Year 12 Chemistry   <u>**Test #2 - 2011**</u>

Name: _____   Mark =   / 46

Part 1: Multiple Choice Section   **10 marks**

_____

1.   A substance has molecules which are triatomic and non-linear. Which of the following correctly fits this description?

    A.   Hydrogen cyanide

    B.   Hydrogen sulfide

    C.   Carbon dioxide

    D.   Methane

2.   The total number of protons and electrons in the hydrogencarbonate ion is:

    A.   63

    B.   62

    C.   32

    D.   31

3.   Which of the molecules would be polar molecules?

  (i) CH_4 (ii) $CH_3C\ell$ (iii) $CH_2C\ell_2$ (iv) $CHC\ell_3$ (v) $CC\ell_4$

    A.   (ii) and (iv)

    B.   (i), (iii) and (v)

    C.   all of them

    D.   (ii), (iii) and (iv)

4.   The strength of dispersion forces is a major influence on the melting point of:

    A.   ammonium nitrate

    B.   chlorine

    C.   copper

    D.   graphite

5.   Hydrogen bonding would affect the boiling points of which of the following compounds?

C_2H_6, CH_3Br, C_2H_5OH, CH_3NH_2

A. C_2H_5OH and CH_3NH_2 only

B. CH_3Br and C_2H_5OH only

C. CH_3NH_2 only

D. C_2H_5OH only

6.   The following statements concern the structure of the atom. Which statement is correct?

A.   The nucleus is always neutral.

B.   Protons, neutrons and electrons are almost identical in size.

C.   The number of neutrons might not equal the number of protons.

D.   Electrons are held stationary in fixed positions around the nucleus.

7.   Which of the following does not represent an ascending order of boiling points of the three substances?

A. CH_4, NH_3, H_2O

B. CH_4, C_2H_6, C_3H_8

C. HF, H_2, H_2O

D. H_2, H_2S, H_2O

8.   Two elements X and Y have the following successive molar ionisation energies:

	Ionisation Energies in MJ mol^{-1}			
	1st	2nd	3rd	4th
X	0.41	2.66	3.90	5.10
Y	0.56	1.07	4.10	5.50

If the atomic number of Element Y is greater than that of X by one, X is likely to be:

A.   An alkali metal

B.   A halogen

C.   An inert gas

D.   A Group 2 element

9.   Which of the following statements is incorrect for an ionic substance?

A.   The substance will have a high melting point because of the strong electrostatic attraction between oppositely charged ions.

B.   When heated sufficiently charged particles can move and allow the passage of an electric current through the substance.

C.   When dissolved in water the ionic lattice breaks up and makes electrons available to allow the passage of an electric current through the solution.

D.   When the ions in the lattice are forced to move, electrostatic repulsion tends to make the solid shatter.

10.   Eight consecutive elements in the Periodic Table have the following first ionisation energies:

Ionisation Energies in kJ mol^{-1}							
707	833	870	1010	1170	376	502	540

One of the eight elements is a halogen. The first ionisation energy of the halogen is:

A.   1170

B.   1010

C.   870

D.   376

Part 2: Written Section (36 marks)

1.   The melting points of the metals Sodium, Aluminium and Potassium are given in the table below. Fill in the table to assign the melting points of the three elements.

Element	Melting point °C
	63.25
	97.81
	660.37

Explain your reasoning in assigning these melting points:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(1,5 marks)

2. For each species listed in the table below:
   - Draw the structural formula, including all valence shell electron pairs and representing each pair as : or –
   - Indicate the shape of each species by either a sketch or name
   - The polarity of the molecule

Species	Structural formula (showing all valence shell electrons)	Shape (sketch or name)	Polar or Non-Polar
SO_2			
SO_3			
SO_3^{2-}			Not applicable

(8 marks)

Referring to the above answers explain why SO_2 boils at -10^oC while SO_3 boils at 45^oC.

_____

_____

_____

_____

_____

_____

3. Consider the elements in Group 15 of the Period Table (N, P, As, Sb, Bi)

    (a) Which element would most easily form a monatomic negative ion? _____

    (b) Which of the hydrides of Group 15 would have the lowest melting point? _____

    (c) Which element is the most metallic? _____

    (d) Name the shape of the molecule of the hydride of phosphorus? _____

(4 marks)

4. Which of the elements sodium, sulphur, chlorine, bromine and iodine is the most electronegative?

    _____

    Define the term electronegativity and hence justify your choice:_____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

    _____

(4 marks)

5.   The following five substances have their boiling points (at 1 atm) listed in the table below:

   Ethanol, CH_3CH_2-O-H

   Hydrogen chloride. $HC\ell$

   Hydrogen fluoride,   HF

   Methane, CH_4

   Ethan-1,2-diol,   H-O-CH_2CH_2-O-H

Consider the intermolecular forces between the molecules and so match the boiling points to the substances listed and complete the table.   (3 marks)

Boiling Point (ºC)	Substance
-162	
-85	
19	
78	
198	

Justify your choices.   (7 marks)

_____

_____

_____

_____

_____

_____

_____

_____

_____

End of Test

Year 12 Chemistry   <u>**Topic Test #2 - 2011**</u>

Name: **ANSWERS**   Mark = _____ / 46

Part 1: Multiple Choice Section   **10 marks**

_____

1. **B**   2. **A**   3. **D**   4 **B**   5. **A**   6. **C**   7. **C**   8. **A**   9. **C**   10. **B**

Part 2: Written Section   **36 marks**

_____

1.   The melting points of the metals Sodium, Aluminium and Potassium are given in the table below. Fill in the table to assign the melting points of the three elements.

