Economics 5250/6250 Dr. Lozada
Fall 2016 Midterm Exam

This exam has 33 points. There are six questions on the exam; you should work all of them. Half the questions are worth 5 points each and the other half are worth 6 points each.

Put your answers to the exam in a blue book or on blank sheets of paper.

Answer the questions using as much precision and detail as the time allows. Correct answers which are unsupported by explanations will not be awarded points. Therefore, even if you think something is "obvious," do not omit it. If you omit anything, you will not get credit for it. You get credit for nothing which does not explicitly appear in your answer. If you have questions about the adequacy of an explanation of yours during the exam, ask me.

For the question involving a figure, you may either draw on the original figure, then remove it from the exam and include it with your answers; or you may redraw the figure on your answer sheet. If you choose the first option, write your first name on each page (to prevent confusion if the page gets separated from the rest of your exam).

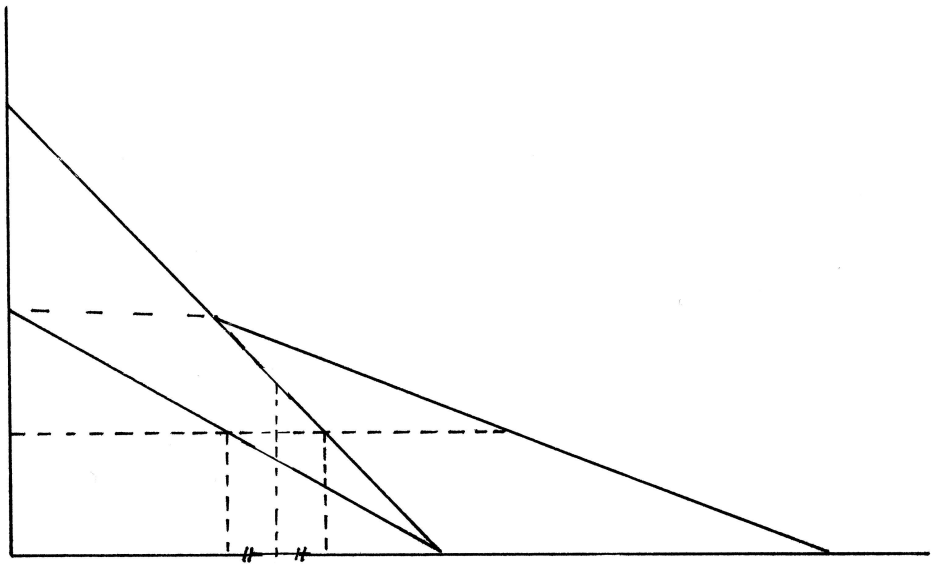

Figure 1

Answer all of the following six questions.

1. **[6 points]** Use Figure 1 to prove the efficiency of marketable permits compared to pollution standards. Label axes and all important points and explain thoroughly.

2. **[5 points]** What is the "assimilative capacity" of the environment for a pollutant?

   Other things being equal, in which situation is the socially optimal level of pollution larger: when the assimilative capacity is zero or when it is strictly positive? Illustrate with a graph.

3. **[5 points]** Draw the diagram typically used for analyzing simple Coasian bargaining situations. It should have an MEC curve and an MNPB curve. (What do "MEC" and "MNPB" mean? How are the diagram's axes labeled and why are they labeled that way?)

   Suppose pollution victims have the property right to clean air.

   (a) What does the standard Coase Theorem predict will happen? Why?

(b) Now assume that if pollution victims' incomes go up, their MEC curve changes.

i. When pollution victims' incomes go up, is the pollution victims' MEC curve likely to go up or to go down? Why?

ii. If the pollution victims' MEC curve behaves as you predict when pollution victims' incomes go up, would the economy still end up at the position you predicted in part (a) of this question? Why or why not?

4. **[6 points]** Consider three different allocations of money in a small society (for example, a society of 15 people.)

A. Start with $100.
Throw away $1.
Distribute the rest evenly.

B. Give $100 to one person and $0 to everyone else.

C. Distribute $100 evenly.

Create an example using these three allocations to support the following position:

> "Society should not use the criterion of 'Potential Pareto Improvement' to decide which policy changes should be made."

(In answering this question you are supposed to support this position, regardless of whether you actually support it or not.)

5. **[6 points]** We discussed several reasons why the Travel Cost Method might fail to accurately measure people's value of an environmental amenity (such as a national park). Two of the reasons were:

A. the problem of nearby sites (more than one site visited); and

B. the problem of "Substitute Sites" (only one site visited).

Tell me everything you know about these two problems. Be sure to distinguish one from the other.

