Multiple Choice

1. The economic effect of open-access regulations for a fishery
   a) is an increase in the number of vessels in the fishery
   b) is an increase in the demand for the species that is sought commercially
   c) is an increase in the costs associated with operating in the fishery
   d) is a decrease in the rents earned by those fishing in the fishery prior to regulation
   e) all of the above

2. If on average construction workers are willing to accept a 1/1000 th increase in their annual risk of death in exchange for an increase in their annual earnings by $4000 then we would say that the value of a statistical life based on these choices was
   a) 2 million dollars
   b) 200,000 dollars
   c) cannot be computed from the information given
   d) 4 million dollars
   e) 5 million dollars

3. Benefit cost analysis can be described as usually making several important assumptions. Identify the assumption it does not make from below:
   a) marginal benefits from the proposed policy intervention will be equal to the marginal costs
   b) improvements can be judged as taking place as long as there is the potential for gainers to compensate losers from a policy
   c) benefits and costs that are realized over time can be represented in present value terms
   d) the activities associated with implementing a project’s objectives are done in the lowest cost way.

   The ___________________ the discount rate used in computing a cost-benefit analysis, the ____________________ the weight placed on future benefits and costs.
   a) lower; lower
   b) higher; higher
   c) higher; lower
   d) greater the risk component of; higher
   e) lower the risk component of; lower
5. Given the demand curve below, the consumer surplus for a price change of $1 from 1 to 2 is: ________________.

   a) 3  
   b) 9  
   c) 15 
   d) 10 
   e) 1

In our simple model of the behavior of a firm with a known stock of a non-renewable resource the efficient allocation of amounts extracted of that resource over time would equalize the

   a) costs of extracting the resource over time
   b) the present value of the price over time
   c) marginal reserves available for the future at each point in time
   d) price realized taking account of market conditions for the ore and the stock market
   e) the present value of profit per unit of output over time

7. Advantages of effluent taxes over command and control policies in the control of externalities include

   a) taxes lead to minimized total abatement costs across the taxed entities
   b) taxes provide incentives to develop and adopt new technology
   c) taxes lead to a level of pollution that is known in advance
   d) both a) and b)
   e) both a) and c)

When one person's consumption of a good does not diminish the quantity available for another consumer, this is referred to as:

   a) rivalry
   b) exclusivity
   c) nonrivalry
   d) nonexclusivity
   e) a real deal

The Coase Theorem relies on several assumptions; identify which of the following is not required:
a) zero or low transactions costs from enforcing pollution rights
b) low or no income and wealth effects from property rights to pollute
c) structured joint and several liability provisions
d) complete or near complete information to all participants
e) none of the above

The following market demand and private supply relate to a good that generates an externality. D is the demand, S is the private supply function, SS is the "social supply" -- that is it reflects both the private marginal costs of production and the marginal social costs (i.e. it is the sum of these marginal costs). *Each of the next two questions relate to this diagram.*

10. The marginal social costs at the social equilibrium are

   a) E B 
   b) E G 
   c) A C 
   d) A H 
   e) H C 

11. The consumer surplus at the private equilibrium is

   a) P_C B Q_1, 0 
   b) P_C B P_1 
   c) P_C A P_2
12. Consider an unregulated market with two polluting firms and no controls on pollution. The marginal abatement costs of firms 1 and 2 are given as

\[
\begin{align*}
(1) \quad MAC_1 &= 30 - 3E_1 \\
(2) \quad MAC_2 &= 12 - 2E_2
\end{align*}
\]

\[E_1 = \text{emissions from firm 1} \]
\[E_2 = \text{emissions from firm 2}\]

With no controls on these firms how much will they emit?

a) 7 units by firm 1 and 6 units by firm 2  
b) 18 units by firm 1 and 18 units by firm 2  
c) 30 units by firm 1 and 12 units by firm 2  
d) 10 units by firm 1 and 6 units by firm 2  
e) none of the above

13. Given the same structure for marginal abatements costs for these firms as in question 12, suppose an effluent charge of $6 per unit is imposed on both polluters, what would be each firms’ level of pollution?

a) 3 for firm 1 and 0 for firm 2  
b) 8 for firm 1 and 3 for firm 2  
c) 18 for both firms  
d) 5 for firm 1 and 3 for firm 2  
e) none of the above

14. When the marginal abatement cost is uncertain and marginal damages are known, the preference for a price (effluent charge) versus permit system may be different than in the case with no uncertainty. Based on the potential economic surplus losses we would prefer:

a) a quantity system when the slope of the marginal damage (in absolute magnitude) exceeds the marginal abatement cost  
b) a price system when the slope of the marginal damage (in absolute magnitude) exceeds the marginal abatement cost  
c) a quantity system when the slope of the marginal damage (in absolute magnitude) is less than marginal abatement cost  
d) a price system when the slope of the marginal damage (in absolute magnitude) is less than marginal abatement cost
1. The travel cost method is based on the premise 
   
   a) that surveys of individuals at different recreational sites will provide information about the appropriate level of pollution at camp sites.
   b) that travel cost to a site can be regarded as the price of access to the site.
   c) existence value can be effectively measured from observed behavior.
   d) both b) and c)
   
2. An example of use value of a non-market environmental good is 
   
   a) The benefits from the existence of a rare species of bird in the Galapagos Islands.
   b) The benefits from access to a local lake for swimming or fishing.
   c) The benefits from knowing the Grand Canyon will be available for future generations to enjoy.
   d) All of the above.
   
3. To evaluate the optimal (economically efficient) rotation period for a forest from the perspective of the private owner, assuming that the time trees are allowed to grow before harvesting is the only choice variable, we would seek to maximize:
   
   a) the net yield taking account of losses as a result of the harvesting process
   b) the net profit realized on the board feet of lumber produced from the forest
   c) the gross yield of board feet; to do otherwise would create the wrong incentives in harvesting
   d) the economic value of the land devoted to the production of timber
   e) the sustainability index which includes both board feet and an imputed value for community stability.
   
4. The group presenting the American Trader Case in class emphasized one aspect of the analysis and concluded one side (i.e., plaintiff versus defense) had done a better job. The issue and side were:
a) more plausible prediction of beach days lost by plaintiff
b) more plausible prediction of beach days lost by defense
c) better screening of relevant variables such as children’s beach visitation decisions and separate travel cost analysis by defense
d) more systematic treatment of the activities of surfers and nonuse values by the plaintiff
e) none of the above.

5. The discussion of wetland banking programs after the presentation in class emphasized the importance of

a) the location of the new or restored wetland areas to assure services comparable to those lost would be provided
b) the bonding process to assure private individuals and/or government agencies in fact create or restore the wetlands promised
c) the difficulties of developing inter-jurisdictional trading programs in the presence of different state development policies
d) the potential for expanding these types of programs in the cleanup of brownfields with assurances of reductions in environmental risk
e) none of the above.

6. Mettrick and Weitzman defined biodiversity using an analogy to

a) the bar-code system used in food stores where the spacing and thickness of the lines allows unique entities to be distinguished and classified
b) a set of libraries where each library contains potentially different sets of books with the importance of the loss of any one of them determined by whether close substitutes exist
c) benefit-cost analysis except in the cases that they described the benefits were defined based on the expected genetic endowment
d) a windows based operating system where the file folders represent species and the sub directories sub-species
e) none of the above.

