

"ASTEROIDS, COMETS & METEORS" TEACHER'S GUIDE

This Teacher's Guide is designed to help you, the teacher, better prepare your students for their upcoming presentation of *Asteroids, Comets & Meteors* when the Northern Stars Planetarium visits your school. This guide contains background information and a few worksheets that you can copy and distribute to your students. Please remember, this guide is for teachers grades 3-8, so some of it may be either too advanced or too simple for your students, depending on your grade level. Use only what you feel is appropriate for your class.

PROGRAM OUTLINE

I. Asteroids

- A. Main Belt between Mars and Jupiter
 - 1. Sizes and spacing
 - 2. *NEAR/Shoemaker* Space Probe Encounters Eros
 - 3. Where did they come from?
 - 4. Two different types
 - a. stony/bright inner asteroids
 - b. carbon-based/dark outer asteroids
- B. Apollo Asteroids – Earth crossing asteroids
 - 1. Icarus – a sun grazer
 - 2. Could they ever hit Earth?
- C. Trojan Asteroids – asteroids in Jupiter's orbit
- D. Chiron – beyond the orbit of Saturn – asteroid or comet?

II. Comets

- A. How do comets move?
 - 1. Do they zip through the sky? (no!)
 - 2. Plotting a comet's path over the course of several nights
 - 3. Orbits
- B. What are comets and what are their parts?
 - 1. Dirty, snowy mud-balls
 - 2. Parts of a comet and how they form
- C. Giotto space probe and Halley's Comet
- D. Two views of Halley's Comet – a pop quiz!!
- E. Comet Shoemaker/Levy hits Jupiter
- F. Kuiper Belt and Pluto
- G. The Oort Cloud – where comets come from

III. Meteors

- A. What are meteors? How do they work? How big are they?
- B. Meteor Showers
 - 1. What causes meteor showers?
 - 2. When do meteor showers happen?
- C. Bolides – or the really big ones!!
 - 1. Barringer Crater, Arizona
- D. Meteorites
 - 1. Iron meteorites
 - 2. Stony and carbonaceous meteorites

ASTEROIDS INFORMATION SHEET

Asteroid: A object too small to be classified as a planet. Sizes range from 1000 km (just over 620 miles) in diameter to less than 1 km (1/2 mile). They are also called “Minor Planets” or “Planetoids.”

GROUPS OF ASTEROIDS CLASSIFIED BY ORBITS:

Apollo Asteroids: Asteroids that cross Earth's orbit.

Amor Asteroids: Asteroids that cross Mars' orbit, but not Earth's.

Trojan Asteroids: Asteroids found within the orbit of Jupiter. There are two groups of Trojan asteroids: one group is ahead of Jupiter in its orbit, the other is behind Jupiter in its orbit. The distance from Jupiter to each group is the same distance as from Jupiter to the Sun.

Asteroid Belt: The area between Mars and Jupiter where most asteroids are found. Asteroids found here are divided in nature. Those on the inside edge, nearer Mars, tend to be light-colored and stony. Those near the outside edge, nearer to Jupiter, tend to be very dark and made up of carbon compounds. There are also a few asteroids scattered through the inner and the beginning of the outer sections that tend to be made mostly of metals.

3 TYPES OF ASTEROID COMPOSITIONS:

C-Type Asteroids: Those asteroids made of carbonaceous materials, typical of the outer asteroid belt and the Trojan asteroids.

S-Type Asteroids: Those asteroids made of stony or silicate materials, typical of the inner asteroid belt.

M-Type Asteroids: Those asteroids made mostly of metals.

SOME ASTEROIDS OF NOTE:

CERES 1000 km (620 miles) in diameter – the largest asteroid. First asteroid discovered, in 1801. It is a C-Type found in the main belt.

CHIRON 300? km (186 miles) in diameter, or larger. Discovered in 1977, it is tentatively classed as a C-Type. It is unique because it's found between the orbits of Saturn and Uranus.

