A LEVEL H2 PHYSICS (9749)

complete list of definitions

Chapter 1: Measurements

1. **Physical Quantity:** quantity that can be measured. It consists of a numerical value and a unit
2. **Scalar Quantity:** a physical quantity that has magnitude but no direction (eg. mass, distance, speed, quantity)
3. **Vector Quantity:** a physical quantity that has both magnitude and direction (eg. force, displacement, velocity, acceleration)
4. **Base Quantities:** 7 physical quantities chosen by scientists, from which other physical quantities are derived
   *The 7 Base Quantities are length, mass, time, current, temperature, luminous intensity, amount of substance
5. **Derived Quantities:** physical quantities that are obtained by multiplying and/or dividing base quantities together
6. **Homogenous Equation:** an equation that has equivalent base units for all its terms on either side of the equation.
   *Not all homogenous equations are correct, but all correct equations in physics must be homogenous.
7. **Dimensionless Constants:** constants that have a numerical value but not a unit. They are usually ratios of physical quantities eg. refractive index, radian etc.
8. **Precision of an instrument:** smallest unit of measurement of an instrument
9. **Precision of readings:** how close the readings are to each other
10. **Accuracy:** how close a measurement is to the true value
11. **Systematic error:** errors that always deviate from the true value by the same magnitude and sign when measurements are repeated
12. **Random error:** errors that deviate from the true value with varying magnitudes and sign when measurements are repeated
13. **Uncertainties of a Measurement:** the range within which the true value of a measurement lies in

Chapter 2: Kinematics

14. **Distance:** total length covered by a moving object regardless of direction of motion
15. **Displacement**: shortest distance measured in a specified direction from a reference point.
16. **Speed:** rate of change in distance with respect to time
    *Often understood as the magnitude of velocity
17. **Instantaneous Speed:** rate of change in distance with respect to time at a particular instant in time
18. **Average Speed:** total change in distance divided by total time taken
19. **Velocity:** rate of change in displacement with respect to time
20. **Instantaneous Velocity:** rate of change in displacement with respect to time at a particular instant in time
21. **Average Velocity:** total change in displacement divided by total time taken
22. **Acceleration:** rate of change in velocity with respect to time
23. **Instantaneous Acceleration:** rate of change in velocity with respect to time at a particular instant in time
24. **Average Acceleration:** total change in velocity divided by total time taken
25. **Jerk:** rate of change in acceleration with respect to time

Chapter 3: Forces and Dynamics

26. **Hooke's Law:** the extension of a body is proportional to the force provided the limit of proportionality (or elastic limit) is not exceeded.
27. **Elastic Limit:** The maximum extension beyond which the body does not return to its original length even when the force is removed.
28. **Frictional Force:** a tangential contact force that occurs between two surfaces and tends to oppose the motion of each surface. Frictional force is directly proportional to normal contact force. $f = \mu N$
29. **Viscosity:** the ability of a fluid to resist motion
30. **Normal Contact Force:** the push exerted by a surface on an object pressing on it. It is always 90° to the surface
31. **Pressure:** perpendicular force per unit area
32. **Upthrust:** upward force on an object immersed partially or fully in a fluid due to pressure at the bottom surface being larger than the pressure at the top surface
33. **Archimedes' Principle:** upthrust experienced by an object partially or fully immersed in a fluid is equal to the weight of fluid displaced by the object. (Upthrust $= p_F V_F g$)
34. **Principle of Floatation:** an object floats in equilibrium if the weight of the floating body is equal to the weight of fluid displaced by the object. (Upthrust $= p_F V_F g = p_o V_o g$)
35. **Mass:** a measure of the amount of matter and hence inertia of a body
36. **Inertia:** reluctance of an object to change its state of rest or motion, due to its mass
37. **Centre of Gravity, (CG):** point at which the entire weight of the object appears to act from
38. **Centre of Mass, (CM):** point at which the entire mass of the object appears to be concentrated at

*Often understood as the point through which a resultant force must act so that the body accelerates without rotation.

