MOLECULAR SUBSTANCES

1) Fill in the spaces in the passage with suitable words.

Simple molecular substances are substances made of ..... . A molecule is a particle made from atoms joined together by ..... bonds. A covalent bond is ..... shared electrons between two atoms. Simple molecular substances have ..... melting and boiling points. This is because there are weak forces between the ..... . They do not conduct electricity because molecules are not electrically charged, they are ..... .

2) Give the letters of the substances in the table which have a simple molecular structure. .....

Substance	Melting point (°C)	Boiling point (°C)	Electrical conductivity as	
			solid	liquid
A	125	192	does not conduct	does not conduct
B	212	352	does not conduct	does not conduct
C	-39	357	conducts	conducts
D	732	1037	does not conduct	conducts
E	1984	2510	does not conduct	does not conduct
F	-196	-152	does not conduct	does not conduct

3) Some stick diagrams are shown below. Complete the dot-cross diagram for each molecule.

Substance	hydrogen bromide HBr	sulfur dichloride SCl_2	phosphorus chloride PCl_3
Stick diagram	H—Br	Cl—S—Cl	Cl—P(—Cl)—Cl
Dot-cross diagram	H Br	Cl S Cl	Cl P Cl Cl

4) Complete the stick diagram and draw a dot-cross diagram for each molecule shown below.

Substance	bromine Br_2	hydrazine N_2H_4	oxygen fluoride OF_2
Stick diagram	Br Br	H N N H H H	F O F
Dot-cross diagram			

Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Understands key properties of molecular substances		
Good SPG			Knows which compounds are molecular		
Knows what a molecule is			Can draw dot-cross diagrams		
Knows what a covalent bond is			Can draw stick diagrams		

DRAWING MOLECULES 1

When non-metals combine with other non-metals, the atoms share electrons to form a molecule. The atoms are held together by these shared electrons which are known as covalent bonds.

Molecule = a particle made up of atoms joined by covalent bonds **Covalent bond** = 2 shared electrons

How many covalent bonds?

Atoms	Number of electrons in outer shell	Number of extra electrons needed to fill the outer shell	Number of covalent bonds formed
Group 7 (e.g. F, Cl, Br, I)	7	1	1
Group 6 (e.g. O, S)	6	2	2
Group 5 (e.g. N, P)	5	3	3
Group 4 (e.g. C, Si)	4	4	4
H	1	1	1

Drawing stick diagrams & dot-cross diagrams

Stick diagrams – these show each covalent bond as a stick.

Dot-cross diagrams – these show the outer shell electrons only

1 Draw a stick diagram

2 Re-draw the stick diagram without the sticks

3 Replace the stick with a **X●** which represents the two electrons in the bond (**X** represents electrons from one atom, and ● represents the electron from the other atom).

4 Add in any other outer shell electrons from each atom (electrons are always in pairs)

5 CHECK that there are 8 electrons around each atom (except H where there should be 2 electrons)

Stick diagram	Molecule	Dot-cross diagram
	CH_4	
	NH_3	
	O_2	

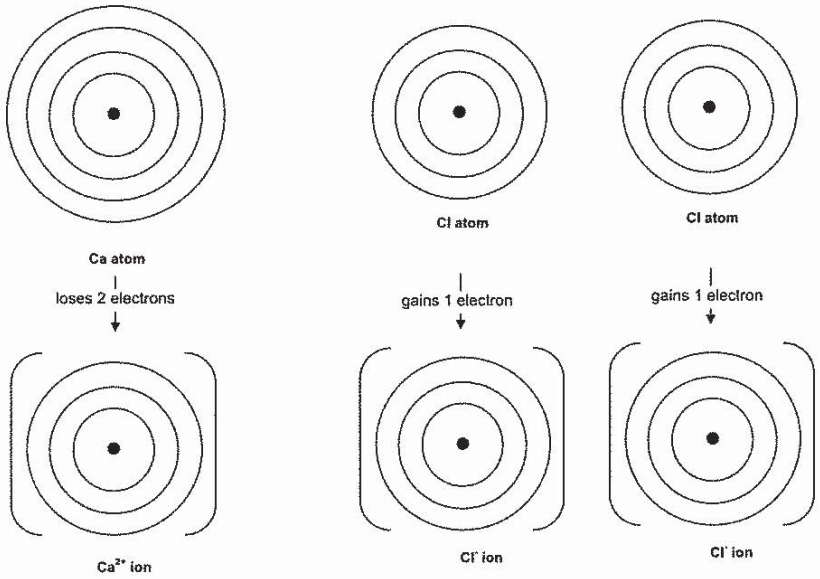
	HCl	
	Br_2	
	PH_3	
	CO_2	
	SiH_4	
	H_2O	
	N_2	
	C_2H_4	
	C_2H_2	
	C_6H_6	

Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Can draw stick diagrams		
Can deduce the number of covalent bonds an atom forms			Can write dot-cross diagrams		

IONIC COMPOUNDS 1

1) Calcium atoms reacts with chlorine atoms to form the ionic compound calcium chloride. Calcium atoms each lose two electrons to form calcium ions. Chlorine atoms each gain one electron to form chloride ions. This means that calcium atoms react with chlorine atoms in the ratio of one calcium atom for every two chlorine atoms.