DACTYL 1.4 km (1 mile) in diameter. Photographed by the Galileo Space Probe, it's the first asteroid moon found. It orbits the asteroid named Ida.

EROS A cigar shaped asteroid that the NEAR/Shoemaker space probe investigated. The probe entered orbit around Eros on February 14, 2000 and crash landed there on February 14, 2001.

GASPRA The first asteroid photographed up close, by the Galileo Space Probe.

HECTOR A & B 230 km (142 miles) in diameter each. Actually, two C-Type Trojan asteroids that either orbit each other very closely, or actually touch. Both oblong shaped, they are the largest irregular shaped asteroids.

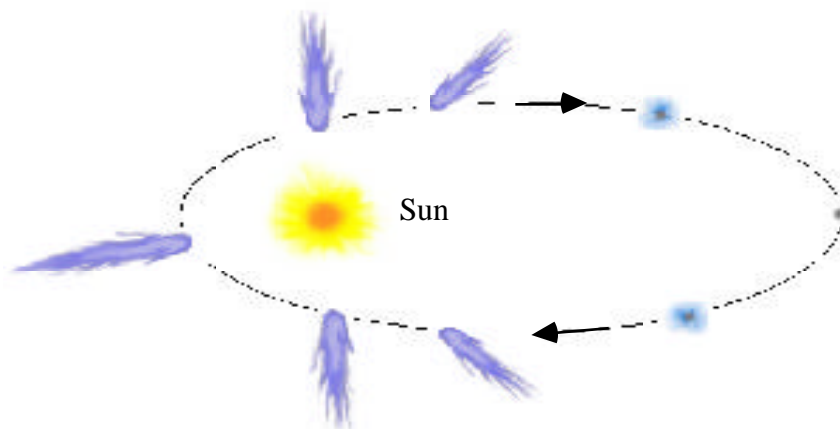
ICARUS 1 km (.62 miles) in diameter. Discovered in 1949, this Apollo asteroid's orbit passes very close to the Sun. When inside Mercury's orbit, it get so hot it is believed to glow red. In 1968, it passed less than 4 million miles from Earth! Astronomically, that's a close call!

IDA The second asteroid visited by the Galileo Space Probe on it's way to Jupiter. Ida was found to have a moon that orbits it. The moon was named Dactyl.

PSYCHE 256 km (159 miles) in diameter. Discovered in 1852. An M-Type found in the main belt. If its metal could be mined, it would supply all our metal needs for hundreds, perhaps thousands, of years.

VESTA 555 km (344 miles) in diameter. Discovered in 1807. It is an S-Type found in the main belt. It is the brightest asteroid and can occasionally be seen with the unaided eye. Its stony composition is largely basalt – a volcanic type of rock. This may be one of the few asteroids to have had volcanoes sometime in its distant past.

A TYPICAL COMET'S ORBIT SHOWING HOW THE TAIL GROWS AND ALWAYS POINTS AWAY FROM THE SUN:



COMET INFORMATION SHEET

PARTS OF A COMET:

Nucleus: The central solid mass of a comet. It is often called the “Dirty Snowball.” It’s made of about 85% water ice, with frozen carbon dioxide, carbon monoxide, methane, ammonia, dirt and dust mixed in. Nucleus sizes average from 1 km (.6 miles) to 20 km (12 miles) in diameter. Halley’s Comet’s nucleus was about 10 km (6 miles) in diameter. When comets are far from the Sun, the nucleus is all that exists; the coma and tail only form when the comet is close to the Sun.

