Physics Executive Summary

Formulas

Measurement

- Uncertainty (always to 1 or 2 s.f.):

  If $c = a \pm b, then\ \Delta c = \Delta a + \Delta b$ (absolute uncertainty)
  If $r = ka, then\ \Delta r = k\Delta a$ (scaling absolute error)
  If $p = \frac{4m}{\pi d^2 l}, then\ \frac{\Delta p}{p} = \frac{\Delta m}{m} + 2\left(\frac{\Delta d}{d}\right) + \frac{\Delta l}{l}$ (fractional uncertainty)
  If complex function, e.g. $Z = sinA$, then $\Delta Z = \frac{1}{2}(Z_{maximum} - Z_{minimum})$ (general approach)

Kinematics

- Constant acceleration:

$$v = u + at$$
$$v^2 = u^2 + 2as$$
$$s = \frac{u + v}{2}$$
$$s = ut + \frac{1}{2}at^2$$

- For 2-D kinematics:

$$v = \sqrt{v_x^2 + v_y^2}$$
$$\theta = \tan^{-1}\frac{V_y}{V_x}$$

Dynamics

- $F = pAv^2$, where p is density, when rate of change in mass is constant
- $p\ (momentum) = mv$
- $\Delta p = Impulse = F_{avg}\Delta t$
- $F = \frac{\Delta p}{\Delta t}$

- POCLM:

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

- For elastic collision, where KE is conserved:

$$u_1 - u_2 = v_2 - v_1$$

- For explosion:

$$E_k = \frac{p^2}{2m}, \text{ where } p \text{ is the momentum of the body}$$
$$KE\ or\ velocity \propto \frac{1}{mass}$$

Forces

- $F = kx$
- $EPE = \frac{1}{2}kx^2$
- $Effective\ spring\ constant, k_{eff} = k_A + k_B$ when springs connected in parallel, F applied is split between the 2 springs
- $k_{eff} = \left(\frac{1}{k_A} + \frac{1}{k_B}\right)^{-1}$, when springs connected in series, each spring experiences the same force F
- $GPE = mgh$ (if gravitational field strength constant)
- $KE = \frac{1}{2}mv^2$
- $Hydrostatic\ pressure = pgh$, where p is the density of the fluid medium
- $Upthrust = pVg = mg$ (if floating in equilibrium), where p is density of the medium

Work, Energy, Power

- $P = \frac{Energy}{time} = Fv$
- $WD = Fxcos\theta$
- $WD_{by\ gas} = p\Delta V$, where p is **constant** external pressure
- $Efficency = \frac{useful\ power\ or\ energy\ output}{total\ power\ or\ energy\ input}\ x\ 100\%$

Temperature and Ideal Gas, First Law of Thermodynamics

- $T(K) = T(°C) + 273.15$
- $PV = nRT = NkT$, where $R = 8.31JK^{-1}mol^{-1}$, $k = 1.38 \times 10^{-23}JK^{-1}$
- $P = \frac{Nm<c^2>}{3V}$[1], where m refers to mass of 1 gas particle
- $Mean\ KE_{1\ particle} = \frac{3}{2}kT$
- $Mean\ KE_{gas} = \frac{3}{2}NkT = \frac{3}{2}nRT$

  for monoatomic gas

  T must be in **kelvin
- $Pt = Q = mc\Delta\theta = mL_v = mL_f$
- $\Delta U = Q + W$, where Q is heat supplied to system, W is work done on system (i.e. $W = -p(V_f - V_i)$)
- $\Delta U = \frac{3}{2}P_fV_f - \frac{3}{2}P_iV_i$ for ideal gas (monoatomic)

[1] Need to know how to derive

Motion in a Circle

- Angular velocity, $\omega = \frac{2\pi}{T} = 2\pi f$
- $v = r\omega$
- $a_c = \frac{v^2}{r} = r\omega^2$
- For uniform circular motion, constant ω and r. FBD is important for analysis in both HCM and VCM. Note that friction is directed into centre of circular motion.

Gravitational Field

- $F_G = \frac{GMm}{r^2} = -\frac{d(GPE)}{dr}$, where $G = 6.67 \times 10^{-11} Nm^2kg^{-2}$
- $T^2 = \frac{4\pi^2}{GM_s} r^3$ (Kepler's Third Law- no need memorise)
- $\frac{GM_AM_B}{(r_A+r_B)^2} = m_B r_B \omega^2$ (Binary star)
- $g = \frac{F}{m} = \frac{GM}{r^2} = -\frac{d\phi}{dr}$, units of g can be either Nkg^{-1}or ms^{-2} choose carefully
- $GPE = -\frac{GMm}{r}$ (scalar, always negative)
- $\Delta GPE = F_{ext}\Delta x = m\Delta\phi = m(\phi_{final} - \phi_{initial})$ (can be positive)
- $\phi = \frac{GPE}{m} = -\frac{GM}{r}$ (scalar, always negative)
- $KE = +\frac{GMm}{2r}$
- $TE = GPE + KE = -\frac{GMm}{2r}$
- $v_{escape} = \sqrt{\frac{2GM}{r}}$ (Escape velocity, can be derived)

Do remember to set calculator to **radian mode** where appropriate for oscillations, wave motion and superposition.

Oscillations

- Generic SHM equations:

$$x = x_o sinwt$$
$$v = wx_o coswt = v_o coswt = \pm w\sqrt{x_o^2 - x^2}$$
$$a = -w^2 x_o sinwt = -w^2 x = -a_o sinwt$$

  **as long as position at t=0s change, all 3 equations will change. Possible variations are $\pm sin, \pm cos$. If relating to object in circular motion, x will be changed to radius of circular motion.

- $v_{maximum} = wx_o$
- $a_{maximum} = -w^2 x_o$
- $F_{restoring} = -mw^2 x$
- $w^2 = \frac{k}{m}, T = 2\pi\sqrt{\frac{m}{k}}, T = 2\pi\sqrt{\frac{L}{g}}$

- For horizontal (pendulum) oscillation involving PE and KE only:

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}mw^2(x_o^2 - x^2) = \frac{1}{2}mw^2 x_o^2 \cos^2 wt$$
$$PE = \frac{1}{2}kx^2 = \frac{1}{2}mw^2 x^2 = \frac{1}{2}mw^2 x_o^2 \sin^2 wt$$
$$TE = \frac{1}{2}mw^2 x_o^2$$

Wave Motion

- $v = f\lambda$ (wave speed will be constant if medium and type of wave does not change)
- $\Delta\phi = \frac{\Delta x}{\lambda}2\pi = \frac{\Delta t}{T}2\pi$ (Unit: radian)
- $Intensity, I = \frac{P}{Area} = \frac{Energy}{(time)(area)}$ (Unit Wm^{-2})
- $I \propto Ampltidude^2$
- Spherical waves: $I = \frac{P}{4\pi r^2} \propto \frac{1}{r^2}$
- Circular waves: $I = \frac{P}{2\pi rh} \propto \frac{1}{r}$
- Plane waves: $I = constant$
- $I = I_{maximum} \cos^2\theta \propto \cos^2\theta$

Superposition

- Speed of sound= $330 ms^{-1}$
- Speed of microwave: $3.0 \times 10^8 \ ms^{-1}$
- For stationary waves formed where 2 extreme ends are nodes (string experiment)/ antinodes (open pipe): $\lambda = \frac{2L}{n}$, where L is the length of the of pipe and n refers to the nth harmonic
- For stationary waves formed where 1 extreme end is a node and the other an antinode (closed pipe/ microwave experiment): $\lambda = \frac{4L}{2n-1}$
  Thereafter, can re-express to find frequency, since speed of wave is a constant value when medium doesn't change.

- Path difference $\Delta = |S_1P - S_2P|$ (Units: λ)

	Constructive interference (maxima)	Destructive interference (minima)
Coherent sources S1, S2 emit waves in phase	$\Delta = n\lambda$	$\Delta = (n + \frac{1}{2})\lambda$
Coherent sources S1, S2 emit waves in anti-phase	$\Delta = (n + \frac{1}{2})\lambda$	$\Delta = n\lambda$

where n= 0,1,2… representing nth order of maximum/ minimum

- Limit of resolution: $\theta \approx \frac{\lambda}{b}$, $d = L\theta$ (Remember to use RADIAN for θ!)

