SAMPLE PROBLEM A

Work Done on or by a Gas

PROBLEM

An engine cylinder has a cross-sectional area of 0.010 m^2. How much work can be done by a gas in the cylinder if the gas exerts a constant pressure of 7.5×10^5 Pa on the piston and moves the piston a distance of 0.040 m?

SOLUTION

Given: $A = 0.010\ m^2$ $d = 0.040\ m$

$P = 7.5 \times 10^5\ Pa = 7.5 \times 10^5\ N/m^2$

Unknown: $W = ?$

Use the equation for the work done on or by a gas.

$$W = P\Delta V = PAd$$

$$W = (7.5 \times 10^5\ N/m^2)(0.010\ m^2)(0.040\ m)$$

$$\boxed{W = 3.0 \times 10^2\ J}$$

TIP *Because W is positive, we can conclude that the work is done by the gas rather than on the gas.*

PRACTICE A

Work Done on or by a Gas

1. Gas in a container is at a pressure of 1.6×10^5 Pa and a volume of 4.0 m^3. What is the work done by the gas if
   a. it expands at constant pressure to twice its initial volume?
   b. it is compressed at constant pressure to one-quarter of its initial volume?
2. A gas is enclosed in a container fitted with a piston. The applied pressure is maintained at 599.5 kPa as the piston moves inward, which changes the volume of the gas from 5.317×10^{-4} m^3 to 2.523×10^{-4} m^3. How much work is done? Is the work done *on* or *by* the gas? Explain your answer.
3. A balloon is inflated with helium at a constant pressure that is 4.3×10^5 Pa in excess of atmospheric pressure. If the balloon inflates from a volume of 1.8×10^{-4} m^3 to 9.5×10^{-4} m^3, how much work is done on the surrounding air by the helium-filled balloon during this expansion?
4. Steam moves into the cylinder of a steam engine at a constant pressure and does 0.84 J of work on a piston. The diameter of the piston is 1.6 cm, and the piston travels 2.1 cm. What is the pressure of the steam?