39. **Momentum:** product of an object's mass and its velocity. Its direction is the same as the velocity.
40. **Impulse:** product of the resultant force and the duration which the resultant force acts
    *Impulse is represented by the net area under a F_R-t graph
41. **Principle of Conservation of Momentum:** The total momentum of a system remains constant before, during and after a collision, provided no net external force acts on the system.
42. **Head-on collision:** a collision in which the colliding bodies move in the same straight line before and after collision.
43. **Elastic Collision:** total momentum and total kinetic energy of the colliding bodies is conserved.
    *($u_1 - u_2 = v_2 - v_1$) applies.
44. **Inelastic Collision:** total momentum of the colliding bodies is conserved but the total kinetic energy is not conserved
    *($u_1 - u_2 > v_2 - v_1$) applies assuming no explosive separation.
45. **Perfectly Inelastic Collision:** a type of inelastic collision where the 2 colliding bodies coalesce (join together) after impact
46. **Moment of a force:** product of the force F and the perpendicular distance ⊥d from the pivot to the line of action of the force
47. **Principle of Moments:** when a body is in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of anti-clockwise moments about the same pivot
48. **Couple:** a pair of forces that is equal in magnitude but opposite in direction that act at different points on a body to cause rotation
49. **Torque of a Couple:** product of one of the forces and the perpendicular distance between their lines of action
50. **2 Conditions for Static equilibrium:**
    - Resultant force in any direction is zero (translational equilibrium) and
    - Resultant torque about any axis is zero (rotational equilibrium)
51. **Conditions for system of coplanar forces to be in equilibrium:**
    - Resultant force and torque must be zero
    - Line of action of forces must intersect at a single point
    - When arranged in tip-to-tail, the forces will form a closed continuous loop

Newton's Laws of Motion

52. **N1L:** an object will continue in its state of rest or uniform velocity unless a resultant force acts on it.
53. **N2L:** the resultant force acting on a body is proportional to the rate of change of its momentum and the change in momentum takes place in the same direction of the resultant force.
54. **N3L:** for every action, there is an equal and opposite reaction force OR
    If body A exerts a force F_{AB} on body B, then body B will exert an equal and opposite force F_{BA} on body A.
    These forces also act on mutually opposite bodies, are of the same nature, and act for the same duration.

Chapter 4: Work Energy Power

55. **Principle of Conservation of Energy:**
    (1) Energy cannot be created nor destroyed, it can only be converted from one form to another AND
    (2) Total amount of energy in an isolated system remains constant
56. **Work Done by a Force:** the product of the force, F, and the displacement, s, of the body in the direction of the force
    *It is represented by the net area under a F-s graph
    *Often understood as the amount of energy converted/transferred to a body
57. **Work Done by an Expanding Gas:** product of its pressure, p and the change in volume, ΔV
58. **Energy:** the capacity to do work
59. **Power:** rate of work done OR
    rate of energy conversion (with respect to time)
60. **Efficiency:** the ratio of useful energy output to total energy input OR
    ratio of useful power output to total power input
61. **Kinetic Energy:** the energy of a body due to its speed
62. **Internal Energy:** the sum of kinetic and potential energy possessed by all particles within an object
63. **Gravitational Potential Energy:** energy stored in a mass due to its vertical height above a reference point in a gravitational field
64. **Elastic Potential Energy:** energy stored in an elastic object due to its deformation (stretch/compression)
65. **Electric Potential Energy:** energy stored in a charge as a result of bringing it from infinity to a particular point in an electric field without any change in kinetic energy/without acceleration
66. **Chemical Potential Energy:** energy stored in chemical bonds that can be released through chemical reactions
67. **Nuclear Energy:** energy holding the nucleus of an atom together. Energy released obeys $E = mc^2$.
68. **Force of a Field:** the negative gradient of its potential energy ie. $F = -\frac{dE}{dx}$, where the negative sign implies that the force is directed towards a potential energy decrease
69. **Field of a force:** a region of space where a body experiences a non-contact force due to the presence of other similar typed bodies.

Chapter 5: Circular Motion

70. **One Radian:** the angle subtended at the centre of a circle by an arc length equal to the circle's radius
71. **Period:** time taken for one complete revolution
72. **Frequency:** number of complete revolutions per unit time
73. **Angular displacement, θ:** directed angle through which an object is turned about its reference point
74. **Angular velocity, ω:** the rate of change in angular displacement
75. **Angular Acceleration:** rate of change in angular velocity
76. **Centripetal Force:** the resultant force producing centripetal acceleration that is directed radially inwards towards the centre of the circular path
    *It always acts in the same direction as centripetal acceleration and is perpendicular to the instantaneous linear velocity of the object.
77. **Centripetal Acceleration**: the resultant acceleration that is directed radially inwards towards the centre of the circular path due to the centripetal force acting on an object.
    Note: An object moving at constant speed in a circle still has centripetal acceleration.
78. **Centrifugal Force:** the perceived force experienced by a body in circular motion, directed radially outwards from the centre of the circle