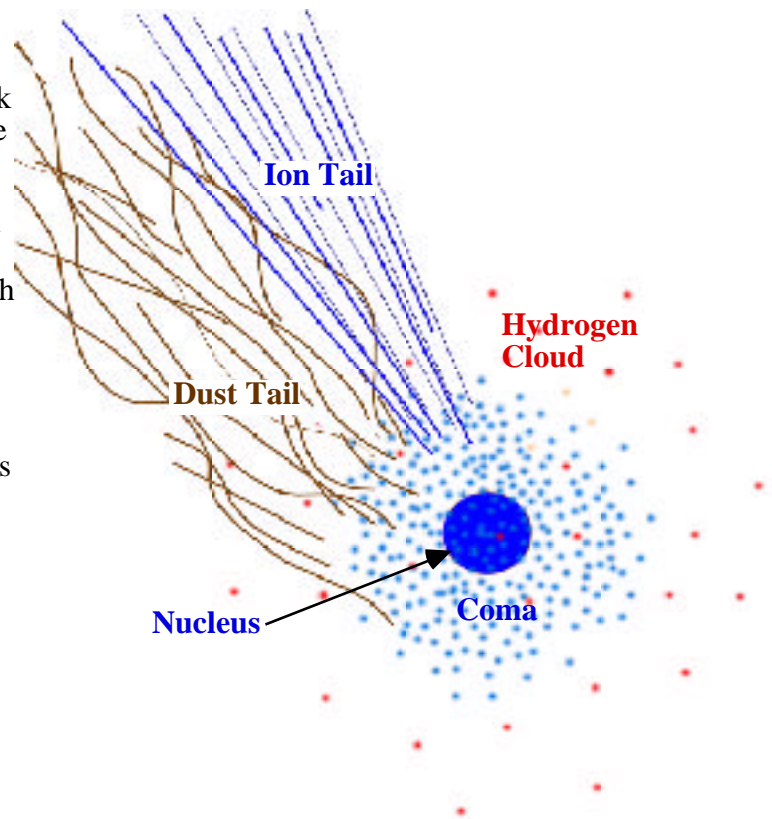
Coma: The large cloud of gas that melts and sublimates from the snowball due to heat from the Sun. It is often referred to as a fog bank surrounding the nucleus. The coma can reach a diameter of 200,000 km (124,000 miles), larger than the size of Jupiter.

Hydrogen Cloud: An even larger and more tenuous cloud that surrounds the coma, made of light hydrogen gas. This often is larger in volume than the size of the Sun.

Tail: The tail of the comet is simply the gases and dust of the coma being pushed back by the pressure of sunlight. The tail therefore does not drag behind – it points away from the Sun. The tail is the longest when the comet is closest to the Sun. Comet tails have been measured as long as 100 million miles! That’s greater than the distance between Earth and the Sun. The tail has two parts:

Ion Tail: The ionized gas (Gases that have lost electrons and carry an electrical charge are called ionized gases. This happens due to interaction with the solar energy.) that is pushed back away from the Sun by the solar wind. It often shines due to glowing particles.

Dust Tail: The dust particles released from the ice of the snowball as the ice sublimates (turns directly from a solid to a gas) into the coma. The dust tail shines by reflected light.



METEOR INFORMATION SHEET

WHAT IS A "SHOOTING STAR"?

Answer: A Meteor!!

Commonly called "Falling Stars" or "Shooting Stars," meteors really have nothing to do with stars. They are not even pieces of stars. They are simply "rocks" that are burning due to friction as they fall through Earth's upper atmosphere. 99.9% of all meteors seen are very small rocks no larger than single grains of sand or even specks of dust. The small particles are often the remains of dust and pebbles released from comets. The 0.1% remaining meteors are often larger and burn much brighter when falling to Earth. They are believed to be small pieces of asteroids.

1. **Meteoroid:** A small rocky object in space. Sizes may range from dust-sized to 1 km (.62 miles).
2. **Meteor:** The light we see streaking through the sky and then quickly disappearing. It is caused when a meteoroid enters Earth's upper atmosphere and ignites due to friction with the air. The light is actually the rock and the air burning together. They are usually 80-160 km (50-100 miles) high in the atmosphere.
3. **Meteorite:** The rock that makes it to the Earth's surface after surviving the journey through the Earth's atmosphere. Two types of meteorites are found: Stony and Iron/Nickel.

