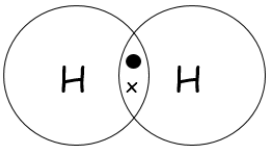
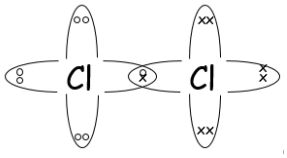
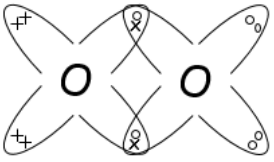
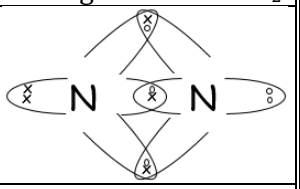
National 5 Chemistry
Unit 1.2b Covalent Bonding

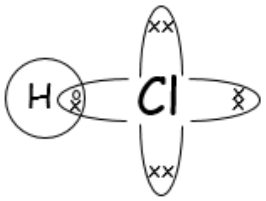
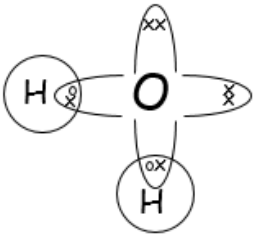
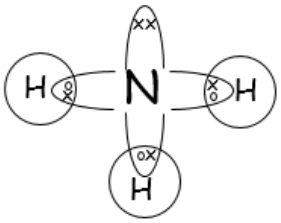
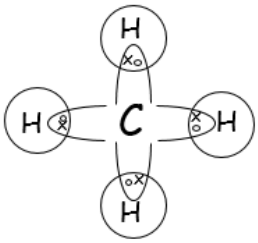
JAB chem

JAB chem

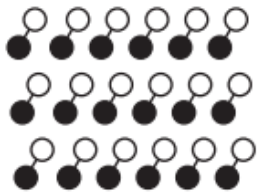
		Lesson	Traffic Light Red	Amber	Green
17 18	A covalent bond forms when two positive nuclei are held together by their common attraction for a shared pair of electrons. • Covalent bonds form between non-metal atoms.		☹	😐	☺
19 22	Outer electrons can be shared to form the covalent bond(s) in a molecule. • More than one bond can be formed between atoms leading to double & triple covalent bonds.		☹	😐	☺

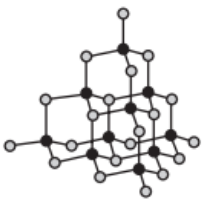
Hydrogen molecule H_2	Hydrogen molecule Cl_2	Oxygen molecule O_2	Nitrogen molecule N_2
			
$H-H$	$Cl-Cl$	$O=O$	$N\equiv N$

20	7 elements exist as diatomic molecules through the formation of covalent bonds: Diatomic Elements: H_2 N_2 O_2 F_2 Cl_2 Br_2 I_2		☹	😐	☺
21	The shape of simple covalent molecules depends on the number of bonds and the orientation of these bonds around the central atom. • The shape of molecules can be described as linear, angular, trigonal pyramidal or tetrahedral.		☹	😐	☺

Hydrogen chloride	Water	Ammonia	Methane
HCl	H_2O	NH_3	CH_4
			
linear	angular	trigonal pyramidal	tetrahedral

23	Covalent substances can form either discrete molecular or giant network structures		☹	😐	☺
24	Covalent molecular substances: • have strong covalent bonds within the molecules and only weak attractions between the molecules • have low melting and boiling points as only weak forces of attraction between the molecules are broken when a substance changes state • do not conduct electricity because they do not have charged particles which are free to move		☹	😐	☺
25	Covalent molecular substances which are insoluble in water may dissolve in other solvents.		☹	😐	☺
26	Covalent network structures: • have a network of strong covalent bonds within one giant structure • have very high melting and boiling points because the network of strong covalent bonds is not easily broken • do not dissolve		☹	😐	☺
27	In general, covalent network substances do not conduct electricity. This is because they do not have charged particles which are free to move.		☹	😐	☺

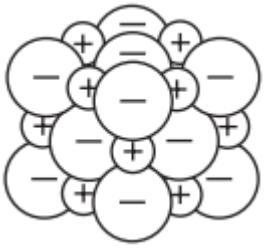




National 5 Chemistry
Unit 1.2c Ionic Bonding

JAB chem

JAB chem

		Lesson	Traffic Light		
			Red	Amber	Green
28	Ions are formed when atoms lose or gain electrons to obtain the stable electron arrangement of a noble gas.		☹	😐	☺
29 30	In general: Metal atoms lose electrons to form positive ions $Na \longrightarrow Na^+ + e^-$ 2,8,1 2,8 Non-metal atoms gain electrons to form negative ions $Cl + e^- \longrightarrow Cl^-$ 2,8,7 2,8,8		☹	😐	☺
31	Ionic bonds are the electrostatic attraction between positive and negative ions.		☹	😐	☺
32	 Ionic compounds form lattice structures of oppositely charged ions with each positive ion surrounded by negative ions and each negative ion surrounded by positive ions.		☹	😐	☺
33	Ionic compounds have high melting and boiling points because strong ionic bonds must be broken in order to break up the lattice.		☹	😐	☺
34	Many ionic compounds are soluble in water. As they dissolve the lattice structure breaks up allowing water molecules to surround the separated ions.		☹	😐	☺
35	Ionic compounds conduct electricity only when molten or in solution as the lattice structure breaks up allowing the ions to be free to move.		☹	😐	☺
36	Conduction in ionic compounds can be explained by the movement of ions towards oppositely charged electrodes.		☹	😐	☺
-					

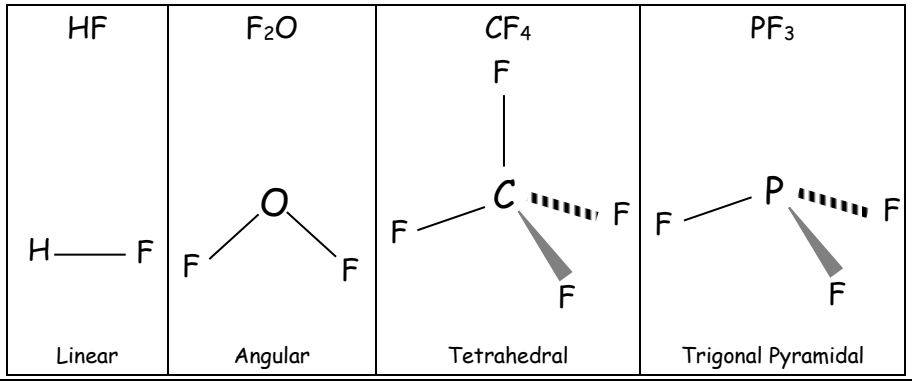
Type of Bonding	Conduction as a Solid	Conduction as a Liquid	Conduction as a Solution
Metallic (Metals only)	✓	✓	metals do <u>not</u> dissolve in water
Covalent (Non-metals only)	×	×	×
Ionic (Metals + Non-metals)	×	✓	✓