Chapter 6: Gravitation

79. **Newton's Law of Gravitation:** two point masses attract each other with a gravitational force that is directly proportional to the product of their masses and inversely proportional to the square of their separation. $\left(F_g = \frac{GMm}{r^2}\right)$
    For non-point masses, the distance of separation from centre to centre must be much larger than their individual diameters.
80. **Gravitational Field:** a region of space in which a mass experiences a gravitational attractive force
81. **Gravitational Field Lines:** show direction of gravitational force acting on a small test mass
    *When a mass moves in the same direction as the gravitational field lines, its gravitational potential energy decreases.
82. **Gravitational Field Strength g at a point:** gravitational force per unit mass acting on a small test mass placed at that point. $\left(g = \frac{F_g}{m}\right)$
83. **Gravitational Potential, ϕ:** Work done per unit mass by an external force in bringing a small test mass from infinity to a point in the gravitational field without a change in kinetic energy/without acceleration $\left(g = -\frac{d\phi}{dr}\right)$
84. **Gravitational Potential Energy, U:** Work done by an external force in bringing a small test mass from infinity to a point, without a change in its kinetic energy/without acceleration. $\left(U = -\frac{GMm}{r}\right)$
    *$U = mgh$ can only be used to find change in gravitational potential energy due to a change in the vertical height, h, when $h \ll$ radius of the planet.
85. **Small Test Mass:** a mass so small that it does not distort the original gravitational field it is placed in
86. **Geostationary Orbit:** orbit in which the object is always above the same point on the planet's surface such that it appears stationary to an observer on the planet's surface.
    *A geostationary orbit around Earth must be a equatorial orbit ie. vertically above the equator, have the same angular velocity as Earth, have a period of 24 hours, and orbit in the same direction ie. from west to east
87. **Sensation of Weightlessness:** occurs when an object is in free-fall ie. only weight acts on the body
88. **Neutral/Null Point:** The point between 2 or more masses where the resultant gravitational field strength is zero
89. **Escape Speed:** the minimum speed a mass must have in order to escape the earth's gravitational field and reach infinity

Chapter 7: Temperature and Ideal Gases

90. **Temperature:** a measure of the average kinetic energy of molecules in a body
91. **Heat:** flow of thermal/internal energy between 2 regions with different temperatures
92. **Thermal Contact:** objects are in thermal contact if thermal energy can be exchanged between them
93. **Thermal Equilibrium:** no net heat flow between objects in thermal contact because they have the same temperature
94. 0^{th} Law of Thermodynamics: if A and B are each separately in thermal equilibrium with body C, then A and B are also in thermal equilibrium with each other
95. **Thermometric Substance:** substance with one or more thermometric property
96. **Thermometric property:** physical property that varies continuously and linearly with temperature
97. **Fixed Point:** specific temperature that is always obtained under specific physical conditions
98. **Ice Point (0°C):** temperature of pure melting ice at one atmosphere (101 325 Pa)
99. **Steam Point (100°C):** temperature of steam from water boiling at one atmosphere (101 325 Pa)
100. **Thermodynamic Scale:** a temperature scale based on ideal gas law ie. $pV \propto T$
101. **Absolute Zero:** temperature at which all substances have a minimum internal energy
102. **Absolute Temperature Scale:** any temperature scale with absolute zero as its zero point eg. Kelvin scale. Absolute temperature scales are independent of any thermometric properties
103. **Kelvin:** a unit of an absolute thermodynamic scale. The kelvin is defined as $\frac{1}{273.16}$ the temperature of the triple point of water.

104. **Triple Point of water:** the temperature at which ice, water and water vapour co-exist in equilibrium at a pressure of 613 pascals
105. **Mole:** a measure of the amount of substance
106. **1 Mole:** One mole of any substance will contain 6.02×10^{23} particles
107. **Avogadro Constant:** the number of particles in 12 g of Carbon-12, which is equal to 6.02×10^{23} particles
108. **Isothermal:** same temperature
109. **Isobaric:** same pressure
110. **Isochoric:** same volume
111. **Adiabatic:** no heat flow occurs with surroundings
112. **Kinetic Theory of Gases:** a simplified model of forces associated with random and continuous motion of gas molecules
113. **Ideal Gas:**
    - obeys ideal gas equation, pV = nRT
    - gas molecules are in continuous random motion
    - gas molecules have negligible size/volume (compared to gas volume)
    - gas molecules have negligible intermolecular forces of attraction
    - collisions between gas molecules are perfectly elastic
114. **Root Mean Squared (rms) speed:** square root of the mean of all the squared speeds of the particles in a substance

