

SOLUTION

NAME: _____

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

1. A fixed mass of 2.65 kg of ammonia expands isothermally from a saturated vapor at 3.25 bar to a superheated vapor at 1.50 bar. If the process is reversible, what is the work done by the ammonia in kJ? You may assume kinetic and potential energy effects are negligible.

GIVEN: NH_3 , m , $\Delta T=0$, P_1 , P_2

FIND: $W = ? \text{ kJ}$

ASSUME: reversible, no KE or PE effects

ANALYSIS: Closed System

So $\Delta E = Q - W \rightarrow \Delta U = Q - W$

$Q_{\text{rev}} = \int_1^2 T ds = T(s_2 - s_1)$
b/c isothermal

$\Delta U = T(s_2 - s_1) - W \rightarrow W = T(s_2 - s_1) - (U_2 - U_1) \rightarrow W = mT(s_2 - s_1) - m(U_2 - U_1)$

Table A-14 @ $p = 3.25 \text{ bar}$, $T = -7.24^\circ\text{C} = 265.76 \text{ K}$

$u_1 = 1311.46 \frac{\text{kJ}}{\text{kg}}$ $s_1 = 5.4275 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$

Table A-15 @ $p = 1.50 \text{ bar}$

$T(^{\circ}\text{C})$	$u(\text{kJ/kg})$	$s(\text{kJ/kg}\cdot\text{K})$
-10	1320.44	5.8338
-5	1329.08	5.8764

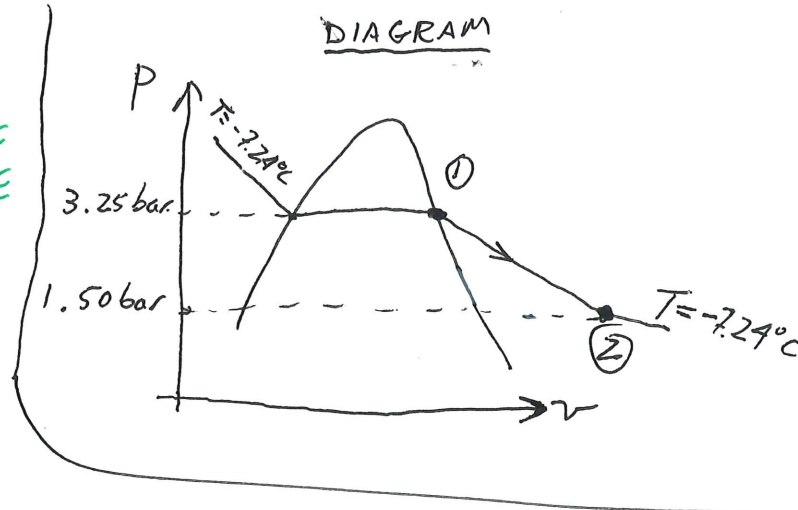
Interpolating

$\frac{(1329.08 - 1320.44) \frac{\text{kJ}}{\text{kg}}}{(-5 - (-10))^{\circ}\text{C}} = \frac{u_2 - 1320.44 \frac{\text{kJ}}{\text{kg}}}{[-7.24 - (-10)]^{\circ}\text{C}} \rightarrow u_2 = 1325.21 \frac{\text{kJ}}{\text{kg}}$

$\frac{(5.8764 - 5.8338) \frac{\text{kJ}}{\text{kg}\cdot\text{K}}}{(-5^{\circ}\text{C} - (-10^{\circ}\text{C}))} = \frac{s_2 - 5.8338 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}}{-7.24^{\circ}\text{C} - (-10^{\circ}\text{C})} \rightarrow s_2 = 5.8573 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}$

Substituting

$W = (2.65 \text{ kg})(265.76 \text{ K})(5.8573 \frac{\text{kJ}}{\text{kg}\cdot\text{K}} - 5.4275 \frac{\text{kJ}}{\text{kg}\cdot\text{K}}) - (2.65 \text{ kg})(1325.21 \frac{\text{kJ}}{\text{kg}} - 1311.46 \frac{\text{kJ}}{\text{kg}})$
 $W = 302.69 \text{ kJ} - 36.438 \text{ kJ}$
 $W = 266 \text{ kJ} \leftarrow \text{ANS.}$



I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE