Unit 3 AOS 2 Formula Sheet - Fields

Constants

Acceleration due to gravity at Earth's surface	$g = 9.81$ m s^{-2}
Universal Gravitational Constant	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}
Mass of Earth	$M_E = 5.97 \times 10^{24}$ kg
Radius of Earth	$R_E = 6.37 \times 10^{6}$ m
Coulomb Constant	$k = 8.99 \times 10^{9}$ N m^2 C^{-2}
Charge of Electron	$q_e = 1.60 \times 10^{-19}$ C
Mass of Electron	$m_e = 9.11 \times 10^{-31}$ kg

Gravitational force and fields

Gravitational Field Strength	$g = G\frac{M}{r^2}$	g = Gravitational field strength (N kg^{-1}) G = Universal gravitational constant (N m^2 kg^{-2}) M = Mass of body exerting gravitational force (kg) r = Distance from centre of mass of body (m)
Newton's law of Universal Gravitation	$F_g = G\frac{m_1 m_2}{r^2}$	F_g = Force due to gravity (N) G = Universal gravitational constant (N m^2 kg^{-2}) m_1 = Mass of first body (kg) m_2 = Mass of second body (kg) r = Distance between the two bodies' centres of mass (m)
Force due to gravity	$F_g = mg$	F_g = Force due to gravity (N) m = Mass of object (kg) g = Gravitational field strength (N kg^{-1})
Gravitational Potential Energy	$E_g = mg\Delta h$ Can also be calculated using the area under a force-distance or field strength-distance graph (the latter needing to also be multiplied by mass).	E_g = Gravitational Potential Energy (J) m = Mass of object (kg) g = Gravitational Field Strength (N kg^{-1}) Δh = Change in height (m)

Satellite Motion

Centripetal Acceleration	$a_c = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$	a_c = Centripetal acceleration (m s^{-2}) v = Orbital speed (m s^{-1}) r = Orbital radius (m) T = Orbital period (s)
Orbital Speed (second equation not on formula sheet)*	$v = \frac{2\pi r}{T} = \sqrt{\frac{GM}{r}}$	v = Orbital speed (m s^{-1}) r = Orbital radius (m) T = Orbital period (s) G = Universal gravitational constant (N m^2 kg^{-2}) M = Mass of body exerting gravitational force (kg)

Kepler's Third Law*	$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$	r = Orbital radius (m) T = Orbital period (s) G = Universal gravitational constant (N m^2 kg^{-2}) M = Mass of body exerting gravitational force (kg)
Kepler's Third Law (Proportionality)*	$\frac{{r_1}^3}{{T_1}^2} = \frac{{r_2}^3}{{T_2}^2}$	r = Orbital radius (m) T = Orbital period (s) *NOTE: This formula can only be used for satellites **orbiting the same body**!*

Electric Fields

Electric Field Strength between parallel charged plates	$E = \frac{V}{d}$	E = Electrical Field Strength (N C^{-1} or V m^{-1}) V = Potential Difference (V) d = Distance between plates (m)
Field of point charge	$E = \frac{kQ}{r^2}$	E = Electrical field strength (N C^{-1} or V m^{-1}) k = Coulomb constant (N m^2 C^{-2}) Q = Magnitude of charge exerting electric force (C) r = Distance from field centre (m)
Work done across a potential difference	$W = qV = qEd = \Delta E_k$	W = Work (J) q = Magnitude of charge (C) V = Potential Difference (V) E = Electrical field strength (N C^{-1} or V m^{-1}) d = Distance accelerated (m) ΔE_k = Change in Kinetic Energy (J)
Force on an electrical charge	$F = qE$	F = Force due to Electrical field (N) q = Magnitude of Charge (C) E = Electrical Field Strength (N C^{-1} or V m^{-1})
Coulomb's Law	$F = \frac{kq_1q_2}{r^2}$	F = Force due to Electrical fields (N) k = Coulomb constant (N m^2 C^{-2}) q_1 = Magnitude of first charge (C) q_2 = Magnitude of second charge (C) r = Distance between charges (m)
Magnitude of charge of electrons	$q = ne$	q = Magnitude of total charge (C) n = Number of electrons e = Charge of electron (C)

Magnetic Fields

Force on a moving charge	$F = qvB$ Note: this formula can only be used if $v \perp B$. If $v \parallel B$, then $F = 0$.	F = Force due to magnetic field (N) q = Magnitude of moving charge (C) v = Speed of moving charge (m s^{-1}) B = Magnetic field strength (T)
Magnetic force on a current carrying conductor	$F = nIlB$ Note: this formula can only be used if $I \perp B$. If $I \parallel B$, then $F = 0$.	F = Force due to magnetic field (N) n = Number of turns in conductor I = Current through conductor (A) l = Length of conductor <u>within magnetic field</u> (m) B = Strength of magnetic field (T)

Radius of a charged particle in a magnetic field	$r = \frac{mv}{qB}$	r = Radius of charged particle (m) m = Mass of charged particle (kg) v = Speed of charged particle (m s^{-1}) q = Magnitude of particle charge (C) B = Magnetic field strength (T)

**Indicates formulas not present on the VCAA formula sheet*

Unit conversions

p=pico=10^{-12}	n=nano=10^{-9}	μ=micro=10^{-6}	m=milli=10^{-3}
k=kilo=10^{3}	M=mega=10^{6}	G=giga=10^{9}	T=tera=10^{12}