6. **[5 points]** One of the effects of increasing carbon dioxide concentration in the atmosphere is the acidification of oceans.

(a) Why does increasing carbon dioxide concentration in the *atmosphere* cause acidification of *oceans*?

(b) What problems might acidification of oceans cause to humans? The following article, published in the *Salt Lake Tribune* on Nov. 9, 2016, might be helpful, but it would be good if you could add some more (direct or indirect) impacts on humans, and it would be good if you could explain why this article says there will be an impact on fishermen.

> Coral reefs around the globe already are facing unprecedented damage due to warmer and more acidic oceans. It's hardly a problem that just affects the marine life that depends on them or deep-sea divers who visit them.
>
> If carbon dioxide emissions continue to fuel the planet's rising temperature, the widespread loss of coral reefs by 2050 could have devastating consequences for tens of millions of people, according to new research published Wednesday in the scientific journal PLOS.
>
> To better understand where those losses would hit hardest, an international group of researchers mapped places where people most need reefs for their livelihoods, particularly for fishing and tourism, as well as for shoreline protection. They combined those maps with others showing where coral reefs are most under stress from warming seas and ocean acidification.
>
> Countries in Southeast Asia such as Indonesia, Thailand and Philippines would bear the brunt of the damage, the scientists found. So would coastal communities in western Mexico and parts of Australia, Japan and Saudi Arabia. The problem would affect countries as massive as China and as small as the tiny South Pacific island nation of Nauru.
>
> In many places, the loss of coral reefs would amount to an economic disaster, depriving fishermen of their main source of income, forcing people to find more expensive forms of protein.
>
> "It means jobs for lots of people," said Linwood Pendleton, the study's lead author and an international chair at the European Institute of Marine Studies.
>
> In addition, many countries depend on coral reefs as a key barrier to guard against incoming storms and mitigate the damage done by surging seas. Without healthy reefs, "you lose what is essentially a moving, undersea sea wall," said Pendleton.

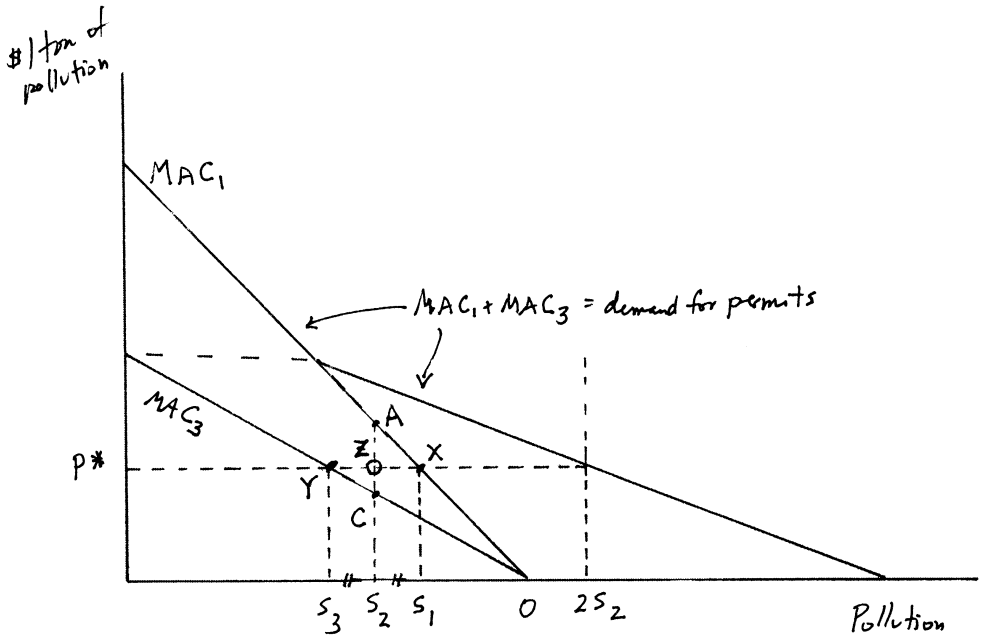

Figure 2

Answers to Midterm Exam, Econ. 5250, Fall 2016

1. Refer to Figure 2.

   The "marginal abatement cost" curves are MAC, for two firms "1" and "3." As pollution goes up, there is less abatement, so abatement is easier (less costly at the margin), so MAC falls as pollution rises.

   Command and Control: suppose firms are limited to S_2 pollution. Firm 1 goes to A and Firm 3 goes to C. Total pollution is $2S_2$. Firm 1's total abatement cost is OAS_2 and Firm 3's total abatement cost is OCS_2, since total abatement cost is the area under the marginal abatement cost curve.

