

PLANET CATEGORIZATION: **WHAT IS A PLANET?**

Create your own definition of a "planet" based on scientific criteria.

1. Look at the data sheet on the next page. Do you see any obvious similarities and differences?
2. Look at the diameters (sizes). Should you include this in your definition?
3. Look at the distances to the sun. Should you include this in your definition?
4. Look at the distances between objects. Should you include this in your definition?
5. Look at the masses. Should you include this in your definition?
6. Look at the composition (what it is made of). Should you include this in your definition?
7. Look at the number of known moons (satellites). Should you include this in your definition?
8. Look at the location of the object. Should you include this in your definition?
9. Are there any other scientific properties that are not on the data sheet that you should include in your definition?
10. Once you have decided which criteria are important, write your definition of a planet on the page provided. Include your reasoning for your definition. You may want or need to create sub-categories of planets. Remember that your definition will need to be flexible, so it can apply to objects astronomers discover in the future as well as the ones we already know about!
11. Complete the chart on the page provided indicating how the celestial objects would be categorized under your new definition.

PLANET CATEGORIZATION: CELESTIAL BODIES DATA SHEET

PLANETS AND DWARF PLANETS

Name	Diameter (km)	Mean Distance to Sun (millions of km)	Mass (kg)	Composition	Known Moons	Location
Mercury	4,880	57.9	3.30×10^{23}	Rock	0	Inner Solar System
Venus	12,100	108.2	4.87×10^{24}	Rock	0	Inner Solar System
Earth	12,756	149.6	5.97×10^{24}	Rock	1	Inner Solar System
Mars	6,787	227.9	6.42×10^{23}	Rock	2	Inner Solar System
Ceres	950	413.7	9.5×10^{20}	Rock	--	Main Asteroid Belt
Jupiter	143,200	778.3	1.9×10^{27}	Gas	63	Outer Solar System
Saturn	120,000	1,427	5.68×10^{26}	Gas	56	Outer Solar System
Uranus	51,800	2,871	8.68×10^{25}	Gas	27	Outer Solar System
Neptune	49,528	4,497	1.02×10^{26}	Gas	13	Outer Solar System
Pluto	2,330	5,913	1.27×10^{22}	Rock & Ice	3	Kuiper Belt*
Eris	3,000	6,000 to 15,000	?	?	1	Scattered Disc**

OTHER CELESTIAL BODIES

Charon	1,184	5,913	1.90×10^{21}	Rock & Ice	--	Kuiper Belt
Sedna	1,700	10,000 to 150,000	$2-6 \times 10^{21}$	Rock & Ice ?	--	Kuiper Belt?
Moon	3,476	149.6	7.34×10^{22}	Rock	--	Inner Solar System
Comet Halley	--	100 to 5,000		Ice and Dust	--	Inner Solar System to Outer Solar System
Theoretical Earth-like Exoplanet	13,000	150 (to its star)	6×10^{24}	Rock	0	Inner Solar System

* The Kuiper Belt is a region of objects found beyond Neptune. Objects in this belt are about 4.5 to 7.5 billion km from the Sun.

** The Scattered Disc is a region of objects found beyond the Kuiper Belt.

Sources: NASA, Bill Arnett



Name: _____

PLANET CATEGORIZATION:
MY DEFINITION OF A "PLANET"

Object Name	My Category
Mercury	
Venus	
Earth	
Mars	
Ceres	
Jupiter	
Saturn	
Uranus	
Neptune	
Pluto	
Eris	
<i>Charon</i>	
<i>Sedna</i>	
<i>Moon</i>	
<i>Comet Halley</i>	
<i>Earth-like Exoplanet</i>	

A PLANET is:

REASONING (Why I think this is a good definition):

PLANET CATEGORIZATION: RUBRIC (MARKING SCHEME)

Scientific Basis

- 3 Criteria are based on scientifically observed data, providing a strong argument
- 1 Most criteria are based on scientifically observed data, providing a weak argument
- 0 Criteria are not scientifically-based, providing a poor argument

Reasoning involves numbers and mathematics

- 3 Reasoning in the definition shows an understanding of properties of numbers and measurement
- 2 Reasoning in the definition may show an understanding of properties of numbers and measurement
- 0 Reasoning in the definition does not show an understanding of properties of numbers and measurement

Applicability

- 3 Definition applies to known celestial objects on hand-outs
- 2 Definition applies to almost all known celestial objects on hand-outs
- 0 Definition does not apply to most of objects on hand-outs

Flexibility

- 3 Definition is open for many new discoveries
- 2 Definition is somewhat specific and restrictive
- 0 Definition is excessively specific and too restrictive

Chart

- 3 Chart "My Category" column is completed
- 2 Chart is mostly completed
- 0 Chart is incomplete

Language

- 5 Definition is written in clear, grammatically correct English language
- 3 Minor errors in language, but meaning is retained
- 1 Many errors, leading to unclear meaning
- 0 Excessive errors, unclear meaning

Bonus

- 1 Definition developed with use of additional knowledge

/20 TOTAL MARKS



PLANET CATEGORIZATION: HOMEWORK

Write a one-page essay that examines one or more of the following questions:

- Is voting on a scientific concept in keeping with the ethical tradition of science and the scientist's search for the truth?
- Is voting a valid way to get the opinion of the scientific community?
- Should scientists accept a "best available explanation" though they know it may not be correct?
- Do you think the IAU's planetary definition decision was made by examining enough of the data, using logical arguments, and using an appropriate amount of skepticism?
- What new scientific evidence would help resolve the planetary definition debate?



