



On July 15, 2011 the NASA spacecraft Dawn completed a 2.8 billion kilometer journey taking four years, and went into orbit around the asteroid Vesta. Vesta is the second largest asteroid in the Asteroid Belt. Its diameter is 530 kilometers. After one year in orbit, Dawn departed in 2012 for an encounter with asteroid Ceres in 2015. Meanwhile, from its orbit around Vesta, it will map the surface and see features less than 1 kilometer across.

**Problem 1** - Use a millimeter ruler and the diameter information for this asteroid to determine the scale of this image in kilometers per millimeter.

**Problem 2** - What is the diameter of the largest and smallest features that you can see in this image?

**Problem 3** - Based on the distance traveled, and the time taken by the Dawn satellite, what was the speed of this spacecraft in A) kilometers per year? B) kilometers per hour?

**Problem 4** - The Space Shuttle traveled at a speed of 28,000 km/hr in its orbit around Earth. How many times faster than the Shuttle does the Dawn spacecraft travel?

**Problem 1** - Use a millimeter ruler and the diameter information for this asteroid to determine the scale of this image in kilometers per millimeter.

Answer: When printed using a standard printer, the width of the asteroid is about 123 millimeters. Since the true diameter of the asteroid is 530 km, the scale is then  $S = 530 \text{ km} / 123 \text{ mm} = \mathbf{4.3 \text{ kilometers per millimeter}}$ .

**Problem 2** - What is the diameter of the largest and smallest features that you can see in this image?

Answer: **Students can find a number of small features in the image that are about 1 mm across, so that is about 4.3 kilometers. Among the largest features are the 9 large craters located along the middle region of Vesta from left to right. Their diameters are about 4 to 7 millimeters or 17 to 30 kilometers across. The large depression located in the upper left quadrant of the image is about 40 mm long and 15 mm wide in projection, which is equivalent to 172 km x 65 km in size.**

**Problem 3** - Based on the distance traveled, and the time taken by the Dawn satellite, what was the speed of this spacecraft in A) kilometers per year? B) kilometers per hour?

Answer: Time = 4 years, distance = 2.8 billion km, so the speed is A)  $S = 2.8 \text{ billion km} / 4 \text{ years} = \mathbf{700 \text{ million km/year}}$ . B) Converting to an hourly rate,  $S = 700 \text{ million km/yr} \times (1 \text{ year}/365 \text{ days}) \times (1 \text{ day}/24 \text{ hours}) = \mathbf{79,900 \text{ km/hour}}$ .

**Problem 4** - The Space Shuttle traveled at a speed of 28,000 km/hr in its orbit around Earth. How many times faster that the Shuttle does the Dawn spacecraft travel?

Answer: Ratio =  $(79,900 \text{ km/hr}) / (28,000 \text{ km/hr}) = 2.9$ . So Dawn is traveling at an average speed that is **2.9 times faster than the Space Shuttle!**

**Note: The Space Shuttle is traveling 8 times faster that a bullet (muzzle velocity) from a high-powered M16 rifle! So Dawn is traveling 23 times faster than such a bullet!**