Part of WJEC

AS PHYSICS

TERMS, DEFINITIONS & UNITS

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This document is issued by WJEC Eduqas to assist teachers with the preparation of candidates for the GCE examination in PHYSICS. It consists of the definitions of terms from the current AS specification.

The definitions were produced by the Principal Examining team. It is acknowledged that there will always be disagreement on precise definitions, but the aim has been to produce wording which is accessible to students while preserving a fair level of rigour.

The rationale for the production of this document is to help learners towards an understanding of the basic vocabulary of Physics, without which clear explanations are impossible. It will also of course aid the learners in revision, as knowledge of terms, definitions and units is examined in every paper.

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AS Component 1

Section	Item	Definition
1.1 (a)	Quantity	In S.I. a quantity is represented by a number × a unit, (e.g. m = 3.0 kg).
1.1 (d)	Scalar	A scalar is a quantity that has magnitude only.
	Vector	A vector is a quantity that has magnitude and direction.
1.1 (f)	Resolving a vector into components in particular directions	This means finding vectors (the so-called *components*) in these directions, which add together vectorially to make the original vector, and so, together, are equivalent to this vector.
1.1 (g)	Density of a material, ρ	$\text{density} = \frac{\text{mass}}{\text{volume}}$ **Unit: kg m^{-3}** or **g cm^{-3}** in which mass and volume apply to any sample of the material.
1.1 (h)	Moment (or torque) of a force	The moment (or torque) of a force about a point is defined as the force × the perpendicular distance from the point to the line of action of the force, i.e. moment = $F \times d$ **Unit: N m** [N.B. the unit is not J]
1.1 (i)	The principle of moments	For a system to be in equilibrium, $\sum$ anticlockwise moments about a point = $\sum$ clockwise moments about the same point.
1.1 (j)	Centre of gravity	The centre of gravity is the single point within a body at which the entire weight of the body may be considered to act.
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	$\text{Mean speed} = \frac{\text{total distance travelled}}{\text{total time taken}} = \frac{\Delta x}{\Delta t}$ **Unit: m s^{-1}**
	Instantaneous speed	Instantaneous speed = rate of change of distance **Unit: m s^{-1}**
	Mean velocity	$\text{Mean velocity} = \frac{\text{total displacement}}{\text{total time taken}}$ **Unit: m s^{-1}**
	Instantaneous velocity	The velocity of a body is the rate of change of displacement. **Unit: m s^{-1}**
	Mean acceleration	$\text{Mean acceleration} = \frac{\text{change in velocity}}{\text{time taken}} = \frac{\Delta v}{\Delta t}$ **Unit: m s^{-2}**
	Instantaneous acceleration	The instantaneous acceleration of a body is its rate of change of velocity. **Unit: m s^{-2}**
1.2 (e)	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’ force (e.g. pull of gravity).
1.3 (a)	Force, F	A force on a body is a push or a pull acting on the body from some external body. **Unit: N**
	Newton’s 3rd law	If a body **A** exerts a force on a body **B**, then **B** exerts an equal and opposite force on **A**.
1.3 (c)	$\Sigma F = m a$	The mass of a body × its acceleration is equal to the vector sum of the forces acting on the body. This vector sum is called the *resultant force*.

1.3 (d)	Momentum	The momentum of an object is its mass multiplied by its velocity. ($p = mv$). It is a vector. **UNIT: kg m s^{-1}** or **Ns**
1.3 (e)	Newton's 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.
1.3 (f)	The principle of conservation of momentum	The vector sum of the momenta of bodies in a system stays constant even if forces act between the bodies, provided there is no external resultant force.
	Elastic collision	A collision in which there is no change in total kinetic energy.
	Inelastic collision	A collision in which kinetic energy is lost.
1.4 (a)	Work, W	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: J**
1.4 (c)	Principle of conservation of energy	Energy cannot be created or destroyed, only transferred from one form to another. Energy is a scalar.
	Potential energy, E_p	This is energy possessed by an object by virtue of its position. $E_p = mgh$ **Unit: J**
	Kinetic energy, E_k	This is energy possessed by an object by virtue of its motion. $E_k = ½mv^2$ **Unit: J**
	Elastic potential energy	This is the energy possessed by an object when it has been deformed due to forces acting on it. $E_{elastic} = ½ Fx$ or $½ kx^2$ **Unit: J**
1.4 (d)	Energy	The energy of a body or system is the amount of work it can do. **Unit: J**
1.4 (e)	Power, P	This is the work done per second, or energy transferred per second. **Unit: W [= J s^{-1}]**
1.5 (a)	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, k	The spring constant is the force per unit extension. **Unit: N m^{-1}**
1.5 (b)	Stress, σ	Stress is the force per unit cross-sectional area when equal opposing forces act on a body. **Unit Pa** or **N m^{-2}**
	Strain, ε	Strain is defined as the extension per unit length due to an applied stress. **Unit: none**
	Young modulus, E	Young modulus $E = \frac{\text{tensile stress}}{\text{tensile strain}}$ Unless otherwise indicated this is defined for the Hooke's law region. **Unit: Pa or N m^{-2}**
1.5 (d)	Crystal	Solid in which atoms are arranged in a regular array. There is a long range order within crystal structures.
	Crystalline solid	Solid consisting of a crystal, or of many crystals, usually arranged randomly. The latter is strictly a *poly*crystalline solid. Metals are polycrystalline.
	Amorphous solid	A truly amorphous solid would have atoms arranged quite randomly. Examples are rare. In practice we include solids such as glass or brick in which there is no long range order in the way atoms are arranged, though there may be ordered clusters of atoms.
	Polymeric solid	A solid which is made up of chain-like molecules.