Chapter 8: First Law of Thermodynamics

115. **First Law of Thermodynamics:** increase in the internal energy of a system is equal to the sum of the heat supplied to the system and the work done on the system $(\Delta U = Q_{to} + W_{on})$
116. **Heat Capacity:** thermal energy required per unit increase in the temperature of a substance without any change in state. $\left(c = \frac{Q}{\Delta T}\right)$
117. **Specific Heat Capacity:** thermal energy required per unit mass per unit increase in the temperature of a substance without any change in state. $\left(c = \frac{Q}{m\Delta T}\right)$
118. **Latent Heat:** thermal energy required to change the state of a substance at constant temperature
119. **Specific Latent Heat of Fusion l_f:** thermal energy required per unit mass of a substance to change it from solid to liquid, vice-versa, without any change in temperature. $\left(l_f = \frac{L_f}{m}\right)$
120. **Specific Latent Heat of Vaporisation, l_v:** thermal energy required per unit mass of a substance to change it from liquid to vapour, vice-versa, without any change in temperature. $\left(l_v = \frac{L_v}{m}\right)$
121. **Internal Energy of a system:** the sum of kinetic and potential energy of all molecules in a system
122. **Evaporation:** the slow process in which molecules of a liquid escape from its surface at any temperature between melting and boiling point such that the remaining liquid experiences a cooling effect

Chapter 9: Oscillations

123. **Periodic Motion:** regular, repetitive motion of a body
124. **Oscillations:** periodic to and fro motion of a body about its equilibrium position
125. **Free Oscillations:** oscillations with no external force and hence no loss of energy
126. **Displacement:** magnitude and direction of a body's position from its equilibrium position
127. **Amplitude:** maximum magnitude of displacement from its equilibrium position
128. **Period:** time taken for one complete oscillation
129. **Frequency:** the number of complete oscillations per unit time
130. **Angular Frequency:** product of frequency and 2π
131. **Phase:** the displacement and direction of an oscillating system with respect to a reference position
132. **Phase Difference:** difference in phases of two oscillating systems
133. **Simple Harmonic Motion:** motion in which the acceleration of a body is proportional but opposite to its displacement from a fixed point $(a \propto -x)$ or $(F \propto -x)$
134. **Damping:** reduction in amplitude of an oscillating system due to loss of energy caused by dissipative forces eg. friction/viscous forces
135. **Light Damping:** displaced system oscillates with gradually decreasing amplitude
136. **Critical Damping:** displaced system returns to rest at its equilibrium position in the shortest possible time, without oscillating
137. **Heavy Damping:** displaced system takes a long time to return to its equilibrium position, without oscillating
138. **Forced Oscillations:** oscillations that are driven by an external periodic force (called a driving force)
139. **Natural Frequency:** the frequency at which a body vibrates freely, without any external driving or resistive force
140. **Driving Frequency:** frequency of the driving force
141. **Resonance:** phenomenon where a system has maximum amplitude because the external driving force has the same frequency as the natural frequency of the system.

Chapter 10: Waves

142. **Wave Motion:** transfer of energy by propagation of oscillations without net movement of the medium
143. **Mechanical Waves:** propagation of waves through physical media
144. **Electromagnetic Waves:** propagation of waves in electromagnetic fields, which do not require physical media
145. **Displacement:** magnitude and direction of a point from the equilibrium
146. **Amplitude:** maximum magnitude of displacement of a wave
147. **Wavelength:** shortest distance between two points that are in phase
148. **Wavefront:** imaginary line that joins all adjacent points of a wave that are in phase
    *The wave velocity is always perpendicular to its wavefront
149. **Wave Speed:** distance travelled per unit time by any part of the waveform
150. **Period:** time taken for one complete wave
151. **Frequency of a Wave:** number of complete waves per unit time
152. **Progressive Wave:** transfers energy from the source in the direction of its propagation
153. **Transverse Wave:** direction of oscillation of particles is perpendicular to the direction of wave propagation
154. **Longitudinal Wave:** the direction of oscillation of particles is parallel to the direction of wave propagation
155. **Intensity:** rate of energy flow (ie. power) per unit area perpendicular to the direction of wave propagation
156. **Polarisation:** when wave's oscillations are made to occur only in one direction perpendicular to the direction of wave propagation
    *only possible for transverse waves
157. **Malus Law:** the intensity of light passing through a polariser and an analyser (2nd polariser) is proportional to $\cos^2\theta$ where θ is the angle through which the analyser has been rotated with respect to the polariser.

