The University of Edinburgh
School of Physics and Astronomy

Honours courses

Physical Data and Mathematical Formulae Sheet -

SI Base Units

length	metre	m
mass	kilogram	kg
time	second	s
electric current	ampère	A
thermodynamic temperature	kelvin	K
luminous intensity	candela	cd
amount of substance	mole	mol

SI Derived Units

frequency (cycles per second)	hertz	Hz
force	newton	N
energy	joule	J
power	watt	W
pressure	pascal	Pa
electric charge	coulomb	C
electric potential	volt	V
electric field	volt per metre	$\mathrm{V\,m^{-1}}$
magnetic flux	weber	Wb
magnetic field B	tesla	T
magnetising field H	ampère per metre	$\mathrm{A\,m^{-1}}$
capacitance	farad	F
inductance	henry	H
resistance	ohm	Ω

Prefixes

P	peta	$= 10^{15}$	k	kilo	$= 10^{3}$	p	pico	$= 10^{-12}$
T	tera	$= 10^{12}$	m	milli	$= 10^{-3}$	f	femto	$= 10^{-15}$
G	giga	$= 10^{9}$	μ	micro	$= 10^{-6}$	a	atto	$= 10^{-18}$
M	mega	$= 10^{6}$	n	nano	$= 10^{-9}$			

PLEASE DO NOT SCRIBBLE ON THIS LEAFLET OR REMOVE IT FROM THE EXAMINATION ROOM.

Other units in common use

1 micron	(μ)	$= 10^{-6}$m
1 angstrom	(Å)	$= 10^{-10}$m
1 fermi	(fm)	$= 10^{-15}$m
1 barn	(bn)	$= 10^{-28}$m^2
1 electron volt	(ev)	$= 1.60 \times 10^{-19}$J
1 gauss	(G)	$= 10^{-4}$T
1 unified atomic mass unit on ^{12}C scale	(u)	$= 1.66 \times 10^{-27}$kg $= 931.494\,\mathrm{MeV/c^2}$

Physical Constants

Speed of light in vacuum	c	3.00	$\times 10^{8}$	$\mathrm{m\,s^{-1}}$
Gravitational constant	G_N	6.67	$\times 10^{-11}$	$\mathrm{N\,m^2\,kg^{-2}}$
Planck's constant	h	6.63	$\times 10^{-34}$	J s
Planck's constant , reduced form	$\hbar = h/2\pi$	1.05	$\times 10^{-34}$	J s
Electronic charge	e	1.60	$\times 10^{-19}$	C
Electronic mass	m_e	9.109	$\times 10^{-31}$	kg
Proton mass	m_p	1.673	$\times 10^{-27}$	kg
Neutron mass	m_n	1.675	$\times 10^{-27}$	kg
Fine structure constant	$\alpha = e^2/4\pi\epsilon_0\hbar c$	7.30	$\times 10^{-3}$ or $(137.04)^{-1}$	
Rydberg constant	$R_\infty = \alpha^2 m_e c/4\pi\hbar$	1.10	$\times 10^{7}$	$\mathrm{m^{-1}}$
Bohr radius	$a_0 = 4\pi\epsilon_0\hbar^2/m_e e^2$	5.29	$\times 10^{-11}$	m
Bohr magneton	$\mu_B = e\hbar/2m_e$	9.27	$\times 10^{-24}$	$\mathrm{J\,T^{-1}}$
Nuclear magneton	$\mu_N = e\hbar/2m_p$	5.05	$\times 10^{-27}$	$\mathrm{J\,T^{-1}}$
Compton wavelength of electron	$\lambda_e = h/m_e c$	2.43	$\times 10^{-12}$	m
Thomson electron cross section	σ_T	6.65	$\times 10^{-29}$	$\mathrm{m^2}$
Acceleration due to gravity at sea level	g	9.81		$\mathrm{m\,s^{-2}}$
Standard atmospheric pressure		1.01	$\times 10^{5}$	$\mathrm{N\,m^{-2}}$
Molar volume of ideal gas at STP		2.24	$\times 10^{-2}$	$\mathrm{m^3\,mol^{-1}}$
Ideal gas constant	R	8.31		$\mathrm{J\,K^{-1}\,mol^{-1}}$
Avogadro's constant	N_A	6.02	$\times 10^{23}$	$\mathrm{mol^{-1}}$
Boltzmann's constant	$k = R/N_A$	1.38	$\times 10^{-23}$	$\mathrm{J\,K^{-1}}$
Stefan $-$ Boltzmann constant	σ	5.67	$\times 10^{-8}$	$\mathrm{W\,m^{-2}K^{-4}}$
Radiation energy density constant	a	7.566	$\times 10^{-16}$	$\mathrm{J\,m^{-3}K^{-4}}$
Faraday's constant	$F = eN_A$	9.65	$\times 10^{4}$	$\mathrm{C\,mol^{-1}}$
Vacuum permeability	μ_0	4π	$\times 10^{-7}$	$\mathrm{N\,A^{-2}}$
Vacuum permittivity	$\epsilon_0 = 1/\mu_0 c^2$	8.85	$\times 10^{-12}$	$\mathrm{F\,m^{-1}}$
Intrinsic impedance of vacuum	$Z_0 = \mu_0 c$	3.77	$\times 10^{2}$	Ω

