

FORMULA OF COMPOUNDS

4.9.1

Use your copy of the periodic table to help you answer these questions.

(a) Predict the formula of each of the following compounds.

(i) barium oxide [1]

(ii) boron oxide [1]

(b) Give the formula of the following ions.

(i) sulphide [1]

(ii) gallium [1]

-----Marking Scheme-----

(a) (i) BaO [1]

(ii) B₂O₃ [1]

(b) (i) S²⁻ [1]

(ii) Ga³⁺ [1]

4.9.2

The table below shows the elements in the second period of the Periodic Table and some of their oxidation states in their most common compounds.

(i) Give the formulae of lithium fluoride and nitrogen fluoride.

lithium fluoride

nitrogen fluoride [2]

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-----Marking Scheme-----

(i) LiF
NF₃

[1]
[1]

Use your copy of the Periodic Table to help you answer some of these questions.

(a) Predict the formulae of the following compounds.

(i) nitrogen fluoride

(ii) phosphorus sulfide

[2]

(b) Deduce the formulae of the following ions.

(i) selenide

(ii) gallium

[2]

(c) Use the following ions to determine the formulae of the compounds.

ions OH^- Cr^{3+} Ba^{2+} SO_4^{2-}

compounds

(i) chromium(III) sulfate

(ii) barium hydroxide

[2]

[Total: 6]

-----Marking Scheme-----

(a)(i)	NF ₃ ;	1
(a)(ii)	P ₂ S ₃ ;	1
(b)(i)	Se ²⁻ ;	1
(b)(ii)	Ga ³⁺ ;	1
(c)(i)	Cr ₂ (SO ₄) ₃ ;	1
(c)(ii)	Ba(OH) ₂ ;	1

4.9.4

Use your copy of the Periodic Table to help you answer these questions.

(a) Predict the formula of each of the following compounds.

(i) aluminium fluoride [1]

(ii) arsenic oxide [1]

(iii) silicon bromide [1]

(b) Deduce the formula of each of the following ions.

(i) phosphide [1]

(ii) barium [1]

(iii) francium [1]

-----Marking Scheme-----

(a)(i)	AlF_3 ;	1	
(a)(ii)	As_2O_3 ;	1	A As_2O_5
(a)(iii)	SiBr_4 ;	1	
(b)(i)	P^{3-} ;	1	
(b)(ii)	Ba^{2+} ;	1	
(b)(iii)	Fr^+ ;	1	

4.9.5

The halogens are a group of non-metals in Group VII of the Periodic Table.

The halogens form interhalogen compounds. These are compounds which contain two different halogens.

Deduce the formula of the compound which has the composition 0.013 moles of iodine atoms and 0.065 moles of fluorine atoms.

.....
..... [2]

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-----Marking Scheme-----

M1 (0.013 moles of I and 0.065 moles of F atoms gives a) ratio 1:5; Formula = IF ₅ ;	Award 2 marks for IF ₅ 2 A one mark for I ₅ F (as ratio is inverted) A one mark for IF ₆ or I ₅ F ₁
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4.9.6

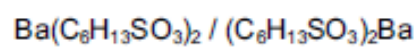
Sulfuric acid is a strong acid. Hexanesulfonic acid is also a strong acid. It has similar properties to sulfuric acid.

The formula of the hexanesulfonate ion is $\text{C}_6\text{H}_{13}\text{SO}_3^-$.

The formula of the barium ion is Ba^{2+} . What is the formula of barium hexanesulfonate?

..... [1]

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[1]

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4.9.7

The titanium ore contains 36.8% iron, 31.6% titanium and the remainder is oxygen.

- (i) Determine the percentage of oxygen in this titanium compound.

percentage of oxygen = % [1]

- (ii) Calculate the number of moles of atoms for each element.

The number of moles of Fe is shown as an example.

number of moles of Fe = $36.8/56 = 0.66$

number of moles of Ti =

number of moles of O = [1]

- (iii) What is the simplest ratio for the moles of atoms?

Fe : Ti : O
..... : :

[1]

- (iv) What is the formula of this titanium compound?

