Year 12 Chemistry **Topic Test # 2 (Bonding) - 2012**

Name: _____ Mark = _____ / 44

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

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1. Two flasks contain pure substances. In each flask, only dispersion forces exist between molecules. The substances in the two flasks could be:

   A. CH_4 and H_2S

   B. NH_3 and F_2

   C. SiH_4 and H_2O

   D. CH_4 and F_2

2. Diamond is an electrical insulator because:

   A. It is a crystalline substance.

   B. All the valence electrons are delocalised.

   C. All the valence electrons are involved in single covalent bonds.

   D. It consists only of non-conducting carbon atoms.

3. Which of the following have hydrogen bonding between their molecules?

   I CH_3F

   II CH_3NH_2

   III CH_3OH

   IV CS_2

   A. II and III only

   B. III and IV only

   C. I and III only

   D. I, II and III only

4. Water exists as discrete H_2O molecules with the two hydrogen atoms each covalently bonded to oxygen. Below 0°C, at atmospheric pressure, water exists as a crystalline solid, ice, in which the individual H_2O molecules are held in an open network lattice. The bonding that holds the water molecules together in the ice lattice is best described as being due to:

   A. dispersion forces only

   B. dispersion forces plus hydrogen bonding

   C. ionic bonding

   D. ionic bonding plus hydrogen bonding

5. Consider the following set of successive ionisation energies (MJ mol^{-1}):

0.74 1.45 7.73 10.54 13.63

Which of the following elements is most likely to have such a set of ionisation energies?

A. C

B. K

C. Mg

D. O

6. Which one of the following compounds has a net dipole?

A. CBr_4

B. CH_3Br

C. C_2Br_6

D. $Br_2C=CBr_2$

7. The molar heat of sublimation (the heat required to convert 1 mol of solid directly to the gas state) of solid helium is 0.015 kJ mol^{-1} whereas that of ice is 46.9 kJ mol^{-1}.

Which of the following statements help to explain these facts?

I Only dispersion forces are present between helium atoms.

II There is strong hydrogen bonding between water molecules in ice.

III There are strong covalent bonds within water molecules in ice.

IV There are weak covalent bonds between helium atoms.

A. I and II only.

B. I, II and III only.

C. I, II and IV only.

D. II, III and IV only.

8. Which of the following equations correctly represents the second ionisation energy of the element aluminium?

A. $A\ell^{+}(s) \rightarrow A\ell^{2+}(g) + e^{-}$

B. $A\ell(g) \rightarrow A\ell^{3+}(g) + 3\ e^{-}$

C. $A\ell^{+}(g) \rightarrow A\ell^{2+}(g) + e^{-}$

D. $A\ell^{2+}(g) \rightarrow A\ell^{3+}(g) + e^{-}$

9. The molecule $N_2C\ell_4$ has the number **X** non-bonding pairs of electrons, number **Y** of polar bonds and the number **Z** bonding pairs of electrons. What are the values of **X**, **Y** and **Z**?

	X	**Y**	**Z**
A.	15	5	4
B.	14	4	5
C.	15	5	5
D	14	4	4

10. Which of the following statements about dispersion forces in a series of molecules is correct?

A. An increased molecular weight leads to greater mass of the molecule and hence stronger dispersion forces.

B. An increased number of protons and electrons lead to stronger dispersion forces.

C. Larger electronegativity differences lead to stronger dispersion forces.

D. The presence of an atom such as O or N bonded to H leads to stronger dispersion forces.

End of Part 1

Part 2: Short Answer Section **34 marks**

1. Nitrogen (N_2) exists is a gas at room temperature. Nitrogen trichloride ($NC\ell_3$) exists as a liquid at room temperature.

   (a) Name the bonding that would exist in a container of each substance giving reasons for your answer.

   N_2 _____

   _____

   _____

   _____

   _____

   _____

   $NC\ell_3$ _____

   _____

   _____

   _____

   _____

   _____

   (5 marks)

;

2. Complete the following table:

Species	*Electron dot diagram*	*Name of shape*	*Polarity (polar or non-polar)*
SO_2			
HCN			
SO_4^{2-}			N/A
PI_3			

(11 marks)

3. The following table gives some information about three elements in the fourth row of the Periodic Table.

Element	*Electrical conductivity (MS m^{-1})*	*First ionisation energy (kJ mol^{-}')*	*Melting point (°C)*
Potassium	14	425	63
Calcium	29	596	650
Germanium	1×10^{-4}	762	938

(a) What type of bonding would you expect to occur in germanium?

(1 mark)

(b) Justify your answer.

(3 marks)

(c) Explain the trend in ionisation energies of the elements above.

