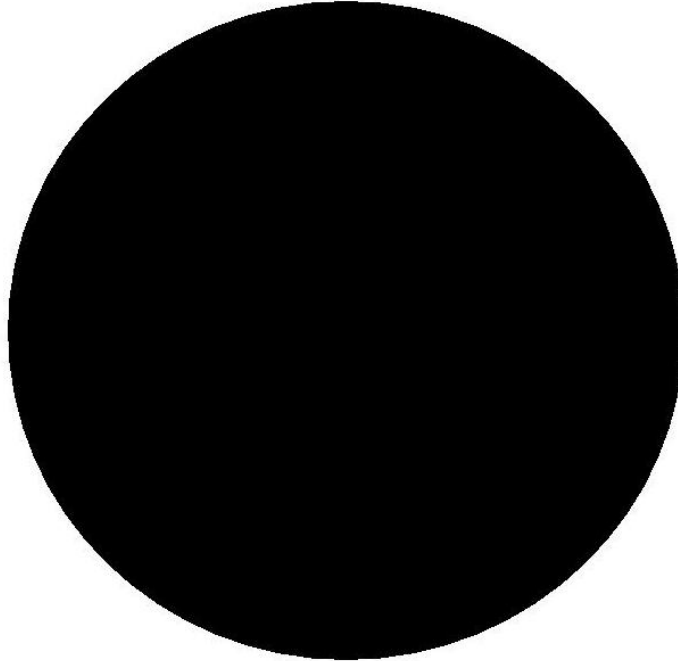This black ball shown below is the <u>exact size</u> of a black hole with a diameter of 9.0 centimeters. Such a black hole would have a mass of **5 times** the mass of our Earth. All of this mass would be INSIDE the ball below.

Although it looks pretty harmless, if this black hole were at arms-length, you would already be dead. In fact, if you were closer to it than the distance from New York to San Francisco, 1 150-pound person would weigh 3 tons and would be crushed by their own weight!

Suppose that you could survive being crushed to death as you got closer to the black hole shown above. To stay in an orbit around the black hole so that you did not fall in, you have to be traveling at a specific speed V, in kilometers per second, that depends on your distance R, in meters from the center of the black hole, is given below:

$$V = \frac{44,700}{\sqrt{R}}$$

Problem 1 - If you were orbiting at the distance of the Space Shuttle (R=6,800 km) from the center of this black hole, what would your orbital speed be in A) kilometers/sec? B) kilometers/hour? C) miles per hour (1 mile = 1.6 km).

Problem 2 - If a small satellite were orbiting 20 centimeters away from the center of the black hole shown above, how fast would it be traveling in A) km/second? B) percentage of the speed of light? (The speed of light = 300,000 km/sec).

Problem 3) If the orbit is a circle, how long: A) would the Space Shuttle in Problem 1 take to go once around in its orbit? B) would it take the satellite in Problem 2 to go once around in its orbit?

Problem 1 - If you were orbiting at the distance of the Space Shuttle (R=6,800 km) from the center of this black hole, what would your orbital speed be in A) kilometers/sec? B) kilometers/hour? C) miles per hour (1 mile = 1.6 km).

Answer; A) The formula says that for R = 6,800,000 meters, **V = 17 km/sec**.
        B) 1 hour = 3600 seconds, so V = 17 km/sec x (3600 sec/1 hour) = **61,200 km/hour.**
         C) V = 61,200 km/sec x (1 mile / 1.6 km) = **38,250 miles/hr**

Problem 2 - If a small satellite were orbiting 20 centimeters away from the center of the black hole shown above, how fast would it be traveling in A) km/second? B) percentage of the speed of light? (The speed of light = 300,000 km/sec).

Answer; A) R = 0.2 meters, so from the formula V = **100,000 km/sec**
        B) Speed =   100% x (100000/300000) so speed = **33% the speed of light**.

Problem 3) If the orbit is a circle, how long: A) would the Space Shuttle in Problem 1 take to go once around in its orbit? B) would it take the satellite in Problem 2 to go once around in its orbit?

A) Orbit circumference, C = 2πR so for R = 6,800 km, C = 40,000 kilometers. The Shuttle speed is V=17 km/sec, so the time is T = C/V or **2,353 seconds. This equals about 39 minutes.**

B) A) Orbit circumference, C = 2πR so for R = 0.2 meters, C = 1.25 meters. The satellite speed is V=100,000 km/sec. Converting this to meters we get 100,000,000 meters/sec, so the time is T = C/V or **0.000000013 seconds. This is 13 billionths of a second!**