NUMERICALS FOR PRACTISE

1. Using the moisture contents (wet basis) of the waste components given in Table P2-14, calculate the overall moisture content of the waste having the composition also shown. This calculation can be simplified by assuming 100 kg of waste.

Component	Moisture content, percent (wet basis)	Percent by weight
Food	70	10
Paper	6	33
Cardboard	5	8
Plastic	2	5
Textile	10	4
Rubber	2	3
Yard waste	60	18
Metals	3	10
Miscellaneous	6	9

2. Imagine a town where 10,000 households each fill one 300-L container of refuse per week. What volume would this refuse occupy in a landfill? Assume that 10% of the volume is occupied by the cover dirt.

Ans: $T = 555.56\ m^3$

3. A residential waste has the following components:

Paper	50%
Glass	20%
Food	20%
Yard waste	10%

Ans: 24%

4. A sample of refuse is analyzed and found to contain 10% water (measured as weight loss on evaporation). The heat value of the entire mixture is measured in a calorimeter and is found to be 8000 kJ/kg. A 1.0 g sample is placed in the calorimeter, and 0.2 g ash remains in the sample cup after combustion. What is

the comparable, moisture-free heat value and the moisture- and ash-free heat value?

Ans: $8888\ kJ/kg$; $11{,}428\ kJ/kg$

5. Using the energy content (wet basis) of the waste components given in the Table P2-17, calculate the overall energy content of the waste having the composition shown. This calculation can be simplified by assuming 100 kg of waste.

Component	Energy, kJ/kg	Percent by weight
Food	4,640	10
Paper	16,704	33
Cardboard	16,204	8
Plastic	32,480	5
Textile	17,400	3
Rubber	23,200	4
Yard waste	6,496	18
Metals	696	10
Miscellaneous	6,960	9

6. A family of four people generates solid waste at a rate of 1 kg/cap/day and the bulk density of refuse in a typical garbage can is about 120 kg/m^3. If the collection is once a week, how many 120-L garbage cans will they need, or the alternative, how many compacted 10-kg blocks would the family produce if they had a home compactor? How many cans would they in that case?

7. Determine the average density, composition and moisture content of the municipal solid waste for a typical Indian city. What is bulk density of the waste mixture prior to compaction? Assume that the compaction in the cell is 600 kg/m^3.

Description	Weight (%)	Typical density (kg/m^3)	Moisture content (%)
Food wastes	39.5	290	70
Yard wastes	3.8	240	60
Paper	0.85	85	6
Plastic	0.7	65	2
Glass/ceramics	0.5	195	2
Metal	0.65	160	2
Textile	2	65	8
Leather	2.5	160	10
Stones/bricks	40.5	480	10
Miscellaneous	9	240	8
Total	100.00		*(Ramachandra, 2003)*

8. Calculate the dry composition, average moisture content and average density of the MSW with the given data. Also find out which component has the greatest impact on the volume of the waste and moisture content. How does the volume composition differ from the waste composition by weight?

Components	Composition, % by wt.	Moisture content (%)
Food Waste	10	70.0
Paper	32	6.0
Cardboard	7	5.0
Plastics	6	2.0
Textiles	2	10.0
Rubber	1	2.0
Leather	2	10.0
Yard Waste	18	60.0
Wood	5	20.0
Glass	7	2.0
Metals	10	3.0

9. Determine the chemical composition of the organic fraction of the waste described below, with and without water.

Component	Wet weight (kg)	% Moisture content
Food wastes	9	70
Paper	34	6
Cardboard	6	5
Plastics	7	1
Textiles	2	10
Rubber	0.5	0
Leather	0.5	20
Yard wastes	18.5	65
Wood	2	20

Use the following data (fraction of each element in types of waste) for calculating composition:

Component	*C*	*H*	*O*	*N*	*S*	*Ash*
Food waste	0.480	0.064	0.376	0.026	0.004	0.050
Paper	0.435	0.060	0.440	0.003	0.002	0.060
Cardboard	0.440	0.059	0.446	0.003	0.002	0.050
Plastic	0.600	0.072	0.228	-	-	0.100
Textiles	0.550	0.066	0.312	0.046	0.002	0.025
Rubber	0.780	0.100	-	0.020	-	0.100
Leather	0.600	0.080	0.116	0.100	0.004	0.100
Yard wastes	0.478	0.060	0.380	0.034	0.003	0.045
Wood	0.495	0.060	0.427	0.002	0.001	0.015

Ans: Therefore, the chemical formula for this particular solid waste sample is $C_{654.95} H_{1036.84} O_{411.89} N_{11.06} S$ *without water &* $C_{654.95} H_{1720.80} O_{753.82} N_{11.06} S$ *with water.*

10. A 15 g sample of mixed MSW is combusted in a calorimeter having a heat capacity of 8750 cal/oC. The temperature increase on combustion is 2.75 oC. Calculate the heat value of the sample.

Ans: 1604.2 cal/g

11. The chemical formula for a waste mixture analyzed is $C_{654.95} H_{1036.84} O_{411.89} N_{11.06} S$. Determine the energy content using modified Dulong formula.

Ans: 18230.61 MJ/kg