

Instructions: The due date will be posted on the course website and announced in lecture. Late assignments will NOT be accepted. Assignments must be SINGLE SIDED with a cover page that includes your name, student number, tutorial number, and TA's NAME

Question 1

Suppose that the $MD = 5E$ and with its current technology, the firm's MAC is given by

$$MAC_1 = 200 - 5E.$$

- Determine the socially optimal level of emissions E .
- Determine the emissions tax that would achieve the socially optimal level of emissions.

Now suppose the firm can adopt a new technology that changes its MAC to

$$\text{New } MAC_2 = 160 - 4E$$

Calculate change in costs for the firm from adopting the new technology when:

- The government uses an emissions standard equal to your answer in (a) above
- The government uses an emissions tax equal to your answer in (b)

(Assume no change to standard or tax rate after the change in technology)

Now suppose the government adjusts the standard and/or the tax such that $MD = \text{New } MAC$. Calculate the change in total costs for the firm from adopting the new technology when:

- The government adjusts the standard, and
- The government adjusts the tax rate

Question 2

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

$$MAC_1 = 240 - 2E_1 \quad MAC_2 = 192 - 1.6E_2 \quad MAC_3 = 320 - 2.67E_3$$

The marginal damage function for the region is given as

$$MD = (4/3)E^T \quad \{\text{where } E^T = E_1 + E_2 + E_3\}$$

- Find the aggregate MAC for the region.
- Find the socially optimal level of Emissions for the region
- Suppose that the government imposes a Uniform Standard on the three firms that achieves the socially optimal level. What will be each firm's MAC 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:

- a. Determine the final allocation of permits (after trading)
- b. What is the net cost to each firm (TAC plus/minus permit revenues/costs)
- c. Compare each firm's total cost under permit system to that of the uniform standard and the emission tax.

Question 3 (40)

The Fireyear and Goodstone rubber companies whose factories produce finished rubber and sell it in to the highly competitive world market at a fixed price of \$60 per ton. The process of producing a ton of rubber produces a ton of air pollution that affects the environment. This 1:1 relationship between rubber output and pollution is fixed at both factories.

Let the output of Fire-year and Good-stone be Q_F and Q_G , respectively. The cost formulas for each firm are as follows:

Fire-year Total cost: $C = 300 + 2(Q_F)^2$ Marginal cost is $MC = 4Q_F$

Good-stone Total cost: $C = 500 + (Q_G)^2$ Marginal cost is $MC = 2Q_G$

Total pollution emissions generated are $E_F + E_G = Q_F + Q_G$. The marginal damage of pollution is constant per unit of E at \$12

- a) In the absence of regulation, how much rubber would be produced by each firm? What is the profit for each firm?
- b) The local government decides to impose a Pigouvian tax on pollution in the community. What is the proper amount of such a tax per unit of emissions? What are the post regulation outputs and profits of each firm?
- c) Suppose instead of an emissions tax, the government observes the outcome in part (a) and decides to offer a subsidy to each firm for each unit of pollution abated. What is the efficient per unit amount of such a subsidy? Again calculate the levels of output and profit for each firm.
- d) Compare the output and profits for the two firms in parts (a) through (c). Comment on the differences, if any, and the possibility of one or both firms dropping out of the market?