

List of Formula & Constant

Speed of light in vacuum, $c = 299\,792\,458\text{ m s}^{-1}$

Constant of gravitation, $G = 6.674 \times 10^{-11}\text{ N m}^2\text{ kg}^{-2}$

Solar constant, $A = 1367\text{ W m}^{-2}$

Mean value, Hubble parameter = 68

Diapason of values, $H_O = 50 - 100\text{ km s}^{-1}\text{ Mpc}^{-1}$

Planck constant, $h = 6.626 \times 10^{-34}\text{ J s}$

Charge of electron, $e = 1.602 \times 10^{-19}\text{ C}$

Mass of electron, $m_e = 9.109 \times 10^{-31}\text{ kg}$

Proton-to-electron mass ratio = 1836.15

Faraday constant, $F = 96\,485\text{ C mol}^{-1}$

Magnetic constant, $\mu_0 = 1.257 \times 10^{-6}\text{ H m}^{-1}$

Universal gas constant, $R = 8.314\text{ J mol}^{-1}\text{ K}^{-1}$

Boltzmann constant, $k_B = 1.381 \times 10^{-23}\text{ J K}^{-1}$

Stefan-Boltzmann constant, $\sigma = 5.67 \times 10^{-8}\text{ W m}^{-2}\text{ K}^{-4}$

Wien's Displacement constant, $b = 2.898 \times 10^{-3}\text{ m K}$

Laboratory wavelength of $\text{H}\alpha = 6562.81\text{ \AA}$

Tropical year length, $T = 365.242199\text{ days}$

Sidereal year length, $T = 365.25636\text{ days}$

Anomalistic year length, $T = 365.259636\text{ days}$

Nodal period of lunar orbit = -18.6 years

Standard atmosphere = 101 325 Pa

Visible light extinction by the terrestrial atmosphere in zenith (minimum) = 19%, 0.23 m

Height of homogeneous atmosphere = 7991 m

Refractive index of water at 20°C, $n = 1.334$

Moment of inertia of a solid ball, $I = \frac{2}{5}MR^2$

Moment of inertia of sphere, $I = \frac{2}{3}MR^2$

Volume of a ball, $V = \frac{4}{3}\pi R^3$

Area of sphere, $A = 4\pi R^2$

$\pi = 3.14159265$

$e = 2.71828183$

Golden ratio, $\phi = 1.61803399$

THEORETICAL QUESTION

1. If a sunspot has a temperature of 4,200 K and the solar photosphere has a temperature of 5,800 K, how many times brighter is a square meter of the photosphere compared to a square meter of a sunspot?
2. Two stars have the same absolute magnitude. One star is 1,500 times farther than the other star.
 - (a) What is the difference in the apparent magnitudes of the two stars?
 - (b) What is the larger apparent magnitude?
3. A space probe is sent into an orbit around the Sun that brings it as close as 0.4 AU and as far away as 5.4 AU from the Sun.
 - (a) What is its orbital period?
 - (b) Is the orbit a circle or an ellipse?
4. Make a sketch of the famous diagram for stars called the Hertzsprung-Russell (HR) Diagram. In the diagram, label and mark the vertical and horizontal axes. Also mark in the diagram the various types of stars that exist in the Milky Way Galaxy.
5. The planet Mars was at opposition at UTC 13 hours 13 minutes on 27th July 2018. The next opposition of Mars will be in 2020. What will be the date of the opposition in 2020?
6. A supermassive black hole of 4 million solar masses has been discovered to exist in the centre of the Milky Way Galaxy. What is the Schwarzschild Radius of this supermassive black hole?
7. A star has an effective temperature of $T_{eff} = 9,500$ K, absolute magnitude $M = 2.1$ and apparent magnitude of $m = 7.5$,
 - (a) Find the star's distance, d .
 - (b) Find the star's luminosity, L .
8. What is the minimum diameter of an optical telescope observing in visible light on Earth that is able to resolve a crater on the Moon with a diameter of 2 kilometers?
9. On 14 September 2015 the first direct observation of gravitational waves was made by the LIGO (Laser Interferometer Gravitational-Wave Observatory) in the United States. Explain in about 100 words what do you understand by gravitational waves.
10. The Hubble Space Telescope has measured the Hubble Constant to be $73.52 \text{ km s}^{-1} \text{ Mpc}^{-1}$. Use this value of the Hubble Constant to estimate the Age of the Universe.

END OF QUESTION