Problem Set #8 Name: KEY
PAI 723
Professor John McPeak

1) Consider two herders. Each herder can choose to place zero, one, or two animals on the common pasture. Assume these are cows, and the cows produce milk that the herders consume. Total milk production is a function of aggregate herd size. Zero animals gives zero milk. 1 animal give 5 liters of milk. 2 animals gives 8 liters of milk. 3 animals gives 9 liters of milk. 4 animals also gives 9 liters of milk. Each herders share of the milk reflects their share of the total herd (so if the total herd size is 3, you own one of them, you get 1/3rd of the nine liters). Each animal costs the equivalent of 1 liter of milk for the herder to place on the pasture, in terms of labor time and the capital value of the animal. Define the payoffs to each herder. (to continue the above example, if total herd size is three, I have one of them, my payoff is (1/3)*9 liters -1, or 2, the other herder gets (2/3)*9-2 (since they have 2 animals to account for the total of three), for a payoff of 4.

	Herder 2						
Herder 1		0 cows		1 cow		2 cows	
	0 cows	0	0	0	4	0	6
	1 cow	(5-1) 4	0	(4-1) 3	(4-1) 3	2	4
	2 cows	(8-2) 6	0	(6-2) 4	(3-1) 2	(4.5-2) 2½	2½

a) Define the full set of best response strategies for each herder.

If H1 0, H2 2
If H1 1, H2 2
If H1 2, H2 2

If H2 0, H1 2
If H2 1, H1 2
If H2 2, H2 2

b) What is the outcome of this game and what is this type of solution called?

H1 plays 2, gets payoff of 2½.
H2 plays 2, gets payoff of 2½

This is a Nash Equilibrium outcome where each is playing best response to the other.

c) Assume we decide to give herder 1 exclusive title deed to the pasture. We can do stuff like that. If herder 1 agrees to allow herder 2 to use the pasture if herder 2 pays the equivalent of 1 liter of milk per animal, what will be the payoff structure?

	Herder 2						
Herder 1		0 cows		1 cow		2 cows	
	0 cows	0	0	1	3	2	4
	1 cow	4	0	4	2	4	2
	2 cows	6	0	5	1	$4\frac{1}{2}$	$\frac{1}{2}$

d) What is the full set of best response strategies?

If H2 0, H1 2 | If H1 0, H2 2
If H2 1, H1 2 | If H1 1, H2 1 or 2
If H2 2, H1 2 | If H1 2, H2 1

e) What is the outcome of this game and what is this type of solution called?

The nash equilibrium outcome is H1 places 2 cows and gets 5, H2 plays 1 cow and gets 1.

f) Does this outcome increase or decrease the total payoff amount?

yes. Before we had $(2\frac{1}{2} + 2\frac{1}{2}) = 5$ as the total payoff we now have $(5+1) = 6$.

g) Does this outcome improve in the Pareto sense on the outcome of the original game? Why or why not.

No it does not. Herder 1 is made better off but herder 2 is made worse off.

h) Compare the tenure reform policy described above with a uniform herd size quota policy that lets each herder have a maximum of one cow on the commons under the original scenario. What is the outcome of this policy?

In that case, each herder would place one animal, each gets half of the 8 liters of milk, paid for labor and gets 3.

i) Does the uniform herd quota outcome improve in the Pareto sense on the outcome of the original game?

yes it does since at least one person (in this case both) is made better off without anyone being made worse off.

2) Assume you are given the following matrix of profit for two firms. The firms choose a level of production. The left hand side payoff (profit) is to the coal burning plant, the right hand side payoff is to the laundry.

		Laundry that uses clotheslines		
Coal burning plant		None	Low	High
	None	0, 0	0, 12	0, 11
	Low	10, 0	10, 10	10, 8
	High	14, 0	14, 2	14, 1

a) Does the payoff matrix indicate that both firms are imposing a negative externality on each other, one firm is imposing a negative externality on the other, or that there is no negative externality imposed by either firm on the other? Explain your answer.

The payoff matrix indicates that Laundry does not impose a negative externality on Coal plant since payoffs to coal plant are not changed by Laundry's actions. Coal plant is imposing a negative externality on laundry as laundry's payoffs change (decrease) due to the actions of coal plant.

b) What is the Nash equilibrium outcome of this game in terms of levels of production and payoffs if each firm plays their best response strategy?