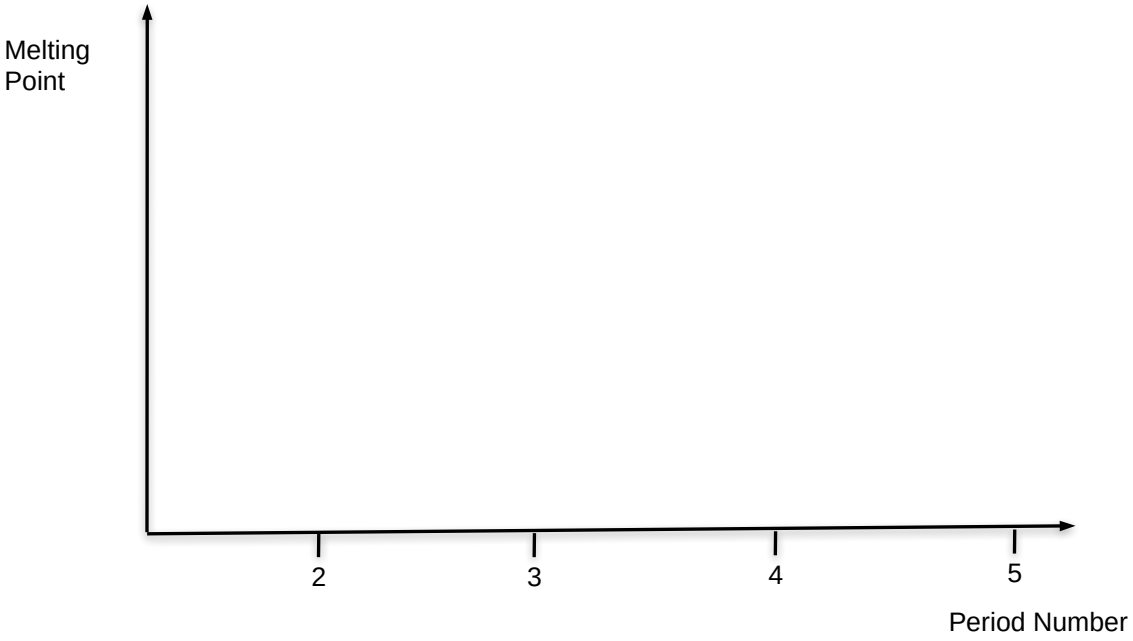
(1 mark)

(d) Would the value of potassium's second ionisation energy be larger or smaller than that for calcium? Explain why.

(2 marks)

4. Use your understanding of atomic structure and bonding to:

(a) Complete a sketch showing the boiling points of the hydrides of group 14 (———) and group 17 (- - - - -) on the following graph.



(4 marks)

(b) Explain the overall trend shown on the graph:

(2 marks)

(c) Give reasons for any exceptions to this trend.

(1 mark)

5. Using your knowledge of atomic structure and bonding explain the following physical data:

Substance	*Solubility in water at 25°C (g L^{-1})*
1-pentanol ($CH_3CH_2CH_2CH_2CH_2OH$)	22.0
1-hexanol ($CH_3CH_2CH_2CH_2CH_2CH_2OH$)	5.9

(4 marks)

End of Test

SVACS

Year 12 Chemistry **<u>Topic Test # 2 (Bonding) - 2012</u>**

Name: **ANSWERS**

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

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

Part 2: Short Answer Section **34 marks**

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1. Nitrogen (N_2) exists is a gas at room temperature. Nitrogen trichloride ($NC\ell_3$) exists as a liquid at room temperature.

   (a) Name the bonding that would exist in a container of each substance giving reasons for your answer.

   N_2 **N-N bonds are covalent** ✓

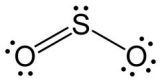
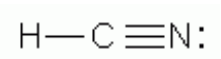
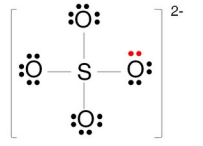
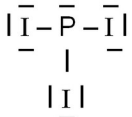
   Intermolecular bonding is dispersion forces only as N_2 molecules are non-polar ✓

   $NC\ell_3$ **N-Cℓ bonds are covalent** ✓

   Intermolecular bonding is dipole-dipole and dispersion forces
   – dipole-dipole because molecule is polar ✓
   − dispersion forces because they occur between all particles ✓

   (5 marks)

2. Complete the following table:

Species	*Electron dot diagram*	*Name of shape*	*Polarity (polar or non-polar)*
SO_2		**bent**	**polar**
HCN		**linear**	**polar**
SO_4^{2-}		**tetrahedral**	N/A
PI_3		**pyramidal**	**polar**

(11 marks)

3. The following table gives some information about three elements in the fourth row of the Periodic Table.

Element	*Electrical conductivity (MS m^{-1})*	*First ionisation energy (kJ mol^{-1})*	*Melting point (°C)*
Potassium	14	425	63
Calcium	29	596	650
Germanium	1×10^{-4}	762	938

(a) What type of bonding would you expect to occur in germanium?

covalent network ✓

(1 mark)

(b) Justify your answer.

