Problem 87

A car engine moves a piston with a circular cross-section of 7.500 ± 0.002 cm in diameter a distance of 3.250 ± 0.001 cm to compress the gas in the cylinder. (a) By what amount is the gas decreased in volume in cubic centimeters? (b) Find the uncertainty in this volume.

Solution

<u>**Part (a)**</u>

Multiply the upper bounds for area $\pi(d/2)^2$ and height to get the maximum volume, and multiply the lower bounds for area and height to get the minimum volume.

$$\text{Maximum Volume:} \quad \pi \left(\frac{7.500 + 0.002}{2} \text{ cm} \right)^2 (3.250 + 0.001 \text{ cm}) \approx 143.7 \text{ cm}^3$$

$$\text{Minimum Volume:} \quad \pi \left(\frac{7.500 - 0.002}{2} \text{ cm} \right)^2 (3.250 - 0.001 \text{ cm}) \approx 143.5 \text{ cm}^3$$

Therefore, the volume the gas decreases is about

$$\frac{143.7 + 143.5}{2} \text{ cm}^3$$

$$143.6 \text{ cm}^3.$$

<u>**Part (b)**</u>

The uncertainty is about

$$\frac{143.7 - 143.5}{2} \text{ cm}^3$$

$$0.1 \text{ cm}^3.$$