A2 Physics definitions

1. Circular motion

- **Linear motion**: Motion in only 1 direction.
- **Projectile motion**: Motion in a plane where force / acceleration is always in one direction only.
- **Circular motion**: Motion in a plane where force / acceleration is always normal / perpendicular to direction of motion.
- **Uniform circular motion**: Magnitude of velocity / speed is same throughout the circular motion.
- **Non Uniform circular motion**: Magnitude of velocity / speed is NOT same throughout the circular motion
- **Angular displacement**: Angle swept in circular motion in travelling between two points (Θ is in radians).
- **The Radian:** The angle subtended at the centre of the circle such that arc length = radius.
- **Angular velocity**: Rate of change of angular displacement.
- **Tangential Velocity:** Instantaneous velocity at a point.
- **Centripetal acceleration**: Net acceleration which is always perpendicular to direction of motion which keeps object in circular motion.
- **Centripetal force**: Net force which is always perpendicular to direction of motion which keeps object in circular motion.

2. Gravitation

- **Gravitation field**: It is the force of gravity experienced per unit mass by a mass placed in a gravitational field.
- **Gravitational force**: It is the force of attraction a mass experiences when placed in the gravitational field of another mass.
- **Gravitational field line**: It is a hypothetical line of force that shows the force on a unit mass when placed in a gravitational field.
- **Point mass**: Mostly spheres with uniform density in which we consider their total mass to act from the centre.
- **Uniform Gravitational field**: It is a region or space where the force experienced per unit mass / gravitational field strength is a constant.
- **Gravitational field strength**: It is the force experienced per unit mass for a mass placed in a gravitational field.
- **Newton's law of gravitation**: It states that force of gravity is directly proportional to the product of the masses but inversely proportional to the square of the distances between their centres.
- **Null point**: The resultant force of gravity at this point is zero.
- **Gravitational potential** : It is the work done per unit mass in bringing that mass from infinity to a point within a gravitational field.
- **Infinity:** A point so far away from a mass that no gravitational force is felt at this point and the gravitational potential at this point is zero.
- **Escape velocity**: Minimum velocity to escape a mass's gravitational field.
- **Kepler's law:** It states that the radius of orbit of a body cubed is directly proportional to the Time period of revolution squared. $T^2 \propto r^3$
- **Geostationary Satellite:** A satellite that orbits at a fixed distance above the equator from west to east.
- Orbits at the equator

- Orbits west to east
- Takes 24 hours to orbit the earth
- It orbits at a distance of 4.23×10^7 m from the Earth's centre.

3. Simple Harmonic Motion / Oscillations

- **Simple harmonic motion**:To and fro oscillatory motion of an object with constant time period in which the acceleration is directly proportional to the displacement but opposite in direction to it.
- **Damping**: Gradual loss of energy of a system over time due to dissipative losses
- **Light damping** : Once an object is displaced, it returns to its equilibrium position after several oscillations.
- **Heavy damping**: Once an object is displaced , the system returns to its equilibrium position over a long period of time, without oscillating.
- **Critical Damping**: Once an object is displaced, the object returns to its equilibrium position in the shortest possible time without oscillating.
- **Forced oscillation**: A light damped system may be made to oscillate continually by applying a periodic force.
- **Driver Force:** The periodic force applied to keep a lightly damped system in Simple Harmonic Motion.
- **Driver Frequency:** The frequency at which the periodic force is being applied to sustain oscillations of a lightly damped system.
- **Resonance**: It is when the resultant amplitude maximises because the driver frequency matches the natural frequency of the oscillatory system.
- **Natural Frequency:** The frequency at which an oscillatory system oscillates once disturbed / displaced

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4. Electric Fields

- **Electric field**: Force experienced per unit positive charge by a charge placed in an electric field.
- **Electric field lines**: Hypothetical lines of forces that depict the force acting on a unit positive charge.
- **Unit charge:** A charge of +1 C.
- **Charge**: Property of matter that causes it to experience a force in an electric field.
- **Point charge**: The complete charge is assumed to be concentrated at the center.
- **Electric field strength**: Force experienced per unit positive charge by a charge placed in an electric field.
- **Coulomb's Law**: The electric force experienced between two charges is directly proportional to the product of the charges but inversely proportional to the square of the distances between their centres.
- **Electric Potential**: Work done per unit positive charge in bringing that charge from infinity to point within an electric field.
- **Uniform Electric Field**: A region or space where the force experienced per unit charge / electric field strength is constant

5. Temperature

- **Temperature**: Measurement of the average kinetic energy of particles of a substance.
- **Centigrade scale**: A temperature scale based on the melting and boiling point of the water.