- Single slit diffraction:
  For a rectangular opening:
  $$tan\theta = \frac{y}{L}$$
  $$y = \frac{\lambda}{b}L$$
  $sin\theta = m\frac{\lambda}{b}$, where m=$\pm1, \pm2$ … (order) for positions of **minima**. Defining equation for single slit. Note that $tan\theta \approx sin\theta \approx \theta$.

  For a circular aperture:
  Angle of spread for first order minima, $\theta \approx \frac{\lambda}{b}$

- Double slit diffraction:
  Fringe separation, $x = \frac{\lambda D}{a}$

- Diffraction grating:
  $dsin\theta = n\lambda$, where n is the order (e.g.1,2,3,4…) for positions of **maxima**.

Current of Electricity

$$I = nAvq$$
$$Q = It$$
$$V = \frac{W}{Q}$$
$$P = VI = I^2R = \frac{V^2}{R}$$
$$R = \frac{V}{I}$$
$$R = \frac{\rho L}{A}$$
$$Efficiency = \frac{output\ power}{input\ power}$$

Electric Field

$F_E = \frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{r^2}$ (Unit: N, Vector)

, where $\varepsilon_0 = 8.85 \times 10^{-12} m^{-3} kg^{-1} s^{-4} A^{-2}$, and $\frac{1}{4\pi\varepsilon_0} = 8.99\ x 10^9$ only in vacuum/ air

$$E = \frac{F}{q}$$

$Electric\ Field\ Strength, E = \frac{F}{q} = \frac{1}{4\pi\varepsilon_0} \times \frac{Q}{r^2}$ (Unit; NC^{-1} or Vm^{-1}, Vector)

$$V = \frac{W}{q}$$

$Electric\ Potential, V = \frac{1}{4\pi\varepsilon_0} \times \frac{Q}{r}$ (Unit: V or JC^{-1}, Scalar)

Electric Potential Energy, U = $\frac{1}{4\pi\varepsilon_0} \times \frac{Qq}{r}$ (Unit: J, Scalar)

$$U = q(\Delta V)$$

$F = qE = \frac{qV}{d}$, hence $a = \frac{F}{m} = \frac{qV}{dm}$

Note: Must include signs of Q/q when calculating V and U. For F and E, can omit if you are only concerned with magnitude. That being said, should be keenly aware of the vector nature of F and E and know what you are doing.

DC Circuit

- Thermistor: T decrease → R increase
- LDR: LI decrease → R increase

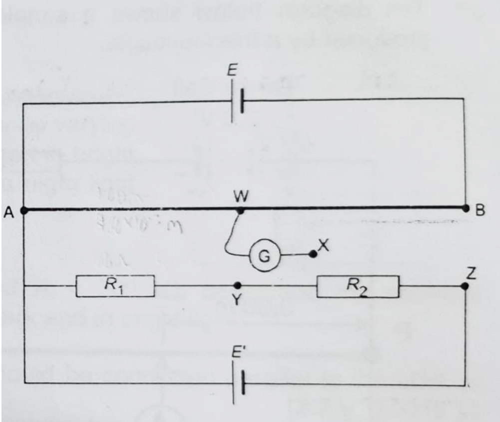
- Potential Divider Principle:

$$V_{AB} = \frac{R_1}{R_1 + R_2}\varepsilon_O$$

$$Then, V_{AB} = \frac{l_1}{l_1 + l_2}\varepsilon_O \ if \ R_1 and \ R_2 \ are \ components \ of \ a \ long \ straight \ conductor$$

Used to find emf of a cell in secondary circuit, internal resistance of cell in secondary circuit, and compare resistance of resistors.

