HL BONDING TEST

1 Potassium dichromate(VI) is an important oxidizing agent in organic chemistry. The formula of the dichromate(VI) ion is $Cr_2O_7^{2-}$. The ***total*** number of electron in the dichromate(VI) ion is

A 106 B 104 C 102 D 56

2 The formula of silver nitrate is

A $Ag(NO_3)_2$ B Ag_3N C $AgNO_3$ D Ag_3N_2

3 What is the electron domain geometry and the F-Xe-F bond angle in XeF_2?

A Tetrahedral 104º B Linear 180º
C Octahedral 90º D Trigonal bipyramidal 180º

4 The formal charge (FC) on the carbon atom in carbon monoxide is

A 0 B 1+ C 1- D 2-

5 In which of the following do all the carbon atoms have sp^2 hybridization?

A CH_3CHCH_2 B H_2CCH_2 C H_3CCH_3 D $HCCCH_3$

6 Which of the following is a catalyst for the destruction of ozone in the upper atmosphere?

A Cl_2 B Cl C O D CF_2Cl_2

7 The molar masses C_2H_6, CH_3OH and CH_3F of are very similar. How do their boiling points compare?

A $CH_3F < C_2H_6 < CH_3OH$ B $CH_3F < CH_3OH < C_2H_6$
C $CH_3OH < CH_3F < C_2H_6$ D $C_2H_6 < CH_3F < CH_3OH$

8 Which of the following nitrogen compounds contains the fewest π bonds?

A N_2 B N_2F_2 C N_2H_4 D N_2H_2

9 Which of the following is correct?

A MgF_2 has a higher melting point than XeF_2 because ionic bonds are stronger than covalent bonds.
B XeF_2 has a higher melting point than MgF_2 because it has stronger London forces between molecules
C MgF_2 has a higher melting point than XeF_2 because MgF_2 is more polar than XeF_2
D MgF_2 has a higher melting point than XeF_2 because ionic bonding is stronger than London forces between molecules.

10 In which of the following are the P-O bond lengths all equal?

A H_3PO_4 B $H_2PO_4^-$ C HPO_4^{2-} D PO_4^{3-}

11 This question is about the hydrides of Group 16 elements with the general formula H_2X.

(a) Draw a Lewis is structure for H_2Se and predict the H-Se-H bond angle. [2]

Lewis structure completely correct for [1]
Do not award mark if H_2O or H_2S drawn

Bond angle 90-108^o [1]

(b) Explain which of the compounds H_2O, H_2S or H_2Se contains the most polar H-X bond. [1]

H_2O *and* biggest difference in electronegativity between H and X

Explanation must be about difference in electronegativity between O and H/between the atoms in the molecule – just saying that O is more electronegative than S/Se does not explain it and should not be awarded a mark.

(c) The boiling points of some of the Group 16 hydrides are shown in the table

	boiling point / ^{o}C
H_2O	100
H_2S	-60
H_2Se	-41

Explain why H_2O has a greater boiling point than H_2S [2]

H_2O has hydrogen bonding <u>between molecules</u> but H_2S does not;
Must be some sort of comparison/implication that H_2S does not have hydrogen bonding

Hydrogen bonding between water molecule stronger than dipole-dipole/van der Waals' forces/London forces between molecules in H_2S;

Must have the idea that intermolecular forces are being considered

12 Cyanogen is a colourless, poisonous gas with the formula $(CN)_2$.

(a) Cyanogen can be prepared by the reaction between copper(II) sulfate and potassium cyanide.

$$\mathbf{2}CuSO_4 + \mathbf{4}KCN \rightarrow \ldots.(CN)_2 + \mathbf{2}CuCN + \mathbf{2}K_2SO_4$$

(i) Balance the equation for the reaction. [1]

(ii) Compare the charge on the copper ion in $CuSO_4$ with that in CuCN. [1]