- **Thermometric property**: Property of a material that allows you to measure temperature as it varies monotonically with temperature. (Means there is no 2 temperature values with the same value of the thermometric property and vice versa)
- **Thermistor**: Resistance based thermometer.
- **Thermocouples**: E.M.F based thermometer. It works on the seebeck effect.
- **Accurate**: How correct is the measured temperature value / How close is the measured value to the true value.
- **Sensitive**: How small of a change can be measured.
- **Responsive**: How fast the value is updated.
- **Range**: The extreme within which you can measure your temperature values
- **Absolute Zero:** It is the temperature at which particles are completely stationary and have no kinetic energy (K = 0)

6. Ideal Gases

- **Ideal gas** : An ideal gas obeys all of the assumptions in kinetic theory and follows an equation of the form $PV \propto T$ where P is pressure, V is volume and T is temperature
- **Assumptions of the Kinetic Model Theory:**
- Particles are always in random motion
- There is no intermolecular forces between particles
- The time for a specific particulate collision is negligible compared to the time between successive collisions.
- The collisions are perfectly elastic.
- The volume of the particles themselves is negligible compared to the volume of the gas.
- There are always a large number of particles for statistical approximations to apply.
- **Mean square speed:** The average speed of all particles in an ideal gas squared.
- **Root mean square speed:** The average speed of all particles in an ideal gas.

7. Thermodynamics

- **Internal energy (U)** : Sum of the microscopic kinetic and potential energies of particles in a substance due to their random motion and intermolecular forces.
  +ΔU = Increase in internal energy
  -ΔU = Decrease in internal energy
  +W = Work done on system
  -W = Work done by system
  +Q = Heat energy gained by system
  -Q = Heat energy lost by system
- **Specific Heat Capacity** : Amount of energy required to change the temperature of 1.0 kg of a substance by 1°C or 1K without a change in the state of the material.
- **Heat capacity** : Amount of energy required to change the temperature of a substance by 1°C or 1K without a change in the state of the material.
- **Specific latent heat of fusion** : Amount of energy required to completely change the state of an object of 1kg from solid to liquid without changing the temperature.
- **Latent heat of fusion** : Amount of energy required to completely change the state of an object from solid to liquid without changing the temperature.
- **Specific latent heat of vaporisation** : Amount of energy required to completely change the state of an object of 1 kg from liquid to gas without changing the temperature.
- **Latent heat of vaporisation** : Amount of energy required to completely change the state of an object from liquid to gas without changing the temperature. Scalar , measured J.

- **First law of thermodynamics** : Its state that the increase in the internal energy ΔU of any system is always equal to the sum of the heat supplied to the system and the work done on the system.
- **Boyle's Law:** Pressure is inversely proportional to Volume for an ideal gas under constant temperature.
- **Charles's Law:** Volume is directly proportional to Temperature for an ideal gas under constant pressure.
- **Pressure Law:** Pressure is directly proportional to Temperature for an ideal gas given its volume remains constant.
- **Adiabatic Process:** No heat exchange takes place during this process. Q = 0.

8. Capacitance

- **Capacitance** : Ratio of change on a body to its electrical potential.
- **Capacitance for a parallel plate capacitor** : Ratio of charge on one of the plates to the potential differences between the plates.
- **Capacitors do not store charge as their plates are equally and oppositely charged but store Electric potential energy due to the separation between the charges.**
- **Time constant**
  - It is the time required for the capacitor to charge to ⅔ of the supply voltage.
  - It is the time required for the capacitor to discharge by ⅔ of its initial voltage.
  - Given by Resistance x Capacitance.
- **Half life of capacitor**
  - The time taken by a capacitor to charge to half of the supply voltage.
  - The time taken by a capacitor to discharge to half of the initial value.

