Try Yourself 5.4 a

An air balloon is being inflated to its full extent by heating the air inside it. In the final stages of this process, the volume of the balloon changes from 4.00 x 10^6 L to 4.50 x 10^6 L by the addition of 1.3 x 10^8 J of heat energy. Assuming that the balloon expands against a constant pressure of 1.0 atm., calculate ΔU for the process. (Conversion factor: 1 L.atm = 101.3 J).

$$\text{Try Yourself } 5.4a$$

$$\Delta U = ?$$

$$\Delta U = q + w \qquad q = 1.3 \times 10^8 \text{ J}$$
$$w = ?$$

$$w = -P\Delta V$$

$$\text{※ } \Delta V = V_{final} - V_{initial}$$
$$= (4.50 \times 10^6 \text{ L}) - (4.00 \times 10^6 \text{ L})$$
$$= 5.00 \times 10^5 \text{ L}$$

$$\text{※ } w = -(1.0 \text{ atm.})(5.00 \times 10^5 \text{ L})$$
$$= -5.00 \times 10^5 \text{ L.atm.}$$
$$= -(5.00 \times 10^5 \text{ L.atm})(101.3 \text{ J})$$
$$= -5.07 \times 10^7 \text{ J}$$

$$\text{※ } \Delta U = q + w$$
$$= 1.3 \times 10^8 \text{ J} + (-5.07 \times 10^7 \text{ J})$$
$$= 7.93 \times 10^7 \text{ J}$$
$$\rightarrow 7.93 \times 10^4 \text{ kJ}$$

A certain gas expands in volume from 2.0 L to 6.0 L at constant temperature. Calculate the work done by the gas (in joule and in kilojoule) if it expands **(1)** against a vacuum and **(2)** against a constant pressure of 1.2 atm. (Conversion factor: 1 L.atm = 101.3 J).

(1) **Because the external pressure = 0, no work is done.**

$$W = - P \Delta V$$
$$= - (0)(6.0 \, L - 2.0 \, L)$$
$$= 0$$

(2) **Against a constant pressure of 1.2 atm.**

$$W = - P \Delta V$$
$$= -(1.2 \, atm)(6.0 \, L - 2.0 \, L)$$
$$= -4.8 \, L.atm$$

Convert to joule and kilojoule.

(J)
$$W = (-4.8 \, L.atm)(101.3 \, J)$$
$$= -4.9 \times 10^2 \, J \quad (-486.24 \, J)$$
$$L.D \approx -490 \, J$$

(kJ)
$$W = \frac{-490 \, J}{1000}$$
$$= 0.49 \, kJ$$