Homework 9 (70 Points)

Part I

Multiple Choices (2 Points Each)

1. The tragedy of the commons is

   (a) a problem due to common resources being over-consumed

   (b) a problem due to negative externality

   (c) none of the above

   (d) **both a and b**

2. Which of the following is not an example of externality?

   (a) Lung cancer caused by second-hand exposure to cigarette smoke

   (b) Pollution from a factory on the health of people in the vicinity of the factory.

   (c) **Increase in health care costs on the health of individuals in society.**

   (d) Traffic accidents caused by alcohol consumption

3. A benevolent social planner[1] would prefer that the output of good x be increased from its current level if, at the current level of output of good x,

   (a) social value = private value = private cost $<$ social cost.

   (b) social cost $>$ private value = social value $>$ private cost.

   (c) **social cost = private cost = private value $<$ social value.**

   (d) social value = private cost = social cost $>$ private value.

[1] A government that aims to maximize total welfare.

4. Two firms, A and B, each currently dump 20 tons of chemicals into the local river. The government has decided to reduce the pollution and from now on will require a pollution permit for each ton of pollution dumped into the river. The government gives each firm 10 pollution permits, which it can either use or sell to the other firm. It costs Firm A $100 for each ton of pollution that it eliminates before it reaches the river, and it costs Firm B $50 for each ton of pollution that it eliminates before it reaches the river. After the two firms buy or sell pollution permits from each other, we would expect that

   (a) Firm A will no longer pollute, and Firm B will not reduce its pollution at all.

   (b) **Firm B will no longer pollute, and Firm A will not reduce its pollution at all.**

   (c) Firm A will dump 10 tons of pollution into the river, and Firm B will dump 10 tons of pollution into the river.

   (d) Firm A will increase its pollution and Firm B will reduce its pollution.

5. Information tend to be non-excludable because it can be spread easily, and non-rival in consumption because one person's "consumption" of information does not directly diminish another person's "consumption" of information. Hence, information tend to be a

   (a) Private good

   (b) **Public good**

   (c) Club good

   (d) Common resource

6. Which of the following is an advantage of tradable pollution permits?

   (a) Each firm is allowed to pollute exactly the same amount.

   (b) Revenue from the sale of permits is greater than revenue from a corrective tax.

   (c) **The initial allocation of permits to firms does not affect the efficiency of the market.**

   (d) Firms will engage in joint research efforts to reduce pollution.

7. Suppose that Company A's railroad cars pass through Farmer B's corn fields. The railroad causes an externality to the farmer because the railroad cars emit sparks that cause $1,500 in damage to the farmer's crops. There is a special soy-based grease that the railroad could purchase that would eliminate the damaging sparks. The grease costs $1,200. Suppose that the railroad is not liable for any damage caused to the crops. Assume that there are no transaction costs. Which of the following characterizes the efficient outcome?

   (a) The railroad will continue to operate but will pay the farmer $1,500 in damages.

   (b) The railroad will purchase the grease for $1,200 and pay the farmer nothing because no crop damage will occur.

   (c) The farmer will incur $1,500 in damages to his crops.

   (d) **The farmer will pay the railroad $1,200 to purchase the grease so that no crop damage will occur.**

8. Two firms, A and B, each currently emit 100 tons of chemicals into the air. The government has decided to reduce the pollution and from now on will require a pollution permit for each ton of pollution emitted into the air. The government gives each firm 40 pollution permits, which it can either use or sell to the other firm. It costs Firm A $200 for each ton of pollution that it eliminates before it is emitted into the air, and it costs Firm B $100 for each ton of pollution that it eliminates before it is emitted into the air. After the two firms buy or sell pollution permits from each other, we would expect that Firm A will emit

   (a) **20 fewer tons of pollution into the air, and Firm B will emit 100 fewer tons of pollution into the air.**

   (b) 100 fewer tons of pollution into the air, and Firm B will emit 20 fewer tons of pollution into the air.

   (c) 50 fewer tons of pollution into the air, and Firm B will emit 50 fewer tons of pollution into the air.

   (d) 20 more tons of pollution into the air, and Firm B will emit 100 fewer tons of pollution into the air.

9. Two firms, A and B, each currently dump 50 tons of chemicals into the local river. The government has decided to reduce the pollution and from now on will require a pollution permit for each ton of pollution dumped into the river. It costs Firm A $100 for each ton of pollution that it eliminates before it reaches the river, and it costs Firm B $50 for each ton of pollution that it eliminates before it reaches the river. The government gives each firm 20 pollution permits. Government officials are not sure whether to allow the firms to buy or sell the pollution permits to each other. What is the total cost of reducing pollution if firms are not allowed to buy and sell pollution permits from each other? What is the total cost of reducing pollution if the firms are allowed to buy and sell permits from each other?

