

MAE160
HOMEWORK 1
Due Date: April 10, 2007

- 1)
- a) Commodity A is currently consumed at the rate C_A tonnes per year, and commodity B at the rate C_B tonnes per year ($C_A > C_B$). If the two consumption rates are increasing exponentially to give growths in consumption after each year of r_A % and r_B %, respectively ($r_A < r_B$), derive an equation for the time, measured from the present day, before the annual consumption of B exceeds that of A.
 - b) The table shows 2007 figures for the consumptions and growth rates of steel, aluminum and polymers. What are the doubling times (in years) for consumption of these commodities?
 - c) Calculate the number of years, measured from 2007, before the consumption of (a) aluminum and (b) polymers would exceed that of steel, if exponential growth continued. Is this continued growth probable?

Material	Current (2007) world consumption (tonnes per year)	Predicted growth rate in consumption (% year ⁻¹ , (2007))
Iron and steel	6×10^8	3
Aluminum	5×10^7	4
Polymers	1.8×10^8	5

- 2)
- a) Discuss ways of conserving engineering materials, and the technical and social problems involved in implementing them.
 - b) 12% of the world production of lead is used dissipatively as an antiknock compound in petrol. If laws were passed to prevent this use, how many years would it require before the consumption of lead returned to the level obtaining just before the new laws took effect? Assume that the other uses of lead continue to grow at an average rate 3% per year.
- 3)
- a) Explain what is meant by exponential growth in the consumption of a material.
 - b) A material is consumed at C_0 tonnes per year in 2007. Consumption is increasing at r % per year. If the resource base of the material is Q tonnes, and consumption continues to increase at r % per year, show that the resources will be half exhausted after a time $t_{1/2}$, given by

$$t_{1/2} = \frac{100}{r} \ln \left\{ \frac{rQ}{200C_0} + 1 \right\}$$

- c) Discuss, giving specific examples, the factors that might cause a decrease in the rate of consumption of a potentially scarce material.