Zachary Ahmad
PSE 380
Due 3/17/21

3.28) A piston motion moves a 25-kg hammerhead vertically down 1 m from rest to a velocity of 50 m/s in a stamping machine. What is the change in total energy of the hammerhead?

$m = 25\ kg$, $h = 1\ m$, $V = 50\ m/s$

Initially, the piston is at rest, so it has potential energy.

$$E_{initial} = PE = m \times g \times h \rightarrow (25kg)(9.81\ m/s^2)(1\ m)$$

$$= 245.25\ J$$

At the end of its motion, piston has kinetic energy.

$$E_{final} = KE = \frac{1}{2} m v^2 = \frac{1}{2}(25\ kg)(50\ m/s)^2$$

$$= 31250\ J$$

$E = U + KE + PE$
& there is no internal E.

Since Total E is:

$\Delta E = E_{final} - E_{initial}$

$\Delta E = 31250 - 245.25$

$= 31004.75\ J \approx 31\ kJ$

- I understand how to solve this problem.

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3.33) A hydraulic hoist raises a 1750kg car 1.8m in an auto repair shop. The hydraulic pump has a constant pressure of 800 kPa on its piston. What is the increase in potential energy of the car and how much volume should the pump displace to deliver that amount of work?

$m = 1750\ kg$, $P = 800\ kPa$, $h = 1.8\ m$

Increase of PE. $PE = m \times g \times h = (1750\ kg)(9.81\ m/s^2)(1.8\ m)$
$= 30.891\ kJ$ $(z_2 - z_1)$

No KE so work is from increase of PE.
$W = PE = P \times V$

$$\Delta V = \frac{E_2 - E_1}{P} = \frac{30891\ J}{800000\ Pa} = 0.0386\ m^3 =$$

- I understand how to solve this problem

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3.39) Two hydraulic piston/cylinders are connected with a line. The master cylinder has an area of $5cm^2$, creating a pressure of 1000 kPa. The slave cylinder has an area of $3cm^2$. If 25J is the work input to the master cylinder, what is the force and displacement of each piston and the work output of the slave cylinder piston?

$A_1 = 5cm^2$, $A_2 = 3cm^2$, $P_1 = 1000kPa$, $W_1 = 25J$

$$P_2 = P_1 = 1000kPa$$

because cylinders are connected, P_1 & P_2 are equivalent and so is work, so $W_2 = 25J$

$$W_1 = P_1 \times A_1 \times s_1 \rightarrow s_1 = \frac{W_1}{P_1 \times A_1} = \frac{25}{1000000 \times 0.0005}$$

$s_1 = \underline{0.05m}$ so $F_1 = \frac{W_1}{s_1} = \frac{25}{0.05} = \underline{500N}$

2nd. Cylinder: $F_2 = P_2 \times A_2 = 1000000 \times 0.0003 = \underline{300N}$

$$F_1 \times s_1 = F_2 \times s_2 \rightarrow s_2 = \frac{F_1 \times s_1}{F_2} = \frac{500 \times 0.05}{300} = \underline{0.08m}$$

$F_1 = 500N$
$F_2 = 300N$
$s_1 = 0.05m$
$s_2 = 0.08m$
$W_2 = 25J$

- I do not fully understand how to solve this problem.

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3.47) A 400-L tank contains argon gas at 250 kPa and 30°C. Cylinder B, having a friction-less piston of such mass that a pressure of 150 kPa will float it, is initially empty. The valve is opened, and argon flows into B and eventually reaches a uniform state of 150 kPa and 30°C throughout. What is the work done by the argon?

Ideal gas law
Conservation of Mass

$$(P_A)_1 V_A = (P_B)_2 (V_A + V_{B2}) \rightarrow V_A + V_{B2} = \frac{(P_A)_1 V_A}{(P_B)_2}$$

$$V_{B2} = \frac{(P_A)_1 V_A}{(P_B)_2} - V_A = \frac{(250)\left(\frac{400}{1000}\right)}{(150)} - \left(\frac{400}{1000}\right) = \underline{0.2667\ m^3}$$

$$W = \int_1^2 P_{leaving}\, dV$$

$$= P_{leaving}(V_{B2} - V_{B1}) = 150(0.2667 - 0)$$

$$= \underline{40\ kJ}$$

- I do not fully understand how to solve this problem.

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3.49) Air in a spring-loaded piston/cylinder setup has a pressure that is linear with volume, $P = A + BV$. With an initial state of $P = 150\,kPa$, $V = 1\,L$, and a final state of $800\,kPa$, $V = 1.5\,L$, it is similar to the setup in Problem 3.48. Find the work done by the air.

$P = A + BV$, $P_1 = 150\,kPa$, $V_1 = 1\,L \rightarrow 1\times10^{-3}\,m^3$
$P_2 = 800\,kPa$, $V_2 = 1.5\,L \rightarrow 1.5\times10^{-3}\,m^3$

$150 = A + B(1)$ $\quad 150 - B = A$
$800 = A + B(1.5)$ $\quad \frac{800 - A}{1.5} = B$ $\rightarrow 150 - \left(\frac{800 - A}{1.5}\right) = A$

$A = -1150$, plug into $150 = A + B \rightarrow B = 1300$

$$W = \int p\,dV \rightarrow \int_1^2 A\,dV + \int_1^2 BV\,dV = A(V_2 - V_1) + B\left(\frac{V_2^2}{2} - \frac{V_1^2}{2}\right)$$

$$= -1150\left(1.5\times10^{-3} - 1\times10^{-3}\right) + 1300\left(\frac{(1.5\times10^{-3})^2}{2} - \frac{(1\times10^{-3})^2}{2}\right)$$

$$= \underline{-0.574\,J}$$

- I understand how to solve this problem

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3.56) A balloon behaves so that the pressure is $P = C_2 V^{1/3}$ and $C_2 = 100\ kPa/m$. The balloon is blown up with air from a starting volume of $1\ m^3$ to a volume of $4\ m^3$. Find the final mass of air, assuming it is at 25°C, and the work done by the air.

$V_1 = 1 m^3$, $V_2 = 4 m^3$, $C_2 = 100 kPa/m$, $T_2 = 293.15 K$

$P_1 = C_2 \times V_1^{1/3} \rightarrow (100 \cdot 10^3)(1)^{1/3} = 100000\ Pa = P_1$

$P_2 = C_2 \times V_2^{1/3} \rightarrow (100 \cdot 10^3)(4)^{1/3} = 158740\ Pa = P_2$

$P_2 \times V_2 = mRT_2 \rightarrow m = \frac{P_2 \times V_2}{R \times T_2}$

$m = \frac{(158740)(4)}{(0.287 \times 10^3)(293.15)} = \underline{7.5\ kg}$

(Table A.5)

comparison for polytropic eq gives $n = -1/3$

$W = \frac{P_2 V_2 - P_1 V_1}{1 - n}$

so $W = \frac{(158740)(4) - (100000)(1)}{n - (-\frac{1}{3})} = \underline{401.22\ kJ}$

- I understand how to solve this problem.

(6)