The following pages contain a list of questions that you should be able to answer given the material covered in AGEC 350. In preparing for the exam I recommend focusing on these questions, the key concept sheets, and old exams. In terms of graphs, in addition to those covered directly below, you should make sure that you can quickly make graphs dealing with demand/WTP, MC/supply, consumer and producer surplus, positive or negative externalities and public goods.

Copies of previous exams are available at http://agecon2.tamu.edu/people/faculty/woodward-richard/350/. However, the material changes somewhat from one year to the next. So it is possible that material included in previous years is excluded this year or vice versa. The exam from the most recent semester is the best example of what to expect this semester.

YOU WILL BE ALLOWED TO BRING TO THE EXAM TWO 3X5 INCH NOTECARD WITH NOTES ON BOTH SIDES OF THE CARD. No calculators will be allowed. When calculations are necessary, you can simply write out the formula that you would type into your calculator.

- The final exam is comprehensive. About 2/3 of the material will focus on topics covered since the midterm exam, but will often rely on basic theoretical concepts presented in the first half of the class.
- To perform well on the exam you must be able to answer these questions. You must understand the concepts, not simply be able to reiterate the answers to questions you’ve already seen.
- There will also be at least one “clippings question” in which you are asked to apply economic concepts to a newspaper clipping.
- There will two RAT-repeat questions, taken from RATs 3, 4 or 5.

Population

1. Define each of the following in a way that would be understandable to someone who has never studied environmental economics.
   a. Total fertility rate
   b. Replacement rate

2. The graph above presents the basics of the microeconomic theory of fertility. Referring to the graph, explain what happens and why in the third stage of the theory of demographic transition.
3. Give an economic argument why policy makers should or should not worry about population growth. (i.e., explain why there is or is not a market failure with respect to population).

**Toxic risks**

![Graph showing cost-benefit analysis of perchlorate in water]

4. The figure above presents two demand curves for water, with and without perchlorate, which may lead to thyroid damage.
   a. Assume that the area enhd has a measure of $1.50, the probability of thyroid damage drinking water with perchlorate is 0.00001, and the probability is zero if the water does not have perchlorate. What is the statistical value to the consumer of avoiding thyroid damage?
   b. If government is committed to supplying perchlorate-free water at the price $b/unit, what is the total net benefit to the consumer? What area would equal the welfare cost if any?
   c. If government is committed to supplying perchlorate-free water, but will pass the cost on at the price $c/unit, what is the total net benefit to the consumers?
   d. Assuming that consumers pay the marginal cost of the water they consume, what area(s) would reflect the welfare change to the economy if water utilities were required to remove perchlorate from the water?

**Climate Change**

5. According to the best available scientific measurements, what has been the pattern of global temperatures in the past 50 years? One sentence.

6. What is a greenhouse gas and what is the basic theory behind the hypothesis that climate change has been anthropogenic. One to two sentences.

7. For each of the consequences of global climate change listed below, identify
   1) one of the most important impacts on humans,
   2) whether the impact is a market or non-market impact,
   3) the valuation method that would be best suited to placing a dollar value on the impact,
   4) a brief explanation how adaptation might diminish to some extent the magnitude of the consequences.
   a. Global average sea level has rise
   b. Poleward and altitudinal shifts of plant and animal ranges,
   c. Loss of habitat for species.
   d. Climatic disruption, with some areas experiencing drought
8. The figure above presents the MC curves for corn and wheat in a particular region before climate change (solid lines) and after climate change (dashed lines). Using the graphs, explain how adaptation will occur in this region and how adaptation is related to the cost of climate change.

9. Describe the difference between adaptation and mitigation.

10. Assuming that global climate change is in fact anthropogenic, is the US economy currently producing the efficient level of CO$_2$? Explain. (Hint: CO$_2$ is not regulated in the US).