PLANET CATEGORIZATION:
HOW DOES YOUR DEFINITION COMPARE?

According to the International Astronomical Union (August 2006)...

A **PLANET** is a celestial body that:

- (a) is in orbit around the Sun,
- (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and
- (c) has cleared the neighborhood around its orbit.

There are eight planets under this definition:

Mercury, Earth, Venus, Mars, Jupiter, Saturn, Uranus and Neptune.

A **DWARF PLANET** is a celestial body that:

- (a) is in orbit around the Sun,
- (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape,
- (c) has not cleared the neighborhood around its orbit, and
- (d) is not a satellite.

A **SMALL SOLAR SYSTEM BODY** (also known as a **MINOR PLANET**) is a body that orbits the Sun, is too small to be a planet or dwarf planet, and is not a satellite.

A **KUIPER BELT OBJECT** is anything found in a disk-shaped region of icy debris at the edge of the solar system. Objects in this belt are about 4.5 to 7.5 billion km from the Sun.

<http://www.pbs.org/newshour/extra>

PLANET CATEGORIZATION: CELESTIAL BODIES DATA SHEET

PLANETS AND DWARF PLANETS

Name	Diameter (km)	Mean Distance to Sun (millions of km)	Mass (kg)	Composition	Known Moons	IAU Category (Late 2006)	Location
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Eris	3,000	6,000 to 15,000	?	?	1	Dwarf Planet, Trans-Neptunian Object	Scattered Disc**

OTHER CELESTIAL BODIES

Charon	1,184	5,913	1.90×10^{21}	Rock & Ice	--	Satellite, Trans-Neptunian Object	Kuiper Belt
Sedna	1,700	10,000 to 150,000	$2-6 \times 10^{21}$	Rock & Ice ?	--	Trans-Neptunian Object	Kuiper Belt?
Moon	3,476	149.6	7.34×10^{22}	Rock	--	Satellite	Inner Solar System
Comet Halley	--	100 to 5,000		Ice and Dust	--	Comet	Inner Solar System to Outer Solar System
Theoretical Earth-like Exoplanet	13,000	150 (to its star)	6×10^{24}	Rock	0	--	Inner Solar System

* The Kuiper Belt is a region of objects found beyond Neptune. Objects in this belt are about 4.5 to 7.5 billion km from the Sun.

** The Scattered Disc is a region of objects found beyond the Kuiper Belt.

Sources: NASA, Bill Arnett

PLANET CATEGORIZATION: ARE THESE PLANETS?

Use these celestial bodies to test a planetary definition

Name	Diameter (km)	Mean Distance to Sun (millions of km)	Mass (kg)	Composition	Known Moons	Category (Late 2006)	Location
Charon	1,184	5,913	1.90×10^{21}	Rock & Ice	--	Satellite, Trans-Neptunian Object	Kuiper Belt

Notes: The IAU had considered classifying Charon and Pluto as a "binary planet system" because neither clearly orbits the other. The "center of mass" is found between the two objects, not within one as is usually the case with a planet-satellite system like Earth-Moon.

Sedna	1,700	10,000 to 150,000	$2-6 \times 10^{21}$	Rock & Ice ?	--	Trans-Neptunian Object	Kuiper Belt?
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Notes: Sedna is a likely candidate for the "dwarf planet" designation. Under the current IAU planetary definition, it is possible that dozens of other objects could also be called "dwarf planets."

Moon	3,476	149.6	7.34×10^{22}	Rock	--	Satellite	Inner Solar System
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Notes: The Moon is more massive than other satellites and dwarf planets, but it clearly orbits the Earth.

Comet Halley	--	100 to 5,000		Ice and Dust	--	Comet	Inner Solar System to Outer Solar System
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Notes: The core of Halley's comet has a small diameter, and it orbits the sun with a "short" 76-year-long period (on average).

A Theoretical Earth-like Exoplanet	13,000	150 (to its star)	6×10^{24}	Rock	0	--	Inner Solar System
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Notes: Of the 200 "exoplanets" recently found by astronomers in other star systems, most are more massive than the Earth. The August 2006 IAU decision does not apply to objects outside of the solar system. In 2003, the IAU would have called this a "planet."