Upper Sec Physics:

Year 3:

1. Physical Quantities and Units
2. Measurement Techniques
    a. Random errors
        i. Occur in all measurements, cannot be predicted. Take many readings and find average to reduce random errors.
    b. Systematic errors
        i. Constant, usually due to equipment used. (eg zero error) Cannot be reduced by averaging.
3. Waves
    a. Longitudinal waves
        i. Waves travel in direction parallel to direction of vibration of particles
    b. Transverse waves
        i. Waves travel in direction perpendicular to direction of vibration of particles
    c. Definitions
        i. Peak/Crest: The high point of a wave
        ii. Trough: The low point of the wave
        iii. Amplitude (a): The maximum displacement from the rest position
        iv. Wavelength (λ): The distance between any two identical points on successive waves
        v. Frequency (f): The number of complete waves generated per second (measured in Hz, ie s^{-1})
        vi. Period (T): Time taken to generate 1 complete wave
        vii. Speed (v): Distance moved by a wave in one second
    d. Equations:
        i. $T = \frac{1}{F}$
        ii. $v = f\lambda = \frac{\lambda}{\mathrm{T}}$
    e. Refraction of waves:
    f. $\frac{\lambda 2}{\lambda 1} = \frac{\mathrm{v2}}{\mathrm{v1}} = \frac{\mathrm{n1}}{\mathrm{n2}}$
4. Electromagnetic Spectrum
    a. All travel at $3 * 10^8\ ms^{-1} = 300{,}000\ km/s$
5. Sound and CRO
    a. Travels by vibrations in particles
        i. Compressions are regions of highest pressure
        ii. Rarefactions are regions of lowest pressure

b. Humans hear 20 Hz to 20,000 Hz (audible range)

6. Lenses
    a. Definitions
        i. Principal axis: Line passing through optical centre and perpendicular to plane of the lens
        ii. Optical centre: Point midway between the lens surfaces on its principal axis
        iii. Principal focus (aka Focal point): Point on the principal axis where light rays parallel to principal axis converge
        iv. Focal length (f): Distance between optical centre and principal focus
        v. Focal plane: Vertical plane passing through principal focus
    b. $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$
        i. u: object distance
        ii. v: image distance (positive v denotes real image, negative v denotes virtual image)
        iii. f: focal length
    c. $\text{Magnification}=\frac{\text{image height}}{\text{object height}}=\frac{\text{image distance}}{\text{object distance}}$ (by similar triangles)
7. Kinematics
    a. Definitions (Vector units represent both magnitude and direction)
        i. Displacement (s): Distance moved in a particular direction
        ii. Velocity (initial: u, final: v): Rate of change of displacement
        iii. Acceleration (a): Rate of change of velocity
        iv. Time (t): Amount of time elapsed
    b. Gravitational acceleration (g): 9.81 ms^{-2} (occurs during 'freefall')
    c. 'SUVAT' equations
        i. $s=\frac{1}{2}(u+v)t$
        ii. $v=u+at$ OR $a=\frac{v-u}{t}$
        iii. $s=ut+\frac{1}{2}at^2$
        iv. $s=vt-\frac{1}{2}at^2$
        v. $v^2=u^2+2as$
8. Scalars and Vectors
    a. For separating vectors into 2 perpendicular components, (magnitude x)
        i. $xcos\theta$ for the component adjacent to angle θ
        ii. $xsin\theta$ for the component opposite to angle θ
9. Dynamics and Forces I and Gravitational Fields
    a. $F_{grav}=mg$
        i. F_{grav} is gravitational force, N
        ii. m is mass of object, kg

iii. g is gravitational field strength (ie 9.81), N kg^{-1}

b. $F_{net} = ma$

i. F_{net} is net force, N
ii. m is mass of object, kg
iii. a is acceleration, m s^{-2}

10. Dynamics and Forces II (Moments)

a. $T = Fd$

i. T is moment, N m
ii. F is the force, N
iii. d is the perpendicular distance from direction of force to pivot

b. Principle of moments

i. For a body in rotational equilibrium about any point,
ii. the sum of clockwise moments is equal to the sum of anticlockwise moments.

c. Centre of gravity (CG)

i. The point through which the whole weight of an object seems to act on.