11. The figure above presents the aggregate demand for energy and the marginal cost to produce energy from two sources, coal and solar.
   a. In the equilibrium, how much energy would be demanded?
   b. How much of this would be provided by coal and how much by solar?
   c. Recently, George Shultz, a prominent Republican politician, and Gary Becker, a conservative Nobel Prize economist, have advocated a tax on carbon. If coal had to pay a tax of $1 per unit and solar didn’t have to pay anything, what would be the new answers to questions a and b?
EPA’s policies on climate (there will be one question derived from the class in which Dr. David Evans of EPA spoke.

12. What is “Massachusetts vs. EPA” and how has this affected EPA’s activities with regard to climate change?

13. Explain what it would mean for a policy to address climate change to be cost-effective. What is one impediment faced by EPA that makes it difficult for the agency to pursue a completely cost-effective policy.

**Efficient allocation of a resource. The problem of water**

- Al lives downhill from the reservoir, so for him the cost to use water is zero.
- Betty has to pump water uphill, every unit she uses costs her $1.

![Graph showing marginal benefit (MB) curves for Al (MB_A) and Betty (MB_B).](image)

14. What is the marginal net benefit to Al of the 20th unit that he uses?

15. What is the marginal net benefit to Betty of the 20th unit that she uses?

16. Suppose Betty already has a right to 20 units of water. How much would she be willing to pay per unit for a marginal increase water delivered to her field? What price per unit would she be willing to pay to increase her water rights by a little bit?

17. Suppose there are 100 units of water available in the supply. What would be the efficient allocation of water between Al and Betty?

18. Suppose there are only 15 units of water available in the reservoir. What would be the efficient allocation of water between Al and Betty?

19. Now suppose there are 30 units of water available. What would be the efficient allocation of water between Al and Betty?

20. Suppose it turns out that Al has complete control over the water supply with 30 units of water. Al doesn’t feel like dealing with water sales, so Betty ends up with nothing. What is the welfare cost that results?
21. When Al’s son takes over the property, he is willing to make a deal. What is the welfare gain to both parties?

22. Describe in words how the third equimarginal principle is satisfied or not satisfied under riparian and prior appropriation systems of rights. If the equimarginal principle is not satisfied, which characteristic of efficient property rights fails?

**Efficient allocation over time**

23. A policy maker is considering whether to spend $6,000 on a project that will generate a $1200 per year in benefits for five years? How do we know that for any discount rate, the will not project pass a benefit-cost test?

24. Suppose a project costs $10,000 immediately and then $1,000 each year for 3 years. The benefits of the project are worth $3,500 per year and occur for 4 years starting one year from now. Given a 10% discount rate, does the project pass the benefit cost test?

25. At one time, it was not permitted to use discounting to evaluate water projects such as the construction of reservoirs. How does this restriction lead to socially inefficient allocations of resources? Hint: Think about what we give up when we spend money on a reservoir.

26. The figure above presents the demand for a nonrenewable resource. There are 950 units of the resource available that must be used in two periods.

a. If the discount rate is 10% per year, what is the dynamically efficient allocation of the resource over two periods?
   \[ Q(\text{today}) = \underline{\quad}, \quad Q(\text{next yr}) = \underline{\quad}. \]

b. What price in each period would lead to the dynamically efficient allocation across the two periods?
   \[ P(\text{today}) = \underline{\quad}, \quad P(\text{next yr}) = \underline{\quad}. \]
27. Using the figure above question 26, and assuming a 0% discount rate and that there are 600 units of the resource to be used over the two periods, which of the curves below is the marginal user cost curve for a user of the resource in the first period? On the exam, you should be able to actually derive the user cost curve.

![Marginal User Cost Curves](image)

28. If the decision maker had a discount rate of 10%, how would that change the marginal user cost curve relative to question 27.