General results

Base of natural logarithms :	e	$=$	2.718
	$\ln 10$	$=$	2.303
	1 radian	$=$	57.3°
	1 arcsec	$=$	4.84814×10^{-6} radians

Relations used in vector calculus

$$\underline{A} \times (\underline{B} \times \underline{C}) = (\underline{A} \cdot \underline{C})\underline{B} - (\underline{A} \cdot \underline{B})\underline{C}$$

If ψ and U are scalar fields and $\underline{F}$ is a vector field

$$\begin{aligned} \underline{\nabla} \cdot (\psi \underline{F}) &= \underline{F} \cdot \underline{\nabla}\psi + \psi \underline{\nabla} \cdot \underline{F} \\ \underline{\nabla} \times (\psi \underline{F}) &= \psi \underline{\nabla} \times \underline{F} + (\underline{\nabla}\psi) \times \underline{F} \\ \underline{\nabla} \times (\underline{\nabla} \times \underline{F}) &= \underline{\nabla}(\underline{\nabla} \cdot \underline{F}) - \nabla^2 \underline{F} \\ \int\int\int (U\nabla^2\psi - \psi\nabla^2 U) dV &= \int\int (U\underline{\nabla}\psi - \psi\underline{\nabla}U) \cdot \underline{dS} \end{aligned}$$

The Laplacian operator ∇^2 acting on a scalar field U

Cartesian coordinates (x, y, z):

$$\nabla^2 U = \frac{\partial^2 U}{\partial x^2} + \frac{\partial^2 U}{\partial y^2} + \frac{\partial^2 U}{\partial z^2}$$

Cylindrical coordinates (ρ, ψ, z):

$$\nabla^2 U = \frac{1}{\rho} \frac{\partial}{\partial \rho} \left(\rho \frac{\partial U}{\partial \rho} \right) + \frac{1}{\rho^2} \frac{\partial^2 U}{\partial \phi^2} + \frac{\partial^2 U}{\partial z^2}$$

Spherical polar coordinates (r, θ, ϕ):

$$\nabla^2 U = \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{\partial U}{\partial r} \right) + \frac{1}{r^2 \sin\theta} \frac{\partial}{\partial \theta} \left(\sin\theta \frac{\partial U}{\partial \theta} \right) + \frac{1}{r^2 \sin^2\theta} \frac{\partial^2 U}{\partial \phi^2}$$

Astrophysical constants

Earth mass	$M_\oplus$	5.984	$\times 10^{24}$	kg
Earth radius	$R_\oplus$	6.378	$\times 10^{6}$	m
Solar mass	$M_\odot$	1.989	$\times 10^{30}$	kg
Solar radius	$R_\odot$	6.960	$\times 10^{8}$	m
Solar luminosity	$L_\odot$	3.862	$\times 10^{26}$	W
Solar effective temperature	$T_{eff_\odot}$	5780		K
H recombination coefficient at 8000K	α_{rec}	3.0	$\times 10^{-19}$	$\mathrm{m^3\,s^{-1}}$
H photoionization cross section	σ_{pi}	6.0	$\times 10^{-22}$	$\mathrm{m^2}$
Astronomical unit	AU	1.496	$\times 10^{11}$	m
1 parsec	pc	3.262		light years
1 parsec	pc	3.086	$\times 10^{16}$	m
1 year		3.156	$\times 10^{7}$	s

Masses of fundamental particles (in MeV/c^2 unless stated)

Leptons		**Quarks**	(approx. GeV/c^2)	**Bosons** (GeV/c^2)	
e	0.511	u	0.003	$W^{\pm}$	80.39
μ	105.7	d	0.006	Z	91.19
τ	1777.0	s	0.1	Higgs	125.9
		c	1.3		
		b	4.3		
		t	173.3		

Mesons		**Baryons**	
$\pi^{\pm}$	139.6	p	938.3
π^0	135.0	n	939.6
$\mathrm{K}^{\pm}$	493.7	Λ	1116
K^0	497.7	Σ^+	1189
η	547.8	Σ^-	1197
ρ	775.8	Σ^0	1193
ω	782.6	Δ	1232
$\mathrm{K}^{*\pm}$	891.7	Ξ	1315
K^{*0}	896.1	Ξ^-	1321
η'	957.8	Σ^{*+}	1383
ϕ	1019	Σ^{*0}	1384
J/ψ	3097	Σ^{*-}	1387
$\Upsilon(1S)$	9460	Ξ^{*0}	1532
D^0	1865	Ξ^{*-}	1535
B^0	5279	Ω^-	1672

PLEASE DO NOT SCRIBBLE ON THIS LEAFLET OR REMOVE IT FROM THE EXAMINATION ROOM.