

## Department of Building, Civil and Environmental Engineering

### ENGR 202: SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL STEWARDSHIP (SUMMER 2015, AA)

Assignment No. 2 (Given June 1, 2015; Due on June 8, 2015)  
(Total 9 marks)

**Special Instructions: Provide a cover page clearly showing your name and student ID. 10% of the total grade will be deducted for the late submission per day. Submit your assignment before class starts on the due date.**

**1 (2 marks).** In section 7.3.2., the recommended choice of material for the computer housing was PVC. Let's consider the option of making a computer housing entirely from steel. The environmental burdens for manufacturing the housing entirely with steel are assumed to be 10 times the burden associated with making a steel plate for the PVC housing shown in Table 7.7. Compare the inputs needed for 3 types of housings: **PVC with additives**, **PVC resin**, and **steel**. The first 2 housings require a steel plate, which has environmental burdens that must be added in. Which inputs (raw materials) have maximum values for the housing made of PVC with additives? Which inputs are maximum for the PVC resin? The steel housing?

**2 (2 marks).** Consider shipping the computer housing by trailer truck as described in Example 7.3. Each computer housing without packaging measures 45 cm x 45 cm x 20cm. If the computer housing could be shipped without packaging, determine the mass of PM emitted per housing for the same conditions as in Example 7.3. What fraction of PM would be emitted from transportation as compared with the emissions from manufacturing the housing?

**3 (2marks).** Based on your answer to the above problem. 2, it would be worthwhile minimizing packaging to reduce environmental effects associated with transportation. Assume that on average 10 % of the unpackaged housings in a shipment are damaged and must be discarded.

(a) Based on particular emissions from both manufacturing and transportation of the housing, would it be more beneficial to ship packaged or unpackaged housings? Ignore emissions from manufacturing the packaging material.

(b) Another transportation company using the same size trailer trucks claims they are more careful in handling the shipment. What is the maximum

breakage rate that would make it worthwhile to ship unpackaged housings based on particulate emissions?

**4 (2 marks).** Of the  $0.1 \mu\text{g/g}$  of lead in food, assume 80 % of this amount is a constant, whereas 20 % results from deposited airborne lead. The amount of deposited airborne lead in food varies in proportion to the airborne lead concentration, which varies over time as given in the problem solved at the end of the class. Write an expression for the amount of lead absorbed by a child as a function of time, and compute the total dose from food over the 10 year period. How does this compute with the total dose of lead from food, assuming constant exposure over this period (example 10.6)?

**5 (1 mark).** Solve part (c) of problem 10.5 in Rubin's textbook.

**Table 7.3** Inputs needed to make a computer housing for Example 7.2.

Substance	Units	3. Example 7.2			
		1. All Processes Up to and Including Producing PVC Resin (1.38 kg), Identical to Table 7.2, Column 1	2. Molding PVC Resin (1.72 kg), Assumed Same as Molding PVC Mixture in Table 7.2, Column 2	Calculation: Complete Production of Housing Made Entirely of PVC Resin (1.72 kg)	4. Complete Production of Housing Made of 1.38 kg Resin and 0.34 kg Additives (Copied from Table 7.2, Column 4)
<i>Raw Materials</i>					
Crude oil (in ground)	kg	0.65	0.016	0.83	0.94
Coal (in ground)	kg	0.27	0.26	0.6	0.81
Lignite (in ground)	kg	0	0.031	0.031	0.049
Natural gas (in ground)	kg	0.8	0.027	1	1.2
Limestone	kg	0.021	0	0.026	0.18
Sand	kg	0.0014	0	0.0017	0.0014
NaCl	kg	0.96	0	1.2	0.93
Bauxite	kg	0.0003	0	0.00038	0.00034
Iron ore	kg	0.0005	0	0.00063	0.00054
Ilmenite ore	kg	0	0	0	0.095
Water	liters	27	0.0088	34	55
Energy	MJ	89	12	123	137

**Table 7.7** Environmental burdens associated with an inventory analysis for manufacturing copper paint and also a steel plate, two options for shielding the PVC computer housing. In the last column, "s" indicates that the steel plate is preferred, whereas "c" indicates that copper paint is preferred.

Substance	Units	Steel Plate	Copper Paint	Difference (Copper – Steel)	
<b>Raw Materials</b>					
Crude oil (in ground)	kg	0.051	0.09	0.039	s
Coal (in ground)	kg	0.1	0.12	0.02	s
Lignite (in ground)	kg	0.012	0.014	0.002	s
Natural gas (in ground)	kg	0.011	0.1	0.089	s
NaCl	kg	0	0.0003	0.0003	s
Iron ore	kg	0.99	0	-0.99	c
Copper ore	kg	0	2.9	2.9	s
Water	liters	68	0.59	-67	c
Energy	MJ	22	13	-9	c
<b>Air Emissions</b>					
Particulate matter	g	23	0.4	-23	c
CO <sub>2</sub>	g	1,889	505	-1,400	c
CO	g	1.5	0.21	-1.3	c

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