- An example to illustrate how resistance of resistors can be compared:



$$Since, \frac{\left(\frac{R_1}{R_1 + R_2}E'\right)}{E'} = \frac{L_1}{L_2}$$

$$Then, \frac{R_2}{R_1} = \frac{L_2}{L_1} - 1, since \ p \ and \ A \ are \ constants$$

Electromagnetism

$$Long \ straight \ conductor: B = \frac{\mu_o I}{2\pi d}$$

$$Flat \ circular \ coil: B = \frac{\mu_o NI}{2r}$$

$Solenoid: B = \mu_o nI$, where $\mu_o = 4\pi \times 10^{-7} Hm^{-1}$, unit of B= T

$$F_B = BIlsin\theta$$
$$F_B = Bqvsin\theta$$

$$Forces \ between \ 2 \ current \ carrying \ conductors \ X \ and \ Y = \frac{\mu_o I_x I_y l}{2\pi d}$$

If $F_B \ perpendicular \ to \ v, F_B \ provides \ for \ F_c, \ r = \frac{mv}{qB} \ and \ T = \frac{2\pi m}{qB}$

Velocity Selector: $F_B = F_E \rightarrow qvB = qE$

Electromagnetic Induction

$$\Phi = BAcos\theta$$

$N\Phi = NBAcos\theta$, unit of Φ and $N\Phi$= Wb

- Induced emf caused by rate of change of magnetic flux (linkage):

$$E = -\frac{d(NBAcos\theta)}{dt}$$

- Induced emf caused by rate of cutting of magnetic flux
    1. Moving a current carrying conductor through a magnetic field would induce an emf

    $$E = Blv$$

    2. Rotating a disc in a magnetic field would induce an emf

    $$E = B\pi r^2 f$$

FLHR may be used to aid in explanation, but not FRHR.

Alternating Current

$$P = (I_{rms})^2 R$$

$$V_{rms} \text{ or } I_{rms} = \frac{V_o \text{ or } I_o}{\sqrt{2}}$$

$< P > = \frac{1}{2} P_O$, for full wave sinusoidal ac source

$$\frac{V_S}{V_P} = \frac{N_S}{N_P} = \frac{I_P}{I_S}$$

Quantum Mechanics

Energy of a photon, $\boldsymbol{E = hf}$, where $\boldsymbol{h = 6.63 \times 10^{-34}\ J\ s}$

$$\boldsymbol{1eV = 1.6 \times 10^{-19} J}$$

Considering, $v = c = f\lambda$, energy for photon = $\frac{hc}{\lambda}$

Total energy of monochromatic beam containing N photons= Nhf

Power of radiation= $\left(\frac{N}{t}\right)(hf)$

Intensity of radiation= $\frac{P}{A} = \left(\frac{N}{t}\right)\left(\frac{hf}{A}\right)$

$$\boldsymbol{hf = \phi + \frac{1}{2}mv^2_{maximum}} = \phi + eV_{stopping}$$

$$\boldsymbol{p = \frac{E}{c}} \rightarrow substitute\ E = hf \rightarrow \boldsymbol{\lambda = \frac{h}{p}}$$

$$\boldsymbol{hf = \Delta E = E_f - E_i}$$

$$\boldsymbol{\Delta p \Delta x \geq h}$$

Nuclear Physics

$$1u = 1.66 \times 10^{-27} kg$$

$$E = mc^2$$

Mass defect = sum of masses of nucleons – mass of nucleus

Binding energy per nucleon = $\frac{binding\ energy}{number\ of\ nucleons}$

Binding energy of reactants + energy released = Binding energy of products

$$A = -\frac{dN}{dt}$$

$$A = \lambda N$$

$$x = x_o e^{-\lambda t}, x = N, m, A\ or\ C$$

$$t_{\frac{1}{2}} = \frac{ln2}{\lambda}$$

N.B. Proton and neutrons have no binding energy

Definitions

Measurements

- SI Base Units
  Base quantities are physical quantities that cannot be defined in terms of other quantities.

- Vector Quantity
  Physical quantity that has a magnitude as well as a direction.

- Scalar Quantity
  Physical quantity that has a magnitude but does not have a direction.

- Systematic Errors
  Systematic errors are errors of measurements in which the measured quantities are displaced from the true value by fixed magnitude and in the same direction.

- Random Errors
  Random errors are errors of measurements in which the measured quantities differ randomly from the mean value with different magnitudes and directions.

