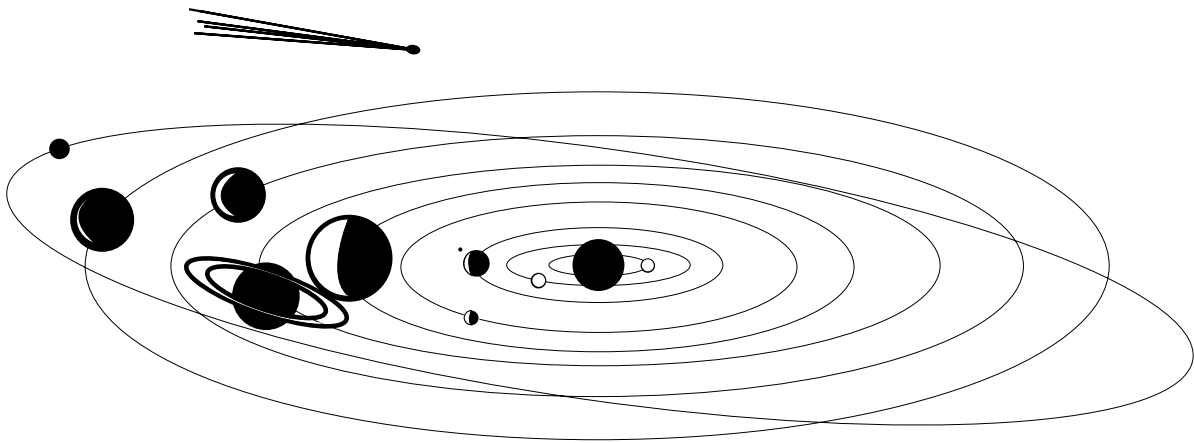

The Secret of the Cardboard Rocket



**A Study Guide Produced
by the Staff of
Craigmont Planetarium**

The Secret of the Cardboard Rocket

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THE SECRET OF THE CARDBOARD ROCKET
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The Secret of the Cardboard Rocket

An Overview of the Solar System

Mercury, Venus, Earth, and The Moon

Mercury

Average distance from Sun: 57,900,000 kilometers or 0.39 AU

Length of year: 88 Earth days

Length of day: 59 Earth days

Diameter: 4,880 kilometers

Gravity: 0.38 of Earth's (0.38g)

Composition: Basaltic (dark volcanic material) dust and rocks

Atmosphere: Virtually none

Satellites: None

Surface temperature: "Afternoon" temperature can rise well above 227 degrees K (441 degrees F) while at night the temperature can drop to -173 degrees C (-279 degrees F).

Surface appearance: Battered by meteorites, comets, asteroids; covered with craters, dust, and rock

Venus

Average distance from Sun: 108,200,000 km or 0.72 AU

Length of year: 224.7 days

Length of day: 243 days (5,832 hours)

Diameter: 12,100 km

Gravity: 0.91g

Composition: Basaltic (dark volcanic material) and granitic (hard volcanic) rocks

Atmosphere: Carbon dioxide, some hydrogen sulfide, sulfuric acid; dense cloud covering completely enveloping the planet, constant lightning displays; 90 times thicker than Earth's

Satellites: None

Surface temperature: Day and night temperature of 460 degrees C (860 degrees F), which is hot enough to melt lead; Cloud temperature ranges from 13.3 degrees C (56 degrees F) at the top to 220 degrees C (428 degrees F) at the bottom.

Surface appearance: Lighting is like an overcast day on Earth; landscapes rocky rubble or dusty, flat rock outcrops

Earth

Average distance from Sun: 149,000,000 km or 1.00 AU

Length of year: 365.25 days

Length of day: 23 hours, 56 minutes

Diameter: 12,756 km

Gravity: 1.00g

Composition: Basaltic (dark volcanic material) rock, dust

Atmosphere: Nitrogen, oxygen

Satellites: 1 moon

Surface temperature: Daytime range of -20 degrees C (-4 degrees F) to 45 degrees C (113 degrees) depending on season and location

Surface appearance: Rocky, top soil; mostly covered with water; ice caps at the north and south poles

