



Theme A

Space, Time & Motion

#	Physical Quantity	Definition
A.1 Kinematics		
1	Mechanics	" Is the study of the Motion of objects, and the related concepts of Force and Energy."
2	Position	" Is the location that an object has at a given time relative to a reference position, called the origin."
3	Distance	" Is a scalar that is the total length of the path taken from an initial position to a final position."
4	Displacement	" Is a vector that is the shortest distance from an initial position to a final position."
5	Speed	" Is the rate of change of distance."
6	Velocity	" Is the rate of change of displacement."
7	Acceleration	" Is the rate of change of velocity."
8	Uniform Linear Acceleration	" Is a straight line motion with constant acceleration that produces a constant change in velocity in equal time intervals."
A.2 Forces and Momentum		
9	A Force	" Is an external influence that can cause an object to change its state of rest or motion. It can change the shape or size of a body. It is a vector quantity."
10	The Weight, W	" of an object is the product of its gravitational mass m and the gravitational field strength g at the location of the object."
11	The Normal Force, F_N	" Is the component of the contact force acting perpendicular to the surface that counteracts the body."
12	Buoyancy	" Is the ability of any fluid (liquid or gas) to provide a vertical upwards force on an object placed in, or on it."
13	Buoyancy (upthrust) Force, F_b	" Is the upward force exerted by a fluid on an object that is completely or partly immersed in a fluid. It is given by $F_b = \rho Vg$."
14	Archimedes' Principle	" States that an object partially or completely immersed in a fluid experiences a buoyant force of magnitude equal to the weight of the displaced fluid."
15	Newton's First Law of Motion (Law of Inertia)	" A body will remain at rest or moving with constant velocity along a straight line, unless acted upon by an unbalanced force."
16	Inertia	" of an object is the resistance to a change in its state of motion."
17	Newton's Second Law of Motion (Version 1)	" The net force on a body of constant mass is proportional to that body's acceleration and is in the same direction as the acceleration."
18	Newton's Second Law of Motion (Version 2)	" The rate of change of momentum of a body is directly proportional to the unbalanced force acting on that body and takes place in the same direction."
19	Newton's Third Law of Motion	" For every action force, there is a simultaneous reaction force that is equal in magnitude and opposite in direction."
20	Friction	" Is a dissipative force that does negative work on an object in motion and transforms mechanical kinetic energy into random thermal energy."



21	Hooke's Law	" The restoring force for an elastic stretching spring is given by: $F_H = -k\Delta x$, where k is the spring constant."
22	The Spring Constant, k	" of a spring is the force per unit length needed to extend the spring. Unit: $N.m^{-1}$."
23	Elastic Limit	" Is the maximum force and/or extension that a spring can sustain before it becomes permanently deformed."
24	Linear Momentum	" of an object is the product of its mass and velocity."
25	Collision	" Is an interaction between objects that involves a change in their velocities and therefore in their momenta."
26	Elastic Collision	" Is a collision in which the total kinetic energy before and after the collision is the same."
27	Inelastic Collision	" Is a collision in which the total kinetic energy is reduced after the collision."
28	Totally (Perfectly) Inelastic Collision	" Is a collision after which the colliding objects stick together."
29	Isolated System	" One which cannot exchange thermal energy, work or matter with its surroundings."
30	Law of Conservation of Momentum	" For a system of isolated bodies, the total momentum is always the same if no resultant external force acts on the system."
31	Impulse	" Is the change of momentum of an object when the object is acted upon by a force for an interval of time."
32	Viscosity	" Is a fluid's resistance to flow. It represents the internal friction of a moving fluid."
33	Viscous Drag Force, F_d	" Is the force acting on a moving object due to the viscosity of the fluid through which it is moving. $F_d = 6\eta r v$."
34	Stokes' Law	" States that a smooth spherical object moving through a fluid will experience an opposing force that is directly proportional to the size of the sphere and its speed in non-turbulent motion."
35	Gravitational Field	" Is a region in which a mass would experience a non-contact force."
36	Electric Field	" Is a region in which a charged particle would experience a non-contact force."

A.3 Work, Energy and Power

37	Work	" Is the scalar product of force and displacement when the applied force lies in the direction of the displacement."
38	Energy	" Is the ability to do work."
39	Kinetic Energy	" of a rigid object is its active energy of motion."
40	Gravitational Potential Energy	" Is the energy an object has because of its position within a gravitational field."
41	Elastic Potential Energy	" Is the energy stored in a material that has been deformed elastically."
42	Mechanical Energy	" Is the sum of kinetic energy, gravitational potential energy and elastic potential energy within a system."
43	Power - Def.1	" Is the rate of doing work or the rate of energy transferred."
44	Power - Def.2	" Is the rate at which work is done by a force, F applied to an object moving at a constant velocity, v ."
45	Law of Conservation of Energy	" In the absence of frictional forces, the total mechanical energy of a system is conserved."
46	Efficiency	" Is the ratio of useful energy/power output to total energy/power input."
47	Specific Energy, E_s	" Is the amount of energy that can be released from a unit mass of fuel, it is measured in $J.Kg^{-1}$."
48	Energy Density, E_d	" Is the amount of energy that can be released from a unit volume of fuel, it is measured in $J.m^{-3}$."

