ANNOUNCED QUIZ #4 – ME 3030 — Section 001 – Spring 2024

NAME: SOLUTION

This is an open book quiz. You may use a four function calculator. An unsigned honors pledge will result in a zero.

1. Consider 2.2 kg of water at 440°C in a piston-cylinder assembly, expanding from a pressure of 30 bar to 10 bar in an isothermal, reversible process. Determine the work for the water in kJ. You may assume kinetic and potential energy effects are negligible.

GIVEN: 2.2kg H_2O, $T = 440°C$ (constant), reversible, $P_1 = 30$ bar, $P_2 = 10$ bar

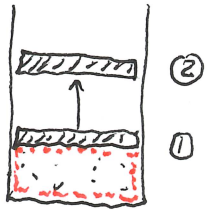
FIND: $W = ?$ kJ

ASSUME: $\Delta KE = \Delta PE = 0$

ANALYSIS: $\Delta E = Q - W \rightarrow \Delta U = Q - W \rightarrow W = Q - \Delta U$

↑ b/c no KE or PE effects

DIAGRAM



$W = Q - m(u_2 - u_1)$

$\Delta S = \int_1^2 \frac{\delta Q}{T} + \sigma^{0}$ b/c reversible

$m(s_2 - s_1) = \frac{1}{T}\int \delta Q \rightarrow m(s_2 - s_1) = \frac{Q_{12}}{T}$

↑ b/c constant T

$Q = mT(s_2 - s_1)$

$W = mT(s_2 - s_1) - m(u_2 - u_1) = m[T(s_2 - s_1) - (u_2 - u_1)]$

From Table A-4

$u_1 = 3002.9$ kJ/kg $\quad u_2 = 3023.6$ kJ/kg

$s_1 = 7.0520$ kJ/kg·K $\quad s_2 = 7.5883$ kJ/kg·K

$$W = (2.2\text{kg})\left[(440+273)\text{K}\left(7.5883 \tfrac{\text{kJ}}{\text{kg·K}} - 7.0520 \tfrac{\text{kJ}}{\text{kg·K}}\right) - \left(3023.6 \tfrac{\text{kJ}}{\text{kg}} - 3002.9 \tfrac{\text{kJ}}{\text{kg}}\right)\right]$$

$$W = (2.2\text{kg})\left[382.38 \tfrac{\text{kJ}}{\text{kg}} - 20.70 \tfrac{\text{kJ}}{\text{kg}}\right]$$

$W = 795.70$ kJ ← ANS.

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE