Disney · PIXAR
LIGHTYEAR
SEE THE NEW MOVIE

SO, WHAT IS A LIGHT YEAR?

A light year is a measurement of distance (despite the name!)

1 light year is:

5.9 trillion miles (5.9 x 1012, 5900000000000)
9.7 trillion kilometres (9.7 x 1012, 9700000000000)

The fastest thing in the Universe

Light travels at a speed of 3 x 108 metres per second (300 000 000) in the vacuum of space (and not much slower through the air here on Earth). While it is the fastest thing in the Universe, it still takes time to travel, particularly when we are talking about the vast distances in space.

And this is where the term light year comes from – it's simply ***the distance that light travels in one year!***

Time travel!

The neat thing about knowing distances to night-sky objects in light years is that it allows us to instantly know how old the light we are seeing from that object is!

Object	**Distance**	**Light we see was emitted…**	**At that time…**
Sun	8.3 light minutes	8.3 minutes ago	You were walking into this space
Proxima Centauri (next nearest star)	4.2 light years	Feb 2018	I was watching the winter Olympics on TV from Korea
Beta Canum Venaticorum (G class star)	27 light years	In 1995	First Toy Story Movie released!
Polaris (pole star)	323 light years	In 1699	Isaac Newton became warden of the Royal Mint
Andromeda galaxy (heading towards us!)	2.54 million light years	2.54 million years ago	Homo habilis (an early ancestor of humans), began to use simple stone tools
Earendel (one of the oldest stars observed so far)	27.7 billion light years	12.8 Billion years ago	Wait…What?! See below!

How can really, really distant objects be further away than our 'light year distance = light travel time' method suggest? Well, thanks to the observed cosmological red shift of stars (the lengthening of the wavelength of the light we see from them into the redder part of the visible spectrum - a result of them moving away from us) we know that the Universe is expanding, and evidence suggests that this expansion of the Universe has been accelerating for some time. As a result, in the time since light from that object was emitted, the space between that object and us has expanded, causing the actual distance to be greater. **More info on cosmological red-shift and related demos can be found in the Webb Telescope section of Destination Space.**

A neat application of light speed and distance – measuring the distance to the Moon

Thanks to the Apollo Lunar missions, we can use our knowledge of the speed of light to measure the distance to the Moon. The Apollo 11, 14 and 15 missions left devices called retroreflectors on the surface of the Moon.

These are effectively giant ‘cats eyes’ like we see lining the lanes of motorways, which reflect light directly back to the source.

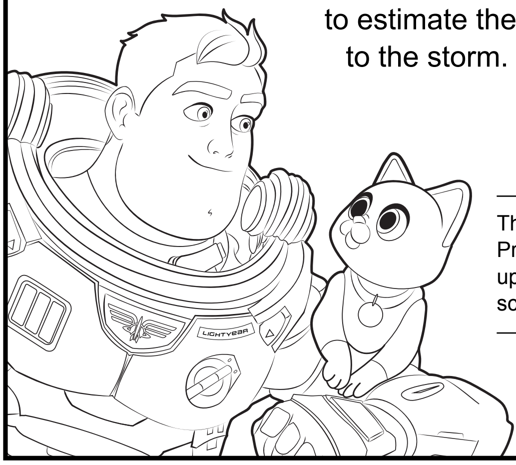
We can beam extremely strong laser pulses at these retroreflectors and time how long it takes for the pulse to travel there, reflect, and return to a sensitive receiver. This gives us a time of travel (2.6 seconds round trip, 1.3 seconds one way).

And once we know this, we can use the equation **distance = speed of light x time** to calculate the distance – 390 000 000 metres, or 390 000 kilometres. However, each year, it takes a very slightly longer time for the pulse to make this journey, indicating that the Moon is getting further away from us – at a rate of just under 4cm per year! **You can find out more about this in the *Destination Space: Moon handbook*.**

So why don’t we notice the speed of light every day?

The short answer is – we do! Or at least we notice the difference between the speed of light and the speed of sound. Light is so fast, that the time it takes to travel from a source to an observer anywhere on the Earth is effectively negligible (if someone in Edinburgh could shine a strong enough light source towards you standing in London, it would only take 0.0022 seconds for you to see it).

Sound however, travels much slower than light – about 330 m/s (about a million times slower than light). If a big event, like a lightning clap, produces sound and light, you see the light almost instantaneously, but the sound lags behind by an amount of time that depends on the distance the storm is from us. Therefore people will often use the time between the flash of lightening and the thunder to estimate the distance to the storm.



This resource was created by ASDC as part of Project Lightyear: Disney and Pixar have teamed up with ASDC to engage people with exciting science topics inspired by the film *Lightyear*.

Association for Science and Discovery Centres

www.sciencecentres.org.uk/projects/lightyear