METEOR SHOWERS occur when Earth, during its journey around the Sun, crosses the path of a comet and picks up the dust and pebbles left behind by the slowly disintegrating comet. Each speck of material that collides with Earth burns up as a meteor; therefore, we see a greater number of meteors in a short period of time. And because Earth will always cross the same region of space each year at the same time, every year we will have a meteor shower on the same dates.

Meteors from a shower all seem to radiate out of one spot in the heavens. This spot is called the radiant and the shower is named for the constellation that the radiant is in. This effect is actually an illusion caused by the meteors falling parallel to each other, yet on all sides of us on Earth. Like two railroad tracks that seem to touch at the horizon when you stand between them, the meteors seem to all come from a point overhead.

SOME IMPORTANT METEOR SHOWERS

<i>Shower</i>	<i>Peak Date</i>	<i>Radiant Constellation</i>	<i>#/hour</i>	<i>Parent Comet</i>
Quadrantids *	Jan 3	Bootes	20-80	----
Zeta Bootids	Mar 12	Bootes	10	----
April Lyrids	Apr 22	Lyra/Hercules	5	Thatcher
Eta Aquarids	May 4	Aquarius	20	Halley
June Lyrids	Jun 15	Lyra	12	----
Delta Aquarids	Jul 30	Aquarius	35	----
Perseids *	Aug 12	Perseus/Cassiopeia	70	Swift-Tuttle
Orionids	Oct 21	Orion	35	Halley
Taurids	Oct 31	Taurus	12	Encke
Leonids *	Nov 17	Leo	10-100	Tempel-Tuttle
Geminids *	Dec 13	Gemini	58	----

**Denotes the most outstanding meteor showers each year.*

A RECIPE FOR A 13 POUND COMET

What exactly is a comet? It is made of materials that are fairly common and available. With a little preparation and a few simple precautions, you can build a comet right in your classroom. Here is the recipe for a 13 pound comet.

INGREDIENTS:

- 10 pounds of ice or snow
- 2 pounds of dry ice (frozen carbon dioxide). Hint: Ask your local chemistry teacher how to get some.
- 1 quart of oil (motor oil is most realistic, but for easy and environmentally safe disposal, cooking oil is recommended)
- 1 pint of sand
- 1 pint of dirt
- 2 tablespoons of iron filings
- 1 tablespoon of nickel filings
- a sprinkle of graphite (pencil lead)
- a dusting of mixed powdered minerals of your choice.

DIRECTIONS:

Step #1 Crush the ice and put it in a 5 gallon bucket.

Step #2 Crush the dry ice (be sure to wear gloves as dry ice is much colder than water ice. It can burn bare skin!) Add crushed dry ice to water ice in bucket.

Step #3 Add oil, sand, dirt, iron and nickel to the ices in the bucket.

Step #4 Stir and mix.

Step #5 Sprinkle in graphite and bits of asphalt (break asphalt into as small of pieces as possible).

