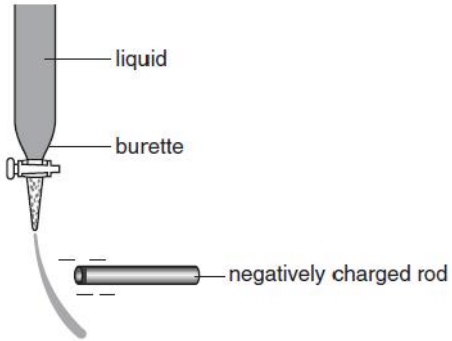
CHEMISTRY MULTIPLE CHOICE QUESTIONS

C. Chemical Bonding

2002 -2014

1.

A slow stream of water from a tap can be deflected by an electrostatically charged plastic roc because water is a polar molecule.



Why is a water molecule polar?

A Molecules are bonded together by hydrogen bonds.

B The oxygen and hydrogen atoms have different electronegativities.

C The oxygen atom has two lone pairs of electrons.

D Water is able to dissociate into ions.

[2002 M/J (4)]

2.

In which sequences are the molecules quoted in order of increasing bond angle within the molecule?

1	H_2O	NH_3	CH_4
2	H_2O	SF_6	BF_3
3	CH_4	CO_2	SF_6

[2002 M/J (32)]

3.

Which of the following molecules has **no** permanent dipole?

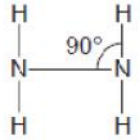
A CCl_2F_2 **B** $CHCl_3$ **C** C_2Cl_4 **D** C_2H_5Cl

[2002 O/N (5)]

4.

Which is the most likely shape of a molecule of hydrazine, N_2H_4?

A



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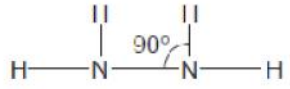

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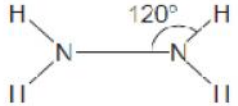

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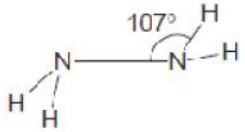


[2002 O/N (6)]

5.

Which of the following solids has a simple molecular lattice?

A magnesium oxide

B sodium

C silicon(IV) oxide

D sulphur

[2003 M/J (5)]

6.

Silicon tetrachloride, $SiCl_4$, is a liquid of low boiling point. In the presence of water it decomposes to form silicon(IV) oxide and hydrogen chloride.

What types of bonding occur in $SiCl_4(l)$?

1 co–ordinate bonding

2 covalent bonding

3 van der Waals forces

[2003 M/J (31)]

7.

Which molecule contains only six bonding electrons?

A C_2H_4 **B** C_2F_6 **C** H_2O **D** NF_3

[2003 O/N (6)]

8.

Chemists have been interested in the properties of hydrogen selenide, H_2Se, to compare it with 'bad egg' gas hydrogen sulphide, H_2S.

Which set of data would the hydrogen selenide molecule be expected to have?

	number of lone pairs on Se atom	bond angle
A	1	104°
B	2	104°
C	2	109°
D	2	180°

[2003 O/N (7)]

9.

Magnesium oxide is used to line industrial furnaces because it has a very high melting point.

Which type of bond needs to be broken for magnesium oxide to melt?

A co-ordinate

B covalent

C ionic

D metallic

[2004 M/J (6)]

10.

Which solid exhibits more than one kind of chemical bonding?

A brass

B copper

C diamond

D ice

[2004 M/J (7)]

11.

Which ion is most polarising?

A Al^{3+}

B Ba^{2+}

C Mg^{2+}

D Na^{+}

[2004 M/J (14)]

12.
Which molecule is planar?

A NF_3

B C_2Cl_4

C C_3H_6

D C_3H_8

[2004 M/J (20)]

13.
Which pairs of compounds contain one that is giant ionic and one that is simple molecular?

1 Al_2O_3 and Al_2Cl_6

2 SiO_2 and $SiCl_4$

3 P_4O_{10} and PCl_3

[2004 M/J (34)]

14.
The gecko, a small lizard, can climb up a smooth glass window. The gecko has millions of microscopic hairs on its toes and each hair has thousands of pads at its tip. The result is that the molecules in the pads are extremely close to the glass surface on which the gecko is climbing.

