Year 11 – Chemistry units 1. Periodic trends and bonding test – Revision 1

Section A: Multiple choice (25 questions = 25 marks)

1. A characteristic of metallic elements is that:

A. their atoms usually share electrons with atoms of non-metals

B. their electronegativities are high, which means they lose electrons easily

C. their atoms have only a small number of electrons in the valence shell and these can be removed relatively easily

D. in the solid state, electrostatic forces are not important since strong metallic bonds hold the atoms together

2. Some properties of various metals are identified in the list below.

I. Ductility

II. Electrical conductivity

III. Magnetism

IV. Malleability

Identify which of the properties listed above can be explained using the metallic bonding model.

A. I and II only

B. I, II and III only

C. I, II and IV only

D. II, III and IV only

3. The likely order of melting points from lowest to highest for the list of substances below will be:

A. N_2, H_2O, CH_4, Na, NaCl

B. N_2, Na, CH_4, H_2O, NaCl,

C. Na, N_2, NaCl, H_2O, CH_4,

D. CH_4, Cl_2, H_2O, NaCl, Al

4. An aqueous solution of copper (II) chloride conducts electricity because

A. there are electrons that are free to move

B. the water that forms the solution conducts electricity

C. copper is a good conductor

D. ions are free to move in the solution

5. In an ionic compound formed by the elements of atomic numbers 9 and 13, the ratio of positive to negative ions respectively is:

A. 1:1

B. 13:9

C. 3:1

D. 1:3

AlF_3

$Al^{3+} : F^-$

1 : 3

6. Water (H_2O) is a liquid under standard laboratory conditions of 25°C temperature and 1 atm pressure, but hydrogen sulfide (H_2S) is a gas under the same conditions. This occurs because there are:

A. stronger dispersion forces in water than those in H_2S

B. Weaker dipole-dipole forces in water than those in H_2S

C. covalent bonds between the water molecules

D. hydrogen bonds between the water molecules

7. Many compounds can be formed from two different elements. Identify which one of the following pairs of elements reacts to form a compound with **ionic bonding?**

A. Magnesium and sulphur

B. Fluorine and iodine

C. Iron and chromium

D. Hydrogen and oxygen

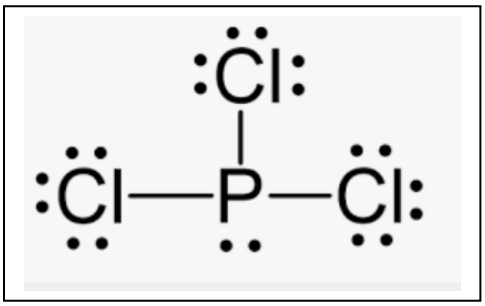
8. The **total** number of non-bonding outer-shell electron pairs in a molecule of PCl_3 is:

A. 0

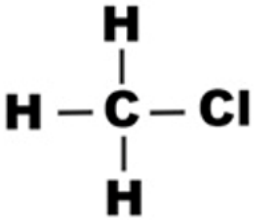
B. 1

C. 4

D. 10



9. The molecule shown below will:



A. contain polar bonds but be non-polar

B. be non-polar and contain no polar bonds

C. contain polar bonds and be polar

D. form a three-dimensional network solid

10. In liquid methanol (CH_3OH) covalent bonds, hydrogen bonds and dispersion forces are present.

Identify which of these bonds or forces are broken when a sample of methanol is vaporised into a gas?

A. Hydrogen bonds only

B. Hydrogen bonds and dispersion forces only

C. Covalent bonds and hydrogen bonds only

D. Covalent bonds, hydrogen bonds and dispersion forces

11. Identify which of the following molecules is non-polar?

A. NH_3

B. F_2O

C. C_2H_6

D. HCl

12. Which of the following does **not** explain a substance displaying a high melting point?

A. Strong intermolecular forces between molecules.

B. Strong covalent bonds.

C. Strong electrostatic attraction between oppositely charged ions.

D. Strong electrostatic attraction between positive ions and delocalised electrons

Strong intermolecular forces alone don't give very high mp compared to, ionic, metallic and network covalent lattices such as SiO_2 , diamond and graphite.