   Tradeable Permits: Each MAC curve represents the "demand for permits" curve in the context of tradeable pollution permits. For example, if the permit price were P^*, Firm 3's demand for permits would be Y (or S_3): buying less permits than at S_3 would be a bad idea because it would lead it to less pollution, costing MAC_3, which at less than S_3 would be more costly than buying permits at P^*; and buying more permits than at S_3 would be a bad idea because it would lead

it to more pollution, costing P^* for the extra permits, which at more than S_3 would be more costly than abating at MAC_3.

The total demand for permits is the horizontal summation of the MAC's.

If each firm is given S_2 permits then the market supply is $2S_2$. The equilibrium price of permits is P^*, where market demand and supply of permits are equal.

In this equilibrium, Firm 1 goes to X and Firm 3 goes to Y. Total pollution is

$$\begin{aligned} S_3 + S_1 = S_3 - S_2 + S_2 + S_1 - S_2 + S_2 &= (S_3 - S_2) + S_2 + (S_1 - S_2) + S_2 \\ &= (S_3 - S_2) + S_2 - (S_2 - S_1) + S_2 \\ &= S_2 + S_2 \quad \text{since } (S_3 - S_2) = (S_2 - S_1) \\ &= 2S_2 \end{aligned}$$

which is the same as under Command and Control.

Firm 1's total abatement cost is OXS_1, which has fallen from its value under Command and Control by AXS_1S_2.

Firm 2's total abatement cost is OYS_3, which has risen from its value under Command and Control by YCS_2S_3.

The fall in total abatement cost of Firm 1 is greater than the rise in total abatement cost of Firm 3, so society's total abatement cost under Tradeable Permits is less than under Command and Control, while its pollution is the same. (Mathematical proof: fall in Firm 1's total abatement cost = $AXS_1S_2 > ZXS_1S_2 = YZS_2S_3 > YCS_2S_3$ = rise in Firm 3's total abatement cost.) So Tradeable Permits are more efficient than Command and Control.

2. see Fall 2008 Exam 1 Question 1

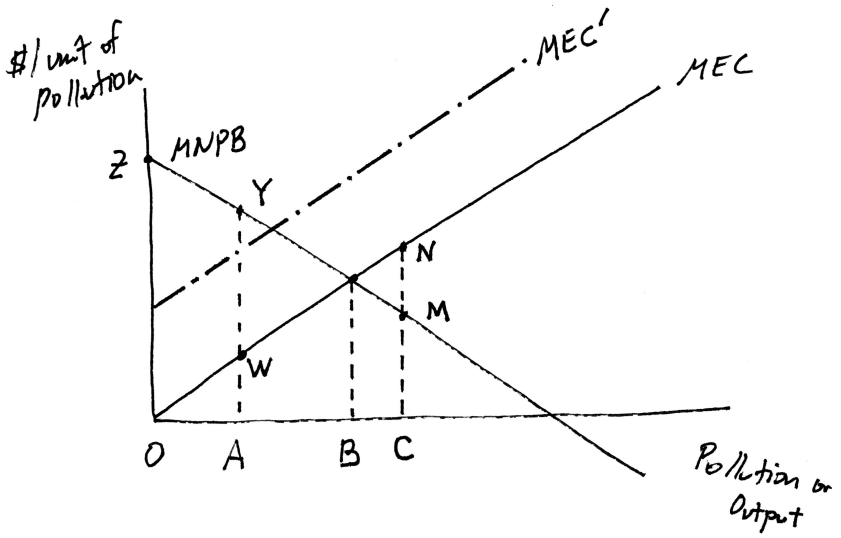

Figure 3

3. Refer to Figure 3.

   MEC is "marginal external cost." MNPB is "marginal net private benefit." In the figure, pollution is assumed to rise rigidly as output rises, so the horizontal axis can be either one. Ignore the dash-dotted MEC′ for now.

   As pollution rises, it becomes more damaging at the margin, so MEC rises. As output rises, additional units of output become less valuable (as marginal costs rise), so MNPB falls.

   (a) Bargaining begins at "O," where pollution victims assert their property right to clean air. However, clean air on the margin is worth 0 to them there, while firms value output at Z, so if firms offer to pay between 0 and Z for the right to pollute a little, victims will accept (if they behave non-strategically/myopically). At A, firms will offer Y or less to marginally increase pollution, and pollution victims would accept W or more, so a deal to increase pollution from A would be made. At C, though, firms will offer M or less to marginally increase pollution, and pollution victims would accept N or more, so no deal to increase pollution from A could be made. Bargaining will end at B.

