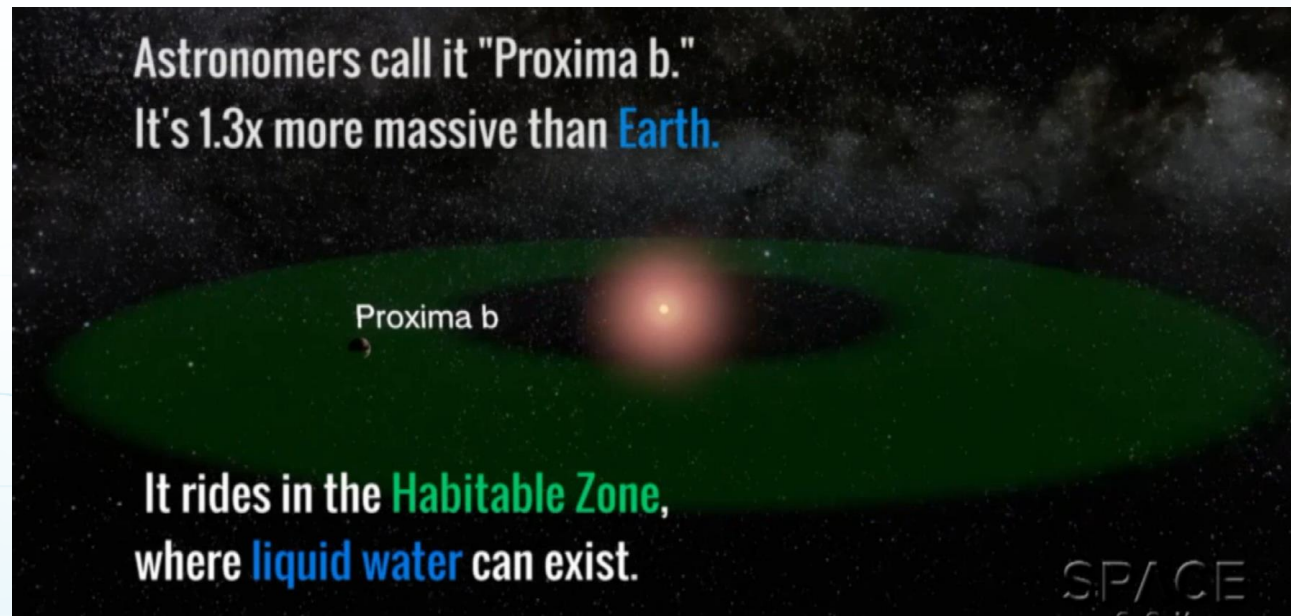


Our Neighbor....



TH: The closest star to the Sun also has an Earth-like planet orbiting around it. True or false?

Astronomers have discovered a roughly Earth-size alien world around **Proxima Centauri**, which lies just **4.2 light-years** from our own solar system. What's even more exciting is that the planet, known as **Proxima b**, circles in the star's "**habitable zone**" — the range of distances at which liquid water could be stable on a world's surface.



For more info (link on SUCourse):

Space.com > Search for Life

Found! Potentially Earth-Like Planet at Proxima Centauri Is Closest Ever

By Mike Wall, Space.com Senior Writer | August 24, 2016 01:01pm ET

f 56

<https://www.space.com/33834-discovery-of-planet-proxima-b.html#oid=tlcWZpNTE6ZWYMBu4dSz-HgURsvvYI25>

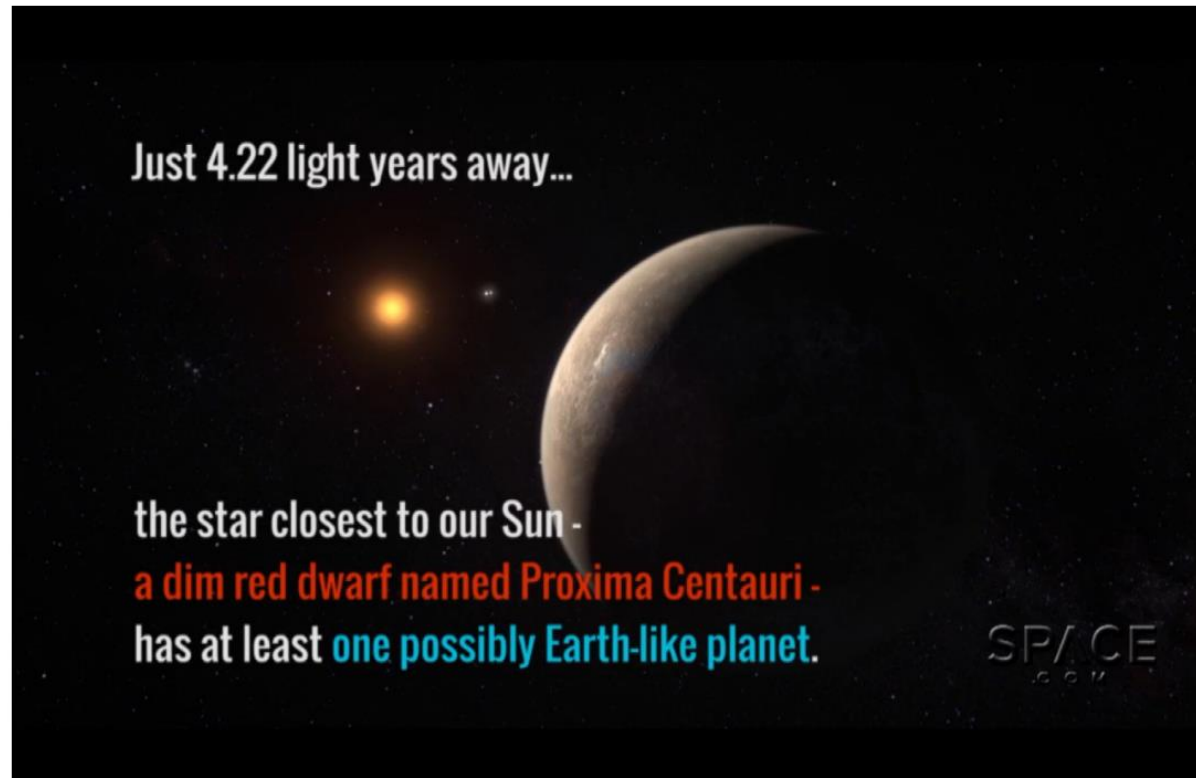
4

F

reddit

stumbleupon

MORE ▾



UNV Week 1: What is life? Where do we come from? Our planet and the solar system



This Week's Learning Objectives:

By the end of this week, you should be able to:

