Organic Molecules Detected on Distant Planet!

The basic chemistry for life has been detected in a second hot gas planet, HD 209458b, depicted in this artist's concept. Two of NASA's Great Observatories – the Hubble Space Telescope and Spitzer Space Telescope, yielded spectral observations that revealed molecules of carbon dioxide, methane and water vapor in the planet's atmosphere. HD 209458b, bigger than Jupiter, occupies a tight, 3.5-day orbit around a sun-like star about 150 light years away in the constellation Pegasus. (NASA Press release October 20, 2009)

Some Interesting Facts: The distance of the planet from the star HD209458 is 7 million kilometers, and its orbit period (year) is only 3.5 days long. At this distance, the temperature of the outer atmosphere is about 1,000 C (1,800 F). At these temperatures, water, methane and carbon dioxide are all in gaseous form. It is also known to be losing hydrogen gas at a ferocious rate, which makes the planet resemble a comet! The planet itself has a mass that is 69% that of Jupiter, and a volume that is 146% greater than that of Jupiter. The unofficial name for this planet is Osiris.

Problem 1 - The mass of Jupiter is 1.9×10^{30} grams. The radius of Jupiter is 71,500 kilometers. A) What is the volume of Jupiter in cubic centimeters, assuming it is a perfect sphere? B) What is the density of Jupiter in grams per cubic centimeter (cc), based on its mass and your calculated volume?

Problem 2 - From the information provided; A) What is the volume of Osiris in cubic centimeters, if it is in the shape of a perfect sphere? B) What is the mass of Osiris in grams? C) What is the density of Osiris in grams/cc, and how does this compare to the density of Jupiter?

Problem 3 - The densities of some common ingredients for planets are as follows:

Rock	3 grams/cc	Ice	1 gram/cc
Iron	9 grams/cc	Mixture of hydrogen + helium	0.7 grams/cc
Water	5 grams/cc		

Based on the average density of Osiris, from what substances do you think the planet is mostly composed?

Problem 1 - The mass of Jupiter is 1.9 x 10^{30} grams. The radius of Jupiter is 71,500 kilometers.

A) What is the volume of Jupiter in cubic centimeters, assuming it is a perfect sphere?

Answer: The radius of Jupiter, in centimeters, is

R = 71,500 km x (100,000 cm/1 km)

  = 7.15 x 10^9 cm.

For a sphere, V = 4/3 π R^3 so the volume of Jupiter is

V = 1.33 x (3.141) x (7.15 x 10^9)^3

V =   1.53 x 10^{30} cm ^{3}

B) What is the density of Jupiter in grams per cubic centimeter (cc), based on its mass and your calculated volume?

Answer: Density = Mass/Volume so the density of Jupiter is D = (1.9 x 10^{30} grams)/(1.53 x 10^{30} cm ^{3}) = 1.2 gm/cc

Problem 2 - From the information provided;

A) What is the volume of Osiris in cubic centimeters, if it is in the shape of a perfect sphere?

Answer: The information says that the volume is 146% greater than Jupiter so it will be V = V=1.46 x (1.53 x 10^{30} cm ^{3})

  = 2.23 x 10^{30} cm ^{3}

B) What is the mass of Osiris in grams?

Answer: the information says that it is 69% of Jupiter so

M = 0.69 x (1.9 x 10^{30} grams)

  = 1.3 x 10^{30} grams

C) What is the density of Osiris in grams/cc, and how does this compare to the density of Jupiter?

Answer: D = Mass/volume

      = 1.3 x 10^{30} grams / 2.23 x 10^{30} cm ^{3}

      = 0.58 grams/cc

Problem 3 - The densities of some common ingredients for planets are as follows:

Rock	3 grams/cc	Ice	1 gram/cc
Iron	9 grams/cc	Mixture of hydrogen + helium	0.7 grams/cc
Water	5 grams/cc		

Based on the average density of Osiris, from what substances do you think the planet is mostly composed?

Answer: Because the density of Osiris is only about 0.6 grams/cc, the closest match would be a mixture of hydrogen and helium. This means that, rather than a solid planet like earth, which is a mixture of higher-density materials such as iron, rock and water, Osiris has much in common with Jupiter which is classified by astronomers as a Gas Giant!