Getting to know the Physics Formula and data book

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UNIT 3 TOPIC 1	**MOTION**	
Formula in booklet	**Description**	**Explanation of symbols**
Projectiles		
$v_y = u_y + gt$	Final vertical velocity	v_y = final velocity in the vertical (or y) direction u_y = starting velocity in the vertical (or y) direction g = acceleration due to gravity in metres per second squared ($m\,s^{-2}$). Near the surface of Earth g = – 9.8 $m\,s^{-2}$
$s_y = u_y t + \frac{1}{2} g t^2$	Final vertical displacement	s_y = displacement in the vertical (y) direction
$v_y^2 = 2gs_y + u_y^2$ or $v_y^2 = u_y^2 + 2gs_y$	Final vertical velocity	v_y = final velocity in the vertical (or y) direction u_y = starting velocity in the vertical (or y) direction
$v_x = u_x$	Final horizontal velocity is same as initial horizontal velocity	v_x = final velocity in the horizontal (or x) direction u_x = starting velocity in the horizontal (or x) direction
$s_x = u_x t$	Final horizontal displacement	s_x = displacement in the horizontal (x) direction (also called the 'horizontal range')
$u_y = u \sin\theta$	Not in formula book	u_y = vertical component of initial velocity
$u_x = u \cos\theta$	Not in formula book	u_x = horizontal component of initial velocity
Inclined planes		
$F_g = mg$	Gravitational force (also called *weight* F_W in Unit 2)	F_g = gravitational force (weight) in newtons (N) *m* = mass of object in gravitational field in kilograms (kg) *g* = gravitational field strength in newtons per kilogram ($N\,kg^{-1}$), or acceleration due to gravity in metres per second squared ($m\,s^{-2}$)
Circular motion		
$v = \frac{2\pi r}{T}$	Centripetal velocity	*v* = velocity of revolving object in metres per second ($m\,s^{-1}$) *r* = radius of orbit of revolving object in metres (m) *T* = period of revolution in seconds (s)
$a_c = \frac{v^2}{r}$	Centripetal acceleration	a_c = centripetal acceleration in metres per second squared ($m\,s^{-2}$) *v* = velocity of revolving object in metres per second ($m\,s^{-1}$) *r* = radius of orbit of revolving object in metres (m)

$F_{net} = \frac{mv^2}{r}$	Centripetal force	F_{net} = centripetal force in newtons (N), also F_c. m = mass of revolving object in kilograms (kg) *v* = velocity of revolving object in metres per second ($m\,s^{-1}$)
Orbits		
$F_g = \frac{GMm}{r^2}$	Newton's Universal law of gravitation	F_g = gravitational force between two objects in newton (N) *G* = Gravitational constant (see table) *M*, *m* = mass of objects in kilograms (kg) *r* = radial distance between objects in metres (m)
$g = \frac{F}{m} = \frac{GM}{r^2}$	Gravitational field strength as measured by force (F) acting on a mass (m) in the field, or by radial distance (r) from centre of mass of local astronomical body of mass (M)	*g* = gravitational field strength in newtons per kilogram ($N\,kg^{-1}$) or metres per second squared ($m\,s^{-2}$) *m* = mass of object in field in kilograms (kg) *M* = mass of local astronomical body s in kilograms (kg) *G* = Gravitational constant (see table) *r* = radial distance from centre of astronomical body in metres (m)
$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$	Law of periods. Kepler's ratio T^2 / r^3 is constant for all planets orbiting a central star of mass M. This formula is derived from Newton's laws of gravity and centripetal force.	*T* = period of revolution about a central star in seconds (s) *r* = radius of orbit in metres (m) *G* = Gravitational constant (see table) *M* = mass of central star in kilograms (kg)
UNIT 3 TOPIC 2	ELECTROMAGNETISM	
Electrostatics		
$F = \frac{1}{4\pi\varepsilon_o}\frac{Qq}{r^2}$	Coulomb's Law – gives the force between two charged objects whose centres are the distance *r* apart	*F* = force between charged particles $\frac{1}{4\pi\varepsilon_o}$ = Coulomb's constant *Q*, *q* = electric charge on particle in coulomb (C) *r* = radial distance between charges in metres (m)
$E = \frac{F}{Q} = \frac{1}{4\pi\varepsilon_o}\frac{q}{r^2}$	Electric field strength as measured by force acting on a charged object; or by radial distance from the centre of a charged object	*E* = electrical field strength in newtons per coulomb ($N\,C^{-1}$) *F* = force acting on a charged particle in an electric field *q* = electric charge on particle in coulombs (C) $\frac{1}{4\pi\varepsilon_o}$ = Coulomb's constant, *k* = $9\times10^9\,N\,m^2\,C^{-2}$. *r* = radial distance from a charge in metres (m)
$V = \frac{\Delta U}{q}$	Electric potential difference when work is	*V* = electric potential in volts (V)

