Answer Key: Homework Assignment #6

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1. a. Each firm must reduce pollution by 50% or 5 units.
   C1 = 5(5) + (5*5) = 50
   C2 = 1 + 3(5*5) = 80 Total Cost = 130

   b. The optimal pollution reduction is found by setting the marginal cost of pollution reduction the same at each firm.

   $MC1 = 5 + 2q_1$ and $MC2 = 1 + 6q_2$

   $5 + 2q_1 = 1 + 6q_2$ and then substitute in $q_1 + q_2 = 10$.
   $5 + 2q_1 = 1 + 6(10 - q_1)$ ===> Solving we get $q_2 = 3$ and $q_1 = 7$.

   c. We want to find the tax such that $q_2 = 3$ and $q_1 = 7$. Set MC of each firm = tax.
   $5 + 2(q_1)$ = tax or $1 + 6(q_2)$ = tax, so tax = 19.

   The pollution reduction is $q_2 = 3$ and $q_1 = 7$. Pollution emissions are $p_2 = 7$ and $p_1 = 3$.

   The costs to firm 1 are 84 (for reducing the pollution) plus 57 (for the tax) = 141.
   The costs to firm 2 are 30 (for reducing the pollution) plus 133 (for the tax) = 163.

   Note that C1 = 84 and C2 = 30 so total cost for reducing the pollution has fallen to 114 from 130. In addition, the firms pay a total of 190 in tax but that is merely a transfer to the government and not a net loss to society as a whole.

   d. Each firm has incentive to trade permits to one another as long as the marginal cost of reducing pollution at one firm is higher than the marginal cost of reducing pollution at the other firm. In this case, firm 1 will trade two of their permits to firm 2 for a price. (If there were a large number of buyers and sellers, the price per permit would equal the size of the required tax or 19. With just two firms, the price is simply determined by bargaining. Firm 1's pollution costs go from $50 to $84, so they would demand at least $34 to make the switch. Firm 2's pollution costs go from $80 to $30, so they would be willing to pay at most $50 to switch. Thus, the price the two firms agree on would be between $34 and $50. The exact cost to each firm would vary with price of the permits, but as in the pollution tax case, the total pollution reduction cost is 114.

   e. i. If a metropolitan area faced a federal mandate, command and control or permits might be best as they guarantee a certain level of reduction.
   ii. Permits would likely be most politically popular as they allow industry to reduce pollution at the lowest possible costs to the industry.
   iii. Pollution taxes have the advantage of reducing overall pollution levels as industry experiences advances in pollution control technology.
   iv. It's hard to figure out exactly how to distribute pollution taxes and how to have a uniform

pollution tax when many countries are involved. Most international carbon reduction schemes involve cap and trade programs between countries even if countries utilize pollution taxes within their own borders.

v. Command and control regulations are close to optimal if all firms face the same pollution control costs or if optimal pollution amounts are at or near zero. Command and control may be necessary if monitoring costs are high.

2. There is no single right answer for this puzzle. Permits are more politically popular among industry, so if firms have more political power in the U.S. than in Europe, they could have lobbied for permits. In addition, Europe is much more highly taxed than the U.S. Thus, pollution taxes may meet less resistance in Europe and any tax switching may be more beneficial. Of course, from an economic standpoint neither system is superior to the other, so there is no obvious reason for either society to switch to the other's pollution control method. It is not a sufficient answer here to simply list the positive and negative aspects of each method if these advantages and disadvantages apply to each area in a similar way.

3. a. Theoretically, SO_2 emissions should be taxed according to the amount of damage they cause. Thus SO_2 should be taxed higher in highly populated areas, near hot spots, and upwind from areas that are particularly susceptible to acid rain damage. The primary disadvantages of levying different tax rates is the difficulty in determining the efficient amount to charge each different emitter of SO_2.

   b. CO_2 emissions, on the other hand, mix freely throughout the atmosphere and cause the same amount of damage no matter where they are emitted. Thus, there is no reason to charge different polluters a varying charges.

4. 1. Three Mile Island killed the idea of nuclear power in the United States.
   - While nuclear power didn't end in the U.S., over 100 projects were killed, and no new plants were planned between 1979 and just the past year or two. That being said, plants were being cancelled prior to Three Mile Island and roughly 40 plants under construction during the accident did make it through to completion.

   2. Long half-lives make radioactive materials dangerous
   - The real question raised by Greenpeace is not whether long half-lives makes things dangerous but whether plutonium 239, a byproduct of uranium fission, is dangerous for a long period of time. Just because some materials with long half-lives are less dangerous than others with short ones doesn't change the fact that many wastes will have to be isolated from the environment for 240,000.

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3. Nuclear power is bad for the environment.

- As we have discussed in class, this is all about picking your poison. Nuclear energy is clearly bad for the environment, but so are the alternatives, and the author is correct to suggest that coal could easily be as bad or worse than nuclear.

4. Nuclear power is "unnatural."

- Just because cosmic rays bombard us constantly and radioactive isotopes of common elements are unavoidable doesn't mean they are safe. While uranium, the primary fuel in most nuclear reactors, is a natural substance found all over the globe, roughly as plentiful as tin, this doesn't mean it's not dangerous. Earthquakes and hurricanes are natural occurrences as well.

5. A nuclear power plant is similar to a nuclear bomb

- Saying that modern nuclear weapons use nuclear fusion and only small nuclear bombs use fission while nuclear plants use exclusively fission is just weird. While the author is right that controlled reactions in nuclear plants are different than uncontrolled explosions, catastrophic accidents are still possible if the reaction gets out of control as shown by Chernobyl (and somewhat by Three Mile Island) While the author is correct that you couldn't turn a nuclear reactor into a bomb any more easily than you could power your house with a hand grenade, you could still spread poisonous explosive all over your house without actually setting off the grenade.