Complete the following diagram to show the electronic structure of the calcium and chlorine atoms and the calcium and chloride ions.



2) Complete this passage:

The elements in Group 1 of the Periodic Table are called the ..... . They are all metals. When any Group 1 element reacts with a non-metal, an ionic compound is formed in which the metal ion has a ..... charge (e.g. Li^+, Na^+, K^+, Rb^+, Cs^+) as the metal atom ..... one electron.

The elements in Group 7 of the Periodic Table are called the ..... . They are all non-metals. When any Group 7 element reacts with a metal, an ionic compound is formed in which the ion has a ..... charge (e.g. F^-, Cl^-, Br^-, I^-, called halide ions) as the non-metal ..... one electron.

3) When metals react with non-metals:

a) What happens to the metal atoms? .....

b) What happens to the non-metal atoms? .....

c) What type of substance is made? .....

4) Potassium reacts with fluorine to form potassium fluoride.

a) Potassium is in Group 1 of the Periodic Table. Name this group. .....

b) Fluorine is in Group 7 of the Periodic Table. Name this group. .....

c) Give the formula of the potassium ions in potassium fluoride. .....

d) Give the formula of the fluoride ions in potassium fluoride. .....

e) Draw the electronic structure of the potassium and fluoride ions formed in the space below.

f) Explain why potassium fluoride has a high melting point. .....

.....

g) Explain why potassium fluoride conducts electricity when dissolved or molten but not as a solid. .....

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Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Names of Gp 1 & 7			Why ionic compounds have high mpt		
Good SPG			Ions formed from Gp 1 & 7			Explain conductivity of ionic cpds		
Electron structure of atoms/ions			When metals & non-metals react					

IONIC FORMULAE 1

1

a) sodium iodide .....
b) potassium oxide .....
c) aluminium chloride .....
d) magnesium bromide .....
e) aluminium oxide .....
f) iron(II) oxide .....
g) iron(III) oxide .....
h) magnesium sulfide .....
i) copper(II) fluoride .....
j) lithium iodide .....
k) barium bromide .....
l) zinc(II) sulfide .....
m) lead(II) iodide .....
n) iron(III) sulfide .....
o) magnesium oxide .....
p) rubidium bromide .....
q) strontium chloride .....
r) caesium selenide .....
s) calcium astatide .....
t) radium polonide .....
u) gallium fluoride .....
v) scandium(III) bromide .....
w) chromium(III) oxide .....
x) strontium iodide .....
y) lithium arsenide .....

2

a) sodium sulfate .....
b) calcium sulfate .....
c) magnesium hydroxide .....
d) zinc(II) nitrate .....
e) copper(II) carbonate .....
f) sodium hydroxide .....
g) potassium carbonate .....
h) iron(III) hydroxide .....
i) ammonium nitrate .....
j) ammonium hydroxide .....
k) iron(III) sulfate .....
l) aluminium nitrate .....
m) silver(I) nitrate .....
n) calcium carbonate .....
o) magnesium nitrate .....
p) ammonium astatide .....
q) caesium nitrate .....
r) strontium hydroxide .....
s) platinum(II) nitrate .....
t) cobalt(II) carbonate .....
u) copper(I) oxide .....
v) copper(II) oxide .....
w) francium telluride .....
x) gold(I) fluoride .....
y) rubidium sulfate .....

Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Knows charge and formula of common multi-element ions		
Can deduce charge of main group ions			Can write simple ionic formula		
Can deduce charge of ions with roman numerals			Can write more complex ionic formula		

REACTIONS OF ACIDS 1

metal + acid → .....

metal oxide + acid → .....

metal hydroxide + acid → .....

metal carbonate + acid → .....

ammonia + acid → .....

PART A Complete the table to show the name of the salt formed when the following acids react with the bases.

	nitric acid, HNO_3	hydrochloric acid, HCl	sulfuric acid, H_2SO_4
sodium carbonate, Na_2CO_3			
magnesium, Mg			
potassium oxide, K_2O			
copper hydroxide, $Cu(OH)_2$			
ammonia, NH_3			

PART B Now complete the following word equations for reactions between some acids and some bases.

1) iron + hydrochloric acid → .....

2) hydrochloric acid + copper carbonate → .....

3) iron(II) hydroxide + sulfuric acid → .....

4) nitric acid + calcium oxide → .....

5) sulfuric acid + ammonia → .....

6) ..... → zinc sulfate + water + carbon dioxide

7) ..... → magnesium nitrate + hydrogen

8) ..... → ammonium nitrate

9) ..... + potassium oxide → potassium chloride + ...

10) calcium hydroxide + ... → calcium citrate + ...

PART C On the back of the sheet, write a balanced equation for reactions 2-9.

Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Word equations for acid + oxide			Write formulae		
Good SPG			Word equations for acid + hydroxide			Write balanced equations		
Can identify salts formed from acids			Word equations for acid + carbonate					
Word equations for acid + metal			Word equations for acid + ammonia					

BALANCING EQUATIONS 1

- An equation is balanced when there are the same number of atoms of each type on both sides of the equation.
- An equation can only be balanced by putting numbers in front of formulas – you cannot change the formula itself.
- Equations can be written with state symbols: (s) = solid, (l) = liquid, (g) = gas, (aq) = aqueous (dissolved in water).

How to balance an equation:

a) Calculate how many atoms of each type are on each side of the equation.

b) If the numbers are the same then the equation is balanced.

c) If the numbers are not the same, then numbers are put in front of the formulas (this adds more of that substance). You cannot change the formulas (this would make a different substance). Hint – start with unbalanced elements that only appear in one substance on each side of the equation.

d) Keep doing this until the equation is balanced.

e.g. $CH_4 + O_2 \rightarrow CO_2 + H_2O$

Questions

Put your final answers here although you may wish to do your working on a separate sheet of paper or on the back.

1) $Ca + O_2 \rightarrow CaO$

2) $Na_2O + H_2O \rightarrow NaOH$

3) $Al + O_2 \rightarrow Al_2O_3$

4) $Na + Cl_2 \rightarrow NaCl$

5) $Na_2CO_3 \rightarrow Na_2O + CO_2$

6) $K + O_2 \rightarrow K_2O$

7) $C_4H_8 + O_2 \rightarrow CO_2 + H_2O$

8) $Fe_2O_3 + HCl \rightarrow FeCl_3 + H_2O$

9) $F_2 + KBr \rightarrow KF + Br_2$

10) $C_5H_{12} + O_2 \rightarrow CO_2 + H_2O$

11) $NH_3 + O_2 \rightarrow NO + H_2O$

12) $HNO_3 \rightarrow NO_2 + H_2O + O_2$

RELATIVE FORMULA MASS

Calculate the relative formula mass of the following substances.

1 F_2 .....

2 Fe .....

3 H_2SO_4 .....

4 Al_2O_3 .....

5 $Mg(OH)_2$ .....

6 $Al(NO_3)_3$ .....

7 $(NH_4)_2SO_4$ .....

8 $CuCO_3$ .....

9 $AgNO_3$ .....

10 NH_4NO_3 .....

11 $CuSO_4.5H_2O$ .....

12 magnesium .....

13 oxygen .....

14 sodium bromide .....

15 calcium fluoride .....

16 potassium sulfate .....

17 chlorine .....

18 chromium(III) oxide .....

19 sodium .....

20 iron(III) sulfate .....

Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Can work out M_r from complex formula		
Can work out M_r from simple formula			Can write write formulae		

MOLES

1) Calculate the number of moles of each of the following substances. Give your answers to 3 sig figs.

a) 90.0 g of H_2O .....

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b) 20.0 g of C_4H_{10} .....

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c) 685 g of NH_3 .....

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d) 102 tons of O_2 .....

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e) 2.00 kg of Al_2O_3 .....

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f) 20.6 mg of Au .....

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2) Calculate the mass of each of the following substances. Give your answers to 3 sig figs.

a) 4.00 moles of N_2 .....

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b) 0.100 moles of HNO_3 .....

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c) 0.0200 moles of K_2O .....

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d) 2.50 moles of PH_3 .....

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e) 0.400 moles of C_2H_5OH .....

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f) 10.0 moles of $Ca(OH)_2$ .....

.....

3) 0.0200 moles of a compound is found to have a mass of 1.64 g. Find the formula mass of the compound. Give your answers to 3 sig figs. .....

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Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Can find moles from mass			Can convert units		
Shows suitable working			Can find mass from moles			Can find M_r from mass and moles		
Can work out M_r			Can use sig figs			Gives units		

REACTING MASS CALCULATIONS - INTRODUCTION

Step 1 Write ✓ for the substance whose mass is given and ? for the substance whose mass is to calculated on the balanced equation

Step 2 Find the moles of the ✓ substance (using $\boldsymbol{moles} = \frac{\boldsymbol{mass}}{\boldsymbol{M_r}}$)

Step 3 Use the balanced equation and your answer from step 2 to find the moles of the ? substance

Step 4 Find the mass of the ? substance (using $\boldsymbol{mass} = \boldsymbol{M_r} \boldsymbol{x} \boldsymbol{moles}$)

1) What mass of oxygen reacts with 12 g of magnesium? $2Mg + O_2 \rightarrow 2MgO$

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2) What mass of calcium hydroxide is made from 14 kg of calcium oxide? $CaO + H_2O \rightarrow Ca(OH)_2$

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3) What mass of aluminium is needed to react with 640 g of iron oxide? $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$

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4) What mass of titanium chloride reacts with 460 g of sodium? $TiCl_4 + 4Na \rightarrow Ti + 4NaCl$

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