

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED CHEMISTRY
END OF SEMESTER EXAMINATIONS - DECEMBER 2000
INORGANIC CHEMISTRY I - SCH1101
TIME: 3 HOURS

INSTRUCTIONS TO CANDIDATES

Answer **ALL** questions from Section A and **ANY THREE** from Section B.

Periodic Tables Required

SECTION A

1. Explain how the following below apply, with reference to the atomic orbitals with principle quantum number $n = 4$, where there are 4 subshells, 4s, 4p, 4d, and 4f.
 - (a) The number of nodes in an atomic orbital is $n-1$. How are these nodes distributed (as radial or angular nodes) in the orbitals of each subshell? (4 marks)
 - (b) The total number of electrons which can be accommodated is $2n^2$. How are these single electron states distributed in number over the subshells? (4 marks)
2. (a) The terms (i) first ionisation energy, (ii) electron affinity, refer to the enthalpies of which processes? (4 marks)
(b) The Mulliken definition relates the electronegativity of an element to both its first ionisation energy and electron affinity. State Mulliken's formula, and explain its significance. (6 marks)
3. Show with drawings which of the combinations of an s- or p-orbital on one atom with an s- or p-orbital on a second atom result in non-zero net overlap. Which type of bond (σ or π) is formed in each case? (10 marks)
4. Draw Lewis diagrams for each of the equivalent resonance structures for the carbonate CO_3^{2-} and for the hydrogencarbonate HCO_3^- ion. Two of the bonds in hydrogencarbonate are shorter than in those in carbonate, while one is longer. Explain. (9 marks)
5. Using VSEPR Theory, predict which of the following dihalide molecules would be linear, and which bent:-
 - (a) BeCl_2 (b) SnCl_2 (c) OF_2 (d) XeF_2 . (8 marks)

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6. Strontium crystallises in a ccp (fcc) structure. The metallic radius is 194 pm.
- (a) What is the length of the unit-cell edge? (5 marks)
- (b) What is the density of Sr(s)? (5 marks)

SECTION B

7. (a) What are (i) the Pauli Exclusion Principle, (ii) the Aufbau Principle, (iii) Hund's Rule? (6 marks)
- (b) Give the detailed electronic configurations of the elements Li to Ne, and show how they are determined by the above three principles. (9 marks)
8. (a) Describe the geometry of a trigonal bipyramid. (3 marks)
- (b) Describe the geometry of the following species in detail, including a sketch and an estimate of the bond angles in each case: (i) ClF_3 (ii) SeOF_4 (iii) XeO_2F_2 (12 marks)
9. (a) Using methane CH_4 as an example, explain why the use of hybrid orbitals is preferable to the use of single atomic orbitals in forming bonds. (6 marks)
- (b) Describe the bonding in ethene C_2H_4 , making use of hybrid orbitals. (9 marks)
10. Sketch the unit cell of CsCl , and estimate its density given the ionic radii $\text{Cs}^+ = 169 \text{ pm}$; $\text{Cl}^- = 181 \text{ pm}$. (15 marks)
11. (a) What are the two main contributions to the lattice energy of an ionic solid? Write the Born-Meyer expression for the lattice energy, and explain the form in which each contribution is represented. (6 marks)
- (b) Draw a sketch one of the MX structure types, and from it determine the corresponding limiting value of the radius ratio r_+/r_- . How does the co-ordination number change on passing this limiting value? (9 marks)

END OF QUESTION PAPER!!!!

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