IB physics definitions and explanations

quantity	definition
Mechanics Chaper 1, 2, and 10	
systematic error	Sources: zero error, wrongly calibrated instrument. Cannot be reduced by repeating readings.
Random error	Sources: readability of instrument, observer being less than perfect, effects of a change in surroundings.
***displacement, s* [m]**	displacement of a particle is the length and direction of a line drawn to the particle from the origin
***velocity, v* [m s^{-1}]**	rate of change of position with time $\vec{v}_{average} = \frac{\Delta \vec{s}}{\Delta t}$
***speed, v* [m s^{-1}]**	rate of distance travelled along a path $v_{average} = \frac{\text{distance travelled along the actual path}}{\text{time taken } \Delta t}$
***acceleration, a* [m s^{-2}]**	rate of change of velocity with time $\vec{a}_{average} = \frac{\Delta \vec{v}}{\Delta t}$
	change in velocity / rate of change of velocity; per unit time / with time; *(ratio idea essential to award this mark)*
(translational) equilibrium	a body in equilibrium has zero resultant force acting on it and therefore has zero acceleration
	sum of the (net) forces acting is zero;
weight, W [N]	the weight of an object is the gravitational attraction of a massive body (eg Earth) for that object
conserved	any quantity which is conserved maintains a constant total value ▪ kinetic energy is conserved in elastic collisions ▪ total mechanical energy is conserved when friction is negligible and KE and PE are not changed to other forms (such as sound, internal energy) ▪ total mass is conserved in all non-relativistic situations ▪ total mass-energy is conserved in all situations
conservation of energy	appropriate statement of principle of conservation of energy; *e.g. "Energy can not be created or destroyed, it just changes form."*
Newton's 1st law	a body will remain at constant velocity unless a net force acts on it
Newton's 2nd law	the rate of change of momentum of a body is proportional to the net force acting on it $\vec{F}_{net} = \frac{\Delta \vec{p}}{\Delta t}$ This simplifies to $\vec{F}_{net} = m\vec{a}$ when the mass of the body remains constant
Newton's 3rd law	when two bodies A and B interact the force that A exerts on B is equal and opposite to the force that B exerts on A; ***or*** when a force acts on a body, an equal an opposite force acts on another body somewhere in the universe;
***linear momentum, p* [kg m s^{-1}]**	the product of a body's mass and its velocity (therefore momentum is a vector with the same direction as the velocity) $\vec{p} = m\vec{v}$
***impulse, Δp* [kg m s^{-1}] or [N s]**	the change in momentum of a body, $\Delta\vec{p} = m\vec{v} - m\vec{u}$
	impulse is force × time / change in momentum;
law of conservation of momentum	if the total external force acting upon a system is zero / for an isolated system; the momentum of the system is constant;
work, W [J]	force × distance (moved) in the direction of the force
power	the rate of working / work/time;
	the rate of working / $\frac{\text{work}}{\text{time}}$;