What is the attraction between the gecko's toe pads and the glass surface?

A co-ordinate bonds

B covalent bonds

C ionic bonds

D van der Waals' forces

[2004 O/N (6)]

15.
What are the bond angles in the PH_3 molecule likely to be?

A 90° **B** 104° **C** 109° **D** 120°

[2004 O/N (7)]

16.
Which of the following molecules and ions have a regular trigonal planar shape?

1 $AlCl_3$

2 CH_3^+

3 PH_3

[2005 M/J (31)]

17.
Which molecules are planar?

1 BCl_3

2 NH_3

3 PH_3

[2005 O/N (32)]

18.
In which process are hydrogen bonds broken?

A $H_2(l) \rightarrow H_2(g)$

B $NH_3(l) \rightarrow NH_3(g)$

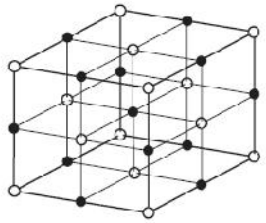
C $2HI(g) \rightarrow H_2(g) + I_2(g)$

D $CH_4(g) \rightarrow C(g) + 4H(g)$

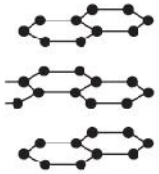
[2006 M/J (5)]

19.

The diagram shows part of the lattice structures of solids **X** and **Y**. [In **X**, ○ and ● represent particles of different elements.]



X



Y

What are the types of bonding present in **X** and **Y**?

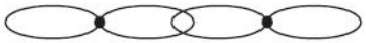
	X	Y
A	covalent	metallic
B	ionic	covalent
C	ionic	metallic
D	metallic	ionic

[2006 M/J (7)]

20.

Which diagram describes the formation of a π bond from the overlap of its orbitals?

A



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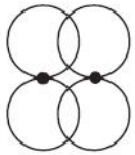

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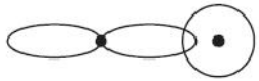

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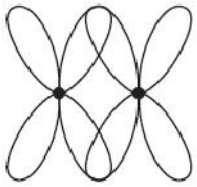


[2006 O/N (5)]

21.

The CN ion is widely used in the synthesis of organic compounds.

What is the pattern of electron pairs in this ion?

	bonding pairs of electrons	lone pairs on carbon atom	lone pairs on nitrogen atom
A	2	1	1
B	2	2	1
C	3	1	1
D	3	1	2

[2007 M/J (5)]

22.

Which chlorine compound has bonding that can be described as ionic with some covalent character?

A $NaCl$ **B** $MgCl_2$ **C** $AlCl_3$ **D** $SiCl_4$

[2007 M/J (12)]

23.

Which of the following solids contain more than one type of chemical bond?

1 brass (an alloy of copper and zinc)

2 graphite

3 ice

[2007 M/J (32)]

24.

Use of the Data Booklet is relevant to this question.

In forming ionic compounds, elements generally form an ion with the electronic structure of a noble gas.

Which ion does **not** have a noble gas electronic structure?

A I^- **B** Rb^+ **C** Sn^{2+} **D** Sr^{2+}

[2007 O/N (2)]

25.

Lycra® is a polyurethane fibre used in the fashion industry. It is a polymer made from two monomers, one of which has the following formula.

$$O=C=N-(CH_2)_n-N=C=O$$

What is the O–C–N bond angle in this molecule?

A 90° **B** 109° **C** 120° **D** 180°

[2007 O/N (6)]

26.

What are the lattice structures of solid diamond, iodine and silicon(IV) oxide?

	giant molecular	simple molecular
A	diamond, silicon(IV) oxide	iodine
B	diamond, iodine	silicon(IV) oxide
C	iodine	diamond, silicon(IV) oxide
D	silicon(IV) oxide	diamond, iodine

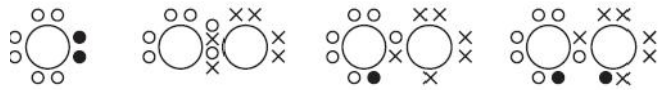
[2007 O/N (7)]

27.