Chapter 11: Superposition

158. **Monochromatic Light:** light of only one frequency and hence one colour
159. **Principle of Superposition:** when two or more waves of the same type meet, the resultant displacement at any point is the vector sum of the individual displacements that the two waves would separately produce at that point.
160. **Phase:** state of waves with regard to its displacement and direction
161. **Phase Difference:** difference in phases of two waves
    *A measure of how much a wave is lagging or leading another
162. **In Phase:** when the phase difference between two waves/particles is zero or an **even** integer multiple of π
163. **Anti-phase:** when the phase difference between two waves/particles is an **odd** integer multiple of π
164. **Coherent:** waves are coherent when they have a constant phase difference between them
    *This implies that they must have the same frequency and period
165. **Path Difference:** difference in the distances travelled by each wave to a point
166. **Interference:** phenomenon which occurs when two or more waves of the same type overlap (superpose) according to the principle of superposition.
167. **Constructive Interference:** interference between two waves of the same frequency, amplitude and phase that results in displacements that are twice of each individual wave
    *Occurs when path difference is zero or an integer number of wavelengths
    *Occurs when phase difference is zero or an **even** integer multiple of π
168. **Destructive Interference:** interference between two waves of same frequency, amplitude but anti-phase that results in zero resultant displacements.
    *Occurs when path difference is an odd integer multiple of a ½ wavelength
    *Occurs when phase difference is an **odd** integer multiple of π
169. **Conditions for observable interference:**
    (1) The overlapping waves must be coherent (same frequency and period implied)
    (2) The waves should have equal or similar amplitudes.
    (3) For transverse waves, they must be either unpolarised or polarised in the same plane.
170. **Stationary Wave:** wave where energy is not transferred but stored in the oscillations of the medium
    *formed when two identical progressive waves (same amplitude, frequency) travelling along the same line with the same speeds but in opposite directions.
171. **Nodes:** points along a resultant wave at which displacement is always zero
    *Always at the closed end of an air column
172. **Anti-nodes:** points along a resultant wave at which displacement is always maximum
    *Anti-nodes are found mid-way between nodes
    *Always found just past the open end of an air column
173. **Pressure Nodes:** points where pressure variation is least, because particles are vibrating with maximum amplitude (ie. oscillation anti-nodes)
174. **Pressure Anti-nodes:** points where pressure variation is maximum.
    *While the medium particles do not move (oscillation nodes), the medium particles move towards it during one part of the wave cycle and away from it during another part of the cycle

175. **Diffraction:** spreading of waves after they pass through a small opening or round an obstacle
*Diffraction becomes more pronounced when the gap or object is smaller/closer to wavelength of wave
176. **Resolving Power (of an optical instrument):** ability to distinguish between the images of relatively close objects
177. **Rayleigh criterion:** When the central maximum of one image falls on the first minimum of another image, the images are distinguishable and said to be just resolved
178. **Diffraction Grating**: a surface that consists of many parallel, evenly spaced slits of equal width

Chapter 12: E-fields

179. **Coulomb's Law:** The magnitude of force between two point charges is directly proportional to the product of the charges and inversely proportional to the square of their separation. $\left(F_E = \frac{Qq}{4\pi\varepsilon_0 r^2}\right)$
180. **Electric Field:** a region in space where an electric charge experiences an electric force.
181. **Electric Field Lines:** indicate the direction of force acting on a small positive test charge
182. **Electric Field Strength, E, at a point:** electric force per unit positive charge placed at that point. $\left(E = \frac{F_E}{q}\right)$
It is numerically equal to the potential gradient at that point. $\left(E = -\frac{dV}{dr}\right)$
183. **Electric Potential at a point, *V*:** work done per unit positive charge in bringing a small positive test charge from infinity to that point without a change in the kinetic energy/without acceleration
184. **Electric Potential Energy:** work done in bringing a charge from infinity to that point without a change in the kinetic energy/without acceleration
185. **Equipotential Lines/Surfaces:** Lines/Surfaces with equal potential and are always perpendicular to electric field lines.
*No work is done to move a charge from one point to another along this surface, as the electric potential is the same at all points of the surface
186. **One Electron Volt:** energy gained by an electron when it moves through a potential difference of 1 V