The Moon

Average distance from Earth: 384,000 km or 239,000 miles

Orbital period: 27 days, 7 hours, 44 minutes

Diameter: 3,476 km/2,160 miles

Surface gravity: 0.16g

Composition: Basaltic (dark volcanic material) dust and rocks

Atmosphere: None

Surface temperature: Daytime can exceed 93 degrees C (200 degrees F); night temperature can drop to -129 degrees C (-200 degrees F)

Surface appearance: Battered by meteorites, comets and asteroids; covered with craters, dust and rock

The Secret of the Cardboard Rocket

An Overview of the Solar System

Mars, Phobos, and Deimos

Mars

Average distance from Sun: 227,900,000 km or 1.52 AU

Length of year: 687 days

Length of day: 24 hours, 37 minutes

Diameter: 6,787 km

Gravity: 0.38g

Composition: Basaltic (dark volcanic material) rock, dust

Atmosphere: Carbon dioxide, very thin

Satellites: 2 moons

Surface temperature: Usually below 0 degrees C (32 degrees F) but occasionally up to 27 degrees C (80 degrees F)

Surface appearance: Rocky, dusty; ice caps at north and south poles growing larger and smaller with seasons; dry channels—perhaps left over from a time when water flowed freely on the surface

Phobos

Average distance from Mars: 9,400 km or 5,850 miles

Orbital period: 7 hours, 40 minutes

Diameter: 21 km/13 miles

Gravity: 0.0008g

Composition: Basaltic (dark volcanic material) rocks

Atmosphere: None

Surface temperature: -100 degrees C (-148 degrees F) on sunlight side, -150 degrees C (-238 degrees F) on night side

Surface appearance: Entirely covered with craters and rock

Deimos

Average distance from Mars: 23,500 km or 14,600 miles

Orbital period: 1 day, 6 hours, 19 minutes

Diameter: 12 km/7.3 miles

Gravity: 0.0003g

Composition: Basaltic (dark volcanic material) rocks

Atmosphere: None

Surface temperature: -100 degrees C (-148 degrees F) on sunlight side, -150 degrees C (-238 degrees F) on night side

Surface appearance: Entirely covered with craters and rock

The Secret of the Cardboard Rocket

An Overview of the Solar System

Jupiter and its Galilean Satellites

Jupiter

Average distance from Sun: 778,300,000 km or 5.2 AU

Length of year: 11.9 years

Length of day: 9 hours, 55 minutes

Diameter: 142,800 km

Gravity: 2.54g

Composition: Scientists do not agree whether Jupiter has a rocky core. Some believe Jupiter consists only of gases that condense in the middle to form liquids. The primary constituents of the interior ocean are hydrogen and helium.

Atmosphere: Hydrogen, helium, some methane and ammonia

Satellites: 16 moons, one ring; Some of the moons are twice as large as Earth's Moon

Surface temperature: About 127 degrees C (261 degrees F) in its interior ocean, -123 degrees C (-189 degrees F) at the cloud tops, 13,500 – 35,000 degrees C (24,300 – 63,000 degrees F) in the center; Jupiter radiates twice as much heat as it receives from the Sun.

Surface appearance: Probably a hydrogen ocean

Io

Average distance from Jupiter: 422,000 km or 262,000 miles

Orbital period: 1 day, 18 hours, 28 minutes

Diameter: 3,630 km/2,250 miles

Gravity: 0.188g

Composition: Basaltic (dark volcanic material) rocks and dust

Atmosphere: None

Surface temperature: -150 degrees C (-238 degrees F) on sunlight side, -190 degrees C (-310 degrees F) on night side

Surface appearance: Craters, rock; known to have active volcanoes releasing sulfur onto surface

Europa

Average distance from Jupiter: 671,000 km or 417,000 miles

Orbital period: 3 days, 13 hours, 13 minutes

Diameter: 3,140 km/1,950 miles

Gravity: 0.137g

Composition: Water ice and carbon dioxide ice

Atmosphere: None

Surface temperature: -150 degrees C (-238 degrees F) on sunlight side, -190 degrees C (-310 degrees F) on night side