Recognize Earth as a biosphere, and describe its position and motion in a larger structure such as the Solar system, an environment that hosts a habitable planet

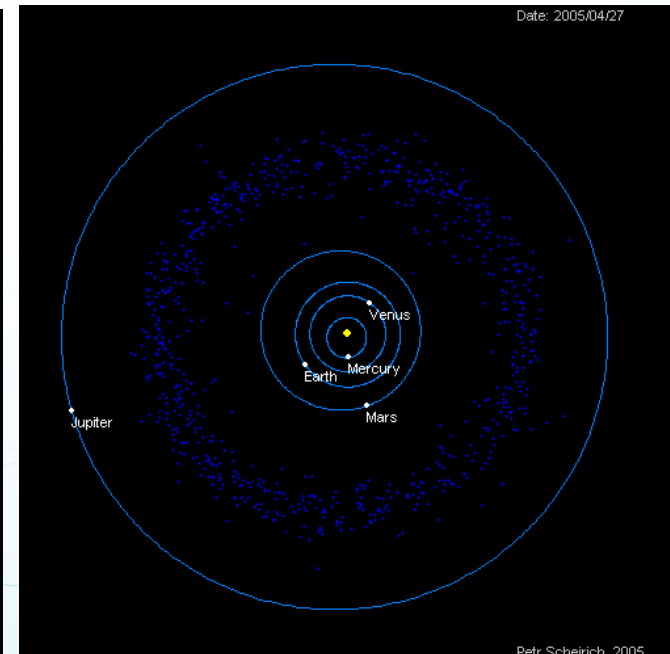
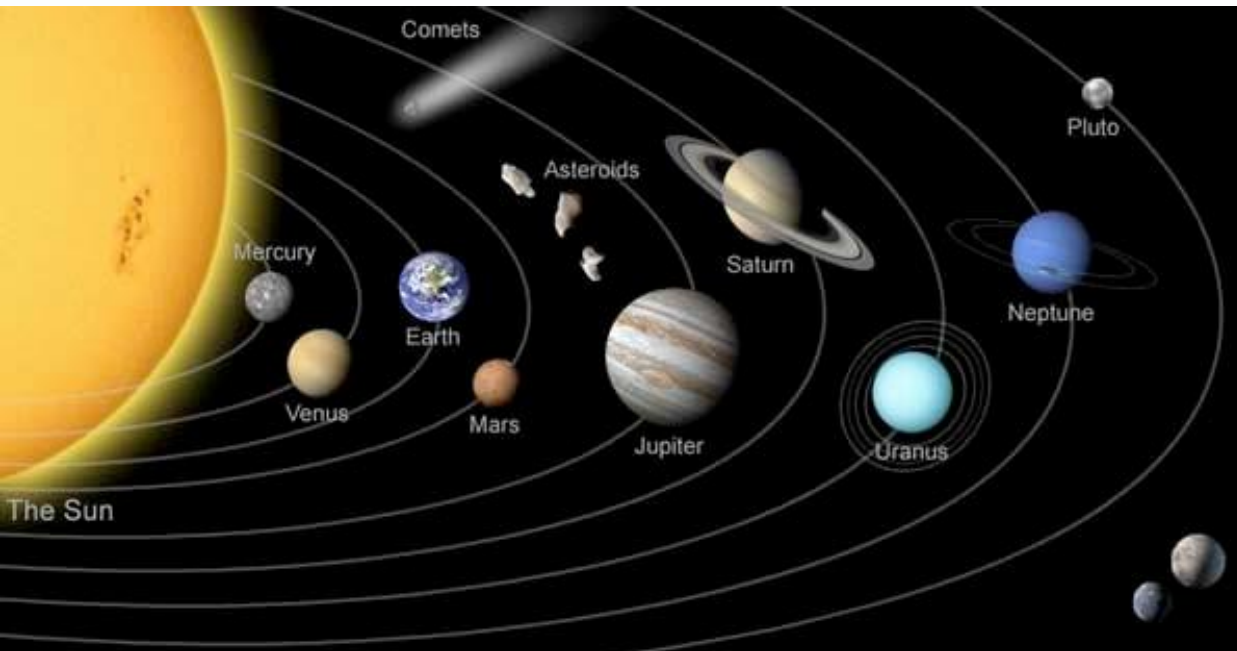
1. Distinguish “**living**” from “non-living” by evaluating their essential characteristics
2. Identify and differentiate the constituents of our **solar system**, and describe our position (uniqueness) in the universe
3. Explain the difference between **vector** and **scalar** quantities by giving examples
4. Analyze a simple motion of an object by correctly calculating the **position**, **velocity** and **acceleration** values/functions at given instances, given any one of the functions
5. Given the **graph** of any one of position, velocity or acceleration as a function of time, sketch the graph of other parameters as a function of time

NS 101 – Are we alone in the Universe?

Where do we come from?

Life, the Earth and the Solar system

Describing motion



OUR Criteria of Life

Living organisms have all of the following traits:

1. **Organization:** Exhibit complex but ordered organization (cells → tissues → organs) [see figure](#)
2. **Regulation:** Regulate their internal environment to maintain the conditions needed for cell function (e.g., body temperature)
3. **Response to environment:** Change properties reacting to environment / stimulus (mimosa plant)
4. **Growth and Development:** Information carried by genes controls the pattern of growth and development
5. **Energy utilization:** Use energy to function (chemical reactions = “metabolism”)
6. **Reproduction:** Reproduce to carry on their own kind
7. **Evolution:** Capacity of populations to change (evolve) over time for the survival of the species