Cu^{2+} in $CuSO_4$ but Cu^{+} in CuCN

(b) (i) Draw the Lewis structure of cyanogen [1]

$$|N{\equiv}C\text{-}C{\equiv}N|$$

Do not accept alternative structures such as |N≡C-N≡C| or |C≡N-N≡C| These have higher FC. Still linear though so next question fine

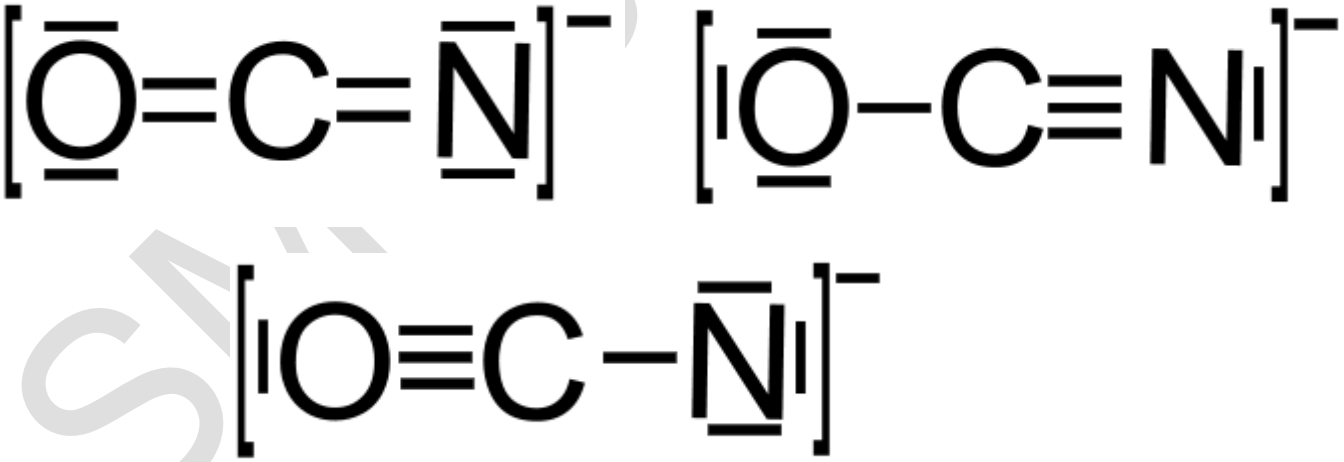
(ii) Deduce the shape of cyanogen [2]

Linear;
Two electron domains about each C;

(c) In alkaline solution the following reaction occurs:

$$(CN)_2 + 2OH^- \rightarrow CN^- + OCN^- + H_2O$$

(i) Deduce two possible Lewis structures for OCN^-. [2]



Allow the third structure but it is highly unlikely

(iii) Explain whether the C-N bond length is longer in CN^- or OCN^- [3]

C-N bond is longer in OCN^-
Triple bond in CN^-
But resonance structures/delocalization in OCN^- (where only one of the resonance structures has a triple bond between C and N)
If only first and third Lewis structures drawn allow explanation based on the fact that only C-N and C=N present.

13 Some physical properties of some Group 13 halides are shown in the table

	melting point / ^{o}C	Conducts electricity in solid state?	Conducts electricity in liquid state?
AlF_3	1290	no	yes
$AlBr_3$	98	no	no
AlI_3	189	no	no

Explain the data in the table in terms of structure and bonding. [5]

AlF_3 ionic bonding and giant structure but $AlBr_3$ and AlI_3 covalent molecular;

AlF_3
High melting point because strong electrostatic forces of attraction between oppositely-charged ions require a lot of energy to break (OWTTE)

$AlBr_3$/AlI_3
Low melting point because not much energy required to break dipole-dipole/van der Waals' forces/London forces between molecules;

AlI_3 has higher melting point than $AlBr_3$ due to higher molecular mass/more electrons therefore stronger London forces between molecules;

AlF_3 conducts electricity because mobile ions present ion liquid state but $AlBr_3$/AlI_3 do not because no ions/only neutral molecules present;