Chapter 13: Current of Electricity

187. **Electric Charge:** quantity of electricity given by the product of current and time
188. **One Coulomb:** quantity of charge passing through a cross-section of a conductor when a current of one ampere flows for one second. $(Q = It)$
189. **Electric Current:** rate of flow of electric charges
190. **One Ampere:** flow of 1 Coulomb of charges per second through a cross-section of a circuit
191. **Drift Velocity:** average flow velocity of charged particles along axis of a conductor due to the external electric field of a power supply
192. **Electromotive Force (e.m.f):** energy converted by a source from other forms to electrical energy per unit charge driven round a complete circuit
193. **Potential Difference**: work done per unit charge in moving it between 2 points OR
electrical energy converted to other forms per unit charge in moving it between 2 points OR
power dissipated per unit current between the two points
194. **One Volt:** p.d across two points when 1 J of electrical energy is converted to other forms of energy as 1 C of charge moves between the two points. $\left(V = \frac{WD}{q}\right)$
195. **Resistance:** ratio of the potential difference across the component to the current flowing through it. $(R = \frac{V}{I})$
*Resistance, R of a conductor depends on: length (l), cross-sectional area (A) and resistivity (ρ). $\left(R = \frac{\rho l}{A}\right)$
196. **Resistivity:** a measure of a material's resistance to current flowing through it
197. **Internal Resistance:** resistance that a charge encounters when moving through the source itself
198. **Terminal Potential Difference:** p.d. between the terminals of the cell when current flows through it
*Usually lower than e.m.f since there will be some p.d. across the cell's internal resistance
199. **One Ohm:** electrical resistance between two points of a conductor through which a steady current of 1 A flows when a constant potential difference of 1 V is maintained across it. $\left(R = \frac{V}{I}\right)$
200. **Ohm's Law:** current passing through a metallic conductor is directly proportional to the p.d. across it, provided the physical conditions (such as temperature) remains constant
*Ohmic conductors have constant resistance
201. **Diode:** a device which has very low resistance in forward biased and very high resistance in reverse biased, hence allowing current flow in only one direction
202. **Positive Temperature Coefficient (PTC):** resistance increases with temperature
203. **Negative Temperature Coefficient (NTC):** resistance decreases with temperature, vice-versa
204. **Light Dependent Resistor:** light sensor whose resistance decreases non-linearly when light intensity increases
205. **Thermistor:** temperature sensor whose resistance decreases non-linearly when temperature increases
206. **Electrical Power:** rate of change in electrical energy to other forms of energy
207. **Joule Heating Effect:** the dissipation of thermal energy as current passes through a conductor due to collisions between the electrons and the atoms of the conductor

208. **Maximum Power Transfer Theorem:** maximum power is supplied to external load when the internal resistance of the cell is equal to the resistance of the external load

Chapter 14: D.C. Circuits

209. **Kirchoff's 1st Law:** total current that enters a junction or node must be equal to the total current leaving it
*This is a result of conservation of charges
210. **Kirchoff's 2nd Law:** total p.d. across a closed circuit loop is equal to the sum of potential drops around the loop
*This is a result of conservation of energy
211. **Potential Divider:** a line of resistors connected in series to provide a fraction of their p.d. to another part of a circuit
212. **Potentiometer:** a variable resistor that is connected at three terminals and used to provide a fraction of its p.d. to another part of a circuit

Chapter 15: Electromagnetism

213. **Magnetic Field:** region of space where a permanent magnet or a moving charge or a current-carrying conductor (may) experience a magnetic force.
214. **Magnetic Field Lines:** indicate the direction of force that a magnetic north pole in the field would experience
215. **Magnetic Flux Density:** magnetic force per unit current per unit length of conductor acting on a straight current-carrying conductor placed perpendicular to the magnetic field. $\left(B = \frac{\mu_0 I}{2\pi r}\right)$
216. **One Tesla:** The magnetic flux density of a uniform magnetic field in which a 1 m long straight conductor, carrying current of 1 A and placed at right angle to the B-field, experiences a magnetic force of 1 N. $\left(B_\perp = \frac{F_B}{IL}\right)$
*The magnetic force is perpendicular to both the current and the magnetic field
217. **Magnetic Permeability:** measure of a material's ability to allow magnetic field through it