When barium metal burns in oxygen, the ionic compound barium peroxide, BaO_2, is formed.

Which dot-and-cross diagram represents the electronic structure of the peroxide anion in BaO_2?

A **B** **C** **D**



key

○ electron from first oxygen atom

× electron from second oxygen atom

● electron from barium atom

[2008 M/J (4)]

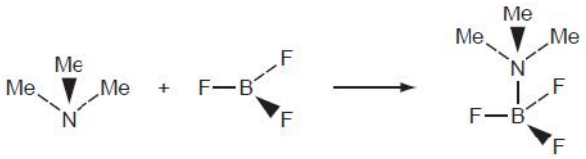
28.

In this question, the methyl group, CH_3, is represented by Me.

Trimethylamine, Me_3N, reacts with boron trifluoride, BF_3, to form a compound of formula $Me_3N.BF_3$.

How may this reaction be written in terms of the shapes of the reactants and products?

A



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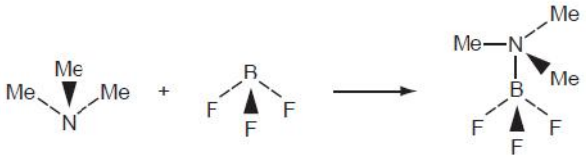

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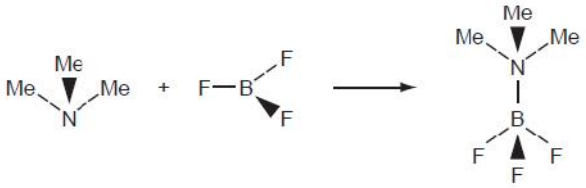

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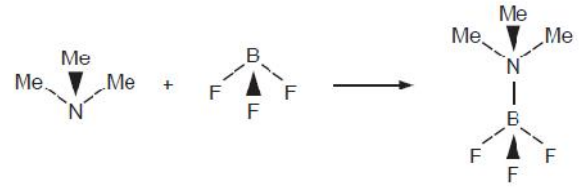


[2008 M/J (5)]

29.

Which pair of elements have bonds of the same type between their atoms in the solid state?

A aluminium and phosphorus

B chlorine and argon

C magnesium and silicon

D sulphur and chlorine

[2008 M/J (7)]

30.

In which reaction does the carbon-containing product have a smaller bond angle than the organic reactant?

A bromoethane refluxed with ethanolic sodium hydroxide

B complete combustion of methane in air

C methane and an excess of chlorine under ultraviolet light

D polymerisation of ethene

[2009 M/J (6)]

31.

A crystal of iodine produces a purple vapour when gently heated.

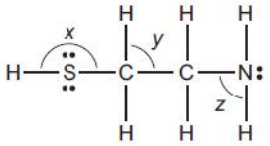
Which pair of statements correctly describes this process?

	type of bond broken	formula of purple species
A	covalent	I
B	covalent	I_2
C	induced dipole-dipole	I_2
D	permanent dipole-dipole	I_2

[2009 M/J (7)]

32.

The antidote molecule shown can help to prevent liver damage if someone takes too many paracetamol tablets.



What is the order of **decreasing** size of the bond angles *x*, *y* and *z*?

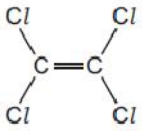
	largest ⟶		smallest
A	*x*	*y*	*z*
B	*x*	*z*	*y*
C	*y*	*z*	*x*
D	*z*	*y*	*x*

[2009 O/N-11 (4)]

33.

Which molecule has the largest overall dipole?

A



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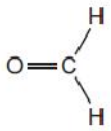

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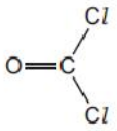


D

[2009 O/N-11 (5)]

34.

Which physical properties are due to hydrogen bonding between water molecules?