29. Suppose that a project that will be completed in 10 years depends upon the region’s population growth. If the population growth is strong over the next decade then the project will be worth $1 million per year for 50 years (a year-10 value of about $20 million, or a present value of $20/1.05^{10} = $12.28 million). If the population growth is weak, then the project will be worth $0.5 million per year for 50 years (a year-10 value of about $10 million, PV = $6.14). There is a 50-50 chance of each outcome.

a. What is the expected year-10 value and expected present value of the benefits of the project?

b. If the project cost is $9 million, does it pass a benefit-cost test?

c. Suppose that instead of building now, we wait for 10 years to and then reconsider whether to build the project after knowing whether the population has grown or not. If the population growth is strong, would you build the project? If the population growth is weak, would you build the project? Remember, even though you wait 10 years to make a decision, you still have to wait 10 years until the project starts to generate benefits.

d. Assuming you wait for 10 years, what is the year-10 net benefits of the project and the present value (year-0) of net benefits? What is the best option, build now, wait and see, or never build?

e. Using this example, explain the general idea of quasi-option value.

30. Consider the decision about whether to build a windmill on your property. You know that it will generate electricity, but if you build it you won’t be able to develop the land for tourism. Explain how the principle of quasi option value might help you think through this decision.
Fisheries and open-access resources

![Graph showing fishing effort vs. revenue and cost]

31. Using the figure above,
   a. What is the open-access equilibrium level of effort, revenue, cost and profit?
   b. Approximately, what is the maximum sustainable revenue?
   c. Approximately, what is the economically efficient level of effort, revenue, cost and profit?
   d. Assuming fishing effort started at 100 fishing days, explain how it eventually ends up at the open-access equilibrium.
   e. In a single sentence, explain what is meant by the Tragedy of the Commons? How is it represented in the figure above?
   f. If the fishery were owned by a single owner who seeks to maximize sustainable profits, approximately how many boat days would the fisherman use?

32. Most U.S. fisheries today are heavily managed, usually with an objective to maximize the net benefits to the fishermen who use the fishery. This has not, however, resulted in an efficient approach to the problem of bycatch. In economic terms, explain how optimal management of one fishery will not lead to social efficiency with regard to bycatch?

Recycling

33. Using your economic lens, if recycling is the answer, what is the question
   a. from the perspective of a city trying to minimize its waste management costs?
   b. from the perspective of an individual, who places a value on environmental actions?
   c. from the perspective of society, taking into account external and internal costs.

34. How does marginal-cost pricing lead to more socially efficient waste management?

A few good basic questions

35. The word externalities refers to benefits or costs that are external to the person that controls the asset. Using a graph, explain how a tax can internalize a negative externality.

36. True or false and explain. (note: if a T/F question is on the exam, the majority of the points will be based on the explanation, not on the true or false answer).
   a. A resource is being used efficiently if the marginal net benefits are maximized.
b. If the marginal benefit of an additional unit is greater than the marginal cost, then it would be efficient for the economy to provide that unit.

37. Give an example of the failure of each of the characteristics of efficient property rights.

38. Don’t forget Uncle Bob and Aunt Sue. One of them is very likely to visit us on the final exam.

Energy and the future

39. Several questions will be developed in class on Tues. 4/23.
OLD QUESTIONS Global Warming

40. Explain the basic scientific theory behind the argument that the planet will warm over time due to human emissions of a set of gases usually referred to as greenhouse gases.

41. What is meant by the expression, "An efficient level of global warming"?

42. How does adaptation affect the efficient level of mitigation?

43. Suppose you have been given the job of estimating the cost to the transportation sector (say automobiles and trucks) of achieving a 10% reduction in greenhouse gas emissions.
   a. Would it make a difference how the reduction is going to be implemented? Explain.
   b. Assuming that the reduction is going to be achieved by a tax on gasoline, using a graph, explain what would be the theoretical objective of your study.
   c. Describe some of the methods you might use to carry out your study (i.e., surveys, engineering analysis, etc.)

44. Should the U.S. participate in the Kyoto Protocol? Take a position on this question and support it using economic logic.

