

**TABLE 4-4**  
**Typical data on the ultimate analysis of the combustible components**  
**in residential MSW<sup>a</sup>**

Component	Percent by weight (dry basis)					
	Carbon	Hydrogen	Oxygen	Nitrogen	Sulfur	Ash
Organic						
Food wastes	48.0	6.4	37.6	2.6	0.4	5.0
Paper	43.5	6.0	44.0	0.3	0.2	6.0
Cardboard	44.0	5.9	44.6	0.3	0.2	5.0
Plastics	60.0	7.2	22.8	—	—	10.0
Textiles	55.0	6.6	31.2	4.6	0.15	2.5
Rubber	78.0	10.0	—	2.0	—	10.0
Leather	60.0	8.0	11.6	10.0	0.4	10.0
Yard wastes	47.8	6.0	38.0	3.4	0.3	4.5
Wood	49.5	6.0	42.7	0.2	0.1	1.5
Inorganic						
Glass <sup>b</sup>	0.5	0.1	0.4	<0.1	—	98.9
Metals <sup>b</sup>	4.5	0.6	4.3	<0.1	—	90.5
Dirt, ash, etc.	26.3	3.0	2.0	0.5	0.2	68.0

<sup>a</sup>Adapted in part from Ref. 6.

<sup>b</sup>Organic content is from coatings, labels, and other attached materials.

**EXAMPLE 4-2 Estimation of the chemical composition of a solid waste sample.** Determine the chemical composition of the organic fraction, without and with sulfur and without and with water, of a residential MSW with the typical composition shown in Table 3-4.

**Solution**

- Set up a computation table to determine the percentage distribution of the major elements composing the waste. The necessary computations are presented below:

Component	Wet weight, lb	Dry weight, lb	Composition, lb					
			C	H	O	N	S	Ash
Food wastes	9.0	2.7	1.30	0.17	1.02	0.07	0.01	0.14
Paper	34.0	32.0	13.92	1.92	14.08	0.10	0.06	1.92
Cardboard	6.0	5.7	2.51	0.34	2.54	0.02	0.01	0.28
Plastics	7.0	6.9	4.14	0.50	1.57	—	—	0.69
Textiles	2.0	1.8	0.99	0.12	0.56	0.08	—	0.05
Rubber	0.5	0.5	0.39	0.05	—	0.01	—	0.05
Leather	0.5	0.4	0.24	0.03	0.05	0.04	—	0.04
Yard wastes	18.5	6.5	3.11	0.39	2.47	0.22	0.02	0.29
Wood	2.0	1.6	0.79	0.10	0.68	—	—	0.02
Total	79.5	58.1	27.39	3.62	22.97	0.54	0.10	3.48

Moisture content = 21.4 lb (79.5 lb - 58.1 lb)

2. Prepare a summary table of the percentage distribution of the elements without and with the water contained in the waste.

Component	Weight, lb	
	Without H <sub>2</sub> O	With H <sub>2</sub> O
Carbon	27.39	27.39
Hydrogen	3.62	6.00
Oxygen	22.97	41.99
Nitrogen	0.54	0.54
Sulfur	0.10	0.10
Ash	3.48	3.48

3. Compute the molar composition of the elements neglecting the ash.

Component	Atomic weight, lb/mole	Moles	
		Without H <sub>2</sub> O	With H <sub>2</sub> O
Carbon	12.01	2.280	2.280
Hydrogen	1.01	3.584	5.940
Oxygen	16.00	1.436	2.624
Nitrogen	14.01	0.038	0.038
Sulfur	32.07	0.003	0.003

4. Determine an approximate chemical formula without and with sulfur and without and with water. Set up a computation table to determine normalized mole ratios.

Component	Mole ratio (Nitrogen = 1)		Mole ratio (Sulfur = 1)	
	Without H <sub>2</sub> O	With H <sub>2</sub> O	Without H <sub>2</sub> O	With H <sub>2</sub> O
Carbon	60.0	60.0	760.0	760.0
Hydrogen	94.3	156.3	1194.7	1980.0
Oxygen	37.8	69.1	478.7	874.7
Nitrogen	1.0	1.0	12.7	12.7
Sulfur	0.1	0.1	1.0	1.0

(a) The chemical formulas without sulfur are:

1. Without water  $C_{60.0}H_{94.3}O_{37.8}N$

2. With water  $C_{60.0}H_{156.3}O_{69.1}N$

(b) The chemical formulas with sulfur are:

1. Without water  $C_{760.0}H_{1194.7}O_{478.7}N_{12.7}S$

2. With water  $C_{760.0}H_{1980.0}O_{874.7}N_{12.7}S$

**Comment.** The fractional coefficients reported in these formulas are usually rounded off, as the original data do not warrant such precision.