..... [1]

(i) percentage of oxygen = 31.6% [1]

(ii) calculate the number of moles of atoms for each element

number of moles of Ti = $31.6/48 = 0.66$

number of moles of O = $31.6/16 = 1.98$ **accept 2** [1]
both correct for one mark

(iii) the simplest whole number ratio for moles of atoms:

Fe	:	Ti	:	O	
1		1		3	[1]

(iv) formula is FeTiO_3 **accept** TiFeO_3 [1]
must be whole numbers from (iii) or cancelled numbers from (iii)
mark ecf throughout

4.9.8

The table below shows the elements in the second period of the Periodic Table and some of their oxidation states in their most common compounds.

element	Li	Be	B	C	N	O	F	Ne
number of outer electrons	1	2	3	4	5	6	7	8
oxidation state	+1	+2	+3	+4	-3	-2	-1	0

(i) Give the formulae of lithium fluoride and nitrogen fluoride.

lithium fluoride

nitrogen fluoride [2]

(i) LiF
NF₃

[1]
[1]

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4.9.9

Two of the oxidation states of vanadium are +3 and +4.

- (i) Write the formula of vanadium(III) oxide and of vanadium(IV) oxide.

vanadium(III) oxide

vanadium(IV) oxide [2]

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-----Marking Scheme-----

(i) V_2O_3
 VO_2

[1]
[1]

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4.9.10

Use your copy of the Periodic Table to answer these questions.

Predict the formula of each of the following compounds.

(a) (i) germanium oxide

(ii) tellurium bromide [2]

(b) Give the formula of each of the following ions.

(i) strontium

(ii) fluoride [2]

-----Marking Scheme-----

- (a) (i) $\text{GeO}_2 / \text{GeO}$ [1]
(ii) $\text{TeBr}_2 / \text{TeBr}_4$ [1]
- (b) (i) Sr^{2+} [1]
(ii) F^- [1]

4.9.11

Use your copy of the Periodic Table to help you answer some of these questions.

(a) Predict the formulae of the following compounds.

(i) nitrogen fluoride

(ii) phosphorus sulfide

[2]

(b) Deduce the formulae of the following ions.

(i) selenide

(ii) gallium

[2]

(c) Use the following ions to determine the formulae of the compounds.

ions OH^- Cr^{3+} Ba^{2+} SO_4^{2-}

compounds

(i) chromium(III) sulfate

(ii) barium hydroxide

[2]

[Total: 6]

-----Marking Scheme-----

(a)(i)	NF ₃ ;
(a)(ii)	P ₂ S ₃ ;
(b)(i)	Se ²⁻ ;
(b)(ii)	Ga ³⁺ ;
(c)(i)	Cr ₂ (SO ₄) ₃ ;
(c)(ii)	Ba(OH) ₂ ;

4.9.12

Vanadium is a transition element.

Two of the oxidation states of vanadium are +3 and +4.

(i) Write the formula of vanadium(III) oxide and of vanadium(IV) oxide.

vanadium(III) oxide

vanadium(IV) oxide [2]

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(i) V_2O_3
 VO_2

[1]
[1]

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4.9.13

(a) Deduce the formula of iron(III) sulfate.

..... [1]

(b) What is the formula of a magnesium ion?

..... [1]

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-----Marking Scheme-----

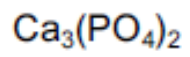
(a)	$\text{Fe}_2(\text{SO}_4)_3$;	1
(b)	Mg^{2+} ;	1

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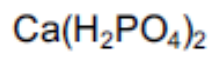
4.9.14

Rock phosphate (calcium phosphate) is obtained by mining. It reacts with concentrated sulphuric acid to form the fertiliser, superphosphate. Predict the formula of each of these phosphates.

fertiliser	ions	formula
(i) calcium phosphate	Ca^{2+} and PO_4^{3-}
(ii) calcium superphosphate	Ca^{2+} and H_2PO_4^- [2]



[1]



[1]

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4.9.15

Hydrocarbons are compounds which contain only carbon and hydrogen.

20 cm³ of a gaseous hydrocarbon was burned in 120 cm³ of oxygen, which is in excess. After cooling, the volume of the gases remaining was 90 cm³. Aqueous sodium hydroxide was added to remove carbon dioxide, 30 cm³ of oxygen remained. All volumes were measured at r.t.p..

(a) Complete the following.

volume of gaseous hydrocarbon =cm³

volume of oxygen used =cm³

volume of carbon dioxide formed =cm³ [2]

(b) Use the above volume ratio to find the mole ratio in the equation below and hence find the formula of the hydrocarbon.



hydrocarbon formula = [2]

-----Marking Scheme-----

- (a) volume of gaseous hydrocarbon 20 cm^3 [1]
volume of oxygen used = 90 cm^3 [1]
volume of carbon dioxide formed = 60 cm^3

no mark for 20 cm^3 of hydrocarbon.

