THE OPEN UNIVERSITY OF SRI LANKA
B.Sc DEGREE PROGRAMME 2007/2008
CHU2123/CHE 4123 – INORGANIC CHEMISTRY- LEVEL 4
ASSIGNMENT TEST I - MCQ TEST

MCQ ANSWER SHEET: Mark a cross (X) over the most suitable answer.

Name:- ....

Reg.No/Index No.

	Marks
Part A	
Part B	
Total %	

FOR EXAMINERS USE	
Unanswered	
Correct Answers	
Wrong Answers	
Total	

1.	1	2	3	4

2.	1	2	3	4

3.	1	2	3	4

4.	1	2	3	4

5.	1	2	3	4

6.	1	2	3	4

7.	1	2	3	4

8.	1	2	3	4

9.	1	2	3	4

10.	1	2	3	4

11.	1	2	3	4

12.	1	2	3	4

13.	1	2	3	4

14.	1	2	3	4

15.	1	2	3	4

Part B- Structured Essay (55 marks)

Answer all the questions in the space provided.

1. (a) The diagram given below depicts the unit cell for a compound containing atoms A (filled circles •) and B (open circles O).
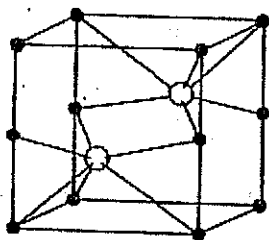
Show (by working out) that **empirical formula** of the given compound is AB.

(b) Would you get a diffraction effect by passing 500 nm visible radiation through a crystalline solid? Explain your answer.

(c) The density of silver is 10.5 g/cm^3 and the metal crystallizes in the FCC structure. Draw the unit cell of gold crystal

(d) Three physical properties of diamond are listed below. Write down the structural feature/s of diamond related to each property.

Poor conductor of electricity ....

....

High melting point   ....

....

Extreme Hardness   ....

.... (30 marks)

2. A molecule with formula XY$_5$ was prepared starting with a BF$_3$ molecule. First B nucleus was replaced with a nucleus of X. Then the three F nuclei were replaced with three Y nuclei without changing the geometry of BF$_3$. The length of X-Y bond formed in XY$_3$ is p. Then two more nuclei of Y were bonded to X on either side of the XY$_3$ plane so that the two Y nuclei and X are on a straight line which is perpendicular to the said XY$_3$ plane. The new XY bonds are of length q so that p $\neq$ q.

   (a) Indicating the order locate the principal axis of XY$_5$

   (b) Indicating the order, locate any other axes of rotation in this molecule.

(c) What is the symmetry point group of this molecule. ....

(d) How many groups of equivalent X nuclei does this molecule have? Identify the X nuclei belonging to each group. Briefly describe your answer.

(e) If one Y is substituted by Z, how many different **mono-substituted** molecules can XY_4Z have? Briefly describe your answer.

(25 marks)

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THE OPEN UNIVERSITY OF SRI LANKA
B.Sc/ B.Ed DEGREE PROGRAMME
Level 4 - CHU2123/ CHE4123
INORGANIC CHEMISTRY

ASSIGNMENT TEST - I

21st November 2007 (Wednesday)   Duration : 1.5 h   3.30 p.m – 5.00 p.m.

Part A - Multiple Choice Questions (45 marks)

Answer all the questions
Select the most correct answer to each question given below and mark a cross *X* over the answer on the **given answer sheet**. Any answer with more than one *X* will not be counted. 3 marks will be awarded for each correct answer. 1/6 th of a mark will be deducted for each incorrect answer.

1. Covalent bonds are the **only type** of bond or intermolecular forces in:
   (1) $KF(s)$ (2) $CO_2(s)$ (3) $H_2O(s)$ (4) $NH_4NO_2(s)$ (5) C (diamond)

2. Which of the following compounds shows **intermolecular** bonding in the liquid or solid state?
   (1) argon   (2) diamond   (3) water   (4) sodium chloride   (5) none of the above

3. Which of the following sets includes an amorphous substance and a crystalline substance?
   (1) rubber and plastic   (2) rubber and sodium chloride   (3) silica and rubber
   (4) caesium chloride and sodium chloride   (5) plastic and silica

4. A substance melts with some decomposition at 730 °C. As a solid, it is a nonconductor of electricity but it dissolves in water to form a conducting solution. The white substance is best described as
   (1) a covalent network solid   (2) an ionic solid   (3) a molecular solid
   (4) a metallic solid   (5) solid Ar.

5. Based on intermolecular interactions, which of the following should have the highest boiling point?
   (1) CH_2Cl_2 (2) $CHCl_3$ (3) H_2S (4) CH_3OH (5) C_2H_6

6. The **number of unit cells** that share an atom represented by the filled circle in the diagram below is

   (1) 1   (2) 2   (3) 4   (4) 8   (5) 16

1

7. Covalent crystals have:
   (1) higher melting points than molecular crystals
   (2) lower melting points than molecular crystals
   (3) discrete molecules linked by van der Waals forces
   (4) hydrogen bonding
   (5) always excellent electrical conductivity

8. The equation $2d\sin\theta = n\lambda$ is known as the Bragg equation. Here, n is referred to as
   (1) the number of unit cells in the crystal.
   (2) the number of atoms in the crystal
   (3) the order of reflection
   (4) the order of inference
   (5) the order of inference or reflection

9. Which of the following will **not** give rise to a crystal defect?
   (1) an ion dislocated to an interstitial site
   (2) formation of a hole in the lattice.
   (3) a plane shift
   (4) substitution of a cation M^{2+} by M^{3+}.
   (5) passing X-rays through a crystal.

