## Sample Exam 1 from Chemistry 126, Spring 2003, Hanson

- 1. (10 points) A deck of 40 cards contains four each of cards numbered 1-10. Two cards are drawn from the top of the deck. What is the probability that the numbers on the two cards add up to 4?
- 2. (10 points) A chemical system contains 1.0 mol of H<sub>2</sub>, 2.0 mol of D<sub>2</sub>, and 3.0 mol of HD. Using principles of probability, predict the amount of HD to be expected at equilibrium, assuming H and D behave identically.
- 3. (10 points) Briefly explain why in chemistry we take the "casino" perspective, and why it works.
- 4. (15 points) Each of the three distributions of energy shown below involve 10 particles and 10 units of energy. Determine the most probable of the three. Support your claim with a calculation of relative probability for the other two.

4	1	
3	0	
2	1	
1	4	
0	4	

4	0
3	0
2	4
1	2
0	4

 $\mathbf{C}$ 

4	0
3	1
2	0
1	7
0	2

A

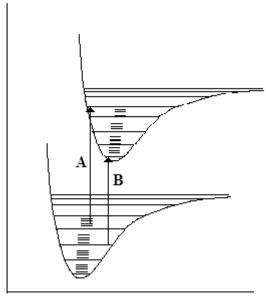
B

- 5. (15 points) A hypothetical system contains particles that can only absorb energy in packets of  $5x10^{-21}$  J. Shown on the right is a partially completed depiction of the most probable distribution of energy in this system. Complete the diagram by determining the number of particles in levels a (particles with one unit of energy) and b (particles with three units of energy) and determine the approximate temperature of the system.
- 4180
- 6. (10 points) Fill in each blank with one of the following words: electronic, vibrational, rotational, or translational.

\_\_\_\_\_ excitation generally requires the most energy.

- b. Reduced mass must be used for calculating \_\_\_ energies because in that case the atoms of a molecule are moving closer and further away from one another.
- c. Microwave spectroscopy generally involves \_ excitation.
- excitation is generally only possible for molecular liquids and molecular gases.
- e. Only a handful of energy levels for gaseous HCl are populated at room temperature.
- 7. (15 points) In relation to the diagram shown on the right, which is for H<sub>2</sub>, describe:
- a. What is shown by arrow A.
- b. What is shown by arrow B.
- c. Why it is reasonable that the energy levels in the upper well are more closely spaced than the levels in the lower well.
- 8. (25 points) Discuss ONE of the following topics. In each case, (i) provide some sort of energy diagram to support your discussion and (ii) provide a concrete real-world example. For full credit, demonstrate that you have a firm understanding of the underlying atomic/molecular/energy "picture" in the case you have selected what sort of atomic or molecular action is involved; what sort of energy excitation is involved.
- a. Chemical reactions can result from the absorption of either IR or UV radiation.
- b. Some materials are colored, while some aren't. In addition, some materials glow when exposed to UV light.
- c. Under the appropriate conditions, some materials lase.
- d. IR spectroscopy can be used to determine what sort of bonds are present in a compound.
- e. Visible spectroscopy can be used to investigate the bonding in excited states of molecules.

## Energy



Internuclear distance, R