27. The optimal level of pollution is:

a) always equal to zero
b) less than one might think
c) the level of pollution where marginal abatement cost is equal to marginal damage
d) the level which minimizes the total abatement cost
e) the level where marginal abatement cost equals the marginal private cost of the good creating the pollution.
28. At the margin all but one of the following pollution policies create the same incentive effects; identify the one that does not:

   a) per unit effluent charges
   b) price thresholds for input fuels
   c) per unit subsidies for abatement of pollution
   d) tradeable emission permits

29. When non-timber values are introduced into the analysis of the economically optimal rotation period for a private forest we find that the efficient policy calls for ____________________ because of ____________________

   a) shorter rotation periods, reducing the effect of roads to facilitate harvesting or recreation
   b) longer rotation periods, the increased board feet can be paid for with fees from recreation site charges
   c) shorter rotation period, recreation values are generally assumed to decline over time as congestion increases
   d) longer rotation period, recreation values are generally assumed to increase over time as the tree stand increases in age
   e) none of the above

30. We discussed the effects of an international trading scheme for permits to emit carbon dioxide (CO₂) or an equivalent greenhouse gas as one policy for reducing CO₂ emissions. The plans involved trading among: (a) only developed economies; (b) two separate groups of developed economies -- the European Union and everyone else with no trading between them; and (c) trading among everyone including developed and less developed countries. The lowest cost option was ____________________ because ____________________ .

   a) trading type “a”, it focused on the primary source of the problem
   b) sometimes trading type “a” and “b”, the distinctions in some models helped to highlight the places where trading would be desirable
   c) trading type “c”, it took full advantage of any differences in the incremental costs of reducing CO₂ accumulation rates
   d) trading type “c”, it is possible within this system to be fairer to developed and developing countries
   e) c) and d)
33. In the Slovic reading about risk perceptions, he argues that people

a) can accurately perceive risks from many environmental and non-environmental sources that form risk perceptions based on more than the probability of “bad” outcome.
b) consider whether the source of the risk is voluntary, whether the information is well-known and other features.
c) are incapable of dealing with risky events and do not make systematic decisions.
d) can be distinguished by age with young adults and older individuals displaying the least rational responses; middle age individuals seem best able to deal with risk perceptions.
e) b) and d)

34. Consider a project that extends over three years, compute the present value of net benefits treating the decision as one year before any of these benefits and costs are realized

<table>
<thead>
<tr>
<th>Time</th>
<th>Benefits</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>9.9</td>
</tr>
</tbody>
</table>

With a discount rate of _____ percent we can say that this project is __________ .

a) 10, positive
b) 10, negative
c) 5, positive
d) 5, zero
e) b) and d)

35. Based on the presentations in class it appears that the biggest issue with the retrospective analysis of the Clean Air Act involves

a) the relevance of the value of statistical lives
b) the cost estimates developed for the program
c) the full implications of lead and carbon monoxide
d) the effects of an emission trading program as an alternative to current policies
e) the interaction effects between indoor and outdoor exposures to air pollution.
38. One of the following statements is false. Identify the incorrect statement:

   a) the market demand for a private good is the horizontal sum of all individuals' demands
   b) the market demand for a public good is the vertical sum of all individuals' demands
   c) an efficient allocation of resources requires that all goods and services be allocated to their highest valued uses
   d) efficient rationing is assured for congestible resources because each person experiences both external and internal effects

1. A paper mill in Western North Carolina produces a wide range of paper products and residuals. The residuals are released into both the air and the water. In issuing a permit to the plant for its waterborne effluents, EPA considered the interests of residents of North Carolina and Tennessee. The river involved is in both states. The waterborne residuals create an example of:

   a. an input to the production process essential to satisfy materials and energy balance
   b. an externality arising because production activities must satisfy materials and energy balances
   c. a Coasian solution where two states bargain, exchange payments, and realize some level of improved water quality
   d. opportunities for development of other paper plants along the river
   e. a transaction cost that the firm realizes because production activities are constrained by materials and energy balances.

2. The Coase Theorem leads to two important conclusions. Four conclusions are listed below. Identify the selection (from the pairs below) that specifies the two Coase conclusions.

   I. With negligible transactions costs, an efficient negotiated settlement will not be affected by the assignment of property rights to resources conveying an externality.

   II. Efficient resource allocations require that each resource be allocated to its highest valued use. Under consumer sovereignty, this requirement implies policies based on equating the marginal willingness to pay to the marginal cost will select the efficient output levels.
III. For laws and social institutions to be efficient, they should place the burden of adjusting to externalities on those who can undertake the adjustment at the lowest cost.

IV. Open access resources are self-limiting in the sense that those using them experience some of the costs of others' use.

Answers:
   a. I and IV
   b. II and III
   c. I and III
   d. III and IV
   e. II and IV
   f. I and II

3. Benefit cost analysis relies on assumptions and a standard to judge desirable actions. Identify the assumption or standard that is not relevant to a conventional benefit-cost test.

   a. To evaluate whether a project (or regulation) offers a movement toward the efficient level of the output (or outputs) desired, we consider the ratio of the present value of benefits to the present value of costs. Ratios exceeding 1.5 improve efficiency after taking account of transactions costs.

   b. The Kaldor-Hicks compensation test which means that it is the aggregate of net benefits that is important. Gains or losses to individuals are not important provided the aggregate net benefit in present value terms is positive.

   c. The initial distribution of income and wealth must be taken as a given because it provides the basis for defining what people would be willing to pay for the output(s) produced by the project or regulation being evaluated.

   d. When the project (or regulation) being evaluated by benefit cost methods involves outputs and costs over time, the evaluation converts the relevant dollar measures into present value terms.

   e. We cannot as a rule be sure that use of the benefit cost criteria will lead to selecting the most efficient policies, only that we can judge movements toward or away from an efficient allocation of resources.

4. The primary distinction between an incentive-based policy instrument and a command and control policy is that:
a. Incentive-based policies improve the equity of environmental programs while command and control do not.

b. Command and control policies improve the equity of environmental programs while incentive-based do not.

c. Command and control policies prescribe responses and provide little encouragement to do more while incentive-based create such encouragement through the gains or costs avoided that those responding can realize by changing their behavior.

d. Incentive-based policies target specific types of firms or households, and thereby, pinpoint the problems with key instructions, while command and control offer blanket guidance that is generally considered less efficient.

e. Command and control policies are guided by the marginal benefits of improvements while incentive-based are defined by the marginal costs of realizing those improvements.

5. Much of the regulation of criteria air pollutants in the U.S. was defined by an underlying assumption about how those pollutants affect people. A key assumption was that:

a. Pollution in any of its many forms has synergistic effects on people's health.

b. Specific criteria for guidance are important for the most serious pollutants to assure everyone knows what is safe.

c. It is possible to identify levels of air pollution that will have no effect on people.

d. The technology for measuring pollutants is continuously improving, so standards can improve.

e. People are the best judges of their own well-being; our current regulations on smoking provides adequate precedent.