1.5 (e)	Ductile material	A material which can be drawn out into a wire. This implies that plastic strain occurs under enough stress.
	Elastic strain	This is strain that disappears when the stress is removed, that is the specimen returns to its original size and shape.
	Plastic (or inelastic) strain	This is strain that decreases only slightly when the stress is removed. In a metal it arises from the movement of dislocations within the crystal structure.
	Elastic limit	This is the point at which deformation ceases to be elastic. For a specimen it is usually measured by the maximum force, and for a material, by the maximum stress, before the strain ceases to be elastic.
	Dislocations in crystals	Certain faults in crystals which (if there are not too many) reduce the stress needed for planes of atoms to slide. The easiest dislocation to picture is an *edge* dislocation: the edge of an intrusive, incomplete plane of atoms.
	Grain boundaries	The boundaries between crystals (grains) in a polycrystalline material.
	Ductile fracture (necking)	The characteristic fracture process in a ductile material. The fracture of a rod or wire is preceded by local thinning which increases the stress.
1.5 (f)	Brittle material	Material with no region of plastic flow, which, under tension, fails by brittle fracture.
	Brittle fracture	This is the fracture under tension of brittle materials by means of crack propagation.
1.5 (g)	Elastic hysteresis	When a material such as rubber is put under stress and the stress is then relaxed, the stress-strain graphs for increasing and decreasing stress do not coincide, but form a loop. This is hysteresis.
1.6 (b)	Black body	A black body is a body (or surface) which absorbs all the electromagnetic radiation that falls upon it. No body is a better *emitter* of radiation at any wavelength than a black body at the same temperature.
1.6 (d)	Wien's displacement law	The wavelength of peak emission from a black body is inversely proportional to the absolute (kelvin) temperature of the body. $\lambda_{max} = \frac{W}{T}$ [W = the Wien constant = 2.90×10^{-3} m K]
	Absolute or kelvin temperature	The temperature, T in kelvin (K) is related to the temperature, θ, in celsius (°C) by: T / K= θ / °C + 273.15 At 0 K (-273.15°C) the energy of particles in a body is the lowest it can possibly be.
	Stefan's law [The Stefan-Boltzmann law]	The total electromagnetic radiation energy emitted per unit time by a black body is given by *power* = $A\,\sigma T^4$ in which A is the body's surface area and σ is a constant called *the Stefan constant*. [$\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}]
	Luminosity of a star	The luminosity of a star is the total energy it emits per unit time in the form of electromagnetic radiation. **UNIT: W** [Thus we could have written *luminosity* instead of *power* in Stefan's law (above).]

	Intensity	The intensity of radiation at a distance R from a source is given by $I = \frac{P}{4\pi R^2}$ **UNIT: W m^{-2}**
1.7 (c)	Lepton	Leptons are electrons and electron-neutrinos [and analogous pairs of particles of the so-called *second and third generations*].
1.7 (f)	Hadron	Hadrons are particles consisting of quarks or antiquarks bound together. Only hadrons (and quarks or antiquarks themselves) can ‘feel’ the *strong* force.
	Baryon	A baryon is a hadron consisting of 3 quarks or 3 antiquarks. The best known baryons are the *nucleons*, i.e. protons and neutrons.
	Meson	A meson is a hadron consisting of a quark-antiquark pair.

