Comet Hartley 2 is seen in this spectacular image taken by the Deep Impact/EPOXI Medium-Resolution Instrument on November 4, 2010 as it flew by the nucleus at a distance of 700 kilometers. The pitted surface, free of large craters, shows a complex texture in regions where gas plumes are actively ejecting gas. The potato-shaped nucleus is 2 kilometers long and 0.4 kilometers wide at its narrowest location. (Credit: NASA/JPL-Caltech/UMD).

**Problem 1** - Suppose that the shape of the comet nucleus can be approximated by the following function

\[ y(x) = -1.22x^4 + 5.04x^3 - 6.78x^2 + 3.14x + 0.03 \]

rotated about the x-axis between x=0 and x=2.0, where all units are in kilometers.

A) Graph this function;
B) Perform the required volume integration by using the method of circular disks.
C) To two significant figures, what is the total volume of the nucleus in cubic meters?

**Problem 2** - Assuming that the density of Comet Hartley-2 is 0.6 grams/cm³, what is your estimate for the mass of Comet Hartley-2 in megatons? (Note: 1000 kg = 1 metric ton)
**Problem 1 - Answer:**

A) **Graph:**

![Graph of the function](image)

B)

\[ V = \pi \int_0^2 y(x)^2 \, dx \]

then

\[ V = \pi \int_0^2 \left(-1.22x^4 + 5.04x^3 - 6.78x^2 + 3.14x + 0.03\right)^2 \, dx \]

**Expand integrand and collect terms (be careful!):**

\[ V = \pi \int_0^2 \left(1.49x^8 - 12.30x^7 + 41.94x^6 - 76.00x^5 + 77.55x^4 - 42.28x^3 + 9.46x^2 + 0.18x + 0.0009\right) \, dx \]

**Integrate each term:**

\[ V = \pi \left[ 0.17x^9 - 1.54x^8 + 5.99x^7 - 12.67x^6 + 15.51x^5 - 10.57x^4 + 3.15x^3 + 0.09x^2 + 0.0009x + c \right]_0^2 \]

**Now evaluate V(x) at the two limits to get V = V(2) - V(0):** Note that the answer for V will be sensitive to the accuracy of the polynomial coefficients, here given to 4 decimal place accuracy:

\[ V = (3.14)(0.1655(2)^9 - 1.5375(2)^8 + 5.9914(2)^7 - 12.6667(2)^6 + 15.51(2)^5 - 10.57(2)^4 + 3.1533(2)^3 + 0.09(2)^2 + 0.0009(2)) \]

\[ V = 3.14[0.157] \]

So \( V = 0.49 \) cubic kilometers.

**Problem 2 - Mass = Density \times Volume;** First convert the volume to cubic centimeters from cubic kilometers: \( V = 0.49 \text{ km}^3 \times (10^3 \text{ meters/1 km})^3 \times (100 \text{ cm/1 meter})^3 = 4.9 \times 10^{14} \text{ cm}^3 \). Then, Mass = 0.6 gm/cm\(^3\) \times 4.9 \times 10^{14} \text{ cm}^3 = 2.9 \times 10^{14} \text{ gm}. Convert grams to megatons: Mass = \( 2.9 \times 10^{14} \text{ gm} \times (1 \text{ kg/1000 gm}) \times (1 \text{ ton/1000 kg}) = 2.9 \times 10^8 \) tons or **290 megatons**.