- Accuracy
  Accuracy of a measurement is the closeness of a reading of an instrument to the true value of the quantity being measured. (when evaluating accuracy, take mean of data set)

- Precision
  Precision describes the level of uncertainty in an instrument's scale OR a measure of how close the results of an experiment agree with each other. (when evaluating precision, take range of data set)

Kinematics

- Distance/ speed/ displacement/ velocity/ acceleration (just remember "with respect to time")

Dynamics

- Newton's Laws
  [N1L] Newton's first law states that an object will remain in its state of rest or uniform motion in a straight line, unless a resultant force acts on it.
  [N2L] Newton's second law states that the rate of change of momentum of a body is directly proportional to the resultant fore acting on it, and acts in the same direction as the resultant force.
  [N3L] Newton's third law states that if object A exerts a force on object B, object B will exert an equal and opposite force on object A.

Forces

- Hooke's Law
  Hooke's law states that the restoring force is directly proportional to the extension/ compression in a material, if its limit of proportionality is not exceeded.

- Spring constant
  Spring constant is a measure of the stiffness of the material/ spring.

- Moments
  Moment is the turning effect of a force. Moment of a force is the product of a force and the perpendicular distance from the pivot to the line of action of the force.

- Principle of moments
  The principle of moments states that if a body is in rotational equilibrium, the sum of all clockwise moments about any axis must be equal to the sum of all anticlockwise moments about the same axis.

- Static equilibrium
  Translational equilibrium (resultant/ net force acting on body= 0N), Rotational equilibrium (net torque about any point= 0Nm)

- Impulse
  Impulse is the product of the average force acting on an object and the time interval that the force is being applied.

- Linear momentum
  Linear momentum of a body is defined as the product of its mass and velocity.

- Principle of conservation of linear momentum
  The principle of conservation of linear momentum states that the total momentum of a system is constant, when no external resultant force acts on it.

- Up-thrust
  Upthrust is the net upward force acting vertically on a body by the fluid medium, as a result of the body being immersed in the fluid.

- Archimedes' Principle
  Archimedes' Principle states that when an object is partially or fully submerged in a fluid, it experiences an upward force (upthrust) equal to the weight of fluid displaced.

- Principle of flotation
  Principle of flotation states that, for an object floating in equilibrium, upthrust is equal to the weight of the object.

Work, Energy, Power

- Principle of conservation of energy
  Principle of conservation of energy states that energy can neither be created nor destroyed in any process. It can be transformed from one form to another and transferred from one body to another. The total energy of an isolated system is constant.

- Work done
  Work done by a force is defined as the product of the force and the displacement in the direction of the force.

- ~~Conservative force~~
  ~~A conservative force is equal in magnitude to the potential energy gradient and acts in the direction of decreasing potential energy.~~

Temperature and Ideal Gas/ First Law of Thermodynamics

- Ideal gas
  A hypothetical gas that obeys the equation of state $PV = nRT$ at all temperatures, pressures and volume.

- Zeroth Law of Thermodynamics
  Zeroth Law of Thermodynamics states that if object A and B are separately in thermal equilibrium with object C, then object A and B are in thermal equilibrium with each other.

- First Law of Thermodynamics
  The increase in the internal energy of the system is the sum of heat supplied to the system and work done on the system.

- Heat capacity
  The heat capacity of a body is defined as the amount of thermal energy required to raise its temperature by one degree.

- Specific heat capacity
  The specific heat capacity of a body is defined as the amount of thermal energy required to raise the temperature of unit mass of substance by one degree.

- Specific latent heat
  Specific latent heat of a body is defined as the thermal energy required to change phase of unit mass of substance without a change in temperature.

- Internal energy
  Internal energy of a system is sum of a random distribution of microscopic kinetic (due to random motion) and potential (due to intermolecular forces of attraction) energy associated with the molecules of a system.

- One mole is defined as the amount of substance that contains as many elementary particles as there are in 0.012kg of carbon-12.
- Avogadro's constant is the number of atoms in 0.012kg of carbon-12.

Gravitational Field

- Gravitational force/ Newton's Law of Gravitation
  The force of attraction between any two-point masses is directly proportional to the product of their masses and inversely proportional to the square of their separation.

