Chemistry Flash Cards - Bonding Structures

Though originally intended to be printed out, laminated and cut-up to be used as traditional Flash Cards, they have now been incorporated into an App which could be the cheaper option! (At the time of writing the App is under Apple Review prior to being published so link leads to the Preview version on my website)

However, for those wishing to print-out, here is my advice on how to do it successfully. Margins are 5mm which should be no problem for most printers these days.

Assuming you can open the pdf file in Acrobat:

Initial settings should be:
1. pages 2-19
2. odd (or even only)
3. actual size
4. portrait

Page is A4 (210 x 297 mm) but all printers have slightly different default margins so you need to set up your own version of an A4 page using the Custom Settings found under 5 ‘Page Setup’.

select A4 as usual but open choices and select ‘Manage Custom Sizes at bottom.

Finally, select your new custom size.

put in correct values then
Question: Which molecule is non-polar?

Question: Which molecule is most polar?

Question: Which type of Van der Waals force would exist here?

Question: Which form of carbon is shown here?

Question: Which substance is shown here?

Question: Why does this have such a high Melting Point?

Question: What type of bond is broken when this melts?

Question: What Bonding Structure is shown here?

Question: What type of Van der Walls force is shown here?

Question: What two types of bond are shown here?

Question: What two types of bond are present here?

Question: What type of Van der Walls force is shown here?

Question: Which type of bonding is broken when pentane boils?

Question: Explain the BPt difference.
CCl₄ is NON-POLAR so it has only LONDON DISPERSION forces between molecules.

there is a limit to how much charge can be drawn away and CH₃Cl has the advantage of it all being concentrated in the single Cl atom - bigger dipole

though it has 4 polar covalent bonds the dipoles all cancel out - the charge is arranged SYMMETRICALLY

CCl₄ is NON-POLAR so it has only LONDON DISPERSION forces between molecules.

Many strong covalent bonds would have to be broken.

Many strong covalent bonds would have to be broken.

Pentane’s chain allows MORE LDF’s between molecules.

or 2,2-dimethylpropane is more compact so LESS LDF’s between molecules

Pentane’s chain allows MORE LDF’s between molecules.

LONDON DISPERSION FORCES

HYDROGEN BONDING

(L)POLAR COVALENT & HYDROGEN BONDS

HYDROGEN BONDING

HYDROGEN BONDING

COVALENT BONDS

COVALENT BONDS

COVALENT BONDS

HYDROGEN BONDING

HYDROGEN BONDING

HYDROGEN BONDING

COVALENT & LDF

COVALENT & LDF

COVALENT & LDF

LONDON DISPERSION FORCES
Question Which molecule has the stronger Van der Waals forces?

Question Describe how attractions occur between non-polar bromine molecules.

Question What type of Van der Waals forces exist between bromine molecules?

Question Are bromine molecules polar or non-polar?

Question What type of Van der Waals forces between Butanes?

Question What type of Van der Waals forces between Acetones?

Question Why are Butane & Acetone so suitable for comparing?

Question This is a polar molecule. What charge will be on the Lithium atom?

Question Hydrogen cyanide is a very polar molecule. Which atom has the highest EN value?

Question Chloroethene is a polar molecule. Which atom(s) will be δ+?

Question Chloroethene is a polar molecule. Which atom(s) will be δ-?

Question Lithium is a metal. Why is this NOT an ionic compound?

Question Hydrogen cyanide is a very polar molecule. Which atom will be δ-?

Question Hydrogen cyanide is a very polar molecule. Which atom will be δ+?

Question Does CO₂ have PURE covalent or POLAR covalent bonds?

Question Is CO₂ a POLAR or a NON-POLAR molecule?
ACETONE as the higher BPt shows London dispersion forces.

LONDON DISPERSION FORCES

A temporary dipole in one molecule induces a dipole in the other.

POLAR-POLAR or DIPOLE-DIPOLE

Same number of electrons so equal strength LDF's.

LONDON DISPERSION FORCES

Both bromine atoms have equal attraction for the shared electrons so NON-POLAR.

Lithium has a lower electronegativity so will be POSITIVE or \( \delta^+ \).

The chlorine has the highest EN value so will pull electrons away from the hydrogen.

Small difference in Electronegativity so electrons shared.

The chlorine has the highest EN value so will pull electrons away from the hydrogen.

The chlorine has the highest EN value so will pull electrons away from the hydrogen.

NITROGEN has the highest EN value.

NITROGEN has the highest EN value.

Oxygen has a large enough EN value to make the bond POLAR Covalent.

As the N draws electrons from the C the HYDROGEN will become \( \delta^+ \).

The chlorine has the highest EN value so will pull electrons away from the hydrogen.

NITROGEN has the highest EN value and so will become \( \delta^- \).

The SYMMETRY of the charge means no overall dipole so NON-POLAR.
Answer

As they do not readily form bonds - do not attract SHARED electrons.

Extra shell (screening) results in less attraction for SHARED electrons.

Increase in protons (nuclear charge) so more attraction for SHARED electrons.

Measures the attraction an atom has for SHARED electrons in a bond.

Answer

F — I would have the biggest EN difference and would be the most POLAR.

Be has the same EN value as Al so is most likely to form a covalent chloride.

P and H have same EN so PH₃ or N and Cl have same EN so NCl₃

Answer

CO₂ is non-polar so only weak LDF's acting between molecules.

Syrup molecules must have stronger VDW forces than water.

Hydrogen bonds will need to be broken.

Hydrogen bonds will need to be broken.

Answer

The SYMMETRY of the charge means no overall dipole so NON-POLAR.

Chlorine has a large enough EN value to make the bonds POLAR COVALENT.

Polar Molecule. Chlorine has a high enough EN value to pull from rest of molecule.
Question
Explain how a dipole can arise in a Helium atom.

Question
What name is given to this type of dipole?

Question
What effect can the dipole on the second He atom have on the first?

Question
What type of Van der Waals force can be set up between He atoms?

Question
Which 3 types of Van der Waals forces are shown here?

Question
Which molecule will have the strongest VDW forces?

Question
Why does HF have a higher Melting Point than HCl?

Question
Why does H2 have the lowest Melting Point?

Question
What type of Van der Waals forces exist here?

Question
Why do pentane and water not mix?

Question
What type of Van der Waals forces exist here?

Question
What type of Van der Waals forces exist here?

Question
Why should ammonia (NH3) and methane (CH4) have similar London Dispersion Forces?

Question
Why does ammonia (NH3) have a much higher MP than methane (CH4)?

Question
Will methanol be likely to dissolve in water?

Question
Will methanal be likely to dissolve in water?
Answer

LONDON DISPERSION FORCES

It can cause (INDUCE) another temporary dipole

TEMPORARY DIPOLE

Uneven distribution of the negative charge in the electron cloud

Answer

H₂  HCl  HF

H₂ only has weak LDF's

HF has extra strong HYDROGEN BONDING

HF has extra strong HYDROGEN BONDING

Answer

H₂  HCl  HF

London Dispersion

Polar — Polar

Hydrogen Bonding

Answer

H₂  HCl  HF

This is HYDROGEN BONDING as there is a H atom between two O atoms.

‘Only’ dipole-dipole as the H atom isn’t bonded to O atom.

Too big a difference between the 2 types of VDW forces.

Answer

Ammonia can do HYDROGEN BONDING but methane only has London Dispersion.

Similar sizes, shapes and both have same number of electrons.

SOLUBLE as both molecules do HYDROGEN BONDING.

SOLUBLE as H BONDING can be set up between the two molecules.

Hydrogen bonding as the H atom is between 2 O atoms.
**Question**

All of these have polar covalent bonds but which ones are POLAR MOLECULES?

**Question**

What type of Van der Waals force can be set up between these atoms?

**Question**

To see effect of polarity on MPt, which molecule should this be compared with?

**Question**

What type of Van der Waals force can be set up between these atoms?

**Question**

What type of Van der Waals forces exist here?

**Question**

What type of Van der Waals forces exist between alkane molecules?

**Question**

Which of these is likely to be the more viscous?

**Question**

Describe how a London Dispersion Force can arise between these two molecules.

**Question**

Describe how a London Dispersion Force can arise between these two atoms.

**Question**

What VDW forces explain the trend for Group 14?

**Question**

What VDW forces explain the BPTs of H₂O, HF and NH₃?
As you go down the Noble Gas Group an extra Electron Shell is being added.

As shells increase (more screening) the size of a temporary dipole increases.

To be polar, there must be an OVERALL MOLECULAR DIPOLE.

LONDON DISPERSION FORCES (Temporary Dipoles)

O atom has high enough EN value to make bond polar and shape makes molecule polar.

O atom could do hydrogen bonding with water so may be slightly soluble in water.

As the chain length increases, the NUMBER of LDF's set up will increase.

H₂O, HF and NH₃ can all do Hydrogen Bonding so a lot more energy required to move apart.

Ethylene glycol as it has more hydroxyl groups so more hydrogen bonding.

H₂O, HF and NH₃ can all do Hydrogen Bonding so a lot more energy required to move apart.

As the chain length increases, the NUMBER of LDF's set up will increase.

H₂O, HF and NH₃ can all do Hydrogen Bonding so a lot more energy required to move apart.

As the chain length increases, the NUMBER of LDF's set up will increase.
Question: Which form of Carbon is shown here?

Question: What type of Bonding Structure is shown here?

Question: What two types of Bonding are found in this structure?

Question: Which type of bond explains the high Melting Point?

Question: Why is this such a good conductor?

Question: What type of Bonding Structures are shown here?

Question: Why are they all good conductors?

Question: Why are K atoms bigger than Na Atoms?

Question: Why are Ca atoms smaller than K Atoms?

Question: Why does the M Pt increase Na → Al?

Question: What type of Bonding Structures are shown here?

Question: What two types of Bonding are found in these structures?

Question: Why are the Melting Points so high?

Question: Why is the M Pt for C higher than Si?
COVALENT Bonds in the layers and LONDON DISPERSION forces between.

This is GRAPHITE.

Many strong COVALENT Bonds have to break.

COVALENT NETWORK

Metals have DELOCALISED electrons that can move freely when voltage applied.

Weaker LDF's allow the layers to slide easily.

Carbon only uses 3 of 4 electrons to bond so layers have DELOCALISED electrons that can move freely when voltage applied.

Carbon & London Dispersion

Covalent & London Dispersion

C is smaller and shared electrons are closer (less screening).

Many strong covalent bonds have to be broken.

METALLIC LATTICE (NETWORK)

K has an extra electron shell

Metallic bonds get stronger

Delocalised electrons increase from 1 to 3, nuclear charge increases so metallic bonds get stronger

Same number of shells but Ca has greater nuclear charge so shell pulled closer

COVALENT NETWORKS

Covalent & London Dispersion

COVALENT MOLECULAR

COVALENT BOND

Electrons do not move freely when voltage applied.

K has an extra electron shell

METALLIC LATTICE (NETWORK)

K has an extra electron shell

DELOCALISED electrons increase from 1 to 3, nuclear charge increases so metallic bonds get stronger

K has an extra electron shell
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Why does S have a higher Mpt than P?</td>
<td>Why does Cl₂ have a higher Mpt than F₂?</td>
<td>What type of Bonding Structure is shown here?</td>
<td>What type of Van der Waals forces exist here?</td>
</tr>
<tr>
<td><img src="image1" alt="Molecular Structure" /></td>
<td><img src="image2" alt="Molecular Structure" /></td>
<td><img src="image3" alt="Molecular Structure" /></td>
<td><img src="image4" alt="Molecular Structure" /></td>
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<td>DESCRIBE the trend in atomic size across a period.</td>
<td>EXPLAIN the trend in atomic size across a period.</td>
</tr>
<tr>
<td><img src="image5" alt="Periodic Table" /></td>
<td><img src="image6" alt="Periodic Table" /></td>
<td><img src="image7" alt="Periodic Table" /></td>
<td><img src="image8" alt="Periodic Table" /></td>
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<td><img src="image9" alt="Periodic Table" /></td>
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<td><img src="image16" alt="Periodic Table" /></td>
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</table>
MORE atoms means MORE LDF’s

LARGER atoms MORE electrons STRONGER LDF’s

MORE atoms means MORE LDF’s

The atomic size increases as you go down a group.

