A lesson on Gravity and the Solar System

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Our Solar System

Solar System Map - showing size, mass and orbital period, and orbit scale of planets & dwarf planets [http://www.theplanetstoday.com/the_planets.html]
Solar System: formation, components, limits

- How did it form? From a giant cloud of dust and gas that began to collapse 5 Byears ago under its own gravity. Atoms melt down.
- At the center of this spinning cloud, a star began to form, and grew larger as it collected more dust and gas that collapsed into it.
- Further away, smaller clumps of dust and gas were also collapsing.
- The star eventually ignited forming our Sun, while the smaller clumps became the planets, minor planets, moons, comets, and asteroids.
- Nuclear reaction, the Sun's powerful solar winds began to blow: atomic particles blown outwards pushed remaining gas and dust away from SS.
- Inner planets are rocky and smaller. Outer planets grew larger, accumulating lots of gas, more than dust. (E-S ~ 93 million miles)
- SS made up of over 100 worlds (planets+moons), which are fascinating.
- Asteroids and minor planets: Asteroid and Kuiper Belts, Oort Cloud.
- Heliosphere extends out to a distance of 15 billion miles, more than 160 times the Sun-Earth distance: solar winds mix with stars’ winds.

[http://www.kidsastronomy.com/solar_system.htm]
Auxiliary: Q & A quiz

- Those of you who think the Sun is going around the Earth, please rise your hands! ---Now the opposite....
- How long does it take a light signal from the Moon to reach the Earth? 1 s. And from the Sun? Over 8 min. (1 ly ~ 6,000 B miles)
- How far is the star nearest to the Sun? Proxima Centauri is 4.24 lightyears away. The dual system a Centauri some .24 ly from it: they form a triple.
- There are some 2,100 exoplanets around 1,340 star. From 100 stars <20 ly away, only 3 have exoplanets: forming a solar system is not so easy.
- What are the smallest components of living things, rocks, everything? ---Cells, atoms, nucleus, electron, proton, quarks...
- What’s a nuclear reaction? ---Atoms are disrupted, recombine...
- P.3 Why the Moon does not escape from the Earth? ---Gravity. Galileo: leaning tower of Pisa, free fall; Earth not center of Universe; Jupiter moons [1610:4 Ganimede (>Mercury), Europa, Io, Calisto; now 67]
- P.4 Why the Moon does not fall towards the Earth? ---As sling. Gravity Earth-Moon: like invisible rope (thread)
- How many of did go to Italy?
- Where is the center of the Universe?
- How many different forces are there in Nature? ---Magnets (fridge), electricity, atoms, nuclei, radioactivity,…
- Do you know what a nuclear plant is? And an H bomb?
- Did you hear about Black Holes? What’s a BH?
GRAVITY

Galileo Galilei
1564--1642

Isaac Newton
1642--1726

leaning tower of Pisa
THE SLING

- Tangential velocity
- Centripetal force, draw weight
- Radius, sling length
- Orbital frequency, angular velocity
- Projectile mass

Diagrams illustrating the mechanics of the sling.
GRAVITY IS

Gravity is the main force of all (electromagnetic, strong, weak)

It is the weakest of all forces of Nature

But the most important force in the Universe

It helped create the Sun, the Planets of the Solar System, out of dust and gas

By bringing huge amounts of matter close together, it provides the conditions for the nuclear fusion reactions in the Sun and all the other Stars: $\text{H} + \text{H} \rightarrow \text{He} + \text{energy}$

When the mass is big enough it produces Black Holes

Gravitational Waves
The Sun

Diameter: 1,390,000 km.
Mass: 99.8% of the total mass of the Solar System.
Temperature: 5,800 K (surface) 15,600,000 K (core).
Pressure: 250 billion atmospheres (core).
Density: 150 times that of water (core).

Our Sun is a normal main-sequence star, one of more than 100 billion stars in our galaxy.
The Sun is in the top 10% by mass. The median size of stars in our galaxy is probably less than half the mass of the Sun. The Sun is about 4.5 billion years old.

