Reversible and irreversible work

Using the result in the last problem for irreversible work, let's see show that the reversible work of expansion is larger than the irreversible work. Use three different conditions to test. Assume 1 mol of gas (to make it easy). Let's assume an initial volume of V_1 =1 L and then calculate both w_{irr} and w_{rev} for three final volumes.
A. $V_2 = 2$ L B. $V_2 = 5$ L and C. V_2 =10 L.

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A. $V_2 = 2$ L B. $V_2 = 5$ L and C. V_2 =10 L.

Solution: Since both works contain nRT,

$$w_{rev} = -nRTln\left(\frac{V_2}{V_1}\right)$$

$$w_{irr} = -nRT\left(1 - \frac{V_1}{V_2}\right)$$

We calculate that value nRT = (1 mol)(8.31 J/molK)(298 K)
nRT = 2480 Joules

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A. For 2 L we have

$$w_{rev} = -(2480) ln\left(\frac{2}{1}\right) = -1720\ Joules$$

$$w_{irr} = -(2480)\left(1 - \frac{1}{2}\right) = -1240\ \text{Joules}$$

$$\frac{w_{rev}}{w_{irr}} = 1.39$$

Reversible and irreversible work

Let's assume an initial volume of V_1 =1 L and then calculate both w_{irr} and w_{rev} for three final volumes.

A. $V_2 = 2$ L B. $V_2 = 5$ L and C. V_2 =10 L.

B. For 5 L we have

$$w_{rev} = -(2480) ln\left(\frac{5}{1}\right) = -3990\ Joules$$

$$w_{irr} = -(2480)\left(1 - \frac{1}{5}\right) = -1980\ \text{Joules}$$

$$\frac{w_{rev}}{w_{irr}} = 2.01$$

Reversible and irreversible work

Let's assume an initial volume of V_1 =1 L and then calculate both w_{irr} and w_{rev} for three final volumes.

A. $V_2 = 2$ L B. $V_2 = 5$ L and C. V_2 =10 L.

C. For 10 L we have

$$w_{rev} = -(2480) ln\left(\frac{10}{1}\right) = -5910\ Joules$$

$$w_{irr} = -(2480)\left(1 - \frac{1}{10}\right) = -2230\ \text{Joules}$$

$$\frac{w_{rev}}{w_{irr}} = 2.65$$