1 Water has a higher boiling point than H_2S.

2 Ice floats on water.

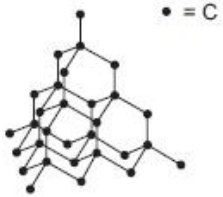
3 The H–O–H bond angle in water is approximately 104°.

[2009 O/N-11 (32)]

35.

I Which diagrams represent part of a giant molecular structure?

1



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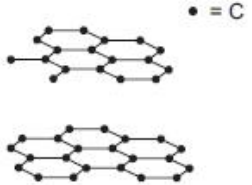

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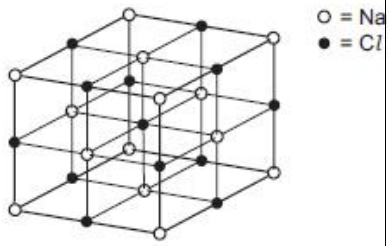
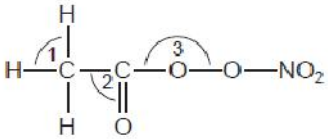


[2010 M/J-11 (31)]

36.

Organic nitrates in photochemical smog can cause breathing difficulties.

The diagram shows an example of an organic nitrate molecule.



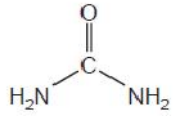
What is the correct order of the bond angles shown in ascending order (smallest first)?

A 1 → 2 → 3 **B** 2 → 1 → 3 **C** 3 → 1 → 2 **D** 3 → 2 → 1

[2010 O/N-11 (7)]

37.

Which types of intermolecular forces can exist between adjacent urea molecules?



urea

1 hydrogen bonding

2 permanent dipole-dipole forces

3 temporary induced dipole-dipole forces

[2010 O/N-11 (33)]

38.

The ability of an atom in a covalent bond to attract electrons to itself is called its electronegativity.

The greater the difference between the electronegativities of the two atoms in the bond, the more polar is the bond.

Which pair will form the most polar covalent bond between the atoms?

A chlorine and bromine

B chlorine and iodine

C fluorine and chlorine

D fluorine and iodine

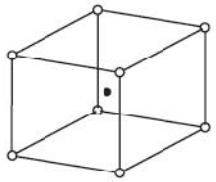
[2010 O/N-12 (1)]

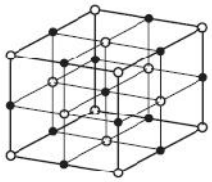
39.

The table gives the radii, in pm, of some ions. [1pm = 10^{-12} m]

ion	radii
Na^+	102
Mg^{2+}	72
Cs^+	167
Cl^-	181
O^{2-}	140

Caesium chloride, CsCl, has a different lattice structure from both sodium chloride, NaCl, and magnesium oxide, MgO.


CsCl lattice


NaCl and MgO lattice

Which factor appears to determine the type of lattice for these three compounds?

A the charge on the cation

B the ratio of the ionic charges

C the ratio of the ionic radii

D the sum of the ionic charges

[2010 O/N-12 (3)]

40.

Which solid has a simple molecular lattice?

A calcium fluoride

B nickel

C silicon(IV) oxide

D sulfur

[2010 O/N-12 (5)]

41.

Which molecule or structure does **not** contain three atoms bonded at an angle between 109° and 110°?

A ethanoic acid

B graphite

C propane

D silicon(IV) oxide

[2010 O/N-12 (10)]

42.

Which statements about covalent bonds are correct?

1 A triple bond consists of one π bond and two σ bonds.

2 The electron density in a σ bond is highest along the axis between the two bonded atoms.

3 A π bond restricts rotation about the σ bond axis.

[2010 O/N-12 (33)]

43.

Which are features of the structure of metallic copper?

1 a lattice of ions

2 delocalised electrons

3 ionic bonds

[2011 M/J-11 (32)]

44.

Which descriptions of the ammonium ion are correct?

1 It contains ten electrons.

2 It has a bond angle of 109.5°.

3 It has only three bonding pairs of electrons.

[2011 M/J-11 (37)]

45.

