Test 1 – Review **Dr. Weppner**
PHN 242 **Feb. 2004**

NAME _____ SCORE____

Remember to get full credit label answers with correct units, show all work, draw diagrams, remember conversions.

1. [6 pts] Answer true or false and explain why:
(a) The Fahrenheit and Celsius temperature scales differ **only** in their choice of the zero temperature

False. Difference between freezing and boiling of water is 100° or 190°

(b) The Kelvin is the same size as the Celsius degree

True, difference between freezing and boiling is 100°C and 100°K

2. [8 pts] A vacuum pump in the Eckerd Advanced Physics Lab can obtain a pressure of 1.33×10^{-4}Pa. How many molecules are there in a $1.0cm^3$ region of space at 300K?

$PV = nRT$

$1.33\times10^{-4}\,Pa\,(1cm^3)\left(\frac{1m}{100cm}\right)^3 = n(8.314)\,J/_{Kmol}(300K)$

$n = 5.3\times10^{-14}\,mol$

$n\,N_A$ = # of molecules

$= 3.2\times10^{10}$

3. [6 pts] You clean your bedroom thereby decreasing the entropy in the room. Explain why this is not a violation of the 2nd Law of Thermodynamics. (**Show Reasoning**)?

Because your entropy in exercise increases more.

4. [6 pts] Can a system change its temperature with no absorption of heat(**Give reasoning**)?

Yes (increase pressure for example)

5. [16 pts] If 250 grams of molten (liquid) lead at 327° C is poured into a cavity in a large block of ice at 0° C, how much of the ice melts?

First "Freeze" Lead then cool it down

$$Q = mL + |mc\Delta T|$$

$$= (.25\,kg)\left(\frac{23200\,J}{K}\right) - (.250kg)\left(\frac{128\,J}{Kg\,K}\right)(327°)$$

$$= -16300\,J$$

ice picks up 16300 J $\quad 16300\,J = m_{ice}(333000\,J/K)$

$m_{ice} = .049\,kg$ or 49 grams

6. [14 pts] A copper collar is to fit tightly about a steel shaft whose diameter is 6.0000 cm at 20° C. The inside diameter of the copper at that temperature is 5.9800 cm. To what temperature must the copper collar be raised so that it will just slip on the steel shaft, assuming that the steel shaft remains at 20°C while heating the copper?

$\Delta L = .02cm$ $\quad \Delta L = \alpha L_0 \Delta T$

$L_0 = 5.98cm$ $\quad \alpha_{copper} = \frac{17 \times 10^{-6}}{C}$

$$\Delta T = \frac{\Delta L}{\alpha L_0} = \frac{.02cm}{\left(17\times10^{-6}/C\right)(5.98cm)}$$

$$\Delta T = 197°C$$

So $T = 217°C$

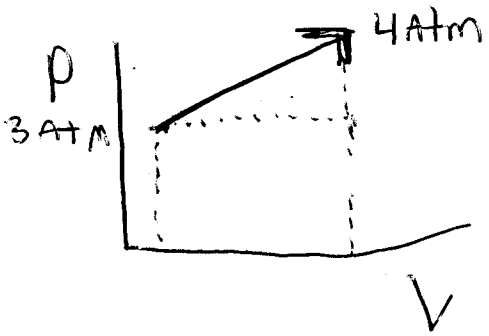
7. [18 pts] We have one mole of a mon-atomic ideal gas. Its initial state has: $p_{initial} = 3.0atm$, $V_{final} = .015m^3$. Its final state has: $p_{final} = 4.0atm$, $V_{final} = .030m^3$. It follows a straight line path on a pV diagram.

(a) draw a pV diagram of the process

(b) How much work was done by the gas during the process?

(c) What was ΔU for the process?

(d) How much heat was gained or lost?



b) $W = \square + \triangle$

$= (3Atm)\left((.03m^3) - (.015m^3)\right)\left(\frac{1.02\times10^5 Pa}{1Atm}\right)$

$+\left(\frac{1}{2}\right)(1Atm)(.03m^3 - .015m^3)$

$4590J + 765J = 5355J$

c) $\Delta U = 3/2\, nR\Delta T$

$PV = nRT$ so $T = \frac{PV}{nR}$

$T_1 = 550K \quad T_2 = 1470K$

$\Delta T = 920K$ so $\Delta U = +9560J$

d) $\Delta U = Q - W$ so $Q = \Delta U + W = 14920J$

8. [16 pts] A sailor is in a tropical sea on a boat. She has a 2.0 kg piece of ice at 0° C, and the temperature of the water is 27°C. Assume she is able to use the heat from the water to melt this ice.

