PHYSICS 215

Final Test

16 December 1999

Student's name_____ S.N._____

A. Multiple choice; choose the best of the list of answers given. (20 points total)

1. Young's modulus best describes

   a) ☐ a wire twisting.

   b) ☐ a wire bending.

   c) ☐ a wire stretching.

   d) ☐ a wire carrying electricity.

2. Normal atmospheric pressure can support a column of mercury 0.760 m tall. A column of oil, with density $\frac{1}{4}$ that of mercury, is supported by normal atmospheric pressure. What is the maximum height of the column of oil that can be supported?

   a) ☐ 0.190 m.

   b) ☐ 0.760 m.

   c) ☐ 3.04 m.

   d) ☐ 10.3 m.

   e) ☐ none of these.

3. In a mixture of hydrogen gas, oxygen gas and nitrogen gas, the molecules with the lowest speed are those of

   a) ☐ hydrogen.

   b) ☐ oxygen.

   c) ☐ nitrogen.

   d) ☐ all have the same speed.

4. When heat is added to boiling water, its temperature

   a) ☐ increases.

   b) ☐ decreases.

   c) ☐ stays the same.

5. A metal disk has a small off-centered hole drilled in it. When heated,

a) ☐ the disk expands and so does the hole.
b) ☐ the disk expands but the hole shrinks.
c) ☐ the disk expands but the hole remains unchanged.
d) ☐ the disk remains unchanged but the hole expands.
e) ☐ none of these.

6. The first law of thermodynamics is a restatement of the

a) ☐ principle of entropy.
b) ☐ law of heat addition.
c) ☐ Carnot cycle.
d) ☐ conservation of energy.
e) ☐ none of these.

7. When an ideal gas is subjected to an adiabatic process

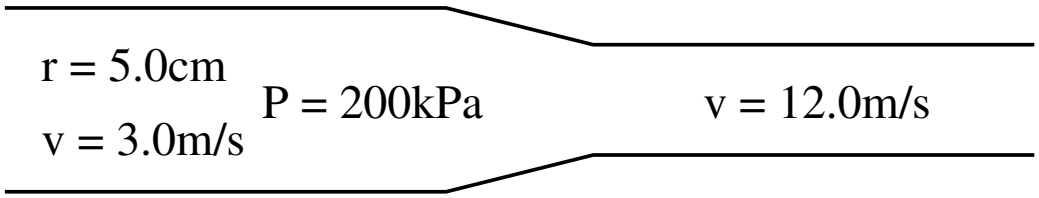
a) ☐ no work is done by the gas.
b) ☐ the temperature of the gas does not change.
c) ☐ the internal energy of the gas does not change.
d) ☐ no heat flows into or out of the system.
e) ☐ none of these.

8. A Carnot cycle heat engine would have 100% efficiency if its input reservoir were

a) ☐ 100 times hotter than the exhaust.
b) ☐ 1000 times hotter than the exhaust.
c) ☐ 100 times colder than the exhaust.
d) ☐ any temperature if the exhaust is at absolute zero.
e) ☐ none of these.

B. Solve 4 of the 5 problems given below. (20 points each)

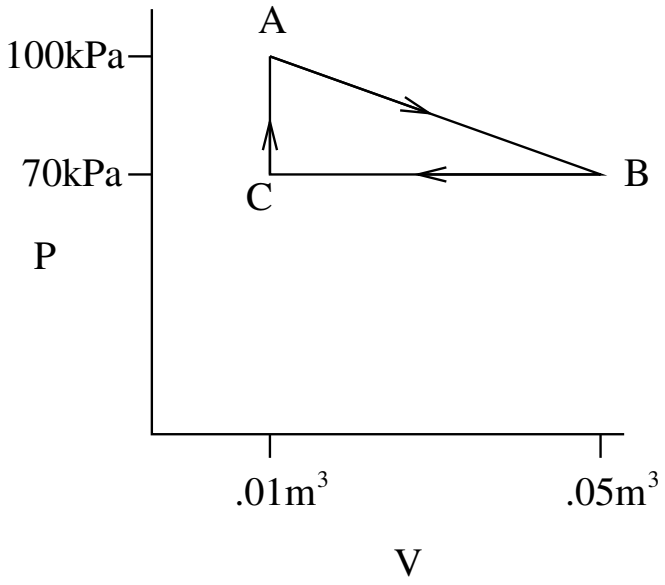
1. Two pipes of different cross sectional area are connected together, and are lying on the ground horizontally. Water is flowing through. I show you the radius, water speed and water pressure at the left end of the pipe, and the water speed at the right end. ($\rho = 1000\ kg/m^3$)
   a) What is the pressure at the right end?
   b) What is the radius at the right end?



2. One way to cool a gas is to let it expand. In a typical cooling process, a gas at $27°C$ and 4000 kPa is expanded to atmospheric pressure and a volume 36 times larger. ($R = 8.314 \frac{J}{mol \cdot K}$ and $N_A = 6.02 \times 10^{23}$)
   a) What is the temperature of the cooled gas?
   b) Calculate the initial average kinetic energy of the gas atoms in the sample, and the *rms* speed of the gas atoms, assuming the gas is helium. ($k = 1.38 \times 10^{-23}\ J/K$ and $M = 4.0\ g/mol$) How would the average kinetic energy and *rms* speed change if the gas were heated to $327°C$ rather than being expanded and cooled?

3. After cooking yourself breakfast, you pour some hot water into your skillet. The skillet has a mass of 500 g, is made of aluminum ($c = 0.220\ \frac{cal}{g \cdot ^\circ C}$) and is originally at 230°C. You pour in 100 g of water originally at 40°C ($c = 1.00\ \frac{cal}{g \cdot ^\circ C}$, $H_v = 539\ cal/g$). The final temperature of the water+skillet is 100°C; assume that no heat is lost to the surroundings.
   a) How much heat is given off by the skillet as it cools?
   b) How much heat is absorbed by the water as it get hotter?
   c) How much of the water is converted to steam?

4. In the figure given below, I show a thermodynamic process, involving an ideal gas, which is cyclic. The cycle runs from A to B to C to A... The ideal gas constant $R = 8.314\ \frac{J}{mol \cdot K}$.
   a) If there are 3 moles of gas involves, calculate the temperature of the system at point A.
   b) How much work is done in one cycle? What is the change in internal energy (ΔU) after one cycle?



5. If you roll 2 dice and sum the two numbers showing, there are 11 possible macrostates (2, 3,..., 12). ($k = 1.38 \times 10^{-23}\ J/K$)

   a) List all microstates for each macrostate in the table below. Which microstate is most likely? Which macrostate is most likely?

   b) Using the Boltzmann definition of entropy, fill in the entropy of each macrostate.

macrostate	microstates	entropy
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		