	done on or by a charge q in an electric field	ΔU = change in electric potential energy (work done) in joules (J) q = electric charge on particle in coulombs (C)
$B = \frac{\mu_\circ}{2\pi} \times \frac{I}{r}$	Field about a wire (carrying a current I, at a point r metres measured radially from the wire)	B = magnetic field strength in tesla (T) $\mu_\circ$ = magnetic constant (see table of constants) I = current in the wire in ampere (A) r = radial distance to wire in metres (m) $\mu_\circ / 2\pi$ = electromagnetic constant $k = 2\times10^{-7}\,T\,m\,A^{-1}$
$B = \mu_\circ n I$	Field inside a solenoid	B = magnetic field strength in tesla (T) $\mu_\circ$ = magnetic constant
$F = BIL\sin\theta$	Force on a wire (use with Fleming's LH rule)	F = force on a charged particle in newton (N) B = magnetic field strength in tesla (T) I = current in the wire in ampere (A) L = length of wire in the magnetic field in metres (m) θ = angle between wire or direction of travel and the magnetic field direction in degrees ($^\circ$)
$F = qvB\,sin\,\theta$	Force on a charged particle	F = force on a charged particle in newton (N) q = electric charge on particle in coulomb (C) v = velocity of particle in metres per second ($m\,s^{-1}$) B = magnetic field strength in tesla (T) θ = angle between the direction of travel of the charged particle and the magnetic field direction in degrees ($^\circ$)
$\phi = BA\cos\theta$	Flux in a loop	ϕ = magnetic flux in weber
emf $= -\frac{n\Delta(BA_\perp)}{\Delta t}$	Faraday's Law of Induction (1st version)	emf = electromotive force n = number of turns (loops) of wire in a coil B = magnetic field strength $A_\perp$ = area of loop perpendicular to magnetic field Δt = time elapsed
emf $= -n\frac{\Delta\phi}{\Delta t}$	Faraday's Law of Induction (2nd version)	emf = electromotive force ϕ = magnetic flux in weber Δt = time elapsed
$I_p V_p = I_s V_s$	transformer – energy conservation relationship	I_p = current in primary coil I_s = current in secondary coil V_p = voltage across primary coil V_s = voltage across secondary coil
$\frac{V_p}{V_s} = \frac{n_p}{n_s}$	transformer formula (for ideal transformer)	n_p = number of turns on primary coil n_s = number of turns on secondary coil
UNIT 4 TOPIC 1	**SPECIAL RELATIVITY**	

$t = \frac{t_0}{\sqrt{1 - v^2 / c^2}}$	time dilation	t = relativistic or dilated time interval t_0 = proper time interval v = speed of frame of reference relative to observer c = speed of light in a vacuum
$L = L_o \sqrt{1 - v^2 / c^2}$	contraction of length	L = contracted or relativistic length (as measured by observer moving relative to object being measured L_0 = proper length (as measured by observer at rest to the object being measured)
$p_v = \frac{m_0 v}{\sqrt{1 - v^2 / c^2}}$	relativistic momentum	p_v = relativistic momentum as measured by person at rest with respect to object being observed
$\Delta E = mc^2$	mass–energy equivalence relationship	ΔE = energy in joules (J) for a given amount of mass m_0 = rest mass in kilograms (kg) converted to an equivalent amount of energy c = speed of light in a vacuum (see table of constants)

UNIT 4 TOPIC 2	QUANTUM PHYSICS	
$\lambda_{\max} = \frac{b}{T}$	Wien's displacement law	$\lambda_{\max}$ = wavelength at which maximum intensity occurs for blackbody radiation b = Wien's displacement constant (see QCAA Formula and Data book table of constants)
$E = hf = \frac{hc}{\lambda}$	black body radiation	E = energy of a photon in joules (J) h = Planck's constant f = frequency of emitted light (photon) c = speed of light in a vacuum λ = wavelength of light
$E_k = hf - W$	kinetic energy and work function	E_k = maximum kinetic energy of photo-ejected electrons in joules (J) f = frequency of incident light in hertz (Hz) W = work function of electron in joules (J)
$\lambda = \frac{h}{p}$	photon momentum	λ = wavelength of light h = Planck's constant p = momentum of photon
$n\lambda = 2\pi r$	Electron wavelength and radius of electron for the steady state in a hydrogen atom	n = atomic energy level λ = wavelength of electron in (Bohr) standing wave in metres (m) r = (Bohr) radius of electron orbit in metres (m) $2\pi r$ = circumference of electron orbit in metres (m)
$mvr = \frac{nh}{2\pi}$	Angular momentum (quantised angular momentum of electron in atom)	mvr = angular momentum of electron in atom (usually given symbol 'L') in $kg\, m^2 s^{-1}$ m = mass of electron in kilograms (kg) v = velocity of electron in atom in metres per second ($m\, s^{-1}$) n = atomic energy level h = Planck's constant
$\frac{1}{\lambda} = R_H \left(\frac{1}{n_f^{\ 2}} - \frac{1}{n_i^{\ 2}} \right)$	Rydberg's equation (for hydrogen spectrum)	λ = wavelength of light in metres (m) R_H = Rydberg's constant (see table of constants) n_f = final energy level n_i = initial energy level
$E_n = \frac{E_1}{n^2}$ (not in QCAA Formula and Data book)	Atomic energy level diagram (for hydrogen or other one-electron atom)	E_n = energy of electron in energy level n in joules (J) E_1 = energy of electron in energy level 1 in joules (J) n = atomic energy level
UNIT 4 TOPIC 2	**STANDARD MODEL**	
$B = \frac{1}{3}(n_q - n_{\bar{q}})$ (in NCPQ student book syllabus glossary but not in QCAA Formula and Data book	Baryon number	B = baryon number n_q = number of quarks $n_{\bar{q}}$ = number of antiquarks
$L = (n_l - n_{\bar{l}})$ (in NCPQ textbook and syllabus glossary but not in QCAA	Lepton number	L = lepton number n_l = number of leptons $n_{\bar{l}}$ = number of antileptons

Formula and Data book)		