

From Earth to the Galaxies

Name : _____

Group : _____ Date : _____

Do you know how fast light travels? Almost 300,000 km a second! Nothing in the Universe moves faster than light. Use this figure to answer the questions below. When measuring the distance between two bodies, make sure you measure from centre to centre. When arrows appear on a drawing, measure the distance between the tips of the arrows.

- 1.** How many times could a ray of light circle the Earth in one second? Clues: the Earth's diameter is 12,756 km and $\pi = 3.1416$.

The Earth's diameter is 12,756 km and $\pi = 3.1416$. The Earth's circumference = $\pi \times 12,756 \text{ km} = 40,074 \text{ km}$.

In one second, a ray of light travels $300,000 \text{ km/s} \div 40,074 \text{ km} = 7.49$ circles around the Earth in one second.

- 2.** The constancy of the speed of light enables us to create units of length to measure very large distances in the Universe. For example, the light second is the distance that a ray of light travels in one second. How many kilometres does a light second equal?

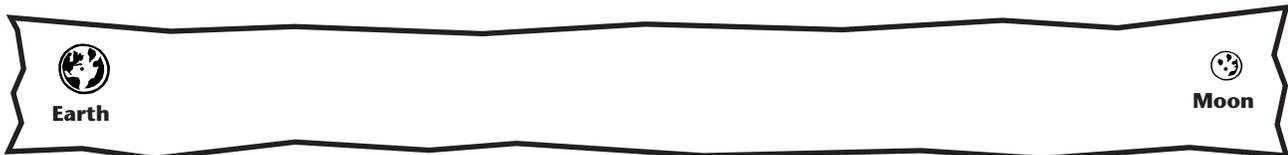
A light second amounts to $300,000 \text{ km/s} \times 1 \text{ s} = 300,000 \text{ km}$.

- 3. a)** What's the distance in kilometres separating the Earth and Moon? (Use a ruler to measure the distance in centimetres between the Moon's centre and the Earth's centre on the drawing below. Then convert the distance into kilometres using the scale factor for the drawing.)

Scale: 1 cm = 25,000 km.

The Earth-Moon distance measured on the handout is 15.2 cm, which corresponds in reality to $15.2 \text{ cm} \times$

$25,000 \text{ km/cm} = 380,000 \text{ km}$



b) How many light seconds does the Earth-Moon distance equal?

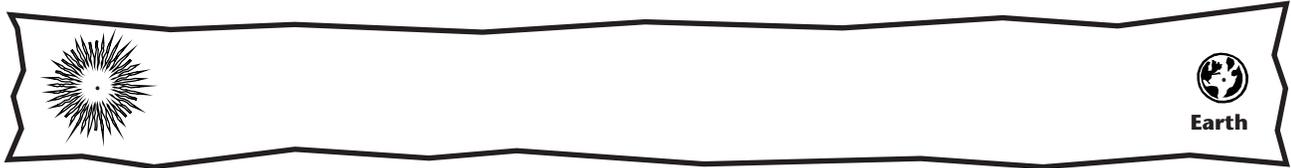
This distance amounts to $380,000 \text{ km} \div 300,000 \text{ km/s} = 1.27 \text{ light seconds}$

4. a) What is the average distance between the Earth and Sun in kilometres?

Scale: 1 cm = 10,000,000 km.

Scale = 1 cm = 10,000,000 km. The Earth-Sun distance measured on the handout is 15 cm, which corresponds

in reality to $15 \text{ cm} \times 10,000,000 \text{ km/cm} = 150,000,000 \text{ km}$.



b) How many light minutes does this distance equal?

This distance amounts to $150,000,000 \text{ km} \div 300,000 \text{ km/s} = 500 \text{ light seconds}$. One light minute

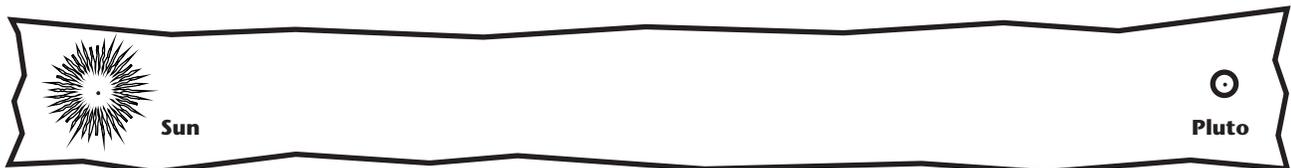
equals 60 light seconds, hence $500 \text{ ls} \div 60 \text{ s/min} = 8.33 \text{ light minutes}$.

5. a) How many kilometres from the Sun is Pluto, the most distant planet?

Scale: 1 cm = 400,000,000 km.

The Sun-Pluto distance measured on the handout is 15 cm, which corresponds in reality

to $15 \text{ cm} \times 400,000,000 \text{ km/cm} = 6,000,000,000 \text{ km}$.



b) How many light hours does this distance equal?

