H2 Physics Contents

Measurement	• SI base units: kg, m, s, A, K, mol. • A systematic error is one that occurs consistently more or consistently less than the actual reading. • A random error is one that gives a scatter of readings about a mean value. • $\Delta y = y_{max} - y_{average}$ • $y = 3A + 5B - 6C \Rightarrow \Delta y = 3\Delta A + 5\Delta B + 6\Delta C$ • $y = \frac{3A^m}{4B^n} \Rightarrow \frac{\Delta y}{y} = m\frac{\Delta A}{A} + n\frac{\Delta B}{B}$ • Error is 1 s.f. and reading follows the d.p. of error (e.g. (2.00+0.01) kg).
Kinematics	• Effects of air resistance on the vertical velocity:  When rising, deceleration > 9.81 When v=0, deceleration = 9.81 When falling, deceleration < 9.81
Dynamics	• Newton's First Law: A body will continue in its state of rest or uniform motion in a straight line until an external resultant force acts on it. • Newton's Second Law: The rate of change of momentum of a body is directly proportional to the resultant force acting on it. The change in momentum is in the same direction as the resultant force. • Newton's Third Law: If Body A exerts a force on Body B, Body B will exert a force of the same type, equal in magnitude and opposite in direction on Body A. • Force is defined as the rate of change of momentum of an object which is free to move. 1 N is a force that will give a mass of 1 kg an acceleration of 1 m s^2 in its direction. • For a stream of particle, $F = \frac{dP}{dt} = v\frac{dm}{dt}$ • For a moving body, $F = \frac{dP}{dt} = ma$ • Principle of conservation of linear momentum: If there is no external force acting on a system, the sum of linear momentum of all bodies in the system remains constant. • A collision is elastic if the total kinetic energy is conserved.
Forces	• The centre of gravity is the point at which the entire weight of a body appears to act through. • Principle of moments: For a body to be in rotational equilibrium,

<table>
<tr><td></td><td>sum of clockwise moment about any point is equal to sum of anti-clockwise moment about the same point.</td></tr>
<tr><td>Work, Energy and Power</td><td></td></tr>
<tr><td>Circular Motion</td><td>• $v = \omega r$
• $a = \omega^2 r = \frac{v^2}{r}$
• $\omega = \frac{2\pi}{T} = 2\pi f$</td></tr>
<tr><td>Gravitational Field</td><td>• A gravitational field is a region of space in which a mass experiences a force.
• $F = \frac{GMm}{r^2}$
• Gravitational field strength at a point is defined as the gravitation force per unit mass acting on a small mass placed at that point.
• $g = \frac{GM}{r^2} = \frac{F}{m}$
• Gravitational potential energy is defined as work done by external agents in bringing a mass from infinity to that point.
• $GPE = -\frac{GMm}{r}$ (External agents do negative work as gravitational force is attractive.)
• Gravitational potential is defined as work done per unit mass by external agents in bringing a small test mass from infinity to that point.
• $\phi = -\frac{GM}{r}$
• Geostationary orbit:
(i) Orbit period is same as Earth, 24 hours.
(ii) Orbital plane must coincide with the Earth's equatorial plane.
(iii) Satellite must rotate from the west to the east.</td></tr>
<tr><td>Thermophysics</td><td>• Absolute scale is independent of the thermal property of any substance.
• $pV = nRT = Nkt$
• T must be converted to Kelvin.
• First Law of Thermodynamics: $\Delta U = W + Q$
• Thermodynamic processes:
<table>
<tr><td>Isothermal</td><td>Constant temperature</td></tr>
<tr><td>Isobaric</td><td>Constant pressure</td></tr>
<tr><td>Isochoric/Isovolumetric</td><td>Constant volume</td></tr>
</table></td></tr>
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		Adiabatic	No heat exchange
		Cyclic	Same states
Oscillations	• Simple harmonic motion: The motion of an object is simple harmonic if the acceleration of the object is always proportional to its displacement from the equilibrium point and the direction of acceleration is towards the equilibrium point. • $x = Acos(\omega t)$ • $v = -\omega Asin(\omega t)$ • $a = -\omega^2 Acos(\omega t) = -\omega^2 x$ • At equilibrium point, v is maximum. $KE_{max} = \frac{1}{2}m\omega^2 A^2 = \frac{1}{2}kA^2$		
Waves	• $v = f\lambda$ • Stationary wave is a wave in which vibrational energy is stored. • Phase difference: $\frac{\Delta \phi}{2\pi} = \frac{\Delta x}{\lambda} = \frac{\Delta t}{T}$ • $I = \frac{P_{source}}{\text{Are}}$ • $I \propto A^2$ • Unpolarised: $I_{out} = \frac{1}{2}I_{in}$ • Polarised: $A = A_0 cos\theta;\ I = I_0 cos^2\theta$		
Superposition	• Principle of superposition: When two or more waves meet at a point, the resultant displacement at that point is the vector sum of the displacement due to each individual wave. • Conditions for interference fringes to be observed: (i) Waves must meet. (ii) Waves must be coherent. (iii) Waves must have the same amplitude. (iv) Waves must be unpolarized or polarized along the same axis. • Coherence: The phase difference between two waves remains constant and does not vary with time. • Young's Double Slit: $x = \frac{\lambda D}{A}$, x is the distance between two adjacent dark fringes. • Single/Multiple Slit: $sin\theta = \frac{n\lambda}{D}$, D is the width of the slit. • Rayleigh Criterion: Two images are just resolved when the first diffraction minimum of one image coincides with the central maximum of the other.		
Electric Field	• An electric field is a region of space where an electric force acts on a stationary charge placed inside.		

