PH1

Ref	Item	Definition
3.1.1(c)	Scalar	A scalar is a quantity that has magnitude only.
	Vector	A vector is a quantity that has magnitude and direction.
3.1.1(i)	The moment (or torque) of a force.	The turning effect of a force (or moment or torque) about a point is defined as the force x the perpendicular distance from the point to the line of action of the force, i.e. moment = $F \times d$. **UNIT: Nm**.
3.1.1(j)	The principle of moments.	For a system to be in equilibrium, $\sum$ anticlockwise moments about a point = $\sum$ clockwise moments about the same point.
3.1.1(k)	Centre of gravity.	The centre of gravity is the single point within a body at which the entire weight of the body is considered to act.
3.1.2(a)	Displacement	The displacement of a point *B* from a point *A* is the shortest distance from *A* to *B*, together with the direction. **UNIT: m.**
	Mean Speed	Mean speed = $\frac{\text{total distance travelled}}{\text{total time taken}} = \frac{\Delta x}{\Delta t}$ **UNIT: ms^{-1}.**
	Instantaneous Speed	instantaneous speed = rate of change of distance **UNIT: ms^{-1}.**
	Mean Velocity	Mean velocity = $\frac{\text{total displacement}}{\text{total time taken}}$ **UNIT: ms^{-1}.**
	Instantaneous Velocity	The velocity of a body is the rate of change of displacement. **UNIT: ms^{-1}**
	Mean Acceleration	Mean Acceleration = $\frac{\text{change in velocity}}{\text{time taken}} = \frac{\Delta v}{\Delta t}$ **UNIT: ms^{-2}.**
	Instantaneous Acceleration	The instantaneous acceleration of a body is its rate of change of velocity. **UNIT: ms^{-2}**
	Terminal Velocity	The terminal velocity is the constant, maximum velocity of an object when the resistive forces on it are equal and opposite to the accelerating forces (e.g. pull of gravity).
3.1.3(b)	Hooke's Law	The tension in a spring or wire is proportional to its extension from its natural length, provided the extension is not too great.
	Spring Constant	The spring constant is the force per unit extension. **UNIT: Nm^{-1}**.

3.1.3(c)	Stress	Stress is the force per unit cross-sectional area when equal opposing forces act on a body. **UNIT: Pa** or **Nm^{-2}**.
	Strain	Strain is defined as the extension per unit length due to an applied stress. **UNIT: none**
	The Young Modulus	Young Modulus $E = \dfrac{\text{tensile stress}}{\text{tensile strain}}$ Unless otherwise indicated this is defined for the Hooke's Law region. **UNIT: Nm^{-2}**
3.1.4(d)	Amplitude	The amplitude is defined as the maximum displacement of any particle from its equilibrium position.
	Wavelength of a progressive wave	The wavelength of a progressive wave is the minimum distance between two points on the wave oscillating in phase.
	Frequency of a wave	The frequency of a wave is the number of cycles of a wave that pass a given point in one second, <u>or equivalently</u> The frequency of a wave is the number of cycles of oscillation performed by any particle in the medium through which the wave is passing.
	Velocity of a wave	The velocity of a wave is the distance that the wave profile moves per unit time.
3.1.4(e)	Intensity of a wave	$\dfrac{\text{Energy per second passing normally through a given area}}{\text{Area}}$
3.1.4(h)	Transverse wave	A transverse wave is one where the particle oscillations are at 90° (right angles) to the direction of travel (or propagation) of the wave.
	Longitudinal wave	A longitudinal wave is one where the particle oscillations are in line with (parallel to) the direction of travel (or propagation) of the wave.
3.1.4(i)	The principle of superposition.	The principle of superposition states that if two or more waves occupy the same region then the total displacement at any one point is the vector sum of their individual displacements at that point.
3.1.4(m)	Coherence	Waves or wave sources, which have a constant phase difference between them (and therefore must have the same frequency) are said to be coherent.
	Phase difference	Phase difference is the difference in position of 2 points within a cycle of oscillation measured as a fraction of the cycle. [Alternatively it can be expressed as an angle where one whole cycle is 360°]
3.1.5(a)	Snell's law	At the boundary between any two given materials, the ratio of the **sine** of the angle of incidence to the **sine** of the angle of refraction is a constant.

