

Some formulas for astronomy
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There are not a lot of numbers that you need to remember, but I recommend knowing these three

- Astronomical unit (distance from earth to sun): $1 \text{ A.U.} = 150 \times 10^6 \text{ km}$.
- Temperature of the photosphere of the sun: 6000 K.
- Speed of light: $3 \times 10^8 \text{ m/s}$.

Here are six basic physical laws that you should know.

- If an object moves a distance d in a time t traveling at a velocity v , then

$$d = v t$$

- The wavelength λ , the frequency ν and the speed c of electromagnetic radiation (or any other kind of wave) are related by

$$\lambda \nu = c$$

- The energy radiated by a blackbody per unit surface area per unit time is related to the temperature of the surface by

$$I = \sigma T^4$$

where σ is a constant.

- The wavelength of peak intensity of blackbody radiation is related to the temperature by

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

- The energy of a single photon is related to its frequency by

$$E = h\nu$$

where h is a constant (“Planck’s constant”).

- Energy conservation for photon emission from an atom

$$E_{\text{atom}}^{\text{before}} = E_{\text{atom}}^{\text{after}} + h\nu$$

while for photon absorption by an atom

$$E_{\text{atom}}^{\text{before}} + h\nu = E_{\text{atom}}^{\text{after}}$$

There some more laws that we have used. For these, you don't need to memorize the formulas, but you should know how to use them. For exams, I will just give you formulas from this list that you might need, although you may need to figure out which formula applies to a particular problem.

- Let p be the parallax angle of a star. Then we can determine the distance d to the star using

$$d = (\text{arc second} \times \text{pc}) \frac{1}{p}$$

- Suppose that two stars are in orbit about their center of mass in approximately circular orbits. The masses of the two stars are M_1 and M_2 . The distance of star 1 from the center of mass is a_1 and the distance of star 2 from the center of mass is a_2 . Then the ratio of the star's masses can be determined from

$$\frac{M_1}{M_2} = \frac{a_2}{a_1}$$

This equation amounts to the definition of "center of mass."

- Let P be the period of the orbit and let $a = a_1 + a_2$. Then we can determine the sum of the masses of the stars using

$$M_1 + M_2 = \frac{4\pi^2}{G} \times \frac{a^3}{P^2}$$

where G is a constant ("Newton's constant"). A convenient way to write this that makes the units simple is

$$M_1 + M_2 = \frac{(1 \text{ year})^2 M_{\text{sun}}}{(1 \text{ AU})^3} \times \frac{a^3}{P^2}$$

This same formula applies to a star and a planet.

- The luminosity L of a star is related to its apparent brightness b and its distance d to us by

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

or

$$L = 4\pi d^2 b$$

or

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

- The luminosity L of a star is related to its radius R and its temperature T by

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

where σ is a certain constant.