   (a) $3,000; $1,500

   (b) **$4,500; $3,500**

   (c) $4,500; $4,000

   (d) $4,500; $2,500

10. According to the Coase theorem, in the presence of externalities

   (a) **private parties can bargain to reach an efficient outcome.**

   (b) government assistance is necessary to reach an efficient outcome.

   (c) the assignment of legal rights can prevent externalities.

   (d) the initial distribution of property rights will determine the efficient outcome.

11. A dentist shares an office building with a radio station. The electrical current from the dentist's drill causes static in the radio broadcast, causing the radio station to lose $10,000 in profits. The radio station could put up a shield at a cost of $30,000; the dentist could buy a new drill that causes less interference for $6,000. Either would restore the radio station's lost profits. What is the economically efficient outcome?

   (a) The radio station puts up a shield, which it pays for.

   (b) The radio station puts up a shield, which the dentist pays for.

   (c) Neither the radio station nor the dentist purchase additional equipment.

   (d) **The dentist gets a new drill; it does not matter who pays for it.**

12. Abe owns a dog; the dog's barking annoys Abe's neighbor, Jenny. Suppose that the benefit of owning the dog is worth $200 to Abe and that Jenny bears a cost of $400 from the barking. Assuming Abe has the legal right to keep the dog, a possible private solution to this problem is that

    (a) Jenny pays Abe $150 to give the dog to his parents who live on an isolated farm.

    (b) Abe pays Jenny $350 for her inconvenience.

    (c) **Jenny pays Abe $300 to give the dog to his parents who live on an isolated farm.**

    (d) There is no private transaction that would improve this situation.

13. A city street is

    (a) always a public good, whether or not it is congested.

    (b) a public good when it is congested, but it is a common resource when it is not congested.

    (c) **a common resource when it is congested, but it is a public good when it is not congested.**

    (d) always a common resource, whether or not it is congested.

14. The provision of a public good generates a

    (a) positive externality, as does the use of a common resource.

    (b) **positive externality and the use of a common resource generates a negative externality.**

    (c) negative externality, as does the use of a common resource.

    (d) negative externality and the use of a common resource generates a positive externality.

15. Both public goods and common resources are

    (a) rival in consumption.

    (b) nonrival in consumption.

    (c) excludable.

    (d) **nonexcludable.**

16. A television broadcast is an example of a good that is

    (a) private.

    (b) **not rival in consumption.**

    (c) social.

    (d) normal.

17. Some goods can be either common resources or public goods depending on

    (a) **whether the good is rival in consumption.**

    (b) whether the good is excludable.

    (c) the marginal cost of the good.

    (d) None of the above is correct.

18. A free-rider problem exists for any good that is not

    (a) rival in consumption.

    (b) a private good.

    (c) free.

    (d) **excludable**

19. Market failure associated with the free-rider problem is a result of

    (a) a problem associated with pollution.

    (b) **benefits that accrue to those who don't pay.**

    (c) losses that accrue to providers of the product.

    (d) market power.

20. By driving onto a congested road for which no toll is charged, a driver

    (a) contributes to the overuse of a common resource.

    (b) contributes to a negative-externality problem.

    (c) is inflicting additional time cost on all of the other drivers.

    (d) **All of the above are correct.**

Problem 1 (4 Points)

There are three industrial firms in Happy Valley.

Firm	Initial Pollution	Cost of Reducing Pollution by 1 Unit
A	70 units	\$20
B	80 units	\$25
C	50 units	\$10

The government wants to reduce pollution to 120 units, so it gives each firm 40 tradable pollution permits.

1. Who sells permits and how many do they sell? Who buys permits and how many do they buy? (2 Points)

   B buys 40 permits and C sells 40 permits.

   Reasoning: If B buys permits from C at a price $\in (\$10, \$25)$, then both B and C would benefit from the trade. If A buys permits from C at a price $\in (\$10, \$20)$, then both A and C would benefit from the trade. Who gets to buy from C? Since B is willing to pay a price $\in (\$20, \$25)$, A would not be able to compete with B, therefore, B would be able to buy all 40 permits from C. After buying 40 permits from C, B no longer needs permits and C no longer has permits to sell, therefore, A will not participate in any trade and will keep its 40 permits[2].

