# 5 Forces

| Contact forces | Non contact forces |
| --- | --- |
| Friction | Gravitational |
| Air resistance | Electrostatic |
| Tension | Magnetic |
| Normal contact force | |

| Scalar | Vector |
| --- | --- |
| Speed | Velocity |
| Distance | Displacement |
| Temperature | Force |
| Time | Acceleration |

**Work done**

- Work is done when energy is transferred from one store to another.
- When work is done **against frictional** forces acting on an object the energy goes into the **thermal energy store** and the temperature increases.
- When a spring is stretched work is done and energy is transferred to the **elastic potential energy** store.

**Definitions**

**Scalar** – A measurement that has magnitude (size or quantity)only.
**Vector** – A measurement that has magnitude and direction. They are represented by arrows.
**Contact forces** – Forces that happen when objects are touching or in contact.
**Non contact forces** – Forces that act on an object over distances.
**Resultant force** – The overall force acting on an object which has the same effect as all the original forces acting together.
**Vector diagram** – The arrows showing the direction and size of a force.
**Free body diagram** – A single dot to represent the object with arrows showing the direction and size of the force.
**A Joule** – One joule of work is done when a force of 1N causes a displacement of 1m.
**Elastic deformation** – An object returns to its original shape and size after the forces are removed.
**Inelastic deformation** – An object doesn't return to its original shape and size after forces are removed.

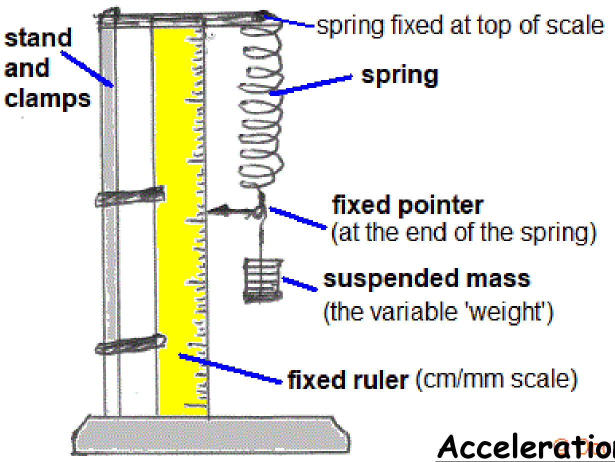
**Equations**

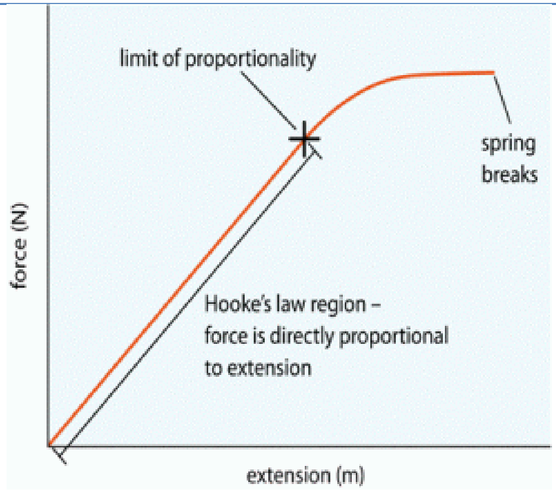
Weight (N) = mass (kg) x Gravity (N/kg)
Work done (J) = Force (N) x Distance (m)
Force (N) = Spring constant (N/m) x extension (m)
Elastic Potential Energy (J) = 0.5 x spring constant(N/m) x extension$^2$ (m)

## Hook's Law Required Practical

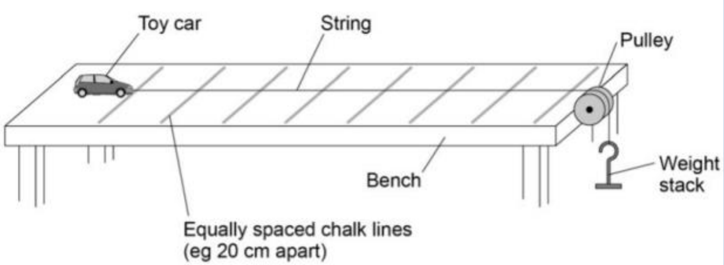
For a given spring and other elastic objects, the extension is directly proportional to the force applied. For example, if the force is doubled, the extension doubles. This works until the limit of proportionality is exceeded.

A sketch of the apparatus to investigate the link between the force applied to a spring and the resulting extension




## Acceleration Required Practical




Release the weight stack (allowing it to fall) and begin the timer.
Stop timing when the car hits the pulley at the other end of the bench.

