Fall 2004

Name: _____ Pledge: _____

Envr 201 Test #3

Point Total: 100 pts possible

4 pts 1. **True** or **false** (circle one): the EPA must perform a cost-benefit analysis before revising air quality standards.

False.

8 pts 2. List the main environmental problems caused by air pollution.

- photochemical smog, caused by the emission of VOCs and NO_x
- particulate matter, especially fine PM, which results in health problems, reduced visibility, eutrophication, and acidification. Fine PM is a secondary pollutant formed by emissions of SO_2, NO_x and VOCs.
- acid deposition, caused by emission of SO_2 and NO_x
- ozone depletion, caused by the emission of CFCs, HCFCs, halons, and a few other compounds
- global warming, caused by the emission of greenhouse gases (mostly CO_2, N_2O, CH_4)
- health problems caused by the emission of 'air toxics' such as mercury, lead and carbon monoxide

10 pts 3. What are the main criticisms of CERCLA? How do its supporters respond to these criticisms?

See next page.

The main criticisms of CERCLA, and typical responses to them, are:

- *The liability scheme is unfair*. A PRP may be liable for the entire cleanup even if it is only responsible for a portion of the contamination. The standard needed to be identified as a PRP is also set pretty low, and may include a lot of small businesses. In addition, insurance companies complain that they are forced to pay for policies long thought defunct.

  Supporters of CERCLA say that this provision increases the likelihood that those responsible will end up paying the bulk of the cleanup cost: if the EPA goes after the PRP with the deepest pockets, that PRP (or its insurance company) has all the incentive to turn around and sue the other PRPs and find a more equitable arrangement. And the PRPs often have access to non-public information about the nature and extent of the contamination. Finally, the high evidentiary burden faced by PRPs has been widely viewed as an effective deterrent for future improper waste disposal, making compliance with RCRA more likely.

- *The cleanup goals are too strict*. The EPA has some discretion as to what standards the contaminated site should eventually meet, and critics argue that they do not often include the most probable future use of the site. For example, the EPA may assume residential use (and demand groundwater standards based on the Safe Drinking Water Act) even if that is unlikely to happen.

  Supporters of CERCLA feel that it is not possible to accurately predict future land use, and that if a site is known to be contaminated, it is disingenuous to say that it is not likely to be used for residential purposes. If the site were cleaned up to high health standards, residential use is more likely. Plus, some feel that a site should be returned, as much as possible, to conditions that existed prior to the contamination.

- *The EPA does not rank NPL sites well*. In particular, a common criticism is that the EPA does not consider the size of the population exposed to the pollution. For example, an NPL site in a rural area should have a lower priority than a site that affects a larger human population, all other things equal.

  Supporters respond that this attitude smacks too much of utilitarianism, where the aggregate good is paramount, and doesn't consider a citizen's right to a healthy environment. In other words, they object to a 'majority rules' ethic.

- *Cleanup is too costly.* Critics cost that cleanup is too costly, both because of high transaction costs (eg in legal fees; see first criticism above) and high cleanup standards. In addition, the EPA often insists on using outmoded (and cost-inefficient) methods of cleanup.

  Supporters argue that transaction costs are not too high compared to other cases in litigation, and that those costs are lowered because much of it is borne more by the PRPs and their insurace companies when they sue each other. And these supporters aren't too concerned about those costs (the parties could always choose not to sue, or to use less-costly mediation). Admittedly, cleanup technology used by the EPA is not always cutting-edge, but the EPA also allows the PRPs themselves to clean up sites: EPA sets the standards but allows the PRPs to achieve those standards however they choose. This results in cost-savings in both the cleanup costs (about 20%) and government legal fees.

- *Cleanup takes too long*, for reasons previously specified: litigation and high cleanup standards. Supporters counter that both liability scheme and standards are appropriate, and the most of the cleanup time is due to the complex and difficult nature of the cleanup process itself (groundwater contamination is notoriously difficult to remediate). One shouldn't expect a rapid solution to such a problem.

8 pts 4. It has been estimated that approximately 4000 people died in London's 'killer smog' episode in 1952. How was this estimate obtained?

This estimate was obtained using epidemiology, with a time-series analysis. The number of deaths was plotted as a function of time, as was some measure of air quality (e.g., the concentration of SO_2 in the air). The smog episode starts when the SO_2 level spikes, and ceases when it returns back to normal. A corresponding increase in daily mortality rate (delayed by 1-2 days) is assumed to be related to, and caused by, the smog episode. The excess deaths during the episode—that is, the number of deaths above the normal, background level—can then be determined (essentially by integration).

5 pts 5. What was the 'swales hypothesis' advanced by Lois Gibbs?

Although she didn't attribute it to Gibbs, Beverly Paigen describes the hypothesis in her essay:

> I planned to plot the illnesses geographically with the following expectations: (1) if illnesses were clustered in families, that would indicate a possible genetic susceptibility to low-level chemical exposure...(2) if illnesses were geographically clustered, that would probably indicate migration of chemicals from the canal; or (3) if illnesses were randomly distributed, that would indicate no relationship to chemical exposure.... Plotting the results on a map revealed a strong geographical clustering of disease that appeared to be related to former stream beds and swales, which are low marshy areas that collect water but do not have a particular direction of flow.

Gibbs had noticed this clustering earlier and had proposed the 'swales hypothesis' for migration of chemicals from Love Canal, in which the chemicals seeped from the Canal and spread preferentially along former swales . Paigan's more systematic study was consistent with Gibbs' hypothesis, although still not definitive proof (nor was it meant to be).

8 pts 6. In "Why worry about trace poisons?' Alan Mazur states that 'it is fairly certain that synthetic chemicals are not a major cause of human cancer.' Yet Sandra Steingraber is still alarmed about this very issue. What is the basis of her concern?

Because even if they are 'only' a minor cause of cancer (which she doesn't necessarily concede), they still cause a lot of deaths annually. For example, an estimate of 2% of annual cancer deaths due to synthetic environmental carcinogens (a figure that Steingraber considers conservative) still results in 10,940 deaths per year. Steingraber notes that factors that result in fewer annual deaths than this, such as children/teenage deaths due to firearms, or deaths due to secondhand smoke, have resulted in much more attention and action than anthropogenic environmental carcinogens.

8 pts 7. How do CFCs deplete the ozone layer?

Unlike virtually all natural sources of chlorine, CFCs are inert in the troposphere, which means that they 'last' long enough to cross over the tropopause into the stratosphere, where the ozone layer is located. Once there, they are exposed to more energetic UV light (ie, UV-A wavelengths), which breaks apart the CFC molecule, yielding chlorine atoms. These chlorine atoms destroy ozone catalytically, according to the following two reactions:

$$\mathrm{Cl} + \mathrm{O_3} \longrightarrow \mathrm{ClO} + \mathrm{O_2}$$
$$\mathrm{ClO} + \mathrm{O} \longrightarrow \mathrm{Cl} + \mathrm{O_2}$$

Each time through the catalytic cycle destroys two odd-oxygen species (one O_3 molecule and one O atom) and yet the chlorine atom is regenerated. Each atom can thus destroy hundreds or thousands of ozone molecules before it leaves the stratosphere.

5 pts 8. (a) What are the usual objections to emissions trading schemes?

- An objection to allowing polluters to pay for the right to pollute.
- Even if aggregate pollution is down, it results in pollution 'hotspots,' which causes a health hazards to nearby residents and raises issues of environmental justice.

  In a related criticism: trading schemes really only work for long-lived pollutants that mix fairly well throughout a region to which multiple sources are contributing.
- If there is no cap, then there is little control over the pollution level. Basically amounts to letting the market decide the 'economically efficient' pollution level, which may be too high for those who prefer health-based pollution standards.
- Pollution prices can be directly manipulated by the strategic behavior of large polluters.

5 pts (b) What are the advantages usually cited to support these schemes?

- It is a more economically efficient way to achieve compliance with health-based standards (theoretically it may be the most efficient way of doing so).
- It give polluters a financial incentive to develop innovative pollution-reducing technology or processes. It is much preferable to technology-based command-and-control standards, particularly since the technology specified in those standards is often outdated and inefficient.
- It may result in pollution levels even lower than the 'command and control' method, since polluters have a financial incentive to exceed those standards.

5 pts 9. What was the purpose of the Helsinki Protocol?

The Helsinki Protocol was an environmental treaty aimed at the reduction of acid deposition caused by transboundary SO_2 emission, such as acid rain in Scandinavian countries that is caused by emissions in the United Kingdom.

10 pts 10. Describe in detail the main ways in which agriculture affects both water quantity and quality.

There are many ways agriculture affects water quality/quantity:

- Irrigation is the primary use of groundwater. Although many aquifers recharge fairly rapidly, some—including some very large ones—have very slow rates of replenishment, and these are being depleted. Such 'fossil' aquifers are best viewed as nonrenewable resources.
- When the water from irrigation evaporates, it leaves behind in the soil the residue of the salts that were dissolved in it. Thus, the salinity of the soil increases (and its productivity eventually suffers), as does the salinity of the water that percolates through the soil. Thus, irrigation causes salinization of nearby ground and surface waters.
- Landscape alteration results in increased siltation due to soil erosion. For example, deforestation results in increased surface runoff when it rains, and this runoff carries the topsoil away with it. The particulates eventually reach a surface water body, resulting in increased turbidity and sedimentation. Good farming practices minimize soil erosion, but the rate will always exceed that of the forest the farm replaced.
- Livestock increase the levels of disease-causing pathogens in receiving water bodies.
- Livestock waste and crop residue washes into the water and biodegrades, causing oxygen depletion. This is bad for ecosystems and also mobilizes noxious and toxic pollutants.
- Chemical fertilizers result in nutrient pollution of receiving water bodies. Nitrate pollution especially is a problem, since nitrate is very mobile in the soil and groundwater. High levels of nitrate in drinking water can be unhealthy—they cause 'blue baby' syndrome—but the increased levels of nutrients also cause eutrophication of surface waters. This leads to more frequent algae blooms, which is unpleasant at best and toxic at worst, and also leads to oxygen depletion. The 'dead zone' that forms in Gulf of Mexico in the late Spring and early Summer is thought to be largely due to nutrient pollution in the Mississippi.
- Chemical pesticides, applied to increase crop yields, migrate in the air and groundwater to pollute other water bodies. Pesticide contamination of the groundwater in the midwest is well documented. Some of these pesticides are particularly inert and hydrophobic, so that they spread regionally and globally, and magnify up food webs.

8 pts 11. In her article, Beverly Paigen mentions 'type I' and 'type II errors.' What role do these factors play in risk assessment and policy decisions?

In assessing the risk posed by environmental degradation of some sort—such as the health risk posed by chemical pollution—there are two possible conclusions: (i) the risk is negligible or (ii) the risk is significant. A type I error is a false positive, falsely believing that the risk is significant, while a type II error is a false negative, incorrectly concluding that the risk is not significant. In setting policy responses to a possible environmental risk, it is important to keep in mind the consequences of type I and type II errors; only then can their appropriate level be set.

Scientists are generally trained to keep the type I error small (5% or less), in other words to impose a fairly high burden of proof for the conclusion that risk is present. Paigen believes that the barrier is set too high; she believe the requirements of *prudence* are less than the requirements of absolute *proof*. This is a view also articulated in the Precautionary Principle, which in one version states "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." Or as put in the UN Framework Convention on Climate Change (UNFCCC): 'When there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing ... (precautionary) measures.' In other words, action can be taken even in the face of some significant scientific uncertainty.

8 pts 12. Increasing atmospheric concentrations of CFCs have a direct *warming* and an indirect *cooling* effect on global climate. In contrast, HFCs have only a net warming effect. Explain these statements.

Both CFCs (chlorofluorocarbons) and HFCs (hydrofluorocarbons) are greenhouse gases with long atmospheric lifetimes; hence they both directly cause a positive radiative forcing (i.e., they absorb outgoing infrared radiation). But CFCs release chlorine in the stratosphere and contribute to stratospheric ozone depletion. (In contrast, HFCs contain no chlorine or bromine, and fluorine does not deplete ozone.) Since ozone is also a greenhouse gas, stratospheric ozone depletion causes some global cooling.

8 pts 13. Summarize the reasons that Richard Benedick thinks the Kyoto Protocol is flawed.

One of Benedick's biggest complaints is about the time scale of proposed actions. On the one hand, he thinks that the short-term targets for GHG emission reduction are too strict to engender universal compliance, or to entice industry cooperation. On the other hand, he thinks that the long-term impact of Kyoto—even with full compliance—is too small to make much of a difference. In other words, the treaty's time frame does not match that of the problem (Benedick: 'it suffers from its short-term approach to a long-term problem').

Benedick thinks that the US was being unfairly treated in one respect: allowance was not made for its higher rate of population increase relative to other industrial countries ('[the US and Canada] are, in effect, being penalized for having more liberal immigration policies').

Benedick also doesn't think that enough was done to secure commitments from developing countries. Granted, the collective will doesn't seem to be there ('most developing nations still do not act as if they realize their own vulnerability to the effects of climate change'), and there do exist some mechanisms in Kyoto to help developing countries, in particular the Clean Development provision (article 12).

Benedick doesn't like the emissions trading scheme of Kyoto, basically for two reasons: (i) they increase GHG emissions (relative to a situation with no trading); (ii) there are too many complications involving trade between industrial and developing countries (such as problems with neocolonialism and changes in government). Basically, although international emissions trading has been used before, it has never been done on such a grand scale, and Benedick questions whether successful implementation is possible anytime soon. Certainly he feels that the current scheme actually slows down the adoption of meaningful emission control measures.

Finally, Benedick feels that Kyoto should have required countries to adopt universal policy measures such as stricter fuel-efficiency standards for vehicles, increased development of renewable energy alternatives, and the phase-out of subsidies and other measures the distort that market price of fossil fuels.