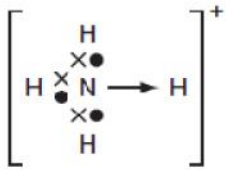
Which diagram correctly shows the bonding in the ammonium ion, NH_4^+?

key

● N electron

× H electron

A



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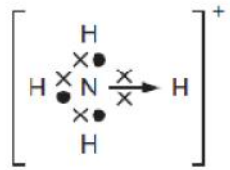

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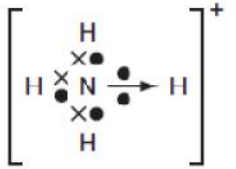

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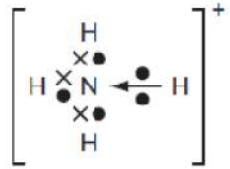


[2011 M/J-12 (2)]

46.

What is involved when a hydrogen bond is formed between two molecules?

1 a hydrogen atom bonded to an atom less electronegative than itself

2 a lone pair of electrons

3 an electrostatic attraction between opposite charges

[2011 M/J-12 (32)]

47.

In which change would only van der Waals' forces have to be overcome?

A	evaporation of ethanol	$C_2H_5OH(l) \rightarrow C_2H_5OH(g)$
B	melting of ice	$H_2O(s) \rightarrow H_2O(l)$
C	melting of solid carbon dioxide	$CO_2(s) \rightarrow CO_2(l)$
D	solidification of butane	$C_4H_{10}(l) \rightarrow C_4H_{10}(s)$

[2011 M/J-13 (10)]

48.
Which element shows the greatest tendency to form some covalent compounds?

A aluminium

B magnesium

C neon

D potassium

[2011 O/N-11 (13)]

49.
Why does aluminium chloride, Al_2Cl_6, sublime at the relatively low temperature of 180 °C?

1 The intermolecular forces between the Al_2Cl_6 molecules are weak.

2 The co-ordinate bonds between aluminium and chlorine are weak.

3 The covalent bonds between aluminium and chlorine are weak.

[2011 O/N-11 (32)]

50.
The three statements that follow are all true.

Which of these can be explained, at least in part, by reference to hydrogen bonding?

1 At 0 °C ice floats on water.

2 The boiling point of propan-2-ol is 82 °C. The boiling point of propanone is 56 °C.

3 At 20 °C propanone and propanal mix completely.

[2011 O/N-11 (33)]

51.
The presence of dipoles helps to explain why the element Br_2 and the compound $CHCl_3$ exist as liquids at room temperature.

Which types of dipole are involved?

	Br_2	$CHCl_3$
A	induced dipoles and permanent dipoles	induced dipoles and permanent dipoles
B	induced dipoles and permanent dipoles	induced dipoles only
C	induced dipoles only	induced dipoles and permanent dipoles
D	induced dipoles only	induced dipoles only

[2011 O/N-12 (5)]

52.
Which statements about bond angles are correct?

1 The bond angle in SO_2 is smaller than the bond angle in CO_2.

2 The bond angle in H_2O is smaller than the bond angle in CH_4.

3 The bond angle in NH_3 is smaller than the bond angle in BF_3.

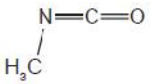
[2011 O/N-12 (31)]

53.
Methyl isocyanate, CH_3NCO, is a toxic liquid which is used in the manufacture of some pesticides.

In the methyl isocyanate molecule, the sequence of atoms is $H_3C—N=C=O$.

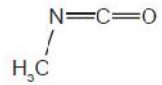
What is the approximate angle between the bonds formed by the N atom?

A



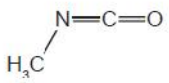
104°

B



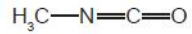
109°

C



120°

D



180°

[2011 O/N-13 (5)]

54.

Two conversions are outlined below.

$$NH_4^+ \rightarrow NH_3$$

$$C_2H_4 \rightarrow C_2H_6$$

What similar feature do these two conversions have?

A a lone pair of electrons in the product

B change in oxidation state of an element

C decrease in bond angle of the species involved

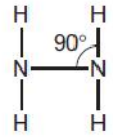
D disappearance of a π bond

[2012 M/J-11 (5)]

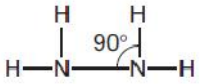
55.