13. Phosphine has a molecular formula of PH_3. The shape of phosphine molecules is most likely to be:

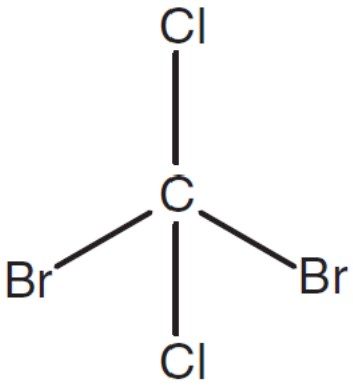
A. linear

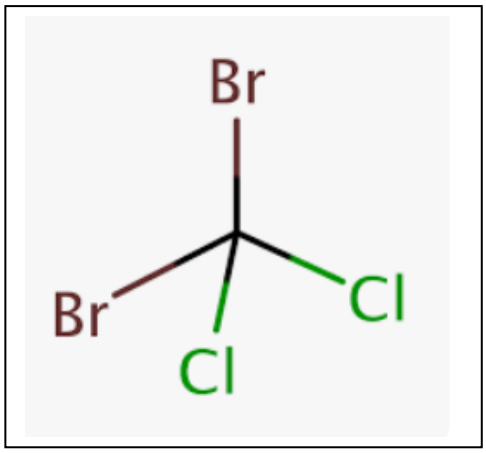
B. V-shaped

C. a trigonal pyramid

D. a tetrahedron

14. Consider the following diagram.





The image is deceptive as it tries to portray the molecule as symmetrical, but in 3 dimensional space it is asymmetrical and therefore polar with two unequal halves as shown. It also has polar covalent bonds.

The molecule is

A. non-polar, but it contains polar bonds.

B. non-polar, and it contains only non-polar bonds.

C. polar, and it contains polar bonds.

D. polar, but it contains non-polar bonds.

15. Listed below are four processes or reactions and the types of bonds broken during each of the processes or reactions. Identify which matching of process/reaction and bond type is **incorrect**?

	Process/reaction	Types of bonds broken
A.	$N_2(s) \rightarrow N_2(g)$	dispersion forces
B.	$Hg(l) \rightarrow Hg(g)$	metallic bonds
C.	$2NaCl(s) \rightarrow 2Na(g) + Cl_2(g)$	ionic bonds
D.	$H_2O(l) \rightarrow H_2O(g)$	covalent bonds

Covalent bonds are not broken when water evaporates. It is the intermolecular forces ie. H-bonding and dispersion forces, that are broken with heat.

16. Which of the molecules listed below dissolve well in water.

A. Methanol (CH_3OH)

B. Propanol ($CH_3CH_2\ CH_2OH$)

C. Butane ($CH_3CH_2\ CH_2CH_3$)

D. Carbon tetrachloride (CCl_4)

Methanol is polar and has hydrogen bonding dissolves well in water. Also it has the shortest carbon chain when compared to propanol making more soluble in water than propanol.

17. Which of the following molecular substances, when mixed together, will not separate out into layers.

A. Butane ($CH_3CH_2\ CH_2CH_3$) and carbon tetrachloride (CCl_4)

B. Liquid hexane (C_6H_{14}) and water

C. Liquid iodine (I_2) and methanol (CH_3CH_2OH)

D. Octanol ($CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2OH$) and water

Substance with similar intermolecular forces will interact well with each other.

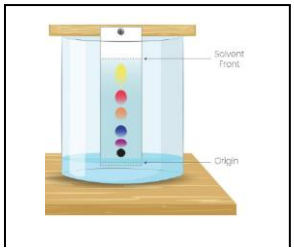
18. A black ink was analysed using paper chromatography and the chromatogram shown on the right. Water was used as the solvent. Which statement is correct?