Chapter 16: Electromagnetic Induction

218. **Magnetic Flux (ϕ) through a plane surface in uniform magnetic field:** product of the magnetic flux density and the area normal to the field. $(\phi = B_\perp A \; or \; \phi = BA\cos\theta)$
219. **One Weber:** The magnetic flux passing through a plane surface of 1 m^2 placed normally to uniform magnetic field of flux density 1 T
220. **Magnetic Flux Linkage through a coil of N turns:** product of the number of turns N of the coil and the magnetic flux linking each turn $(\Phi = NB_\perp A \; or \; \Phi = NBA\cos\theta)$
221. **Electromagnetic Induction:** phenomenon whereby a changing magnetic flux can induce an e.m.f in a conductor
222. **Faraday's Law of Electromagnetic Induction:** magnitude of induced e.m.f is directly proportional to the rate of change of magnetic flux linkage.
223. **Lenz's Law:** direction of the induced e.m.f. and hence current in a closed circuit will produce a magnetic effect to oppose the change producing it

Chapter 17: Alternating Current

224. **Alternating Current, a.c.:** flow of electric charge that periodically reverses
225. **Peak Value/Amplitude:** maximum value in either direction
226. **Peak to Peak Value:** difference between positive peak value (max) and negative peak value (min) of an alternating current
227. **Root Mean Square (r.m.s.) current:** value of the direct current that would provide an equivalent average power as the alternating current
228. **Transformer:** device that can change a high alternating voltage (at low current) to a low alternating voltage (at high current), vice versa, using the principles of electromagnetic induction
229. **Step-up Transformer:** device that changes an alternating voltage to a higher alternating voltage and hence lower alternating current. The number of coils in secondary coil must be higher than the primary coil.
230. **Step-down Transformer:** device that changes an alternating voltage to a lower alternating voltage and hence higher alternating current. The number of coils in secondary coil must be lower than the primary coil.
231. **Eddy Currents:** small localized current loops induced in a conductor, due to a varying magnetic field.
*Eddy currents result in heat loss
232. **Hysteresis:** the lag time needed for magnetic domains / atomic dipoles within a magnetic material to align with the external magnetic field
233. **Hysteresis Losses:** energy loss due to the constant reversal of magnetic domains / atomic dipoles within a magnetic material by an alternating magnetic field
*The use of soft magnetic materials with high magnetic permeability like iron helps to reduce hysteresis loss.
234. **Direct Current, d.c.:** current that flows only in one direction
235. **Rectification:** process of converting an a.c. source into a d.c. supply, often through the use of diode(s)
236. **Half-wave Rectification:** converts a.c. to d.c. by preventing the negative current from flowing

Chapter 18: Quantum Physics

237. **Photon:** discrete bundle of electromagnetic radiation with energy, E = hf
238. **Photoelectric effect:** phenomenon where electrons are emitted from a metal surface when electromagnetic radiation with frequency higher than the threshold frequency is incident on the surface
239. **Work Function of a material:** minimum amount of energy necessary to remove an electron (with zero KE) from the surface of the material.
240. **Threshold Frequency:** minimum frequency an electromagnetic radiation must have in order to cause photoelectric emission
241. **Threshold Wavelength:** maximum wavelength an electromagnetic radiation must have in order to cause photoelectric emission
242. **Stopping Potential:** minimum retarding potential to stop all the electrons from reaching the collector plate.
243. **Wave-Particle Duality:** exhibition of both wave-like and particle-like properties by a single entity
244. **De Broglie Wavelength:** the wavelength associated with a moving particle $\left(\lambda = \frac{h}{mv}\right)$
245. **Quantisation of charge:** charges exist only in discrete amounts
246. **Ground State:** all electrons in an atom are at their respective lowest energy levels OR
no electron has an unoccupied energy level beneath it
247. **Excited State:** one or more electrons have transited to a higher energy level OR
one or more electrons have a lower unoccupied energy level beneath it
248. **Excitation Energy:** energy absorbed by an electron to transit from a lower to higher energy level
249. **Ion:** atoms that have gained or lost electron(s).
250. **Ionised State:** one or more electrons have escaped the atom
251. **Ionisation Energy:** energy required to remove the outermost electron of an atom completely (ie. to infinity)
252. **Line Spectra:**
    (1) Emission line spectrum: discrete bright coloured lines on a dark background. The bright colours are due to the emission of electromagnetic radiation as the high energy atoms de-excite
    (2) Absorption line spectrum: dark lines against a continuous spectrum of the white light. The dark lines represent frequencies of white light that has been absorbed and then re-emitted in all directions
253. **Bremsstrahlung Radiation:** the broad spectrum of wavelength/frequency due to the sudden deceleration of electrons when they collide into a dense metal target
254. **Characteristic X-rays:** the sharp peaks that represent electromagnetic radiation when electrons transit from higher to lower energy levels in target atoms
255. **Cut-off Wavelength:** minimum wavelength corresponding to the most energetic single photon that can be produced when all the kinetic energy of the colliding electron is lost in a single collision with the metal atom
256. **Threshold Voltage:** minimum voltage needed to accelerate electrons for characteristic X-rays to be observed from target metal.
257. **Heisenberg's Uncertainty Principle:**
    (1) position and momentum of a body cannot be measured to a high degree of precision simultaneously $(\Delta x \Delta p \geq h)$
    (2) energy of a quantum state and its life time cannot be measured to a high degree of precision simultaneously $(\Delta E \Delta t \geq h)$

