<u>S357 Data</u>
<u>Fundamental physical constants</u>

speed of light in a vacuum $c = 3.00 \times 10^8$ m s^{-1} [exact 299 792 458 m s^{-1}]
Planck's constant $h = 6.63 \times 10^{-34}$ J s
gravitational constant $G = 6.67 \times 10^{-11}$ m^3 kg^{-1} s^{-2}
electron mass $m_e = 0.911 \times 10^{-30}$ kg $= 0.511$ MeV/c^2
proton mass $m_p = 1.67 \times 10^{-27}$ kg $= 938$ MeV/c^2
neutron mass $m_n = m_p + 2.31 \times 10^{-30}$ kg $= m_p + 1.29$ MeV/c^2
proton electric charge $e = 1.60 \times 10^{-19}$ C
permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2}
Coulomb's law factor $1 / 4\pi\varepsilon_0 = 8.99 \times 10^9$ N m^2 C^{-2}
permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ kg m C^{-2}

<u>Useful astronomical data</u>

mass of Sun $M_\odot = 1.99 \times 10^{30}$ kg

radius of Sun $R_\odot = 6.96 \times 10^8$ m

surface gravity of Sun $g_\odot = 2.74 \times 10^2$ m s^{-2}

mass of Earth $M_\oplus = 5.98 \times 10^{24}$ kg

equatorial radius of Earth $R_\oplus = 6.38 \times 10^6$ m
surface gravity of Earth $g = 9.81$ m s^{-2}
period of rotation 1 sidereal day $= 8.62 \times 10^4$ s
orbital period of Earth around Sun 1 sidereal year $= 3.16 \times 10^7$ s
orbital velocity of Earth around Sun 29.8 km s^{-1}
distance of Earth to Moon 3.84×10^8 m
distance of Earth to Sun 1 AU $= 1.50 \times 10^{11}$ m
distance to nearest star ≈ 1.3 pc ≈ 4 ly
diameter of our Galaxy ≈ 30 kpc $\approx 10^5$ ly
distance to Andromeda galaxy ≈ 0.67 Mpc $\approx 2.2 \times 10^6$ ly
Hubble's constant $H_0 = h \times 100$ km s^{-1} Mpc^{-1}
$H_0 = h \times 3.24 \times 10^{-18}$ s^{-1}
(1996 best value) $h \approx 0.7$
critical density $\rho_0^c \approx 10^{-26}$ kg m^{-3}

<u>Conversion constants</u>

1 year (y) $= 3.16 \times 10^7$ s
1 astronomical unit (AU) $= 1.50 \times 10^{11}$ m
1 light-year (ly) $= 9.46 \times 10^{15}$ m
1 parsec $= 3.26$ ly $= 3.09 \times 10^{16}$ m
1 second of arc $= 4.85 \times 10^{-6}$ radians
1 electronvolt (eV) $= 1.60 \times 10^{-19}$ J

<u>Common geometrical relations</u>

Conversion between spherical polar and Cartesian coordinates
$x^1 = R\sin\theta\cos\phi, \ x^2 = R\sin\theta\sin\phi, \ x^1 = R\cos\theta$
Scalar and vector products of vectors **a** and **b** at mutual angle θ
$\mathbf{a} \cdot \mathbf{b} = a^1 b^1 + a^2 b^2 + a^3 b^3 = |\mathbf{a}||\mathbf{b}| \cos\theta$
$\mathbf{a} \times \mathbf{b} = (a^2 b^3 - a^3 b^2, \ a^3 b^1 - a^1 b^3, \ a^1 b^2 - a^2 b^1)$

S357 Important Concepts

3K radiation

absolute magnitude

absorption spectrum

angular distribution

angular power spectrum

apparent magnitude

baryonic density

baryons

big bang

Cepheid variable

cluster of galaxies

cosmic microwave background radiation

cosmic variance

cosmological redshift

cosmology

decoupling

dipolar anisotropy

Doppler broadening

Doppler shift

emission spectrum

evolution of galaxies

flux density

galactic dust

galaxy

Hubble parameter, H

Hubble's law

luminosity

mass fraction

nuclear synthesis

size of radio galaxies

spectrum

temperature of matter

temperature of radiation

thermal spectrum

thermalization

Type Ia supernova

Type II supernova