10. Consider the following statements regarding a chemical defect.
    (i) composition of the lattice is changed due to new chemicals incorporated.
    (ii) ruby is an example of a crystal lattice with chemical impurity
    (iii) crystal colour is due to the incorporation of transition metals.
    The correct statement/s is/are
    (1) (i) only   (2) (i) and (ii) only   (3) (i) and (iii) only
    (4) All (i), (ii) and (iii)   (5) None of (i), (ii) and (iii).

11. Consider the following statements.
    (i) **Any** improper rotation about an improper axis is a symmetry operation.
    (ii) The outcome of **any** improper rotation does **not** depend on the order in which the
         rotation and reflection were performed.
    (iii) The outcome of a given improper rotation does **not** depend on the order in which
         the rotation and reflection were performed **only if** it is a symmetry operation.

    The correct statements out of (i), (ii) and (iii) above are
    (1) (i) and (ii) only.   (2) (i) and (iii) only.   (3) (ii) and (iii) only.
    (4) All (i), (ii) and (iii)   (5) None of the <u>answers</u> (1), (2), (3) or (4) is correct.

12. An improper rotation about an axis by $90°$ is a symmetry operation. Improper rotation
    by $360°$ about the same axis **is equivalent** to the identity operation. What is the
    smallest possible order of this axis?

    (1) 2   (2) 3   (3) 4   (4) 5   (5) 6

13. The dipole moment of a SCl_6 molecule is zero.

    (i) The resultant dipole moment of any five S-Cl bonds is cancelled by that of the remaining S-Cl bond.

    (ii) The above statement is true because the molecule has at least three symmetry planes which meet on a straight line.

    (iii) The above statement is true because the molecule has more than one non-coincident rotation axes of symmetry.

    The correct statements out of (i), (ii) and (iii) above are
    (1) (i) and (ii) only.   (2) (i) and (iii) only.   (3) (ii) and (iii) only.
    (4) All (i), (ii) and (iii)   (5) None of the <u>answers</u> (1), (2), (3) or (4) is correct.

14. Consider the following statements.

    (i)   A centre of inversion (of a molecule) may **not** be located at a nucleus.

    (ii) Some molecules may have two centres of inversion.

    (iii) In principle, a macromolecule may have a centre of inversion.

    The correct statements out of (i), (ii) and (iii) above are
    (1) (i) and (ii) only.   (2) (i) and (iii) only.   (3) (ii) and (iii) only.
    (4) All (i), (ii) and (iii).   (5) None of the <u>answers</u> (1), (2), (3) or (4) is correct.

15. Consider the following statements.

    (i) A molecule containing a vertical plane **cannot** have C_2 axes.

    (ii) A molecule containing a dihedral plane definitely contains C_2 axes.

    (iii) A molecule having a dihedral plane and a horizontal plane definitely contains C_2 axes lying on the horizontal plane.

    The correct statements out of (i), (ii) and (iii) above are
    (1) (i) and (ii) only.   (2) (i) and (iii) only.   (3) (ii) and (iii) only.
    (4) All (i), (ii) and (iii).   (5) None of the <u>answers</u> (1), (2), (3) or (4) is correct.

Part A- MCQ

1) 5	6) 4	11) 5
2) 3	7) 1	12) 3
3) 2	8) 5	13) 2
4) 2	9) 5	14) 2
5) 4	10) 4	15) 3

Part B – Structured Essay

1. (a) Contribution from atom A in the corner $1/8 \times 8 = 1$
   Contribution from atom A at half length $\frac{1}{4} \times 4 = 1$
   Contribution from atom B (open circles) $= 2$

   Therefore the formula $= A_2B_2$

   Empirical formula (the simplest ratio) $= AB$

(b) NO.

   In order to get a diffraction pattern, the wave length of the passing rays should be in the same order of magnitude as the distance between the atoms in a crystal. The wavelength of the visible radiation does not satisfy this requirement.
   Therefore no diffraction pattern will be observed.

   OR

By considering the Bragg Equation,
$$2d \sin \theta = n\lambda$$

When the angle is maximum, $\sin 90^0 = 1$
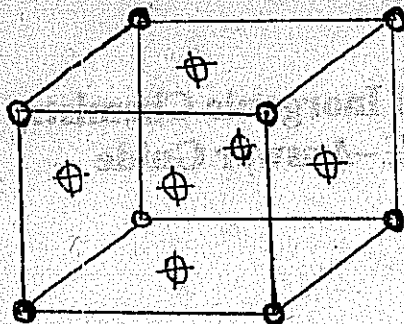When the order of scattering is one
$$2d = \lambda$$
As $\lambda = 500$ nm $\quad 2d = 500$ nm
$$d = 250 \text{ nm}$$

As this distance is not the same order of magnitude as the distance between the atoms in a crystal, the diffraction cannot occur.

(c)

Silver atoms are at the corners of the cube and the center of the faces of the cube.

(d)
Poor conductor of electricity- Carbon atoms are sp^3 hybridized, therefore no free electrons are available for conducting electricity.

High melting point – Covalent network solid. Many bonds have to be broken in order to melt the solid.

Extreme Hardness - Covalent network solid, with sp^3 hybridized carbon atoms, forming 4 bonds in each to form a giant structure.

2.
(a) C_3, The axis passing through X and the two Y nuclei added last.

(b) There are three C_2, passing through X and each of the Y nuclei which replaced the F nuclei.

(c) D_{3h}

(d) The molecule has 2 groups of equivalent Y nuclei.
The three Y nuclei which replaced F from one group. The other two Y nuclei form the other group.
By definition , equivalent nuclei can be exchanged with a rotational symmetry operation of the molecule. the three Y in one group can be exchanged using C_3^n (or C_2). The two Y in the other group can be exchanged by C_2.

(e) Can have only two mono-substituted molecules
There are two different groups of equivalent Y.