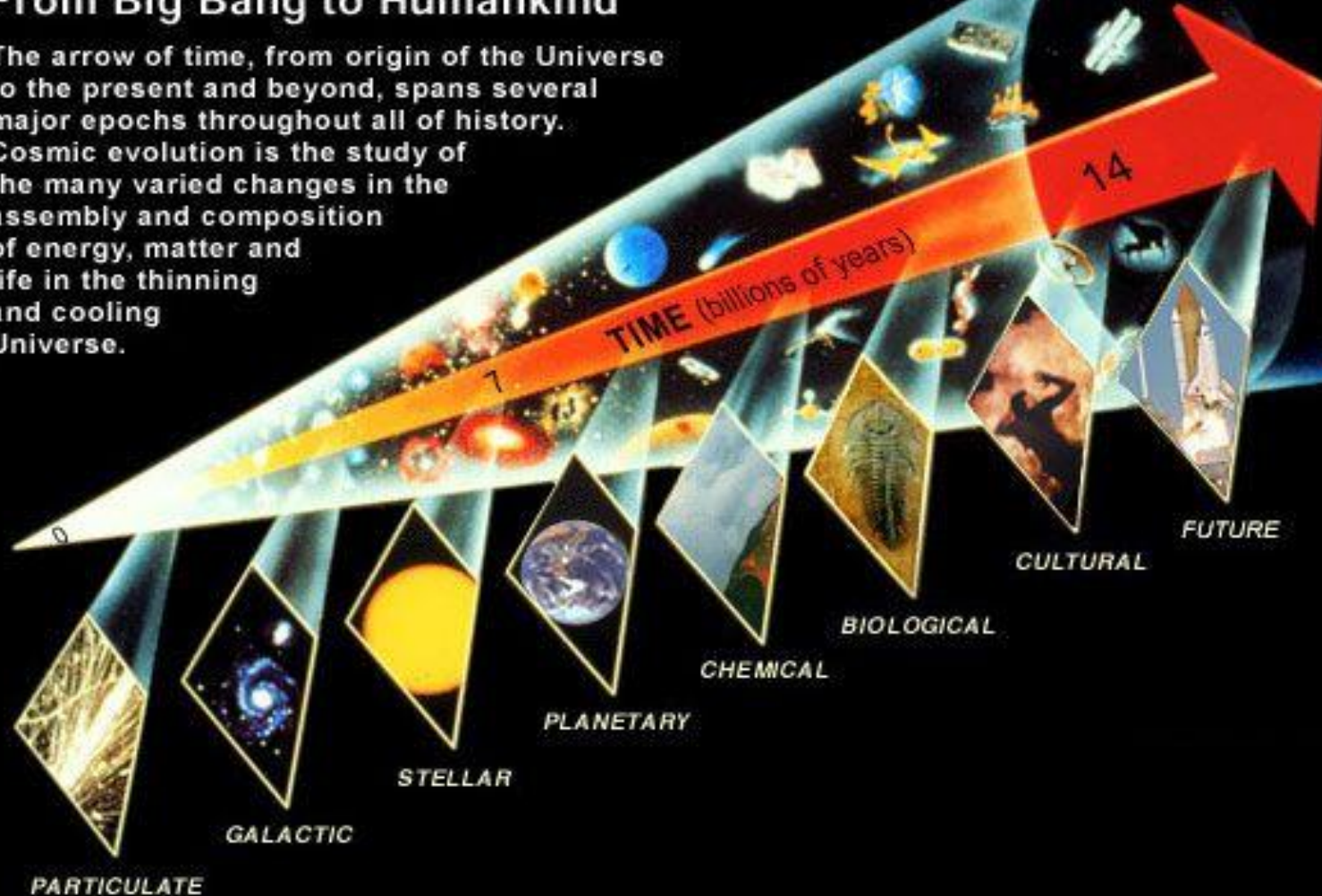
Note: More details of all criteria of life at the cellular level in ABR module

How did life and technology emerged on Earth?

Cosmic Evolution

From Big Bang to Humankind

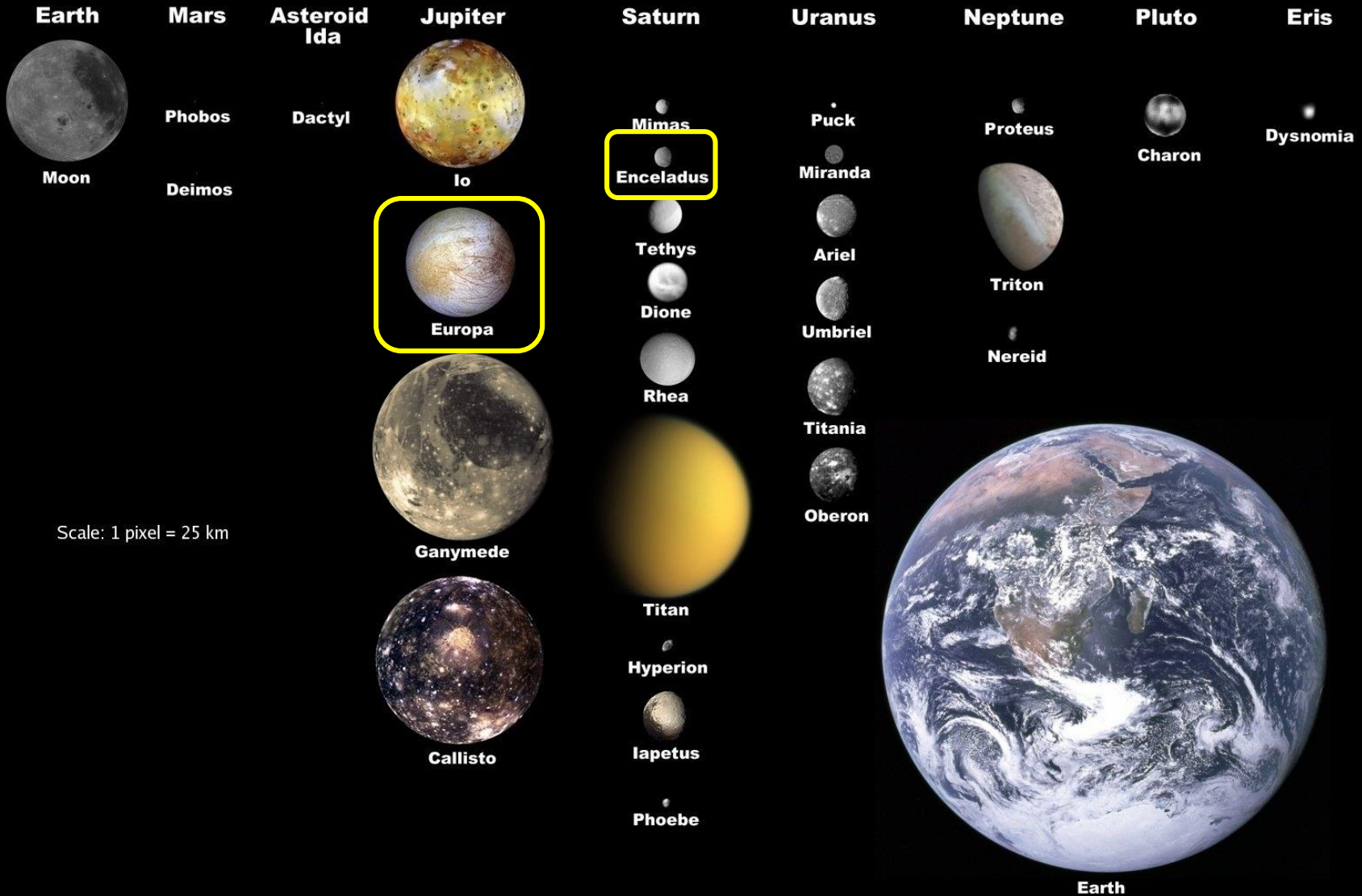
The arrow of time, from origin of the Universe to the present and beyond, spans several major epochs throughout all of history. Cosmic evolution is the study of the many varied changes in the assembly and composition of energy, matter and life in the thinning and cooling Universe.