	• $F_E = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ • Electric field strength at a point is defined as the electric force per unit positive charge acting on a small stationary test charge placed at that point. • $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2} = \frac{F_E}{q}$ • Electric potential energy is defined as the work done by external agents in bringing a stationary charge from infinity to that point. • $EPE = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r}$ • Electric potential is defined as the work done by external agents per unit positive charge in bringing a small stationary test charge from infinity to that point. • $\mathrm{V} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{\mathrm{r}}$ • Electric potential energy is negative when the force is attractive; Electric potential is negative when the source is negative.
Current	• $I = \frac{Q}{t} = nAvq$ • Electromotive force is the energy per unit charge transferred from some other energy to electrical energy when charge is moved round a whole circuit.
DC Circuits	
Electromagnetism	• $F = BILsin\theta = Bqvsin\theta$ • Magnetic flux density (B) is defined as the magnetic force per unit length per unit current acting on a conductor perpendicular to the magnetic field. Its unit is T (Tesla).
Electromagnetic Induction	• $\Phi = BAcos\theta$ • Magnetic flux (Φ) is defined as the product of the area and the magnetic flux density that is perpendicular to it. Its unit is Wb (Weber). • Faraday's Law: The induced e.m.f. in a conductor is directly proportional to the rate of change of magnetic flux linkage or the rate of cutting of magnetic flux. • Lenz's Law: The direction of the induced current is such that it produces a magnetic field that opposes the change in magnetic flux linkage causing it. • $\varepsilon = -\frac{d(N\Phi)}{dt}$
AC Circuit	• The r.m.s. value for an AC current is the equivalent constant DC current that can dissipate the same average power. • For ideal transformers, P is constant.
Quantum Physics	• A photon is a quantum of energy associated with electromagnetic

	radiation. • Photoelectric effect is a phenomenon where electrons are emitted from the surface of certain types of metals when electromagnetic radiation is incident on the surface of these metals. • $E = hf$ • Work function energy (φ) is the minimum energy required to remove an electron from the surface of a metal involved in photoelectric emissions. • $\frac{1}{2}mv_{max}^2 = hf - \phi$ • $Intensity = \frac{NE}{tA},\ Current = \frac{N}{t}e$ • Three observations supporting particulate model: (i) Threshold frequency (ii) No time delay (iii) Max k.e. independent of intensity • Wave-particle duality: $P = \frac{h}{\lambda}$ • $\Delta P \Delta x \geq h$ • Emission Line Spectrum is a series of separate, differently coloured lines on a black background corresponding to the wavelengths of electromagnetic radiation emitted by atoms when excited electrons in the atoms return to their ground state. • Absorption Line Spectrum is the spectrum produced when light from a hot body passes through a cooler gas; it appears as a series of separate dark lines on a continuous spectrum.
Nuclear Physics	• Mass defect is the difference between the mass of a nucleus and all its constituents. • Nuclear binding energy is the energy needed to take apart all the constituent nucleons of a nucleus and separate them at an infinite distance apart from each other. • $BE = \Delta mc^2$ • Radioactive decay refers to the random and spontaneous transformation of an unstable nucleus to a lighter one in which radiation is released in the forms of α-particles, β-particles and neutrinos and/or γ-rays.