This distance amounts to $6,000,000,000 \text{ km} \div 300,000 \text{ km/s} = 20,000 \text{ light seconds}$. One light hour equals

60 light minutes (or 3,600 light seconds). Consequently, $20,000 \text{ ls} \div 60 \text{ s/min} = 333.33 \text{ light minutes}$,

and $333.33 \text{ lm} \div 60 \text{ min/h} = 5.56 \text{ light hours}$.

6. To measure distances beyond our solar system, we use the light year as a unit of length. One light year is the distance that a ray of light travels in one year. How many kilometres are in one light year?

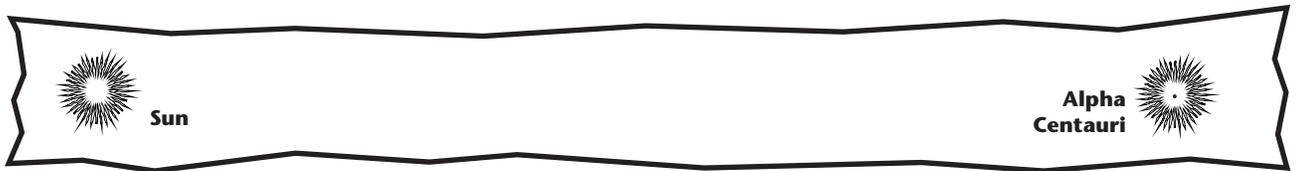
One light year amounts to $300,000 \text{ km/s} \times 60 \text{ s/min} \times 60 \text{ min/h} \times 24 \text{ h/d} \times 365 \text{ d/y}$, which equals

9,460,000,000,000 km or nearly 10 trillion kilometres.

7. a) Alpha Centauri is the closest star to our Sun. How far apart are these two stars in light years? Scale: 1 cm = 0.3 ly.

The distance between the Sun and Alpha Centauri measured on the handout is 14.3 cm,

which corresponds in reality to $14.3 \text{ cm} \times 0.3 \text{ ly/cm} = 4.3 \text{ ly}$.



- b) Express the same distance in kilometres.

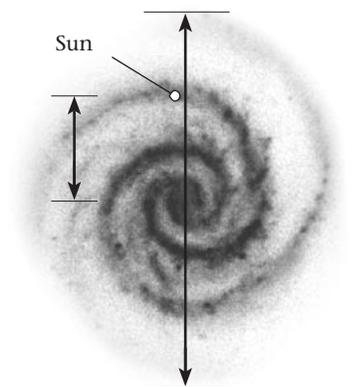
$4.3 \text{ ly} \times 9,460,000,000,000 \text{ km/ly} = 40,678,000,000,000 \text{ km}$ or 40.678 trillion km.

8. a) The Sun is just one of the hundred of billions of stars populating our Galaxy, the Milky Way. What's the Milky Way's diameter in light years? (Use the ruler to measure the distance in centimetres between the tips of the arrows on the drawing below. Then convert the distance into light years by using the scale factor for the drawing.) Scale: 1 cm = 20,000 ly.

The Milky Way's diameter measured on the handout is 5 cm,

which corresponds in reality

to $5 \text{ cm} \times 20,000 \text{ ly/cm} = 100,000 \text{ ly}$.



- b) What distance in light years separates the Sun from our Galaxy's centre?

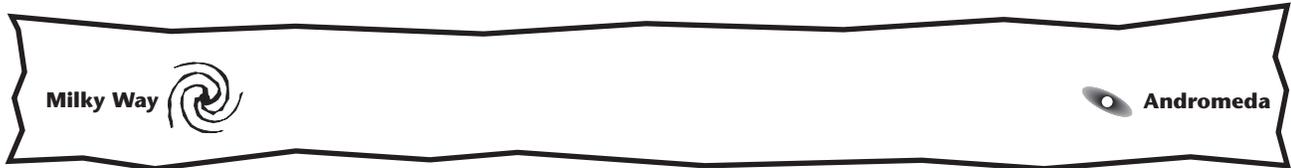
The distance between the Sun and the Milky Way's centre measured

on the handout is 1.4 cm, which corresponds in reality to $1.4 \text{ cm} \times 20,000 \text{ ly/cm} = 28,000 \text{ ly}$.

- 9.** Our Milky Way is part of a small group of about 40 galaxies called the Local Group. In this group, Andromeda is the galaxy most resembling the Milky Way. What distance in light years separates Andromeda's centre from the Milky Way's centre?
Scale: 1 cm = 200,000 ly.

The distance between the Milky Way and the Andromeda galaxy measured on the handout is 12 cm,

which corresponds in reality to $12 \text{ cm} \times 200,000 \text{ ly/cm} = 2.4 \text{ million ly}$.



- 10.** The entire Universe harbours hundreds of billions of individual galaxies, each one containing hundreds of billions of stars. What's the estimated radius of the observable Universe?
Scale: 1 cm = 15,000,000,000 ly.

The radius of the observable Universe measured on the handout is 4 cm,

which corresponds in reality to $4 \text{ cm} \times 15,000,000,000 \text{ ly/cm} = 60 \text{ billion ly}$.