Water and the static efficient allocation of a resource

45. Al and Betty both share a water supply. Al lives downhill from the reservoir, so for him the cost to use water is zero. Betty, has to pump water uphill, every unit she uses costs her $1.

![Graph showing marginal net benefits (MB) for Al and Betty.]

   a. What is the marginal net benefit of the right to the 200th unit of water for Al?
   b. What is the marginal net benefit of the right to the 200th unit of water for Betty?
   c. Suppose that there are 700 units of water available in the reservoir. What is the efficient allocation between Al and Betty?
   d. Suppose that there are 150 units of water available in the reservoir. What is the efficient allocation between Al and Betty?
   e. Suppose that there are 525 units of water available in the reservoir. What is the efficient allocation between Al and Betty?
46. Suppose that the water in a river is used for both recreational and municipal purposes. The marginal net benefits of the water are presented in the figure below.

![Graph showing marginal net benefits for municipal and recreational use of water]

a. If there is 100 cubic feet per second available, what would be the efficient level of use by the city?

b. If there is only 50 cubic feet per second available, approximately what would be the efficient level of use by the city?

c. Suppose that the water is owned by the state and the city has to pay for the right to use the water. Furthermore, assume the state is charging the equivalent of $4 per cubic feet per second. How much water would the city choose to buy?

d. Explain using words but referring to the graph why the price of water should be different in a drought.

47. Much of the regulation governing water allocation policy is built on the principle of “minimum instream flow,” e.g., that level of flow that is required to maintain habitat for endangered species and not violate water quality regulations. Economists argue that it would be preferable to instead ask, “is the public willing to pay more to increase instream flows than it is willing to pay for other uses?” Explain how this alternative question might lead to different water allocations and why this might “better.” Indicate what you mean by “better.”

48. Explain in simple terms why there is a user cost when we think about groundwater reserves

**Dynamic Efficiency and nonrenewable resources**

49. True or false and explain. If a resource is used in a dynamically efficient manner then the marginal net benefits obtained from the resource should be equal in all periods.

50. Explain why there is a natural tendency for the price of a non-renewable resource to rise over time.

51. Building on your answer to the previous question, explain why prices would not tend to increase as far if there is an alternative resource (i.e. a backstop technology) that can provide the same benefits as the non-renewable resource.
52. A two-period resource allocation problem
A resource is to be used this year (period 1) and next year (period 2). There is no use for the
resource after period 2. The graph below shows the marginal benefit of using the resource and the
marginal cost of extracting the resource in both periods.

![Graph of marginal benefits and costs](image)

a. Assuming that your objective is to maximize the present value of the net benefits from the
resource stock (10% discount rate) and that there are only 40 total units available, make a
graph of the marginal user cost of consumption today.

b. Show graphically the efficient allocation of the resource over the two periods. While you
don’t need to give an exact numerical answer, you should be able to show whether more is
consumed in period 1 or 2.

c. If the resource is used efficiently over two periods, approximately at what price would the
resource sell for this period and what price would it sell for next period?

53. The figure below presents a simplistic economic model of the decision by a family regarding how
many children to have.

![Graph of demand and marginal cost](image)

a. What externalities (both positive and negative) might be relevant here so that the private
choices of parents might not lead to the socially efficient number of children?
b. Suppose that additions to the population impose costs on the rest of society. Using a separate graph, show how the private choices of the family might not lead to socially efficient choices.

c. Suppose that additions to the population provide substantial benefits to the rest of society. Using a separate graph, show graphically how the private choices of the family might not lead to socially efficient choices and explain in words why the government might then want to encourage people to have more children.

d. In the model of demographic transition in stage 3 the birth rate falls. Using the model above and using a separate graph, show and explain how development over time might shift curves in such a way that would lead families to choose to have fewer children.

