Please be sure to write your SID # and full name on your blue book, no abbreviations or nicknames. Each problem will contribute equally to the final score; manage your time accordingly. Make your solutions neat and concise. Start each problem on a separate page, and obey essay length restrictions (graders reserve the right to only read up to the page limit).

Please read through the entire exam before you start. Do you have any questions? Ask them now. Then, take a deep breath and begin. Good Luck!!

Problem 1:

Suppose that the United States has agreed to abide by a Global Warming Treaty.

1.1. Draw a figure showing the relationship between the quantity of CO_2 emissions, Q, and the Marginal Benefit for the U.S. if $MB=1600-2Q$. Assume the treaty only allows the U.S. to emit $Q_0=600$. Label Q_0 and Q_1 on your graph, if Q_1 is the emissions level that U.S. would emit if there were no treaty. Calculate the compliance cost for U.S. **graphically** and **numerically.**

1.2 Now assume that the U.S. utilizes two alternative reduction mechanisms:
- Purchasing permits from Russia at price $P=\$100$ dollar per unit of CO_2 emissions;
- Using the Clean Development Mechanism (CDM) to build a clean energy plant in India. This plant will reduce overall CO_2 emissions at a marginal cost equal to $MC=2Q_a$, where Q_a is the amount of CO_2 emissions reductions obtained through the CDM.

(a)   Draw a new graph showing the marginal benefit for the U.S. of CO_2 emissions beyond Q_0. Let Q_p denote the amount of CO_2 emissions accounted for through the purchase of permits. Derive Q_p and Q_a **numerically**, also show them on your graph.

(b)   What are the treaty compliance costs for the U.S.?

(c)   What is the total level of CO_2 emissions in the U.S.?

1.3 In less than one page, describe and discuss at least five different obstacles to carbon trading between countries.

Problem 2.

2.1. Essays:
   (a) If a price support program is already in place, will banning pesticides
       increase or decrease welfare? (A price support program increases the
       output price above the market price). Page limit: half a page.
   (b) Under what kind of market structure and externality costs can we have
       under-use of pesticides. Provide a graph to explain your point. Page
       limit: one page.

2.2. Pesticide damage control framework.

A farmer knows that during a high pest year, the proportion of the total crop lost
due to pest damage is $D_H(X)$, where X is the amount of pesticide used. During a
low pest year, the damage function is $D_L(X)$. Potential output (in the absence of
pests) is Y. The probability for a high pest year is φ and output price is p and
fertilizer price is w. The farmer can use pesticides preventatively (**Prevention**)
or she can use Integrated Pest Management (**IPM**).

Prevention:
   (a) Write the equation for expected profit under preventative approach.
       Interpret.

   (b) Write the condition for the optimal level of pesticide use under a
       preventive approach. The condition should be in general terms (using the
       notation above) and employ the concept of marginal benefit and cost.

IPM:
Under IPM the farmer invests in monitoring to find out whether it is a high or a
low pest year and applies pesticides accordingly.

   (c) Write out the conditions for optimal level of pesticide use under IPM for
       high-pest year and for low-pest year.

Assume that under Prevention, farmer profits are 40 in a high-pest year and 60
in a low-pest year; under IPM, profits are 45 (high-pest) and 75 (low-pest) but
with an additional fixed cost of 5 for monitoring. Suppose that the probability of
a high pest year, φ, is .5.

   (d) What is the average profit under Prevention and IPM?

   (e) How much are farmers willing to pay to use IPM?

Problem 3:

While sitting in your favorite café studying for your finals, you overhear someone talking on his cellar phone for all to hear. He is a government employee, and you learn that he works for the Sate of Euphoria Department of Environmental Safety.

"…I mean, it's my job to make sure people are safe from environmental dangers. I'm going to quit because the governor only listens to those evil economists, who don't care about people's safety at all. In fact, they want to cut my budget, while people are still getting sick! I told the governor that as long as people are still getting sick from pesticides, I should be getting a bigger budget in order to help stop people from getting sick!…" says the man on the phone.

a)   You, as an economist, sit back and think about what he just said and wonder if the economists really are evil. Write a note to this government employee, a paragraph or two in length; explain why a good economist could possibly advise the governor to cut the budget for Environmental Safety, even when not every single person is perfectly safe? How should the government decide how large of a budget to give the Department of Environmental Safety?
Hint: Your answer should include the word "Marginal"

The Environmental Safety employee sees you listening to his conversation and comes over to talk to you. After talking to him for a few minutes he tells you a few things: 1) His job is to build and install water filters throughout the state, and 2) He happens to know that there is a direct relationship between how many filters he installs, and the number of days people are sick in the state.

$$\text{\# Sick-Days} = f(\text{\# filters})$$
$$S = \frac{1,000,000}{1+F}$$

b)   If all the government employee cares about is preventing people from getting sick, how many filters would he like to install?
c)   If the price of a water filter is $1000, and the Department of Environmental Safety has a budget of $3,999,000, how many sick days will occur?
d)   If instead of a budget cut, the Department of Environmental Safety actually receives $1,000,000 in additional budget money. How many fewer sick days occur from this additional budget?
e)   What is the implicit price of reducing one more sick-day?

Congratulations. You made it!