A. The yellow pigment is the least polar molecule in the mixture.

B. The blue pigment is more polar than the purple pigment.

C. The purple pigment is most soluble in water.

D. All pigments are just as soluble in water.



Water is a polar solvent and polar solutes dissolve well and move further up the paper

Consider the following information for questions 19 and 20.

The table below shows properties of four substances identified only by the symbols W–Z.

Substance	Density ($g\ mL^{-1}$)	Melting point (°C)	Boiling point (°C)	Electrical conductivity	
				solid	liquid
W	2.0	119	445	nil	nil
X	13.5	–39	357	high	high
Y	2.4	714	1437	nil	high
Z	2.6	1713	2230	nil	nil

19. Identify which substance is most likely to be hard, brittle and soluble in water?

A. W
B. X
C. Y
D. Z

Hard, brittle and soluble are the properties of an ionic compound that conducts electricity only in the liquid state.

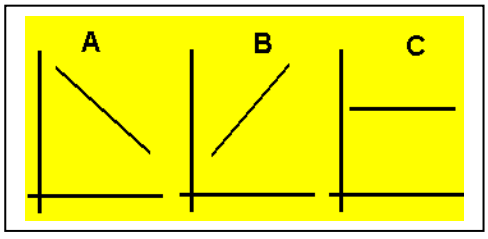
20. Identify which substance is most likely to be a molecular compound?

A. W
B. X
C. Y
D. Z

Molecular compounds do not conduct electricity in any state and have relatively low MP compare to metals and ionic substances

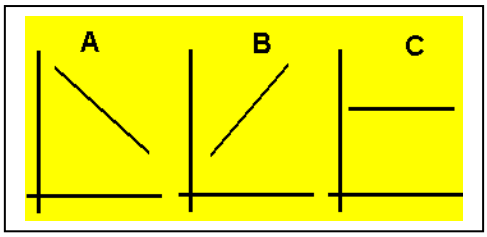
21. The trend in electronegativity across a period from left to right is best given by which graph.

A. A
B. B
C. C
D. Either B or C



Electronegativity increases across a period

22. Which of the graphs shows the change in core charge down a group?



A. A
B. B
C. C
D. Either B or C

Core charge is constant down a group

23. Which of the following is the correct ground state subshell configuration of copper (Cu)?

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9\ 4s^2$
B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$
C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ 4s^2\ 4p^1$
D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$

*A **completely filled d subshell ($3d^{10}$)** is **more stable***
So one electron moves from 4s → 3d
Filled d subshells are especially stable

24. An atom of cobalt (Co atomic number 27) in an excited state. Which configuration represents this excited state?

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ \ 3d^7\ 4s^2$
B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ \ 3d^6\ 4s^2\ 4p^6$
C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ \ 3d^8\ 4s^2$
D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ \ 3d^7\ 4s^1\ 4p^1$

*An **excited state** occurs when an electron is promoted to a **higher energy orbital***
*Here: **$4p^1$** has an electron before 4s is filled*
This requires energy, so it is not the ground state
Excited states involve electrons in higher energy orbitals than expected

25. What is the correct electron configuration of the Iron ion Fe^{3+}?

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ \ 3d^5\ 4s^1$
B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ \ 3d^5$
C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ \ 3d^6$
D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ \ 3d^4\ 4s^2$

When ionising, electrons are removed from 4s before 3d
Final configuration is $3d^5$, which is:
A half-filled d subshell
Half-filled d subshells are particularly stable

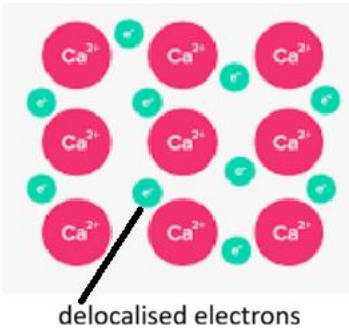
Section B: short answer questions

1. Calcium is a silvery-white, soft metal with an atomic number of 20.

a) Draw a **labelled** diagram to represent a calcium metal lattice. **(2 marks)**

