

6

**Unit 1 Test - Structure and Properties of Matter**

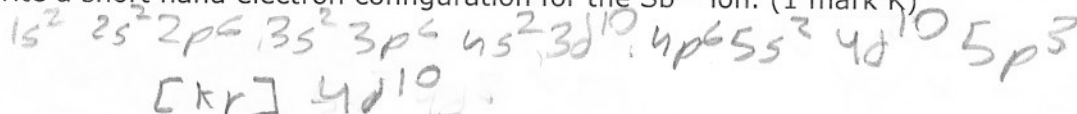
KU = 13 / 17	TI = 19 / 19	COM = 9.5 / 10	APP
--------------	--------------	----------------	-----

For full marks, please ensure all answers are complete and concise, with appropriate units and digits where necessary. Good luck! ☺

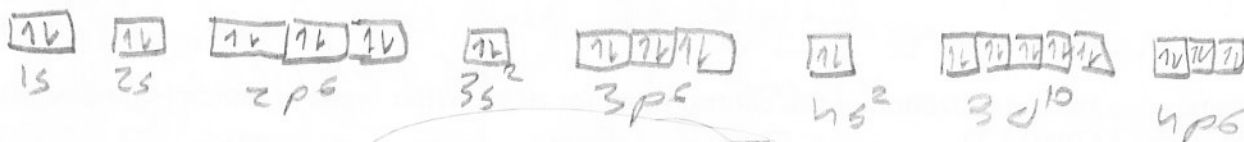
**Part A: Knowledge and Understanding**

1. Multiple choice: please answer all questions on your scantron card in pencil. (15 marks)

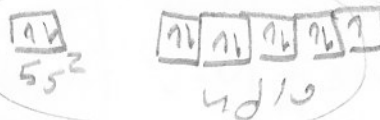
2. Write a short hand electron configuration for the  $\text{Sb}^{5+}$  ion. (1 mark K)



3. Draw an orbital diagram for silver. (1 mark K)

**Part B: Thinking and Investigation**

4. In the ground state of indium,



a) How many electrons occupy orbitals with  $n = 4$ ? Explain. (2 marks T)

$2(4)^2 = 32 - 14 = 18$   
 $2 + 6 + 10 = 18$   
 $4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^1$   
 18 electrons fill  $n=4$  in Indium because

b) How many electrons have  $l = 2$  as one of their quantum numbers? Explain. (2 marks T)

$1s^2 2s^2 2p^6 3s^2 3p^4 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^1$   
 $2 \times 10 = 20$   
 20 electrons because there are 2 d orbitals and each orbital has 10 electrons

c) How many electrons have spin "down" ( $m_s = -1/2$ )? Explain. (2 marks T)

$2n$  would spin down because we assume electrons spin up while half spin down but that half the round down to  $2n$  because the extra one we assume spins up

5. Several elements deviate from the trend in ionization energy on the periodic table.

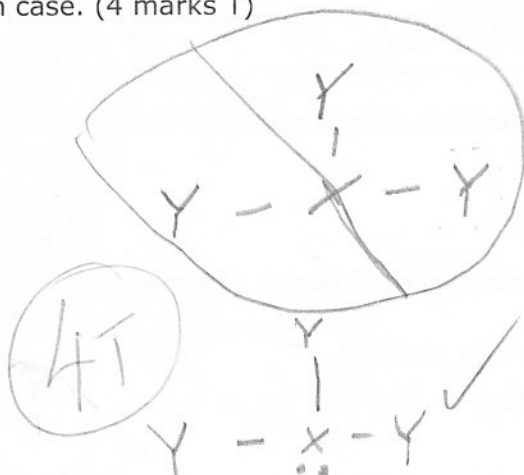
a) What is the general trend for ionization energy on the periodic table? (1 mark T)

IE increase across a period and up a group

b) Oxygen is one element that deviates from the trend. Explain why oxygen does not follow the trend using your knowledge of the quantum model of the atom. (2 marks T)

Oxygen deviates from this trend because examining reveals that the  $2p$  orbital has  $4e^-$  in it however half of an orbital shell filled is more stable than having one extra therefore its first IE will be lower as it wishes to lose that  $e^-$ .

