Questions and Problems, Part III: The Practice, Chs. 8, 9 and 12 (40 points maximum, 32 points = 100%; * indicates a required question or problem)

*(20)8-1. Use the Travel cost method to evaluate the loss in consumer surplus to residents of surrounding counties if the St. James Foundation decided to increase its entry fee from $2 to $5 per car. Relevant data and instructions are provided in an excel spreadsheet file: [http://www.umr.edu/~rrbryant/cba/TC exercise1.xls](http://www.umr.edu/~rrbryant/cba/TC exercise1.xls).

*(20)12-1. Suppose there are two sources of pollution A and B. Currently there are 70 tons of emission annually with source A contributing 30 tons, and B 40 tons. The yearly cost of clean up is given by:

\[
C_A = \frac{(E_A^3)}{12} + 10 \quad \quad \quad C_B = \frac{(3E_B^3)}{4} + 45
\]

where \(E_A\) is the number of tons cleaned up by source A, and \(E_B\) is the number of tons cleaned by by source B. The marginal cost of clean up is \(\frac{\partial C}{\partial E}\), and given by:

\[
MC_A = \frac{(3E_A^2)}{12} \quad \quad \quad MC_B = \frac{(9E_B^2)}{4}.
\]

Suppose the benefits of clean up is given by: \(B = -0.25E^2 + 40E + 49\) where \(E\) is the number of tons cleaned by annually. The corresponding marginal benefit equation, is \(\frac{\partial B}{\partial E} = - 0.50E + 40\).

a. What is the efficient level of clean up? That is, how many tons should be cleaned up, and how should this clean up be divided between A and B? What are the annual net benefits of this level of clean up?

b. Contrast the efficient solution with an “equitable” solution that would reduce total emissions by 25 percent, by requiring a 25 percent reduction for both sources (from 70 to 52.5 total, and from 30 to 22.5 for source A, and from 40 to 30 for source B).

c. Suppose a tax on pollution is feasible. To accomplish the efficient clean up, as in part (a), what would be the tax per ton of emissions? What would this tax policy cost source A, source B? What is the social cost of the tax policy? Explain why the social cost (it should be the same as what you calculated in part (a) is different from the sum of the source cost. In practice, part of the cost to the firm will be shifted to the consumer in the form of higher prices. Since higher prices reduce the quantity demanded as consumer switch from “dirty” products to “clean” and now cheaper, products, the social cost will be less than you calculated in part (a). We may ignore these two considerations for this problem.

d. An alternative policy would be to issue transferable permits that allow the holder to either emit one ton per year, or sell the permit in a market for permits. To accomplish the efficient clean up, as in part (a), how many permits per year should be issued? Suppose the question of how to distribute the permits is settled by issuing permits based on historical emission levels. For example if 35 permits are issued source A would receive 3/7 of the permits, or 15, and source B would receive the remained, or 20 permits (= 4/7 of 35). How would this initial distribution
change given their transferable characteristic? That is, would A be willing to sell or buy permits from B? With an efficient allocation, how many permits will A use as a permit to emit pollution? How many will B use to emit pollution? How many tons will A clean up, how many will B clean up? What will be the equilibrium price of the permits? Last, what is the cost of clean up to society, to source A, and to source B? The cost to the sources will depend on the number of tons they clean up plus or minus revenue from the sale or purchase of permits. Although the market for permits would take time to adjust to an equilibrium price, you may assume for the purposes of this exercise the adjustment is instantaneous. That is, use the equilibrium price to determine the revenue gain or loss from selling or buying permits.

e. Suppose, now the marginal costs given above are uncertain. In setting the appropriate tax we may be wrong by either underestimating the marginal costs, \( MC_U \), or overestimating the marginal costs, \( MC_H \). The estimates are given below.

Under: \( MC_{AU} = \frac{(2E_A^2)}{12} \)

High: \( MC_{AH} = \frac{(4E_A^2)}{12} \)

Assume we know the benefit function and thus the marginal benefit function. What is the tax implied by the \( MC_{AU} \) and \( MC_{BU} \) functions? What is the tax implied by the \( MC_{AH} \) and \( MC_{BH} \) functions? Suppose we set the tax equal to the average of these two and the actual cost turns out to be \( MC_U \). What is the cost of our mistake? Suppose the actual cost turns out to be \( MC_H \) functions? What is the cost of our mistake? Assume our uncertainty pertains to whether marginal costs will be either higher or lower for both sources. That is, either \( MC_{AH} \) and \( MC_{BH} \), or \( MC_{AU} \) and \( MC_{BU} \).

f. Now assume that rather than the marginal costs being uncertain, marginal benefits are uncertain. Suppose the marginal costs are as they were originally:

\[ MC_A = \frac{(3E_A^2)}{12} \]
\[ MC_B = \frac{(9E_B^2)}{4} \]

We have two estimates of marginal benefits. They may be high: \( MB_H = -0.10 + 100 \); or low, \( MB_L = -1.0 + 20 \). What is the tax implied by the \( MB_H \) and \( MC \) functions? What is the tax implied by the \( MB_L \) and \( MC \) functions? What is the cost of a mistake?