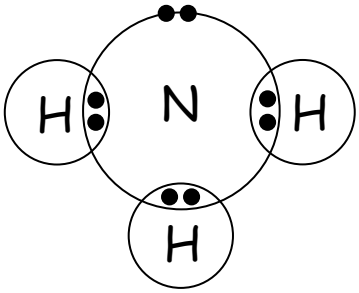
Nat5
Traffic Lights

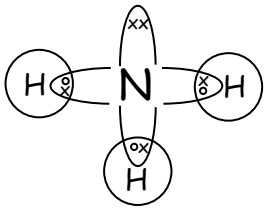
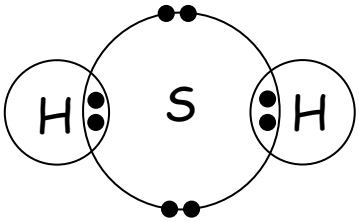
Past Paper Question Bank
Unit 1.2b Covalent Bonding

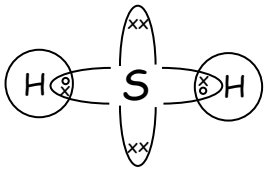
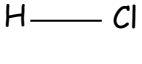
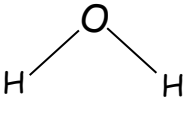
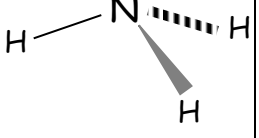
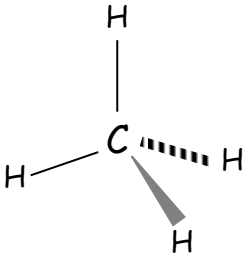
JABchem

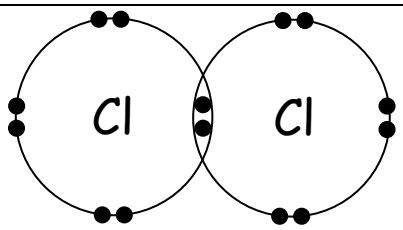
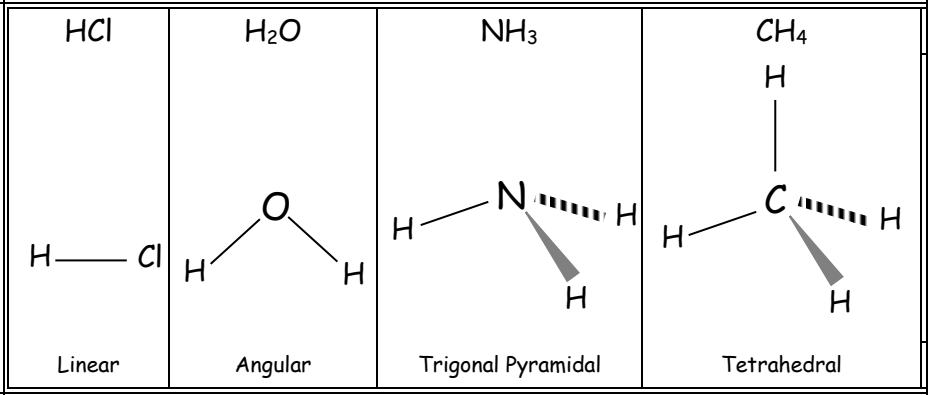
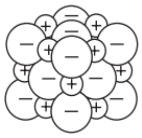
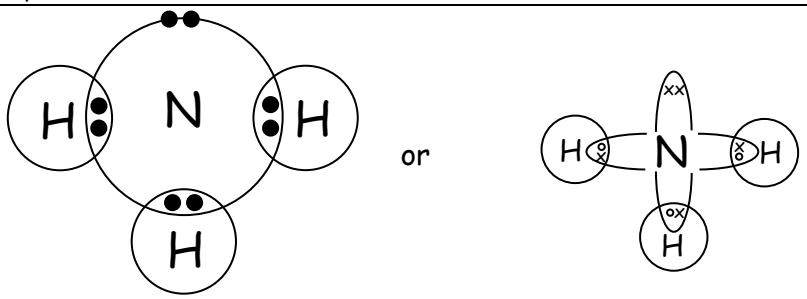
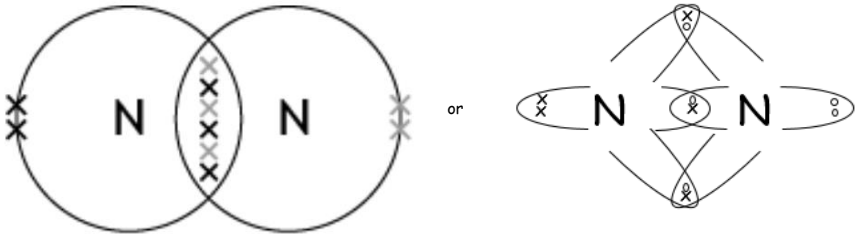
Outcome	Original Specimen Paper	New Specimen Paper	Nat5 2014	Nat5 2015	Nat5 2016	Nat5 2017	Nat5 2018	Nat5 2019								
17 18					mc5											
19 22						L3a		L3a								
20		mc1					mc3									
21	mc4 L7b(i)	mc4 L7b(i)	L7a(ii)	L4a	L1c(i)	L3b	mc4 L10b	mc6								
23																
24	L7b(ii)	L7b(ii)		mc5 L14a(ii)	L11c		L4c									
25																
26	mc1						mc6									
27																
28																
29 30				L11a			mc5	mc7								
31																
32							L7a									
33					mc5											
34																
35	mc3	mc3		L9b(ii)			L7b(i)									
36																
-			L2a		mc6	L3d	mc6	mc8								
Marking Scheme	Back of Paper	Back of Paper	SQA Nat5 2014 Msch	SQA Nat5 2015 Msch	SQA Nat5 2016 Msch	SQA Nat5 2017 Msch	SQA Nat5 2018 Msch	SQA Nat5 2019 Msch								