Ionisation Energy decreases as you go down a group.

The electronegativity decreases as you go down a group.

The atomic size decreases as you go across a period.

Ionisation Energy increases as you go across a period.

The electronegativity increases as you go across a period.

Increasing NUCLEAR CHARGE pulls the electrons in (same) shell closer & closer.

Increasing NUCLEAR CHARGE makes it harder to remove an electron.

Increasing NUCLEAR CHARGE results in increased attraction for shared electrons.

Increasing ELECTRON SHELLS will increase the size of the atom

The atomic size decreases as you go across a period.

Increasing ELECTRON SHELLS will increase the size of the atom

The atomic size increases as you go down a group.

The electronegativity increases as you go across a period.

Ionisation Energy increases as you go across a period.

The electronegativity increases as you go across a period.

More shells (more screening) so easier to remove an electron.

More shells (more screening) so weaker attraction for shared electrons.

The atomic size increases as you go down a group.

The electronegativity decreases as you go down a group.
Question
Which type of bonding is never found in elements?
A Metallic
B London dispersion forces
C Polar covalent
D Non-polar covalent

Question
Which of the following is not an example of a Van der Waals’ force?
A Covalent bonding
B London dispersion forces
C Hydrogen bonding
D Permanent dipole-permanent dipole interactions

Question
Common salt, NaCl, is widely used in the food industry as a preservative and flavour enhancer.
What is the ion-electron equation for the first ionisation energy of sodium?

Question
Explain clearly why the first ionisation energy of sodium is much lower than its second ionisation energy.
1st: 496 kJ mol⁻¹
2nd: 4562 kJ mol⁻¹

Question
Each molecule below contains at least one polar bond. Which molecule is non-polar?
A CO₂
B H₂O
C HCl
D CHCl₃

Question
Sodium is the first element in the third period of the periodic table. Which of the following elements would have the strongest London dispersion forces?
A Ar gon
B Chlorine
C Nitrogen
D Oxygen

Question
What information about four elements from the third period of the Periodic Table is needed to complete the table?
Answer
Must be 1 mole: Na
Must be free atoms: Na\(_{\infty}\)
Must remove one electron from each atom:
\[ \text{Na} \rightarrow \text{Na} + e^- \]

Answer
In which of the following molecules will the Cl atom carry a partial positive charge (δ+)?
A. Covalent bonding
B. Cl\(_6^-\) — F\(_8^-\)
Only F has a higher EN value and will be able to attract shared electrons more strongly than Cl.

Answer
Which of the following is not an example of a Van der Waals’ force?
A. Covalent bonding
Van der Waal forces exist between atoms or molecules, whereas Covalent Bonding is within the molecule.

Answer
Explain that ionisation energy is removal of an electron.
1st ionisation removes electron from 3rd shell and 2nd is removal of electron from an inner shell.
Inner electrons less well shielded from (closer to) nuclear attraction.

Answer
For elements in Group 7 of the Periodic Table, which of the following statements is true as the group is descended?
C. EN value decreases.
An extra shell is added so electrons are more screened (further away) from nuclear charge.

Answer
Which of the following elements has the greatest attraction for bonding electrons?
B. Chlorine
The attraction is given by the Electronegativity value in the Data Book. Cl has the highest value (3.0).

Answer
Which type of bonding is never found in elements?
C. Polar covalent
To be a Polar bond two different atoms have to be sharing electrons and an element can only have one type of atom.

