

Sample Exam 1 from Chemistry 126, Spring 2003, Hanson

- (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?
- (10 points) A chemical system contains 1.0 mol of H₂, 2.0 mol of D₂, 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.
- (10 points) Briefly explain why in chemistry we take the “casino” perspective, and why it works.
- (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

A

4	0
3	0
2	4
1	2
0	4

B

4	0
3	1
2	0
1	7
0	2

C

- (15 points) A hypothetical system contains particles that can only absorb energy in packets of 5×10^{-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.

4	3
3	b
2	112
1	a
0	4180

- (10 points) Fill in each blank with one of the following words: *electronic*, *vibrational*, *rotational*, or *translational*.

- _____ excitation generally requires the most energy.
- 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.
- Microwave spectroscopy generally involves _____ excitation.
- _____ excitation is generally only possible for molecular liquids and molecular gases.
- Only a handful of _____ energy levels for gaseous HCl are populated at room temperature.

- (15 points) In relation to the diagram shown on the right, which is for H₂, describe:

- What is shown by arrow A.
- What is shown by arrow B.
- Why it is reasonable that the energy levels in the upper well are more closely spaced than the levels in the lower well.

- (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.

- Chemical reactions can result from the absorption of either IR or UV radiation.
- Some materials are colored, while some aren't. In addition, some materials glow when exposed to UV light.
- Under the appropriate conditions, some materials lase.
- IR spectroscopy can be used to determine what sort of bonds are present in a compound.
- Visible spectroscopy can be used to investigate the bonding in excited states of molecules.