6. These are several important aspects of greenhouse gases and the externalities their production creates. Identify the element below that is not one of them:

a. With the accumulation of the greenhouse gases and their long half-lives in the atmosphere, we can expect that solar energy will be diminished from the chemical and photosynthetic processes these gases promote.

b. Each gas has a different half-life, or time before it dissipates from the atmosphere. This implies that we should evaluate their respective importance taking account of both their initial and cumulative effect on global warming.
c. CO₂ appears to be the most important of the greenhouse gases both because of its cumulative effect and because it is being increased at a relatively high rate with the burning of fossil fuels.

d. Even if we stopped all new emissions of greenhouse gases, scientists believe that there is some climate change that is inevitable because of what has already been done.

e. There is nothing special about doubling of the atmospheric concentration of CO₂. Cline argues that because the process can, at this point, be expected to continue analyses should consider the long term nature of the problem.

7. Pesticide policy illustrates a situation where: (circle the one that best describes the economically important aspect of current policy)

   a. Food production is central to satisfying consumer preferences through market forces.

   b. There is a discrepancy between experts' judgments about the risks associated with pesticide residues versus those of consumers.

   c. There is a clear need for government intervention to mandate the sale of organically grown produce, admittedly in smaller total quantities.

   d. Ignoring consumers' irrational concerns will assure that the problem goes away.

   e. We should rely primarily on a technical solution because it will be recognized by all to be best.

8. Natural resource damage assessments (circle the most appropriate answer):

   a. Compute the costs associated with cleaning up a natural resource injured by hazardous substances or oil so it meets a health standard.

   b. Involve the assessment of costs of restoration or the losses from not restoring injured resources to their baseline condition (i.e. how it existed before the injury) after the resources already meet a health standard.

   c. Involve only resources like Prince William Sound where oil tankers receive the oil extracted from public lands.

   d. Provide the basis for estimating the maintenance costs of the public parks, forests, and wild and scenic rivers.

   e. Can be traced to Colorado because most of the early mining generated mining
waste that is exempt from the manifest system that characterizes the
disposal of currently generated hazardous waste.

9. When one person's consumption of a good does not diminish the quantity
available for another consumer, this is referred to as:

   f) rivalry
   g) exclusivity
   h) nonrivalry
   i) nonexclusivity
   j) a real deal

10. Economic value is determined by people’s willingness to make tradeoffs. In the
market these tradeoffs could take the form of: (select the one from below that
does not fit a market tradeoff)

   a) free time that would be available for leisure, but given up for money
   b) goods given up for other goods
   c) protection of endangered species for cleaner air
   d) lower risk of accidents or death for lower wages
   income available for savings given up for purchasing commodities

11. Revealed preference methods for measuring economic value (select all that apply)

   a) focus on measuring non-use values
   b) focus on measuring use and non-use value
   c) elicit values directly from people with surveys
   d) do not require people to actually pay for their choices
   e) focus on measuring use values

12. If on average construction workers are willing to accept a 1/1000th increase in
their annual risk of death in exchange for an increase in their annual earnings by
2000 then we would say that the value of a statistical life based on these choices
was

   f) 2 million dollars
   g) 200,000 dollars
   h) cannot be computed from the information given
   i) 4 million dollars
   j) 5 million dollars
13. Benefit cost analysis can be described as usually making several important assumptions. Identify the assumption it does not make from below:

- e) marginal benefits from the proposed policy intervention will be equal to the marginal costs
- f) improvements can be judged as taking place as long as there is the potential for gainers to compensate losers from a policy
- g) benefits and costs that are realized over time can be represented in present value terms
- h) the activities associated with implementing a project’s objectives are done in the lowest cost way.

14. The ___________________ the discount rate used in computing a cost-benefit analysis, the __________________ the weight placed on future benefits and costs.

- f) lower; lower
- g) higher; higher
- h) higher; lower
- i) greater the risk component of; higher
- j) lower the risk component of; lower

15. The travel cost method is based on the premise(s) [select one or two that apply]

- a) that a survey of individuals at different recreation sites will provide information about the appropriate level of pollution at those sites based on their judgments of how satisfactory their experiences were
- b) the travel costs people experience and the trips they take to recreation sites for people at different locations will reveal their demand for a recreation site
- c) measures of the consumer surplus derived from using a recreation site can be derived from the travel cost demand model
- d) people involved in the travel cost study are retired so they can be observed having sufficient time to visit the sites
- e) none of the above

16. The approach to non-market valuation that treats environmental quality or amenities as an attribute that people obtain based on where they live is referred to as

- a) hedonic property value
- b) mitigation or averting behavior model
- c) comparative conjoint methods
d) hedonic travel cost
e) a) and d)

17. Global warming refers to

a) the accumulation of a variety of gases in the atmosphere
b) the injection of specific gases into the atmosphere that trap infrared radiation
c) the disruption of the equilibrium between the amount of heat entering the earth’s atmosphere and the amount of heat leaving the atmosphere
d) all of the above.

18. The Eagle River Case highlighted two important distinctions in the way that the plaintiff and the defendant’s economists modeled the injuries to the river from releases of hazardous substances. Identify the two from the list given below:

a) each group used different discount rates for the time profile of losses
b) loss of use measured as the complete loss of the consumer surplus versus consumer surplus loss due to a higher price for the same type of recreation
c) different assumptions about the risks of contamination from groundwater for the houses in the area
d) different assumptions about the number of people who would use the river cleaned or be willing to pay for the cleanup of the site
e) different assumptions about the size of the premium in their respective hedonic property value models for living near the river

19. An example of an averting behavior model for measuring the benefits people would put on cleaning up air pollution:

a) a hedonic property value model that included air pollution
b) the lowest cost technology for cleaning up air pollution as it is estimated by policy staff at EPA
c) purchase of water filters to purify water so that it tastes better when you drink it in the open air
d) air conditioning installed to avoid indoor air pollution that cause health problems
e) a) and d)

20. To maximize the discounted profits from extracting a known deposit of ore, the firm should
a) in some circumstances equate price to marginal extraction cost
b) only equate price to marginal extraction cost in the presence of taxes on profits
c) equalize the present value of profit earned per unit extracted in each time period
d) select the time profile of ore to be sure that a positive amount is withdrawn in each period
e) follow the procedure outlined by Malthus, allowing for Mansfield’s adjustment only in those cases where it is appropriate

21. When the competitive fringe of a dominant firm oligopoly model succeeds in producing a significant portion of the market output, the result will be

a) a fall in market price
b) a decline in monopoly profits earned by the cartel
c) a shift in the influence of the cartel
d) an increase in the amount of output supplied
e) all of the above.

22. The present value of net benefits from a project that lasts three years will be \[ \text{________________} \] at a five percent discount rate. The project net benefits are given below. Select the value that offers the closest answer

<table>
<thead>
<tr>
<th>Year</th>
<th>Net benefits (benefits – costs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Today</td>
<td>-10</td>
</tr>
<tr>
<td>One year from now</td>
<td>-15</td>
</tr>
<tr>
<td>Two years from now</td>
<td>10</td>
</tr>
<tr>
<td>Three years from now</td>
<td>18</td>
</tr>
</tbody>
</table>

a) positive
b) negative
c) zero
d) one needs more information to answer

23. Nordhaus summarizes the primary conclusion of most economic studies of climate change as:

a) questions associated with these types of problems are beyond the capability of rational economic models and should be resolved by ethicists and through a public choice process as it is embodied in politicians
b) the deep uncertainty associated with shifting currents that could easily turn Europe’s climate into what is currently experienced in Alaska
suggest immediate significant efforts are needed to reduce greenhouse gases regardless of the costs

c) in the face of the fairly certain 3° to 6° C rise in mean global temperature we should accumulate physical capital (e.g., dykes, new technologies to build cities within domes, etc.) to publicly provide the necessary mitigation
d) impose modest restraints to reduce greenhouse gases and concentrate on other more immediate problems that deserve our attention now
e) none of the above

24. Given the demand curve below, the consumer surplus for a price change of $1 from 1 to 2 is: ____________________.

f) 3
g) 9
h) 15
i) 10
j) 1

25. The primary criticisms of the contingent valuation or stated preference method for measuring people’s values for changes in environmental resources are that (select the one or two answers that apply):

   a) individuals do not consider their budget constraint when answering and therefore may state they are willing to pay an amount they cannot afford
   b) the method is not able to measure nonuse values
   c) individuals do not have experience valuing environmental amenities and therefore their answers are questionable
   d) the tradeoffs used should be in other commodities because this would permit measurement of use and nonuse values
   e) amenity values should be derived from a group process for public goods; contingent valuation relates to the individual instead of the group.

