Fall 2012 *ECON 460: Environmental Economics*

INSTRUCTIONS: Your final exam will be made of questions from this sheet plus questions from previous Homework (Though the numbers in the questions may change). In addition, there may be one or more question that you have not seen. You will NOT be permitted to bring any notes, cheat sheets or books into the exam.

1) How can (a) CAC regulation and (b) pollution taxes change market structure?

2) How does CV, EV, and CS measure a person's willingness to pay for changes in environmental quality? How do the three approaches differ and what are the advantages/disadvantages of each?

3) How does the hedonic model measure WTP for changes in environmental quality? What are the problems likely to be encountered with this technique?

4) What policy instrument would you advocate for a transboundary pollutant? Take into account efficiency, uncertainty, market structure, enforcement.

5) Why is cost efficiency a desirable goal of environmental policy? How is it achieved?

6) Explain how the modified ABS marketable permit policy works and what problems it is meant to address.

7) Suppose the government wishes to regulate mercury emissions of factories in a specific industry by either setting an emissions standard or imposing an emissions fee (per ton of mercury). The government is uncertain as to the marginal abatement costs, which may be high (MC_1) or low (MC_2).

$MC_1 = 15M + 500$
$MC_2 = 15M - 500$

where M is the units of mercury abated. The government believes there is a 50% chance of each of the marginal abatement costs. The marginal benefit of abatement is known to be:

$MB = 1500 - 10M$

a. What is the optimal level of emissions for each of the cost curves above?
b. What is the expected marginal abatement cost (equation)?
c. What is the optimal emissions standard according to the expected abatement costs?
d. What is the optimal abatement fee according to the expected abatement costs?
e. Which regulation will result in a lower DWL in the presence of the uncertainty? Explicitly compute the expected DWL arising from each proposal.

8) Suppose that there are three firms in a region that are producing a common emission. The marginal abatement cost (MS) for each firm is given by:

$\mathbf{MS_1 = 120 - E_1}$ $\mathbf{MS_2 = 96 - 0.8E_2}$ $\mathbf{MS_3 = 160 - 1.33E_3}$

The marginal damage function for the region is given as

$\mathbf{MD = (2/3)}E^T$ **{where** $\mathbf{E^T = E_1 + E_2 + E_3}$**}**

a) Find the aggregate MS for the region.
b) Find the socially optimal level of Emissions for the region
c) Suppose that the government imposes a *Uniform Standard* on the three firms that achieves the socially optimal level. What will be each firm's MS and TAC?
d) Now, instead of a standard, the government uses an Emission Tax. Find the tax rate that achieves the socially optimal level of emissions. Determine each firm's emissions, TAC, and Tax Bill. Compare the total cost to each firm from a tax policy to your answer in (c).
e) Suppose the government decides to use a Marketable Permit program. If permits are initially given to each firm in the amount equal to the uniform standard, then:
   i) Determine the final allocation of permits (after trading)
   ii) What is the net cost to each firm (TAC plus/minus permit revenues/costs)
   iii) Compare each firm's total cost under permit system to that of the uniform standard and the emission tax.

9) Suppose there are two firms with different MS's.

Firm 1: $MS_1 = 100 - E_1$ Firm 2: $MS_2 = 150 - 1.5E_2$

The government wishes to reduce total emissions to **100.**

a) Suppose the government imposes a uniform standard equal to 50 units per firm. Calculate the total abatement cost to each firm and graph your result. Does this meet the equi-marginal principle.
b) Now suppose the government wants to use an emissions tax. Find the tax rate that will reduce the total emissions by 100. What will be the emissions of each firm and what will be their total abatement cost under this system? Is abatement costs the firms' only cost under this system? *(Hint: find the aggregate MS to find the optimal tax)*
c) Which system would they prefer? Demonstrate your choice with numbers (costs)
d) Suppose each firm was allocated 50 permits. What would be the amount traded and what would be the NET private cost for each FIRM?

10) Suppose that the ***MD = 5E*** and with its current technology, the firm's MS is given by ***$MS_1 = 200 - 5E$.***
a) Determine the socially optimal level of emissions E. What is the TOTAL Social Cost?
b) Determine the emissions tax that would achieve the socially optimal level of emissions. What is the total PRIVATE costs to the Firm?
Now suppose the firm can adopt a new technology that changes is MS to
New ***$MS_2 = 160 - 4E$***

Assuming no change to standard or tax rate after the change in technology, Calculate change in costs for the firm from adopting the new technology when:
c) The government uses an emissions standard equal to your answer in (a) above
d) The government uses an emissions tax equal to your answer in (b)

Now suppose the government adjusts the standard and/or the tax such that MD = New MS. Calculate the change in total costs for the firm from adopting the new technology when:
e) The government adjusts the standard, and
f) The government adjusts the tax rate

11) Consider the following pollution offset problem: There are two firms, each with the same total abatement cost functions:
$TC_1 = (100 - e_1)^2$ and $TC_2 = (100 - e_2)^2$

The marginal cost functions are, respectively, are

$MC_1 = -200 + 2e_1$ and $MC_2 = -200 + 2e_2$

At receptor Station One, the diffusion coefficients are $a_{11} = 0.5$ and $a_{12} = 1$. The target ambient level is 100. Therefore, at Station One, the emission constraint is:

$0.5e_1 + e_2 = 100$

a) Determine the cost minimizing levels of emissions at Station One (hint: either use the Lagrange method or the method outlined in the text).

Now suppose that there is a second receptor, Station Two, that has the following emissions constraint:

$2e_1 + e_2 = 120$

Where the diffusion coefficients are $a_{21}=2$ and $a_{22} = 1$; with a target ambience of 120.

b) Use the same approach as in part (a) to determine the cost minimizing level of emissions that satisfy Station Two.

c) Carefully graph both constraints on a graph with e1 on the horizontal axis and e2 on the vertical axis. Indicate the region that satisfies both constraints.

d) Label the solutions to (a) and (b) on your graph. Can you determine if each violates the other constraint? Is there a solution where both constraints are satisfied? If so, which receptor has the binding constraint?

e) Suppose the government had initially granted emission permits to each firm: firm one was given 13.33 permits and firm two was given 93.33 permits. (These are the initial allocations that satisfy both constraints). Given the information in your answers for (a) to (d), determine who will sell permits and who will buy permits. What will be the price ratio of the permits that are traded?