Answer
For elements in Group 7 of the Periodic Table, which of the following statements is true as the group is descended?
C. EN value decreases.
An extra shell is added so electrons are more screened (further away) from nuclear charge.

Answer
Which of the following statements is true?
C. Na atom is larger than the Na ion.
Na atom (2,8,1) has 3 shells whereas the Na\(^+\) ion (2,8) has only 2 shells and will be much smaller.

Answer
Al is 2,8,3 to begin with.
Fourth electron being removed is from an inner electron shell
OR
shell closer to the nucleus (and therefore requires more energy to remove)

Answer
Electronegativity values increase across the period.

Answer
Which of the following statements is true?
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Answer
The attraction is given by the Electronegativity value in the Data Book. Cl has the highest value (3.0).

Answer
Smallest difference = least ionic
Large increase (after 3 electrons) means there were 3 electrons in outer shell so Group 3.
Question
Which of the following does not contain covalent bonds?
A Hydrogen gas
B Helium gas
C Nitrogen gas
D Solid Sulphur

Question
Which of the following elements exists as discrete molecules?
A Boron
B Carbon (Diamond)
C Silicon
D Sulfur

Molecule ① is 10 x more soluble in water than ②
Explain clearly, in terms of VDW forces, why this is the case.

Question
In which solid will only London dispersion forces be broken when the substance melts?

<table>
<thead>
<tr>
<th>Melting Point / °C</th>
<th>Conductivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 714</td>
<td>non-conductor</td>
</tr>
<tr>
<td>B 98</td>
<td>conductor</td>
</tr>
<tr>
<td>C 660</td>
<td>conductor</td>
</tr>
<tr>
<td>D 44</td>
<td>non-conductor</td>
</tr>
</tbody>
</table>

Question
Atoms of nitrogen and element X form a bond in which the electrons are shared equally. Element X could be
A carbon
B oxygen
C chlorine
D phosphorus

Lithium to neon make up the second period of the periodic table.
Li Be B C N O F Ne
Name an element in the second period that has a covalent network structure.

Question
Complete this table

<table>
<thead>
<tr>
<th>Bonding Structure</th>
<th>Name of Element</th>
</tr>
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<tbody>
<tr>
<td>metallic solid</td>
<td>Sodium</td>
</tr>
<tr>
<td>monatomic gas</td>
<td></td>
</tr>
<tr>
<td>covalent network solid</td>
<td></td>
</tr>
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Question
Which of the following chlorides is likely to have most ionic character?
A BeCl₂
B CaCl₂
C LiCl
D CsCl

The structure found in Diamond is
A an ionic lattice
B a covalent network
C covalent molecules linked by LDF’s
D covalent sheets with only LDF’s between

Question
On descending Group 1 from Li to Cs, the electronegativity decreases.
Explain clearly why the electronegativity decreases as you go down the Group
Which of the following does not contain covalent bonds?
A. Hydrogen gas
B. Helium gas
C. Nitrogen gas
D. Solid Sulphur

Which of the following elements exists as discrete molecules?
D. Sulfur, $S_8$

To share electrons equally $X$ must have a very similar EN value to Nitrogen (3.0).
A. carbon (2.5)
B. oxygen (3.5)
C. chlorine (3.0)
D. phosphorus (2.2)

Diamond has a covalent network structure

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<td>sodium</td>
</tr>
<tr>
<td>monatomic gas</td>
<td>any noble gas</td>
</tr>
<tr>
<td>covalent network solid</td>
<td>$B$, $C$ (graphite), or $C$ (diamond)</td>
</tr>
<tr>
<td>covalent molecular gas</td>
<td>$H_2$, $F_2$, $Cl_2$, $N_2$, or $O_2$</td>
</tr>
<tr>
<td>covalent molecular solid</td>
<td>sulphur ($S$) or phosphorus ($P$)</td>
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Only first 20 elements considered.
Since Aug 12th 2015, there is an iOS App for iPhone, iPad and iPod touch available on the App Store under the name ChemFlashCards.