Element	Melting point (^{o}C)
K	63.25
Na	97.81
Aℓ	660.37

✔

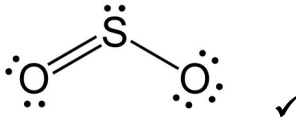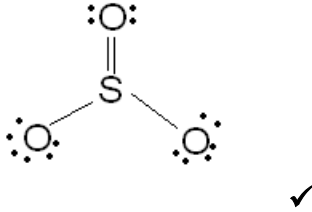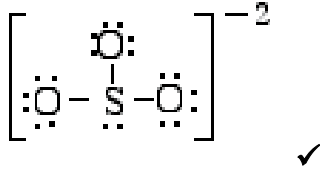Explain your reasoning in assigning these melting points:

(1, 5 marks)

The strength of the metallic bond depends on the cationic radius and the magnitude of the cationic charge. Stronger bond results from greater ion charge and smaller radius. ✔

K < Na: Both K and Na have a charge of +1 ✔**, but the increased radius of the K results is a weaker metallic bond hence K has a lower m.pt** ✔

Na < Aℓ: Both are in the same period so there is only a small difference in the ionic radius, ✔**however Aℓ ion is Aℓ^{3+} whereas Na is Na$^+$, hence the metallic bond in Aℓ is stronger than in Na.** ✔

2.   For each species listed in the table below:
   - Draw the structural formula, including all valence shell electron pairs and representing each pair as : or –
   - Indicate the shape of each species by either a sketch or name
   - The polarity of the molecule

Species	Structural formula (showing all valence shell electrons)	Shape (sketch or name)	Polar or Non-Polar
SO_2	✔	**Bent of V-shape** ✔	**Polar** ✔
SO_3	✔	**Trigonal Planar** ✔	**Non-polar** ✔
SO_3^{2-}	✔	**Pyramidal** ✔	Not applicable

(8 marks)

Referring to the above answers explain why SO_2 boils at -10°C while SO_3 boils at 45°C.

SO_2 being a polar molecule has dipole-dipole and dispersion forces of attraction between molecules.   ✔

SO_3 being non-polar only has dispersion forces between molecules.   ✔

You would expect that the SO_2 would have the higher boiling point since dipole-dipole bonds are stronger than dispersion for similar mass.   ✔

Since SO_3 has a higher boiling point then the dispersion forces in SO_3 must be stronger than the dipole-dipole in SO_2 due to the increase in number of electrons in SO_3.   ✔

(4 marks)

3.   Consider the elements in Group 15 of the Period Table (N, P, As, Sb, Bi)

   (a)   Which element would most easily form a monatomic negative ion?   **N** ✓

   (b)   Which of the hydrides of Group 15 would have the lowest melting point? **P** ✓

   (c)   Which element is the most metallic?   **Bi**   ✓

   (d)   Name the shape of the molecule of the hydride of phosphorus? **pyramidal** ✓

                                                                              (4 marks)

4.   Which of the elements sodium, sulphur, chlorine, bromine and iodine is the most
       electronegative?

    Chlorine ✓

    Define the term electronegativity and hence justify your choice

    Electronegativity is the measure of the attraction an atom has for the shared

    pair of electrons in a covalent bond.   ✓

    Across the period, $C\ell$ > S since the nuclear charge increases (constant

    shielding effect) there is a greater force of attraction between the nucleus

    and the valence electrons.   ✓

    Down a group, $C\ell$ >, Br > I since there is an increased distance of valence

    electrons from the nucleus.   ✓
    (Although the nuclear charge increases so does the shielding effect and

    hence the effective nuclear charge decreases)

                                                                              (4 marks)

5.   The following five substances have their boiling points (at 1 atm) listed in the table below:

Ethanol, CH_3CH_2-O-H
Hydrogen chloride. $HC\ell$
Hydrogen fluoride,   HF
Methane, CH_4
Ethan-1,2-diol,   H-O-CH_2CH_2-O-H

Consider the intermolecular forces between the molecules and so match the boiling points to the substances listed and complete the table.

Boiling Point (^{o}C)	Substance
−162	**CH_4**
− 85	**$HC\ell$**
19	**HF**
78	**CH_3CH_2-O-H**
198	**H-O-CH_2CH_2-O-H**

1 mark if 2 correct   *2 marks if three correct*   *3 marks if all correct*
(3 marks)

Boiling point depends on the strength of attraction between molecules.   ✓

CH_4 is non-polar molecule with weak dispersion forces between molecules, hence has the lowest boiling point.   ✓

$HC\ell$ < HF, both are linear polar molecules. $HC\ell$ has dipole-dipole forces of attraction between its molecules whereas HF has H-bonding. In this case the H-bonding is stronger than the dipole-dipole + dispersion forces in $HC\ell$.   ✓✓

Ethanol and ethan-1,2-diol are polar molecules with H-bonding between molecules. ✓

Since they both have a greater number of electrons than HF, their dispersion forces are considerably stronger and hence have higher boiling points than HF. ✓

Ethan-1,2-diol > ethanol since there are two OH and hence there are two places for H-bonding interaction to occur, hence it has a higher boiling point.   ✓
(7 marks)

End of Test