PH2

Ref.	**Item**	**Definition**
3.2.1(a)	Electric current, I.	This is the rate of flow of electric charge. $I = \Delta Q/\Delta t$. **Unit: A**
3.2.2(a)	Potential difference (p.d.), V.	The p.d. between two points is the energy converted from electrical potential energy to some other form per coulomb of charge flowing from one point to the other. **Unit: volt (V) [= JC^{-1}].**
3.2.2(b)	e.m.f.	The e.m.f. of a source is the energy converted from some other form (e.g. chemical) to electrical potential energy per coulomb of charge flowing through the source. **Unit: volt (V) [= JC^{-1}].**
3.2.3(b)	Ohm's Law.	The current flowing through a metal wire at constant temperature is proportional to the p.d. across it.
3.2.3(d)	Electrical Resistance, R.	The resistance of a conductor is the p.d. (V) placed across it divided by the resulting current (I) through it. $R = V / I$ **Unit: ohm (Ω) [= VA^{-1}].**
3.2.3(f)	Resistivity, ρ	The resistance, R, of a metal wire of length L and cross-sectional area A is given by $R = \rho L / A$, in which ρ, the resistivity, is a constant (at constant temperature) for the material of the wire. **Unit: ohm-metre (Ωm)**
3.2.3(h)	Temperature coefficient of resistance, α.	If the resistance of a conductor at 0°C is R_0 and its resistance at θ°C is R_θ then α is defined by: $\alpha = (R_\theta - R_0) / R_0\theta$. [It is the *fractional* change in resistance per degree rise in temperature above 0°C.] **Unit: $°C^{-1}$**
3.2.4(a)	The Law of Conservation of Charge.	Electric charge cannot be created or destroyed, (though positive and negative charges can neutralize each other). In a purely resistive circuit charge cannot pile up at a point.
3.2.5(b)	Nucleon.	Protons and neutrons have similar masses. They are both classed as 'nucleons'**.**
	Atomic mass number, A	The atomic mass number of an atom is the number of nucleons (number of protons + number of neutrons) in its nucleus.
	Atomic number, Z.	The atomic number of an atom is the number of protons in its nucleus. [This determines the chemical element which the atom represents.]
3.2.5(c)	Nuclide	A nuclide is a particular variety of nucleus, that is a nucleus with a particular A and Z.
3.2.5(d)	Isotope.	Isotopes are atoms with the same number of protons, but different numbers of neutrons in their nuclei.

3.2.6(e)	Electron volt. (eV)	This is the energy transferred when an electron moves between two points with a potential difference of 1 volt between them. 1 eV = 1.6×10^{-19} J
3.2.6(f)	Ionisation	The removal of one or more electrons from an atom.
	Ionisation energy	The ionization energy of an atom is the minimum energy needed to remove an electron from the atom. **Unit: J**
3.2.6(i)	Work function	The work function of a surface is the minimum energy needed to remove an electron from the surface. **Unit: J** [or eV]
3.2.6(k)	Photoelectric effect	When light or ultraviolet radiation of short enough wavelength falls on a surface, electrons are emitted from the surface. This is the photoelectric effect.

PH4

Ref	Item	Definition
3.4.1(a)	Period T for a point describing a circle.	Time taken for one complete circuit.
	Frequency f.	The number of circuits or cycles per second.
3.4.1(b)	Angular velocity ω.	For a point describing a circle at uniform speed, the angular velocity ω is equal to the angle θ swept out by the radius in time t divided by t . ($\omega = \theta/t$) **UNIT: [rad] s^{-1}**
3.4.1(d)	Simple harmonic motion (shm).	Shm occurs when an object moves such that its acceleration is always directed toward a fixed point and proportional to its distance from the fixed point. ($a=-\omega^2 x$)
	Simple harmonic motion (shm). (Alternative definition).	If the displacement x of a point changes with time t according to the equation $x = a \sin(\omega t+\varepsilon)$ where a, ω and ε are constants, the motion of that point is shm. **[**Variations of this kind are said to be *sinusoidal* because they are determined by a sine term.**]**
3.4.1(h)	Period T for an oscillating body	Time taken for one complete cycle.
	Amplitude A of an oscillating object	The maximum value of the object's displacement (from its equilibrium position).
3.4.1(n)	Free oscillations.	Free oscillations occur when an oscillatory system (such as a mass on a spring, or a pendulum) is displaced and released. [The frequency of the free oscillations is known as the *natural frequency*.]
	Damping.	Damping is the dying away **of** amplitude with time of free oscillations due to resistive forces.
3.4.1(p)	Forced oscillations.	These occur when a sinusoidally varying force is applied to an oscillatory system, causing the system to oscillate with the frequency of the applied force.
	Resonance.	If, in forced vibrations, the frequency of the applied force is equal to the natural frequency of the system (e.g. mass on spring), the amplitude of the resulting oscillations is very large. This is resonance.
3.4.2(a)	Momentum	The momentum of an object is its mass multiplied by its velocity. ($p = mv$). It is a vector. **UNIT: kg m s^{-1}**
	Newton's Laws of Motion. 1st Law	An object continues in a state of uniform motion in a straight line, or remains at rest, unless acted upon by a resultant force.

