PH202 Recitation 7: Midterm 2 Review Solutions

Discussion question 1:

A) Top ↓ bottom same X
B) Top ↑ Bottom same X
C) Top ↓ Bottom ↑ ✓
D) Top ↑ Bottom ↓ X
E) Height of water ↓ X
F) after fully submerged, both scales constant ✓

Discussion Question 2: Increase pressure in a sealed container of ideal gas by 1.5x

A) T ↑ 1.5x V constant ✓
B) T ↓ 2/3x V constant X
C) T ↑ 2x V ↑ 3x X
D) T ↓ 1/2x V ↓ 1/3 ✓
E) T ↑ 6x V ↑ 4x ✓

Discussion Question 3: Entropy may decrease locally, how is it justified?

A) not possible X
B) possible since entropy can decrease for an isolated system X
C) decrease is compensated by increase elsewhere ✓
D) none of above X

PH202 Recitation [redacted] 7: Midterm 2 review

Problem 1: Water is flowing in a fire hose with a velocity of 1.0m/s and a pressure of 200kPa. Velocity at the nozzle?

Bernoulli's equation:

$$\frac{1}{2}\rho v_1^2 + \rho g h_1 + P_1 = \frac{1}{2}\rho v_2^2 + \rho g h_2 + P_2$$

no height change $\Rightarrow \rho g h_1 = \rho g h_2$

$$\Rightarrow \frac{1}{2}\rho v_1^2 + P_1 = \frac{1}{2}\rho v_2^2 + P_2$$

P_2 → P_{atm} at nozzle (or right after)

looking for v_2

$$\frac{1}{2}\rho v_1^2 + P_1 - P_2 = \frac{1}{2}\rho v_2^2$$

$$\Rightarrow \sqrt{\frac{2}{\rho}\left(\frac{1}{2}\rho v_1^2 + P_1 - P_2\right)} = v_2$$

$$\Rightarrow \sqrt{\left(\frac{2}{1000\frac{kg}{m^3}}\right)\left(\frac{1}{2}(1000kg/m^3)(1.0m/s)^2 + 200000Pa - 101325Pa\right)} = v_2$$

$$\Rightarrow v_2 = 14.1m/s$$ (or 14m/s in 2 sig figs)

Problem 2

dam holds back water in a lake. dam has small hole 1.4m below surface of lake. What speed does water exit the hole?

Bernoulli's equation:

$$P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2$$

well, $P_1 = P_2$ since both open to atmosphere

$$\Rightarrow \rho g h_1 + \frac{1}{2}\rho v_1^2 = \rho g h_2 + \frac{1}{2}\rho v_2^2$$

Since hole is small, and lake is huge

$\Rightarrow v_1 = 0$ for velocity of water in dam

$$\Rightarrow \rho g h_1 = \rho g h_2 + \frac{1}{2}\rho v_2^2$$

$$\Rightarrow \rho g (h_1 - h_2) = \frac{1}{2}\rho v_2^2$$

$$\Rightarrow \sqrt{2g(h_1 - h_2)} = v_2$$

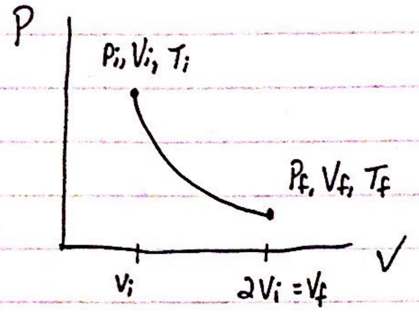
1.4m below surface $\Rightarrow h_1 - h_2 = 1.4m$

$$\Rightarrow \sqrt{2(9.8m/s^2)(1.4m)} = v_2$$

$$\Rightarrow v_2 = 5.2m/s$$

Problem 3 1mol of monatomic gas, pressure of 2atm at 350K.
then adiabatically double volume with temperature decreasing to 300K.

a) sketch process



b) $P_i = 2atm$ $T_i = 350K$ $n = 1mol$

=> $PV = nRT$ since monatomic ideal gas

=> $V = \frac{nRT}{P} = \frac{(1mol)(8.314\frac{J}{mol K})(350K)}{(2 \cdot 101325 Pa)} = .014m^3$ initial volume

final => $T_f = 300K$ doubled volume => $2V_i = .029m^3$

$PV = nRT$

=> $P = \frac{nRT}{V} = \frac{(1mol)(8.314\frac{J}{mol K})(300K)}{(.029m^3)} = 86000 Pa$ or $86kPa$

adiabatic process => $Q = 0$

$\Delta E = Q + W$ => $\Delta E = W$

$\Delta E = \frac{3}{2} nR\Delta T = \frac{3}{2}(1mol)(8.314\frac{J}{mol K})(300-350K)$

$= -623.85J = -624J$

$\Delta E = W = -624J$

	P	V	T
initial:	2atm ($2 \cdot 101325 Pa$)	$.014m^3$	350K
final:	86kPa	$.029m^3$	300K

$Q = 0$

$W = -624J$

$E = -624J$

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