IB MECHANICS DEFINITIONS AND CONCEPTS

DISPLACEMENT: The distance travelled in a particular direction from a specified origin.

VELOCITY: The rate of change of displacement with time. A vector. Unit: ms^{-1}

$$v_{av} = \frac{\Delta s}{\Delta t}$$

SPEED AND DISTANCE: The scalar versions of velocity and displacement.

ACCELERATION: The rate of change of velocity with time. A vector. Unit ms^{-2}

$$a_{av} = \frac{\Delta v}{\Delta t}$$

INSTANTANEOUS: The value of a quantity measured at an instant in time, as opposed to an average quantity measured over a period of time.

EQUATIONS OF UNIFORMLY ACCELERATED MOTION: Equations relating five quantities, u, v, a, s, t. Each equation contains 4 of the variables.

ACCELERATION DUE TO GRAVITY: Ignoring air resistance, a free-falling object accelerates at the surface of the Earth at approx. $9.8ms^{-2}$ This is numerically equal to gravitational field strength.

TERMINAL VELOCITY: Air resistance is proportional to speed, so an accelerating object will achieve terminal velocity.

DISPLACEMENT-TIME GRAPHS: Gradient is velocity.

VELOCITY-TIME GRAPHS: Gradient is acceleration. Area under graph is displacement.

ACCELERATION-TIME GRAPHS: Area under graph is change in velocity.

RELATIVE VELOCITY: A velocity measured from the point of view of another moving object (eg the velocity of a car with respect to the bicycle it passes).

WEIGHT - The force of gravity on a body. **W** = m**g,** where **W** is weight/ N; m is mass/ kg; **g** is gravitational field strength/ Nkg^{-1}. On Earth, **g** = 9.81 Nkg^{-1}

FORCE: An unbalanced force causes an acceleration.

NEWTON: One Newton is the force which will accelerate 1 kg by 1 ms^{-2}

FREE-BODY DIAGRAM: Shows all of the forces acting ON an object.

FRICTION: The force which opposes motion when one surface moves over another. It is caused by the roughness of the surfaces.
NORMAL REACTION: Two objects in contact each exert a force on the other which is perpendicular to the surface.

TENSION: A force produced in a body when opposing forces are stretching it. The opposite is a compression force when two forces are squashing a body.

UPTHRUST: An upward force on a body which is immersed in a fluid (liquid or gas).

LIFT: An upward force on the wing of an aircraft due to the air flowing around it.

TRANSLATIONAL EQUILIBRIUM: When the net force on an object is zero in all directions (ie no linear acceleration).

ROTATIONAL EQUILIBRIUM: When the net torque on an object is zero about all axes (ie no centripetal acceleration).

NEWTON'S FIRST LAW OF MOTION: A body continues to maintain its state of rest or of uniform motion in a straight line unless acted upon by an external unbalanced force.

INERTIA: The property of matter which makes it resists acceleration.

LINEAR MOMENTUM: the product of mass and velocity. It is a vector measured in $kgms^{-1}$

IMPULSE: The change in momentum. A vector. Unit is Ns
The impulse is the area under a Force-time graph.

NEWTON'S SECOND LAW OF MOTION: $\sum F = ma$
The rate of change of momentum of an object is proportional to the applied force and takes place in the direction in which the force acts.

NEWTON'S THIRD LAW OF MOTION: Whenever a particle A exerts a force on another particle B, B simultaneously exerts a force on A with the same magnitude in the opposite direction.

LAW OF CONSERVATION OF LINEAR MOMENTUM: The momentum of an isolated system remains constant (i.e. when no external forces are acting). Or, in any isolated system, the change in momentum is zero.

WORK: Work is done when a force moves an object in the direction of the force. Work is a scalar quantity.

JOULE: The unit of energy. The SI unit is the joule. 1 J =1 N*m

WORK DONE BY A NON-CONSTANT FORCE: Work done is the area under the force-distance graph. E.g. for Hooke's law, $W=\frac{1}{2}kx^2$

ENERGY: The ability to do work.

KINETIC ENERGY: Energy an object has as a result of its motion.

GRAVITATIONAL POTENTIAL ENERGY: Energy an object has a result of its position in a gravitational field.

PRINCIPLE OF CONSERVATION OF ENERGY: Energy is never created nor destroyed. It just changes from one form to another.

ELASTIC COLLISIONS: KE is conserved in these collisions. (Momentum is conserved in every collision).

INELASTIC COLLISIONS: The total KE is decreased. If the objects stick together, the collision is PERFECTLY inelastic.

EXPLOSIVE COLLISIONS: KE is increased in this collision.

POWER: The rate of doing work. Unit is the watt. $1W=1Js^{-1}$

EFFICIENCY: Fraction of energy which is usefully transferred.
Efficiency=Useful work done/ Total work done

CENTRIPETAL ACCELERATION: The acceleration of a body moving in a circle. It is directed towards the centre of the circle. A body with a centripetal acceleration must be under the influence of a centripetal force.

EQUATIONS OF CIRCULAR MOTION

$$\theta = \frac{s}{r} \qquad \frac{\alpha}{360^\circ} = \frac{\theta}{2\pi}$$

$$\sin\theta \approx \tan\theta \approx \theta$$

$$\omega_{av} = \frac{\Delta\theta}{\Delta t}$$

$$\omega = \lim_{\delta t \to 0}\left(\frac{\delta\theta}{\delta t}\right) = \frac{d\theta}{dt}$$

$$s = r\theta$$

$$v = \frac{s}{t} = \frac{\theta r}{t} = \omega r$$

$$\omega = \frac{2\pi}{T} \qquad T = \frac{2\pi}{\omega}$$

$$a_{centripetal} = \frac{v^2}{r} = r\omega^2 = \frac{4\pi^2 r}{T^2}$$

$$F_c = ma_{centripetal} = \frac{mv^2}{r} = mr\omega^2 = m\frac{4\pi^2 r}{T^2}$$