1-----mark for correct charge on the cations

1-----mark for correct labelling of delocalised electrons

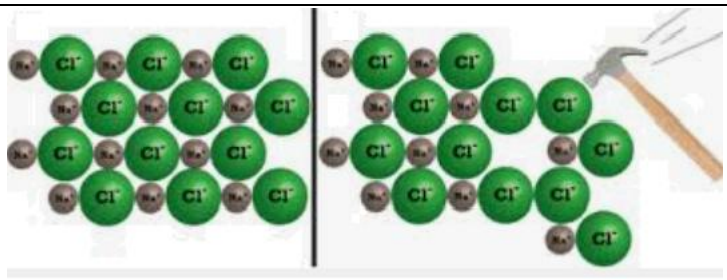


b) Describe the type of force holding the metal lattice together and the particles between which it acts . **(2 marks)**

1-----mark Electrostatic force of attraction

1-----mark between cation (positive ions) and the negative sea of delocalised electrons

2. Explain why an ionic crystal will shatter upon impact with a hammer. Use a diagram to support your response. **(2 + 1 = 3 marks)**



1-----mark for a diagram correctly showing like charges next to each other or layers sliding past each other when a force is applied that brings like charges next to each other.

1-----mark – electrostatic forces of repulsion are created when like charges come next to each other.

1-----mark this repulsion causes an irreversible fracture in the crystal.

3. a) List the following fluorine-containing substances in order of **increasing** melting temperature and justify your answer. **(3 marks)**

HF NaF F_2 CF_4

1-----mark for correct order F_2 < CF_4 < HF < NaF

1-----mark for stating that the melting point increases as intermolecular forces become stronger:

1-----mark for identifying the intermolecular forces and their relative strengths

b) Justify the difference in melting point between CF_4 and HF. **(2 marks)**

1-----mark stating the intermolecular forces in each

CF_4 *weak dispersion forces whilst HF has hydrogen bonding*

1-----mark for stating that greater energy is required to break H-bonds than dispersion forces

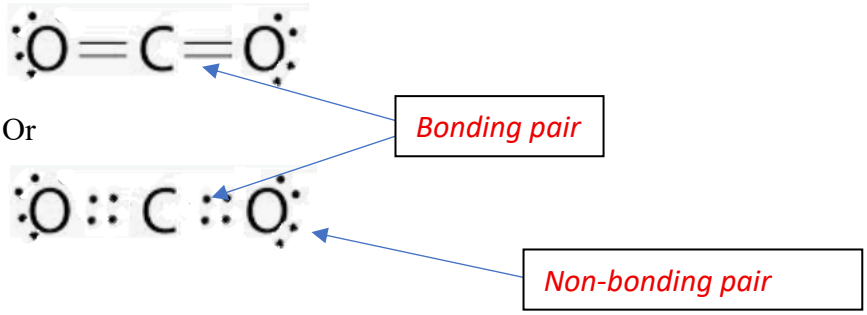
c) Justify the difference in melting point between HF and NaF. **(2 marks)**

1-----mark stating the intermolecular forces in each

NaF has strong ionic bonding whilst HF has hydrogen bonding

1-----mark for stating that greater energy is required to break ionic bonds than H-bonds

a) Draw an electron dot structure of the CO_2 molecule clearly labelling all bonding and non-bonding electrons. **(2 marks)**



1-----mark for correct Lewis dot structure

1-----mark for correct labelling

b) Describe the shape of the CO_2 molecule and explain why it has this shape. **(2 marks)**

1-----mark Linear

1-----mark The central carbon atom has two regions of electron density (two double bonds) These regions repel equally and arrange as far apart as possible.