Nat5	Answer	% Correct	Reasoning
2015 5	D	78	☒A this structure shows metallic bonding ☒B this structure shows ionic bonding ☒C this structure shoes molecular covalent bonding ☑D this structure shows covalent network bonding
2016 5	B	78	☒A ionic compounds contain at least one metal and one non-metal in compound ☑B monatomic substances are single atoms with no bonds between them ☒C covalent network compounds e.g. SiO_2 are compounds with many covalent bonds ☒D covalent molecular compounds e.g. H_2O are compounds with covalent bonds inside
2018 3	B	-	☒A Oxygen exists a diatomic O_2 molecules ☑B Helium is a monatomic noble gas in group 0 ☒C Bromine exists as diatomic Br_2 molecules ☒D Hydrogen exists as diatomic H_2 molecules
2018 4	D	-	Hydrogen bromide has the formula HBr using the cross-over rule. The correct structure for this can only be linear.
2018 5	A	-	☑A Na atoms have electron arrangement 2,8,1 ∴ Na^+ ions have arrangement 2,8 ☒B Mg atoms have electron arrangement 2,8,2 ∴ Mg^+ ions have arrangement 2,8,1 ☒C F atoms have electron arrangement 2,7 ∴ F^+ ions have arrangement 2,6 ☒D Ne atoms have electron arrangement 2,8 ∴ Na^+ ions have arrangement 2,7
2018 6	D	-	☒A Bonding type is covalent molecular as it does not conduct and has low mpt/bpt ☒B Bonding type is ionic as is does not conduct as solid but does conduct as liquid ☒C Bonding type is metallic as it conducts both as a solid and a liquid ☑D Bonding type is covalent network as it does no conduct and has very high mpt
2019 6	D	-	
2019 7	A	-	☑A Na^+ electron arrangement is 2,8 and O^{2-} electron arrangement is 2,8 ☒B Li^+ electron arrangement is 2 and F^- electron arrangement is 2,8 ☒C K^+ electron arrangement is 2,8,8 and Br^- electron arrangement is 2,8,18,8 ☒D Mg^{2+} electron arrangement is 2,8 and Cl^- electron arrangement is 2,8,8
2019 8	B	-	☒A ionic copper sulphate in the solid state is a non-conductor ☑B ionic compounds will conduct is both the molten/liquid state and in solution ☒C ionic potassium nitrate in the solid state is a non-conductor ☒D hexane C_6H_{14} is a hydrocarbon and is covalent molecular and is a non-conductor

<table>
<tr><th>Nat5</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>2014
2a</td><td>Covalent Network
Ionic Lattice
Metallic Lattice
Discrete Covalent Molecular</td><td>
<table>
<tr><th>Bonding Type</th><th>Features of Bonding Type</th></tr>
<tr><td>Covalent Network</td><td>Substances with covalent bonding do not conduct electricity in any state.
Covalent networks have very high melting points as covalent bonds in network must be broken before melting can take place</td></tr>
<tr><td>Ionic Lattice</td><td>Ionic compounds are all solids at room temperature with high mpt.
Ionic compounds do not conduct as solids as ions are not free to move but conduct electricity when molten or in solution as the ions become free to move.</td></tr>
<tr><td>Metallic Lattice</td><td>All metallic substances conduct as solids or liquids.
Metals have a range of melting point ranging from low to high
e.g. mercury mpt = -39°C and iron mpt=1538°C</td></tr>
<tr><td>Discrete Covalent Molecular</td><td>Substances with covalent bonding do not conduct electricity in any state.
As there are weak bonds between molecules, melting and boiling points are low as there are no strong bonds to be broken between molecules.</td></tr>
</table>
</td></tr>
<tr><td>2014
7a(ii)</td><td>Diagram showing:</td><td> 

or

</td></tr>
<tr><td>2015
4a</td><td>Diagram showing:</td><td> 

or

</td></tr>
<tr><td>2015
9b(ii)</td><td>Ions
free/able to move</td><td>Solid ionic compounds are unable to conduct as the ions are locked tightly in an ionic lattice. On melting or dissolving in water, ions become free to move and will conduct.</td></tr>
<tr><td>2015
11a</td><td>2,8,6</td><td>$Cl_{(g)} \longrightarrow Cl^+_{(g)} + e^-$
2,8,7 2,8,6</td></tr>
<tr><td>2015
14a(ii)</td><td>Covalent</td><td>As titanium (IV) chloride is a compound of a metal and non-metal, your first assumption would be that it contains ionic bonding. However, ionic compounds are always solids at room temperature with high melting points and conduct electricity when in the liquid/molten state.
Titanium (IV) chloride contains covalent bonding as it is a liquid at room temperature and does not conduct electricity in the liquid state. Metallic bonding can be ruled out as it does not conduct electricity in the liquid state.</td></tr>
<tr><td>2016
1c(i)</td><td>Trigonal pyramidal</td><td>
<table>
<tr><td>HCl</td><td>H_2O</td><td>NH_3</td><td>CH_4</td></tr>
<tr><td> 
</td><td> 
</td><td> 
</td><td> 
</td></tr>
<tr><td>Linear</td><td>Bent</td><td>Trigonal Pyramidal</td><td>tetrahedral</td></tr>
</table>
</td></tr>
</table>

2016 11c	weak strong	The bonds *inside* molecules are strong covalent bonds which required much energy to break them. The bonds *between* molecules are weak bonds which are easier to overcome and break.
2017 3a	Diagram showing:	
2017 3b	tetrahedral	
2017 3d	low no high no	Chloromethane CH_3Cl is covalent molecular because it contains non-metals in the compound and is a gas at room temperature indicating a low melting point. Covalent substances do not conduct in any state. Sodium chloride is ionic because it is a compound of a metals and non-metal. Ionic compounds are all have high melting points and do no conduct in the solid state.
2018 4c	stronger intermolecular	The process of evaporation/boiling does not change the strong covalent bonds inside a molecule. Boiling/evaporation is dependent on the weaker intermolecular bonds between molecules. The higher boiling point of butane compared to isobutene is due to the stronger intermolecular bonds between butane molecules compared to isobutene molecules.
2018 7a	Lattice	Ionic compounds have a structure of alternating positive and negative ions in each direction. This structure is called a lattice structure. 
2018 7b(i)	Ions are free to move	In the solid state, ions are locked together in a lattice structure and cannot move. The circuit cannot be completed without the movement of ions. In the liquid/molten state or the solution state, ions are free to move and will compete the circuit.
2018 10b	Answer showing:	
2019 3a	One diagram from:	