Surface appearance: Entirely covered with ice, possibly an ocean layer under the ice

Ganymede

Average distance from Jupiter: 1,070,000,000 km or 665,000 miles

Orbital period: 7 days, 3 hours, 43 minutes

Diameter: 5,260 km/3,270 miles

Gravity: 0.15g

Composition: Basaltic (dark volcanic material) rocks and ice

Atmosphere: None

Surface temperature: -150 degrees C (-238 degrees F) on sunlight side, -190 degrees C (-310 degrees F) on night side

Surface appearance: Entirely covered with craters and rock

Callisto

Average distance from Jupiter: 1,885,000 km or 1,170,000 miles

Orbital period: 16 days, 16 hours, 32 minutes

Diameter: 4,800 km/2,930 miles

Gravity: 0.13g

Composition: Basaltic (dark volcanic material) rocks and ice

Atmosphere: None

Surface temperature: -150 degrees C (-238 degrees F) on sunlight side, -190 degrees C (-310 degrees F) on night side

Surface appearance: Entirely covered with craters and rock

The Secret of the Cardboard Rocket

An Overview of the Solar System

Saturn, Titan, Uranus, and Miranda

Saturn

Average distance from Sun: 1,427,000,000 km or 9.5 AU

Length of year: 29.5 years

Length of day: 10 hours, 40 minutes

Diameter: 120,000 km

Gravity: 1.08g

Composition: Again, scientists are not sure if the planet has a rocky core. The entire planet has a density less than water —

Saturn would float if you could find a big enough ocean.

Atmosphere: Hydrogen, helium, some ammonia and methane

Satellites: 22 moons, 23 major rings. The entire ring system is only about half mile thick when viewed edge on, but is 275,000 km in diameter. The ring particles are either composed of water or coated with it. Most of them are from the size of marbles to basketballs, but a few reach sizes as large as 60 miles across.

Surface temperature: At the cloud tops, the temperature is -190 degrees C (-300 degrees F). Like Jupiter, Saturn also radiates more heat than it receives from the Sun.

Surface appearance: Probably covered with an ocean of hydrogen

Titan

Average distance from Saturn: 1,221,000 km or 759,000 miles

Orbital period: 15 days, 22 hours, 41 minutes

Diameter: 5,150 km/3,200 miles

Gravity: 0.141g

Composition: rock and ice

Atmosphere: Extensive nitrogen atmosphere with a surface pressure 1.6 times that of Earth. Atmosphere is colored orange by a smog of organic material

Surface temperature: -320 degrees C (-544 degrees F)

Surface appearance: Uncertain; possibly methane oceans, ice, and rock

Uranus

Average distance from Sun: 2,870,000,000 km or 19.2 AU

Length of year: 84 years

Length of day: 17 hours, 14 minutes

Diameter: 51,200 km

Gravity: 0.91g

Composition: Possible rocky core overlaid with methane, water, and ammonia ice covered with a liquid hydrogen ocean

Atmosphere: Helium, hydrogen, methane

Satellites: 15 moons, 9 rings

Surface temperature: At cloud tops -195 degrees C (-320 degrees F); definitely very cold

Surface appearance: Possibly a liquid surface, but no one knows for sure

Miranda

Average distance from Uranus: 129,900 km or 80,700 miles.

Orbital period: 1 day, 9 hours, 55 minutes.

Diameter: 485 km/300 miles.

Gravity: 0.0089g

Composition: Rock and ice.

Surface temperature: -195 degrees C (-320 degrees F).

Surface appearance: One of the most varied surfaces, with features including mountains, craters, and giant cliffs

The Secret of the Cardboard Rocket

An Overview of the Solar System

Neptune, Triton, Pluto, and Charon

Neptune

Average distance from Sun: 4,497,000,000 km or 30.1 AU

Length of year: 165 years

Length of day: 18 hours, 25 minutes

Diameter: 48,600 km

Gravity: 1.19g

Composition: Ice, hydrogen, helium

Atmosphere: Hydrogen, helium, methane

Satellites: 2 large moons, 4+ smaller moons, possibly rings or ring arcs

Surface temperature: At cloud tops -205 degrees C (-340 degrees F).