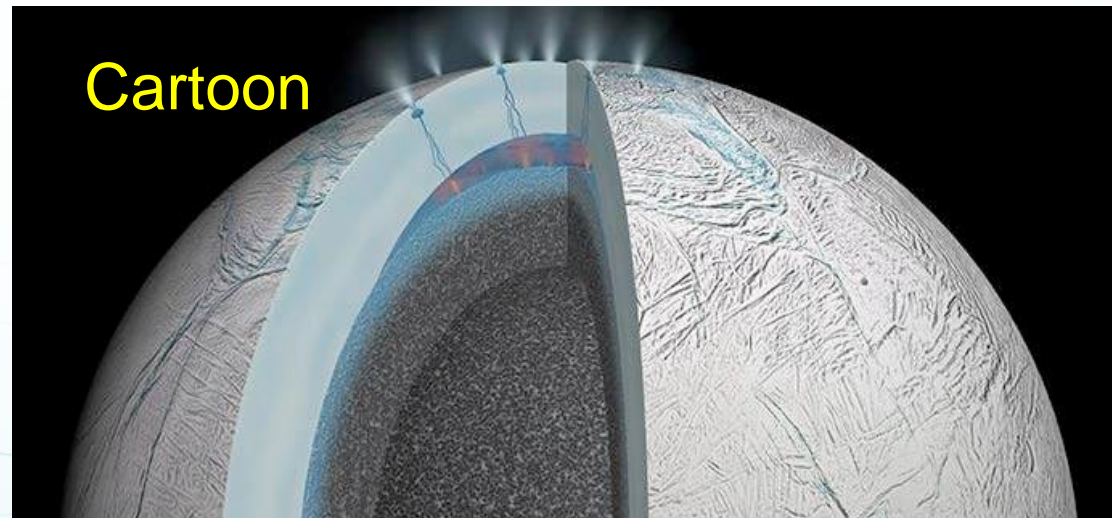
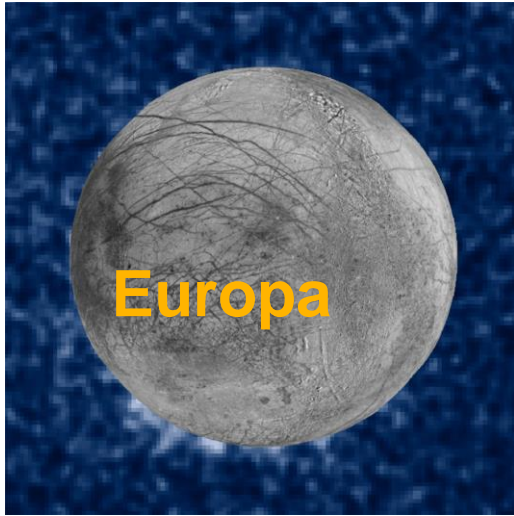
https://www.cfa.harvard.edu/~ejchaisson/cosmic_evolution/docs/splash.html

Life on satellites of planets?

Selected Moons of the Solar System, with Earth for Scale



Recent discoveries of water on moons!



From this week's VL...

https://solarsystem.nasa.gov/docs/Comet_factsheet_4-25-12_b.pdf

See also: <http://solarsystem.nasa.gov/planets/meteors>



Icy, "dirty snowball"

Comets vs. Asteroids!

Both are leftovers from the formation of our solar system.

Comets are icy.

Asteroids are rocky.

Comets and asteroids orbit the Sun similar to the way the Earth does. Scientists believe many of these small worlds have changed very little since they first formed. They are unlike Earth with all its weathering, volcanoes and earthquakes. Asteroids and comets can tell us what the early solar system was like.

NASA likes it when scientists use their imaginations to find creative ways to explore our solar system. With NASA's help, scientists use small, robotic spacecraft—no humans on board—to be their eyes and unlock the mysteries of comets and asteroids—and our solar system itself.

Join us on a journey as we explore small worlds in our solar system.

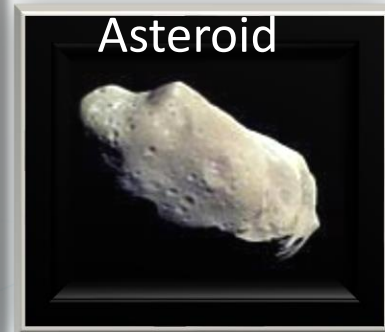
Comets

- Reside mostly in Kuiper Belt beyond orbit of Neptune, and in Oort Cloud in outer solar system.
- Probably formed in the outer solar system.
- Diameters range from about 6 - 25 miles.
- Contain a lot of ice, along with rock, and hydrocarbons.
- Surface is very unstable and changeable, as ice boils off when comet approaches Sun.
- Develop comas and tails as they approach the Sun.
- Orbit can be disturbed to toss comet into elongated orbit, so we see it in the inner solar system.
- May have contributed large part of Earth's water.

Asteroids

- Most reside in Asteroid Belt between orbits of Mars and Jupiter.
- Probably formed inside the orbit of Jupiter.
- Diameters range from the size of small rocks to more than 600 miles.
- Composed of rock and metals.
- Surface is solid and stable, showing craters where other objects have crashed into it.
- Surface does not boil off, thus no coma or tails.
- Orbit is stable and fairly circular.
- Have left craters on Earth, and may have caused mass extinctions, such as of the dinosaurs.

Asteroids come in a large range of sizes.



rocks+metals
"space potato"

Meteors, asteroids can hit the Earth!

Most **meteors** burn out completely as they hit the atmosphere, but some reaches the ground. Some of these **meteorites** carry valuable materials (metals and maybe evidence of life???).