(According to VSEPR theory)

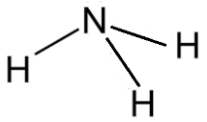
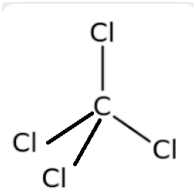
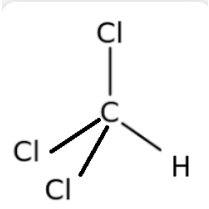
c) i) State whether carbon dioxide is a polar or non-polar molecule. **(1 mark)**

1-----mark non-polar

ii) Explain your response to i). **(1 mark)**

1-----mark Although each C=O bond is polar, the molecule is symmetrical hence the bond dipoles cancel out leaving no overall dipole moment.

5. Complete the following table. **(6 marks)**

Name	Molecular formula	**Draw structural diagram of molecule**	**Is the molecule polar or non-polar?**	**Shape of the molecule**
Hydrogen chloride	HCl	H-Cl	Polar	Linear
Ammonia	NH_3		polar	Trigonal pyramid
Tetrachloromethane	CCl_4		Non-polar	tetrahedral
Trichloromethane	$CHCl_3$		Polar	tetrahedral

6. Write a full balanced chemical equation and net ionic equation for the reaction between silver nitrate and potassium iodide **(4 marks)**

$AgNO_3(aq) + KI(aq) \rightarrow AgI(s) + KNO_3(aq)$

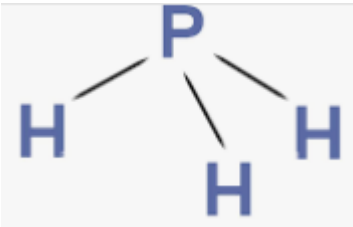
1-----mark for correct formulas 1-----mark for correct states.

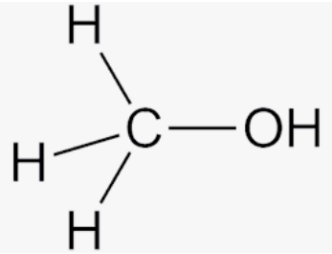
$Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$

1-----mark for correct ions 1-----mark for balanced charge.

7. Methanol (CH_3OH) and phosphine (PH_3) are molecules with a similar molar mass.

a) Draw full structural diagrams showing **all** bonds, in 3D, for methanol and phosphine in the space provided below. **(2 marks)**





1-----mark for correct 3d orientation

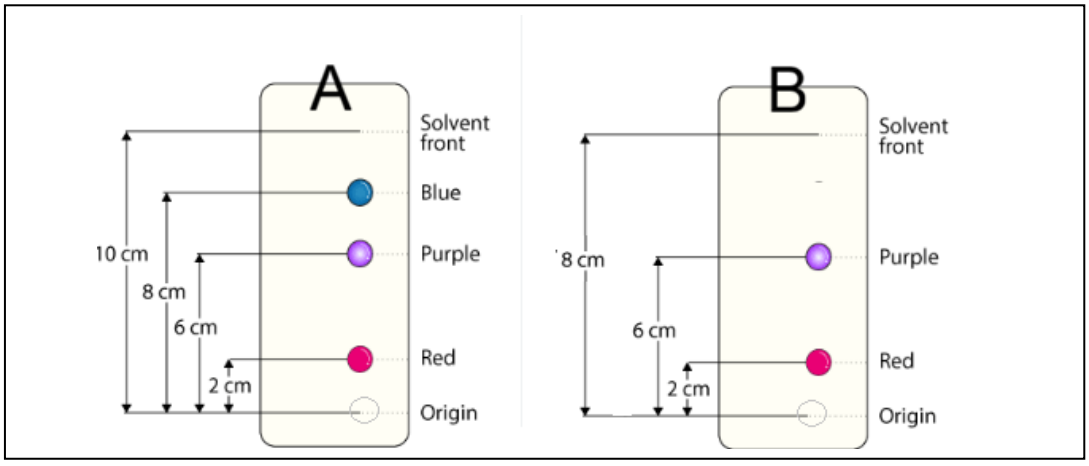
1-----mark for correct structural formula

b) Explain why the boiling point of methanol (65°C) is much higher than that of phosphine (–88°C). **(2 marks)**

1-----mark Methanol has intermolecular forces composed of H-bonding and dispersion forces, phosphine intermolecular forces composed of dispersion forces and weak dipole-dipole interactions due to the asymmetry of the molecule.