9. Magnetism

- **Magnetic fields** : A region or space where a current carrying conductor or a moving charge perpendicular to the field or a permanent magnet or a magnetic material experiences a force.
- **Magnetic field strength / field density / flux density (B**) :
  - Force acting per unit current, per unit length on a current carrying conductor placed perpendicular in the magnetic field.
  - Force acting per unit charge, per unit velocity on a moving charge moving perpendicular to the magnetic field.
- **The Tesla:** Defined as having 1N of force per 1A of current per 1m length of wire on a current carrying wire placed perpendicular in a magnetic field.
- **Current Balance** : Used to measure the magnetic field strength of a magnet.
- **Cross Field:** A region or space where both a magnetic field and an electric field exist and are perpendicular to each other.
- **Hall probe** : Used to measure magnetic field strength.
- **Hall Voltage:** The voltage produced across the ends of a hall probe when it is kept in a magnetic field.
- **Number density:** Number of free electrons per unit volume in a conductor

10. Electromagnetic induction

- **Magnetic flux** : It is defined as the product of the magnetic field density into the perpendicular cross sectional area of a single loop of wire placed in a magnetic field.
- **Faraday's law of induction** : The e.m.f induced across the ends of a conductor placed in a magnetic field is directly proportional to the rate of change of magnetic flux linkage through it.

- **Lenz's Law :** The e.m.f induced across the ends of a conductor is such that it opposes the change producing it.
- **Magnetic Material** :
    1. Soft magnets : They get magnetised and demagnetised easily and temporarily e.g. Iron
    2. Hard magnets : These materials are harder to magnetise and demagnetise but get magnetised and demagnetised permanently e.g. Steel

11. Quantum physics

- **Photoelectric Effect:** When the photons incident on a target metal surface have an incident frequency greater than the threshold frequency, electrons are emitted from its surface.
- **Threshold Frequency** : It is the minimum frequency for a photon incident on a targeted metal above which electrons are emitted from the metal.
- **Threshold wavelength** : It is the maximum wavelength for the photon incident on a target metal below which electrons are emitted.
- **Photon** : It is the smallest indivisible packet/quantum of energy of electromagnetic radiation.
- **Work function energy:** Minimum amount of incident photon energy on a target metal required to eject electrons from the surface of the metal.
- **Stopping Voltage** : It is the voltage at which electrons from the photocell with the highest kinetic energy are completely stopped.
- **De Broglie's Wavelength:** Moving particles behave like waves.
- **Diffraction:** Spreading of a wave into its geometric shadow as it passes through a narrow slit or edge.

12. Radioactivity

- **Mass defect** : The difference in mass of a nucleus bounded atom and the mass of its individual components
- **Binding energy** : Minimum energy required to break a nucleus and separate its individual components at infinity
- **Isotopes** : Atoms of the same element having the same number of protons but different numbers of neutrons.
- **Fusion** : Combination of the smaller unstable nuclei to form bigger more stable nucleus
- **Fission** : Breaking of a larger unstable nucleus into more stable daughter nuclei.
- **Radioactivity** : It is the random and spontaneous decay of unstable nuclei emitting β-, β+, α, or γ radiation.
- **Random** : Every unstable nucleus in the radioactive sample has an equally likely probability to disintegrate.
- **Spontaneous** : The rate of decay of a radioactive sample does not depend on external factors such as pressure and temperature.
- **Activity** : Rate of disintegrations per unit time.
- **Decay constant :** It is the probability of an unstable nucleus decaying per unit time.
- **Half life** : It is the time required for half the nuclei in the radioactive sample to decay. / It is the time required for the initial activity of the sample to become half its value.

13. Medical Physics

- **Ultrasounds:** Sound waves having frequencies greater than 20 KHz.
- **A Scan** : An Ultrasound taken along 1 line of action.
- **B Scan** : An Ultrasound taken along multiple lines of action.