- Geostationary satellites
  Geostationary satellites are satellites that appear to be fixed over one spot above the equator. It orbits the Earth in exactly one day, lies in the plane containing the equator and moves from West to East.

- Gravitational field
  A region of space where a mass will experience a gravitational force acting on it.

  N2018/III/2a
  A field of force (or simply a force-field) is a region of space that can be mapped with lines of force or with lines of potential. Within the gravitational field, gravitational forces act at a distance on objects with non-zero mass (2m).

- Gravitational field strength
  Gravitational field strength at a point is defined as the gravitational force per unit mass acting on a small mass placed at that point.

- Gravitational potential energy
  The gravitational potential energy U_G of a mass at a point is defined as the work done by an external agent in bringing the mass from infinity to that point without any change in KE (velocity remains constant).

- Gravitational potential
  The gravitational potential at a point is defined as the work done per unit mass by an external agent in bringing the mass from infinity to that point without any change in KE (velocity remains constant).

- Escape velocity
  The escape velocity of earth is the minimum velocity a body must have at the Earth's surface in order to escape from the influence of Earth's gravitational field.

- Kepler's third law
  Kepler's third law states that the square of the orbital period of a planet is directly proportional to the cube of its average distance from the sun.

- A binary star is a system consisting of two stars orbiting around a common centre of mass (usually in empty space).

Oscillations

- Displacement is the distance moved by a particle in a wave in a specified direction from its equilibrium position.
- Amplitude is the magnitude of the maximum displacement of an oscillating particle from its equilibrium position
- Period of a wave is the timed elapsed between successive occasions when a particle is moving through the same point in the same direction.
- The period *T* of an object in circular motion is the time taken for the object to make one complete revolution.
- Frequency is the number of oscillations per unit time.
- Angular displacement (in radian) : the angle through which an object turns; $\theta = \frac{s}{r}$, where *s*: arc length ; *r*: radius of the circle
- Radian: angle subtended at the centre of a circle by an arc of length equals to the radius of the circle.
- Angular frequency is given by w = 2(pi)f, where f is the frequency[2]. VS
- Angular velocity is defined as the rate of change of angular displacement with respect to time.
- Wavelength is the shortest distance between two points on a progressive wave which are vibrating in phase.
- Wavefront are the locus of points having the same phase.
- A phase is an angle which gives a measure of the fraction of a cycle that has been completed by an oscillating particle/ wave.
- Phase difference is a measure of how much one wave is out of step with another.
- One radian is that angle subtended at the centre of a circle by an arc equal in length to the radius.

- Simple harmonic motion
  Simple harmonic motion is defined as the oscillatory motion of a body whose acceleration is directly proportional to its displacement from a fixed point (equilibrium position) and is always directed toward that fixed point.

- A freely oscillating system oscillates at its own natural frequency without external influences, other than the initial impulse when displaced from its equilibrium position with no dissipation of energy.

- Natural frequency of vibration is the frequency at which an object will vibrate when it is allowed to do so freely.

- Damped oscillations are oscillations in which the amplitude diminishes with time as a result of dissipative forces that reduce the total energy of the oscillation.
- A system is in forced oscillations when it is forced to oscillate at a frequency other that its natural frequency by a periodic external force.

[2] In context of SHM, angular frequency: It is a measurement related to the frequency of a sinusoidal motion. For a sinusoidal motion of frequency *f* the angular frequency ω is given by $\omega = 2\pi f$.

- Forced frequency of vibration is the frequency at which a body is made to vibrate by applying a periodic force on it.

- Resonance
  A phenomenon that occurs when the frequency at which an object is being made to vibrate is equal to its natural frequency of vibration.

Wave Motion

- Progressive Waves
  Progressive waves are waves in which energy is carried from one point to another by means of vibrations/ oscillations within the wave. Particles are not transported along the wave.

- Transverse Waves
  Transverse waves are waves in which the plane of oscillation of particles is normal to the direction of transfer of wave energy of the wave.

- Longitudinal Waves
  Longitudinal waves are waves in which the plane of oscillation of particles are along the direction of transfer of wave energy of the wave.

- Intensity
  Intensity of wave is the wave energy incident per unit time per unit area normal to the wave.

