

Name \_\_\_\_\_

Practice Exam: Paper 2

Topic 4: Bonding

SL Score

/48

Key

SL

1. Explain why:

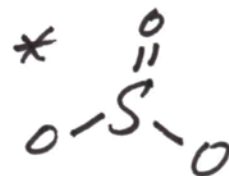
(i) calcium has a higher melting point than potassium.

calcium is a smaller ion with twice the charge of potassium ( $\text{Ca}^{2+}$ ,  $\text{K}^+$ ) and therefore has a stronger attraction for its delocalized electrons.

(2)

(ii) sodium oxide has a higher melting point than sulfur trioxide.

Sodium oxide is bonded by strong electrostatic attractions between the  $\text{Na}^+$  and  $\text{O}^{2-}$  ions within an ionic crystal lattice.  $\text{SO}_3$  is a nonpolar molecule with only weak dispersion forces existing between its molecules



(3)

2. Describe and compare **three** features of the structure and bonding in the three allotropes of carbon: diamond, graphite and  $\text{C}_{60}$  fullerene.

• **Diamond:** Tetrahedral covalent bonding.

Nonconductor of electricity.

Macromolecular network solid.

Hardest known natural substance.

• **Graphite:** Trigonal planar covalent bonding.

Conducts electricity.

Parallel layers are held only by weak van der Waals' forces.

Used as a lubricant and in pencils.

• **Fullerene:** Each carbon is covalently bonded to 3 other carbons in a sphere of 60 carbon atoms.

(6)

1

3. Draw the Lewis structure of  $\text{CO}_2$  and predict its shape and bond angle.



(2)

4. Describe the structure and bonding in  $\text{SiO}_2$ .

- Macromolecular-covalent (or Giant covalent network solid)
- Each silicon atom is covalently bonded to four oxygen atoms and each oxygen atom covalently bonded to two silicon atoms.

(2)

5. Explain why silicon dioxide is a solid and carbon dioxide is a gas at room temperature.

Silicon dioxide contains strong covalent bonds in a macromolecular network solid. Carbon dioxide only has weak dispersion forces between its molecules.

(2)

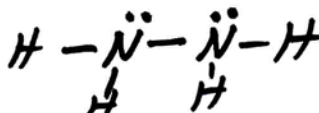
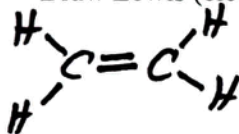
6. Explain the electrical conductivity of molten sodium oxide and liquid sulfur trioxide.

Molten sodium oxide conducts electricity due to free-moving ions.

(2)

7. Ethene,  $\text{C}_2\text{H}_4$ , and hydrazine,  $\text{N}_2\text{H}_4$ , are hydrides of adjacent elements in the periodic table.

(a) (i) Draw Lewis (electron dot) structures for  $\text{C}_2\text{H}_4$  and  $\text{N}_2\text{H}_4$  showing all valence electrons.



(2)

(ii) State and explain the H-C-H bond angle in ethene and the H-N-H bond angle in hydrazine.

Ethene:  $120^\circ$   
due to three negative charge centers around each carbon atom

Hydrazine:  $107^\circ$   
due to the four negative charge centers around each nitrogen atom. Extra repulsion due to the lone pair of electrons

(4)



(cont.)

(b) The polarity of a molecule can be explained in terms of electronegativity.

(i) Define the term electronegativity.

The measure of attraction for shared electrons in a covalent bond. (2)

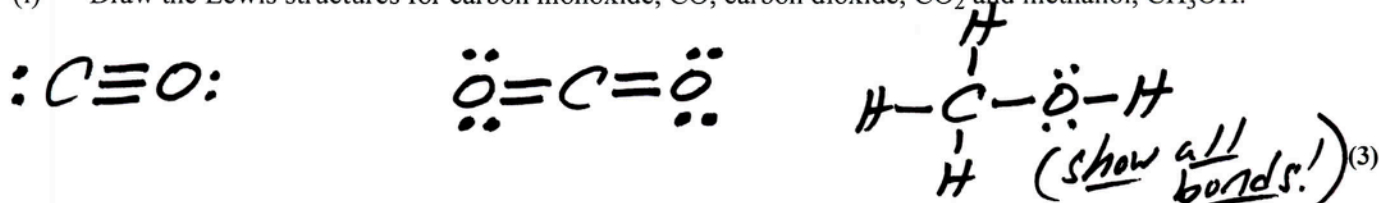
(ii) Compare the relative polarities of the C-H bond in ethene and the N-H bond in hydrazine.