- (b) $2\text{C}_3\text{H}_6(\text{g})/2\text{C}_x\text{H}_y(\text{g}) + 9\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$ [1]
OR ... $\text{C}_3\text{H}_6(\text{g}) + 9/2\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$

C_3H_6 [1]

C_3H_6 can be given in the equation for the second mark

4.9.16

20 cm³ of a hydrocarbon was burnt in 175 cm³ of oxygen. After cooling, the volume of the remaining gases was 125 cm³. The addition of aqueous sodium hydroxide removed carbon dioxide leaving 25 cm³ of unreacted oxygen.

(i) volume of oxygen used = cm³ [1]

(ii) volume of carbon dioxide formed = cm³ [1]

(iii) Deduce the formula of the hydrocarbon and the balanced equation for the reaction.

.....
.....
.....
..... [2]

- (i) volume of oxygen used = 150 cm^3 [1]
- (ii) volume of carbon dioxide formed = 100 cm^3 [1]
any equation of the combustion of an alkene
- (iii) e.g. $2\text{C}_5\text{H}_{10} + 15\text{O}_2 \rightarrow 10\text{CO}_2 + 10\text{H}_2\text{O}$ [1]
formulae [1]
COND balancing [1]

4.9.17

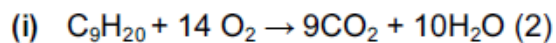
The complete combustion of hydrocarbons produces carbon dioxide and water only.

- (i) Write the equation for the complete combustion of nonane, C_9H_{20} .

..... [2]

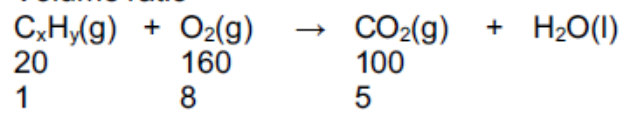
- (ii) 20 cm^3 of a gaseous hydrocarbon was mixed with an excess of oxygen, 200 cm^3 . The mixture was ignited. After cooling, 40 cm^3 of oxygen and 100 cm^3 of carbon dioxide remained. Deduce the formula of the hydrocarbon and the equation for its combustion. All volumes were measured at r.t.p..

.....
.....
.....
.....
.....
..... [3]

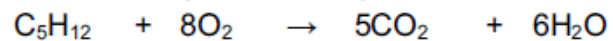


[2]

(ii) Volume ratio



all in cm³
mole ratio



For evidence of method (1)

for equation as above (2)

[3]

4.9.18

Deduce the molecular formula of the alcohol whose $M_r = 158$. Show your working.

.....

.....

..... [2]

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-----Marking Scheme-----

<p>if molecular formula is given as $C_{10}H_{22}O$ award 2 marks</p> <p>if not, look for evidence of some correct working for one mark</p> <p>$158 - 17 = 141$</p> <p>OR</p> <p>$12n + 2n + 1 = 141$</p> <p>OR</p> <p>$n = 10$</p>	<p>A $C_{10}H_{21}OH$ for two marks</p> <p>2 A $(10 \times 12) + (22 \times 1) + 16 = 158$ for one (working) mark</p>
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4.9.19

- (a) An analysis of the compound, $\text{Pb}(\text{C}_2\text{H}_5)_n$, showed that 0.026 moles of Pb was combined with 0.104 moles of C_2H_5 groups.
What is the value of n? Show how you arrived at your answer.

.....
..... [2]

- (b) Some of the pollutants emitted by vehicle exhausts are carbon monoxide, oxides of nitrogen and unburnt hydrocarbons. Explain how the emission of these gases is reduced by a catalytic converter.

.....
.....
..... [3]

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-----Marking Scheme-----

- (a) 0.104/0.026 [1]
n = 4 [1]
- (b) (oxides of nitrogen) change carbon monoxide into carbon dioxide [1]
oxides of nitrogen then become nitrogen [1]
(oxides of nitrogen) change hydrocarbons into carbon dioxide and water [1]
accept: balanced equations for first two marks
 $2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$ **and** $2\text{NO} \rightarrow \text{N}_2 + \text{O}_2$ [2]
oxygen changes hydrocarbons into carbon dioxide and water [1]