Introduction

Chapter 1

The Nature of Astronomy

- Astronomy is the study of everything outside of the Earth. Originally that was what you could see in the sky, but now we can "see" and observe much more than what humans can see with their eyes.
- It is also the physics of these objects, understanding why they behave the way they do, or exist at all.

The Nature of Science

- Astronomy is a science, which means we use the scientific method to determine what is true.
- The scientific method is as follows:
    1. Observe nature
    2. Form hypothesis
    3. Test hypothesis - experiments
    4. Repeat

Numbers in Astronomy

- In astronomy we use crazy big numbers. The Earth is 920 trillion times the mass of the great pyramid at Giza; the Sun is 158 thousand times larger than the tallest mountain on Earth; the Universe is 171 million times older than the average person lives.
- Numbers get so big that we need another way of writing them. 1,000,000,000,000 is both annoying to write and likely that we will add or forget a zero. Instead if we use scientific notation we can write 1×10^{12} to let us know we have 12 zeros.

Scientific Notation

- Many numbers are too big or small to write them out. For these we use scientific notation where we separate the number and how big or small it is. This is similar to saying 3 hundred, or 3 million or 3 trillion.

$10 = 10^{1}$

$100 = 10^{2}$

$1000 = 10^{3}$

$0.01 = 10^{-2}$

$0.001 = 10^{-3}$

so $314 = 3.14 \times 10^{2}$

$0.0068 = 6.8 \times 10^{-3}$

$784{,}000 = 7.84 \times 10^{5}$

Scientific Notation

- Distance to Andromeda Galaxy is 3,000,000 light years = 3×10^{6} ly
- The size of a hydrogen atom is 0.00000000005 meters = 5×10^{-11} m
- Diameter of the Sun is 1,392,000 kilometers = 1.392×10^{6} km
- U.S. national debt is 26,659,458,000,000 dollars = $\$2.6659458 \times 10^{13}$

www.youtube.com/watch?v=ofKBhvDjuy0

Example 1.2

Getting Familiar with a Light-Year

How many kilometers are there in a light-year?

Solution

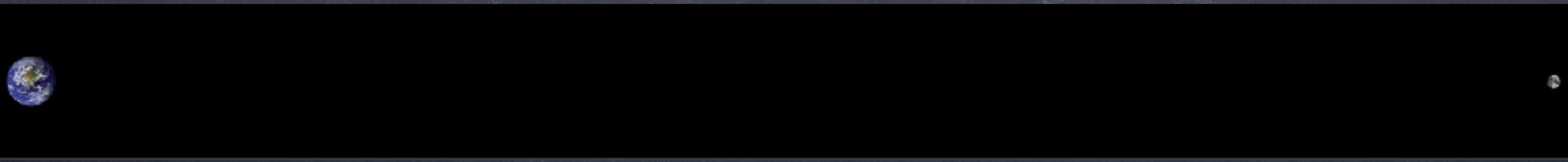
Light travels 3×10^5 km in 1 s. So, let's calculate how far it goes in a year:
There are 60 (6×10^1) s in 1 min, and 6×10^1 min in 1 h.
Multiply these together and you find that there are 3.6×10^3 s/h.
Thus, light covers 3×10^5 km/s $\times$ 3.6×10^3 s/h = 1.08×10^9 km/h.
There are 24 or 2.4×10^1 h in a day, and 365.25 (3.65×10^2) days in 1 y.
The product of these two numbers is 8.77×10^3 h/y.
Multiplying this by 1.08×10^9 km/h gives 9.46×10^{12} km/light-year.
That's almost 10,000,000,000,000 km that light covers in a year. To help you imagine how long this distance is, we'll mention that a string 1 light-year long could fit around the circumference of Earth 236 million times.

Light Time Travel

- The speed of light is very fast for distances on Earth, but it is actually quite slow outside of Earth.
- It takes light 8.3 minutes to get from the Sun to the Earth. It takes light 4.2 hours to reach the farthest planet in our solar system and more than 3 years to reach the nearest star.
- It takes tens of thousands of years for light to cross the galaxy and millions of years to reach the nearby Andromeda galaxy.
- These long travel times are actually an advantage in astronomy because when you are looking far away you are also looking back in time. Thus we can learn about the history of the Universe by looking at object billions of light years away.

Tour of the Universe

- The solar system - contains our Sun and the planets that orbit our Sun. While the solar system is large compared to Earth, from the distance of another star the whole solar system is just a dot.
- Stars - most of what we see in the sky are stars, some like our Sun some bigger some smaller.




Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune
Planets
Ceres
Pluto
Haumea
Makemake
Eris
Dwarf planets

Tour of the Universe

- Galaxies - are where stars live. A galaxy may contain thousands to trillions of stars.
- The Universe - we can study by observing millions of galaxies.
- Stars do not live forever, the eventually die. Some explode when they die and create the elements in the Universe.

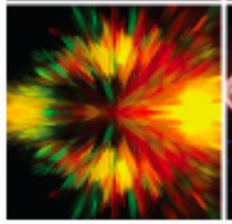
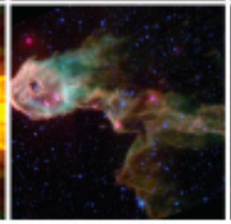
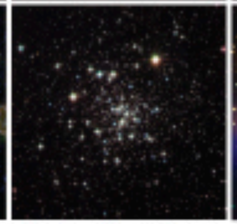
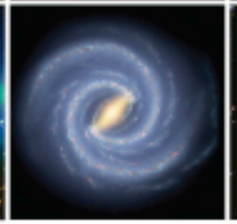
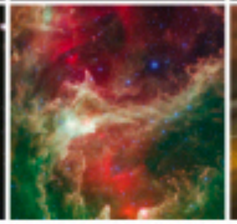
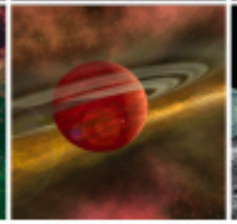
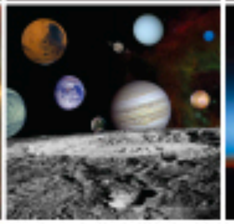
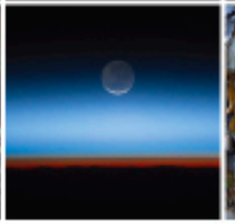
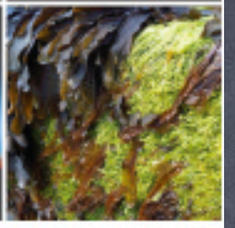
www.youtube.com/watch?v=17jymDnoW6U

Atoms

The smallest things in the Universe, atoms, are made by one of the largest things, stars.

Stars are by definition things that fuse smaller atoms into larger ones. And when they explode they can create the heaviest atoms that exist.

- https://phet.colorado.edu/en/simulation/build-an-atom

January	February	March	April	May	June	July	August	September	October	November
										
Big Bang occurs.				Milky Way Galaxy forms.				Our solar system forms. Life on Earth begins.	Earth's atmosphere becomes oxygenated.	First complex life forms appear.

December						
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19 Vertebrates appear.	20 Land plants appear.	21
22	23	24	25 Dinosaurs appear.	26 Mammals appear.	27	28
29	30 Dinosaurs become extinct.	31 Humans appear.				