quantity	definition
kinetic energy, E_K [J]	the energy associated with a body because of its motion $E_K = \frac{1}{2} mv^2$
potential energy, E_P [J]	the energy possessed by a system due to the relative positions of its component parts (ie due to the forces between the component parts)
elastic collision	a collision in which the total KE is conserved
inelastic collision	a collision in which some kinetic energy is transferred to other forms (eg internal energy, sound), therefore the total KE is less after the collision than before
gravitational field strength ***g*** **[N kg^{-1}]**	force exerted per unit mass; on a small / point mass;
gravitational potential energy	the work done to move a body from infinity to a point in a gravitational field $E_P = -G\frac{m_1 m_2}{r}$
gravitational potential ***U*** **[J kg^{-1}]**	the work done per kilogram to move a body from infinity to a point in a gravitational field $V = -G\frac{m}{r}$
escape speed	speed of object at Earth's surface; so that it will escape from the gravitational field / travel to infinity;
Thermal Physics Chaper 2	
temperature, T [K]	measure of how hot something
	temperature is proportional to a measure of the average kinetic energy; of the molecules of the substance;
heat, Q [J]	energy transferred from one body to another due to a temperature difference
thermal equilibrium	2 bodies that are in thermal contact are in thermal equilibrium when the net heat flow between them is zero, therefore the 2 bodies must have the same temperature
ideal gas	Assumptions: 1. The molecules are identical.2. the molecules are poin masses with negligible size.3. the molecules are in completely random motion. 4. There are negligible forces between the molecules, except when they collide.5. all collisions are elastic, no loss of energy.
internal energy, U [J]	• the sum of all random kinetic energies and mutual potential energies of the particles of the body or system • internal energy does not include the kinetic energy or potential energy of the body as a whole • an ideal gas has no intermolecular forces therefore the gas particles have no mutual potential energies therefore the internal energy of an ideal gas depends only on the KE of the particles (temperature of gas)
mole, n **[mol]**	amount of substance of a system which contains as many elementary units as there are carbon atoms in 12 x 10^{-3} kg of carbon-12
molar mass	the mass of one mole of a substance
Avogadro constant, N_A	the number of atoms in exactly 12 x 10^{-3} kg of the nuclide carbon-12
specific heat capacity ***c*** **[J kg^{-1} K^{-1}]**	specific heat capacity is the amount of energy required to raise the temperature of unit mass through 1 K;
	$c = \frac{\Delta Q}{m\Delta\theta}$;
Heat (thermal) capacity ***C*** **[J k^{-1}]**	the amount of energy / heat required to raise the temperature of a substance / object through 1K/ C;
evaporation	evaporation is the escape of molecules from the surface of the liquid
boiling	boiling occurs when molecules escape in the form of bubbles of vapour from the body of the liquid
specific latent heat, l **[J kg^{-1}]**	specific latent heat of vaporisation: quantity of thermal energy/heat required to convert unit mass / mass of 1 kg of liquid to vapour/gas; with no change of temperature / at its boiling point;
pressure, p **[pascal, Pa]**	the pressure experienced by a body immersed in a fluid is the (normal) force per unit area exerted by the fluid on the surface of the body $p = \frac{F}{A}$

quantity	definition
isochoric (isovolumetric)	a process where the volume remains constant, therefore there is no work done ($W = p\Delta V = 0$)
isobaric	a process where the pressure remains constant
isothermal	a process where the temperature remains constant, therefore the internal energy remains constant for an ideal gas, $\Delta U = 0$
adiabatic	a compression or expansion / change in state (of the gas); in which the work done is equal to the change in internal energy of the gas;
work (derivation)	force on piston = pA; where A is area of piston. Piston moves distance x; work done = pAx; $Ax = V$, so $W = p\ V$;

Waves

Chaper 4, 9

displacement, ***x* [m]**	distance in a particular direction (of a particle) from its mean position;
amplitude, **X_0 [m]**	magnitude of the maximum displacement from the equilibrium position
***frequency, f* [Hz]**	frequency: number of oscillations/vibrations per unit time;
***period, T* [s]**	time taken for one complete oscillation
phase difference	A measure of how “in step”different particles are. In phase: 0 or 360° Out of phase: 180°
monochromatic	single frequency / single colour / *OWTTE*;
simple harmonic motion (SHM)	the net force on (or acceleration of) the object is proportional to the displacement of the object from equilibrium and is directed towards equilibrium
wavefront	line joining (neighbouring) points that have the same phase / displacement
ray	direction in which wave (energy) is travelling
transverse wave	motion of the particles is perpendicular to direction of wave travel
longitudinal wave	motion of the particles is parallel to direction of wave travel
wave *frequency*	the number of vibrations performed in each second by the source
wave *period*	the time for one complete vibration performed by the source
***wavelength,* λ [m]**	wavelength: distance moved by wave during one oscillation of the source; *Accept distance between successive crests or troughs.*
wave speed	distance travelled per unit time; by the energy of the wave / by a wavefront; $v = f\lambda$
wave *intensity*	Power per unit area. $I = \frac{P}{A}$; $I \propto A^2$
refractive index	the ratio of the speed of light in vacuum to the speed of light in the medium / the ratio of the sine of the angle of incidence to the sine of the angle of refraction; $\frac{\sin i}{\sin r}$ or $\frac{c}{v}$
dispersion	splitting/separation (of white light) into its component colours; because different frequencies have different refractive indices;
Doppler effect	change in received frequency of sound (wave); as a result of relative motion of source and observer;
diffraction	When waves pass through apertures or around obstacles, they tend to spread out
principle of superposition	when two (or more) waves meet; resultant **displacement** is the sum of the individual **displacements**;
interference	constructive interference: when two waves meet; resultant displacement found by summing individual displacements; to give maximum displacement / displacement greater than that of an individual wave;
coherent	sources whose phase difference is constant;
Rayleigh criterion	the maximum of one diffraction pattern is coincident with the first minimum of the other;

