

FORMULAE OF COMPOUNDS AND IONS

1 Many organic compounds, such as alcohols, carboxylic acids and esters, contain the elements carbon, hydrogen and oxygen only.

(a) Compound **R** has the following composition by mass: C, 60.00%; H, 13.33%; O, 26.67%.

Calculate the empirical formula of compound **R**.

empirical formula = [2]

(b) Compound **S** has the empirical formula C_2H_4O and a relative molecular mass of 88.

Calculate the molecular formula of compound **S**.

molecular formula = [2]

MARKING SCHEME:

(a)	60 / 12 : 13.33 / 1 : 26.67 / 16 or evaluation 5 : 13.33 : 1.67 or 3:8:1	1
	C_3H_8O	1
(b)	$(C_2H_4O =) 44$	1
	$C_4H_8O_2$	1

- 2 (a)** Nickel(II) iodide crystals are hydrated. A sample of hydrated nickel(II) iodide crystals has the following composition by mass: Ni, 14.01%; I, 60.33%; H, 2.85%; O, 22.81%.

Calculate the empirical formula of the hydrated nickel(II) iodide crystals.

empirical formula = [2]

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MARKING SCHEME:

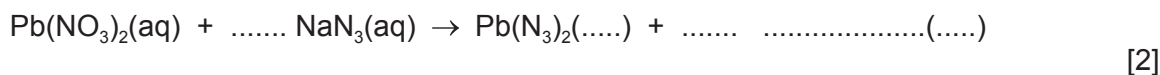
14.01/59 : 60.33/127 : 2.85/1 : 22.81/16 OR 0.237 : 0.475 : 2.85 : 1.43	1
$\text{NiI}_2\text{H}_{12}\text{O}_6$	1

3 Lead(II) azide is insoluble in water. Solid lead(II) azide can be made in a precipitation reaction between aqueous lead(II) nitrate and aqueous sodium azide. Lead(II) azide has the formula $\text{Pb}(\text{N}_3)_2$.

(a) (i) Deduce the formula of the azide ion.

..... [1]

(ii) Complete the chemical equation for the reaction between aqueous lead(II) nitrate and aqueous sodium azide to form solid lead(II) azide and aqueous sodium nitrate. Include state symbols.



(iii) Describe how you could obtain a sample of lead(II) azide that is **not** contaminated with any soluble salts from the reaction mixture.

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

(b) An organic compound made from sodium azide has the composition by mass: 49.5% carbon, 7.2% hydrogen and 43.3% nitrogen.

Calculate the empirical formula of the organic compound.

[3]

MARKING SCHEME

(a)(i)	N_3^-	1
	M1 state symbols on right correct (s) then (aq)	2
	M2 $\text{Pb}(\text{NO}_3)_2 + 2 \text{NaN}_3 \rightarrow \text{Pb}(\text{N}_3)_2 + 2\text{NaNO}_3$	
(ii)	M1 filter	2
(iii)	M2 wash with water	
(b)	M1 49.5 / 12 7.2 / 1 43.3 / 14 OR 4.125 7.2 3.093.... M2 1.33 : 2.33 : 1 OR 4 : 7 : 3 M3 $\text{C}_4\text{H}_7\text{N}_3$	3

4 Predict the formula of the compound formed between Ca^{2+} and N^{3-} .

..... [1]

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MARKING SCHEME

Si : 2 : 8 : 4	1
Ca^{2+} : 2 : 8 : 8	1
N^{3-} : 2 : 8	1

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5

25 cm³ of a gaseous hydrocarbon, C_xH_y, were burnt in 150 cm³ of oxygen. This was an excess of oxygen.

After cooling, the volume of the gases remaining was 100 cm³. This consisted of 75 cm³ of carbon dioxide and 25 cm³ of unreacted oxygen. The water that was produced in the reaction was liquid.

All volumes were measured at the same temperature and pressure.

(i) What is meant by an excess of oxygen?

..... [1]

(ii) What was the volume of oxygen that reacted with the hydrocarbon?

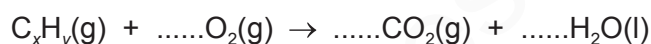
..... cm³ [1]

(iii) Complete the table to show the smallest whole number ratio of volumes.

	volume of hydrocarbon reacted	:	volume of oxygen reacted	:	volume of carbon dioxide produced
smallest whole number ratio of volumes		:		:	

[1]

(iv) Use your answer to (b)(iii) to balance the chemical equation. Deduce the formula of the hydrocarbon.



formula of the hydrocarbon = [2]

MARKING SCHEME:

(i)	more than enough oxygen to react with all of the hydrocarbon	1
(ii)	125 (cm ³)	1
(iii)	1:5:3	1
(iv)	C ₃ H ₈ If full credit is not awarded, allow 1 mark for C _x H _y (g) + 5O ₂ (g) → 3CO ₂ (g) + 4H ₂ O(l)	2