ANSWERS

Physics 6C – 2nd Midterm - 2017 Name: _____

Dr. Nassar (1 ½ -hour exam – one 3x5 card allowed)

Problems:

P1. (20 points) A hot air balloon has a balloon of volume 2500 m^3, filled with air which is heated by a burner under the opening at the bottom of the balloon. The density of the hot air is 1.25 kg/m^3. (a) **(7 points)** Assume first that the balloon is in equilibrium (at rest or constant velocity). What temperature must the air inside the balloon be to lift a load of 240kg (balloon fabric, basket, passenger, etc.) off the ground, if the outside air has a temperature of 20° C and a pressure of 1.0×10^5 Pa?

$\Sigma F = 0$

$\rho_{out} gV - \rho_{in} gV - (240kg)g = 0$ $\qquad$ $(\rho_{out} - \rho_{in})(2500m^3) = 240kg$

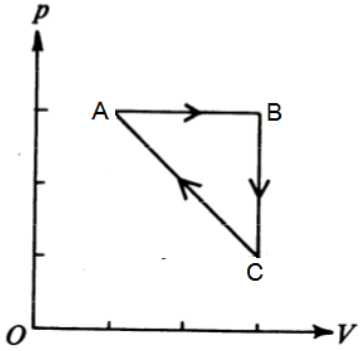
$(\rho_{out})(293K) = (1.25kg/m^3)(T_{in})$ $\qquad$ $(1.25kg/m^3)\left(\frac{T_{in}}{293} - 1\right)(2500m^3) = 240kg$

$T_{in} = 315.5^oK \simeq 316^oK$ or (43^oC) $\qquad$ $\rho_{out} = \rho_{in}\frac{T_{in}}{T_{out}} = 1.25\frac{316}{293} = 1.34kg/m^3$

(b) **(8 points)** If the temperature of the air is increased to 53° C and the load is decreased to 200 kg, what is the acceleration of the balloon?

ρ_{out} and T_{out} do not change in the problem. So, $\rho_{in} = \rho_{out}\frac{T_{out}}{T_{in}} = 1.34\frac{293}{326} = 1.21kg/m^3$

$$\Sigma F = Ma \Rightarrow \begin{array}{l} \rho_{out}Vg - \rho_{in}Vg - 200g = Ma \\ (1.34)(2500)(9.8) - (1.21)(2500)(9.8) - (200)(9.8) = Ma \\ where \;\; M = \rho_{in}V + 200 = 3225kg \\ a \simeq 0.43m/s^2 \end{array}$$



2. (10 points) An ideal gas are taken along the paths ABCA as shown in the pV-diagram above:

A (V_o, $3p_o$), B ($3V_o$,$3p_o$), C($3V_o$,p_o).

(a) Find the work done by the gas from A to B, B to C and C to A.

A to B: $6p_oV_o$ B to C: 0 C to A: $-4\ p_oV_o$

(b) Find the net work done by the gas: Net (total) = $2\ p_oV_o$

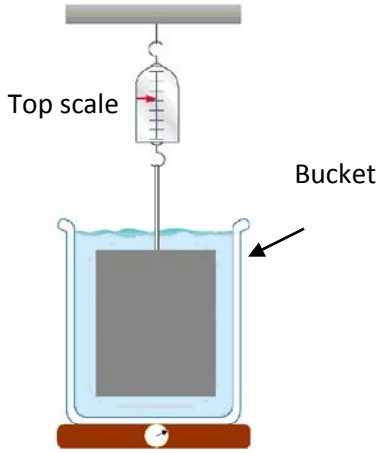
(c) Is heat absorbed or release by the gas? Absorbed ($Q = \Delta E + W_{by} > 0$

(c) Where is the temperature the highest? Point B

4. (10 points) A 0.75 kg bucket holding 4.00 kg of water sits on a scale. A 0.2 kg aluminum block is lowered into the water by a string attached to another scale. $\rho_{\text{aluminum}} = 2.70 \times 10^3\ \text{kg/m}^3$; $\rho_{\text{water}} = 1.00 \times 10^3\ \text{kg/m}^3$.

a) What is the reading on the top scale (from which the aluminum block hangs)?

b) What is the reading on the bottom scale (on which the bucket sits)?



a) $T + F_b - m_ag = 0$

Volume of block:

$V_a = m_a/\rho_a = 0.2/(2.7 \times 10^3) = 7.41 \times 10^{-5}\ m^3$

$T = (0.2)(9.8) - (1 \times 10^3)(7.41 \times 10^{-5})(9.8) =$

$= 1.23$ N

b) N = weight of bucket + weight of water + weight of block – tension =

$= (0.75)(9.8) + (4)(9.8) + (0.2)(9.8) - 1.23$

$= 47.28 \simeq 47.3$ N

4. (10 points) Explain how a refrigerator works.