Table of Candidate Planet Sizes

Size Class	Size (Earth Radius)	Number of candidates
Earths	R <1.25	68
Super-Earths	1.25 < R < 2.0	288
Neptunes	2.0 < R < 6.0	662
Jovians	6.0 < R < 15	165
Super-Jovians	15 < R < 22	19
Dwarf Stars, etc	R > 22	15

NASA's Kepler mission has just completed its first year of surveying 156,453 stars to detect the tell-tail signs of distant planets passing across the faces of their stars .This causes a slight dimming of the starlight, which can be detected by the satellite observatory. From the 1,235 transits detected so far, 33 were eliminated because the planets would have been far larger than Jupiter, and possibly dwarf stars. The table above shows the distribution of the remaining planet candidates among the interesting sizes ranges for planets in our own solar system.

About 30 percent of the candidates have been found to belong to multiple-planet systems, with several planets orbiting the same star. To find Earth-like planets where liquid water could be present, astronomers define a Habitable Zone (HZ) surrounding each star where planet surfaces could be warm enough for liquid water. This is roughly between temperatures of 270 to 300 Kelvin. A careful study of the orbits of the planetary candidates discovered 54 candidate planets in the HZs of their stars. Of these, five planets are roughly Earth-sized, and the other 49 planets range from twice the size of Earth to larger than Jupiter.

Problem 1 - What fraction of the candidate planets from the full Kepler survey were found within the HZs of their respective stars?

Problem 2 - What percentage of Earth-sized planets in the full Kepler survey were found in the HZs of the respective stars?

Problem 3 - If there are about 40 billion stars in the Milky Way that are similar to the stars in the Kepler survey, about how many Earth-sized planets would you expect to find in the HZs of there other stars?

Problem 1 - What fraction of the candidate planets from the full Kepler survey were found within the HZs of their respective stars?

Answer: There are 1,202 candidate planets in the larger survey, and 54 found in their HZ so the percentage is P = 100% x (54/1202) = **4.5%**.

Note: *The essay says that 33 candidates were eliminated because they were probably not planets, so 1,235 - 33 = 1,202 planet candidates.*

Problem 2 - What percentage of Earth-sized planets in the full Kepler survey were found in the HZs of the respective stars?

Answer: There were 68 Earth-sized planets found from among 1,202 candidates, and 5 were Earth-sized, so the percentage of Earth-sized planets in their HZs is P = 100% x (5/68) = 7.4%.

So, if you find one Earth-sized planet orbiting a star in the Kepler survey, there is a 7.4% chance that it will be in its HZ so that liquid water can exist.

Problem 3 - If there are about 40 billion stars in the Milky Way that are similar to the stars in the Kepler survey, about how many Earth-sized planets would you expect to find in the HZs of there other stars?

Answer: Students may use simple scaling. The Kepler star sample contains 156,453 stars. It resulted in the discovery, so far, of 5 Earth-sized planets in the Habitable Zones of their respective stars. So

$$\frac{5}{156,453} = \frac{N}{40 billion}$$ so

N = (40 billion / 156,453) x 5 planets

or about **1.3 million planets**.

Another way to think about this is that if you select 30,000 stars in the sky similar to our own sun, you could expect to find about 1 Earth-sized planet orbiting within the Habitable Zone of its star. (5 x 30,000/156453 = 0.96 or about 1.0 planets)