What is the **most** likely shape of a molecule of hydrazine, N_2H_4?

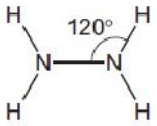
A



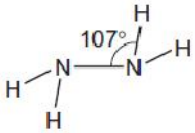
B



C



D



[2012 M/J-12 (3)]

56.

Which solid contains more than one kind of bonding?

A iodine

B silicon dioxide

C sodium chloride

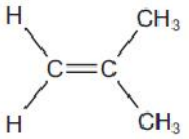
D zinc

[2012 M/J-12 (5)]

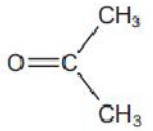
57.

Which molecule has the largest overall dipole?

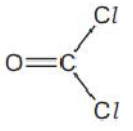
A



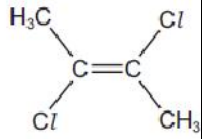
B



C



D



[2012 M/J-12 (10)]

58.

Which of the following molecules and ions have a regular trigonal planar shape?

1 BF_3

2 CH_3^+

3 $AlCl_3$

[2012 M/J-12 (31)]

59.

Sodium borohydride, $NaBH_4$, and boron trifluoride, BF_3, are compounds of boron.

What are the shapes around boron in the borohydride ion and in boron trifluoride?

	borohydride ion	boron trifluoride
A	square planar	pyramidal
B	square planar	trigonal planar
C	tetrahedral	pyramidal
D	tetrahedral	trigonal planar

[2012 O/N-11 (3)]

60.
In which pair do the molecules have the same shape as each other?

A H_2O and CO_2

B H_2O and SCl_2

C NH_3 and BH_3

D SCl_2 and $BeCl_2$

[2012 O/N-11 (12)]

61.
Which of these substances have a giant structure?

1 silicon(IV) oxide

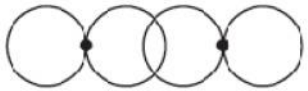
2 baked clay found in crockery

3 phosphorus(V) oxide

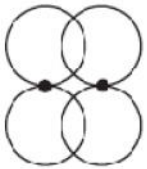
[2012 O/N-11 (33)]

62.
Which diagram represents the overlap of two orbitals which will form a π bond?

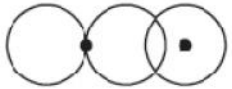
A



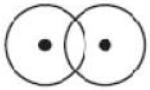
B



C



D



[2012 O/N-13 (6)]

63.
Which molecule is planar?

A C_2Cl_4 **B** C_3H_6 **C** C_3H_8 **D** NF_3

[2012 O/N-13 (11)]

64.
Valence shell electron pair repulsion theory should be used to answer this question.

Which species are trigonal planar?

1 BH_3

2 CH_3^+

3 PH_3

[2013 M/J-11 (33)]

65.
Which pair of elements has chemical bonds of the same type between their atoms in the solid state?

A aluminium and phosphorus

B chlorine and argon

C magnesium and silicon

D sulfur and chlorine

[2013 M/J-12 (6)]

66.
Dicarbon monoxide, C_2O, is found in dust clouds in space. Analysis of it shows that the sequence of atoms in this molecule is C–C–O. All bonds are double bonds and there are no unpaired electrons.

How many lone pairs of electrons are present in a molecule of C_2O?

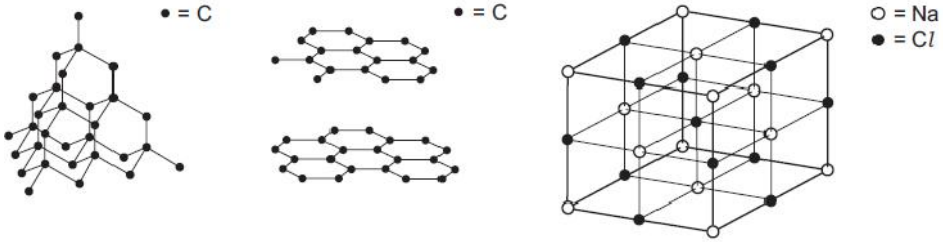
A 1 **B** 2 **C** 3 **D** 4

[2013 M/J-12 (9)]

67.