- Polarisation
  Polarisation is when oscillations in a wave are confined to one plane only. The plane being at right angle to the direction of propagation of the wave.

- Malus's Law
  Malus's Law states that the intensity I of a beam of plane polarised light after passing through a rotatable polariser is directly proportional to the square of the cosine of the angle θ through which the polariser is rotated from the position that gives the maximum intensity.

Superposition

- Principle of superposition
  When two or more waves of the same type meet at a point in space, the resultant displacement of the waves at any point is the vector sum of **displacement** due to each wave acting independently at that point.

- Stationary waves
  Stationary waves are waves whose waveform does not advance and there is no translation of energy. The amplitude of the waves varies according to the position from zero at the nodes to maximum at the antinodes.

- Coherence
  Sources of waves are coherent if they have a constant phase difference with respect to time.

- Interference
  Superposing/ overlapping of two or more waves to produce regions of maxima and minima in space, according to the principle of superposition.

- Path difference
  The extra distance that one wave travels compared to another wave.

- Constructive interference
  The interference that occurs when two or more waves meet at a point such that the resultant displacement is **greater** than the largest individual displacement.

- Destructive interference
  The interference that occurs when two or more waves meet at a point such that the resultant displacement is **less** than the largest individual displacement.

- Diffraction
  Diffraction is the bending or spreading out of waves when they travel through a small opening or when they pass around a small obstacle.

- The Rayleigh criterion for the limit of resolution states that two images are just resolvable when the centre of the diffraction pattern of one is directly over the first minimum of the diffraction pattern of the other. This means that the two images will be distinguishable as 2 separate objects. When this happens the angular separation between the two patterns is equal to the angle between the central maximum and the first minimum of one of the two patterns. (Modified August 2021)

- Fringe separation is the distance between adjacent bright fringes.

Current of Electricity

- The electric current I passing through a particular cross-sectional area A is defined as the rate of flow of charge Q through that cross-sectional area.

- Resistance R is defined as the ratio of the potential difference across the conductor to the current flowing through it.

- The potential difference V between two points of a circuit is defined as the amount of electrical energy converted to other forms of energy per unit charge moved between these two points.

- The electromotive force of a source is defined as the amount of energy transferred from non-electrical forms of energy to electrical energy per unit charge as the charge passes through a complete circuit.

- The direction of conventional current is defined as the direction in which positive charges would move (even if there are no mobile positive charges).

- The number density n is defined as the number of particles per unit volume.

- The drift velocity v is the average velocity at which charge carriers move through a conductor when there is electric current in the conductor.

- One coulomb is the amount of charge that flows through a given cross section of a circuit in one second when there is constant current of one ampere.

- The volt is defined as the potential difference between two points of a conducing wire when one coulomb of charge loses one joule of energy between those points.

- Ohm's law states that the current flowing in a conductor is directly proportional to the potential difference across it under constant physical conditions (i.e. temperature, incident light intensity).

- One ohm is defined as the resistance of a material in which one volt of potential difference across it is required for one ampere of current to flow in it.

- Resistivity is the proportionality constant between the dimensions of a specimen of a material and its resistance (that is constant at constant temperature) such that $R = \frac{\rho L}{A}$.

Electric Field

- Coulomb's Law
  The magnitude of the electric force between two-point charges is directly proportional to the product of the charges and inversely proportional to the square of their separation.

- Electric Field
  A region of space in which a (stationary) electric charge experiences an electric force

- Electric Field Strength
  The electric field strength at a point is defined as the electric force per unit **positive** charge placed at that point.

- Electric Potential
  The electric potential V at a point in an electric field is defined as the work done (against the electric force) per unit **positive** charge by an **external** agent in bringing a **small** test charge from infinity to that point, without any change in net KE of the point charge.

- Electric Potential Energy
  The electric potential energy U of a point charge in an electric field is defined as the work done (against the electric force) by an **external** agent in bringing a charge from infinity to that point, without any change in net KE of the point charge.

DC Circuit

NIL

Electromagnetism

- Magnetic field
  A magnetic field is a region of space where a magnetic pole moving charged particle or current carrying wire will experience a magnetic force.