26. The following equation describes a hedonic property value model. Estimate the marginal willingness to pay at two different levels of air quality measured by miles of visibility. Consider an increase of each of the following amounts. Estimate the marginal willingness to pay per mile of improved visibility that should be used to measure the economic value for each of these changes.

   a change of 75 miles
a change of 90 miles

Housing Property Value (in dollars) = 100,000 + 100 AQ

AQ = air quality measured as miles of visibility

a) $ 1,500 for both
b) $ 7,500 for 75 miles and $ 9,000 for 90 miles
c) $ 8,250 for both (i.e., ($ 7,500 + $ 9,000)/2)
d) $100 for both
e) none of the above

27. An example of a *use value* for a non-market environmental good is

a) the benefits from the existence of the California condor now in the wild in California and Arizona
b) the benefits from knowing the Artic Wildlife reserve protects the habitat of polar bears as well as caribou
c) the benefits from protecting the Grand Canyon so the next generation has the option to use it
d) knowledge that the “living rock” found off the coast of Florida can no longer be harvested for private fish tanks
e) a lake or river available for swimming or fishing

28. In our simple model of the behavior of a firm with a known stock of a non-renewable resource the efficient allocation of amounts extracted of that resource over time would equalize the

a) costs of extracting the resource over time
b) the present value of the price over time
c) marginal reserves available for the future at each point in time
d) price realized taking account of market conditions for the ore and the stock market
e) the present value of profit per unit of output over time

29. Unit Profit = profit from extracting and selling one unit of the ore

AB = total amount available
TR = unit profit schedule for period 1
SV = present value of unit profit for period 2

Indicate which one or two of the following statements is incorrect:
a) selecting AJ output for extraction in period 1 allocates too much output to period 2 to be the maximum present value of profit
b) selecting AK would be the efficient point
c) because a substitute has been found for this material that will eliminate it from the market after period 3, sell AR in first period
d) selecting AH for first period extraction would yield too much extraction in the first period and too little in the second

30. The optimal level of pollution is:
   
   f) always equal to zero
   g) less than one might think
   h) the level of pollution where marginal abatement cost is equal to marginal damage
   i) the level which minimizes the total abatement cost
   j) the level where marginal abatement cost equals the marginal private cost of the good creating the pollution.

31. At the margin all but one of the following pollution policies create the same incentive effects; identify the one that does not:

   e) per unit effluent charges
   f) price thresholds for input fuels
   g) per unit subsidies for abatement of pollution
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32. The Coase Theorem relies on three assumptions; identify which of the following is not required:

   f) zero or low transactions costs from enforcing pollution rights
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   h) structured joint and several liability provisions
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33. One of the following statements is false. Identify the incorrect statement:

   e) the market demand for a private good is the horizontal sum of all individuals' demands
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   g) an efficient allocation of resources requires that all goods and services be allocated to their highest valued uses
h) efficient rationing is assured for congestible resources because each person experiences both external and internal effects

34. The following market demand and private supply relate to a good that generates an externality. $D$ is the demand, $S$ is the private supply function, $SS$ is the "social supply" – that is it reflects both the private marginal costs of production and the marginal social costs (i.e. it is the sum of these marginal costs). Each of the next three questions relate to this diagram.

![Diagram of market demand and supply](image)

The marginal social costs at the social equilibrium are

f) $E B$
g) $E G$
h) $A C$
i) $A H$
j) $H C$

35. The consumer surplus at the private equilibrium is

f) $P_C B Q_1 0$
g) $P_C B P_1$
h) $P_C A P_2$
i) $A B H$
j) $A B C$

36. The marginal social cost at the private equilibrium is given by

a) $E G$
b) $G H$
c) $B E$
d) $A C$
e) $A H$
37. A NC pulp and paper mill emits 100 tons of organic residuals per day into the Pigeon River at Clinton. The organic material is measured in terms of BOD (biochemical oxygen demand) units per liter of water. At the emission pipe, given the river's flow rate, this 100 tons converts to 50 BOD per liter of river water. The transfer coefficient for computing BOD measured at Pigeon Forge, TN (home of Dollywood) is 0.05 BOD per liter for each ton of organic residual introduced at Clinton. The concentration of BOD at Pigeon Forge is:

a) 5 BOD per liter  
 b) 50 BOD per liter  
 c) 2.5 BOD per liter  
 d) 5/50 BOD per liter  
 e) 50/5 BOD per liter

38. If the measured BOD at Pigeon Forge is 7.5 BOD per liter and you know there is only one other source east of Pigeon Forge. It's transfer coefficient is 0.10. What must the organic emissions be from this location?

a) 2.5 tons  
 b) 0.75 tons  
 c) 25 tons  
 d) 250 tons  
 e) 75 tons

39. Moral suasion is

a) a term used to describe the governmental attempts to influence behavior without actually stipulating rules  
 b) a tool used by government and many not-for-profit organizations to reduce waste and promote recycling  
 c) a cost effective, but inequitable approach  
 d) both a and b  
 e) a framework endorsed primarily by the Southern Christian Leadership Forum

40. Marginal damage function describes

a) the costs attributed to reducing emissions so pollution is reduced  
 b) the social opportunity cost of any private production  
 c) the increase in damage that results from an incremental increase in the level of pollution
41. It is possible to observe reductions in pollution emissions as a result of
   a) moral suasion
   b) government production of environmental quality
   c) command and control regulations
   d) economic incentives
   e) all of the above

42. Consider an unregulated market with two polluting firms and no controls on pollution. The marginal abatement costs of firms 1 and 2 are given as
   
   \[ MAC_1 = 21 - 3E_1 \]
   \[ MAC_2 = 12 - 2E_2 \]
   
   \( E_1 = \) emissions from firm 1
   \( E_2 = \) emissions from firm 2
   f) 7 units by firm 1 and 6 units by firm 2
   g) 9 units by firm 1 and 9 units by firm 2
   h) 21 units by firm 1 and 12 units by firm 2
   i) none of the above

43. Given the marginal abatements costs for these firms, suppose an effluent charge of $6 per unit is imposed on both polluters, what would be each firms' level of pollution?
   a) 3 for firm 1 and 0 for firm 2
   b) 5 for firm 1 and 3 for firm 2
   c) 5.6 for both firms
   d) none of the above

44. A bonding system is an alternative type of economic incentive which requires
   a) a refund or the return of a recyclable material
   b) payments per unit of pollution reduced
   c) a large sum of money be placed in escrow by a potential defender of the environment
d) defining legal liability for the damages caused by certain types of environmental damage
e) all of the above