A.4 Rigid Body Mechanics - HL Only

1	Torque	" Is the ability of a force to rotate an object. It is equal to the product of the magnitude of the force and the perpendicular distance between the axis of rotation and the line of action of the force (known as the lever arm or moment arm)."
2	Couple	" A couple is a pair of parallel forces of equal magnitude but with different lines of action and acting in opposite directions."
3	Translational Equilibrium	" Occurs when the resultant force on an object in any direction is zero."
4	Rotational Equilibrium	" Occurs when the resultant torque on an object is zero, i.e. the sum of the clockwise torques equals the sum of the anticlockwise torques."
5	Angular Displacement, θ	" Is defined as the total angle, θ , through which a rigid body has rotated from a fixed reference position."
6	Angular Velocity, ω	" Is the rate of change of angular displacement. The unit is $\text{rad}\cdot\text{s}^{-1}$."
7	Angular Acceleration, α	" Is the rate of change of angular velocity. The unit is $\text{rad}\cdot\text{s}^{-2}$."
8	Moment of Inertia, I	" of an object quantifies its ability to resist changes to its rotational motion. It depends on the distribution of mass throughout the object relative to the axis of rotation."
9	Newton's First Law (Torque Version)	" An object continues to remain stationary or to move at a constant angular velocity unless an external torque acts on it."
10	Newton's Second Law (Rotational Motion)	" If a resultant torque acts on a body, the body will rotate with an angular acceleration that is directly proportional to the net torque."
11	Newton's Second Law (Torque Version)	" The resultant (net) torque on a body is the rate of change of the angular momentum of the body."
12	Angular Momentum, L	" of a rigid body is the product of its moment of inertia I and the angular speed of rotation ω . It is a vector quantity."
13	Law of Conservation of Angular Momentum	" The total angular momentum of a system remains constant unless acted on by an external torque."
14	Angular Impulse	" on a body is equal to the body's change in angular momentum, resulting from the action of a resultant torque."
15	Slipping	" Occurs when there is not enough friction between a wheel and the surface to maintain a rolling motion."
16	Sliding	" Occurs when surfaces moving over each other without any rotation involved."

A.5 Relativity - HL Only

17	Reference Frame	" Is a coordinate system that we use to describe the motion of a body in space and time."
18	Event	" Is a single, instantaneous incident that occurs exactly at a precise time and location."
19	Inertial Reference Frame	" Is one that is not accelerating or decelerating and in which Newton's laws of motion can be applied."
20	Relativistic Motion	" Is one that is travelling at a significant fraction of the speed of light."
21	Galilean Transformation	" Is a method of describing the position or velocity of a moving body, relative to a stationary body."
22	Postulate	" Is an unproven assumption that is accepted to be true, which is then used as starting point to consider new perspectives and predict new patterns."
23	Special Relativity	" Is a physics theory developed by Albert Einstein that deals with objects moving very fast, such as the speed of light."
24	First Postulate	" Einstein's first postulate of special relativity states that the laws of physics apply in the same way in all inertial reference frames."



25	Second Postulate	" Einstein's second postulate of special relativity states that the speed of light is the same for all observers, regardless of their relative motion."
26	Time Dilation - Def.1	" Is where the duration of an event, as measured by an observer moving relative to the event, is found to be greater than the proper time."
27	Time Dilation - Def.2	" In an inertial system moving at high speed, time is observed to pass slowly."
28	Proper Time-Interval	" Is the duration of an event, as measured by an observer who is stationary relative to the event being timed. It is the shortest time interval that can be measured between two events by any observer."
29	Length Contraction - Def.1	" In an inertial system moving at high speed, it is observed that the length of the moving direction axis is shortened."
30	Length Contraction - Def.2	" Is where the length of an object, as measured by an observer moving relative to the object, is found to be less than the proper length."
31	Invariant Quantity	" Is one that is constant across all reference frames, e.g. the speed of light in a vacuum, proper length, and proper time interval."
32	Space-time Interval - Def.1	" Is the combination of space and time into a single invariant entity that is used to describe the fabric of the Universe."
33	Space-time Interval - Def.2	" Is a change experienced in the space of the Universe through which we are constantly moving."
34	Proper Length	" Is the length of an object as measured by an observer who is stationary relative to the object. The proper length is the longest length measured by any observer."
35	Lorentz Transformation	" Is a method of finding the position and time of an event in the reference frame of a moving observer, based on the position and time of the event in the reference frame of a stationary observer."
36	Relativistic Velocity Addition	" Is an equation that can be used to describe the position or velocity of a third body, relative to two other bodies moving relative to each other."
37	Lorentz Factor, γ	" Is the scaling factor that describes the distortion of non-invariant quantities when moving between different relativistic reference frames."
38	Light-year, ly	" Is the distance travelled by light in vacuum in one year."
39	Light-second	" Is the distance travelled by light in vacuum in one second."
40	Muons	" Are unstable subatomic particles that are created when high energy cosmic rays from space interact with the upper atmosphere of the Earth. The muons stream towards the surface of the Earth, a distance of about 10 km."
41	Muon Decay Experiment	" Is an important experiment supporting both time dilation and length contraction. The experiment compares the levels of high-energy muons found in the atmosphere at around 10 km with those found at the Earth's surface, using the muon half-life as a means of measuring time."
42	Space-time Diagrams	" Are graphs showing variations of objects' positions with time, adapted to compare different frames of reference."
43	Simultaneity	" Is when two events happen at the same time in the reference frame of a particular observer."