AS Component 2

Section	Item	Definition
2.1 (a)	Electric current, I	This is the rate of flow of electric charge. $I = \frac{\Delta Q}{\Delta t}$ **Unit: A**
2.1 (d)	Efficiency of a system	$\%\,\text{Efficiency} = 100 \times \frac{\text{useful work (or energy) out}}{\text{work (or energy) put in}}$ **Unit: none**
2.2 (a)	Potential difference (pd), V	The pd 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: V [= J C^{-1}]**
2.2 (d)	Ohm's law	The current in a metal wire at constant temperature is proportional to the pd across it.
2.2 (e)	Electrical resistance, R	The resistance of a conductor is the pd (V) placed across it divided by the resulting current (I) through it. $R = \frac{V}{I}$ **Unit: Ω [= V A^{-1}]**
2.2 (h)	Resistivity, ρ	The resistance, R, of a metal wire of length L and cross-sectional area A is given by $R = \frac{\rho L}{A}$, in which ρ the resistivity, is a constant (at constant temperature) for the material of the wire. **Unit: Ω m**
2.2 (k)	Superconducting transition temperature, T_c	The temperature at which a material, when cooled, loses all its electrical resistance, and becomes *super-conducting*. Some materials (e.g. copper) never become superconducting however low the temperature becomes.
2.3 (a)	The law of conservation of charge	Electric charge cannot be created or destroyed, (though positive and negative charges can neutralise each other). Charge cannot pile up at a point in a circuit.
2.3 (g)	Emf, E	The emf 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: V**
2.4 (a)	Progressive wave	A pattern of disturbances travelling through a medium and carrying energy with it, involving the particles of the medium oscillating about their equilibrium positions.
2.4 (b)	Transverse wave	A transverse wave is one where the particle oscillations are at 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.
2.4 (c)	Polarised wave	A polarised wave is a transverse wave in which particle oscillations occur in only one of the directions at right angles to the direction of wave propagation.
2.4 (d)	In phase	Waves arriving at a point are said to be *in phase* if they have the same frequency and are at the same point in their cycles at the same time. [Wave *sources* are in phase if the waves have the same frequency and are at the same point in their cycles at the same time, as they leave the sources.]
2.5 (e)	Wavelength of a progressive wave	The wavelength of a progressive wave is the minimum distance (measured along the direction of propagation) 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, [or equivalently the number of cycles of oscillation per second performed by any particle in the medium through which the wave is passing.]
	Speed of a wave	The speed of a wave is the distance that the wave profile moves per unit time.
2.5 (a)	Diffraction	Diffraction is the spreading out of waves when they meet obstacles, such as the edges of a slit. Some of the wave's energy travels into the geometrical shadows of the obstacles.
2.5 (f)	The principle of superposition	The principle of superposition states that if waves from two sources [or travelling by different routes from the same source] occupy the same region then the total displacement at any one point is the vector sum of their individual displacements at that point.
2.5 (m)	Phase difference	Phase difference is the difference in position of 2 points within a cycle of oscillation. It is given as a fraction of the cycle or as an angle, where one whole cycle is 2π or 360°], together with a statement of which point is ahead in the cycle.
	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.
2.5 (o)	Stationary (or standing) wave	A stationary wave is a pattern of disturbances in a medium, in which energy is not propagated. The amplitude of particle oscillations is zero at equally-spaced *nodes*, rising to maxima at *antinodes*, midway between the nodes.
2.6 (a)/(b)	Refractive index, n	For light, Snell's law may be written: $n_1 \sin\theta_1 = n_2 \sin\theta_2$ in which θ_1 and θ_2 are angles to the normal for light passing between medium 1 and medium 2; n_1 and n_2 are called the *refractive indices* of medium 1 and medium 2 respectively. The refractive index of a vacuum is fixed by convention as exactly 1. For air, n = 1.000
2.6 (b)	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.
2.6 (e)	Critical angle, C	When light approaches the boundary between two media from the 'slower' medium, the critical angle is the largest angle of incidence for which refraction can occur. The refracted wave is then travelling at 90° to the normal.
2.7 (b)	Photoelectric effect	When light or ultraviolet radiation of short enough wavelength falls on a surface, electrons are emitted from the surface.
2.7 (e)	Work function, ϕ	The work function of a surface is the minimum energy needed to remove an electron from the surface. **Unit: J** or **eV**
2.7 (j)	Electron volt (eV)	This is the energy transferred when an electron moves between two points with a potential difference of 1 V between them. 1 eV = 1.60×10^{-19} J So for an electron being accelerated it is the kinetic energy acquired when accelerated through a pd of 1 V.
2.7 (k)	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 in its ground state. **Unit: J**
2.8 (a)	Stimulated emission	This is the emission of a photon from an excited atom, triggered by a passing photon of energy equal to the energy gap between the excited state and a state of lower energy in the atom. The emitted photon has the same frequency, phase, direction of travel and polarisation direction as the passing photon.

2.8 (b)	Population inversion	A *population inversion* is a situation in which a higher energy state in an atomic system is more heavily populated than a lower energy state (i.e. a less excited state or the ground state) of the same system.
2.8 (e)	Pumping	*Pumping* is feeding energy into the amplifying medium of a laser to produce a population inversion.