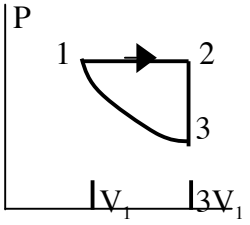
PHYSICS 4B **QUIZ 3** SPRING QUARTER 2018
PROF. HIRSCH **3 Problems** MAY 7

Problem 1 (10 pts)
10g of water at 10ºC are poured onto 100g of ice at -10ºC.
(a) What is the final temperature of the system?
(b) How much ice is there in the final state?
Specific heat of water: 1cal/gºC. Specific heat of ice: 0.5cal/gºC. Heat of fusion of ice: 79.7cal/g. Ice density: 0.92 g/cm^3. Water density 1 g/cm^3.

Problem 2 (10 pts + 3 pts extra credit)
A reversible heat engine consists of 1 mol of a monatomic ideal gas performing the cycle shown in the figure, in clockwise direction. At point 1 the temperature is T_1 and the volume is V_1. The curve connecting 1 and 3 is an isotherm, the straight line connecting 2 and 3 is vertical, the straight line connecting 1 and 2 is horizontal. At points 2 and 3 the volume is $3V_1$.



(a) Find the total net work performed by the system in one cycle.
(b) On which part(s) of this cycle does the system absorb heat, and on which part(s) does it release heat? (12, 23, 31 are the parts). Don't do calculations here, just give the answers and justify them clearly using the first law and the fact that the gas is ideal.
(c) Find the total heat absorbed in the cycle.
(d) Find the efficiency of this engine, defined as "work performed"/"heat absorbed" in one cycle.
(e) Compare with the efficiency of a Carnot engine operating between the highest and lowest temperatures that this engine operates. Which efficiency is larger?
(f) Find the heat absorbed or released in all the portions (Q_{12}, Q_{23}, Q_{31}) and their sum, compare with the work computed in (a), explain why they are the same or different.
Give all your answers in terms of R (gas constant) and T_1 only.

Problem 3 (10 pts)
One mol of a monatomic ideal gas is initially at temperature T_1, occupying volune V_1. The following 3 processes happen in sequence:
Process 1: The gas undergoes free expansion to volume $2V_1$.
Process 2. The gas is adiabatically and reversibly compressed back to volume V_1.
Process 3. The gas is put in thermal contact with a heat reservoir at temperature T_1. The thermal contact is such that heat conduction occurs very slowly. After a long time the gas reaches temperature T_1.
Find the change in entropy of the gas (ΔS) and of the environment (ΔS^{env}) in each process, i.e. find:
(a) process 1: ΔS_1, ΔS_1^{env}
(b) process 2, ΔS_2, ΔS_2^{env}
(c) process 3, ΔS_3, ΔS_3^{env}
(d) Give the total change in entropy of (i) the gas and (ii) the universe between the initial state and the final state after the three processes are completed.
Give all your answers as: number times R, with R the gas constant. Justify all answers.