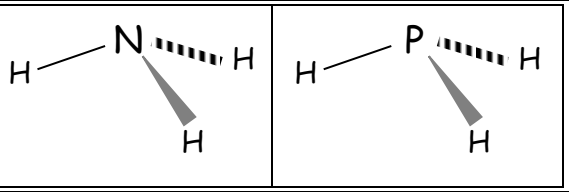
Nat5
Traffic Lights

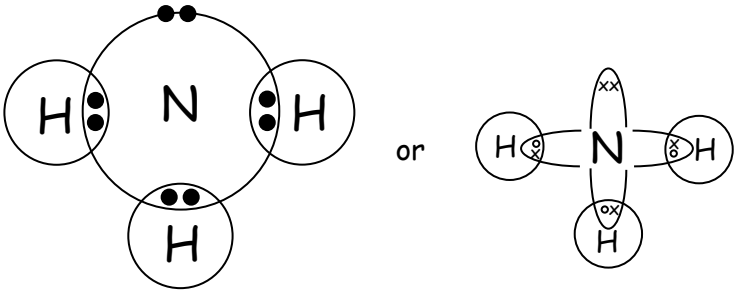
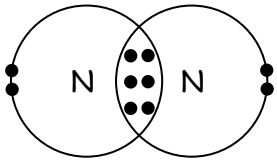
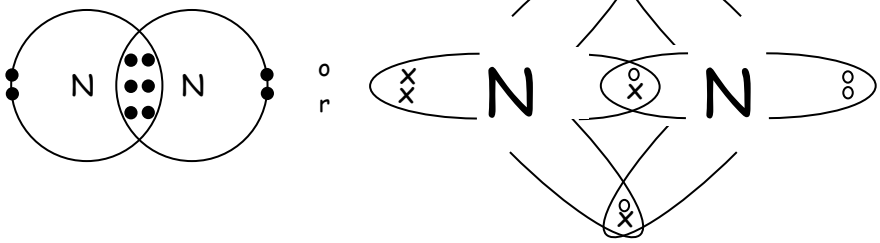
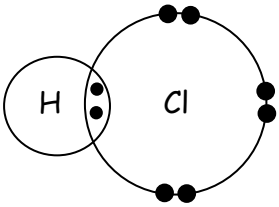
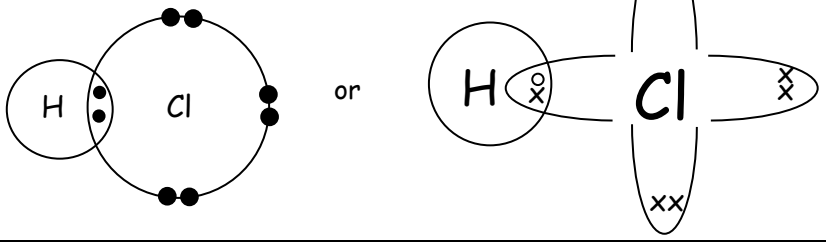
Past Paper Question Bank
Unit 1.2b Covalent Bonding

JABchem

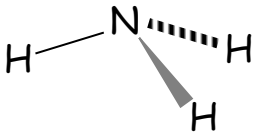
Outcome	Int2 2000	Int2 2001	Int2 2002	Int2 2003	Int2 2004	Int2 2005	Int2 2006	Int2 2007	Int2 2008	Int2 2009	Int2 2010	Int2 2011	Int2 2012	Int2 2013	Int2 2014	Int2 2015
17 18							L2a									
19 22			L4b													L3b
20			mc20								mc5					
21	L4c				L4a		L2b		L5a		L3b(i) L3b(ii)	L2a L2b	mc9	mc6	L4a	L2a
23																
24					L13a			L13a(ii)							L4b	L2b(i) L5a
25																
26			L2b(ii)					mc6			L3a		L1a	L6b		
27			L2b(i)													
28				L12b												
29 30				mc6												
31																
32										mc9						
33																
34																
35													mc10			
36																
-						mc7	mc6		mc10			L1a	mc7		mc7	
Marking Scheme	Not Published	Not Published	Not Published	SQA Int2 2003 MSch	SQA Int2 2004 MSch	SQA Int2 2005 MSch	SQA Int2 2006 MSch	SQA Int2 2007 MSch	SQA Int2 2008 MSch	SQA Int2 2009 MSch	SQA Int2 2010 MSch	SQA Int2 2011 MSch	SQA Int2 2012 MSch	SQA Int2 2013 MSch	SQA Int2 2014 MSch	SQA Int2 2015 MSch

Int2	Answer	% Correct	Reasoning
2002 20	A	75	Type / pH / Ions in Solution: Acid: pH<7, Concentration of H^+ > Concentration of OH^-; Neutral e.g. pure water: pH=7, Concentration of H^+ = Concentration of OH^-; Alkali: pH>7, Concentration of OH^- > Concentration of H^+
2003 6	D	33	Compound formula: X_2O_3 ∴ Valency of X must be 3 forming X^{3+} ion Equation: $X \longrightarrow X^{3+} + 3e^-$ (X loses 3 electrons)
2005 7	A	59	☑A Ionic compounds conduct as liquids but not as solids & have high melting points ☒B Metallic substances conduct as both solids and liquids ☒C Covalent networks do not conduct in any state and have high melting points ☒D Covalent molecular do not conduct in any state and have low melting points

