

# Definitions and Concepts for OCR (A) Physics A-level

## Module 3 - Forces and Motion

### 3.1: Motion

**Acceleration:** The rate of change of velocity.

**Average Speed:** Distance over time for the entire region of interest.

**Braking Distance:** The distance travelled between the brakes being applied and the vehicle coming to a stop. It is affected by the vehicle and road conditions.

**Displacement:** The direct distance between an object's starting and ending positions. It is a vector quantity and so has both a direction and a magnitude.

**Displacement-Time Graphs:** Plots showing how displacement changes over a period of time. The gradient gives the velocity. Curved lines represent an acceleration.

**Free-Fall:** An object is said to be in free fall when the only force acting on it is the force of gravity.

**Instantaneous Speed:** The exact speed of an object at a specific given point.

**Projectile Motion:** The motion of an object that is fired from a point and then upon which only gravity acts. When solving projectile motion problems, it is useful to split the motion into horizontal and vertical components.

**Reaction Time:** The time taken to process a stimulus and trigger a response to it. It is affected by alcohol, drugs and tiredness.

**Stopping Distance:** The sum of thinking distance and braking distance for a driven vehicle.

**Thinking Distance:** The distance travelled in the time it takes for the driver to react. It is affected by alcohol, drugs and tiredness.

**Velocity-Time Graphs:** Plots showing how velocity changes over a period of time. The gradient gives acceleration. Curved lines represent changing acceleration.

**Velocity:** The rate of change of displacement. It is a vector quantity and so has both a direction and a magnitude.

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### 3.2: Forces in Action

**Archimedes' Principle:** The upwards force acting on an object submerged in a fluid, is equal to the weight of the fluid it displaces.

**Centre of Gravity:** The single point through which the object's weight can be said to act.

**Centre of Mass:** The single point through which all the mass of an object can be said to act.

**Couple:** Two equal and opposite parallel forces that act on an object through different lines of action. It has the effect of causing a rotation without translation.

**Density:** The mass per unit volume of a material.

**Drag:** The frictional force that an object experiences when moving through a fluid.

**Equilibrium:** For an object to be equilibrium, both the resultant force and resultant moment acting on the object must be equal to zero.

**Free-Body Diagram:** A diagram showing all the forces acting on an object. It is a good starting point to any mechanics problem.

**Friction:** The resistive force produced when there is relative movement between two surfaces.

**Moment of Force:** The product of a force and the perpendicular distance from the line of action of the force to the pivot.

**Newton:** The unit of force.

**Newton's Second Law:** The sum of the forces acting on an object is equal to the rate of change of momentum of the object. It is also expressed as the net force acting on an object equaling the product of the object's mass and acceleration.

**Normal Contact Force:** The reaction force between an object and surface.

**Pressure:** The force that a surface experiences per unit area. It is measured in Pascals (Pa).

**Principle of Moments:** For an object to be in equilibrium, the sum of the clockwise moments acting about a point must be equal to the sum of the anticlockwise moments acting about the point.



**Tension:** The result of two forces acting on an object in opposite, outwards directions.

**Terminal Velocity:** The maximum velocity of an object that occurs when the resistive and driving forces acting on the object are equal to each other.

**Triangle of Forces:** A method of determining the resultant force of two forces. The two forces are joined tip to tail and the resultant force is given by the force that would complete the triangle.

**Upthrust:** The upwards force that a fluid applies on an object.

**Weight:** The product of an object's mass and the gravitational field strength at its location.

### **3.3: Work, Energy and Power**

**Conservation of Energy:** In a closed system with no external forces the total energy of the system before an event is equal to the total energy of the system after the event. The energy does not need to be in the same form after the event as it was before the event.

**Efficiency:** The useful output (e.g. power, energy) of a system divided by the total output.

**Gravitational Potential Energy:** The energy gained by an object when it is raised by a height in a gravitational field.

**Kinetic Energy:** The energy an object has due to its motion. It is the amount of energy that would be transferred from the object when it decelerates to rest.

**Power:** The work done or energy transferred by a system divided by the time taken for that to be done.

**Work Done:** The energy transferred when a force moves an object over a distance.

### **3.4: Materials**

**Brittle:** A brittle object is one that shows very little strain before reaching its breaking stress.

**Compression:** The result of two coplanar forces acting into an object. Compression usually results in a reduction in the length of the object.

**Compressive Deformation:** The changing of an object's shape due to



compressive forces.

**Ductile:** A material is ductile if it can undergo very large extensions without failure. Ductile materials can be stretched into wires.

**Elastic Deformation:** If a material deforms with elastic behaviour, it will return to its original shape when the deforming forces are removed. The object will not be permanently deformed.

**Elastic Potential Energy:** The energy stored in an object when it is stretched. It is equal to the work done to stretch the object and can be determined from the area under a force-extension graph.

**Extension:** The increase of an object's length.

**Force-Extension Graph:** A plot showing how an object extends as the force applied increases. For an elastic object, the gradient should be linear up to the limit of proportionality. The gradient gives the spring constant.

**Hooke's Law:** The extension of an elastic object will be directly proportional to the force applied to it up to the object's limit of proportionality.



**Plastic Deformation:** If a material deforms with plastic behaviour, it will not return to its original shape when the deforming forces are removed. The object will be permanently deformed.

**Polymeric:** A material made from polymers.

**Spring Constant:** The constant of proportionality for the extension of a spring under a force. The higher the spring constant, the greater the force needed to achieve a given extension.

**Strain:** The ratio of an object's extension to its original length. It is a ratio of two lengths and so has no unit.

**Stress:** The amount of force acting per unit area. Its unit is the Pascal (Pa).

**Tensile Deformation:** The changing of an object's shape due to tensile forces.

**Ultimate Tensile Strength:** The maximum stress than an object can withstand before fracture occurs.

**Young Modulus:** The ratio of stress to strain for a given material. Its unit is the Pascal (Pa).

### 3.5: Momentum

**Conservation of Momentum:** The total momentum of a system before an event must be equal to the total momentum of the system after the event, assuming no external forces act.

**Elastic Collisions:** A collision in which the total kinetic energy of the system before the collision is equal to the total kinetic energy of the system after the collision.

**Impulse:** The change of momentum of an object when a force acts on it. It is equal to the product of the force acting on the object and the length of time over which it acts.

**Inelastic Collisions:** A collision in which the total kinetic energy of the system before the collision is not equal to the kinetic energy of the system after the collision.

**Linear Momentum:** The product of an object's mass and linear velocity.



**Newton's First Law:** An object will remain in its current state of motion, unless acted on by a resultant force. An object requires a resultant force to be able to accelerate.

**Newton's Second Law:** The sum of the forces acting on an object is equal to the rate of change of momentum of the object.

**Newton's Third Law:** Every action has an equal and opposite reaction. If an object exerts a force on another object, then the other object must exert a force back, that is opposite in direction and equal in magnitude.

