Israel Open Astronomy Olympiad 2025

Physical and mathematical constants

Speed of light in vacuum $c = 299\,792\,458$ m/s
Stefan-Boltzmann constant $\sigma = 5.67 \cdot 10^{-8}$ W/m²/K⁴
Gravitational constant $G = 6{,}67 \times 10^{-11} \frac{\mathrm{N \cdot m^2}}{\mathrm{kg^2}}$
Electron mass $m_e = 9.109 \cdot 10^{-31}$ kg
Proton mass $m_p = 1.673 \cdot 10^{-27}$ kg
Neutron mass $m_n = 1.675 \cdot 10^{-27}$ kg
Electron-volt (eV) is an energy unit, 1 eV $= 1.602 \cdot 10^{-19}$ J.
Usual prefixes are used with eV, so 1 keV = 1 000 eV, 1 MeV = 1 000 000 eV
Number of arcseconds in radian: 1 rad = 206265''

Astronomical constants

1 tropical year = 365.2422 days = 31.557 million seconds
1 solar day = 24^h = 86 400 seconds
1 sidereal day = $23^h\ 56^m\ 04^s$ = 86 164 seconds
1 astronomical unit (au) = 149,6 million km
1 parsec (pc) = $3.086 \cdot 10^{16}$ m = 206265 au = 3.262 ly (light years)
Hubble constant $H_0 = 70$ km/s/Mpc
Obliquity of the ecliptic to the equator $\varepsilon = 23.5°$
Inclination of the lunar orbit to ecliptic $\varepsilon_{Moon} = 5.145°$

Solar constants

Mass $\mathcal{M}_\odot = 1{,}989 \times 10^{30}$ kg
Radius $R_\odot = 696$ thousand km
Photosphere temperature $T_\odot = 5778$ K
Luminosity $L_\odot = 3.826 \cdot 10^{26}$ W
Absolute magnitude $M_\odot = +4.73^m$
Apparent bolometric magnitude $m_{b,\odot} = -26.83^m$
Apparent angular diameter, as seen from Earth = 32'

Object	Radius, km	Mass, 10^{24} kg	Semi-major axis, au
Sun	695 500	1 989 000	---
Mercury	2 440	0.330	0.387
Venus	6 052	4.867	0.723
Earth	6 378	5.972	1.000
Mars	3 390	0.642	1.524
Jupiter	69 911	1 898.0	5.203
Saturn	58 232	568.3	9.537
Uranus	25 362	86.81	19.189
Neptune	24 622	102.4	30.070

Formula page

Upper culmination height $h = \delta - \varphi + 90°$; if more than 90°, use $h = -\delta + \varphi + 90°$

Synodic period S and sidereal (orbital) period P, as seen from a planet with orbital period E, are related by $\frac{1}{E} = \frac{1}{P} + \frac{1}{S}$ for outer planets and $\frac{1}{E} = \frac{1}{P} - \frac{1}{S}$ for inner planets.

Third Kepler's law: $\frac{\mathcal{M}T^2}{a^3} = \frac{4\pi}{G}$; for two bodies orbiting the same central object: $\frac{T^2}{a^3} = const$

Pogson formula $\frac{I_1}{I_2} = 10^{0.4(m_2 - m_1)}$ or $m_2 - m_1 = 2.5 \lg(I_1/I_2)$

Absolute magnitude $M = m + 5 \log d\ [\mathrm{pc}] - 5$

Inverse square law $I = L/4\pi d^2$

Annual parallax $p['] = 1/d\ [\mathrm{pc}]$

Stefan-Boltzmann law $\frac{L}{L_\odot} = \left(\frac{R}{R_\odot}\right)^2 \left(\frac{T}{T_\odot}\right)^4$

Hubble-Lemaître law $v = H_0 r$, while $v \ll c$

The scale factor of the Universe is $a = \frac{1}{z+1}$

Area of ellipse is πab

Distance from ellipse center to its focus is ae

Eccentricity is $e = \sqrt{1 - b^2/a^2}$

Spherical sine theorem $\frac{\sin a}{\sin A} = \frac{\sin b}{\sin B} = \frac{\sin c}{\sin C}$

Spherical cosine theorem $\cos a = \cos b \cdot \cos c + \sin b \cdot \sin c \cdot \cos A$