↪ *More discussions later...*

Meteor hitting Russia (Feb, 2013)

<https://www.youtube.com/watch?v=RrL-cWaYdno>



Distance scale in solar system

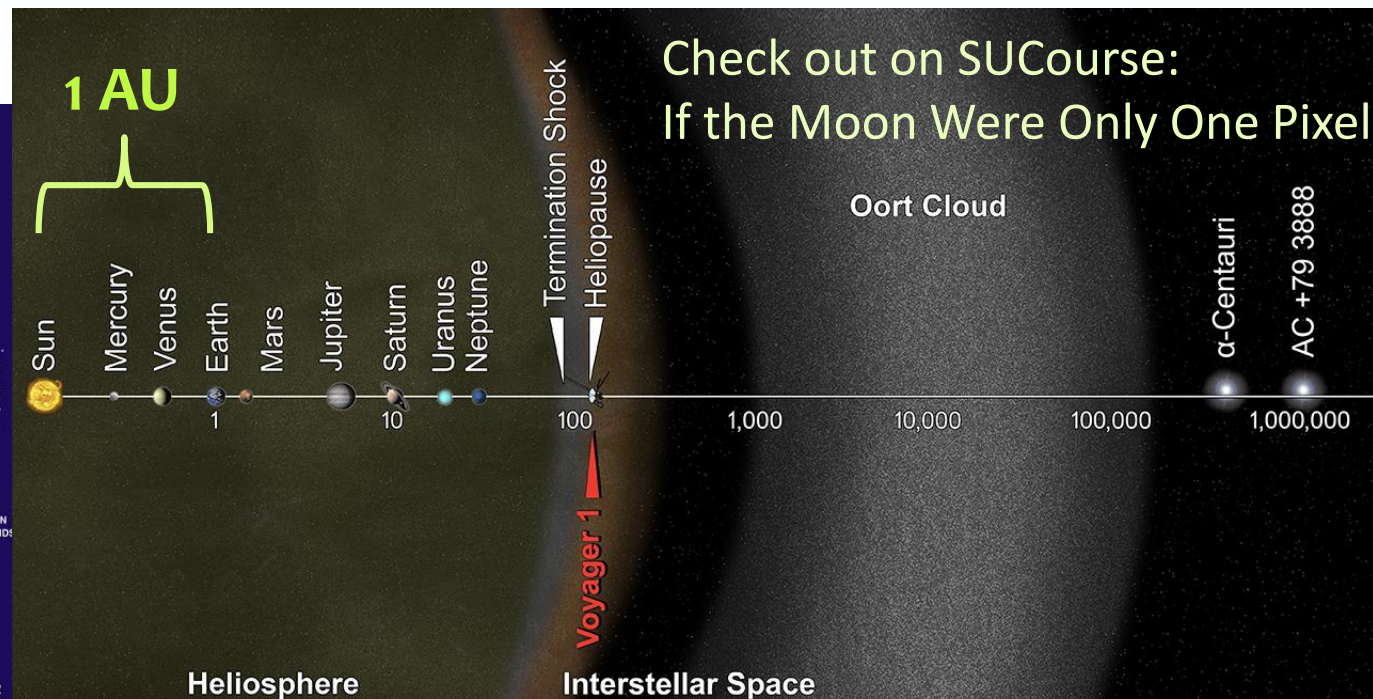
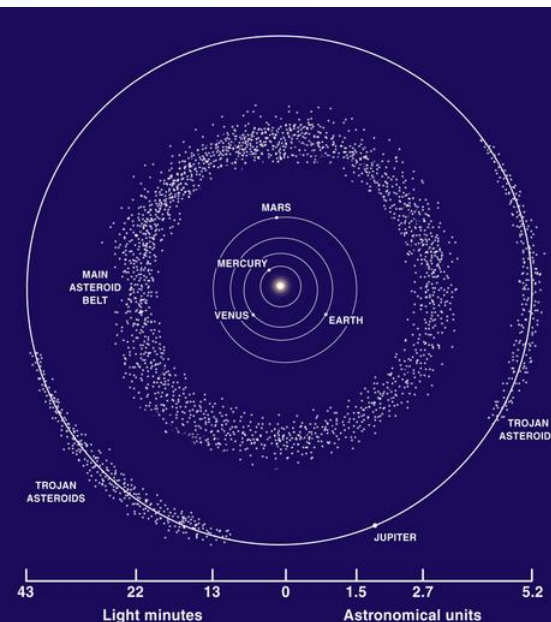
- * **1 light year**

= Distance traveled by light in a year (remember recitation?)

= $300000 \text{ km/s} \times 365 \text{ days} \times 86400 \text{ s/day} \sim 10 \text{ trillion } (10^{13}) \text{ km}$

- * The distances in the solar system can be expressed in terms of

1 Astronomical Unit (AU) = $150\,000\,000\,000 \text{ m} = 1.5 \times 10^{11} \text{ m}$
 $\sim 8 \text{ light-minutes}$



EXOPLANETS, other planetary systems in our Galaxy!

<http://phl.upr.edu/projects/habitable-exoplanets-catalog>

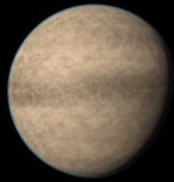


Potentially Habitable Exoplanets

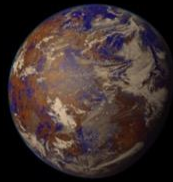
Ranked by Distance from Earth (light years)