Surface appearance: Possibly a liquid surface, but no one knows for sure

Triton

Average distance from Neptune: 354,000 km or 220,000 miles.

Orbital period: 5 days, 21 hours, 3 minutes.

Diameter: 2,720 km/1,690 miles. Gravity: Uncertain.

Composition: Rock and ice.

Surface temperature: -200 degrees C (-340 degrees F).

Surface appearance: There are many craters and bright patches of ice and a few geysers of nitrogen gas.

Pluto

Average distance from Sun: 5,900,000,000 km or 39.4 AU

Length of year: 248 years

Length of day: 6 days, 9 hours

Diameter: 2,300 km

Gravity: .05g

Composition: Probably rock covered with methane ice

Atmosphere: Perhaps a thin atmosphere of methane produced by warmer temperatures when Pluto is closest to the Sun

Satellites: One moon

Surface temperature: About -215 degrees C (-360 degrees F)

Surface appearance: Scientists suppose Pluto's rocky surface to be covered with ice. There are no plans to send a probe to discover what it's really like.

Charon

Average distance from Pluto: 19,100 km or 12,000 miles.

Orbital period: 6 days, 9 hours, 17 minutes.

Diameter: 1,285 km/800 miles.

Gravity: Uncertain.

Composition: Probably ice and rock

The Secret of the Cardboard Rocket

Glossary

Asteroid – Hydrogen

Asteroid	Small rocky worlds of the Solar System, most in orbit between Mars and Jupiter. There are about 7,000 known asteroids.
Atmosphere	Gases surrounding a world, held close to the world by its gravity.
Axis	An imaginary line between the poles of a world around which a planet rotates.
Carbon dioxide (CO ₂)	A colorless, odorless, tasteless gas found on Earth, Venus, Mars, and other worlds.
Ceres	The largest asteroid, spherical in shape, and the size of Texas.
Charon	The icy moon of Pluto, about half the diameter of Pluto.
Coma	Evaporated gas and dust from the surface of a comet nucleus that can expand to more than the size of a planet.
Comet	“Dirty snowball,” a few miles across, made of water, carbon dioxide, ice, rock, and dust similar to the early Solar System, with a highly elliptical solar orbit.
Continent	A major land mass higher than the surrounding area.
Crater	A circular depression left as a result of an impact of asteroids or comets, or a volcanic eruption.
Earth	The third planet from the Sun and the only one known to sustain life.
Elliptical	Shaped like an ellipse, or a stretched circle.
Eruption	The ejection of material or gas from beneath the surface of a world.
Evaporate	The process of changing a liquid into a gas.
Fusion	The joining of atomic nuclei.
Gas	A phase of matter where atoms are far apart.
Gravity	The gravitational attraction of a world that accelerates or pulls another mass to it.
Great Dark Spot	A major feature of Neptune’s atmosphere, a hurricane-like storm the size of Earth.
Great Red Spot	A major feature of Jupiter’s atmosphere, a hurricane-like storm more than twice the size of Earth.
Greenhouse Effect	A cycle that stores more heat energy in an atmosphere than it releases.
Heat	Energy due to a temperature difference between a source and a destination.
Helium (He)	Chemical element number 2, a colorless gas, the second most common atom in the Universe.
Hydrogen (H)	Chemical element number 1, a colorless gas, the lightest and the most common atom in the Universe.