(a) How much heat is released when the chemical bonds of the ice are broken?

(b) What is the maximum amount of heat that she could turn into work?

(c) If she were able to build this 'ideal' situation, what would be the entropy change to the outside environment (the sea) only?

a) $Q = mL = (2\,kg)(333\times10^3\,J/kg)$

$= 6.66\times10^3\,J$

b) $\varepsilon_{Carnot} = 1 - \frac{T_c}{T_h} = 1 - \frac{273}{300} = .09$

$50\,(.09)(6.66\times10^3\,J)$

$= 59950\,J \approx 6\times10^4\,J$

c) exhaust $(666\times10^3\,J - 6\times10^4\,J) = 606\times10^3\,J$ into the sea

$\Delta S = \frac{Q}{T} = \frac{606\times10^3\,J}{300K} = 2020\,J/K$

9. [10 pts] A chamber is filled with 10.0 moles of an ideal mon-atomic gas at 200° C. What is the total amount of energy associated with this gas?

$U = 3/2\,nRT$

$= (3/2)(10\,m)\left(\frac{8.314\,J}{K\,mK}\right) 473K = 59000J$

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[22 pts.] 5. A ice-cube which has a mass of 150 grams and a temperature of -20 C is tossed in a very large lake which has a temperature of +20 C.
(A) How much heat was needed to bring the ice-cube to thermal equilibrium with the lake?
(B) Where did this heat come from?
(C) What is the change in entropy for the lake?
(D) Is the change in entropy for the lake-ice-cube system a positive or negative number for this melting process?

A) 3 steps

$$Q = mc\Delta T + mL + mc\Delta T$$

$$(.150\,kg)\left(2220\,\frac{J}{kg\,K}\right)(20K) + (.150kg)\left(333\times10^3\,\frac{J}{kg}\right) + (.150kg)\left(4190\,\frac{J}{kg\,K}\right)(20K)$$

$$= 69100\,J$$

B) The lake

c) $\Delta S = \frac{-69100J}{293K} = -236\,J/K$

d) Must be positive

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[5 pts.] 6. Why can potatoes be baked more quickly when a metal skewer has been inserted in them?

The skewer will spread heat quickly into the interior.

[5 pts.] 7. Is it possible to create an engine that creates no thermal pollution?

NO, Violation of 2nd Law one must always increase entropy No exhaust would mean a decrease in entropy.

[5 pts.] 8. What is wrong with the statement: "Given any two bodies, the one with the higher temperature contains more heat".

heat is a dynamic energy flow and is not contained in any object

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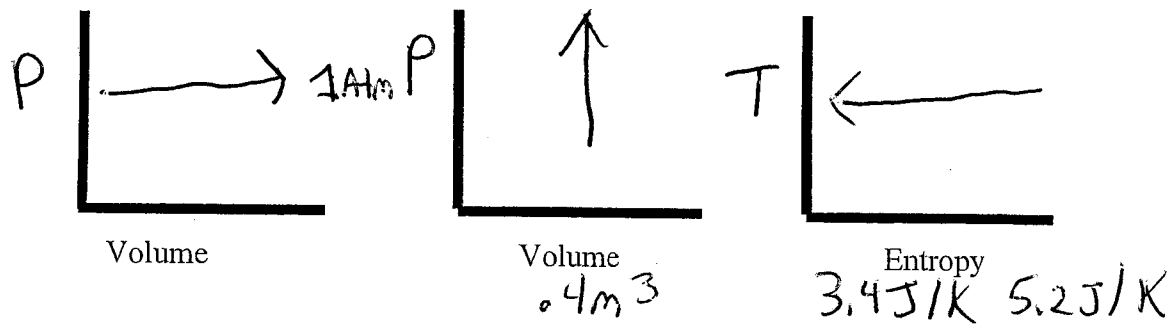
[22 pts.] 4. Sketch 1 mole of an ideal gas which undergoes one of the following processes. In your three sketches include y-axis label and x and y axis tick marks and labels.

(A) undergoes an isobaric process from .20 m^3 to .40 m^3 at 1 atmosphere

(B) undergoes a constant volume process at .40m^3 from 1 atmosphere to 2 atmospheres

(C) undergoes an isothermal process from 5.2 J/K to 3.4 J/K at 275 Kelvin

(D) Calculate work done for all three processes



(A) (B) (C)

Calculations for (D):

A) $W = P\Delta V = (1Atm)(.20m^3)\left(\frac{1.02\times10^5 Pa}{1Atm}\right)$

$= 20400J$

B) $W = 0$

C) usually area under curve is Q

but in an isothermal process $\Delta U = 0$

so $W = Q$