11. Work, Energy and Power

a. Principle of conservation of energy

i. The total energy in an isolated system remains constant, although it can change its form and flow from one body to another.

b. $E_k = \frac{1}{2}mv^2$

i. E_k is kinetic energy, J
ii. m is mass of object, kg
iii. v is velocity, m s^{-1}

c. $E_p = mgh$

i. E_p is gravitational potential energy, J
ii. M is mass of object, kg
iii. g is gravitational field strength (ie 9.81), N kg^{-1}
iv. h is height, m (relative)

d. $W = Fs$

i. W is work done, J
ii. F is force, N
iii. s is displacement, m

e. $P = \frac{W}{t} = Fv$

i. P is power, W
ii. W is work done, J
iii. t is time, s
iv. F is force, N
v. v is velocity, m s^{-1}

12. Pressure

a. $p = \frac{F}{A}$
   i. Pressure (Pa) is Force (N) over Area (m^2)

b. $p = h\rho g$ (For liquid column)
   i. p is pressure due to liquid column, Pa
   ii. h is height of column (vertical), m
   iii. ρ is density of liquid, kg m^{-3}
   iv. g is gravitational field strength (ie 9.81), N kg^{-1}

c. $\frac{p_i V_i}{t_i} = \frac{p_f V_f}{t_f}$
   i. Initial pressure (Pa) multiplied by initial volume (m^3) over initial temperature (K) is equal to final pressure multiplied by final volume over final temperature

d. Barometer
   i. Atmospheric pressure (at sea level) will support a column of mercury 0.76m high
   ii. Standard atmospheric pressure = (0.76) (13.6 x 10^3) (9.81)
   = 1.01325 x 10^5 Pa

e. Manometer
   i. U-tube used to measure pressure difference
   ii. $p = p_0 + h\rho g$

f. Hydraulic press
   i. Since $p_1 = p_2$
      1. Pressure on both sides must be the same
   ii. Hence $\frac{F_1}{A_1} = \frac{F_2}{A_2}$
      1. The smaller the area, the smaller the force needed
   iii. Since $V_1 = V_2$
      1. Volume of hydraulic fluid moved remains the same on both sides
   iv. Hence $A_1 d_1 = A_2 d_2$
      1. The side with a smaller area will need to move more distance (press down more)

13. Kinetic Model of Matter

a. Proposes that:
   i. All matter is composed of a very large number of microscopic particles
   ii. Particles are in a state of continuous random motion
   iii. A higher temperature corresponds to greater average particle kinetic energies

b. Evidences:
   i. Brownian motion

ii. Diffusion

14. Temperature

a. Temperature is the measure of average kinetic energy of the molecules in an object.

b. Thermometer calibration
   i. Ice point: Freezing/melting point, $0^{o}C$
   ii. Steam point: Boiling/condensing point, $100^{o}C$
   iii. $\theta = \frac{x_\theta - x_0}{x_{100} - x_0} \times 100$
      1. Where θ is the temperature on Celsius scale

c. Kelvin Scale (AKA Absolute Zero Scale)
   1. 0 K = $-273.15^{o}C$

15. Thermal Properties of Matter

Measure	Definition	Equation	Units
Heat capacity	Amount of thermal energy require to raise the temperature of the body by 1 K or $1^{o}C$	$C = \frac{Q}{\Delta\theta}$	$J\ K^{-1}$ OR $J\ {}^{o}C^{-1}$
Specific heat capacity	Amount of thermal energy required to raise the temperature of a unit mass of the material by 1 K or $1^{o}C$	$c = \frac{Q}{m\Delta\theta}$	$J\ kg^{-1}\ K^{-1}$ OR $J\ kg^{-1}\ {}^{o}C^{-1}$
Latent heat of fusion	The energy needed to change a substance from solid to liquid without change in temperature		J
Specific latent heat of fusion	The amount of energy needed to change a unit mass of the substance from solid to liquid without a change in temperature	$l_f = Q/m$	$J\ kg^{-1}$
Latent heat of vaporization	The energy needed to change a substance from liquid to gas without a change in temperature		J
Specific latent heat of vaporization	The amount of energy needed to change a unit mass of the substance from liquid to gas without a change in temperature	$l_v = Q/m$	$J\ kg^{-1}$

Year 4:

16. Electric Fields
17. Current of Electricity
    a. Current
        i. Conventional current flow is the flow of positive charges, opposite to electron flow
        ii. $I = \frac{Q}{t}$ (1 Ampere of current is 1 Coulomb of charge flowing through in 1 second)
    b. Electromotive force (EMF) / Current
        i. $\varepsilon / V = \frac{W}{Q}$
        ii. $P = VI$
    c. Resistance/resistivity
        i. $V = RI$ OR $R = \frac{V}{I}$
        ii. Resistivity is measure of resistance of conductor (excluding circumstances)
            1. $R = \frac{\rho l}{A}$
            2. Resistance➔Ω
            3. Resistivity➔ Ω m
18. D.C. Circuits
    a. Series
        i. Current at every point in circuit is the same
        ii. EMF is equal to sum of PD
        iii. $R_{eff} = R_1 + R_2 + \cdots + R_n$
    b. Parallel
        i. Current from source is equal to sum of currents on branches
        ii. PD across each separate branch is the same
        iii. $\frac{1}{R_{eff}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$
19. Practical Electricity
    a. Equations
        i. $P = VI = \frac{E}{t}$
        ii. Therefore $E = Pt = VIt$
    b. Electricity is often measured in kW h, which is equal to 3.6 x 10^6 J
20. Magnetic Fields
21. Electromagnetism
22. Electromagnetic Induction
23. Alternating Current