The Secret of the Cardboard Rocket

Glossary

Hurricane – Solar System

Hurricane	A powerful atmospheric disturbance with sustained high winds.
Impact	The collision of asteroids, comets, or meteors, releasing energy in the form of heat and sound.
Io	The closest of the four large moons of Jupiter. It has active volcanoes that erupt sulfur compounds and give it a multicolored appearance.
Jupiter	The fifth planet from the Sun and largest in the Solar System. Composed mostly of hydrogen, helium, methane, and ammonia.
Life	That property of plants and animals which makes it possible for them to take in food, convert it to energy, grow, and reproduce.
Mars	The fourth planet from the Sun, also known as the Red Planet.
Mass	The characteristic of a body's resistance to being accelerated.
Mercury	The first planet from the Sun; a cratered moon-like world.
Methane (CH ₄)	A colorless, flammable gas found on Earth, Jupiter, and other worlds.
Miranda	A moon of Uranus thought to have been shattered and reformed long ago.
Moon	A natural satellite orbiting a planet.
Neptune	The eighth planet from the Sun; a gas giant composed mostly of hydrogen and helium.
Nitrogen (N)	Chemical element number 7, a colorless and odorless gas forming 78% of our atmosphere.
Olympus Mons	A large active volcano on the planet Mars.
Orbit	The path of one world held in its revolution around another world by the force of gravity.
Planet	Any large, non-luminous body that revolves about a star.
Pluto	The ninth planet from the Sun and the smallest; an icy moon like world covered with red methane ice, polar ice caps and a thin ten-mile high atmosphere of methane gas.
Radar	An acronym for RAdio Detection And Ranging.
Revolution	The completion of a world's orbit. Earth revolves about the Sun once a year.
Rings	Small debris orbiting a world.
Rotate	To spin on an axis.
Saturn	The sixth planet from the Sun; a world with prominent rings.
Solar System	The Sun, or any star, and all planets, moons, asteroids, and comets orbiting it.

The Secret of the Cardboard Rocket

Glossary

Star – Weather

Star	A hot, luminous body of gas held together by its own gravity.
Storm	An atmospheric disturbance.
Sulfuric Acid (H ₂ SO ₄)	A strong mineral acid which is a colorless, oily liquid chemical found in some planets' atmospheres.
Sun	The star at the center of our Solar System.
Sunlight	Visible energy emitted from the Sun.
Tail	The trailing gas and dust in a comet, swept away by the Sun's energy. It can be 100 million miles in length.
Tilt	The leaning of a world's axis with respect to its orbital motion.
Titan	The largest moon of Saturn; it has a thick nitrogen atmosphere and possibly lakes of liquid methane.
Triton	The largest moon of Neptune; it has a thin atmosphere of methane and nitrogen.
Uranus	The seventh planet from the Sun; a gas giant composed mostly of hydrogen and helium.
Venus	The second planet from the Sun; cloud covered and the size of Earth.
Viking	A robot space probe that traveled to Mars to study its features from orbit and from the surface.
Volcano	A rocky world's vent for magma or other material.
Voyager	The two space probes that explored the gas giant planets.
Water (H ₂ O)	A colorless liquid essential to known life.
Weather	The environmental condition of a world's atmosphere.