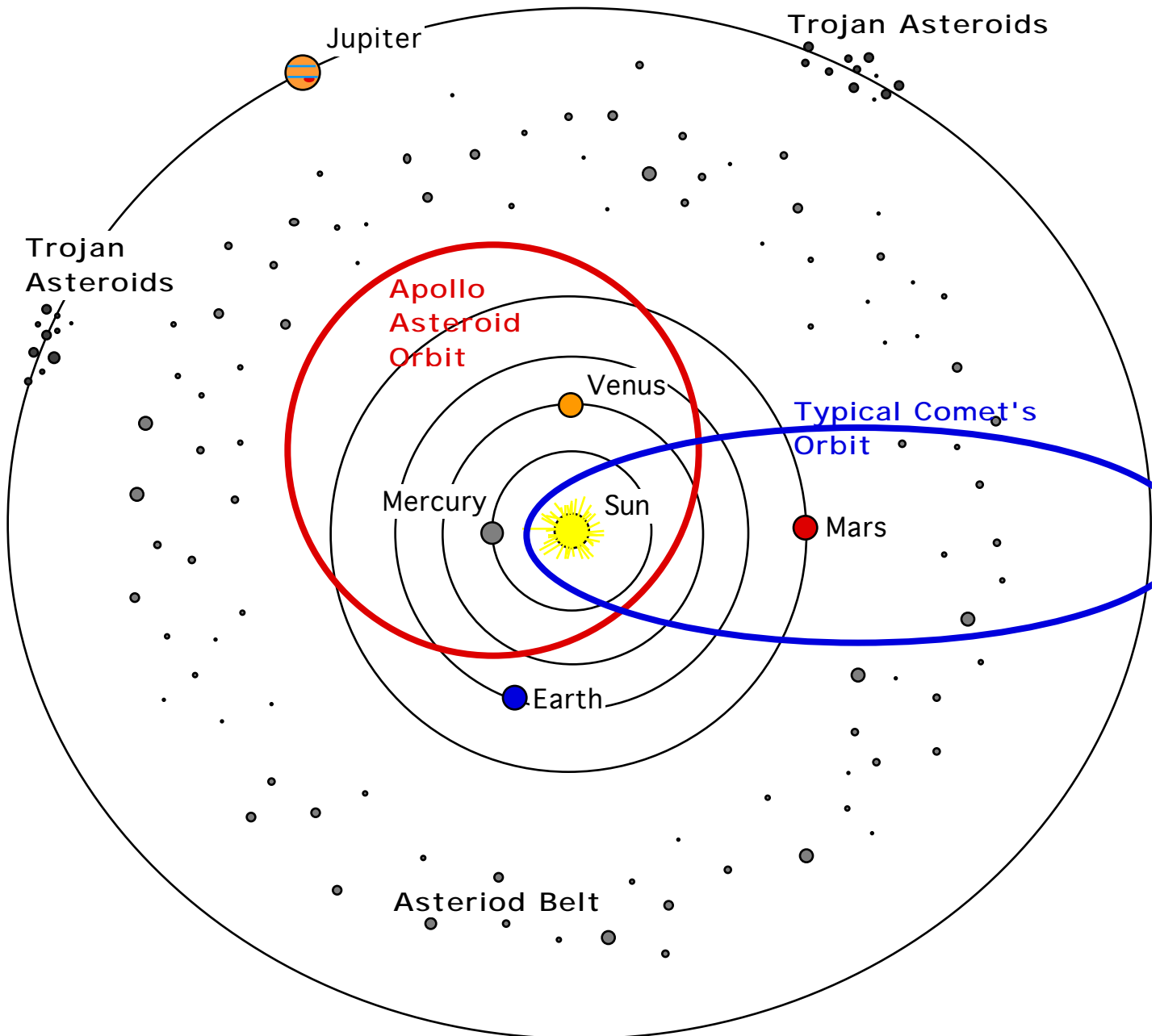
Step #6 Coat with powdered minerals as you like.

Step #7 Stir and compress into a ball. You now have yourself one dirty snowball – the definition of a comet nucleus!

Step #8 Contact NASA to get it launched on the next Space Shuttle flight !! (can be stored in a cold freezer)

Step #9 You must name your comet. All comets have names and a comet is named for the person who discovered it first, or perhaps in this case, who made it.