Which diagrams represent part of a giant molecular structure?

1 2 3



[2013 M/J-13 (34)]

68.

Which types of bonding are present in ammonium carbonate, $(NH_4)_2CO_3$?

1 ionic

2 covalent

3 co-ordinate (dative covalent)

[2013 O/N-11 (35)]

69.

Which solid contains more than one kind of bonding?

A copper

B diamond

C ice

D magnesium oxide

[2013 O/N-13 (8)]

70.

$AlCl_3$ vapour forms molecules with formula Al_2Cl_6 as it is cooled.

What happens to the bond angles during the change from $AlCl_3$ to Al_2Cl_6?

A Some decrease, some remain the same.

B Some increase, some remain the same.

C They all decrease.

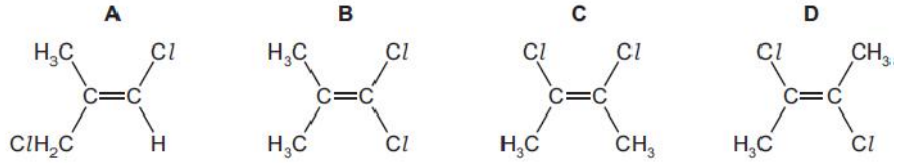
D They all increase.

[2014 M/J-11 (6)]

71.

Which molecular structure will have the **smallest** overall dipole?

A B C D



[2014 M/J-11 (9)]

72.

Substances X, Y and Z are all solids. Some of their physical properties are given in the table.

substance	X	Y	Z
melting point/°C	772	114	1610
boiling point/°C	1407	183	2205
electrical conductivity of the liquid state	conducts	does not conduct	does not conduct

What type of lattice could each substance have?

	X	Y	Z
A	giant molecular	simple molecular	ionic
B	ionic	giant molecular	simple molecular
C	ionic	simple molecular	giant molecular
D	simple molecular	ionic	giant molecular

[2014 M/J-12 (2)]

73.

Which elements have atoms which can form π bonds with atoms of other elements?

1 oxygen

2 nitrogen

3 fluorine

[2014 M/J-12 (33)]

74.

Which compound has the greatest total number of lone pairs of electrons in the valence shells of all of its atoms?

A CH_3Cl B CO_2 C N_2H_4 D NH_4CN

[2014 M/J-13 (2)]

75.

Four substances have the physical properties shown.

Which substance is an ionic solid?

	melting point /°C	boiling point /°C	electrical conductivity of solid	electrical conductivity of molten substance	electrical conductivity of aqueous solution
A	–115	–85	poor	poor	good
B	660	2470	good	good	insoluble
C	993	1695	poor	good	good
D	1610	2230	poor	poor	insoluble

[2014 M/J-13 (8)]

76.

X is an element in Period 2.

In which fluoride is the F–X–F angle the largest?

A BF_3 B CF_4 C NF_3 D OF_2

[2014 M/J-13 (10)]

77.

P and Q are two liquid compounds with similar M_r values. Molecules of P attract each other by hydrogen bonds. Molecules of Q attract each other by van der Waals' forces only.

How do the properties of P and Q differ?

1 P has higher surface tension than Q.

2 P has a higher boiling point than Q.

3 P is less viscous than Q.

[2014 M/J-13 (32)]

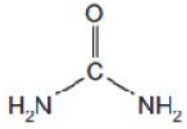
78.
Copper and iodine are both shiny crystalline solids.

Which forces exist between particles in solid copper and between neighbouring iodine molecules in solid iodine?

	copper	iodine
A	ionic bonds	covalent bonds
B	ionic bonds	van der Waals' forces
C	metallic bonds	covalent bonds
D	metallic bonds	van der Waals' forces

[2014 O/N-13 (7)]

79.
Which types of intermolecular forces can exist between adjacent urea molecules?



urea

1 hydrogen bonding

2 permanent dipole-dipole forces

3 instantaneous dipole-induced dipole forces

[2014 O/N-13 (33)]