3.4.2(a)	Newton's Laws of Motion. 2nd Law	The rate of change of momentum of an object is proportional to the resultant force acting on it, and takes place in the direction of that force.
	Newton's Laws of Motion. 3rd Law	If an object A exerts a force on a second object B, then B must exert a force which is equal in magnitude but opposite in direction on A.
3.4.2(c)	Elastic collision.	A collision in which there is no loss of kinetic energy.
	Inelastic collision.	A collision in which kinetic energy is lost.
3.4.3(a)	Work.	Work done by a force is the product of the magnitude of the force and the distance moved in the direction of the force.(W.D. = $Fx\cos\theta$) **UNIT: joule (J) [= Nm]**
3.4.3(c)	Hooke's Law.	The extension of an elastic object such as a wire or spring is proportional to the stretching force, provided the extension is not too large. ($F = kx$).
3.4.3(d)	Energy	**The energy of a body or system is the amount of work it can do.** UNIT: joule (J).
	Power	This is the work done per second, or energy converted or transferred per second. **UNIT: watt (W) [= Js^{-1}].**
3.4.3(e)	Conservation of energy (principle of).	Energy cannot be created or destroyed, only transformed from one form to another.
	Potential energy.	This is energy possessed by virtue of position. (e.g. Gravitational PE = mgh)
3.4.3(h)	Efficiency	% Efficiency = 100×(Useful energy obtained)/(Total energy input).
3.4.3(i)	Internal energy	The internal energy (of say a container of gas) is the sum of the potential and kinetic energies of the molecules.
	Thermodynamics. First Law	The heat supplied **to** a system (e.g. a mass of gas) is equal to the increase in internal energy plus the work done **by** the system. ($Q = \Delta U + W$). **[**The law is essentially a restatement of the law of conservation of energy including heat as an energy form. Any of the terms in the equation can be positive or negative, e.g. if 100 J of heat is lost from a system $Q = -100$ J**]**
3.4.3(n)	Specific heat capacity c.	The heat required, per kilogram, per degree Celsius or Kelvin, to raise the temperature of a substance. **UNIT: $J\,kg^{-1}\,K^{-1}$ or $J\,kg^{-1}\,°C^{-1}$**

	Mole.	This is the amount of substance that has the same number of particles (usually atoms or molecules) as there are atoms in exactly twelve grammes of the nuclide ^{12}C.
3.4.4(a)	Avogdadro constant N_A.	This is the number of particles in a mole. (N_A=6.02×10^{23} to 3 figs).
3.4.4(c)	Boyle's law	For a fixed mass of gas at constant temperature, the pressure varies inversely as the volume. ($p = k/V$)
	Ideal gas.	An ideal gas strictly obeys the equation of state $pV = nRT$.
3.4.5(a)	Capacitor.	A pair of parallel metal plates, a small distance apart, insulated from one another.
3.4.5(c)	Relative permittivity ε_r.of an insulator or 'dielectric'	If capacitance is measured first with vacuum between the plates and then with a slab of insulator between, the capacitance increases by a factor ε_r
3.4.6(a)	Root mean square value (r.m.s.).	This is a form of average, which is really self defined. Thus for three discrete quantities 1,2 and 3, the r.m.s value is given by $\sqrt{\left(\left(1^2+2^2+3^2\right)/3\right)} = 2.16$. For sinusoidal variations the r.m.s. value over a complete cycle is given by the peak (maximum) value divided by $\sqrt{2}$. (e.g. $I_{\text{rms}} = I_O/\sqrt{2}$)
3.4.6(e)	Capacitor, reactance of.	When an AC voltage is applied to a capacitor, the reactance is given by $X_C = V_{\text{rms}}/I_{\text{rms}}$ where V_{rms} and I_{rms} are, respectively, the voltage across and the current 'through' the capacitor. It is equal to $1/\omega C$ (or $1/2\pi fC$).
3.4.6(f)	Inductor, reactance of.	When an AC voltage is applied to an inductor, the reactance is given by $X_L = V_{\text{rms}}/I_{\text{rms}}$ where V_{rms} and I_{rms} are, respectively, the voltage across and the current through the inductor. It is equal to ωL (or $2\pi fL$)

