NAME:

Chemistry 130A, Section 2, Prof. Groves

EXAM #1 Sept. 24, 2001

5 problems: 100 points

10 *extra credit* points
* problems are for *extra credit*: correct answers will add points to your score but points on these questions will not contribute to the class average.

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1. a. (5pts) Indicate whether each of the following quantities is intensive, extensive, or neither:

    Pressure, P

    Volume, V

    Temperature, T

    Energy, E

    Density (mass/V)

   b. (5pts) Which of the following are state variables:

    Enthalpy, H

    Energy, E

    Work, w

    Heat, q

    (w + q) - H

   c. (10pts) Suppose the total energy of the universe is $\mathbf{E}_{total}$ and the total entropy is $\mathbf{S}_{total}$ today. How will $\mathbf{E}_{total}$ and $\mathbf{S}_{total}$ tomorrow relate to their values today? What principals support your answer?

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2. Amides can react with water to obtain carboxylic acids. This reaction occurs in living beings all the time. Calculate the energy for the reaction of formamide with water to obtain formic acid in the gaseous phase with ammonia as another product by the two methods suggested below (parts a and b), then discuss your results in part c.

<u>Heat of formation data:</u>

Formamide $\Delta H_f^0(g) = -186.2$ kJ/mol

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      O
      ||
  H – C – NH2
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Formic Acid $\Delta H_f^0(g) = -378.6$ kJ/mol

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      O
      ||
  H - C - OH
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Water $\Delta H_f^0(g) = -241.8$ kJ/mol

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  H - O - H
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Ammonia $\Delta H_f^0(g) = -46.11$ kJ/mol

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  H - N - H
      |
      H
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<u>Bond dissociation energies</u>

C - H	415 kJ/mol	C - N	292 kJ/mol	O - H	463 kJ/mol
C - O	350 kJ/mol	N - H	391 kJ/mol		

a. (7pts) using heat of formation data.

b. (7pts) using bond dissociation energy.

c. (7pts) Which method is expected to be more reliable (explain briefly)?

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3. For each of the following processes, state whether each of the quantities (q, w, ΔT, ΔE, ΔH, $\Delta S_{(system)}$) is positive, negative, zero, or undetermined.

a. (6pts) An ideal gas expands adiabatically into a vacuum.
b. (6pts) An ideal gas is compressed isothermally and reversibly.
c. (6pts) H_2 and O_2 react explosively to form H_2O in a bomb calorimeter (isolated system at constant volume).
d. (6pts) Ice melts at 0 °C. (Heat of melting for ice = 6.007 kJ/mol)

Answer:

.	q	w	ΔT	ΔE	ΔH	$\Delta S_{(system)}$
a.						
b.						
c.						
d.						

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4. Consider a scuba diver at a depth of 100 meters in the ocean where the pressure is 10 atm. The temperature of the water is 285 K at all depths. The diver has a tank of ideal gas with an internal pressure of 20 atm and a collection of ideal balloons. (Ideal balloons are here defined to be able to expand or contract any amount without the balloon contributing any resistance, force, or pressure to its contents or the surroundings).

a. (5pts) Define one balloon as the system. What is the work (w) for the process of filling one balloon to a volume of 1 liter at a depth of 100 meters? Is this process reversible?

b. (5pts) How many moles (n) of gas are in the balloon filled in part a?

c. (5pts) What is the work done if the sealed balloon from part (a) rises from a depth of 100 meters to the surface where the pressure is 1atm? You may assume this is an isothermal process. Is this process reversible?

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4. continued

d. (5pts) What is the heat (q) for the process of the balloon rising from a depth of 100 meters to the surface?

e. (5pts) What is ΔS_{system} for this process? Explain your result.

f. *(5pts extra credit) Suppose we perform the same task using adiabatic balloons. Would the final temperature inside the adiabatic balloon after rising to the surface be higher, lower, or equal to the isothermal balloon? Which balloon does more work on the surroundings? Explain.

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5. You perform calorimetry experiments on an unknown material and obtain the following results:

For temperatures below 70 °C, you measure C_p and C_v and discover they are very similar to each other.

Above 70 °C you find that both C_p and C_v change and that C_p is now larger than C_v.

There do not appear to be any chemical reactions.

a. (10pts) What could be happening at 70 °C that would account for these observations.

b. *(5pts extra credit) You also notice that a significant amount of heat must be added to the system at a constant temperature of 70 °C before the temperature starts to rise again. You measure this amount of heat at constant pressure (q_p). What have you measured?