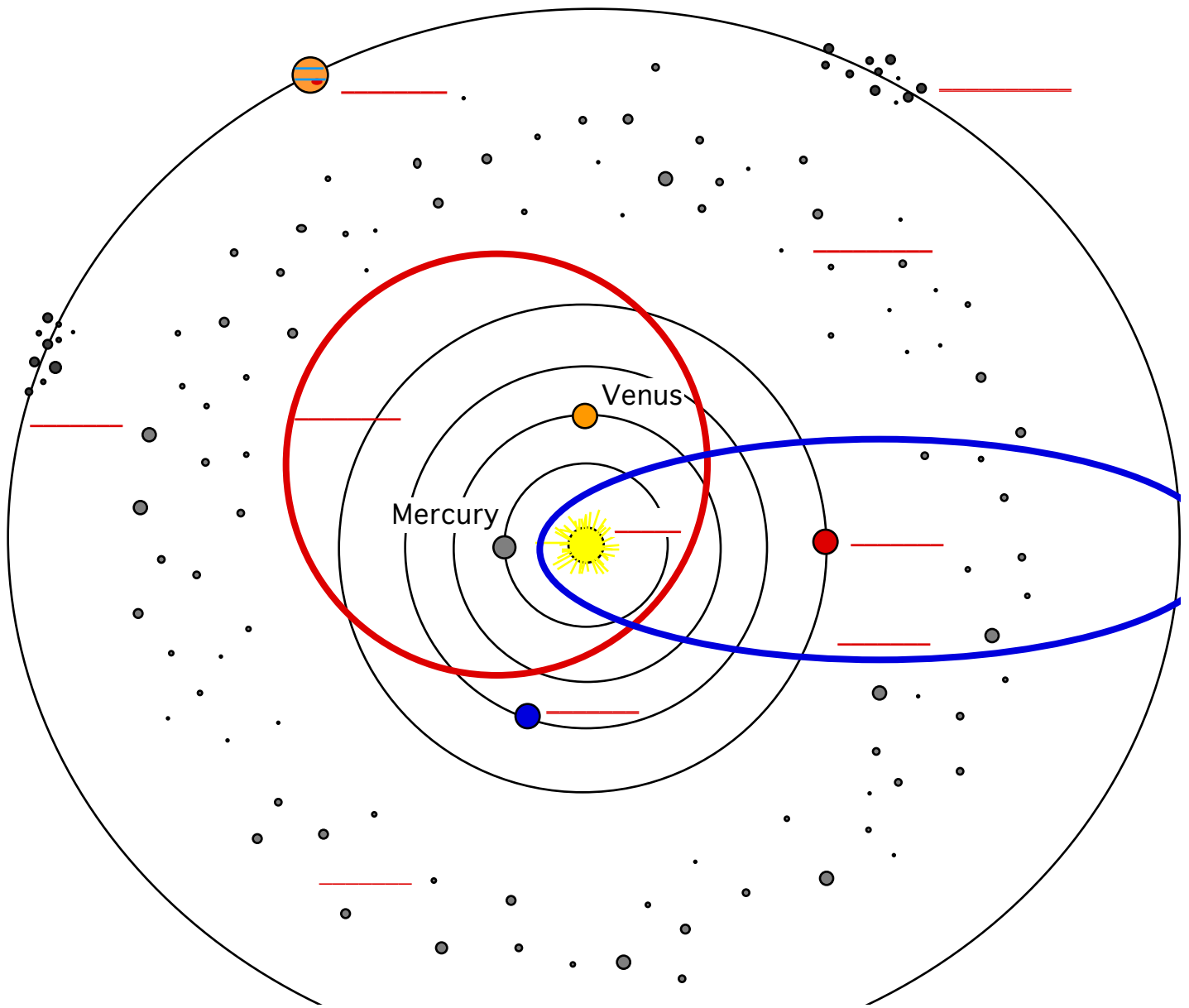
ORBITS OF ASTEROIDS & COMETS



GUESS WHICH ORBIT BELONGS TO WHAT OBJECT

Put the corresponding letters next to the correct orbits.