The Secret of the Cardboard Rocket

Seek-a-Word Puzzle

Junior Astronaut Version



REFRIGERATOR
BOX
TAPE
PASTE
FOIL
SECRET
ROCKET

MOONS
MERCURY
VENUS
EARTH
MARS
JUPITER
SATURN

URANUS
NEPTUNE
PLUTO
UNIVERSE
SUN
GASES
BOOKS

AIR
POPCORN
REECES
PIECES
DANGER
EXPLORE
BEAUTIFUL

The Secret of the Cardboard Rocket

Seek-a-Word Puzzle

Challenger Version

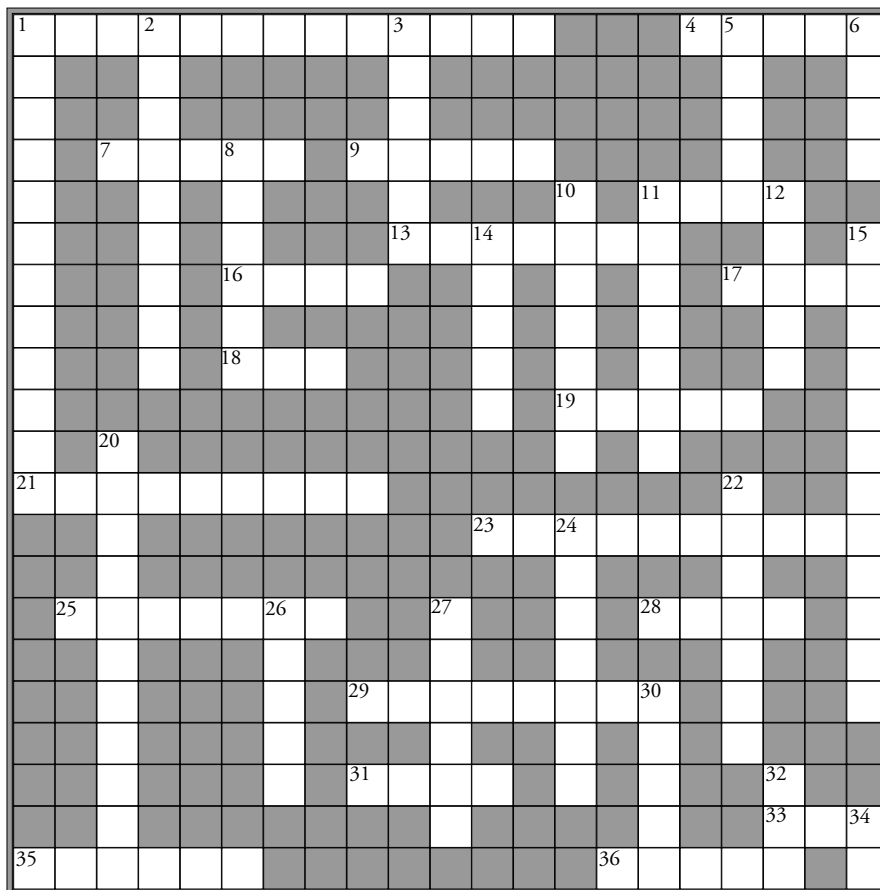
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C X S O H T E N A L P E E A O O U P E E Y O
N O I U O S G N I R G Y E T M Y E S P S G T
S U N S O M S U N A R U T S A L A A T U N U
G R S T P H Q K Y Z E A R T H T N E U N I L
V C A Y I Q N O P C U E O Q U I M A N E K P
X E S P R N V E O P F F O R C U Z O E V I E
H J G R E U E B E I W K N M A R S U D T V H
C O M E T F C N L R S C B J X J U P I T E R
I N I S S A C R T A G A Z O B T K T D C N N
E V A P O R A T E L F S Z G D B Z S S A M A
G E Y S E R S U M N M O I T U L O V E R U A

AXIS	GREENHOUSE	MERCURY	SATURN
CASSINI	HEAT	MOON	SYSTEM
COMA	HELIUM	NEPTUNE	STAR
COMET	IO	OORT	SUN
CONTINENT	JUPITER	PLANET	URANUS
EARTH	LIFE	PLUTO	VENUS
EVAPORATE	MARS	REVOLUTION	VIKING
GEYSERS	MASS	RINGS	VOYAGER

The Secret of the Cardboard Rocket

Crossword Puzzle and Clues

Cardboard Rocket Crossword



ACROSS

- 1 Neptune storm (3 words)
- 4 An astronomer's most important tool is his/her...
- 7 Earth's twin in size is...
- 9 Type of eclipse when Moon enters Earth's shadow
- 11 The "red" planet
- 13 Named for the Roman god of the sea
- 16 Number of planets in our solar system
- 17 As the world turns..., it turns on this
- 18 What the planets orbit
- 19 Our home planet
- 21 Number of asteroids in the solar system
- 23 Surrounding our solar system is the Oort _____ (2 words)
- 25 Depressions on the Moon

- 28 Roman name for our Moon
- 29 Number of comets in our solar system
- 31 Earth's nearest neighbor
- 33 Roman name for our Sun
- 35 They develop tails when near the Sun
- 36 Path of a planet or moon

DOWN

- 1 Jupiter storm (3 words)
- 2 Space rocks too small to be planets or moons
- 3 Planet first discovered to have rings
- 5 Magellan spacecraft uses _____ to see Venus (an acronym)
- 6 National space agency (abbreviation)
- 8 Orbits the Sun on its side
- 10 Largest planet