If L = none, CP = High	If CP = 0, L = Low
If L = Low, CP = High	If CP = Low, L = Low
If L = High, CP = High	If CP = High, L = Low

Nash equilibrium outcome is CP = High gets 14, Laundry plays Low, gets 2

c) Does a policy that gives the Laundry first mover status lead to the socially efficient outcome? Why or why not?

No since the strategy by Coal plant is to play high no matter what Laundry does it will not help if Laundry has first mover status.

3) Market structure, externalities, and taxation. The inverse demand curve is given as p=100-q. The supply curve is p=10+q.

a. What is the equilibrium price quantity pair if the market structure is perfectly competitive?

$100 - q = 10 + q$

$90 = 2q$

$45 = q$

$100 - 45 = p = 55$

$(p^{pc}, q^{pc}) = (55, 45)$

b. What is the equilibrium price quantity pair if production of the good imposes an externality defined by $MC^E = 0.5*q$ and the market structure is perfectly competitive?

still $(55, 45)$

c. What Pigovian tax can be defined as a specific tax on producers in the perfectly competitive market to arrive at the socially optimal price- quantity pair?

$100 - q = (10 + q) + (\frac{1}{2}q)$

$100 - q = 10 + \frac{3}{2}q$

$90 = \frac{5}{2}q$

$\frac{2 \cdot 90}{5} = q$

$36 = q$

$(100 - 36) = p = 64$

$(p^{so}, q^{so}) = (64, 36)$

$T = MC^E(q^{so}) = \frac{1}{2}(36) = 18$

or

$p = 10 + q + T$ at $(64, 36)$

$\Rightarrow 64 = 10 + 36 + T$

$64 - 46 = T = 18$

d. In terms of economic efficiency, does it matter whether we place this tax on consumers or producers? Why does it matter or why does it not matter?

No. It does not matter on whom you place the tax from an efficiency standpoint as the same outcome is achieved in either setting; specific tax on consumer or specific tax on consumer.

e. What is the equilibrium price quantity pair if the market structure is a monopoly?

$MR = 100 - 2q$

$100 - 2q = 10 + q$

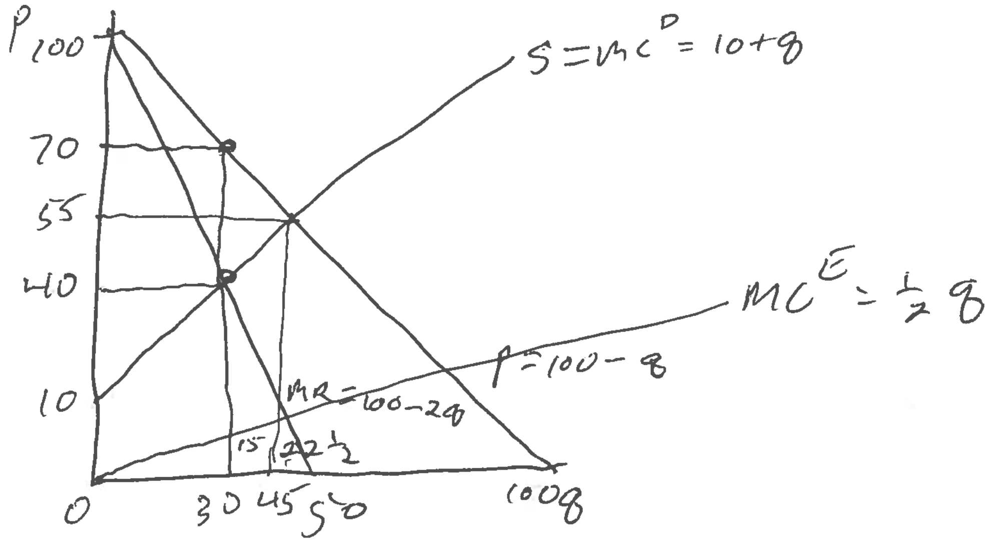
$90 = 3q$

$30 = q$

$p = 100 - q = 100 - 30 = 70$

$(p^m, q^m) = (70, 30)$

f. Draw a graph of the perfectly competitive and monopoly results.



g. Calculate for the monopoly result and the perfectly competitive result the following.