The Greeks called it Helios and the Romans called it Sol.

The Sun is 70% hydrogen and 28% helium by mass, everything else amounts to 2%. This changes slowly over time as the Sun converts hydrogen to helium in its core.

At the equator the surface of the Sun rotates once every 25.4 days; near the poles it takes as much as 36 days.

The Sun's power (about 386 billion billion mega Watts) is produced by nuclear fusion reactions. Each second about 700,000,000 tons of hydrogen are converted to about 695,000,000 tons of helium. Temp. of corona over 1,000,000 K.
**Mercury**

Discovery: Known to the ancients and visible to the naked eye
Named for: Messenger of the Roman gods
Diameter: 3,031 miles (4,878 km)
Orbit: 88 Earth days
Day: 58.6 Earth days
Moons: None
Average Temperature: 332°F

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**Venus**

Discovery: Known to the ancients and visible to the naked eye
Named for: Roman goddess of love and beauty
Diameter: 7,521 miles (12,104 km)
Orbit: 225 Earth days
Day: 241 Earth days
Moons: None
Average Temperature: 850°F
Earth

Diameter: 7,926 miles (12,760 km)
Orbit: 365.24 days
Day: 23 hours, 56 minutes       Moons: 1
Earth's surface rotates about its axis at 1,000 mph at the equator. The planet zips around the sun at more than 18 miles per second
Average Temperature: 59° F

Mars

Discovery: Known to the ancients and visible to the naked eye
Named for: Roman god of war
Diameter: 4,217 miles (6,787 km)
Orbit: 687 Earth days
Day: 24 hours, 37 minutes       Moons: 2
Average Temperature: -81° F
Saturn
Discovery: Known to the ancients and visible to the naked eye
Named for: Roman god of agriculture
Diameter: 74,900 miles (120,500 km)
Orbit: 29.5 Earth years
Day: About 10.5 Earth hours
Moons: 30
Average Temperature: -218° F

Jupiter
Discovery: Known to the ancients and visible to the naked eye
Named for: Ruler of the Roman gods
Diameter: 86,881 miles (139,822 km)
Orbit: 11.9 Earth years
Day: 9.8 Earth hours
Average Temperature: -162° F
Uranus
Discovery: 1781 by William Herschel (was thought previously to be a star)
Named for: Personification of heaven in ancient myth
Diameter: 31,763 miles (51,120 km)
Orbit: 84 Earth years
Day: 18 Earth hours
Moons: 21
Average Temperature: -350°F

Neptune
Discovery: 1846
Named for: Roman god of water
Diameter: 30,775 miles (49,530 km)
Orbit: 165 Earth years
Moons: 8
Day: 19 Earth hours
Average Temperature: -353°F
Pluto (Dwarf Planet)

Discovery: 1930 by Clyde Tombaugh
Named for: Roman god of the underworld, Hades
Diameter: 1,430 miles (2,301 km)
Orbit: 248 Earth years
Day: 6.4 Earth day
Moons: 1
Average Temperature: -356° F

Luna (our Moon)

Diameter: 2,160 miles
Orbit around the Earth: every 29.5 Earth days
Rotation time: same as around the Earth
Temperature: ranges from -230° F to 220° F
Ever since the discovery of Pluto in 1930, kids grew up learning about the nine planets of our solar system. But in the late 1990s, astronomers began to argue about whether Pluto was a planet. The International Astronomical Union decided in 2006 to call Pluto a “dwarf planet,” reducing the list of “real planets” to 8.

However, astronomers are now hunting for another planet, a true ninth planet. Evidence of its existence was unveiled on Jan. 20, 2016. "Planet Nine" is about 10 times the mass of Earth (5,000 times the mass of Pluto).

- See more at: http://www.space.com/16080-solar-system-planets.html#sthash.lmyNKpse.dpuf