- 11 Planet closest to the Sun
- 12 Number of moons in our solar system
- 14 Smallest planet
- 15 It lies between Mars and Jupiter (2 words)
- 20 The Sun and its family (2 words)
- 22 They orbit stars
- 24 "Falling" or "shooting" stars
- 26 Gas giants have these
- 27 Color of our Sun
- 30 Type of eclipse when the Moon covers up the Sun
- 32 Central Standard Time (abbreviation)
- 34 Lunar Module (abbreviation)

The Secret of the Cardboard Rocket

Crossword Puzzle Solution

Cardboard Rocket Crossword Solution

1	G	R	E	2	A	T	D	A	R	K	3	S	P	O	T				4	B	5	R	A	I	6	N			
	R			S								A										A			A				
	E			T								T										D			S				
	A		7	V	E	N	8	U	S		9	L	U	N	A	R						A			A				
	T			R				R									10	J		11	M	A	R	12	S				
	R			O				A				13	N	E	14	P	T	U	N	E			I		15	A			
	E			I				16	N	I	N	E				L		P		R			17	A	X	I	S		
	D			D				U								U		I		C				T		T			
	S			S				18	S	U	N					T		T		U				Y		E			
	P															O		19	E	A	R	T	H			R			
	O			20	S													R		Y						O			
21	T	H	O	U	S	A	N	D	S														22	P		I			
				L												23	C	O	24	M	E	T	C	L	O	U	D		
				A															E				A			B			
				25	C	R	A	T	E	26	R	S			27	Y				T		28	L	U	N	A	E		
				S												E				E				E		L			
				Y					N	29	B	I	L	L	I	O	N	30	S				T			T			
				S					G						L			R		O		S							
				T					S	31	M	O	O	N		S				L				32	C				
				E											W							A			33	S	O	34	L
35	C	O	M	E	T	S																36	O	R	B	I	T		M

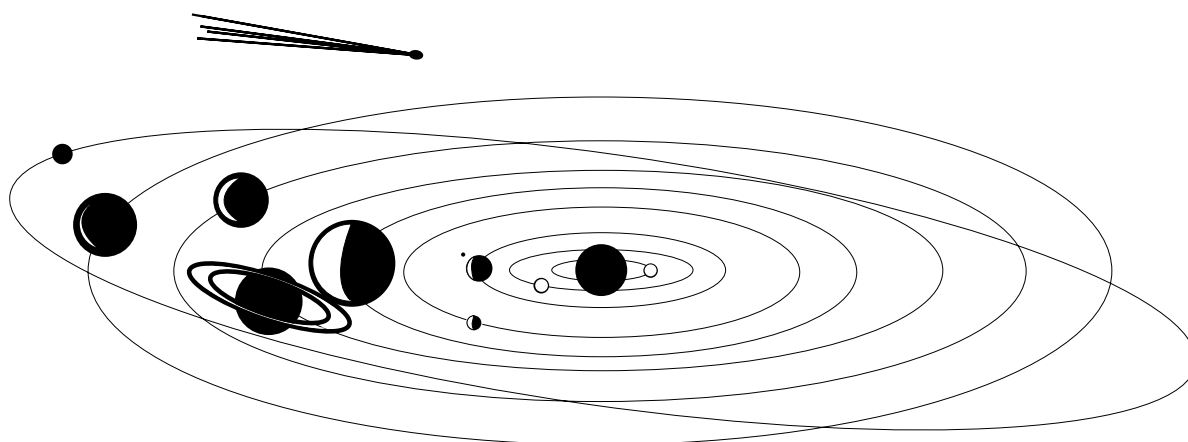
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Solar System Song

Here's a musical way to learn the names of the planets, their order of appearance in the solar system, and the concepts of rotation and revolution. Begin the activity by explaining that there are nine known planets in our solar system, all of which revolve around the Sun. As each planet revolves, it also rotates, or turns on its axis.

Talk about each planet and some of its unusual characteristics, for example, Mars' reddish color, Saturn's rings, Jupiter's red spot, etc. Point out where each planet is in relation to the Sun.

