LIST OF ASTRONOMY MATH EQUATIONS WITH WORKINGS

In mathematics, an equation is a statement of an equality containing one or more variables. Solving the equation consists of determining which values of the variables make the equality true.

Geometry & Trigonometry

Title	Equation	Description	Further Reading
Circle, circumference of	$C = 2\pi r$	Calculating the circumference of a circle.	How Large is the Earth?
Sphere, Surface Area of	$\text{Area} = 4\pi r^2$	The surface area of a sphere of radius r.	Luminosity and Flux of Stars

Size & Distance

Title	Equation	Description	Further Reading
Distance Calculation using Parallax	$d = \frac{1}{p}$	The distance to an object in parsecs is equal to 1 AU over the parallax in arc seconds.	The Astronomical Magnitude Scale

Title	Equation	Description	Further Reading
Angular Size Calculation	$\theta = \frac{S_{ap}}{l}$	Calculate the angular size of an object based on its apparent size and distance between measure and observer, where theta is the angular size in radians, Sap is the apparent size in mm and l is the distance between the measure and the observer.	What is Angular Size?

Magnitude

Title	Equation	Description	Further Reading
Pogsons Relation	$m - n = -2.5 \times \log \frac{F_m}{F_n}$	Pogson's Relation is used to find the magnitude difference between two objects expressed in terms of the logarithm of the flux ratio	The Astronomical Magnitude Scale
Absolute Magnitude Relation	$M - N = -2.5 \times \log \frac{L_M}{L_N}$	Very similar to Pogsons Relation for apparent magnitudes, this equation shows the relation for absolute magnitudes.	The Astronomical Magnitude Scale

Title	Equation	Description	Further Reading
Distance Modulus	$m - M = 5\log d - 5$	Distance modulus can be used to find a relationship between a stars absolute magnitude and its apparent magnitude given a distance, d, in parsecs.	Parallax, Distance and Parsecs
Absolute Magnitude	$M = m - 5\left(\left(\log_{10} D\right) - 1\right)$	Calculating the Absolute Magnitude of a star within our galaxy.	The Astronomical Magnitude Scale
Bolometric Magnitude	$M_{bol_{*}} - M_{bol_{\odot}} = -2.5\log\left(\frac{L_{*}}{L_{\odot}}\right)$	Bolometric magnitude is related to the luminosity ratio	The Astronomical Magnitude Scale
Luminosity ratio of magnitudes	$\frac{L_{*}}{L_{\odot}} = 10^{0.4\left(M_{bol_{\odot}} - M_{bol_{*}}\right)}$		The Astronomical Magnitude Scale

Gravity & Orbits

Title	Equation	Description	Further Reading
Kelpers Law of Planetary Motion	$T^2=R^3$	Keplers law of Planetary Motion is simple and strait forward: The squares of the orbital periods of planets are directly proportional to the cubes of the semi-major axis of their orbits.	Kepler's Laws of Planetary Motion
Gravitational interaction	$U=-G\frac{Mm}{r}$	Gravitational interaction is the most important force, and so the most useful definition of the potential energy. For two-body problems, potential energy, U, is given by this formula.	What is XML?
Centripetal force	$F_c=\frac{mv_c^2}{r}$	An orbiting body, at radius r, experiences the centripetal force Fc, which keeps it moving in a circle.	What is XML?
Gravitational force	$F_g=G\frac{Mn}{r^2}$		What is XML?
Schwarzschild radius	$r_s=\frac{2MG}{c^2}$	The Schwarzschild radius is the radius of a sphere such that, if all the mass of an object were to be compressed within that sphere, the escape velocity from the surface of the sphere would equal the speed of light.	What Is a Black Hole? Black Holes Explained - From Birth to Death

Energy

Title	Equation	Description	Further Reading

Title	Equation	Description	Further Reading
Energy of a Photon	$E=hf$	The energy of a photon in Joules is equal to h (Planck constant) times by its frequency.	The Nature of Light
Frequency of Light	$f=\frac{c}{\lambda}$	The frequency of light is dependant on the speed of light (c) and it's wavelength.	The Nature of Light
Kinetic energy of a particle	$T=\frac{1}{2}mv^2$	The fundamental definition of the kinetic energy of a particle is given by the formula, where v is the velocity of the particle	What is XML?
The energy of a photon	$E=hv=\frac{hc}{\lambda}$	The energy, E, of a photon where h is Planck's constant, v is the frequency of the wave, c is the speed of light and λ is the wavelength.	Software Design Concepts
Normal gas pressure	$P=\frac{NkT}{V}$		Electron Degeneracy Pressure

Time

Title	Equation	Description	Further Reading
Local Sidereal Time	$LST=GST+\lambda$	Use this formula to calculate local sidereal time given the Greenwich sidereal time plus your longitude (east of Greenwich)	Sidereal Time, Civil Time and Solar Time