2006 6	A	73	☑A Lead is a metal and fluorine is a non-metal ∴ ionic bonding in compound ☒B sulphur and oxygen are both non-metals ∴ covalent bonding in compound ☒C carbon and nitrogen are both non-metals ∴ covalent bonding in compound ☒D phosphorus and chlorine are both non-metals ∴ covalent bonding in compound
2007 6	A	79	☑A Covalent Network substances have covalent bonds in a large network of atoms ☒B Substance is ionic due to presence of positive and negative ions ☒C Substance contains covalent molecules. Not big enough to be covalent network ☒D Substance is metallic with electrons able to jump from atom to atom
2008 10	C	72	☒A Metallic substance: conducts when solid and liquid ☒B Covalent substance: does not conduct when solid or liquid ☑C Ionic Substance: Does not conduct when solid but conducts when liquid ☒D Covalent Network: high melting point and does not conduct when solid or liquid
2009 9	B	48	☒A diagram shows a covalent network (sodium chloride is ionic) ☑B diagram shows a ionic lattice and sodium chloride is ionic ☒C diagram shows a covalent molecules (sodium chloride is ionic) ☒D diagram shows a metallic substance (sodium chloride is ionic)
2010 5	C	73	☒A Carbon (diamond) is a covalent network with large tetrahedral structure ☒B Helium is a Noble gas and comes in single atoms (monatomic) ☑C Nitrogen has a C≡C triple bond within the N_2 molecule ☒D Sulphur has an S_8 ring structure
2012 7	A	78	☑A Lead (metal) and fluorine (non-metal) forms an ionic compound ☒B Sulphur (non-metal) and oxygen (non-metal) forms a covalent compound ☒C Carbon (non-metal) and nitrogen (non-metal) forms a covalent compound ☒D Phosphorus (non-metal) and chlorine (non-metal) forms a covalent compound
2012 9	B	63	Phosphorus and nitrogen are both in group 5 and NH_3 and PH_3 both have a trigonal pyramidal shape (Trigonal pyramidal was previous called pyramidal) 
2012 10	A	55	☑A ions are locked together in a solid lattice so no conduction of electricity ☒B ions move through ionic compounds as it conducts, not electrons ☒C solid metals conduct electricity ☒D ionic compounds always have positive and negative ions inside them
2013 6	A	77	Group 0 elements have a full outer shell and are stable. Elements in other groups can share electrons in covalent bonds to achieve a full outer shell.
2014 7	B	47	☒A Covalent Molecular: does not conduct as solid or liquid and has low bpt ☑B Covalent Network: does not conduct as solid or liquid and has high mpt ☒C Ionic: Does not conduct as solid but does conduct as a liquid ☒D Metallic: Conducts as both as solid and a liquid

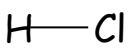
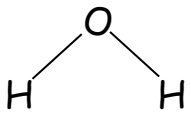
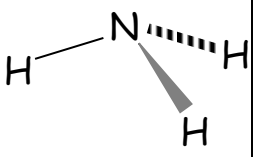
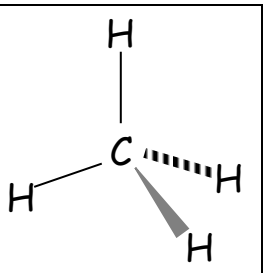
<table>
<tr><th>Int2</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>2000
4c</td><td>Diagram showing:</td><td> 
</td></tr>
<tr><td>2002
2b(i)</td><td>Covalent bonding
or electrons not free to move in silica</td><td>Silica is made of silicon and oxygen bonded together with formula SiO_2.
• Compounds containing only non-metals have covalent bonding
• Covalent compounds to not conduct electricity in any state
<table>
<tr><th>Bonding</th><th>Solid</th><th>Liquid</th><th>Solution</th></tr>
<tr><td>Metallic
(metals only)</td><td>✓</td><td>✓</td><td>-</td></tr>
<tr><td>Covalent
(non-metals only)</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>Ionic
(metals + non-metals)</td><td>×</td><td>✓</td><td>✓</td></tr>
</table></td></tr>
<tr><td>2002
2b(ii)</td><td>Covalent bonds must be broken to melt covalent network substance</td><td>Silica is a covalent network substance due to the strong covalent bonds between atoms. To melt a covalent network, all covalent bonds must be broken. This requires a great deal of energy ∴ high melting point</td></tr>
<tr><td>2002
4b</td><td> 
</td><td> 
</td></tr>
<tr><td>2003
12b</td><td>Each chlorine atom gains one electron</td><td>Chlorine atoms gain one electron each to become chloride ions
$Cl + e^- \longrightarrow Cl^-$
2,8,7 2,8,8</td></tr>
<tr><td>2004
4a</td><td> 
</td><td> 
</td></tr>
<tr><td>2004
13a</td><td>Molecular covalent</td><td>
<table>
<tr><td>Molecular Covalent</td><td>Low melting/boiling point</td></tr>
<tr><td>Covalent Network</td><td>High melting point</td></tr>
</table></td></tr>
<tr><td>2006
2a</td><td>Shared pair of electrons between 2 atoms</td><td>Covalent bonding usually takes place between two non-metal atoms. The 2 atoms share electrons to form pairs and each atom has a full outer shell.</td></tr>
</table>

2006 2b



Trigonal Pyramidal shape

Four shapes to learn area:

			
linear	Angular	Trigonal Pyramidal	tetrahedral

2007 13a(i)

2 or 2,0

Lithium atoms have an electron arrangement of 2,1 (p1 data booklet)

Lithium ions attain a full outer shell by losing 1 electron

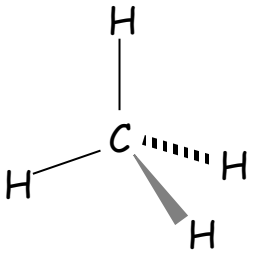
$Li \rightarrow Li^+ + e^-$

2,1 → 2

2008 5a

Tetrahedral

CFC molecule has similar in shape to methane

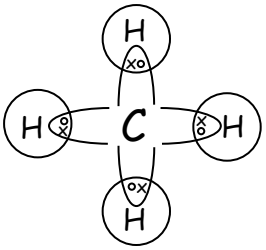


2010 3a

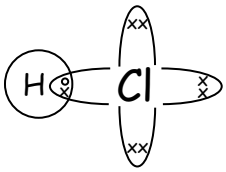
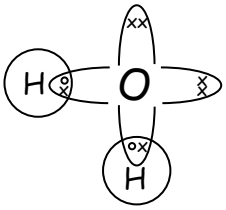
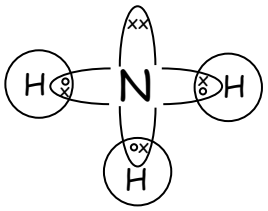
covalent network

Covalent	Carbon is a non-metal which forms covalent bonds
Network	Diamond is a covalent network due to its very high melting point

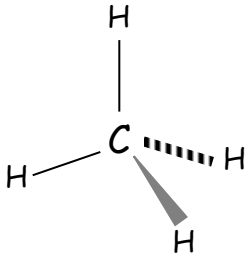
2010 3b(i)



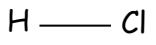
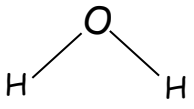
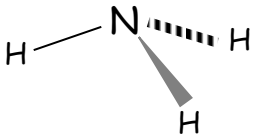
Methane CH_4 is shown left. Other diagrams to learn include:

Hydrogen chloride HCl	Water H_2O	Ammonia NH_3
		

2010 3b(ii)