6. A hypothetical molecule with the formula  $XY_3$  is discovered, through experiment, to exist. It is polar. Which molecular shape(s) are possible for this molecule? Which shape(s) are impossible? Explain why in each case. (4 marks T)

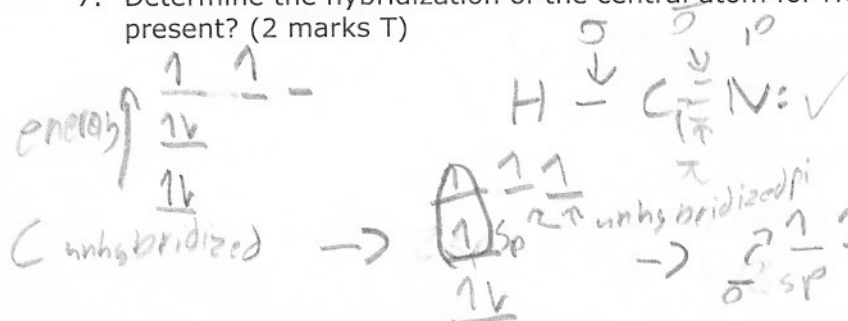


← The molecule could be not be trigonal planar since it is polar and a standard trigonal planar shape is non polar.

← It could be trigonal pyramidal as it has 3 bonds and the lone pair would explain the polarity.

← It could be T-shaped as the lone pairs would explain the polarity.

7. Determine the hybridization of the central atom for HCN. What types of bonds (sigma or pi) are present? (2 marks T)



There are 2 pi bonds and 2 sigma bonds. The hybridization is  $sp$  so 2  $sp$  and 2  $p$  hybridized.

8. Answer the following questions using your knowledge and results from the experiment you conducted to extract caffeine from various energy drinks.

- a) During your experiment, an excess of sodium chloride was added during the extraction process. What was the purpose of adding the sodium chloride? Explain. (2 marks T)

after being becoming  $Na^+$  and  $Cl^-$  in the solution. The salt bonded to the polar water further ionizing the water. This forced the isopropyl alcohol to precipitate or form the upper layer with the isopropyl alcohol and caffeine. The salt.

- b) The caffeine you recovered from your experiment was impure. What were some likely impurities found in your sample? Explain your answer using your knowledge of intermolecular forces and molecular structure. (2 marks T)

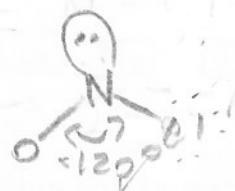
The impurities could have been the dyes, if the dyes here polar they could have been attracted to the polar caffeine or isopropyl alcohol. The now floating free  $Na^+$  and  $Cl^-$  could have bonded. The isopropyl alcohol also potentially may not have all evaporated.

**Part C: Communication**

9. For each of the following molecules: (1 mark each question x 2 = 10 marks C)

- draw the correct 3D Lewis structure
- identify the electron geometry
- identify the molecular shape
- label the bond angle(s) on each molecule
- identify if the molecule is polar or non-polar

A. NOCl



e geometry = trigonal planar  
molecular shape = bent

polarity = polar

4 1/2 C

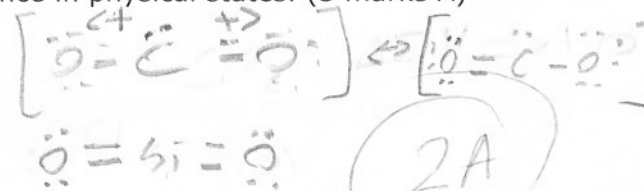
B. XeOF<sub>4</sub>

electron geo = octahedral  
shape = square pyramidal  
bond angles = < 90°  
polarity = polar

5C

**Part D: Application**10. At room temperature, carbon dioxide, CO<sub>2</sub>, is a gas, while silica, SiO<sub>2</sub>, is a hard solid. Compare the bonding in these two compounds to account for this difference in physical states. (3 marks A)CO<sub>2</sub> is a not very polar moleculewhile SiO<sub>2</sub> is a very polar molecule

on the edge between ionic and polar.

Not only this but SiO<sub>2</sub> forms a covalent solid which followsthe same properties as 1st set, a hard solid like diamond, SiO<sub>2</sub> will form a network using covalent bonds causing it to become a solid.

2A

11. Examine the two 3D molecules and determine the electron geometry, molecular shape, molecular polarity and hybridization of each compound. (8 marks A)

	MODEL A	MODEL B
Electron Geometry	octahedral	tetrahedral
Molecular Shape	square pyramidal	trigonal pyramidal
Molecular Polarity	polar	polar
Hybridization of Central Atom	sp <sup>3</sup> d <sup>2</sup>	sp <sup>3</sup>