	PERFECTLY COMPETITIVE	MONOPOLY
Producer Surplus	$\frac{1}{2}(45)(45)$ $1012\frac{1}{2}$	$30 \cdot 30$ $+\frac{1}{2}(30 \cdot 30)$ $900 + 450 = 1350$
Consumer Surplus	$\frac{1}{2}(45)(45)$ $1012\frac{1}{2}$	$\frac{1}{2}(30)(30)$ $= 450$
Negative Externality	$\frac{1}{2}(22\frac{1}{2})(45)$ 506.25	$\frac{1}{2}(15)(30)$ $= 220$
Total Social Welfare	$2(1012\frac{1}{2}) - 506.25$ $1518\frac{3}{4}$	$1350 + 450 - 220$ 1580

Problem Set #9 Name: KEY
PAI 723

1) Public Goods.
   a. Define the concepts of rivalry and exclusion as they apply to goods, and use them to illustrate the difference between private and public goods.

Rivalry - the good is depletable. Consumption of a given unit precludes consumption by another person of that unit.

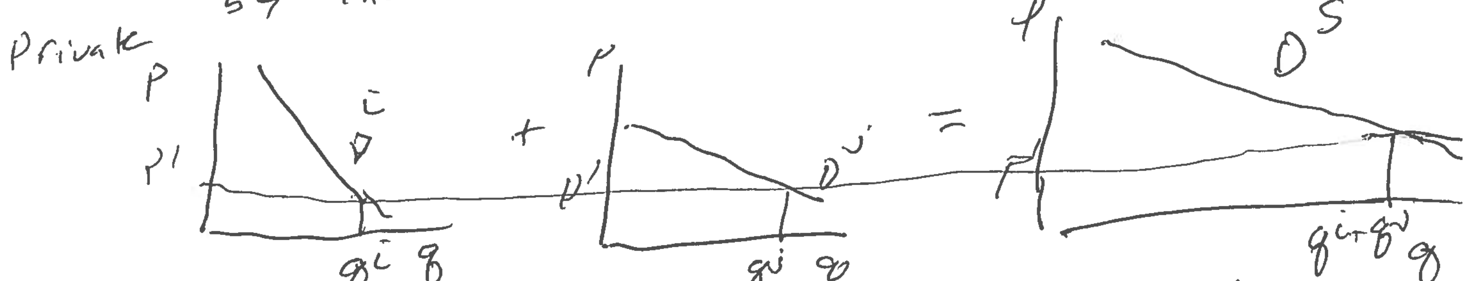
Exclusion. There is a means to allow or prevent access to the good

   b. Fill in the table. Which type of good from (b) goes where?

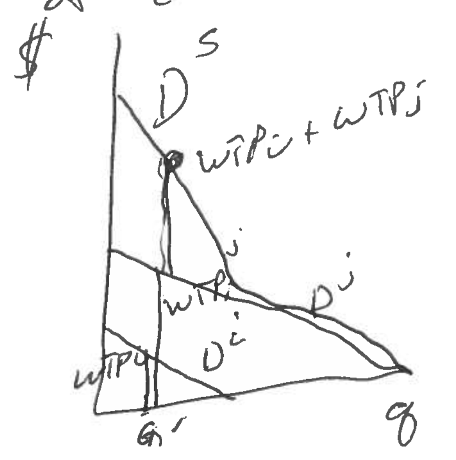
	Exclusion Possible	No Exclusion Possible
Rivalry	Private	Open Access
No Rivalry	Club	Public Good

   c. Discuss how and why derivation of the demand curve for public goods differs from the derivation of the demand curve for a private good.

Derivation of demand for a private good is horizontal summation of the quantity demands by individuals at a given price P'.



Derivation of the demand for a public good is the vertical summation of MWTP for all individuals who share access to and benefit from provision of each unit of the public good.



The good is non-rival so benefits of consumption are shared and non excludable so all can access benefits

2) Two people live next door to each other on a bay, and are the only residents on the bay. During storms, high waves cause property damage on each person's property. By building a breakwater near the mouth of the bay, they can avoid this damage to their shoreline. The only place that it is feasible to build this breakwater will provide this protection to both properties. Dorothy owns one of the houses, and spends \$13,000 repairing her property from the storm damage. Henry owns the other house, and spends \$3,000 repairing his property. Building the breakwater costs \$10,000. If they both agree to build it, they share the cost of building equally (\$5,000 each).

a. Is the total benefit (as reflected in the benefit of not having to pay to repair storm damage) greater than the cost? You can assume both the damage repair costs and the building cost are in present value terms.

Benefits = 13,000 + 3,000 = 16,000

Cost = 10,000.

B > C   16,000 > 10,000.

yes benefits outweigh costs

b. Explain how the Nash Equilibrium outcome of this game illustrates the free rider problem in the provision of public goods.

