CHEM 221

Class Test **Monday 7 May, 2007**

Time allowed: 50 minutes **Total marks:** 50

Instructions: Answer **ALL** questions in the answer book provided. **The number of marks indicates the amount of time you should spend on each question.**

Question 1. (Class invented) (12 marks)

a) Identify this equation and all the variables:

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+\frac{\partial^2\psi}{\partial z^2}+\frac{8\pi^2 m}{h^2}(E-V)\psi=0$$

b) Sketch the wave functions and radial distribution functions for 1s, 2s, and 3s orbitals. Use a separate graph for each orbital.

c) Sketch the radial distribution functions for the 1s, 2s, and 2p orbitals on the same set of axes and use the diagram to explain whether you would expect the 2s and 2p orbitals to be degenerate for a multi-electron atom.

d) Sketch ψ, ψ^2, and $4\pi r^2\psi^2$ for a sp hybrid orbital. Hint: sketch the wavefunctions for the 2s and 2p orbitals first.

Question 2. (10 marks)

Compare and contrast the Rutherford, Bohr, and Schroedinger models for the atom.

Question 3. (7 marks)

Consider the following sets of quantum numbers. For each set, either name an orbital that may be occupied by an electron with such a set of quantum numbers, or explain why the set of quantum numbers is invalid for an electron.

	n	l	m_l	m_s
(a)	1	0	0	+1/2
(b)	1	1	1	1
(c)	3	-2	0	-1/2
(d)	3	1	-1	+1/2
(e)	5	4	3	+1/2
(f)	4	3	2	-1/2

Question 4. (13 marks)

a) Use a Valence Bond approach to describe the bonding in ozone, O_3.

b) Comment on whether you expect the bonds in ozone to be equivalent and discuss whether Valence Bond Theory can account for such situations.

c) Molecular Orbital Theory is often described as taking a delocalised approach to bonding. Explain what this statement means and then discuss its implications in the context of resonance.

Question 5. (8 marks)

The attached energy level diagram for BeH_2 will be useful for this question.

a) Explain why the Be 2s orbital interacts with the bottom hydrogen group orbital and not the top one.

b) Where did the hydrogen group orbitals come from?

c) Why has one electron been placed in each of the hydrogen group orbitals?

d) What is the bond order for the bonds in BeH_2? What will it be in $[BeH_2]^+$ and $[BeH_2]^-$? Explain your answers.

END OF PAPER