PH5

3.5.1(c)	Newton's law of gravitation.	The gravitational force between two objects is directly proportional to the product of their masses and inversely proportional to the distance between their centres. $F = Gm_1m_2/r^2$
3.5.1	Electric field strength *E*.	The force experienced per unit charge by a small positive charge placed in the field. **Unit: Vm^{-1}.**
	Gravitational field strength *g*.	The force experienced per unit mass by a mass placed in the field. **Unit: ms^{-2} or Nkg^{-1}.**
	Electric potential V_E.	Electric potential at a point is the work done per unit charge in bringing a positive charge from infinity to that point. **Unit: V. [= JC^{-1}]**
	Gravitational potential V_g.	Gravitational potential at a point is the work done per unit mass in bringing a mass from infinity to that point. **Unit: Jkg^{-1}.**
3.5.2(c)	Magnetic flux density *B*.	A length *l* of wire perpendicular to a magnetic flux density *B*, carrying a current *I*, experiences a force of magnitude *BIl*. **Unit: T (Tesla) [= $NA^{-1}m^{-1}$]**
3.5.2(i)	Relative permeability μ_r.	When magnetic material of relative permeability μ_r fills a long solenoid, the magnetic flux density in the material is given by $B = \mu_r B_0$ where B_0 is the flux density when the solenoid is evacuated.
3.5.2(l)	Ampere A.	The ampere is that constant current which when flowing through two infinite, thin, parallel wires, one metre apart in vacuum, produces a force between the wires of 2×10^{-7}N per metre of length. **Unit: A.**
3.5.3(a)	Magnetic flux ϕ. Weber Wb.	If a single-turn coil of wire encloses an area *A*, and a magnetic field *B* makes an angle θ with the normal to the plane of the coil, the magnetic flux through the coil is given by $\Phi = AB \cos \theta$. **Unit: $Wb=Tm^2$.**
3.5.3(a)	Flux linkage $N\Phi$.	If the above coil consists of *N* turns, the flux linkage is given by $N\Phi$. **Unit: Wb** or **Wb turn.**
3.5.3(b)	Faraday's law	When the flux linking an electrical circuit is changing, an emf is induced in the circuit of magnitude equal to the rate of change of flux.
	Lenz's Law.	The direction of any current resulting from an induced emf is such as to oppose the change in flux linkage that is causing the current.
3.5.3(e)	Self inductance *L*. Henry H	When a current *I* through a coil produces a flux linkage $N\Phi$, the self inductance of the coil is given by $L= N\Phi/I$. **Unit: $H=WbA^{-1}=Tm^2A^{-1}$ [= VsA^{-1}]**

3.5.4(a)	α radiation	A stream of helium ^4_2He nuclei.
3.5.4(a)	β radiation	A stream of electrons.
3.5.4(a)	γ radiation	Short wavelength electromagnetic radiation (shorter than X-rays).
3.5.4(a)	$^A_Z X$ notation	*X* is the chemical symbol of the element, *A* the mass number (number of protons plus number of neutrons) and *Z* the atomic number (number of protons).
3.5.4(d)	Half life $T_{\frac{1}{2}}$	The time taken for the number of radioactive nuclei *N* (or the activity *A*) to reduce to one half of the initial value. **Unit: s.**
3.5.4(e)	Activity *A*. Becquerel Bq.	The rate of decay (number of disintegrations per second) of a sample of radioactive nuclei. **Unit: Bq=s^{-1}.**
3.5.4(f)	Decay constant λ.	The constant which appears in the exponential decay law $N = N_0 e^{-\lambda t}$ and determines the rate of decay (the greater λ is, the more rapid the rate of decay). It is related to half life by $\lambda = \ln 2 / T_{\frac{1}{2}}$. **Unit: s^{-1}**
3.5.4(i)	Radioisotopes	Isotopes (of the same element) have the same atomic number *Z* but different mass number *A*. Radioisotopes are simply isotopes which are radioactive.
3.5.5(b)	Unified atomic mass unit u.	The unified atomic mass unit is defined as exactly one twelfth of the mass of one atom of carbon 12. Thus one atom of ^{12}C has a mass of exactly 12u. (1u = $10^{-3} / N_A$ = 1.66x10^{-27}kg)
	Electron volt (eV).	This is the energy transferred when an electron moves between two points with a potential difference of 1 volt between them. 1 eV = 1.6 × 10^{-19} J [Within the context of particle accelerators it can also be defined as: the energy acquired by an electron when accelerated through a pd of 1V.]
	Binding energy of a nucleus.	The energy that has to be supplied in order to dissociate a nucleus into its constituent nucleons. [It is therefore *not* energy which a nucleus *possesses*.] **Unit: J [or MeV]**
3.5.6(f)	De Broglie relationship $\lambda = h/p$	The key relationship relating to wave-particle duality. It gives the wavelength λ associated with a moving particle in terms of its linear momentum *p* and the Planck constant *h*.