quantity	definition
Electricity and magnetism Chapter 5 and 11	
electric potential difference ***V*** **[volt, V]**	energy per unit charge; to move positive test charge between points;
electronvolt, eV	the work done to move one electron through a potential difference of 1 V
electric current, I **[ampere, A]**	the rate of flow of charge past a given cross-section (of the conductor)
resistance, R **[ohm, Ω]**	The ratio between potential difference and current.
electromotive force (emf), **ξ [volt, V]**	work done per unit charge in moving charge completely around the circuit / power supplied per unit current;
source of emf	a device which can supply energy to an electric current
Ohm's law	*Ohm's law*: the resistance of a conductor is constant / current proportional to potential difference if its temperature is constant;
electric field strength, ***E*** **[N C^{-1}]**	the force per unit charge felt by a positive test charge placed in the field. $E = \frac{F}{q} = \frac{V}{d}$
electric potential energy **[J]**	the electric potential energy of a system of charges is the work done to move the charges from ∞ separation to their current positions
electric potential, V **[J C^{-1}]**	the work done per unit charge; in bringing a small positive charge; from infinity to that point;
magnetic flux, Φ **[weber, Wb]**	the magnetic flux through a region is a measure of the number of magnetic field lines passing through the region
	product of normal component of magnetic field strength and area that it links / *OWTTE*; $\Phi = BA\cos\theta$
magnetic flux linkage ***NΦ*** **[weber, Wb]**	product of number of turns in a coil and the flux through the coil
Faraday's law of electromagnetic induction	e.m.f. (induced) proportional to; rate of change /cutting of (magnetic) flux (linkage);
Lenz's law	the induced e.m.f. / current is in such a direction that its effect is to oppose the change to which it is due / *OWTTE*;
capacitance, C **[F]**	Capacitance is the charge in coulombs required to raise the potential of a conductor by 1 V, ie 1 F = 1 C V^{-1} $C = \frac{Q}{V} = \varepsilon\frac{A}{d}$
Electric permittivity	$q = \varepsilon\frac{VA}{d}$
Energy stored in a capacitor	$E = \frac{1}{2}CV^2$
Nuclear Physics Chapter 7, chapter 12	
photoelectric emission	the freeing of electrons from the surface of a metal when light of sufficiently high frequency is shone onto the metal $E_{max} = hf - \Phi$
de Broglie waves	All moving particles have a matter wave associated with them. $\lambda = \frac{h}{p}$
nuclide	a species of atom whose nucleus contains a specified number of protons and a specified number of neutrons
isotope	same atomic number but different mass number

quantity	definition
	or in terms of numbers of protons and neutrons
nucleon	a proton or a neutron;
nucleon number ***A***	number of nucleons in the nucleus of an atom (same as mass number)
proton number ***Z***	number of protons contained in the nucleus (same as atomic number)
neutron number ***N***	number of neutrons in the nucleus of an atom
activity	the number of radioactive disintegrations per unit time. $A = -\frac{dN}{dt}$, $N = N_0 e^{-\lambda t}$, $A = A_0 e^{-\lambda t}$
radioactive half-life	the time required for the activity to drop to half. $T_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$
unified atomic mass unit	$\frac{1}{12}$ of mass of carbon 12 atom
decay constant, λ **[s^{-1}]**	probability of decay / constant in expression $\frac{\mathrm{d}N}{\mathrm{d}t} = -\lambda N$;
mass defect	the mass of a nucleus is always less the total mass of its constituent nucleons, the difference in mass is called the ***mass defect***
binding energy	energy required to (completely) separate the nucleons in a nucleus / the energy released when a nucleus is assembled from its constituent nucleons;
binding energy per nucleon	the binding energy of a nucleus divided by the number of nucleons in the nucleus
Energy production Chaper 8	
degraded energy	Energy that has spread into the surroundings and cannot be recovered to do useful work.
energy density **of a fuel [J kg^{-1}]**	amount of available energy stored in a fuel per unit mass
Black body radiation	An idealized object that absorbs all the electromagnetic radiation that falls on it.
Stefen-Boltzmann law	$P = e\sigma AT^4$
Wien's displacement law	$\lambda_{\max} = \frac{2.90\times10^{-3}}{T(kelvin)}$
albedo	fraction of solar radiation reaching Earth that is reflected back into space
surface heat capacity C_S **[J K^{-1} m^{-2}]**	energy required to raise the temperature of 1 m^2 of the Earth's surface by 1 K