

## Definitions and Concepts for Edexcel (IAL) Physics A-level

### Unit 5: Thermodynamics, Radiation, Oscillations and Cosmology

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#### 5.1 Thermodynamics

**Absolute Zero:** The lowest possible temperature of a system, where no heat remains and the particles in the system have no kinetic energy.

**Avogadro's Constant:** The constant number of particles per mole of a substance.

**Ideal Gas:** A hypothetical gas that has molecules with no interactions and occupies negligible space so it obeys the ideal gas law.

**Internal Energy:** The sum of all the randomly distributed potential and kinetic energies of the particles that make up a substance.

**Specific Heat Capacity:** The energy required to raise the temperature of 1 kg of a substance by 1 Kelvin without changing its state.

**Specific Latent Heat:** The energy required to change the state of 1 kg of a substance without a change in temperature. Specific latent heat of fusion for solid to liquid and specific latent heat of vapourization for liquid to gas.

#### 5.2 Nuclear Decay

**Alpha Radiation:** The radiation of a particle containing two protons and two neutrons. It is strongly ionising, slow moving and positively charged so therefore deflected by a magnetic field.

**Atomic Mass Unit:** 1/12 the mass of a Carbon-12 nuclei.

**Background Radiation:** Constant radiation everywhere that is due to radioactive substances in the environment.

**Beta Radiation:** Radiation consisting of a high energy electron or positron that is mildly ionising, fast moving and negatively charged so therefore deflected by a magnetic field.

**Binding Energy:** The energy required to split a nucleus into its individual nucleons. The greater the binding energy per nucleon the more stable the nucleus is.

**Einstein's Mass-Energy Equivalence:** Mass and energy are equivalent, with the energy equivalent of a given mass being equal to the product of the mass and the speed of light

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squared.

**Gamma Radiation:** High energy photons, it is weakly ionising, travels at the speed of light and has no charge so is not deflected by magnetic or electric fields.

**Half-life:** The time taken for half of the radioactive nuclei to decay.

**Isotope:** A form of an element with the same number of protons but different numbers of neutrons.

**Mass Deficit:** The difference between the mass of the nuclei and its individual components. If this mass defect is large and positive then when a nuclei undergoes fission this mass defect is released as energy. If this mass defect is negative then when two nuclei are fused together the mass defect is released as energy.

**Nuclear Fission:** The splitting of a large nucleus to produce smaller nuclei, fast moving neutrons and energy.

**Nuclear Fusion:** The joining of two smaller nuclei to form a larger nucleus and to release energy.

**Spontaneous and Random Nature of Nuclear Decay:** Radioactive decay is random - you cannot predict when a nucleus will decay or which nucleus will decay next.

### **5.3 Oscillations**

**Angular Frequency:** A measure of an object's angular displacement per unit time.

**Damping:** The dissipation of energy from an oscillating system. The consequence is that the amplitude of oscillation will decrease. Damping occurs when a force opposes the system's motion.

**Displacement-Time Graph:** A graph that describes displacement of an oscillator through time. For an oscillator in SHM, this will be sinusoidal. If the oscillator begins at its max displacement, then it will follow a cosine shape. If the oscillator begins at its equilibrium position, then it will follow a sine shape.

**Forced Oscillations:** Repeated up and down oscillations, at the frequency of a driver. The amplitude of oscillation is small at high frequencies and large at low frequencies.

**Free Oscillations:** Oscillations that are not caused by a driver. An object will naturally oscillate at its natural frequency.

**Natural Frequency:** The frequency that a system naturally oscillates at when there is no driving force.

**Resonance:** Resonance occurs when the frequency of oscillations is equal to the natural frequency of the oscillating system. The rate of energy transfer is at a maximum during



resonance.

**Simple Harmonic Motion:** Motion where the acceleration of an object is directly proportional, and in the opposite direction, to its displacement.

**Simple Pendulum:** A mass on a string that oscillates with simple harmonic motion from side to side. The time period is independent of the object's mass and the initial displacement.

**Velocity-time Graph:** A graph that describes velocity of an oscillator through time. For an oscillator in SHM, this will be sinusoidal. If the oscillator begins at its max displacement, then it will follow a negative sin shape. If the oscillator begins at its equilibrium position, then it will follow a cosine shape.

#### **5.4 Astrophysics and Cosmology**

**Black Body Radiator:** A perfect emitter and absorber of all possible wavelengths of radiation

**Dark Matter:** Certain observations of galaxies and their dynamics shows that they are far more massive than they appear to be with just the matter we can observe. This has led to the theory of dark matter to make up the rest of the unobservable mass.

**Doppler Effect:** The apparent change in the wavelength of a wave as the source moves relative to an observer. For a source moving away the wavelength increases, for a source moving towards the observer the wavelength decreases.

**Gravitational Field:** A region surrounding a mass in which any other object with mass will experience an attractive force.

**Gravitational Field Strength:** The force per unit mass exerted on a small test mass placed within the field.

**Hertzsprung-Russell Diagram:** A visual representation of the lifecycle of a star. It is a plot of luminosity against temperature.

**Hubble constant:** The speed of a galaxy moving away from ours is proportional to its distance away from us. The constant of proportionality is Hubble's constant.

**Luminosity:** The total power radiated by a star.

**Newton's Law of Universal Gravitation:** The force between two masses is proportional to the product of the masses involved and inversely proportional to the square of the separation of the masses.

**Point Mass:** An infinitesimally small point with mass  $M$ . Any sphere of mass  $M$  can be approximated as a point mass at its centre of mass; they produce the same gravitational field.



**Radiation Curves:** A graph of intensity of radiation against wavelength. Different temperature black-body radiators produce different curves.

**Redshift:** The shift in light of distant galaxies. This redshift is due to all galaxies moving away from each other and the larger redshift of distant galaxies is due to these galaxies moving away at a faster rate.

**Standard Candles:** Objects of known luminosity used as references to measure other stars and to measure the distance to stars.

**Stefan-Boltzmann Law:** A law stating that the power output (luminosity) of a star is directly proportional to its surface area and its absolute temperature to the 4<sup>th</sup> power.

**Trigonometric Parallax:** The change in position of an object depending on the viewing angle. It can be used to estimate the distance of a star, based on how much it moves relative to the background of stars in the time it takes for the earth to move half an orbit.

**Wien's Law:** A law stating that the peak wavelength of emitted radiation is inversely proportional to its absolute temperature.