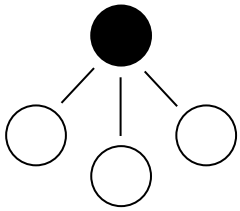
Tetrahedral methane is shown left. Other diagrams to learn include:

HCl	H_2O	NH_3
 Linear	 Angular	 Trigonal Pyramidal

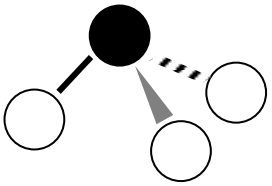
2011 1a

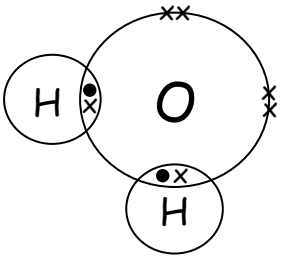
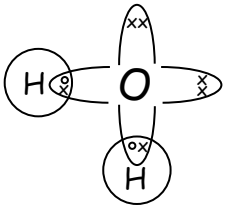
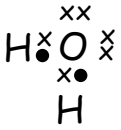
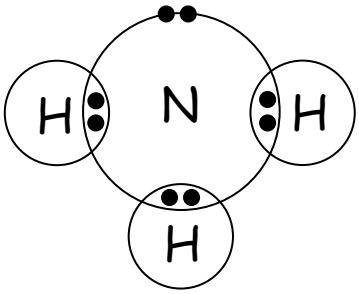
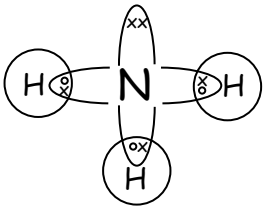
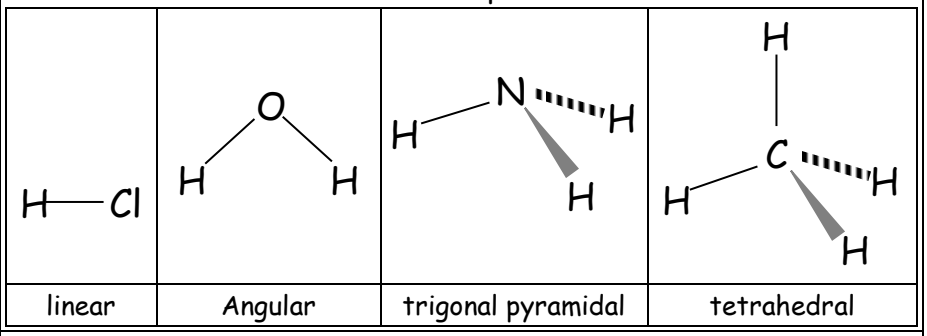
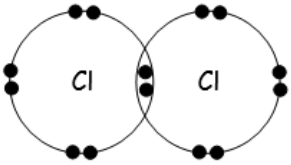
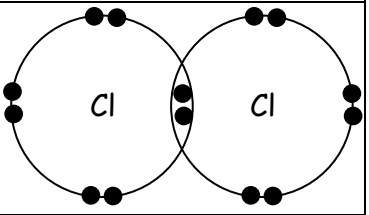
Covalent Network	Covalent as it does not conduct in any state and network due to high m.pt.
Ionic Lattice	Ionic do not conduct when solid but do conduct when molten or in solution
Metallic Lattice	Metallic substances conduct when solid
Discrete Covalent Molecular	Covalent as it does not conduct in any state and molecular due to low m.pt.

2011 2a



Any three dimensional pyramidal shape:

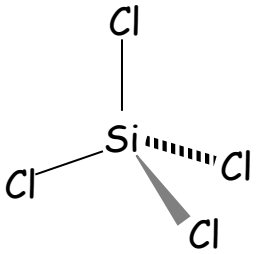
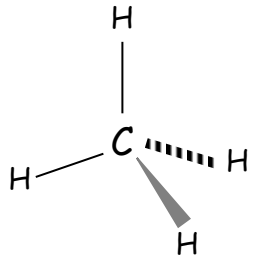
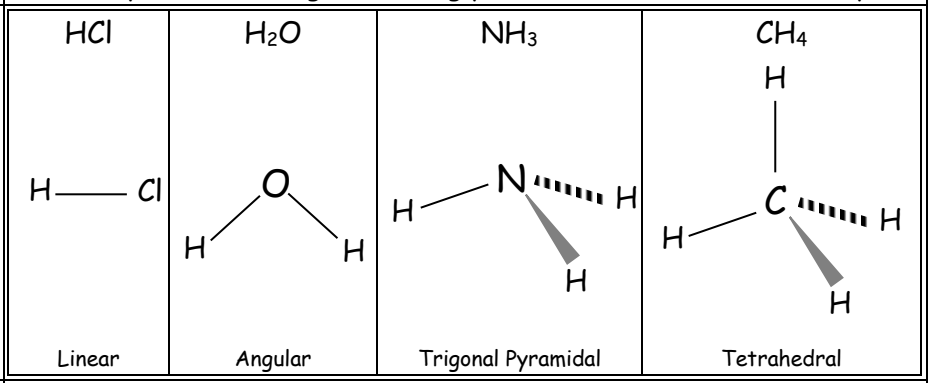
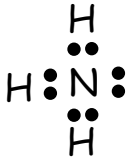
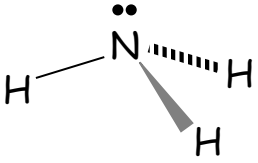


