Year 12 Chemistry
In-class assignment: Structure and Bonding 2006

Name: _____

Please answer the multiple choice questions on the answer key provided below:

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

	Mark	**Out of**
Part One		10
Part Two		21
Part Three		5
Total		36

Part One : Multiple Choice **(10 questions; 10 marks)**
Please answer these questions on the separate multiple choice answer sheet provided.

1. Select the group in which all the substances have ionic bonds
   a) NaF, MgO, RbCl
   b) CO_2, HCl, NaCl
   c) SiO_2, SiC, BN
   d) Al_2O_3, HI, NaI

2. The element with the highest first ionization energy is
   a) oxygen
   b) fluorine
   c) argon
   d) potassium

3. For the substances C(graphite), N_2 , C_3H_8 and C_2H_5OH which of the following correctly represents them in order of increasing boiling point ?
   a) N_2, C_3H_8 , C_2H_5OH , C
   b) N_2 , C , C_3H_5OH , C_3H_8
   c) N_2 , C , C_3H_8 , C_2H_5OH
   d) C, N_2 , C_3H_8 , C_2H_5OH
   e) C_3H_8 , N_2 , C_2H_5OH , C

4. Which one of the following has the lowest electrical conductivity?
   a) molten sodium chloride
   b) dilute sulfuric acid
   c) molten sulfur
   d) graphite
   e) liquid mercury

5. Which of the following is a characteristic property of a covalent molecular compound?
   a) dissolves in polar solvents
   b) relatively low melting point
   c) malleable and ductile
   d) high melting point
   e) conducts electricity when molten but not when solid

6. A neutral fluorine atom has a much greater attraction for electrons than does any other neutral atoms. Consider the following series of molecules

I CH_4 **II** CH_3F **III** CH_2F_2 **IV** CHF_3 **V** CF_4

Which of the above molecules will have a dipole?
a) All of the above
b) None of the above
c) II, III and IV only
d) II and IV only
e) II, III and V only

7. Non-polar organic solvents such as kerosene dissolve non-polar solids such as paraffin wax because
a) the solvent reacts chemically with the solute.
b) intermolecular forces between solute and solvent molecules are similar in strength to those within the pure solute and the pure solvent.
c) very strong solute-solvent intermolecular forces exist.
d) the intermolecular forces between solvent molecules are very weak.
e) the solute and solvent are composed of the same chemical elements.

8. Which of the following is most miscible with water?
a) Hg
b) C_6H_{14}
c) CH_3COCH_3
d) CCl_4
e) C_6H_6

9. The successive ionisation energies (in eV) of an element X are

5.1, 47.3, 71.6, 98.9, 138.4

Which of the following elements is most likely to be X?
a) oxygen
b) calcium
c) sodium
d) argon
e) iodine

10. Which one of the following formula represent a molecule of a compound?
a) Cl_2
b) CO
c) CaO
d) SiO_2
e) Ar

Part Two: Written **(4 questions : 22 marks)**

Answer these questions in the spaces provided below.

1. Draw electron dot diagrams for the following species in the spaces provided

(a) CH_2Cl_2 (b) CN^-

(c) PCl_5 (d) NO_3^-

(4 marks)

2. Elements in group V of the periodic table form a series of hydrides of formula NH_3, PH_3, AsH_3, SbH_3.

(i) Arrange the molecules PH_3, AsH_3 and SbH_3 in increasing order of boiling point. Justify your order.

_____

_____

_____

_____

_____

_____

(ii) Will the group V hydrides be polar or non-polar? Explain

_____

_____

_____

_____

_____

(iii) NH_3 has a much higher boiling point than PH_3, yet its molecular weight is much smaller. Explain this observation in terms of bonding.

_____

_____

_____

_____

_____

(7 marks)

3. Describe the shape of the following molecules and comment on their overall polarity:

	shape	**polarity**
PF_3		
HC_2H		
H_2O		

(6 marks)

4. Write the electronic configuration for the following species using s,p,d,f notation:

(a) a zinc ion _____

(b) a potassium ion _____

(c) a copper atom _____

(d) an argon atom _____ (4 marks)

