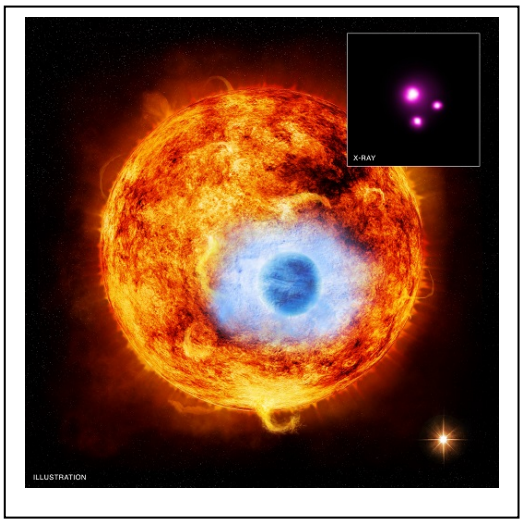

At a distance of 63 light years from Earth, this Jupiter-sized planet orbits its star once every 2.2 days. With a mass only 13% greater than Jupiter, Astronomers have measured its light and found that it would appear like a giant blue marble similar to Neptune. Its atmosphere contains carbon dioxide, along with water vapor and methane. It is so close to its star, less than 3 million miles, that it is permanently locked so that the same side of the planet always faces its star. The daytime, sun-facing temperature is a sizzling 1000 C and nighttime temperature of 700 C.

NASA's Chandra Observatory has detected the X-ray fadeout of this planet as it passes across its star. From this they estimate that the planet is losing about 600 million kg of its mass every second. The intense heat from its star is literally evaporating this planet!

Problem 1 – The mass of Jupiter is 1.9×10^{27} kg. What is the mass of HD189733b?

Problem 2 – The atmosphere of Jupiter is about 1000 km thick, and the radius of Jupiter is 70,000 km. What is the volume of the atmospheric shell of Jupiter?

Problem 3 – The average density of the Jovian atmosphere is about 50 grams/m^3. If the atmosphere of HD189733b is identical to Jupiter's in density and volume, how much mass is in the atmosphere of HD189733b?

Problem 4 – The Chandra observations suggest that the atmosphere of HD189733b is decreasing at a rate of 6.0×10^8 kg/second. How many years will it take for the entire atmosphere of this planet to be lost?

Problem 5 – How many years will it take for the entire planet to be evaporated?

NASA's Chandra Sees Eclipsing Planet in X-rays for First Time
July 29, 2013
http://www.nasa.gov/mission_pages/chandra/news/exoplanet-HD189733b.html

Problem 1 – The mass of Jupiter is 1.9×10^{27} kg. What is the mass of HD189733b?

Answer: The mass is 13% greater than Jupiter so M = $1.13 \times 1.9 \times 10^{27}$kg = **$2.1 \times 10^{27}$ kg.**

Problem 2 – The atmosphere of Jupiter is about 1000 km thick, and the radius of Jupiter is 70,000 km. What is the volume of the atmospheric shell of Jupiter?

Answer: Volume = $4/3\ \pi\ (70000\text{km})^3 - 4/3\ \pi\ (69000\text{km})^3$
$= 1.44 \times 10^{15}\ \text{km}^3 - 1.38 \times 10^{15}\ \text{km}^3$
$= \mathbf{6.0 \times 10^{13}\ km^3}$

Problem 3 – The average density of the Jovian atmosphere is about 50 grams/m^3. If the atmosphere of HD189733b is identical to Jupiter's in density and volume, how much mass is in the atmosphere of HD189733b?

Answer: The volume of the atmosphere is $6.0 \times 10^{13}\ \text{km}^3$ or $6.0 \times 10^{22}\ \text{m}^3$.
Since mass = density x volume.
$M = 50\ \text{gm/m}^3 \times 6.0 \times 10^{22}\ \text{m}^3$
$= 3.0 \times 10^{24}$ grams or **3.0×10^{21} kg**.

Problem 4 – The Chandra observations suggest that the atmosphere of HD189733b is decreasing at a rate of 6.0×10^8 kg/second. How many years will it take for the entire atmosphere of this planet to be lost?

Answer : Time = amount/rate
$= 3.0 \times 10^{21}$ kg / (6.0×10^8 kg/sec)
$= 5.0 \times 10^{12}$ seconds.
$= 5.0 \times 10^{12}$ seconds x (1 year/3.1×10^7 sec) = **161,000 years**.

Problem 5 – How many years will it take for the entire planet to be evaporated?

Answer: Time = 2.1×10^{27} kilograms / 6.0×10^8 kg/sec
$= 3.5 \times 10^{18}$ seconds
= **113 billion years**.