[4 ly]
Proxima b



[13 ly]
Kapteyn b*



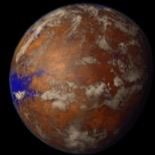
[14 ly]
Wolf 1061 c



[22 ly]
GJ 667 C c



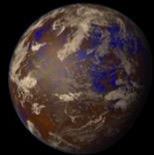
[22 ly]
GJ 667 C e*



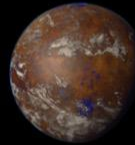
[22 ly]
GJ 667 C f*



[561 ly]
Kepler-186 f



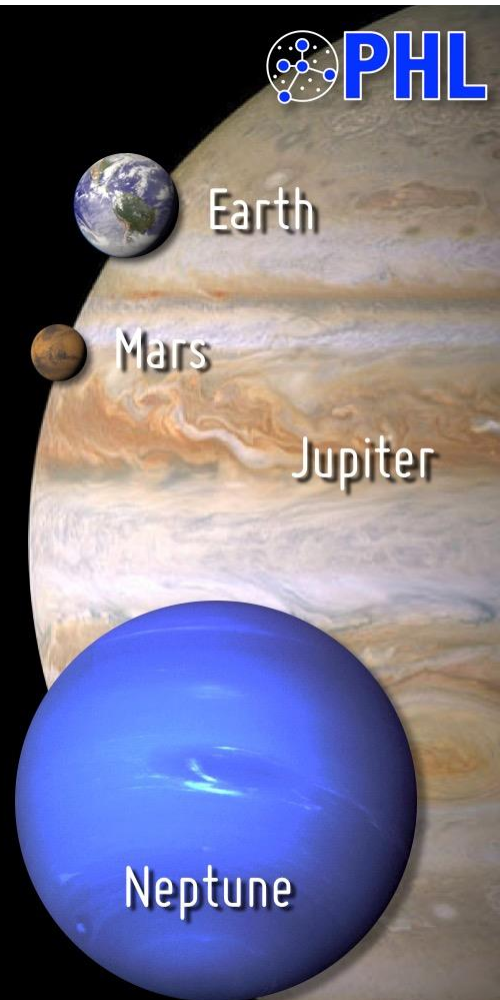
[770 ly]
Kepler-1229 b



[1115 ly]
Kepler-442 b



[1200 ly]
Kepler-62 f

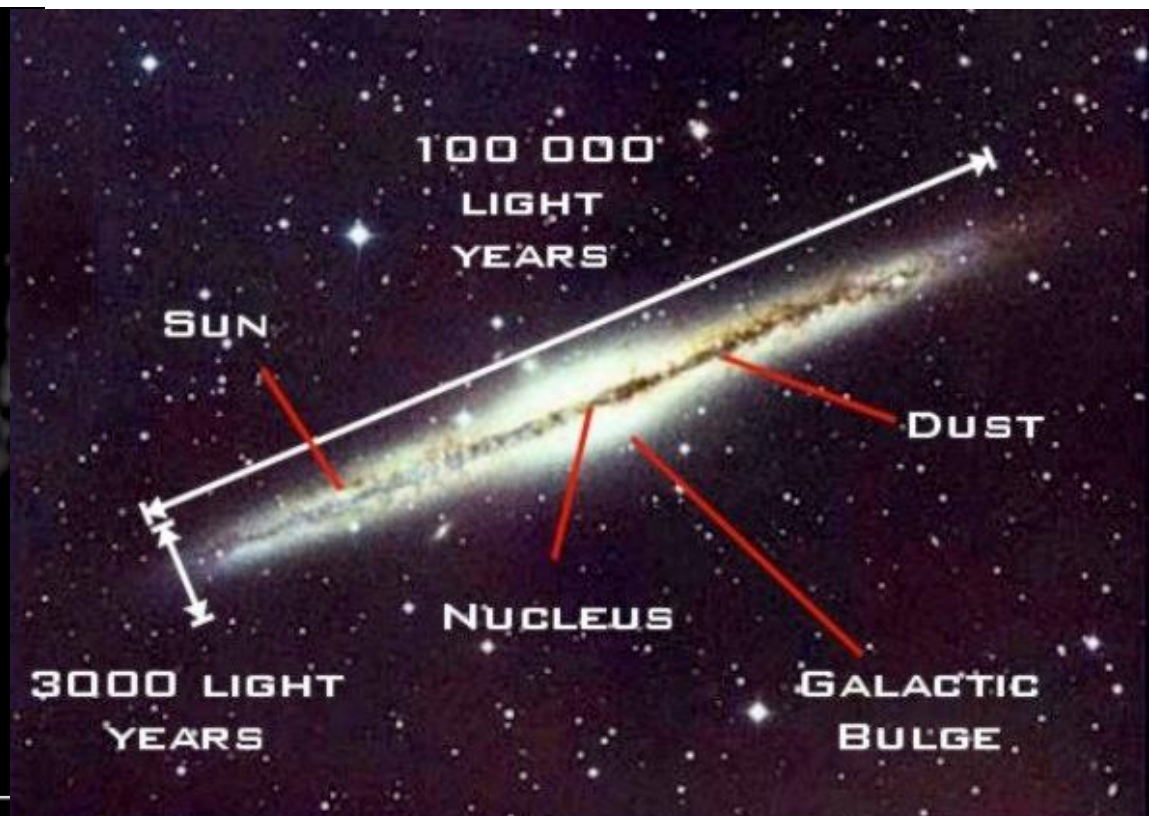
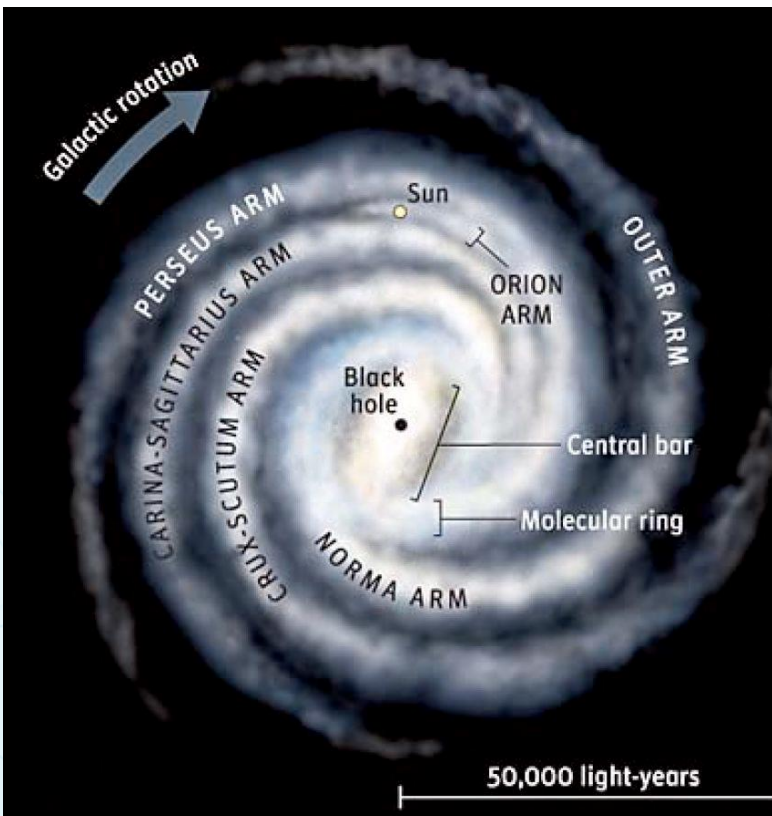


Artistic representations. Earth, Mars, Jupiter, and Neptune for scale.
Distance is between brackets. Planet candidates indicated with asterisks.