2. What is the total cost of pollution abatement in this situation? How much higher would the cost of pollution abatement be if the permits could not be traded? (2 Points)

   C sells all 40 of its permits and needs to reduce its pollution by 50 units at a cost of \$10 $\times$ 50 = \$500. A still has 40 permits and needs to reduce its pollution by 30 units at a cost of \$20 $\times$ 30 = \$600. After buying 40 permits, B has 80 permits and does not need to reduce pollution. Therefore, the total cost of pollution reduction is \$1,100.

[2] What if B buys 40 permits from A instead? It could also happen, but in this case, after selling 40 permits to B at a price $\in (\$20, \$25)$, A can then buy 40 permits from C at a price $\in (\$10, \$20)$. So in the end, B will get 80 permits, A will have 40, and C will have none.

If the permits could not be traded, then A would have to reduce its pollution by 30 units at a cost of \$20 $\times$ 30 = \$600, B would have to reduce its pollution by 40 units at a cost of \$25 $\times$ 40 = \$1,000, and C would have to reduce its pollution by 10 units at a cost of \$10 $\times$ 10 = \$100. The total cost of pollution reduction would be \$1,700, \$600 higher than in the case in which the permits could be traded.

Problem 2 (8 Points)

Four roommates are planning to spend the weekend in their dorm room watching old movies, and they are debating how many to watch. If it costs \$8 to rent a movie. Here is their willingness to pay for each film:

	Judd	Joel	Gus	Tim
First film	\$7	\$5	\$3	\$2
Second film	6	4	2	1
Third film	5	3	1	0
Fourth film	4	2	0	0
Fifth film	3	1	0	0

1. What is the total surplus if they rent 1 movie? What is the total surplus if they rent 5 movies? (2 Points)

   `1 movie:` $7+5+3+2-8=9$
   `5 movie:` $7+5+3+2+6+4+2+1+5+3+1+4+2+3+1-8\times 5=9$

2. How many movies should the roommates rent to maximize total surplus? (2 Points)
   3

3. If they choose the optimal number from 2. and then split the cost of renting the movies equally, how much surplus does each person obtain from watching the movies? (2 Points)

   `Judd:` $7+6+5-2\times 3=12$
   `Joel:` $5+4+3-2\times 3=6$
   `Gus:` $3+2+1-2\times 3=0$
   `Tim:` $2+1-2\times 3=-3$

4. Is there any way to split the cost to ensure that everyone benefits? (2 Points)

   `Split according to each person's willingness to pay`[3].

[3] However, in reality, it is hard to know each person's WTP, as people may not have the incentive to reveal their true WTP.

Problem 3 (4 points)

There are three groups in a community. Their demand curves for public television in hours of programming, T, are given respectively by

$$W_1 = \$200 - T$$
$$W_2 = \$240 - T$$
$$W_3 = \$320 - 2T$$

Suppose public television is a public good that can be produced at a cost of \$200 per hour.

1. What is the efficient number of hours of public television? (2 points)

   `Total demand for public TV:`

   $$W = 760 - 4T$$

   `Social optimum:`

   $$760 - 4T = 200 \Rightarrow T^* = 140$$

2. If the government charges each group for watching public TV at a price of \$200/hour, then it becomes excludable. In such a case, how many hours of programming would the three groups consume, respectively (2 points)

   $T_1 = 0, T_2 = 40, T_3 = 60$.

Problem 4 (6 points)

The Georges Bank, a highly productive fishing area off New England, can be divided into two zones in terms of fish population. The total daily fish catch (in tons) in Zone 1 is

$$F_1 = 200X_1 - 2\left(X_1\right)^2 \tag{1}$$

, where X_1 is the number of boats fishing there. Each boat then equally share the total daily fish catch, i.e. each boat gets $F_1/\,X_1$.

The daily fish catch of Zone 2 is

$$F_2 = 100X_2 - \left(X_2\right)^2 \tag{2}$$

, where X_2 is the number of boats fishing in Zone 2. Each boat then equally share the total daily fish catch, i.e. each boat gets $F_2/\,X_2$.

There are 100 boats now licensed by the government to fish in these two zones. Answer the following questions about this situation:

1. Suppose the boats are allowed to fish where they want, with no government restriction. If each boat aims to maximize its daily catch, how many will fish in each zone (the number of boats need NOT be an integer)?[4](2 points)

   `People will fish until the catch in each zone is the same:`

   $$\frac{F_1}{X_1} = \frac{F_2}{X_2} \Rightarrow 200 - 2X_1 = 100 - X_2 \Rightarrow X_1 = \frac{200}{3}, X_2 = \frac{100}{3}$$

   `, where` $X_1 + X_2 = 100$.

