It equals the ratio of
force over acceleration.**



Momentum



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The product of an object's
mass and velocity. Formula:
 $p=mv$. It is a **vector** quantity

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Conservation of Momentum

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The total momentum of a system **before**
an event is always equal to the total
momentum **after** the event, assuming no
other external forces.

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Force (using Momentum Formula)

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**Force is equal to the rate of
change of momentum.**

Formula: $F = (mv - mu) / t$

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Circular Motion



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The motion of an object travelling in a circle. The speed stays constant, but the **velocity is always changing** because the direction changes continually, meaning the object is always

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Centripetal Force (Separate Science)

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The **resultant force** that acts **towards the centre** of the circular path of an object. This force is required because the object is continually accelerating.

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Newton (N)



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The unit of force



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Free-Fall

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Free-Fall

Motion occurring under the
force of gravity alone

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