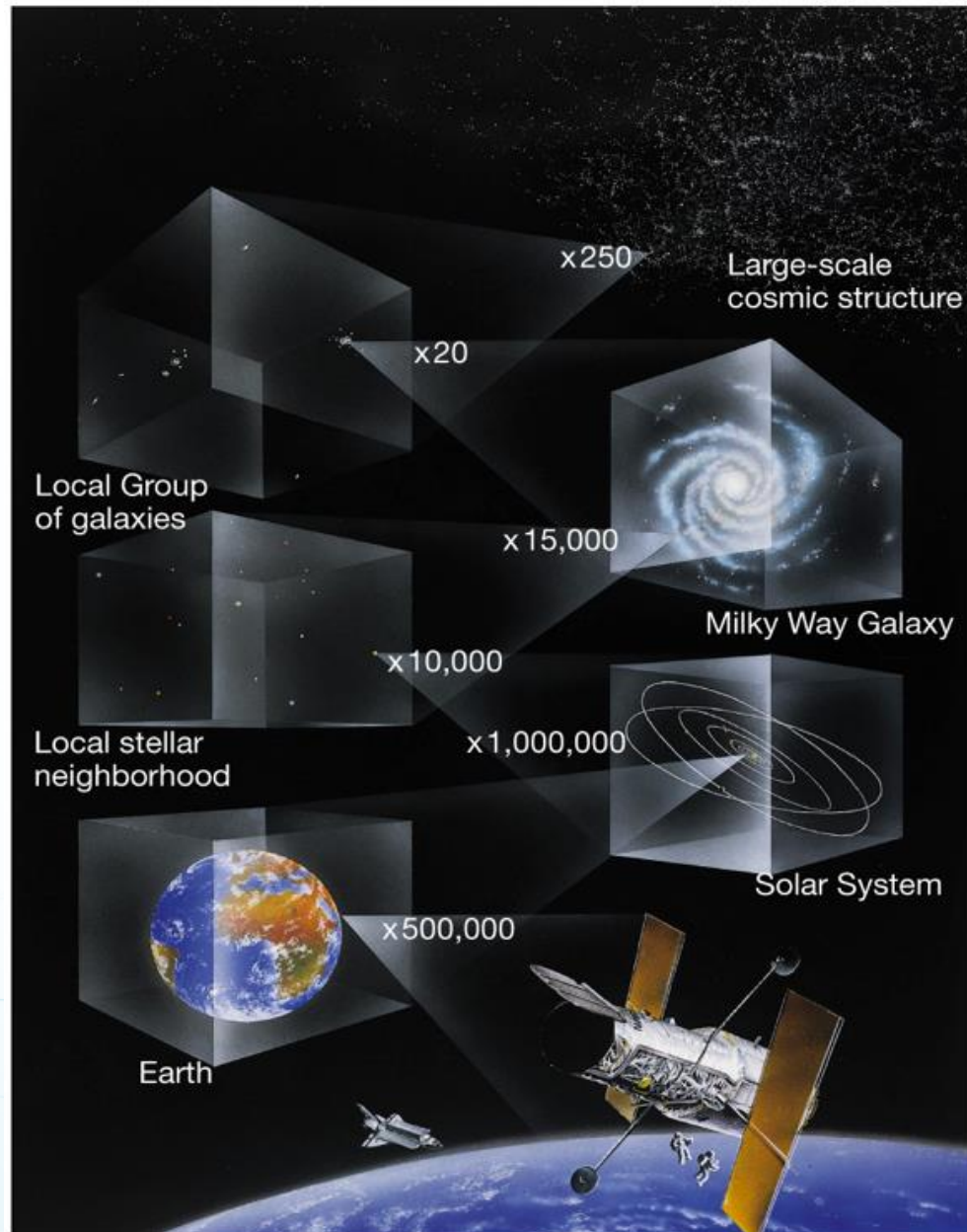
CREDIT: PHL @ UPR Arecibo (phl.upr.edu) August 24, 2016

Where are we?

Our Solar system is located 28,000 ly away from the center of the Galaxy, in the Galactic plane, on Orion Arm.



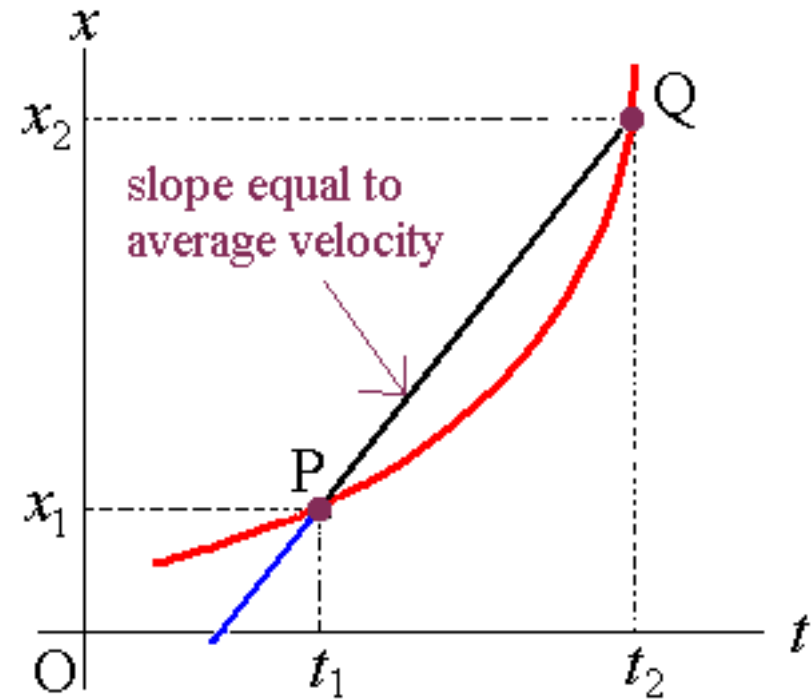
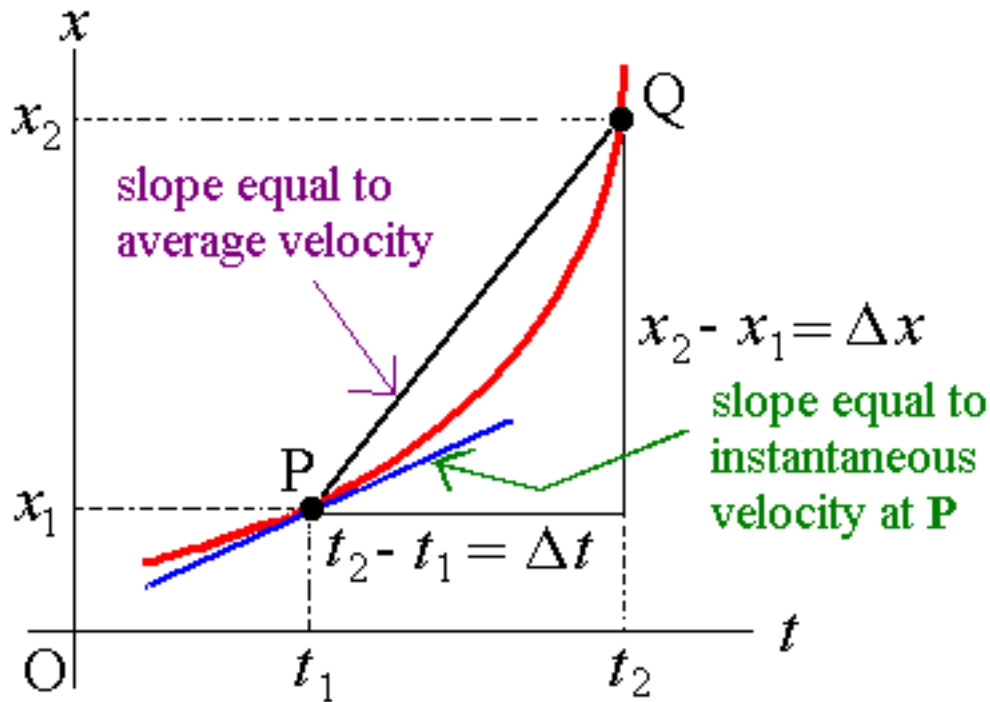
Our place in the Universe?