When you've finished talking about the planets, have the children form a big circle. Have them act out the following song, which is sung to the tune of When Johnny Comes Marching Home Again:



Solar System Song

WORDS

The planets revolve around the Sun, hurrah, hurrah.
The planets revolve around the Sun, hurrah, hurrah.
The planets revolve around the Sun,
And spin on their axis, every one.
And they all go spinning,
Around and around they go.

Mercury, Venus, Earth, and Mars, hurrah, hurrah.
Mercury, Venus, Earth, and Mars, hurrah, hurrah.
Mercury, Venus, Earth, and Mars
All whirling and twirling among the stars.
And they all go spinning,
Around and around they go.

Jupiter and Saturn are next in line, hurrah, hurrah.
Jupiter and Saturn are next in line, hurrah, hurrah.
Jupiter and Saturn are next in line.
Uranus, Neptune, and Pluto make nine.
And they all go spinning,
Around and around they go.

MOVEMENTS

Children form a big circle, join hands, and walk around in a circle. (Have someone act as the Sun and stand in the middle.)

Children drop hands and turn around in a small circle.

Children join hands and continue walking around the circle.

Children drop hands and turn around in a small circle.

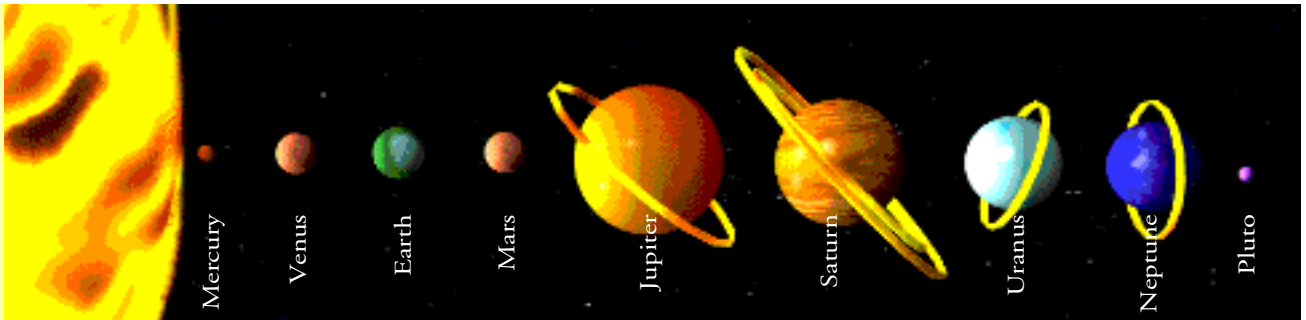
Children join hands and continue around in a circle.

Children drop hands and turn around in a small circle.

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Scale Model Solar System

Scale Model Solar System



Drawing a scale diagram of the solar system is difficult. If the planets' relative sizes are depicted accurately, then you cannot show the proper spacing between the planets on a single page. If the distances are to the same scale, then the inner planets' orbits are too crowded together.

One solution is to use a large enough piece of paper to show the sizes of the planets and their distances from the Sun to the same scale. A roll of adding machine tape is the proper length to make a very impressive scale model of the solar system. Use a meter stick, not a yard stick, to do your measuring. The chart below will show the proper relative sizes of the planets and their distances from the Sun. Even on this large scale some of the planets' sizes will have to be represented by the smallest dot your pencil can make.

Solar System Object	Approximate Diameter in Millimeters	Approximate Distance in Meters
Sun _____	10.00 _____	0.00 _____
Mercury _____	0.04 _____	0.40 _____
Venus _____	0.10 _____	0.70 _____
Earth _____	0.10 _____	1.00 _____
Mars _____	0.05 _____	1.52 _____
Asteroid Belt _____	0.01 _____	2.80 _____
Jupiter _____	1.00 _____	5.20 _____
Saturn _____	1.00 _____	9.50 _____
Uranus _____	0.50 _____	19.20 _____
Neptune _____	0.50 _____	30.10 _____
Pluto _____	0.03 _____	39.40 _____

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