54. As presented in the textbook there are three stages in the theory of demographic transition. Explain how the microeconomic model of fertility (as presented in the previous graph) can be used to explain the changes that take place as a society moves from stage 2 to stage 3.

Fisheries

55. The following graph presents the sustainable yield curve for a fishery as a function of the number of effort at work in the fishery. Effort is measured in terms of fishing-weeks=#boats fishing × # of weeks per boat.

\[\text{Fisheries}\]

\[\text{Tons}\]

\[\text{Effort (weeks of fishing)}\]

\[\text{Sustainable Harvests}\]

\[\text{1 2 3 4 5}\]

\[\text{0 10 20 30 40 50}\]

\[\text{a. Assuming a fixed price of $100 per ton, draw the associated sustainable revenue curve.}\]

\[\text{b. Assuming that the price of operating each boat is $10 per week, draw the corresponding total cost curve.}\]

\[\text{c. Indicate on the graph the effort levels that lead to the maximum sustainable yield, the economically efficient level of effort and the open-access equilibrium. You should be able to provide approximate numerical answers for each of these.}\]

\[\text{d. Explain why, in the absence of restrictions on entry the fishery will not achieve the efficient level of effort.}\]

\[\text{e. Show how a tax on effort could lead to the economically efficient level of effort. Since this is efficient, would the fishermen be better off? Who would be better off?}\]

56. Consider each of the following types of policies and explain whether (i) the policy can be effective in reducing overfishing, (ii) the policy can achieve an efficient outcome in terms of the rents generated by the fishery, and (iii) the policy leads to an improvement in the welfare of fishermen in the fishery.
a. Limits on the season.

b. Restrictions in the type of gear that fishermen can use.

c. A tax on fishing effort

d. A tax on fish sold (reducing the price paid to fishermen).

e. A transferable rights program.

Recycling

57. Consider the problem of waste in a city. There are three options to deal with the waste, putting it in a landfill, recycling it, and burning it.

a. Suppose you work for the waste management division of your city and your job is to figure out how to deal with the trash at the lowest cost. Explain the economic intuition that you would use to solve this problem.

b. Suppose you work for the mayor’s office and your job also includes looking out for the overall welfare of the citizens in your city. How would your analysis differ from the analysis used in part a?

58. The graphs below present the private marginal costs of disposing and recycling waste. Based on these figures, what rate of recycling would be the privately efficient?

59. Explain why economists believe that the traditional system of charging a flat rate for each household's annual trash (i.e. an annual fee that is the same for all households) will lead to an inefficiently high level of garbage and an inefficiently low level of recycling.

60. The city’s cost for garbage collection varies depending on the quantity of garbage collected. Assume that consumers pay a flat monthly fee for garbage collection that does not depend upon how much garbage is collected. Using a graphical model, show that the privately efficient level of recycling will not be socially efficient.
ANSWERS FOR SELECT QUESTIONS

36.
   a. False. A resource is being used efficiently if the marginal net benefits are maximized; this typically happens when the marginal net benefits are equal to zero.
   b. True.

45.a $2  
45.b $2  
45.c 400 to Betty, 250 to Al, 50 left over  
45.d all 150 to Al  
45.e 300 to Betty and 225 to Al. This can be found by picking a dollar value and then checking whether at this dollar value, the total quantity demanded equals 550. For example, $2, the quantity demanded by both Al and Betty would be 200, for a total of 400, less than 550. If we drop to $1, the quantity demanded by Al increases to 225 and the quantity demanded by Betty increases to 300, so the when $Q_A=225$ and $Q_B=300$ (the market clears) and the equimarginal condition is satisfied: $MNB_A=MNB_B=1$.

49. False. If a resource is used in a dynamically efficient manner then the present value of the marginal net benefits obtained from the resource should be equal in all periods.

55.c. Maximum sustainable yield, occurs when effort = 25 and harvest = 4 tons.  
      Maximum economic yield occurs when effort =15  
      Open access equilibrium occurs at 35 units of effort