Terms for describing motion

Quantity	Definition	Vector/ Scalar	SI Unit
Position (\vec{x})	The position (location) of the object with respect to a reference point (origin)	Vector	m
Distance (x)	How much path the object has covered (every step counts!)	Scalar	m
Displacement ($\Delta\vec{x}$)	Change in position [$\Delta\vec{x} = \vec{x}_f - \vec{x}_i$]	Vector	m
Speed (v)	<i>Distance</i> traveled per unit time	Scalar	m/s
Velocity (\vec{v})	Change in position (= displacement) per unit time [= $\Delta\vec{x}/\Delta t$]	Vector	m/s
Acceleration (\vec{a})	Change in velocity per unit time [= $\Delta\vec{v}/\Delta t$]	Vector	m/s ²

Instantaneous velocity on a graph

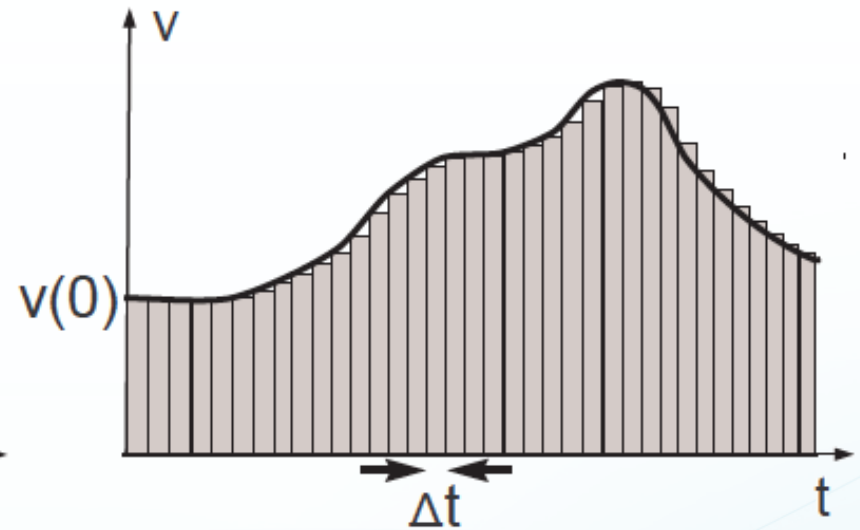
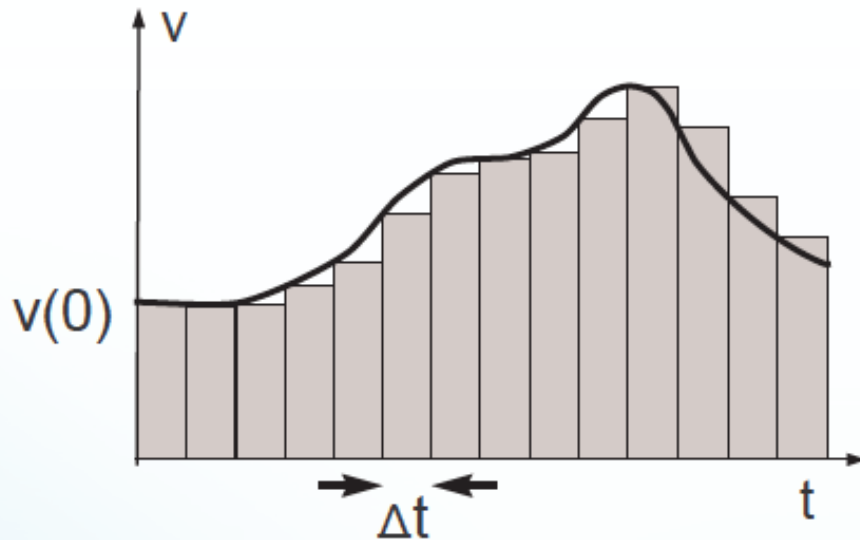


check the steepness of the slope;
steeper means higher speed.

$$v_{\text{inst}} = \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t} = \boxed{\frac{dx}{dt}}$$

Derivative!

INTEGRAL and AREA under the CURVE



$$x(t) - x(0) = \lim_{\Delta t \rightarrow 0} \sum_{n=0}^{N-1} v(n\Delta t) \Delta t = \int_0^t v(t') dt'$$

Integral!

5-Step Problem Solving Strategy

(1) Comprehend the problem

the group agrees on quantitative description of the problem

(2) Represent the problem in formal terms

the group agrees on givens, unknowns, and qualitative description of what they need to find, by also listing related concepts to be applied in the problem

(3) Plan a solution

the group agrees on how to solve the problem quantitatively

(4) Execute the plan

each student solves the problem **individually** first, and then compare the solutions with the other members of the group

(5) Interpret and evaluate the solution

the group discusses what they found, which one is correct, if the answer makes sense, etc.

Group Problem

You go to the Moon and throw a ball. Choosing the +y direction upwards, the vertical velocity as a function of time is given by $v_y(t) = -1.6t + 12$ m/s (assume that the ball moves only in y direction).

- Sketch the vertical velocity vs. time graph for $t = 0$ to 15 s.
- Find the acceleration and position of the ball at $t = 10$ s.
- Describe the ball's motion at $t = 10$ s.
- Find the average speed and average velocity between $t = 0$ and $t = 15$ s.

Answers: (b) $a = -1.6$ m/s² = g_{moon}

$Y = 40$ m

(d) Avg speed = 6 m/s

Avg velocity = 0 m/s