- Magnetic flux density
  Magnetic flux density B is defined as the force per unit current per unit length acting on an infinitely long current carrying conductor placed perpendicular to the magnetic field.

- Tesla
  The tesla is defined as the magnetic flux density require for a long straight conductor carrying 1A of current in a uniform magnetic field perpendicular to the wire to experience 1N of force per meter.

Electromagnetic Induction

- Magnetic flux
  Magnetic flux is the product of an area and the component of the magnetic flux density perpendicular to the area.

- Magnetic flux linkage
  Magnetic flux linkage is defined as the product of the number of turns, N, of a coil and the magnetic flux passing through the coil. Magnetic flux is the product of the magnetic flux density and the area normal to the field through which the field is passing (2m).

- Weber
  1 Weber is the magnitude of the magnetic flux through an area of $1m^2$ when a magnetic field of 1T acts perpendicularly into the area.

- Faraday's Law
  Faraday's Law of magnetic induction states that emf induced in a conductor is directly proportional to the rate of change of magnetic flux linkage/ rate of cutting of magnetic flux.

- Lenz's Law
  Lenz's Law states that the direction of induced emf is such that it may produce an effect that opposes the change producing it.

Alternating Current

- Alternating Current
  An alternating current source creates an electrical current that varies in magnitude and direction with time, as opposed to direct current source where the direction of current stays constant.

- Root-mean-square value
  The root-mean-square value of an alternating current/ voltage is the value of steady direct current/ voltage that would produce the same average power in a given resistor.

- Rectification
  Rectification is the process of converting an alternating current or voltage source into direct current or voltage supply.

Quantum Mechanics

- Photon
  A photon is defined as a quantum of electromagnetic energy, associated with electromagnetic radiation. Its energy, E is given by hf, where h is the planck constant and f is the frequency of electromagnetic radiation. (2m)

- Photoelectric effect
  The photoelectric effect refers to the emission of electrons from a metal surface when the surface is irradiated with electromagnetic radiation of a high enough frequency.

- Stopping potential
  Stopping potential is the value of potential difference between A and B, where the detected photocurrent just becomes 0.

  Threshold frequency
- Threshold frequency is the lowest frequency that will eject electrons from a particular surface.

  Work function
- Work function ϕ is defined as the minimum energy required to eject an electron from the surface of a metal.

- Emission line spectrum
  Emission line spectrum is a series of distinct coloured lines against a dark background.

- Absorption line spectrum
  Absorption line spectrum is a series of distinct dark lines against a continuous spectrum.

Nuclear Physics

- Nuclide
  A nuclide is defined as a particular species of nucleus that is specified by its proton number and neutron number.

- Isotope
  Isotopes of an element have the **same** number of protons and electrons, but they have **different** number of neutrons.

- Unified atomic mass unit
  The unified atomic mass unit is equivalent to **one-twelfth** of the mass of a carbon-12 atom.

- Mass defect
  Mass defect is the amount by which the mass of an atomic nucleus is **less** than the sum of masses of its constituent particles.

- Binding energy of a nucleus
  Binding energy of a nucleus is the amount to energy that is required to **break** a nucleus into its constituent nucleons (i.e. protons and neutrons).

- Binding energy per nucleon
  Binding energy per nucleon is defined as the binding energy of a nucleus divided by the number of nucleons in the nucleus.

- Radioactive decay
  Radioactive decay occurs when an unstable nucleus emits an alpha or beta particle or gamma ray. In the process, the nucleus is transformed into a different and more stable nuclide. This decay is spontaneous and random.

- Count rate
  Count rate is a measure of the rate of radiation received by a radioactivity detector, assuming that every ionizing radiation ($\alpha, \beta \ or \ \gamma$) triggers one count on the ratemeter.

- Background radiation
  Background radiation is the radiation detected by a radiation counter when no radioactive source is nearby.

- (/)Activity A of a radioactive isotope
  Activity A of a radioactive isotope is defined as the number of nuclear disintegrations per unit time.

- (/) The decay constant λ
  The decay constant λ, of a sample of radioactive nuclide is the probability that a nucleus will decay per unit time.

- Half-life of a radioactive isotope
  The half-life of a radioactive isotope is the **average** time taken for its activity to be halved.