45. When the marginal abatement cost is uncertain and marginal damages are known, the preference for a price (effluent charge) versus permit system may be different than in the case with no uncertainty. Based on the potential economic surplus losses we would prefer: (mark either one or two selections that apply)

f) a quantity system when the slope of the marginal damage (in absolute magnitude) exceeds the marginal abatement cost
g) a price system when the slope of the marginal damage (in absolute magnitude) exceeds the marginal abatement cost
h) a quantity system when the slope of the marginal damage (in absolute magnitude) is less than marginal abatement cost
i) a price system when the slope of the marginal damage (in absolute magnitude) is less than marginal abatement cost

46. Stavins explained several reasons why command and control policies dominated environmental policies. One of the following he did not mention

a) firms prefer command and control because they can improve an existing firm's competitive position over a new firm entering the industry
b) environmental organizations prefer command and control because incentive based policies like tradeable permits can lead to localized "hot spots" with reasonably high levels of pollution
c) they reflect the confidence in the rational approach to policy within which deductive logic suggests regulations will be able to deduce what are best methods for recovering effluents by remaining detached to assure fairness and relevance
d) standards offer greater opportunities for symbolic politics because strict standards can be combined with less visible exemptions of each specific regulations.
e) politicians are risk averse and they prefer policies that involve more certain levels of pollution

47. Option price is a monetary measure of the value of a program that may improve a person's utility. If we consider a case where the gain comes from a gamble involving increases in income, it is the same as the certainty equivalent. The size of this value is related to the expected value of the increase in income as follows:
(a) The option price is generally less than the expected value of the income gain when the individual is risk neutral.
(b) The option price will generally be greater than the expected value of the income gain when the individual is risk averse.
(c) The option price can be equal to the expected value of the income gain when the individual is risk averse.
(d) The option price will generally be less than the expected value of the income gain when the individual is risk averse.
(e) We cannot determine the relationship without knowledge of the amounts of income gain and probabilities involved.

48. Benefit cost analysis requires that we accept most of the following conditions. Identify the one(s) that is (are) not required.

(a) The analysis implicitly accepts the initial distribution of income and wealth because they provide the basis for the benefit and cost measures.
(b) Gains and losses only matter in the aggregate. No special consideration is given to evaluating who gains or loses from a policy.
(c) Discounting of net benefits to present value terms must be undertaken with the tax adjusted private rate of return to capital.
(d) While the net benefit criteria requires that we accept an efficiency orientation, it does not guarantee that any particular project will lead to the efficient allocation of resources.
(e) c and d
(f) a and d

49. Natural resource damage liability (NRDL) refers to the liability that individuals (or firms) have when their actions lead to releases of hazardous waste or oil that injures a natural resource. Several features of the liability are important. They include all but one of the following:

(a) NRDL is a residual liability after the PRP has cleaned up the site injured to meet a health based cleanup standard.
(b) The liability requires PRP pay the costs of restoring a resource to its original, baseline condition (i.e. before the injury) unless they are grossly disproportionate.
(c) Market prices for all environmental resources (even if they are freely available to users) must be used to assess damages so as to assure efficient compensation for the injury.
(d) Assessment regulations distinguish small (Type A) and large (Type B) situations and prescribe different rules for each case.
(e) Regulations require that payments be made to the designated trustee agencies and not be returned to the general fund for all tax revenues. This provision was intended to assure that the monies be allocated to maintain and enhance the stock of natural resources.
50. Environmental economists use different procedures to measure how much households would be willing to pay for nonmarketed environmental resources. Several characteristics of these methods include:

(a) Indirect methods such as the travel cost demand models or the hedonic property value models rely on observing people's choices.
(b) The travel cost demand model assumes people react to the increased costs of traveling to a recreation site the same way they would to an increase in the price of entering that site.
(c) Direct or contingent valuation methods ask people to make a choice or to state a monetary value for specified improvements in some environmental resource.
(d) Hedonic property value models require that the analyst ask buyers the reasons they purchased their homes at specific locations in order to adjust the model for differences in these motivations.
(e) Averting behavior or household production models rely on using households' expenditures on other goods or services as substitutes for the deterioration in one or more environmental resources.

51. As a rule, benefit cost analyses use the present value of the net benefits associated with a specific action. A variety of criteria have been suggested for selecting a discount rate. Circle the one criterion that has not been considered as relevant.

(a) The opportunity cost in terms of the rate of return to private investment.
(b) The individual's rate of time preference sometimes argued to be reflected by a market rate of interest.
(c) A weighted average of the individual rate of time preference and the private rate of return on investment based on the method used to finance the public investment project.
(d) A social rate of time preference determined by society's attitude toward the desirability of project under review in meeting society's long term goals.
(d) The opportunity cost of finance as measured by the best of the foreign nation's rates of return on their public investment projects to assure that our public activities are internationally competitive.

52. A steel mill produces rolled steel products and various waste products. Some of the waste is released into a stream beside the rolling plant. Downstream fishermen use the stream as a source of fish. Because of the releases, fish are killed or contaminated and cannot be sold, so during times of releases fishermen must use other streams for fishing. The releases are an example of:

a.an open access resource
b.an implicit cost to the mill
c.negative market coordination effects
d. negative externalities  
e. inferior factor inputs

53. The Coase Theorem offers two important conclusions about externalities. Which one of the following is one of these conclusions:

a. Externalities can usually be eliminated by modifying production activities to contain residuals.
b. With negligible transaction costs, an efficient negotiated settlement will not be affected by the assignment of property rights to resources conveying an externality.
c. Liability rules assigning responsibility for damage to the party generating the externality require identifiable costs to assure efficient outcomes.
d. Production externalities require smaller transaction costs for efficient negotiated solutions than would be necessary with consumption externalities.
e. Positive externalities do not require negotiated solutions because both parties involved in the external effect are better off with them than without having them.

54. Fred purchased a $15 ticket to a rock concert. On the day of the concert he finds out about Big Sweep, the annual beach cleanup activity in N.C. He cannot do both. Had he known about both the Big Sweep and Concert, he would have picked Big Sweep. Which of the following is correct the interpretation of this situation:

a. If Fred is rational, he will participate in Big Sweep regardless of purchasing the concert ticket.
b. Only a true environmentalist would forego the concert to participate in Big Sweep.
c. Fred should only participate in Big Sweep if he can sell the concert tickets.
d. a and b.

55. The concept of industrial ecosystem cycle developed by Frosch and Gallopoulos refers to:

a. The cycle of activities in artificial ecosystems developed by industry to replace natural systems that have been injured by toxic wastes.
b. The set of transformations and activities that link raw materials to production, consumption and recycling.
c. Activities developed through biotechnology to produce new raw materials that substitute for nonrenewable natural resources.
d. a and c.
e. None of the above.

56. When a negative production related externality exists in the market place, which of the following is true:
a. There is no market inefficiency.

b. Marginal social costs of production are greater than marginal private costs to the firm causing the negative externality.

c. Marginal social costs of production are less than the marginal private costs to the firm causing the negative externality.

d. Marginal social costs of production are unaffected by the externality. They relate to consumption externalities from those using the products of the firm causing the negative externality.

e. b and d.

**Short Answer**

57. Fisheries and forests are renewable resources. Identify one reason why private management may not be efficient for each and describe what common feature the two resource problems share.