	Dorothy			
Henry		Build		Don't Build
	Build	-\$5,000	-\$5,000	-\$10,000 \$0
	Don't Build	\$0	-\$10,000	-\$3,000 -\$13,000

Henry has an incentive to free ride on Dorothy as he can count on the fact that she faces incentives to Build in response to his action of Don't Build. He gets benefits without paying knowing she will Build.

c. Does the free rider problem in this example lead to an inefficient outcome?

No, the efficient outcome of building it is realize (in an unfair way).

3) Public goods, voting, and benefit cost.

Jordan Elbridge High School is trying to decide what physical plant improvements to make to the High School Property. There are five families in the school district who will vote on the improvements. They are confronted with three proposals:

Proposal A: Replace wastewater treatment plant, connect to municipal sewage system, and replace and improve drainage system. Total cost is $3,000 ($600 each).

Proposal B: All of what is in proposal A plus a new artificial turf playing field surrounded by an all season track. Total cost is $10,000 ($2,000 each).

Proposal C: All of what is in proposal B plus heated locker rooms and stadium rest rooms. Total cost is $20,000 ($4,000 each)

This table records each household's WTP for each proposal.

	Proposal A 600	Proposal B 2000	Proposal C 4000
Taylor	$1,000	$1,800	$3,500
Feeney	$500	$3,500	$3,500
Badger	$500	$1,800	$9,500
Bennett	$1,600	$1,900	$3,000
McPeak	$700	$1,500	$3,500

a) Each household gets one yes vote. If they have WTP greater than cost for more than one proposal, they will give their yes vote to the proposal that has the greater difference between WTP and cost to that household. How will they vote? (circle)

	Proposal A		Proposal B		Proposal C	
Taylor	Yes	No	Yes	No	Yes	No
Feeney	Yes	No	Yes	No	Yes	No
Badger	Yes	No	Yes	No	Yes	No
Bennett	Yes	No	Yes	No	Yes	No
McPeak	Yes	No	Yes	No	Yes	No

b) If the costs are present value costs, and the willingness to pay figures are present value benefits, what is the net present value of each proposal?

Proposal A	Proposal B	Proposal C
NPV = 4,300 − 3000 = 1,300	NPV = 10,500 − 10,000 = 500	NPV = 23,000 − 20,000 = 3,000

c) Did voting lead us to select the proposal that had the highest net present value? Explain why or why not.

No. The highest NPV is Proposal C but we select proposal A. Badger has a strong preference for C but voting ignores intensity of preference, so valuation of median voter determines outcome. McPeak is median in A, Bennett is median in B, and one of the 3,500 valuations in C is the median.

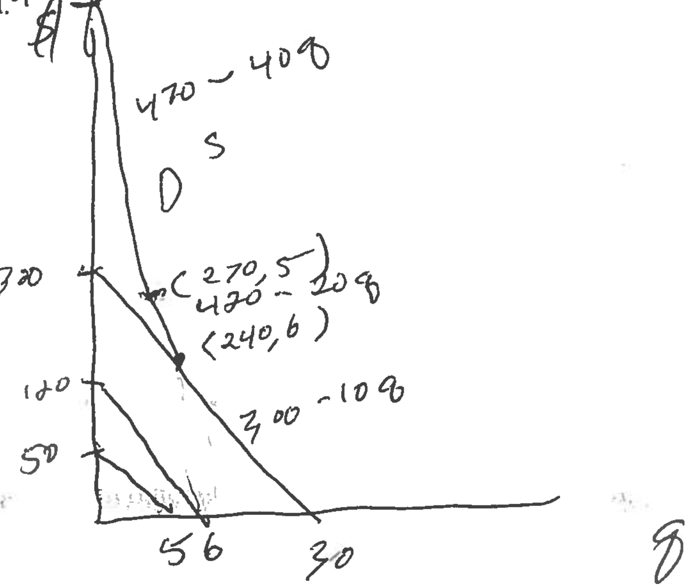
4) Public goods. There are three people who live in a town. They each have a demand curve for the number of snowplows (q is the # of snowplows here) that will keep the streets clear in the winter. Frosty has a willingness to pay for the number of snowplows defined by 50-10*q. Rudolph has a willingness to pay for the number of snowplows defined by 120-20*q. Kris has a willingness to pay for the number of snowplows defined by 300-10*q.

a. Draw these individual demand curves and the societal demand curve for this public good.

F: 50-10q @0 q=5

R: 120-20q @0 q=6

K: 300-10q @0 q=30



b. If the marginal cost of snowplows is constant at 270 per snowplow and no effort is made to avoid the free rider problem, what number of snowplows will be provided and who will provide it?

