

Important Constants

Constant	Symbol	Value
Speed of light	c	$3.00 \times 10^8 \text{ m s}^{-1}$
Earth's rotation period	1 day	24 hours
Earth's orbital period	1 year	365.25 days
parsec	pc	$3.09 \times 10^{16} \text{ m}$
Astronomical Unit	au	$1.50 \times 10^{11} \text{ m}$
Radius of the Sun	R_{\odot}	$6.96 \times 10^8 \text{ m}$
Radius of the Earth	R_{\oplus}	$6.37 \times 10^6 \text{ m}$
Mass of the Sun	M_{\odot}	$1.99 \times 10^{30} \text{ kg}$
Mass of the Earth	M_{\oplus}	$5.97 \times 10^{24} \text{ kg}$
Luminosity of the Sun	L_{\odot}	$3.83 \times 10^{26} \text{ W}$
Absolute magnitude of the Sun	\mathcal{M}_{\odot}	4.74
Hubble constant	H_0	$70 \text{ km s}^{-1} \text{ Mpc}^{-1}$
Stephan-Boltzmann constant	σ	$5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Gravitational constant	G	$6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$
Boltzmann constant	k_B	$1.38 \times 10^{-23} \text{ J K}^{-1}$
Permittivity of free space	ϵ_0	$8.85 \times 10^{-12} \text{ F m}^{-1}$
Permeability of free space	μ_0	$4\pi \times 10^{-7} \text{ H m}^{-1}$
Planck's constant	h	$6.63 \times 10^{-34} \text{ J s}$
Elementary charge	e	$1.60 \times 10^{-19} \text{ C}$
Proton rest mass	m_p	$1.67 \times 10^{-27} \text{ kg}$
Electron rest mass	m_e	$9.11 \times 10^{-31} \text{ kg}$
Wien's displacement law	$\lambda_{\text{max}}T$	$2.90 \times 10^{-3} \text{ m K}$
Avagadro's constant	N_A	$6.02 \times 10^{23} \text{ mol}^{-1}$

Basic calculus formulae:

Chain rule $\frac{d}{dx} f(g(x)) = f'(g(x))g'(x)$

Product rule $\frac{d}{dx}(uv) = \frac{du}{dx}v + u\frac{dv}{dx}$

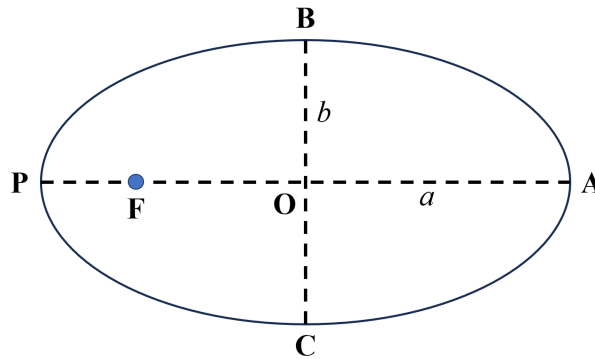
Quotient rule $\frac{d}{dx} \left(\frac{u}{v} \right) = \frac{\frac{du}{dx}v - u\frac{dv}{dx}}{v^2}$

Integration by parts $\int u \frac{dv}{dx} dx = uv - \int v \frac{du}{dx} dx$

Standard integral $\int \frac{1}{x} dx = \ln|x| + C$

Important Formulae

You might find the diagram of an elliptical orbit below useful in solving some of the questions:



Elements of an elliptic orbit:

- $a = \text{OA} (= \text{OP})$ semi-major axis
- $b = \text{OB} (= \text{OC})$ semi-minor axis
- $e = \sqrt{1 - \frac{b^2}{a^2}}$ eccentricity
- F** focus
- $\text{PF} = a(1 - e)$ periapsis distance (shortest distance from **F**)
- $\text{AF} = a(1 + e)$ apoapsis distance (longest distance from **F**)

Kepler's Third Law:

$$T^2 = \frac{4\pi^2}{GM} a^3$$

Vis-Viva Equation:

$$v^2 = GM \left(\frac{2}{r} - \frac{1}{a} \right)$$

Wien's Displacement Law:

$$\lambda_{\text{max}} T = \text{constant}$$

Stephan-Boltzmann Law:

$$L = 4\pi R^2 \sigma T^4$$

Brightness (Intensity):

$$b = \frac{L}{4\pi d^2}$$

Magnitudes:

$$\frac{b_1}{b_0} = 10^{-0.4(m_1 - m_0)}$$

$$m - \mathcal{M} = 5 \log \left(\frac{d}{10} \right)$$

Distance-Parallax Relation:

$$d = \frac{1}{p}$$

Rayleigh Criterion:

$$\theta = \frac{1.22\lambda}{D}$$

Redshift:

$$z = \frac{\Delta\lambda}{\lambda_{\text{emit}}} \approx \frac{v}{c}$$

Hubble's Law:

$$v = H_0 d$$

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