

Chemistry 125 First Examination
September 22, 2004

Name _____

The exam budgets 50 minutes, but you may have 60 minutes to finish it. Good answers can fit in the space provided.

Question values correspond to allotted time. Don't waste too much time on cheap questions.

Read each question carefully to see what it asks for (bold face is used to help highlight questions).

1. (7 minutes) **DRAW TWO** Lewis-Dot structures for a chain of 3 O atoms (ozone). Then **DRAW a graph** to **EXPLAIN** how the “single- vs. double-minimum” concept relates to the idea of resonance involving these structures.

2. (8 min) **State** Earnshaw's Theorem:

Explain how J. J. Thomson's “**plum-pudding**” atom conformed to the requirements of Earnshaw's Theorem:

Explain how G. S. Lewis could advocate his “**octet**” structure for the atom, despite believing Earnshaw's Theorem:

3. (15 minutes) What is the **simplest way** to measure of each of the following with reasonable accuracy?
(Name the **EXPERIMENTAL** method – you **don't** need to describe it - but if any **calculations** are required to interpret the results, **mention them very briefly.**)

A) The approximate size of the molecules in olive oil

B) The precise positions of numerous iron atoms on the surface of a small sheet of copper.

C) The amount of electron density that is *actually* involved in forming a carbon-carbon bond.

E) The arrangement of numerous fluorescent-molecule impurities within a thin layer of organic molecules.

F) The offset between the two helices of a DNA double helix

4. A respected text of molecular spectroscopy uses this figure to describe vibration of the H-Cl molecule (during which the H atom moves, but the Cl atom stays put, because it is so massive).

The vertical axis is labeled "Energy".

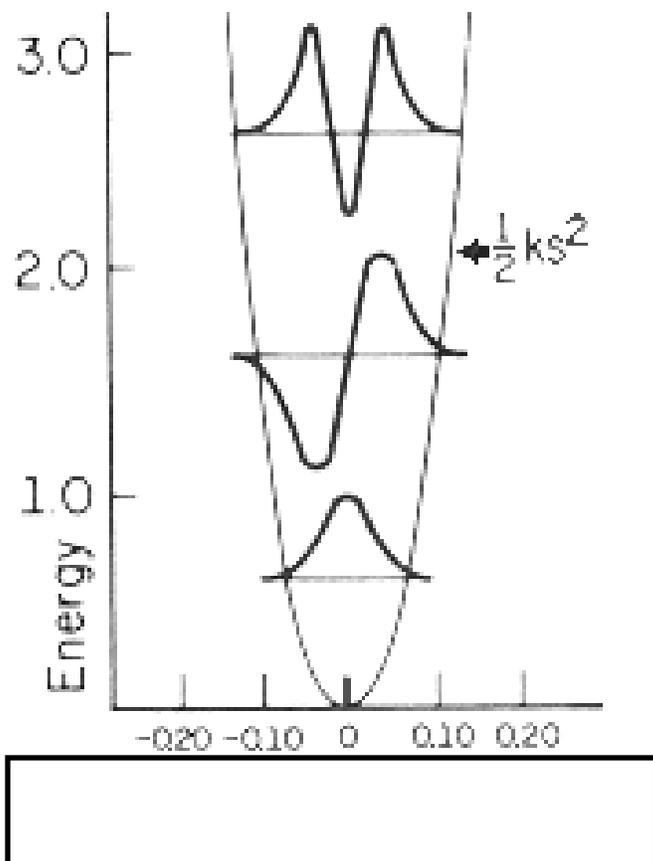
You may ignore the units (which are not kcal/mole).

- A. (1 minute) In the **box** below the graph **label** the **horizontal axis** appropriately, and **identify** its **units** (which run from -0.2 to $+0.2$).
- B. (4 min) Three types of figures appear on the graph. **Explain** below what **each TYPE of feature** is intended to show. [Hint: one type of figure shows two **different** things.]

(1) a **parabola** (labeled $1/2 ks^2$)

(2) **three horizontal straight lines**,

(3) **three curvy lines**

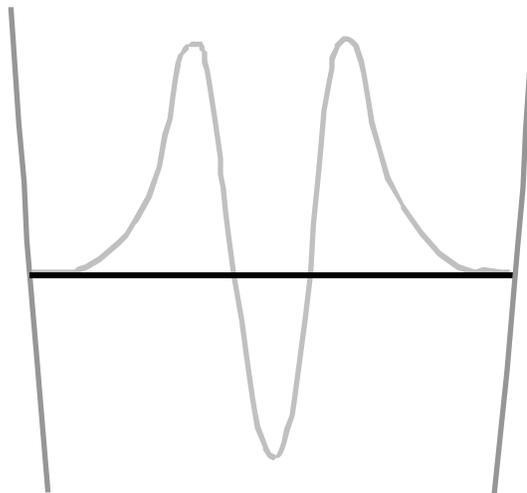


- C. (2 min) **Comment** on the **relative heights** of the three horizontal lines

(Question 4 continued)

D. (6 min) The curvy lines in the figure above were apparently drawn by hand - and none too carefully! The figure to the right reproduces a detail including parabola, horizontal line and curvy line. **REDRAW this curvy line** to make it as accurate as you are able.

Then **EXPLAIN** why the original was faulty, and how your adjustment fixes it.



E. (5 min) “*Ut tensio sic vis*” (“As the extension so the force”)

Who first wrote this statement and in what century? _____

Explain how the statement relates to the parabola in the figure on the previous page, **AND explain** whether one could use the **lines-of-force** concept to describe the direction and intensity of such a force in 3-dimensional space.

5. (2 min) **Why** did Berkovitch-Yellin and Leiserowitz choose a “cumulene” with **three C=C double bonds in a row** for their precise x-ray investigation of bonding density?