(b) i. With more income (for example because of payments by polluters to the pollution victims), pollution victims' ability to pay for pollution reductions increases. We would predict MEC would rise. (This would only fail to occur if clear air were an inferior good, which seems unlikely.)

ii. If MEC moves to MEC′, clearly the end point of bargaining is not B any more. It would be to the left of B (less pollution). The income which pollution victims get from the polluters shifts MEC in a way that results in an end point of less pollution than without this "income effect."

4. "A" is inefficient (not Pareto Optimal), whereas "B" and "C" are efficient, since nothing is wasted. (In "A," $1 is wasted.)

   A movement from "A" to "C" would be an ("actual") Pareto Improvement, because it would make everyone better off.

   A supporter of using the "Potential Pareto Improvement" criterion to decide which policy changes should be made could argue:

   > "We should move from A to B, because B is Pareto Efficient, and from B we could move to C, which is a Pareto Improvement over A."

   Someone critical of this position could say: "I do not want to move from A to B because B is much more unequal. It doesn't matter to me that from B would could potentially move to C, because we're not actually going to move to C, so I don't care about C."

   Note 1: even though "A" is not Pareto Optimal and "B" is Pareto Optimal, moving from "A" to "B" is not a Pareto Improvement, because it would not be unanimously agreed upon.

   Note 2: Another example would be: "A" is a tariff; "B" is "eliminate the tariff, which eliminates the inefficiency and hurts some people and helps other people"; and "C" is "eliminate the tariff and have the winners compensate the losers so everyone is better off." As in the exam's question, "A" is inefficient and both "B" and "C" are efficient; moving from "A" to "C" is a Pareto Improvement; and moving from "A" to "B" is a Potential Pareto Improvement but not an actual Pareto Improvement.

5. The Travel Cost Method ("TCM") asserts that people visiting a site value that site at least as much as the costs they spent to travel to it (because if they valued the site less than the cost of traveling to it, they would not have traveled to it).

   A: ["Nearby sites" problem: one visitor visits more than one site.] It's hard to determine the value of any one site visited if several are visited during one trip. For example, should the travel cost be divided equally? That seems inappropriate if the main purpose of the trip was to go to just one of the places and the others were visited merely because they were mildly interesting and were close to the main location of interest. However, there is no way to observe how interested the visitor was in each destination (without asking for a subjective piece of information—but that would change this into an expressed preference approach, whereas the Travel Cost Method is supposed to be revealed preference).

   B: ["Substitute sites" problem: two visitors visit the same site from different places.] Suppose Visitor A visited Site "X" and Visitor B also visited Site "X" and suppose, although A and B came from different places, the distance from A's home to X is about the same as the distance from B's home to X, so that A and B had approximately the same travel costs. So TCM would place equal values on X for A and for B. Yet suppose A's home has no sites similar to X which are close to it. Suppose B's home has many sites similar to X which are close to it. Then A probably values Site "X" less than B, because A had no alternatives if he wanted to visit a place with approximately the characteristics of Site "X," while B had lots of alternatives but nevertheless bypassed all of those alternatives, presumably because he likes X so much.

6. (a) The oceans are in contact with the atmosphere, so when the CO_2 concentration of the atmosphere increases, more CO_2 will diffuse into the oceans. This causes the oceans to become more acidic.

   Optional Note 1: Burning coal releases SO_2, which causes acid rain, but this mainly changes the pH of lakes and rivers (bodies of fresh water); there is not enough acid rain to change the pH of oceans appreciably.

   Optional Note 2: The chemical reaction is $CO_2 + H_2O \rightarrow H_2CO_3$, carbonic acid. Wikipedia's page on "ocean acidification" says: "Seawater is slightly basic (meaning pH $>$ 7), and the process in question is a shift towards pH-neutral conditions rather than a transition to acidic conditions" (`https://en.wikipedia.org/wiki/Ocean_acidification`).

   (b) The death of coral reefs will decrease the number of tourists who visit them.

   Also, coral reefs provide coastal protection from storms; when the reefs die, ocean storms (such as hurricanes) will hurt human coastal infrastructure more.

   Fishermen are affected because coral reefs support an oceanic ecosystem with lots of biodiversity, which means many fish species of economic value to humans. If the reefs die, those fish populations will shrink or disappear, decreasing fishing opportunities.

   Ocean acidification will decrease the population of shellfish (because their shells are damaged by acidic water). Some of these shellfish have great economic value to humans.