To investigate **changing force** on a constant mass:
Add a 10g mass to the weight stack.
Release the weights and time the car travelling across the bench.
Repeat the experiment by adding 10g weights and recording the time for each.
To investigate **changing mass** with a constant force:
Attach a 10g mass on top of the toy car.
Pull the car back to the starting chalk line.
Release the car and time how long it takes for the car to travel across the bench.
To calculate the acceleration, use the equation acceleration = distance /(time)$^2$

**Equations**

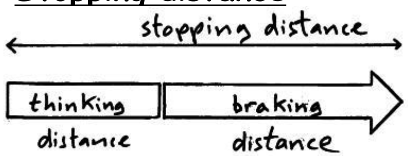
Speed (m/s) = Distance (m) / time (s)

Acceleration ($m/s^2$) = change in velocity (m/s) / time (s)

Resultant force (N) = Mass (kg) x acceleration ($m/s^2$)

Momentum (kgm/s) = mass (kg) x velocity (m/s) **(HT)**

**Stopping distance**




•Stopping distance of a vehicle is the sum of the distance the vehicle travels during the drivers reaction time (thinking distance) and the distance it travels under the breaking force (breaking distance).

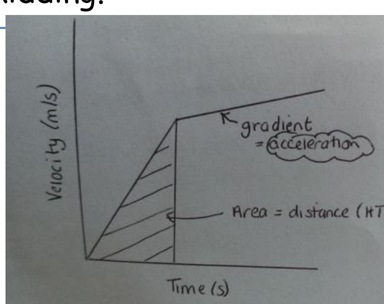
•The greater the speed the greater the stopping distance.

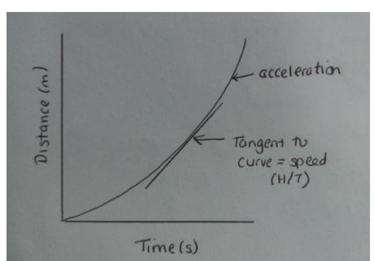
•Reaction times are between 0.2-0.9s. It can be affected by tiredness, drugs and alcohol.

•Breaking distances can be affected by road conditions, weather conditions, and poor condition of the vehicle.

•When a force is applied to the brakes of a vehicle, work done by friction between the brake and the wheel reduces kinetic energy and the temperature of the brakes increases.

•Large deceleration may lead to brakes overheating and / or skidding.




**Definitions**

**Distance** – how far an object moves

**Displacement** – both distance and direction an object moves.

**Speed** – how fast an object moves.

**Velocity** – speed in a given direction.

**Acceleration** – An object is getting faster.

**Deceleration** – An object is getting slower.

**Inertia** – The tendency of objects to continue in their states of rest or uniform motion **(HT)**

**Gravity**

•Near the Earth's surface gravity is $9.8m/s^2$

•When objects fall they accelerate due to gravity.

•When the resultant forces become equal it reaches terminal velocity.

**Newton's Laws**

*Newton's first law* - an object remains in the same state of motion unless a resultant force acts on it.

*Newton's second law* – The acceleration of an object is proportional to the resultant force acting on an object and inversely proportional to its mass.

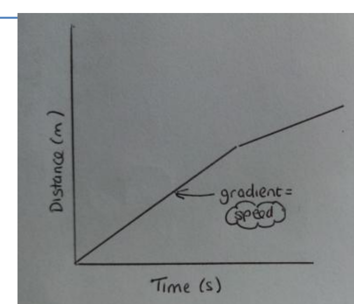
*Newton's third law* – Whenever 2 objects interact with each other, each object exerts the same type of force on the other. These forces will be equal in size and opposite in direction.

**Speeds**

Walking 1.5m/s

Running 3 m/s

Cycling 6 m/s



# Triple only!

## Pressure in liquids (HT)

- The deeper underwater you go the higher the pressure.
- This is because the liquid is more dense so there are more particles.
- This means there are more collisions at 90° so more pressure.

## Upthrust of submerged liquids HT.

- An object in water experiences a greater pressure on the bottom than on the top.
- This resultant force is UPTHRUST.
- An object floats if it's weight = upthrust.
- An object less dense than the liquid displaces a volume of liquid equal to its weight so will FLOAT.
- An object sinks if weight is more than upthrust

## The atmosphere

The atmosphere gets less dense with increasing altitude.

The number of air particles above a surface decreases as height increases, so pressure decreases with height.

## Force as rate of change of momentum

The force acting on an object is equal to the rate of change of momentum.

## Definitions

**Moment** – The forces on a system causing an object to rotate.

**Fluid** – a liquid or a gas.

**Pressure** – The force provided from particles hitting a surface at right angles to it.

**Upthrust** – The resultant force from the weight (down) and the pressure of water (up)

***Atmosphere*** – *A* thin layer of air around the Earth.

## Equations

Moment of a force (Nm) = Force (N) x Distance(m)

Pressure (Pa) = Force (N)/ area($m^2$)

## Momentum

- In a closed system the total momentum before = total momentum after.
- Air bags, seat belts, crash mats, cycle helmets, cushioned surfaces etc all work by <u>increasing</u> the time taken to stop therefore <u>reducing</u> the force.