Poor electrical conductor, so can't be metallic ✓

High melting point, so can't be molecular ✓

Obviously not ionic, so ∴ covalent network ✓

(3 marks)

(c) Explain the trend in ionisation energies of the elements above.

Increasing nuclear charge (from K to Ca to Ge), with a similar degree of shielding

∴ more energy required to remove e^- from Ge than Ca than K.✓

(1 mark)

(d) Would the value of potassium's second ionisation energy be larger or smaller than that for calcium? Explain why.

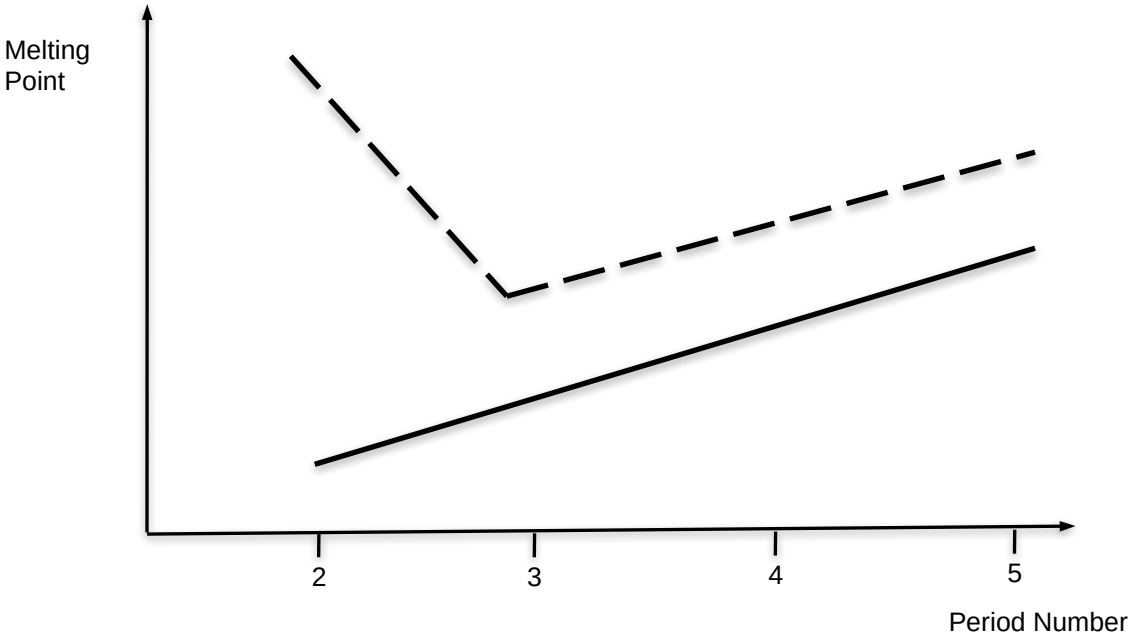
Larger ✓

The removal of 2nd e^- from Ca is from the same (fourth) shell, whereas K is from the third shell – less shielding, ∴ more strongly attracted and more energy required ✓

(2 marks)

4. Use your understanding of atomic structure and bonding to:

(a) Complete a sketch showing the boiling points of the hydrides of group 14 (———) and group 17 (- - - - -) on the following graph.



✓ **mp of group 14 hydrides increasing**
✓ **mp of group 17 hydrides higher than group 14**
✓ **mp of group 17 hydrides increasing from period 3 to period 5**
✓ **mp of group 17 hydride in period 2 (HF) higher than period 3**

(4 marks)

(b) Explain the overall trend shown on the graph:

Increasing mp with increasing size of molecules ✓

This is due to increasing strength of dispersion forces with increasing size of molecule, as temporary dipoles become larger ✓

(2 marks)

(c) Give reasons for any exceptions to this trend.

HF has a particularly strong form of dipole-dipole attraction, called hydrogen bonding.

This arises due to the great difference in electronegativity between H and F and the small size of F. ✓

(1 mark)

5. Using your knowledge of atomic structure and bonding explain the following physical data:

Substance	*Solubility in water at 25°C (g L^{-1})*
1-pentanol ($CH_3CH_2CH_2CH_2CH_2OH$)	22.0
1-hexanol ($CH_3CH_2CH_2CH_2CH_2CH_2OH$)	5.9

Water is polar molecule and contains with dispersion forces and hydrogen bonding between molecules. ✓

Hydrogen bonding also exists between molecules of each alcohol, but dispersion forces become more significant as the molecule becomes larger (as the carbon chain increases in length). ✓

Only dispersion forces form between the carbon chain and water, which are much weaker than hydrogen bonds between water and dispersion forces between alcohols. ✓

As the alcohol size increases, solubility in water decreases. ✓

(4 marks)

End of Test