Physics 102.13
Quiz#4-Quiz#5
Chapter 19-20

Instructor: Dr. A. Mekki

Name: Key Id:

1. A Carnot heat pump is used to keep a house warm at 22 ^{0}C. How much work is required of the pump to deliver 2800 J of heat into the house if the outdoor temperature is – 15 ^{0}C?

$$K_c = \frac{T_H}{\Delta T} = \frac{295}{37} = 8.0 = \frac{Q_H}{W}$$

$$W = \frac{Q_H}{K_c} = \frac{2800}{8.0} = \boxed{350\,J}$$

2. A one mole of an ideal diatomic gas at a pressure of 1 atm and temperature of 450 K undergoes a process in which its temperature increases linearly with temperature. The final temperature and pressure of the gas are 720 K and 1.6 atm. (Hint: What is the relationship between the initial and final volume?) Determine:
   (a) the change in internal energy of the gas
   (b) the work done by the gas
   (c) the heat added to the gas.

We see that $V_i = \frac{nRT_i}{P_i} = \frac{nR\,450}{1}$; $V_f = \frac{nRT_f}{P_f} = \frac{nR\,720}{1.6} = nR \times 450$

V = Constant.

a) $\Delta E_{int} = n C_v \Delta T = 1 \times \frac{5}{2} \times 8.31 \times 270$

$= \boxed{5610\,J}$

b) $W = 0$ (V = Constant)

c) $Q = \Delta E_{int} = \boxed{5610\,J}$

Physics 102.14
Quiz#4-Quiz#5
Chapter 19-20

Instructor: Dr. A. Mekki

Name: Key Id:

1. In a constant pressure process, heat is removed from one mole of oxygen gas (diatomic molecule) initially at 200 °C. The final temperature of the gas is 100 °C. Calculate;
(a) The work done on or by the gas.
(b) The change in internal energy of the gas.
(c) The energy gained of lost by the gas as heat.

a) $W = P\Delta V = nR\Delta T = 1 \times 8.31 \times (100-200)$
$= \boxed{-831\ J}$

b) $\Delta E_{int} = n C_v \Delta T = 1 \times \frac{5}{2} \times 8.31 \times (-100) = \boxed{-2078\ J}$

c) $\Delta E_{int} = Q - W$
$\Rightarrow Q = \Delta E_{int} + W = -2078 - 831$
$= \boxed{-2909\ J}$

2. Find the change in entropy of 1 g of water whose temperature is decreased from 5 °C to 0 °C ice? (C_{water} = 4186 J/kg K, L_f = 333 x 10^3 J/K)

$5^\circ C \xrightarrow[\Delta S_1]{water} 0^\circ C \xrightarrow[\Delta S_2]{ice} 0^\circ C$

$\Delta S = \Delta S_1 + \Delta S_2 = mc \ln\left(\frac{T_f}{T_i}\right) - \frac{mL_f}{T}$

$= 10^{-3} \times 418 \times \ln\left(\frac{273}{278}\right) - \frac{10^{-3} \times 333 \times 10^{3}}{273}$

$\boxed{\Delta S = -1.29\ J/K}$

Physics 102.15
Quiz#4-Quiz#5
Chapter 19-20

Instructor: Dr. A. Mekki

Name: Key Id:

1. A Carnot refrigerator extracts heat from the freezer compartment at a temperature of -17 ^{0}C and exhausts it into the room at 25 ^{0}C.
   (a) What is the coefficient of performance of the refrigerator?
   (b) If 200 J of heat is extracted from the freezer compartment every cycle, how much heat is expelled to the room?

a) $K_c = \frac{T_L}{\Delta T} = \frac{256}{42} = \boxed{6.1}$

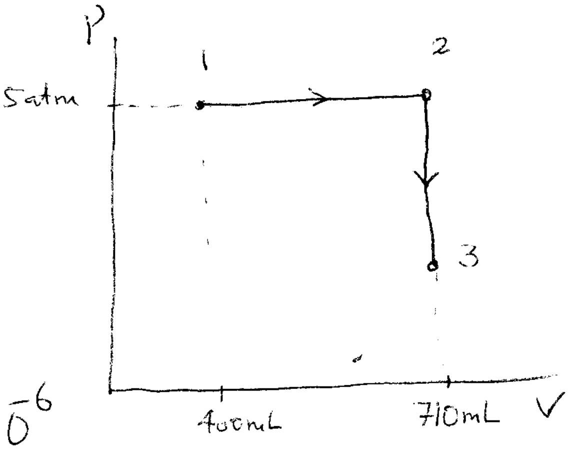
b) $|Q_L| = 200\ J$ $\quad |Q_H = ?$

$K_c = \frac{|Q_L|}{W} \Rightarrow W = \frac{|Q_L|}{K_c} = 32.8\ J = Q_H - |Q_L|$

$\Rightarrow Q_H = W + |Q_L| = \boxed{232.8\ J}$

2. An ideal gas expands at constant pressure of 5.0 atm from 400 mL to 710 mL. Heat then flows out of the gas, at constant volume, and the pressure and temperature are allowed to drop until the temperature reaches its original value. Calculate
   (a) the total change in internal energy of the gas
   (a) the total work done by the gas
   (b) The total heat flow into the gas.

$T_1 = T_3 =$



a) $\Delta E_{int\ Total} = n C_V \Delta T$
$= n C_V (T_3 - T_1) = \boxed{0}$

b) $W_{Total} = P \Delta V$
$= 5 \times 1.01 \times 10^5 \times (710 - 400) \times 10^{-6}$
$\boxed{W = 157\ J}$

c) Since $\Delta E_{int} = 0 \Rightarrow Q_{total} = W_{total} = \boxed{157 J}$