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]

MARKING SCHEME:

	14.01/59 : 60.33/127 : 2.85/1 : 22.81/16 **OR** 0.237 : 0.475 : 2.85 : 1.43	**1**
	$NiI_2H_{12}O_6$	**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 $Pb(N_3)_2$.

(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.

$Pb(NO_3)_2$(aq) + ... NaN_3(aq) $\rightarrow$ $Pb(N_3)_2$(.....) + ...(.....)

[2]

(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) **M2** $(Pb(NO_3)_2 +)$ 2 $(NaN_3) \rightarrow (Pb(N_3)_2 +)$ $2NaNO_3$	**2**
(ii)	**M1** filter **M2** wash with water	**2**
(iii) **(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** $C_4H_7N_3$	**3**

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

..... [1]

MARKING SCHEME

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

5 25 cm^3 of a gaseous hydrocarbon, C_xH_y, were burnt in 150 cm^3 of oxygen. This was an excess of oxygen.

After cooling, the volume of the gases remaining was 100 cm^3. This consisted of 75 cm^3 of carbon dioxide and 25 cm^3 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?

..... cm^3 [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.

$$C_xH_y(g) + ...O_2(g) \rightarrow .....CO_2(g) + ...H_2O(l)$$

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_3H_8 If full credit is not awarded, allow 1 mark for $C_xH_y(g)$ + **5**$O_2(g)$ → **3**$CO_2(g)$ + **4**$H_2O(l)$	**2**