1-----mark for stating that the intermolecular forces of methanol are stronger than those of phosphine and require more energy to break.

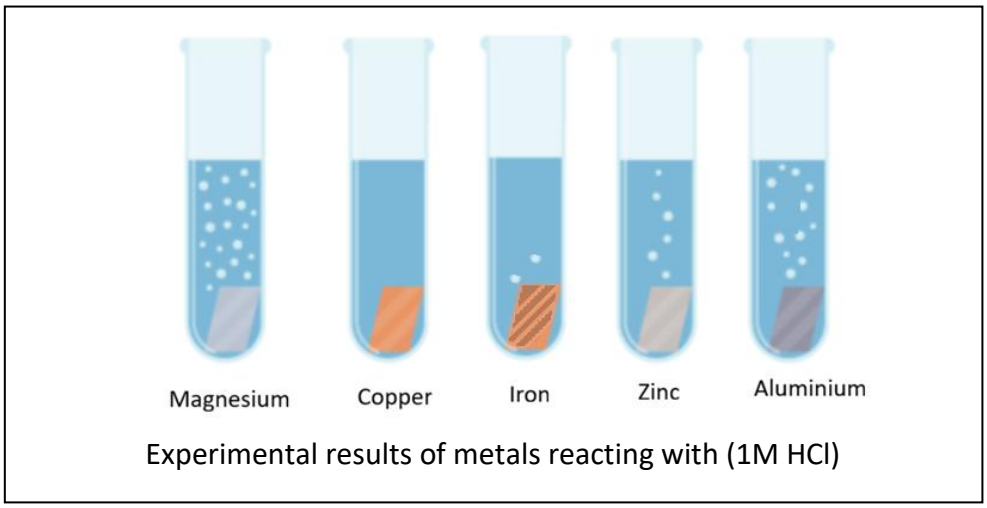
8. Two separate inks were tested using paper chromatography. Both chromatograms are shown below.



Is the same purple dye used in both of these inks? Justify your answer with a calculation based on the chromatograms given above.. **(4 marks)**

1-----mark no it is note the same purple dye.
1-----mark the R_f value for each purple dye is different.
1-----mark $R_{f\ for\ A}$ = 8/10 =0.8
1-----mark $R_{f\ foe\ B}$ = 6/8 = 0.75

9. Five metals were placed in separate test tubes with 10 mL of 1 M HCl. Gas was seen to evolve and bubble out of solution. The results are shown below.



Experimental results of metals reacting with (1M HCl)

a. Place the metals in order of reactivity, most reactive metals on the left and least reactive on the right. **(1 mark)**

___*Mg*_____, _____*Al*____, ___*Zn*_____, _____*Fe* _____, ____ *Cu* _____

Increasing reactivity

b. For each of the metal pairs place an arrow to indicate in which direction electrons will travel when the metals are placed so they are in contact with each other. **(2 marks)**

Magnesium _____ _____ Copper

Aluminium _____ _____ Zinc

c. Consider the rivets shown on the right. When left out in the rain the rivets were badly rusted. Using your chemical knowledge of reactive metals identify the metal that rusted and give an explanation.

1-----mark Iron is the metal that rusted.
1----- mark Electrons flow from iron to copper (less reactive metal). Iron therefore loses electrons and rusts (forms ions such as Fe^{2+}*)*


Copper and aluminium rivets.