First Challenge
Environmental Economics: ECO 345

The following formulas may be useful.

Efficient Allocations

$$MRS^1_{xy} = MRS^2_{xy}, \quad MRTS^1_{LK} = MRTS^2_{LK}. \tag{1}$$

Market Allocations

$$MRS^1_{xy} = MRS^2_{xy} = -\frac{P_x}{P_y} = MRT_{xy}, \quad MRTS^1_{LK} = MRTS^2_{LK} = -\frac{w}{r}. \tag{2}$$

Efficient Allocations of goods with and without externalities

$$P_S = MC_S(S) = \frac{dC_s(S)}{ds}. \tag{3}$$

$$P_S = MC_S(S) + MD(S) = \frac{dC_s(S)}{ds} + \frac{dC_T(T,S)}{ds}. \tag{4}$$

Selling the Right to Pollute

$$P' = MD(S) = P_s - MC(S). \tag{5}$$

Pigouvian Tax

$$t = MD(S) = MD_1(S) + MD_2(S) + MD_3(S) = MC(S). \tag{6}$$

Short Answer (1-2 sentences per part!)

Question 1 (16 points)

Define each term in **bold** as a good or a bad, rival or non-rival, and excludable or non-excludable. Qualify your answer if necessary. Finally, for each does the market economy provide too much, too little, or the efficient amount of the good/bad?

   a. **Bacteria.** Red cedar trees are carriers of a bacteria which kills apple trees within a two mile radius.

   b. **Whales.** Inuit hunt whales for food and oil.

   c. **Whales.** Deana enjoys whale watching in Santa Barbara.

   d. **Rhinos.** Endangered rhinos in Disney's Animal Kingdom sometimes break through the park fence and trample resident's gardens.

Question 2 (16 points)

For each of the following, indicate whether or not the allocation is efficient. If not, come up with a Pareto preferred allocation.

   a. Firm one has $K = 2$ and $L = 4$ and Firm 2 has $K = 2$ and $L = 1$, and electricity (E) production for both firms is $E = \min(K, L)$.

   b. Jack has marginal rate of substitution of good x and pollutant p of $MRS^J_{xp} = 1$. April has $MRS^A_{xp} = 2$.

   c. Jack has 10 units of good x and 0 units of pollution p. April has $x = 0$ and $p = 6$.

   d. The production possibilities set for good x and pollutant p is $p \geq 4 + x^2$. Production is currently $x = 2$ and $p = 9$.

Question 3 (8 points)

Give one reason why the Endangered Species Act may in fact encourage killing of endangered species.

Longer Questions

Question 4 (20 points)

Mountaintop removal mining in West Virginia involves removing the top of a mountain to get at coal deposits inside the mountain. Dust and dirt from mountaintop removal damages nearby rivers. Let C be tons of coal produced. Suppose marginal damages to homeowners living along one of the rivers is:

$$MD(C) = 2C + 4. \tag{7}$$

The price of coal is $20 per ton. The mining company has total and marginal costs equal to:

$$TC\,(C) = C^2 + 8C + 36, \tag{8}$$

$$MC\,(C) = 2C + 8, \tag{9}$$

and marginal damages to homeowners are:

a. Calculate the efficient coal production.

b. Calculate the market provision of coal and mining profits assuming the assumptions of the Coase theorem does not hold.

c. If the mining company owns the river and the assumptions of the Coase theorem hold, will coal production be efficient? Explain.

d. Calculate the price the mining company would charge to reduce coal production.

e. Calculate the mining company's profits if the mining company owns the river.

Question 5 (20 points)

Suppose 60 people are willing to pay $1 each to clean up pollution. The remaining 40 people are more well off, and are willing to pay $10. The cost of pollution clean up is $420. Consider the following proposals:

- (I) Ignore the problem.
- (II) Split the $420 cost evenly across residents.
- (III) Split the cost evenly among the 40 well-off.

a. Will (II) pass with majority rule? Will (III) pass with majority rule?

b. Is (II) Pareto preferred to (I)? Is (III) Pareto preferred to (I)? Explain briefly.

c. Is (I) efficient? If not, come up with an allocation that is Pareto preferred.

Question 6 (20 points)

Consider two countries, the US and China. The US currently has more goods (G) than China, but also less pollution (P). We have:

- US consumption is about $30 (2005 thousand dollars), China's consumption is about $3.

- US SO_2 urban concentration is 15 ppm. China has SO_2 equal to 90 ppm.

One can move pollution to either country by moving goods production to that country. In turn, this generates more income for the country, which can therefore buy more goods. The tradeoff is such that production of 1.25 goods generates one part per million of pollution.

Assume China has a marginal rate of substitution of goods for pollution of $MRS_{GP}^c = 1$ and for the US $MRS_{GP}^{US} = 1.5$.

a. Graph the Edgeworth box diagram for this problem, putting the US in the lower left corner. Be sure to show the endowment point, the indifference curves at the endowment point, the market equilibrium, and the budget line.

b. Is China's pollution too low, too high, or efficient? Is China's goods consumption too low, too high, or efficient?

c. At the market equilibrium, what are the marginal rates of substitution of the US and China?

d. Consider the following statement by then World Bank chief economist Larry Summers: "the World Bank [should] be encouraging MORE migration of the dirty industries to the LDCs [Less Developed Countries]." Is Summer's statement true in this problem? What condition is required for Summer's statement to be true?