

ANGULAR DIAMETERS

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Sometimes you may want to figure out how big something appears in the sky (again, mostly just for setting detail and atmosphere, and better to visualise things). This is called the *angular diameter* - the angle that the diameter of the object covers in the sky.

To calculate this, you need to know the diameter of the object in question, and how far away it is from the observer. Then use the following formula, which works for any spherical body, be it planet or star or asteroid.

$$\alpha = \frac{D}{a} \left(\frac{180}{\pi} \right)$$

Where:

α = angular diameter in degrees

D = Diameter of the observed object

a = distance of the observed object from the observer.

π = pi (3.14159)

Note that the units of diameter and distance used in this equation must be the same!

So, for the sun (diameter 1392000 km, distance 149600000 km) as seen from Earth, you get:

$$\alpha = 1392000/149600000 * (180/\pi) = 0.533 \text{ degrees.}$$

If you actually want to convert this into degrees, arcminutes, and arcseconds (there are 60 arcminutes in a degree, and 60 arcseconds in an arcminute), you have two options:

First, if you have a calculator that has a button that looks like $^{\circ}'''$, then do the inverse of that on the value for angular diameter that you get from the calculation.

Alternatively, you can do the following:

- 1) Subtract the number to the left of the decimal point. The number that is subtracted is the number of degrees.
- 2) Multiply what remains (which will be 0.something) by 60. Subtract the number to the left of the decimal point - the number that is subtracted is the number of arcminutes.
- 3) Multiply what remains (which will again be 0.something) by 60. This is the number of arcseconds (do not subtract anything!).

So for 0.533 degrees, we can see that the number of degrees is 0. Multiply 0.533 by 60 and we get 31.98, so 31 is the number of arcminutes, Multiply 0.98 by 60 and we get 58.8, so 58.8 is the number of arcseconds.

We'd write this in degree format as $0^{\circ} 31' 58.8''$ (functionally, this is exactly the same as saying 0.533 degrees of arc).

We can use this as a reference, as it's the same size as the full moon (which we're all familiar with), so if you end up with an object with an angular diameter that is 10 times bigger than this, you can easily imagine how big it would look in the sky (i.e. 10 times the size of the sun or full moon).

And as a further example, let's look at Jupiter's largest satellite, Ganymede. Jupiter has a diameter of about 140,000 km, and Ganymede orbits it at a distance of 1,040,400 km. So the angular diameter of a "full Jupiter" as seen from Ganymede is:

$$\alpha = (140000/1040400) * (180/\pi) = 7.71 \text{ degrees.}$$

In degree format, this would be: $7^{\circ} 42' 35.74''$

So from Ganymede, Jupiter would appear to be about fifteen times wider than the full moon seen from Earth. It's important to note that this would appear to be a significant difference - 15 times the diameter is 210 times the area covered in the sky!