Exam 4

P201 Fall 2006,
Instructor: Prof. Abanov

11/28/06

Name_____ Section_____

(print in **big** block letters)

Your grade:

Problem 1.

One end of a horizontal rope is attached to a prong of an electrically driven tuning fork that vibrates at 200 Hz. The other end passes over a pulley and supports a 3.00 kg mass. The linear mass density of the rope is 5.50×10^{-2} $\mathrm{kg/m}$.

What is the speed of a transverse wave on the rope?_____

What is the wavelength?_____

What would the speed of the transverse wave be if the mass at the end were doubled? _____

What would the wavelength be in this case? _____

Problem 2.

A wire with mass 60.0 g is stretched so that its ends are tied down at points 86.0 cm apart. The wire vibrates in its fundamental mode with frequency 80.0 Hz and with an amplitude of 0.800 cm at the antinodes.

What is the wavelength of the fundamental mode? _____

What is the speed of the wave?_____

What is the tension of the wire?_____

What are the frequency of the second overtone (harmonic)?_____

Problem 3.

A glass flask whose volume is 1000.45 cm^3 at $T_i = 0\,°C$ is completely filled with mercury at this temperature. When flask and mercury are warmed to $T_f = 55.2\,°C$, 9.00 cm^3 of mercury overflow.

(The coefficient of volume expansion of the mercury is $18 \times 10^{-5}\ K^{-1}$)

What is the volume of the mercury at the final temperature?_____

What is the coefficient of volume expansion of glass?_____

How much more mercury will overflow if we increase the temperature to $T_f = 65\,°C$?_____

Problem 4.

The mixture of 1kg of ice and 1kg of water at equilibrium at normal pressure is heated to $T_f = 10\,°C$. The latent heat of ice is $3.34\text{x}10^5\,J/kg$, the specific heat capacity of water is $4.19\text{x}10^3\,J/kg \bullet K$.

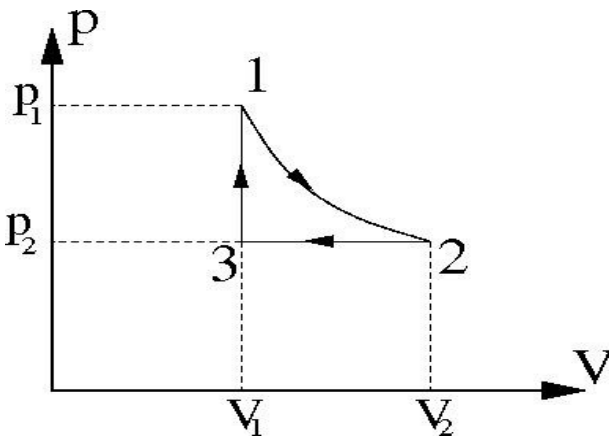
What amount of heat have been supplied to the system?_____

How much more heat we need to supply in order to vaporize the water? What will be the temperature of the resulting vapor? (the heat of vaporization is $2.26\text{x}10^6\,J/kg$)_____,_____

Problem 5.

One mole of an ideal gas has initial temperature 400K and initial volume 1m^3 (1). During an isothermal process its volume doubled (2). Then by an isobaric process it was brought to the initial

volume (3). Finally, increasing pressure at constant volume the gas was brought to the initial state.



What is the initial pressure p_1 ?_____

What are the volume V_2 , the pressure p_2 and the temperature T_2 at the state (2)?_____,_____,_____

What are the volume V_3 , the pressure p_3 and the temperature T_3 at the state (3)?_____,_____,_____

How much work had to be done on the gas during the process 2-3?_____

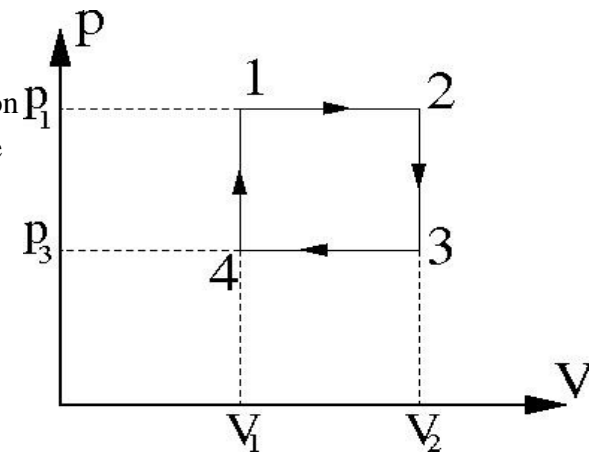
How much internal energy of the gas has changed during the process 2-3?_____

How much heat had to be supplied to the gas during the process 2-3?_____

How much heat had to be supplied to the gas during the process 3-1?_____

Problem 6.

One mole of the ideal gas goes around a cycle as shown on the picture. At the state 1 the temperature is 400K and the volume is $1m^3$. The temperature at the state 3 is the same as in the state 1, but the volume is twice that of the state 1.



What are the pressure at the state 1?_____

What are the pressure at the sate 3? _____

What are the temperatures of the gas at the states 2 and 4? _____,_____

What is the net work done by the gas during the full cycle?_____

Problem 7.

During the adiabatic process the ideal gas increases its volume by a factor of 2.

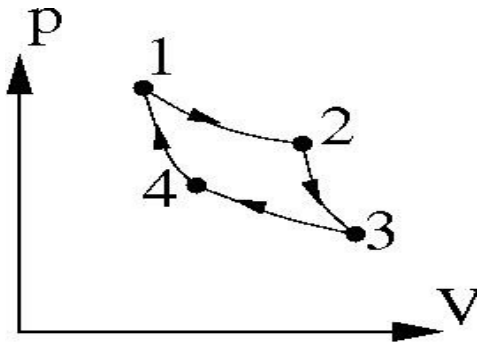
How (by what factor) the pressure has changed?_____

How (by what factor) the temperature has changed?_____

If the initial temperature was 400K, what is the change in internal energy of the gas?_____

How much work the gas has done during this process?_____

Problem 8.



One mole of an ideal gas goes around the Carnot cycle. The temperature of the hot heat bath is $T_H = 400\text{K}$, the temperature of the cold bath is $T_C = 300\text{K}$. During the process 1-2 the gas received 4J of heat.

What work is done by the gas during the process 2-3?_____

What work is done by the gas during the process 4-1?_____

How much work has been done by the gas during the process 1-2?_____

How much heat the gas transfered to the cold bath during the process 3-4?_____

How much work the gas has done during the process 3-4?_____

What is the thermal efficiency of this heat engine?_____

Problem 9.

For the gas and the cycle from the Problem 8.

What is the change of entropy during the processes 1-2, 2-3, 3-4, 4-1?_____,_____,_____,_____

What is the net change of entropy during the cycle? Why?_____

Problem 10.

The latent heat of ice is $3.34\text{x}10^5\,J/kg$. The specific heat capacity of water is $4.19\text{x}10^3\,J/kg \bullet K$.

What is the difference in entropy of one kilogram of ice and one kilogram of water at $0\,^\circ C$?

_____

Approximately, how much the entropy of the water changes when its temperature increases from $50\,^\circ C$ to $55\,^\circ C$?_____