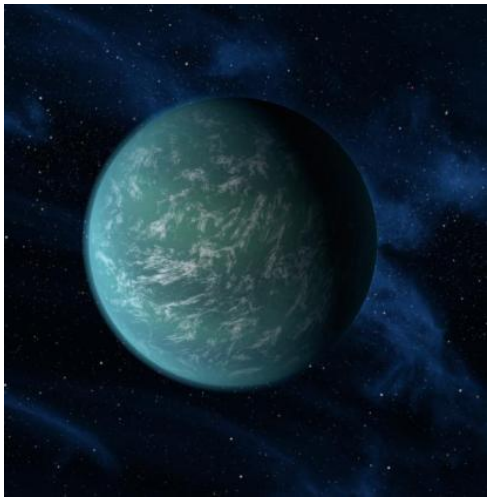

An artists illustration of Kepler-22b (Credit NASA/Ames/JPL-Caltech)

NASA's Kepler mission has confirmed its first planet in the "habitable zone," the region where liquid water could exist on a planet's surface.

The newly confirmed planet, Kepler-22b, is the smallest yet found to orbit in the middle of the habitable zone of a star similar to our sun.

The planet is about 2.4 times the radius of Earth. Scientists don't yet know if Kepler-22b has a rocky, gaseous or liquid composition, but its discovery is a step closer to finding Earth-like planets.

Problem 1 - Suppose Kepler-22b is a spherical, rocky planet like Earth with an average density similar to Earth (about 5,500 kg/meter^3). If the radius of Kepler-22b is 15,000 km, what is the mass of Kepler-22b in A) kilograms? B) multiples of Earth's mass (5.97x1024 kg)?

Problem 2 - The acceleration of gravity on a planetary surface is given by the formula

$$a = \frac{GM}{R^2}$$

where M is in kilograms, R is in meters and G is the Newtonian Constant of Gravity with a value of 6.67 x 10^{-11} m^3 kg^{-1} sec^{-2} What is the surface acceleration of Kepler-22b A) In meters/sec^2? B) In multiples of Earth's surface gravity 9.8 meters/sec^2?

Problem 3 - The relationship between surface acceleration and your weight is a direct proportion. The surface acceleration of Earth is 9.8 meters/sec^2. If you weigh 150 pounds on the surface of Earth, how much will you weigh on the surface of Kepler-22b?

Problem 4 - The dimensions of a typical baseball park are determined by the farthest distance that an average batter can bat a home-run. This in turn depends on the acceleration of gravity, which is the force that pulls the ball back to the ground to shorten its travel distance. For a standard baseball field, the distance to the back-field fence from Home Plate may not be less than 325 feet, and the baseball diamond must be exactly 90 feet on a side.

A) If the maximum travel distance of the baseball scales linearly with the acceleration of gravity, what is the minimum distance to the back-field fence from Home Plate along one of the two foul lines?

B) What are the dimensions of the baseball diamond?

Problem 1 - Suppose Kepler-22b is a spherical, rocky planet like Earth with an average density similar to Earth (about 5,500 kg/meter^3). If the radius of Kepler-22b is 15,000 km, what is the mass of Kepler-22b in A) kilograms? B) multiples of Earth's mass (5.97x10^{24} kg)?

Answer: A) First find the volume of the spherical planet in cubic meters, then multiply by the density of the planet to get the total mass.

R = 15,000 km x (1000 m/1 km) = 1.5 x 10^7 meters.

$V = 4/3\ \pi\ R^3$

$= 1.33 \times 3.14 \times (1.5 \times 10^7 \text{ meters})^3 = 1.41 \times 10^{22} \text{ meters}^3$

Then M = density x volume

= 5,500 kg/m^3 x (1.41x10^{22})

= 7.75 x10^{25} kg

B) M = 7.75x10^{25} kg / 5.97x10^{24} kg = **12.9 Earths**.

Problem 2 - A) In meters/sec^2? B) In multiples of Earth's surface gravity 9.8 meters/sec^2?

Answer: A) $a = 6.67 \times 10^{-11}\ (7.75 \times 10^{25}) / (1.5 \times 10^7)^2$ = **23.0 meters/sec^2**

B) 23.0 / 9.8 = **2.3 times earth's surface gravity**

Note: From the formula for M and a, we see that the acceleration varies directly with the radius change, which is a factor of 2.4 times Earth, so a = 2.4xa(earth)

Problem 3 – The relationship between surface acceleration and your weight is a direct proportion. The surface acceleration of Earth is 9.8 meters/sec^2. If you weigh 150 pounds on the surface of Earth, how much will you weigh on the surface of Kepler-22b?

Answer: By a simple proportion: X/150 = 2.3/1.0 so x = 2.3x150 = **345 pounds**.

Problem 4 - For a standard baseball field, the distance to the back-field fence from Home Plate may not be less than 325 feet, and the baseball diamond must be exactly 90 feet on a side.

A) If the maximum travel distance of the baseball scales linearly with the acceleration of gravity, what is the distance to the back-field fence from Home Plate along one of the two foul lines? Answer: 325 / 2.3 = **141 feet**.

B) What are the dimensions of the baseball diamond? Answer: 90/2.3 = **39 feet** on a side.