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258. **Alpha Particle:** comprises of 2 protons and 2 neutrons bound together ie. ${}_2^4He^{2+}$
259. **Beta Particle:** particle with mass 1/1836 that of a proton and has either a positive charge (positron, β^+) or negative charge (electron, β^-)
260. **Gamma Radiation:** electromagnetic radiation with the highest range of frequencies and energies, and are hence most penetrating
261. **Deductions from Rutherford Scattering (alpha-particle incident on thin gold foil):**
    (1) Most particles passed through undeflected or with a small deflection.
    Deduction: The atom consists of mostly empty space.
    (2) Small fraction (<1%) of α-particles are deflected through large angles
    Deduction: All the positive charges in the atom are concentrated as a nucleus in a small region of space as compared to the diameter of the atom.
    (3) Few particles are reflected backwards through an angle close to 180°
    Deduction: The nucleus is very massive compared to alpha particles which underwent a near head-on collision with the nucleus
262. **Nucleus:** small central core of an atom, consisting of protons and neutrons
263. **Mass number:** nucleon number (ie. total number of protons & neutrons in nucleus)
264. **Atomic number:** number of protons (which is also the number of electrons if atom is neutral)
265. **Isotopes:** atoms with the same number of protons but different number of neutrons.
*Isotopes have the same chemical but different physical and nuclear properties

266. **Unified atomic mass unit, u:** the mass that is equal to 1/12 the mass of a Carbon-12 atom, ${}^{12}_{6}C$
    *1 u = 1.66×10^{-27} kg
267. **Nuclide:** atomic species of class of nucleus with a particular proton and nucleon number
268. **Mass defect of a nucleus:** difference between total mass of its constituent nucleons and the actual mass of the nucleus.
269. **Binding Energy of a nucleus:** minimum energy required to completely separate a nucleus into its constituent nucleons.
270. **Binding Energy per Nucleon:** the average amount of energy per nucleon required to completely separate the constituent nucleons within a nucleus.
271. **Nuclear Fission:** break up of a heavy nucleus into 2 lighter nuclei with masses of similar orders of magnitude
272. **Nuclear Fusion:** the combination of 2 light nuclei to form a more massive nucleus
    *Both fission and fusion seek to achieve a more stable, lower energy final state ie. lower binding energy per nucleon which explains why both processes releases energy
273. **Conservation of mass-energy:** mass and energy are together conserved, but mass and energy is not individually conserved.
    *Conservation of nucleon number, charge and mass-energy holds true for any nuclear process
274. **Radioactive Decay:** spontaneous and random disintegration of an unstable nucleus into a more stable configuration, by emitting α, β and/or γ radiations
275. **Spontaneous Process:** not affected by external conditions (e.g. physical factors such as pressure, temperature, magnetic and electric fields)
276. **Activity:** average number of radioactive nuclei decaying per unit time
277. **Random Process:** It is impossible to predict when a nucleus will decay, with all nuclei having a constant and equal probability of decay in a given time.
278. **Background Radiation:** radiation emitted from a variety of surrounding sources eg. outer space, terrestrial, internal or man-made radiation.
279. **Count Rate:** number of nuclear decays per unit time OR
    rate at which nuclei decay
280. **Decay Constant, λ:** probability of decay per unit time.
281. **Half-life, $t_{½}$:** average time taken for the number of radioactive nuclei to be reduced to half of the original number.