

Chemistry 124 First Examination  
September 26, 2008

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).**

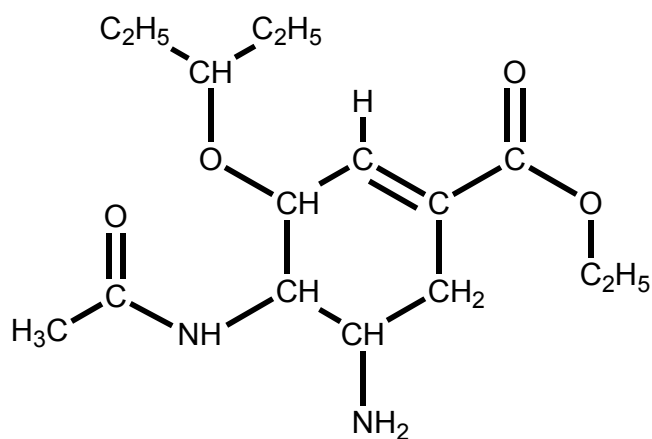
**Make sure you are answering the question, not just saying something vaguely relevant to its topic.**

1. (5 min) A former Chem 125 student sent along a screen capture from last Monday's Season 3 premiere of *Heroes*. The character Hiro finds a paper in his father's safe containing chemical formulae, including one related to the structure of the antiviral *Tamiflu* shown below. Apparently Hiro says, "I knew I should've paid more attention in Chemistry class."

To help Hiro out **CIRCLE**

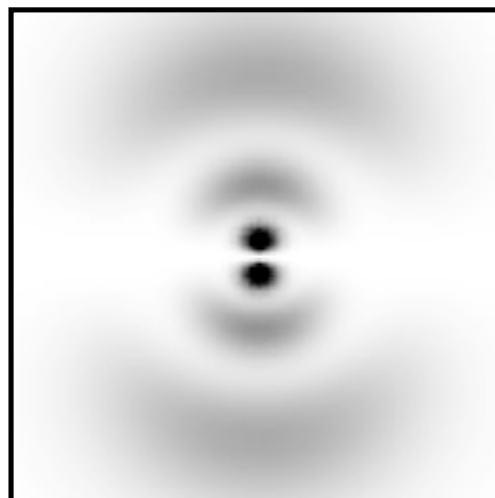
**five functional groups** in

Tamiflu and **NAME THEM**.



2. (3 min) **Draw a pair** of plausible **resonance structures** for a **functional group** that appears in **Tamiflu**. You may show only the functional group and use "R"s to denote other stuff. Use a proper **arrow(s)** to connect the pair.

3. (4 min) **DESCRIBE** the nodal pattern in this atomic orbital  
**AND CIRCLE** its nickname:  $1p$   $2p$   $3p$   $4p$   $5p$   $6p$



4. (4 min) **HOW** did J. J. Thomson propose to modify Coulomb's Law in 1923, and **WHY**?
5. (3 minutes) What is remarkable about the electron difference density map of the  $\text{C}=\text{C}=\text{C}=\text{C}$  group?
6. (4 minutes) **Explain briefly** how combining perpendicular  $2p$  orbitals generates a new  $2p$  orbital.  
(Pictures would help.)

7. (3 minutes) How does each of the following properties of the  $2s$  state of an H-like atom scale with the nuclear charge  $Z$ ?  
**No explanation required**, just give the dependence on  $Z$ .

Radius of the spherical node  $\propto$

Maximum probability density  $\propto$

Total energy  $\propto$

8. (4 minutes) Draw lines between the columns to choose the best experimental technique for studying each phenomenon.

**No explanations required!**

Techniques	Phenomena
Scanning Tunneling Microscopy	Dissolution of monomolecular layers from an organic crystal into a solvent
Atomic Force Microscopy	Shape of covalent bonds
SNOM	Location of rare fluorescent molecules on a microchip
X-ray crystallography	Location of atoms in a molecule deposited on graphite

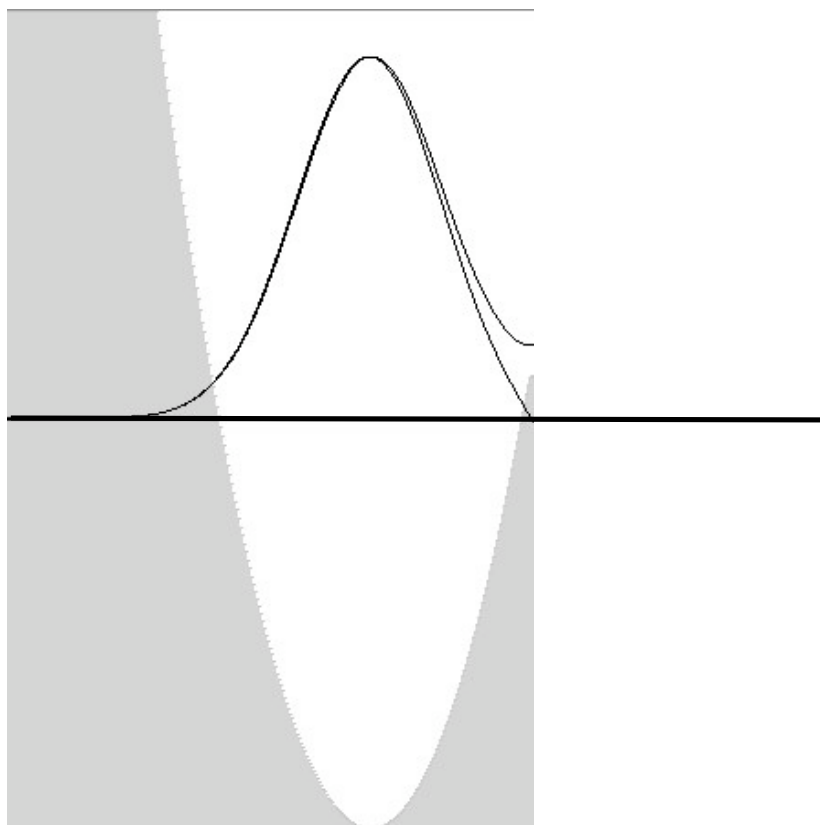
9. (7.5 min) The second laser scattering during our in-class demonstration involved a mask with a large set of evenly-spaced **PAIRS** of vertical bars. **SKETCH** the resulting scattering pattern that appeared on the projection screen **AND MENTION** its relevance to Rosalind Franklin's x-ray pattern from a fiber of b-DNA.

**10.** The diagram is *part* of an “Erwin Meets Goldilocks” plot with two trial wave functions for the potential energy, which is shown in gray.

A) (2 min) **Draw a horizontal line** showing the **TOTAL ENERGY** for the  $\psi$  curve that becomes horizontal at the right. Be as accurate as you can.

B) (2 min) Is the total energy for the other trial  $\psi$  (the one that has a value of 0 at the right) **higher or lower** than that the one you drew in A?

**Explain your thinking.**



C) (3 min) **Assuming** that this is a **Hooke’s Law** single-minimum problem, **draw** in the **correct** lowest-energy  $\psi$  **function** (**NOT** its energy), and **extend all three  $\psi$  curves** to the right as far as possible.

D) (5 min) Now **assume** that this potential is in fact the left half of a **symmetric double minimum**, and the original two  $\psi$  traces are part of *correct* solutions. **Explain** how one  $\psi$  may be considered “bonding”, and the other “antibonding”.

**11.** (0.5 min only – cheap, don't waste time until you've finished the previous questions)

A class member created the following cartoon.

Briefly explain its relevance to our approach to quantum mechanics.