- **Specific Acoustic Impedance:** The product of the density of the medium into the speed of sound in that medium.
- **Absorption coefficient / Linear Attenuation Coefficient (k / μ):** The fraction of the incident radiant energy which is absorbed per unit thickness for a wave travelling through a medium.
- **Intensity Reflection Coefficient:** The fraction of incident intensity that is reflected off of a boundary layer.
- **Intensity Transmission Coefficient:** The fraction of incident intensity that is transmitted through a medium.
- **ADVANTAGES OF ULTRASOUNDS**
- Cheap
- Quick
- Reliable
- Easy to use
- Portable
- Does not cause cause dosage of patient
- Does Not cause anxiety/claustrophobia

DISADVANTAGES OF ULTRASOUNDS
- Cannot produce very fine images
- Cannot be used to examine dense structures

- **X rays** : High energy electromagnetic radiation having wavelengths ranging from $10^{-8}\ to\ 10^{-10} m.$
- **Hard X rays:** X rays having very high energies / small wavelengths.
- **Soft X rays:** X rays having very low energies / large wavelengths.
- **Cutoff Wavelength:** The shortest wavelength and highest energy X-ray produced by the complete stopping of the fastest travelling electron.
- **Direct Electron Bombardment:** Method of production of X rays in which electrons are accelerated and made to be incident on a target metal. The electrons release X rays when they are stopped by nuclei in the target metal.
- **X rays imaging**
    1. Shadow : *Allows you to see outlines in an X ray image.*
    2. Sharpness *: Defines how well the edges of a structure are in an X ray image.*
    3. Contrast : *Differences in degrees of blackening between structures*.
- **Half value thickness** : It is the length of material required to decrease the initial intensity by exactly half of its value for a wave passing through it.
- **CAT Scans**: Computed Axial tomography also known as CT Scan.

ADVANTAGES OF X RAYS
- Produces very fine images and CAT Scans produces a very detailed 3D image of the part of the body being studied
- Reliable
- Allows to study dense structures

DISADVANTAGES OF X RAYS
- Expensive
- Not as quick as Ultrasound
- CAT Scans cause anxiety and claustrophobia
- Not portable

- A Lot of training is required to use the machinery
- Contributes to significant dosage of patient
- The method of production is not efficient and wastes a lot of power.

- **PET Scans** : Positron emission tomography.
- **Annihilation** : When a matter and its antimatter particle interact, their mass completely converts into energy.
- **Tracer:** A substance that is introduced into the body that is absorbed by the tissue being studied.

14. Astronomy and cosmology

- **Luminosity** : Total power delivered by star.
- **Radiant flux density :** Observed amount of power transmitted normally through surface, per unit area as measured on earth.
- **Light year:** It is the distance light travels in an earth year**.**
- **Cosmic distance ladder** : It is a succession of steps / methods by which we determine the distances to celestial objects.
- **Standard candle / Standard** : It is an astronomical object which has a known luminosity due to a characteristic quality possessed by that class of object.
- **Cepheid Variables** : It is defined as a type of star having a periodic pulsating brightness varying in both temperature and diameter with a well defined amplitude.
- **Type 1A Supernova:** A type of supernova that occurs in binary systems in which one of the stars is a white dwarf. It is a type of a standard candle.
- **Weins's Displacement Law** : The maximum wavelength of radiation detected from a star is inversely proportional to its thermodynamic surface temperature.
- **Black Body Radiator:** An ideal thermal radiator (Stars are black body radiators)
- **Stefan Boltzmann Law** : The luminosity of a star is based upon its radius / size and its surface temperature.
- **Doppler's effect** : It is the change in observed frequency due to relative motion between the source and observer.
- **Hubble's law:** The recession velocity of a galaxy from an observer is directly proportional to the distance between the galaxy and the observer.
- **Redshift:** Wavelength of light from a star stretched to longer wavelengths due to a separation velocity between star and observer.
  Blueshift: Wavelength of light from a star shifted to smaller wavelengths due to an approach velocity between star and observer.
- **Big Bang Theory** : The big bang theory states that the universe origin/ated from an infinitely dense point known as the singularity and has been expanding ever since.

15. Alternating currents

- **Direct current** : The current is always in one direction.
- **Alternating Current** : The current periodically switches its direction of flow.
- **Root Mean Square Current / Voltage**: The average amount of current / voltage from an alternating power supply.
- **Diode** : An electrical component that allows constant to pass in one direction only.

- **Half Wave/Bridge Rectification:** Only half of the input alternating current is rectified to direct current
- **Full Wave/Bridge Rectification:** The input Alternating Current is completely rectified to direct current.