   `Total catch:`

   $$F_1 + F_2 = 200 \times \frac{200}{3} - 2 \times \left(\frac{200}{3}\right)^2 + 100 \times \frac{100}{3} - \left(\frac{100}{3}\right)^2 = 6666$$

[4] *Hint*: People will fish until the catch in each zone is the same.

2. Suppose the government wants to maximize the total daily fish catch. If the government can restrict in which zone the boats are allowed to fish, how many boats should be allocated to each zone? (2 points)

   The government maximizes total catch:

$$\begin{aligned} F_1 + F_2 &= 200X_1 - 2(X_1)^2 + 100X_2 - (X_2)^2 \\ &= 200X_1 - 2(X_1)^2 + 100 \times (100 - X_1) - (100 - X_1)^2 \end{aligned} \tag{3}$$

   Maximizing (3) w.r.t. $X_1 \Rightarrow X_1^* = 50, X_2^* = 50$

   Total catch: $F_1 + F_2 = 7500$

3. Suppose the government wants to maximize the total daily fish catch by taxing each boat fishing in Zone 1 by an amount equal to T tons of fish per day. How much should T be (T need NOT be an integer)? (2 points)

   We know that if $X_1 = X_2 = 50$, then total daily fish catch would be maximized. Hence, after taxation, we should have:

$$\begin{aligned} 200 - 2X_1 - T &= 100 - X_2 \\ X_1 &= X_2 = 50 \end{aligned}$$

   $\Rightarrow T = 50$.

4. In what sense do we have a tragedy of the commons or negative externality problem here? Why the "free market" outcome is not the best (total profit maximizing) outcome? (2 Points)

   There is a negative externality problem here because each boat by fishing in a zone, reduces the amount of fish that other boats can catch. For example, in Zone 1, each boat gets $200-2X_1$ amount of fish, which is a decreasing function of X_1 -- the amount of boat fishing there. In the presence of this negative externality, the "free market outcome" (no government restriction) is not the social optimum (total profit maximizing outcome). This is the tragedy of the commons.

Problem 5 (8 points)

The Tragedy of the Commons – a term coined by ecologist Garrett Hardin – describes a phenomenon in which individuals acting in rational pursuit of their self-interest lead to the over-exploitation of common-pool resources. Hardin (1968) recognized two solutions to the tragedy of the commons: government regulation and privatization.

In reality, however, many local communities have successfully managed to build rules and norms to ensure a sustainable management of shared resources without requiring top-down regulation or privatization.

Watch the Nobel Prize Lecture by Elinor Ostrom[5].

1. Summarize her main contributions. (4 Points)

   Elinor Ostrom's research (1) demonstrated that ordinary people are capable of creating rules and institutions that allow for the sustainable and equitable management of shared resources (2) explored the mechanisms and "design principles" that enable these successful efforts.

2. Summarize her critique of Garrett Hardin's model. (2 Points)

   - Hardin blurred the idea of a resource system (the pasture) with resource governance (open access), and at the same time, confused open access (no constraints) with commons (sharing among community members on terms set by the community).
   - Hardin's allegory was based on a rational actor model that resembles a prisoner's dilemma game, which rules out -by assumption-the possibility that people might communicate and find ways to cooperate[6].
   - In reality, extensive studies have found that people often can cooperate effectively and build institutions to enable sustainable use of shared resources[7].

[5] You can find the written lecture here and slides here.

[6] Ostrom (2007): "Making one small change . . . in the structure of laboratory experiments, a change that is predicted by game theory to make no difference in the predicted outcome, has repeatedly had major impacts on interactions and outcomes. Simply enabling subjects to engage in face-to-face communication between decision rounds enables them to approach socially optimal harvesting levels rather than severely overharvesting the commons. In the face-to-face discussions, participants tend to discuss what they all should do and build norms to encourage conformance."

[7] Ostrom (2009): "The prediction of resource collapse is supported in very large,

3. According to Ostrom, what are some of the conditions that may allow people to cooperate and self-organize successfully to manage their shared resources? (2 Points)

   Size of resource system, Productivity of system, Predictability of system dynamics, Resource unit mobility, Number of users, Leadership, Norms/social capital, Knowledge of the SES, Importance of resource to users, Collective-choice rules

highly valuable, open-access systems when the resource harvesters are diverse, do not communicate, and fail to develop rules and norms for managing the resource. The dire predictions, however, are not supported under conditions that enable harvesters and local leaders to self-organize effective rules to manage a resource or in rigorous laboratory experiments when subjects can discuss options to avoid overharvesting. ‘‘