Part Three: Calculations **(1 questions : 5 marks)**

1. Chromium metal occurs mainly as the green mineral chromite, $Fe_2O_3.Cr_2O_3$.
It is extracted from chromite by heating the mineral in air with sodium carbonate to form sodium chromate according to the following balanced equation:

$$2Fe_2O_3.Cr_2O_3 + 4Na_2CO_3 + 3O_2(g) \rightarrow 2Fe_2O_3 + 4Na_2CrO_4(s) + 4CO_2(g)$$

a) Calculate the mass of sodium carbonate needed to react with 1.00 tonne of chromite.
[Hint: 1 tonne = 10^3 kg or 10^6 g.] (3 marks)

b) What volume of oxygen gas measured at 30.0^{o}C and 98.0 kPa pressure is required for the reaction in (a) above? (2 marks)

Year 12 Chemistry

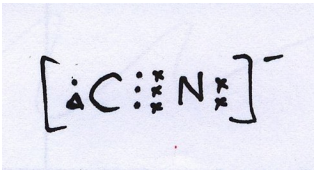
In-class assignment: Structure and Bonding 2006 – ANSWERS

Multiple choice

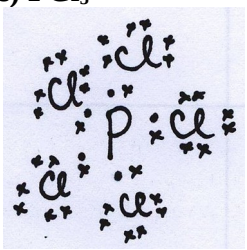
1. a 2. b 3. a 4. c 5. b 6. c 7. b 8. c 9. c 10. b

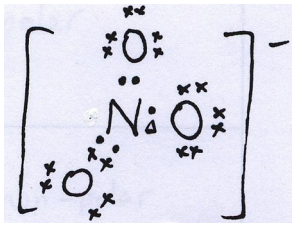
Part two: Written **(4 questions; 22 marks)**

1. a) CH_2Cl_2 **b) CN^-**



c) PCl_5 **d) NO_3^-**





(4 marks)

2. (i)

- SbH_3 is ionic and will have the highest boiling point due to strong electrostatic forces between the cations and anions (1 mark)
- Both PH_3 and AsH_3 are covalent molecular substances made of polar molecules. (1 mark)
- AsH_3 has a larger molecular mass than PH_3 and therefore has more electrons and will have larger temporary dipoles and a higher boiling point. (1 mark)

(ii)

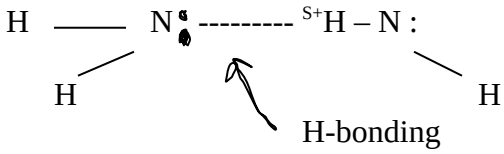
With aid of diagram (1 mark)

Polar due to the lone pair of electrons on the central group V atom making the distribution of electrons unsymmetrical (1 mark)

(iii)

- Hydrogen bonding (1 mark)
- Due to very electronegative N being bonded to a H atom leads to the H atom developing an appreciable positive charge which is attracted to lone pairs of electrons on neighbouring molecules.

H\ /H



(1 mark)

3.

	Shape	Polarity
PF_3	**Pyramidal**	**Polar**
HC_2H	**linear**	**Non-polar**
H_2O	**v-shaped or bent**	**polar**

(6 marks)

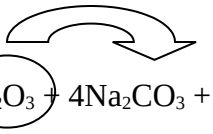
4.

a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$ (28 electrons)
b) $1s^2 2s^2 2p^6 3s^2 3p^6$ (18 electrons)
c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^9$ (29 electrons)
d) $1s^2 2s^2 2p^6 3s^2 3p^6$ (18 electrons)

(4 marks)

Part Three: Calculations

1.



$2Fe_2O_3.Cr_2O_3 + 4Na_2CO_3 + 3O_2(g) \rightarrow 2Fe_2O_3 + 4Na_2CrO_4(s) + 4CO_2(g)$

1 000 000g

a) $^nFeO_3.Cr_2O_3 = \frac{1\ 000\ 000}{(2 \times 55.85 + 3 \times 16 + 2 \times 52 + 3 \times 16)} = \frac{1\ 000\ 000}{311.7} = 3208.2$

(1 mark)

moles $Na_2CO_3 = \frac{4}{2} \times$ moles $Fe_2O_3.Cr_2O_3 = 6416.4$ mol

(1 mark)

mass $Na_2CO_3 = 6416.4 \times (2 \times 22.99 + 12.01 + 3 \times 16)$
$= 6416.4 \times 105.99$
$= 680\ 176.997$g (1 mark)

b) moles $O_2 = \frac{3}{2} \times$ moles $Fe_2O_3.Cr_2O_3$
$= \frac{3}{2} \times 6416.4 = 9624.6$ (1 mark)

$PV = nRT$
$(98)\ V = (9624.6)(8.315)(30 + 273)$
$\Rightarrow V = 819.7$ L
$= 820$ L (to 3 sig fig) (1 mark)