- A. Comet's Orbit
- B. The Sun
- C. Main Asteroid Belt
- D. Apollo Asteroid Orbit
- E. Trojan Asteroids
- F. Jupiter
- G. Mars
- H. Earth



TRUE OR FALSE

1. All asteroids are found between Mars and Jupiter. (F)
2. Comets are balls of fire flying through space. (F)
3. If you put all the asteroids together and made one planet from them, the new planet would be smaller than Earth's moon. (T)
4. Ceres, the largest asteroid, is also the brightest one. (F)
5. Shooting stars are really stars falling out of the sky. (F)
6. Comets are essentially dirty, snowy mud-balls in space. (T)
7. Comets are believed to come from a huge cloud of comets a thousand times more distant than Pluto called the Oort Cloud. (T)
8. If a meteor hits the Earth's surface, we change its name to a meteorite. (T)
9. No asteroids are visible to the naked eye. (F - *occasionally, Vesta, the brightest asteroid, is barely visible to the unaided eyes.*)
10. Comets have two tails. (T - *ion tale and the dust tail.*)
11. A comet's tail always drags behind the comet. (F)
12. A comet's tail always points away from the Sun. (T)
13. Flying a spaceship through the asteroid belt is very dangerous. (F)
14. A comet gets smaller each time it goes around the Sun. (T)
15. Most meteors are rocks smaller than pebbles or sand. (T)
16. On any clear, dark night you can see an average of 3 to 6 meteors per hour. (T)
17. Meteor showers are pieces of disintegrated comets. (T)
18. Bolides are what we call large meteors. (T)
19. Asteroids that cross Earth's orbit are called Apollo asteroids. (T)
20. Some scientists think the extinction of the dinosaurs may have been caused by the collision of a Trojan Asteroid with Earth. (F - *Trojan asteroids are found in the orbit of Jupiter!*)

MORE TRUE OR FALSE

- 21.** Some scientists think the extinction of the dinosaurs may have been caused by the collision of an Apollo Asteroid with Earth. (T)
- 22.** About 5 to 10 tons of meteoric materials hits Earth daily. (T)
- 23.** Most scientists believe the asteroids were once a planet that was destroyed. (F – the fact that *stony-iron asteroids are congregated mainly along the inside half of the asteroid belt (Mars side) and carbon asteroids are congregated mainly along the outside half of the asteroid belt (Jupiter side), it tells scientists that the asteroid belt was never a single planet because it would never have broken apart so neatly concentrating asteroids of different materials in separate regions.*)
- 24.** Mars' two moons, Phobos and Deimos, are likely to be captured asteroids. (T)
- 25.** Asteroid Ida was discovered to have a moon. (T)
- 26.** The first asteroid to be discovered was the brightest one, Vesta. (F – *the first one discovered was Ceres, the largest but not the brightest.*)
- 27.** Over 5000 asteroids have been positively discovered. (F – only a little over 3000, but over 100,000 are believed to exist)
- 28.** All the meteors in a meteor shower always appear to radiate from the same spot in the sky. (T – *the spot is called radiant and the constellation that contains the radiant is what a shower is named after. i.e. the Leonid meteor shower has its radiant in Leo the Lion.*)
- 29.** Comet Shoemaker/Levy collided with Jupiter in July 1994 and destroyed the once great planet. (F – *but it did create the largest explosion ever seen in the Solar System.*)
- 30.** Halley's Comet is the only really bright comet. (F)
- 31.** Earth was nearly hit by an Apollo asteroid in March 1989. (T)
- 32.** Don't watch a meteor shower because you might get hit. (F)
- 33.** On Valentines Day 2000 the NEAR/Shoemaker space probe went into orbit around the asteroid Eros which is named for the Greek god of love. (T)
- 34.** On Valentines Day 2001 the NEAR/Shoemaker space probe crash landed on the asteroid Eros, getting pictures up until just moments before impact. (T)
- 35.** The Stardust Space Probe is on a journey to gather particles from a comet's tail. (T)

WORD SEARCH PUZZLE

Find the words listed below hidden in the following puzzle. Words are written vertically, horizontally, and diagonally. Good Luck!

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

Apollo Asteroid Bolide Carbon Ceres

Coma Comet Earth Icarus Ice Iron

Meteor Meteorite Nucleus Orbit

Planet Rock Shooting Star Solar Wind

Stony Sun Tail Vesta