Title	Equation	Description	Further Reading
Relationship between LST, HA and RA	$$\mathrm{LST}=\mathrm{HA}+\mathrm{RA}$$ $$\mathrm{HA}=\mathrm{LST}-\mathrm{RA}$$ $$\mathrm{RA}=\mathrm{LST}-\mathrm{HA}$$	These equations show the relationsip between Local Sidereal Time, Hour Angle and Right Ascension.	Sidereal Time, Civil Time and Solar Time

Solar Physics

Title	Equation	Description	Further Reading
Ratio of Fluxes	$$\frac{F_m}{F_n}=2.512^{(n-m)}$$	Ratio of flux between two stars with apparent magnitudes *m* and *n* and measured fluxes of F_m and F_n.	Luminosity and Flux of Stars
Flux and Luminosity	$$\mathrm{Flux}=\frac{L}{4\pi r^2}$$	This equation shows the relationship between the observed flux of a star and its luminosity.	Luminosity and Flux of Stars
Inverse Square Law for Flux	$$\frac{F_M}{F_m}=\frac{d^2}{10^2}$$	This equation gives a stars absolute flux (F_M) using the inverse square law for a star at distance d (parsecs), with observed flux F_m.	Luminosity and Flux of Stars

Title	Equation	Description	Further Reading
Stefan-Boltzmann Law	$L = 4\pi\sigma R^2 T^3$	Also known as Stefan's law, states that the total energy radiated per unit surface area of a black body in unit time, is directly proportional to the fourth power of the black body's thermodynamic temperature T.	Hertzsprung-Russell Diagram and the Main Sequence
Electron degeneracy pressure	$P = \frac{h^2}{20 m_e m_p^{\frac{5}{3}}} \left(\frac{3}{\pi}\right)^{\frac{2}{3}} \left(\frac{\rho}{\mu_e}\right)^{\frac{5}{3}}$	Electron degeneracy pressure in a material can be computed, where *h* is Planck's constant, m_e is the mass of the electron, m_p is the mass of the proton, ρ is the density, and $\mu_e = N_e / N_p$ is the ratio of electron number to proton number.	Electron Degeneracy Pressure
Wien's Displacement Law	$\lambda_{max} = \frac{b}{T}$		What is Black Body Radiation?

Cosmology

Title	Equation	Description	Further Reading

Title	Equation	Description	Further Reading
Redshift	$z=\frac{\lambda_{obsv}-\lambda_{emit}}{\lambda_{emit}}$	Redshift calculation based on observed wavelengths.	Redshift and Blueshift
Temperature scale factor	$T_{(t)}=T_0\left[\frac{R_0}{R_t}\right]$	Temperature of the universe through time as a function of scale factor.	Cosmic Scale Factor and Expansion of the Universe
Temperature redshift.	$t_{(z)}=T_0(1+z)$	Temperature of the universe expressed as a function of redshift. T0 represents the temperature of the universe today (~2.7K).	Redshift and Blueshift
Proper Distance	$x(t)=R(t)r$	Proper distance x(t) corresponding to different epochs in terms of the comoving radial distance coordinate r.	Redshift and Blueshift
Redshift and Scale Factor	$R(t)=\frac{1}{1+z}$	Relationship between redshift and scale factor for another epoch.	Redshift and Blueshift
Hubble's Law	$v=H_0D$	The linear relationship between recession velocity, v, and the distance, x, of a local galaxy	System Development Life Cycle

Title	Equation	Description	Further Reading
Planck's Law of Blackbody Radiation	$E_{\lambda}=\frac{8\pi hc}{\lambda^{5}\left(e^{\frac{hc}{\lambda\kappa T}}-1\right)}$	Formula to determine the spectral energy density of the emission at each wavelength (Eλ) at a particular absolute temperature (T).	What is Black Body Radiation?
Wien's Displacement Law	$f_{max}\propto T$	The frequency of the peak of the emission (f_{max}) increases linearly with absolute temperature (T)	What is Black Body Radiation?
Stefan–Boltzmann Law	$E\propto T^{4}$	Relates the *total* energy emitted (E) to the absolute temperature (T).	What is Black Body Radiation?

Relativity

Title	Equation	Description	Further Reading
Special theory of relativity	$E=mc^{2}$	The special theory of relativity states that mass and energy are equivalent.	What is XML?
Lorentz factor	$\gamma=\frac{1}{\sqrt{1-\frac{v^{2}}{c^{2}}}}$	The factor by which time, length, and relativistic mass change for an object while that object is moving.	The Speed of Light

ONE THOUGHT ON "LIST OF ASTRONOMY MATH EQUATIONS WITH WORKINGS"

ravneet kaur
23rd June 2020 at 4:29 pm

thank you for this

Reply