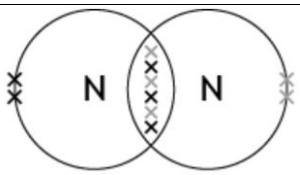
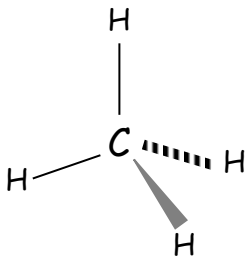
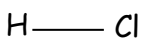
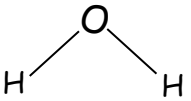
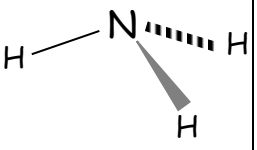
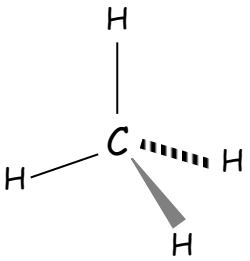
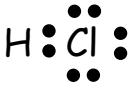
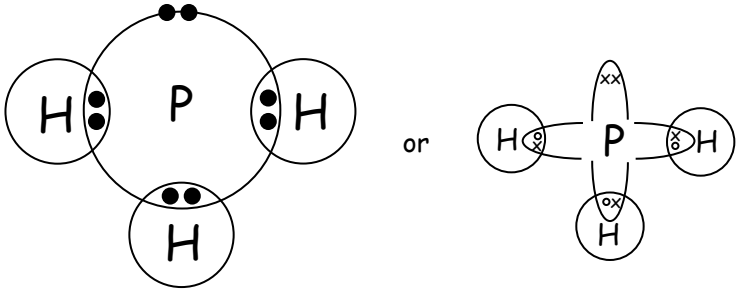
2011 2b		Also Acceptable:  
2012 1a	Covalent Network	SiO_2 contains two non-metals ∴ Covalent bonding in compound • Covalent network substances have high melting points Covalent molecular substances have low melting & boiling points
2013 6b	(Covalent) network	Silicon and oxygen are both non-metals ∴ covalent bonding in SiO_2 Silicon dioxide has a melting point of 1700°C ∴ SiO_2 can not be molecular as the melting point is too high and SiO_2 is a covalent network.
2014 4a	Diagram showing:	 or 
2014 4b	Weak	Covalent molecular substances are often gases or liquids at room temperature because there are only weak attractions/bonds between the molecules.
2015 2a	tetrahedral	Chloroform $CHCl_3$ has the same shape as methane CH_4 
2015 2b(i)	weak strong	The bonds inside molecules are covalent bonds which are strong bonds. The bonds between molecules are not covalent bonds and these bonds are much easier to overcome so they are weak bonds.
2015 3b		Each chlorine atom has 7 electrons of its own and shares an electron with another chlorine to achieve a stable full outer shell of 8 electrons. 
2015 5a	covalent or covalent molecular	Titanium chloride is a compound containing a metal and a non-metal. This would normally form an ionic compound. However, ionic compounds are all solids at room temperature with high melting points but titanium chloride is a liquid at room temperature. Metallic bonding can be ruled out as it is a compound so (molecular) covalent is left due to the low melting and boiling points.

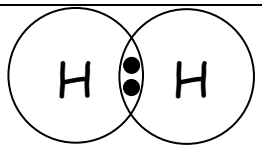
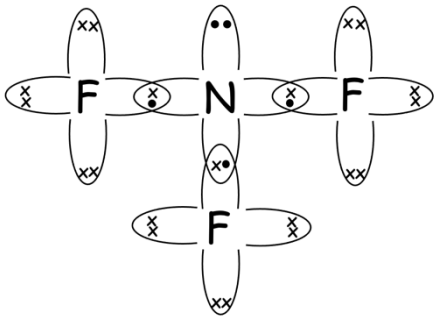
Nat5
Traffic Lights

Past Paper Question Bank
Unit 1.2b Covalent Bonding

Outcome	2000 Credit	2001 Credit	2002 Credit	2003 Credit	2004 Credit	2005 Credit	2006 Credit	2007 Credit	2008 Credit	2009 Credit	2010 Credit	2011 Credit	2012 Credit	2013 Credit		
17 18		16c		11b	13a			15b	10b	12a	15c			17b		
19 22						15a							13a			
20																
21	13d			10c	13b(i) 13b(ii)		9b	15a		12b				17a		
23																
24			12a(ii)								14a					
25																
26																
27																
28																
29 30																
31																
32																
33																
34													18a			
35		18d							13c	10c						
36								19c(i)								
-				13a+b												

SG Credit	Answer	Reasoning
2000C 13d		$SiCl_4$ has the same tetrahedral shape of methane CH_4 • Si can substitute for carbon as they are both in group 4 • Chlorine can substitute for hydrogen as they both have a valency of 1
2001C 16c	Answer to include:	2 electrons form a shared pair between atoms. Atoms must be set distance apart for electrons to form a stable pair instead of remaining as two unpaired electrons
2001C 18d	ions free to move when molten	Solid ionic compounds do not conduct as their ions are not free to move. Melting or dissolving free up the ions and they are able to move during electrolysis.
2002C 12a(ii)	covalent bonding	Covalent compounds have lower melting/boiling points and can be liquids and gases at room temperature. Ionic compounds have higher melting points are all solid at room temp.
2003C 10c		
2003C 11b	Answer to include:	2 electrons form a shared pair between atoms. Atoms must be set distance apart for electrons to form a stable pair instead of remaining as two unpaired electrons
2003C 13a	silver nitrate solution	grey solid at –ve electrode is silver: $Ag^+ + e^- \rightarrow Ag$
2003C 13b	covalent	covalent compounds do not conduct when solid, liquid or in solution
2004C 13a	Answer to include:	2 electrons form a shared pair between atoms. Atoms must be set distance apart for electrons to form a stable pair instead of remaining as two unpaired electrons
2004C 13b(i)		Nitrogen has 5 outer electrons (1 pairs and 3 unpaired) Hydrogen has 1 unpaired electron 3 hydrogen atoms, each with a unpaired electron, pair up with the 3 unpaired electrons of an nitrogen to form a NH_3 molecule
2004C 13b(ii)		Ammonia NH_3 forms a trigonal pyramidal molecule

<table>
<tr><td>2005C
15a</td><td>  </td><td>Any diagram with overlapping of 3 half-filled electron clouds and a non-bonding pair of electrons</td></tr>
<tr><td>2006C
9b</td><td>  </td><td>
<table>
<tr><td>HCl
 
