ANNOUNCED QUIZ #5 – ME 2030 –SECTION 001 – Fall 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. Show all work.

1. A gas is contained in a vertically oriented piston-cylinder assembly where the piston mass is 23.1kg and the piston diameter is $d = 20$cm. As 0.61 kJ of heat is added to the gas, the internal energy of the gas increases by 0.24 kJ. Determine the distance traveled by the piston during this process in units of cm.

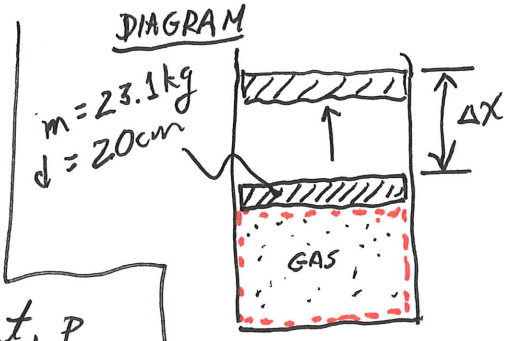
GIVEN: $m, d, Q, \Delta U$

FIND: Δx

ASSUME: No KE or PE changes

ANALYSIS: $\Delta E = Q - W$; since no KE or PE effects,

DIAGRAM



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

$W = \int_{V_1}^{V_2} p\,dV$ since piston mass is constant, p is also constant $\rightarrow$ $W = p\int_{V_1}^{V_2} dV = p(V_2 - V_1) = p\,\Delta V$

$W = p \cdot A \cdot \Delta x$

$A = \frac{\pi d^2}{4} = \frac{\pi (0.2\text{m})^2}{4}$

$A = 0.0314\ \text{m}^2$

$p = p_{atm} + p_{piston} = 101{,}325\ \text{Pa} + \frac{mg}{A}$

$p = 101{,}325\ \text{Pa} + \frac{(23.1\text{kg})(9.81\text{m/s}^2)}{0.0314\text{m}^2}$

$p = 108{,}542\ \text{Pa}$

$\Delta U = Q - W \rightarrow 240\text{J} = 610\text{J} - (108{,}542\text{Pa})(0.0314\text{m}^2)(\Delta x)$

$\Delta x = 0.108\ \text{m}$

$\Delta x = 10.8\text{cm}$ ← ANS.

units check

$= \text{Pa} \cdot \text{m}^2 \cdot \text{m}$

$= \frac{\text{N}}{\text{m}^2} \cdot \text{m}^2 \cdot \text{m}$

$= \text{N} \cdot \text{m}$

$= \text{J}$ ✓

I HAVE NEITHER PROVIDED OR RECEIVED HELP DURING THIS QUIZ.

SIGNATURE