58. State the Coase Theorem and its primary assumptions.

59. Describe the difference between revealed preference and contingent valuation approaches to measuring consumers’ valuations of environmental resources. Give an example of each method.

60. If there are no extraction costs, an exhaustible resource’s (with a known sized deposit) price will rise at the rate of interest. Explain what this means in no more than three (3) sentences.

61. Describe in one or two sentences the difference between use and nonuse value.

62. The paper by Bockstael et al. argues that efforts by ecologists to estimate the economic value of ecosystems are mistaken. List two reasons for the Bockstael et al. conclusion.

63. Describe the difference in one or two sentences between reserves and resources as measures of what is available for extractive resources.
64. In applying benefit-cost analysis to projects where it is not possible to measure, in dollar terms, all the sources of benefits, but all costs can be measured in money -- how do we use the monetary measures to isolate the primary element in a choice? (describe in one or two sentences)

65. Explain the difference between an effluent charge and tradeable pollution permits (include a one sentence description of each and one comparison sentence).

66. Define the polluter pays principle (no more than two sentences).

67. State in one or two sentences the Coase Theorem

68. Explain in two sentences why public goods like environmental quality cannot be provided privately. [hint: do not focus on attributes of public goods]

69. Using a clearly labeled diagram, illustrate how the net benefits criteria of benefit-cost analysis evaluates whether a proposed change in environmental quality is a movement toward an efficient level of environmental quality (graph plus no more than four sentences).

70. Liability rules such as those associated with natural resource damage assessments influence the behavior of firms whose activities could lead to a release of oil or hazardous waste. Command and control regulations such as those associated with the Clean Air Act also affect the disposal of hazardous wastes. Compare the incentives for firms' behavior provided by a liability system with a command and control technology-based regulation (limit of five sentences).

71. Demonstrate for risk averse individuals that the certainty equivalent will be less than the expected value for a gamble that involves a probability p of income Y and (1 - p) of Y + A (where A > 0) (use a clearly labeled graph and no more than four sentences to develop your argument).

72. Hanemann's description of the settlement for the Shell oil spill in Martinez, California identified one central theme that unified all aspects of negotiating a settlement. Provide two examples of how that theme influenced the economic analysis associated with the settlement (three sentences).
73. Three basic mechanisms influence firms' responses to environmental degradation. List the three types of approaches identified for moving firms to internalize environmental costs (include only one sentence description of each).

74. How is the use of markets compatible with sustainable development? (no more than three sentences)

75. Describe how the market demand for a public good is different from a private good. (include graphs and no more than 2 sentences)

76. Why are green final product taxes not an efficient response to the pollution caused by these products?

77. Define and illustrate a damage function (use an example in general terms from EPA's Retrospective or Prospective analyses)

Problems

1. On March 31, 1982 a leak developed in a railroad car that was stored on a railroad siding adjoining the Russian River near Ukiah, California. Over 20,000 gallons of formaldehyde spilled into the Russian River. This toxic substance killed all the fish in the river from this point for 20 miles down the river. It took one month to become sufficiently diluted so there was no remaining hazard to anyone using the river. You can assume that there were two effects of this accident. People were banned from using the river for one month. The fish died in the most productive area of growth (for fish). The population of fish will remain low but grow gradually over the next year. If left undisturbed for one year, the fish stock will return to its "normal" level. The river also provides drinking water to three communities down river. Their supply of water was affected for one month. Your task is to estimate the use values disrupted by the incident. You should include present and future fishing impacts and the effects on drinking water.

Information you know:

Demand for River fishing (for a typical person)

\[ Q = 10.0 - 1.0P \]

where \( Q \) = trips per week

\( P \) = travel cost (based on round trip mileage)
You can assume the fishing season is only one month (April) for the purpose of this analysis and that the cleanup plan required that the River must be left undisturbed for one year after the spill. However, drinking water supplies were only disturbed for one month after the spill.

The three towns with people using the river for fishing are distributed as follows:

<table>
<thead>
<tr>
<th>Town</th>
<th>Number of people</th>
<th>Round trip mileage from River at point of incident to the town (miles)</th>
<th>Next best fishing stream (Round trip mileage to each town)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10,000</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>1,000</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>C</td>
<td>5,000</td>
<td>8</td>
<td>18</td>
</tr>
</tbody>
</table>

You can assume that the travel and related costs are $1 per mile. Another fishing stream that provides exactly the same fishing opportunities is located at the distances given in the third column in the table above.

There are two ways that each town can respond to the one month disruption in the water supply for the three towns - cleaning their water or purchasing water from a larger town outside the area. You can assume the two types of water are perfect substitutes. The quoted prices are different because one town (A) is closer to the supply source than either town B or C.

<table>
<thead>
<tr>
<th>Town</th>
<th>Purchased water (per week)</th>
<th>Increased cleaning cost (per week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$10,000</td>
<td>$45,000</td>
</tr>
<tr>
<td>B</td>
<td>$22,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>C</td>
<td>$40,000</td>
<td>$35,000</td>
</tr>
</tbody>
</table>

The lawyer working for the railroad company has proposed a settlement for natural resource damages of $1,000,000 paid in equal payment of $250,000 for each of the next four years. The market rate of interest at the time of this incident, which you should assume is what you will use, this time was 10 percent. Assume you are representing the state's interest. The lawyer assures you in accumulated interest alone the state will do handsomely at these rates.

(a) Compute the natural resource damages from disrupted uses of the river.
(b) As expert to the State, would you recommend accepting the firm's offer? Explain why (Note - here I expect a specific answer related to the facts of this case, not a
(c) If the market interest rate were only one percent, would this clearly cause you to change your position on the firm's offer? Document your argument.

2. Two firms - National Paper and White-As-New Paper have access to five different production processes, each one of which gives off a different amount of pollution. The daily costs of operating the processes for each firm (based on its specific conditions) along with the corresponding amount of residuals generated (described here as the tons of particulates emitted into the air) are listed in the table below.

<table>
<thead>
<tr>
<th>Process</th>
<th>Amount of Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Paper</td>
<td></td>
</tr>
<tr>
<td>White-As-New</td>
<td></td>
</tr>
</tbody>
</table>

a. If air pollution is unregulated which process would each firm pick and what is the daily amount of particulate emissions?

b. As the air pollution manager, you decide it is essential to cut emissions in half. You want to compare two systems of control requiring each firm to cut emissions in half (from the level they selected in part 2) versus a system where they must purchase permits to be allowed to emit the particulates from their smokestacks. You select a number of permits equal to one-half the total particulates emitted (by both firms) in the no regulation situation. Calculate the equilibrium price that would arise from the market for permits. Compare the total costs of the command system requiring one-half reduction with the market system.

To answer this question about the market for permits, you must: calculate the marginal cost of controlling emissions for each firm; determine the market demand for permits from these costs (recall our first experiment and its demand); determine the allocation of permits between the two firms; and then compare total costs implied by this allocation versus that implied by a 50% reduction for each firm.

Your answers and work must be clearly written and labeled. Otherwise no partial credit!

Cost/Emission Control Options
3. Under the proposed re-authorization of the Clean Water Act, Congress is considering regulating agricultural sources of water pollution. This regulation will increase farm costs of production, but improve recreational opportunities.

Using clearly labeled graphs, describe the economic concepts we would need to measure to evaluate the complete economic costs and benefits of these types of proposals. (Note: I expect clear graphs and one paragraph of explanation; attempts to BS one's way through this question will lead to no partial credit).

Using clearly labeled graphs, compare the implications of externalities and open access resources for the level of industry output and prices. Why is the case of an open access resource considered self-regulating? (a brief explanation, 3 sentences with the graphs should be enough)

4. Given the following total willingness to pay schedules for each of three people derive the aggregate willingness to pay for the society (i.e. all three people) under two different sets of conditions. First, assume that the goods are private; then do it again under the assumption the good is public.

<table>
<thead>
<tr>
<th>Process</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Emissions (tons per day)</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total Daily Cost (thousands of dollars)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White-As-New Paper</td>
<td>100</td>
<td>120</td>
<td>140</td>
<td>170</td>
<td>220</td>
</tr>
<tr>
<td>National Paper</td>
<td>60</td>
<td>100</td>
<td>150</td>
<td>255</td>
<td>375</td>
</tr>
</tbody>
</table>
### Table of Values

<table>
<thead>
<tr>
<th>Amount of good</th>
<th>WTP</th>
<th>Amount of good</th>
<th>WTP</th>
<th>Amount of good</th>
<th>WTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>1</td>
<td>25</td>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
<td>2</td>
<td>10</td>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

5. Suppose you have two firms with marginal abatement costs expressed in terms of their emissions as follows:

<table>
<thead>
<tr>
<th>Firm</th>
<th>Emitting tons With no control</th>
<th>Marginal abatement cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>400</td>
<td>MAC₁ = 400 – 4 (100 – E₁)</td>
</tr>
<tr>
<td>2</td>
<td>200</td>
<td>MAC₂ = 150 + 5E₂</td>
</tr>
</tbody>
</table>

E₁ = firm 1's abatement in tons
E₂ = firm 2's abatement in tons

a) Assume that each firm faces an effluent charge of $200 per ton. What is each firm's abatement level?
b) Compute the efficient level of reducing the total emissions from both firms by 10%.
c) Suppose each firm was paid a subsidy of $300 for each ton it removed. How much would they remove?
d) If the subsidy per ton were $200 would they remove the same amount as with the effluent charge? If your answer is yes -- why does this happen? (one or two sentence answer).
a) Illustrate the efficient level of Q in this diagram. What is the key condition that determines your selection?
b) How does that key condition relate to a demand and supply curve for a private good?
c) Suppose Q is produced with an externality. How does this externality affect the analysis?
d) How does benefit-cost analysis of a project or a regulation relate to this diagram? Illustrate with a new diagram how the benefit-cost criterion relates.

7. The Governor of Florida has asked for advice on a project that will widen the highways leading to Disney World. This will reduce congestion and save time getting to the park. It is estimated that this will save approximately 27 minutes, and that the travel costs to get to the park are primarily the time costs of travel. These time costs are estimated to be 20 dollars an hour and the average time before the widening of the highway is 1½ hours.

The individual household’s demand for trips to Disney World is given as

\[ Q = 12 - \frac{1}{3} p \]

\[ Q = \text{trips} \]

\[ p = \text{travel cost measured by time costs} \]

The project will take 3 years to complete. During construction you can assume it does not have an effect (positive or negative) on trips. You can assume there are 2,000,000 households who would consider using the area and that equation (1) describes each household’s demand.

The widening will provide gains once it is finished 3 years from now. You can assume they will last for three years after it is finished. The project will cost 140 million dollars divided equally between the first two of the three year construction process. There is some debate whether to use 9 or 10 percent discount rate for the project. Consider how this choice affects your answers. Assume we are now in year zero -- before anything happens.
a) compute the value of the savings experienced, per household, from widening the road

b) fill in the table below

<table>
<thead>
<tr>
<th>Year</th>
<th>Project Cost</th>
<th>Project Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

c) Compute the present value for this project with each discount rate. What does it imply should be done?
8. As you know North Carolina is trying to increase the stringency of its regulations of electric power plants to improve air quality.

Suppose you were asked to conduct a short-term analysis of the net benefits of a new proposed set of regulations. Short term means over its first five years.

You have three sets of information. Firms affected by the regulation have reported that their costs will increase by 150 million dollars each year to meet the new regulatory requirements that are technology based standards (and you can believe them). A permit trading program would reduce these costs to 100 million, but the Governor has refused to consider it.

The second set of information is the health effect of the policy. It is estimated that with current air quality conditions 100 asthmatic teenagers die pre-maturely due to the air pollutants. If the policy was adopted we could reduce that number to 75 premature deaths due to pollution.

From a study of the middle aged men and women’s decisions about where they work and what pay they accept you know that they receive $5,000 more annually in increased wages for each 1/1000 increase in the risk of serious accidents that cause death.

a) compute the value of the proposed regulations each year

<table>
<thead>
<tr>
<th>Year</th>
<th>Benefits</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
b) If the discount rate is 8 percent what is the present value of the regulations?

c) Did you need to compute the present value to decide whether the project was warranted?
d) Is the Governor’s position warranted and what would you say in a sentence or two that would explain whether it is important?

e) Do you have concerns about using labor market experience to estimate the benefits of this project? What would you say is a key limitation for this particular policy?

9. Consider a situation with two firms, A and B

<table>
<thead>
<tr>
<th>Firm</th>
<th>Emissions with no control (tons)</th>
<th>Marginal abatement cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>200</td>
<td>$MAC_A = 100 - 1/2 E_A$</td>
</tr>
<tr>
<td>B</td>
<td>500</td>
<td>$MAC_B = 50 - 1/10 E_B$</td>
</tr>
</tbody>
</table>
Where $E_A, E_B$ is the emissions of each firm

a) Compute the marginal abatement cost if each is required to reduce its emissions by 10%.

b) What is the allocation of cleanup between the two firms if they are required to realize a 10% reduction in total emissions at the smallest total cost?

c) If the marginal damages from the emissions are constant and equal to $25 per ton, how much should each firm abate?
d) If firm B is purchased by another firm, C, who is regarded as a “good actor” (that is, they routinely cleanup more than they are required) and has separate abatement costs of:

\[ MAC_C = 1 \cdot AC \]

Where \( AC \) = emissions abated by firm C before the merger. What would its abatement cost be in the absence of controls?

e) If firms C’s total emissions are 100 tons and these emissions are considered in the 10% overall reduction in all emissions, how would this merger affect the allocation of abatement among A, B, and C?

10. After the war with Iraq, the United Nations set up a commission to determine the natural resource damages due to injuries to natural resources in Kuwait and Saudi Arabia that support outdoor recreation.
Suppose you are asked to compute the losses per recreationist for the oiling of beaches in the two countries. Recreationists in each country can be assumed to have a demand for beach recreation that is:

\[ q = 5 - \frac{1}{2}p \]

where:
- \( q \) = trips in a year
- \( p \) = round trip travel cost

a) The average travel cost in the two countries is given below -- What are their respective per recreationist consumer surplus from beach recreation? Also estimate the number of trips.