Linear</td><td>H_2O
 
Angular</td><td>NH_3
 
Trigonal Pyramidal</td><td>CH_4
 
Tetrahedral</td></tr>
</table>
</td></tr>
<tr><td>2007C
15a</td><td>  </td><td>H becomes stable with 2 electrons in outer shell.
Cl becomes stable with 8 electrons in outer shell.</td></tr>
<tr><td>2007C
15b</td><td>Any answer from:</td><td>to form a full/complete/stable electron shell
to become stable
to achieve same electron arrangement as Noble gas
to get 8 outer electrons</td></tr>
<tr><td>2007C
19c(i)</td><td>to complete circuit</td><td>The ions in the electrolyte move between electrodes to complete the circuit</td></tr>
<tr><td>2008C
10b</td><td>positive
then
electrons</td><td>Covalent bonds are formed when two non-metal atoms share a pair of electrons to help achieve a stable electron outer shell.</td></tr>
<tr><td>2008C
13c</td><td>ions free to move in solution but not in solid</td><td>
<table>
<tr><th>Bonding</th><th>Solid</th><th>Liquid</th><th>Solution</th></tr>
<tr><td>Metallic
(metals only)</td><td>✓</td><td>✓</td><td>-</td></tr>
<tr><td>Covalent
(non-metals only)</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>Ionic
(metals + non-metals)</td><td>×</td><td>✓</td><td>✓</td></tr>
</table>
In a solid ionic compound, ions are held tightly together in a lattice and are not free to move ∴solid ionic is a non-conductor.
When molten or dissolved in water, the lattice of ions breaks up and the ions are able to move ∴liquid and solution ionic compounds conduct.
</td></tr>
<tr><td>2009C
10c</td><td>Ions free to move</td><td>
<table>
<tr><td>Solid Ionic Compounds</td><td>Ions unable to move in ionic lattice</td></tr>
<tr><td>Molten Ionic Compounds</td><td rowspan="2">Ions free to move</td></tr>
<tr><td>Ionic Compound Solutions</td></tr>
</table>
</td></tr>
<tr><td>2009C
12a</td><td>Covalent</td><td>Hydrogen is a non-metal, chlorine is a non-metal
Type of bonding in hydrogen chloride molecule: Covalent</td></tr>
<tr><td>2009C
12b</td><td>Diagram showing:</td><td>  </td></tr>
</table>

2010C 14a	Covalent	Titanium (IV) chloride contains a metal and a non-metal in the compound • Metals and non-metals usually join to form ionic bonding • Ionic bonding results in a high melting and boiling points Titanium (IV) chloride contains covalent bonding as it is a liquid at room temperature so must have a boiling point below 20°C
2010C 15c	Protons Electrons	A covalent bond is a shared pair of electrons between two atoms. The electrostatic attraction between the negative electrons and the positive nuclei holds the covalent bond together
2012C 13a		Hydrogen atoms pair up to form a covalent bond between them. A covalent bond is a shared pair of electrons.
2012C 18a	Ionic	<table><tr><td>Bonding Type</td><td>Metallic</td><td>Covalent</td><td>Ionic</td></tr><tr><td>Elements in Bonding Type</td><td>Metals Only</td><td>Non-metals Only</td><td>At least 1 metal and 1 non-metal</td></tr></table>
2013C 17a	Diagram showing:	 or 
2013C 17b	positive electrons	A covalent bond is a shared pair of electrons between two atoms. As the positive nuclei would repel each other, it is the attraction of the positive nuclei for the shared pair of electrons holds the molecule together.

Nat5
Traffic Lights

Past Paper Question Bank
Unit 1.2b Covalent Bonding

Outcome	2000 General	2001 General	2002 General	2003 General	2004 General	2005 General	2006 General	2007 General	2008 General	2009 General	2010 General	2011 General	2012 General	2013 General		
17 18		18a(ii)	13b								10c	10b				
19 22																
20		18a(i)				9a				14b	15a					
21																
23																
24																
25																
26																
27																
28																
29 30																
31																
32													18a			
33																
34																
35	18b					15b		17b			19b		18b			
36																
-																

<table>
<tr><th>SG General</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>2000G
18b</td><td>ions not free
to move when solid</td><td>In the solid state, ionic compounds do not conduct electricity as its ions are not free to move.</td></tr>
<tr><td>2001G
18a(i)</td><td>two atoms
bonded together</td><td>Diatomic molecules are molecules with 2 atoms bonded together in a molecule</td></tr>
<tr><td>2001G
18a(ii)</td><td>covalent</td><td>Molecules always contain covalent bonding.</td></tr>
<tr><td>2002G
13b</td><td>covalent</td><td><table><tr><td>Elements in Substance</td><td>Metals Only</td><td>Non-metals Only</td><td>Metals + non-metals</td></tr><tr><td>Type of bonding</td><td>Metallic</td><td>Covalent</td><td>Ionic</td></tr></table></td></tr>
<tr><td>2005G
9a</td><td>2 atoms
joined by bond</td><td>Diatomic molecules are when two atoms are joined together by at least one chemical bond
Diatomic Elements: H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2</td></tr>
<tr><td>2005G
15b</td><td>Ions are
free to move</td><td>Solid Ionic compounds cannot conduct due to ions being unable to move freely.
Molten and dissolved ionic compounds have ions free to move.</td></tr>
<tr><td>2007G
17b</td><td>Ions cannot move
when solid</td><td>In solid ionic compounds, ions are tightly held in ionic lattice and are unable to move ∴ ionic solids do not conduct electricity
Melting or dissolving ionic compounds breaks up the ionic lattice and allows the ions to move ∴ ionic liquids/solutions conduct electricity</td></tr>
<tr><td>2009G
14b</td><td>2 atoms joined
together</td><td>Diatomic molecules have 2 atoms joined together by covalent bonds:<table><tr><td>Element</td><td>hydrogen</td><td>nitrogen</td><td>oxygen</td><td>fluorine</td><td>chlorine</td><td>bromine</td><td>iodine</td></tr><tr><td>Formula</td><td>H_2</td><td>N_2</td><td>O_2</td><td>F_2</td><td>Cl_2</td><td>Br_2</td><td>I_2</td></tr></table></td></tr>
<tr><td>2010G
10c</td><td>covalent bonds</td><td>Methane CH_4 is a covalent molecule as it is made up on non-metal atoms only.</td></tr>
<tr><td>2010G
15a</td><td>diatomic</td><td>A diatomic molecule is a 2 atom molecule joined by covalent bond(s)</td></tr>
<tr><td>2010G
19b</td><td>Ions free to
move in solution</td><td>In solid ionic substances, the ions are held tightly in a lattice of oppositely charged ions and are unable to move. This prevents conduction of electricity.
When ionic substances are melted or dissolved, the tightly held lattice breaks up and the substance is able to conduct as the ions can move to the oppositely charged electrode.</td></tr>
<tr><td>2011G
10b</td><td>covalent bonds</td><td>N_2H_4 is covalent as it only contains non-metals in the compound.</td></tr>
<tr><td>2012G
18a</td><td>Lattice</td><td>Ions are held together in an ionic lattice by electrostatic attraction between positive and negative ions.</td></tr>
<tr><td>2012G
18b</td><td>Ions are unable to
move in solid lattice</td><td>In solid ionic substances, the ions are held tightly together and are unable to move ∴ solid ionic substances do not conduct. When ionic substances are melted or dissolved, the lattice structure breaks up and the ions are now free to move. Liquid and solution ionic compounds can conduct electricity (compound is broken down as it conducts)</td></tr>
</table>