Nitrogen is more electronegative than carbon, therefore the N-H bond is more polar than C-H. (1)

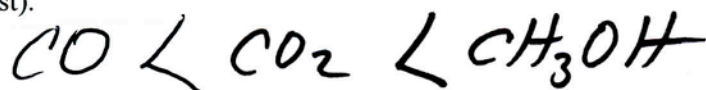
(iii) Hydrazine is a polar molecule and ethene is non-polar. Explain why ethene is non-polar.

Ethene is a symmetrical molecule with an even charge distribution. (1)

8. (i) Draw the Lewis structures for carbon monoxide, CO, carbon dioxide, CO<sub>2</sub> and methanol, CH<sub>3</sub>OH.



(ii) List, with an explanation, the three compounds in order of increasing carbon to oxygen bond length (shortest first).



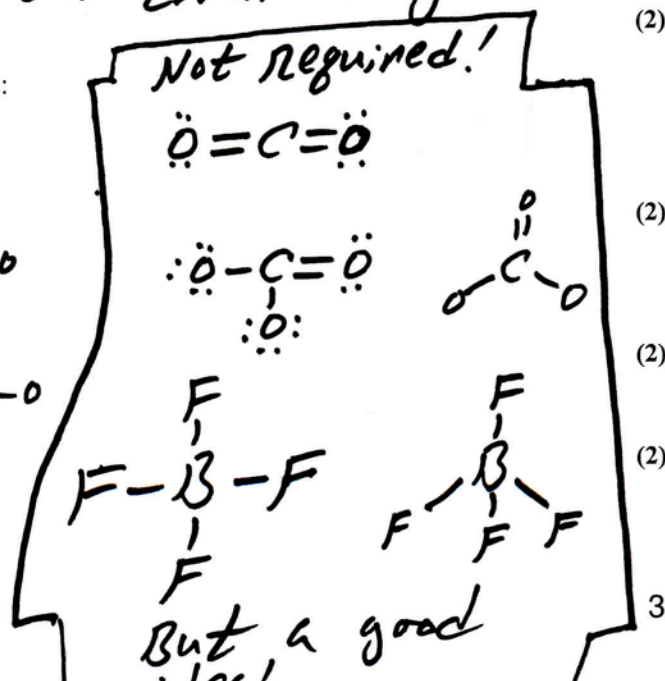
Triple bonds are shorter than double bonds, which are shorter than single bonds. (2)

9. Predict the shape and bond angles for the following species:

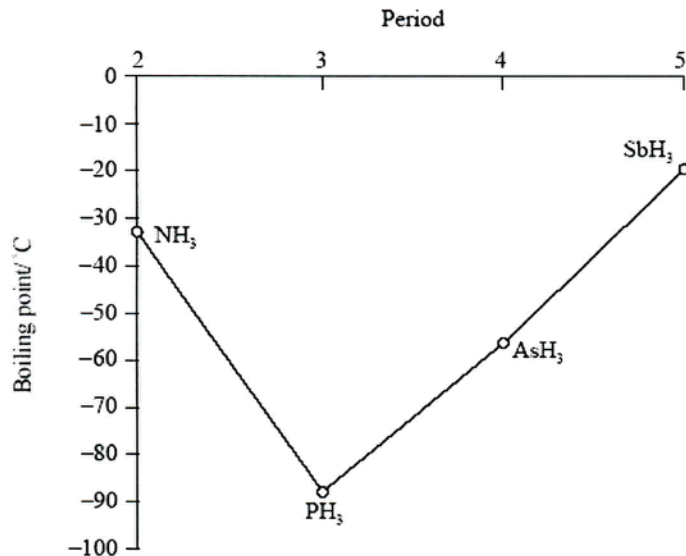
(i) CO<sub>2</sub> Linear, 180°

(ii) CO<sub>3</sub><sup>2-</sup> Trigonal planar, 120°

(iii) BF<sub>4</sub><sup>-</sup> Tetrahedral, 109.5°



10. The graph below shows the boiling points of the hydrides of group 5. Discuss the variation in the boiling points.



Boiling points increase going down the group from phosphorus to antimony due to an increase in molecular size which increases the dispersion forces between the molecules (all dipoles with the same molecular shape). NH<sub>3</sub> has a higher boiling point than would be expected due to the hydrogen bonding between its molecules.

(4)

11. Using Table 7 of the Data Booklet, predict and explain which of the bonds O-H, O-N or N-H would be most polar.

O	H	N
3.4	2.2	3.1

need to show!

(and/or calculate the difference in electronegativity.)

the O-H bond has the greater difference in electronegativity, therefore it's the most polar.

(2)

12. Predict and explain which of the following compounds consist of molecules:



All contain only nonmetals.

(2)