<table>
<thead>
<tr>
<th>Country</th>
<th>Travel Cost</th>
<th>Trips</th>
<th>Consumer Surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuwait</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>3.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) You can assume the war destroyed the beach these recreationists use. Beaches in Lebanon are available, but users must pay a seasonal entry fee of $12.25. What is the best measure of economic loss for the typical recreationist from each country? Assume extra travel cost per trip to Lebanon is $1.00.
11. Given the following total willingness to pay schedules for each of three people, where each value corresponds to the person’s willingness to pay for the additional unit of the goods, answer the questions below:

<table>
<thead>
<tr>
<th></th>
<th>PERSON</th>
<th></th>
<th>PERSON</th>
<th></th>
<th>PERSON</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount</td>
<td>WTP</td>
<td>Amount</td>
<td>WTP</td>
<td>Amount</td>
</tr>
<tr>
<td>1</td>
<td>125</td>
<td></td>
<td>1</td>
<td>75</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td></td>
<td>2</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td></td>
<td>3</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td></td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

a) Derive the aggregate willingness to pay for society (i.e., all three (3) people) if the good is private and then treating the good as public.

b) Suppose that it is possible to offer 3 units of the good at a total cost of $275. Would this option pass a benefit cost test for the case where the commodity assumed to underlie the table above is private and when it is a public good? To derive your answer for the private good how did you assume the commodity was allocated among the three people?
c) Suppose in the case of treating the good as a private commodity that access was allocated by a lottery with each person having an equal chance of getting in. What would the total willingness to pay for one unit be?

12. Evaluate the effects of a tax on effort in comparison to the efficient solution on the performance of a fishery.

   a) Compute the efficient level of effort given the following information:

      Total revenue from effort \( (E) = 8E - 3E^2 \)

      Total cost of effort = 5E
b) The proposed tax on effort is $1 per unit of effort: compute the level of effort, the profit, and compare each of these to the efficient levels of each variable.

13. The demand schedules that three people have for ducks are given as follows:

<table>
<thead>
<tr>
<th>Price</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1</td>
<td>20</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>$2</td>
<td>10</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>$3</td>
<td>8</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>$4</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>$5</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

(Quantity of Ducks Desired)*

If the marginal cost of increasing the amount of ducks is constant regardless of the number at $5. Derive the efficient amount of ducks to be provided when (Note: illustrate each case with a carefully labeled graph):

a. Ducks are considered as a private good.
b. Ducks are considered a public good.
c. Describe in no more than four sentences why the difference in your solutions for (a) and (b) is relevant to policies involving unique natural resources like the Grand Canyon or endangered species.

*You can envision the ducks as being migratory waterfowl and a private demand is for hunting, while a public demand is for bird watching.

14. The Table attached provides an approximate version of the schedule for the spot auction from this year's sale on the Chicago Board of Trade of the permits to emit sulfur dioxide. Each permit is good for one year and gives the owner the right to emit one ton of sulfur dioxide.

(a) If the number of permits issued was 20,000, compute the market clearing price.

(b) As I noted in class, news reporters suggested that environmental groups* were "distorting the incentive-based process." Suppose environmental groups were banned from the market. What effect would this have on the price if the number of permits issued remained the same at 20,000 (be specific)?

(c) Omitting the environmental groups, when firms have experience with this system, we would expect that each bid for permits should allow us to estimate something about firms. If you were
told that EPA was considering an effluent charge of $250 per ton of SO$_2$.

describe how this solution would compare with the permit solution in (b)
without the environmental groups. Include the price, number of tons
emitted, and estimate which leads to higher control costs.

<table>
<thead>
<tr>
<th>Bid</th>
<th>Quantity</th>
<th>Firm</th>
</tr>
</thead>
<tbody>
<tr>
<td>$500</td>
<td>5</td>
<td>Clean Environment for People</td>
</tr>
<tr>
<td>$400</td>
<td>100</td>
<td>UNC, Chapel Hill Power Plant</td>
</tr>
<tr>
<td>$300</td>
<td>5,000</td>
<td>Duke Power</td>
</tr>
<tr>
<td>$250</td>
<td>10,000</td>
<td>CP&amp;L</td>
</tr>
<tr>
<td>$225</td>
<td>5,000</td>
<td>Friends of the Air</td>
</tr>
<tr>
<td>$200</td>
<td>4,000</td>
<td>TVA</td>
</tr>
<tr>
<td>$150</td>
<td>1,000</td>
<td>Developing Innovative Research Techniques, Inc.</td>
</tr>
<tr>
<td>$100</td>
<td>500</td>
<td>Virginia Power &amp; Light Co.</td>
</tr>
<tr>
<td>$75</td>
<td>3,000</td>
<td>Madison Gas &amp; Electric</td>
</tr>
<tr>
<td>$50</td>
<td>10,000</td>
<td>Friends of the Air</td>
</tr>
</tbody>
</table>

*The environmental groups are: Clean Air for People and Friends of the Air.*
15. The World Bank was recently considering a $10 million dollar investment in a water and sanitation project in Kumasi. It would all arise in the first year (this is true). One aspect of the project provides indoor plumbing (referred to as water closets). A second aspect of the project is to provide clean drinking water. To decide whether the project is to be undertaken, they must perform a benefit cost analysis. Assume you are the analyst given this assignment. Unfortunately, the available information is very limited.

Here is what you know about people's behavior. There are 200,000 households that could be served by the system. They could receive both clean water and an indoor water closet from the project. There are 400,000 households in the area. One-fourth of these are on private wells that provide them clean water. Two hundred thousand of the remainder must walk 10 miles for drinking water (round trip) once a week. One adult member of each household does this in about two hours. The remainder purchase water from private vendors for one dollar and fifty cents a week.

As a rule, all adults work and can expect to earn about one dollar an hour. There is some indoor plumbing in the area. All housing is rental in the area and identical units in all other respects (e.g. floor space, number of rooms, location) rent for $100 more per year with indoor plumbing. Unfortunately, there are very few units with this equipment. Only about 1,000 households can get them. At least half of the households would be able to afford this type of better housing if it were available.

To connect, households would be expected to pay $50 a year for both the drinking water and the water closet. Estimate the net present value of the project. For simplicity, you can assume that the project evaluation can only consider the initial two years and that the system can be operational immediately. The World Bank's discount rate is 5 percent. [Be sure to label all your work; spell out your assumptions and write carefully if you expect partial credit; what I cannot read in a short time, I cannot give partial credit].
16. Explain each of the following with **crisp** clearly written answers [*crisp* means a two sentence maximum response].

   a. The polluters pay principle

   b. The self-regulating feature of open access resources
c. A negative externality

d. Certainty equivalent

e. Sustainable development
17. In Maine, a power company has proposed a new hydroelectric facility on the Fishaby River, a noted trout stream. It is also an ideal (based on water flow) site for such a facility.

You are asked to estimate the annual environmental costs in terms of fishing should the dam be built. Fishing parties from four towns currently use the Fishaby. The number of trout fishing people are listed as well as the distance (round trip) for each town.

<table>
<thead>
<tr>
<th>Town</th>
<th>Fishing people</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>B</td>
<td>500</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>D</td>
<td>200</td>
<td>20</td>
</tr>
</tbody>
</table>

You can assume the travel cost is 50 cents a mile. The demand for trout fishing is

\[ Q = 35 - \frac{1}{2} P \]

where \( Q \) = trips trout fishing per year

\( P \) = travel cost

There is a "catch." The next best substitute for all towns is 120 miles away. However, there is a **season pass** for $50 required of each fishing person at Pricey River (the substitute). What is the annual environmental cost of the dam in terms of lost values for trout fishing? How does the season pass influence your evaluation? If the substitute had an entrance fee of $5 per trip (regardless of the number of people in the party) instead of a season pass, how would that change your answer?