K will provide

$300-10q=270$

$30=10q$

$3=q$

c. How much less is this than the socially optimal number of snowplows if the cost is 270 per snowplow?

$470-40q=270$

$200=40q$

$5=q.$

It is 2 less than the socially optimal level.

Problem Set #10 Name: KEY
PAI 723
Professor John McPeak

1) Say there is a community owned plot of land. There are five families who have houses in this community and can use the plot of land; the McPeaks, the Alphas, the Blooms, the Fraisers, and the Lealas. These families have a meeting to decide what they want to put on the plot of land. They will vote for each item in turn. More than one item can pass if a majority votes for it. Assume that the representative of each family knows the household willingness to pay for each project has the values reported in the table below, each household has one vote per item, and each household pays an equal share of a project total cost if it passes.

	McPeaks	Alphas	Blooms	Fraisers	Lealas	*Total Cost*	
Sandbox	$420	$350	$300	$150	$190	*$1000*	200 each
Petting zoo	$250	$510	$150	$290	$420	*$1500*	300 each
Gazebo	$440	$ 50	$410	$450	$ 30	*$2000*	400 each

a) How should each household representative vote for each item, and which of the following items will pass a referendum?

	McPeaks	Alphas	Blooms	Fraisers	Lealas	Pass or not
Sandbox	Y	Y	Y	N	N	Pass
Petting zoo	N	Y	N	N	Y	NOT
Gazebo	Y	N	Y	Y	N	Pass

b) Have we selected the project that maximizes total willingness to pay minus total cost? Why or why not?

Sandbox. PASS. (420 + 350 + 300 + 150 + 190) − 1000 = 1410 − 1000 = 410

Petting zoo. NOT (250 + 510 + 150 + 290 + 420) − 1500
= 1620 − 1500 = 120

Gazebo. PASS. (440 + 50 + 410 + 450 + 30) − 2000
= 1380 − 2000 = − 620

Yes for the sandbox (+410) but no for the Gazebo (−620).

2) Studies have shown that placing trained nutrition monitors in local clinics leads to lower child malnutrition rates in your country. Studies also show that improved school feeding programs leads to lower child malnutrition in your country. Two proposals are on your desk, each designed to reduce the child malnutrition rate in your country by 1% per year. You only have enough operating funds to do one, and you can't combine them – it is pick one or the other.

$t=0$ 2.3
$t=1$ 1.0
$t=2$ 1.0

Placement of nutrition monitors: This is a three year program (start up recruitment and hiring is year zero, year one the monitors are in place working, year two the monitors are in place working, then the project phase ends) to hire and place in local clinics the nutrition monitors. It will cost 2.3 million in the current start up year to hire and place these monitors, and will cost 1 million per year for each of two years of program implementation to pay the salaries of these local nutrition monitors.

$t=0$ 1.6
$t=1$ 1.4
$t=2$ 1.4

School feeding: This is also a three year program (start up and organization in year one, then feeding in the following two years, then the project phase ends) to provide food to children in primary schools. The first year costs 1.6 million, and the operating costs per year are 1.4 million for the following two years.

a. Which program achieves the targeted reduction of the child malnutrition rate at the lowest present value cost if the discount rate is 10%?

Monitors: $2.3 + \frac{1}{1.1} + \frac{1}{1.1^2} = 2.3 + 0.909 + \frac{100}{121} = 4.04$

Feeding: $1.6 + \frac{1.4}{1.1} + \frac{1.4}{1.1^2} = 1.6 + 1.273 + 1.157 = 4.03$

Feeding is lower cost

b. Which program achieves the targeted reduction of the child malnutrition rate at the lowest present value cost if the discount rate is 5%?

monitors: $2.3 + \frac{1}{1.05} + \frac{1}{1.05^2} = 2.3 + 0.952 + .907 = 4.159$

Feeding: $1.6 + \frac{1.4}{1.05} + \frac{1.4}{1.05^2} = 1.6 + 1.333 + 1.2698 = 4.203$

monitors is lower cost

c. Contrast your answer to (a) and (b) by describing how future expenses are impacted by a relatively lower discount rate, and the pattern of cost flows for the two policies.

Higher discount rate places less weight on future costs. The Feeding program has more of its overall costs in future years. when the discount rate changes to the lower value, these future values become higher in present value leading to a different outcome for lowest present value cost.

3) Highland agriculture in Ethiopia is facing problems due to soil erosion. You are considering two different programs that will address the soil erosion problem over a four year time horizon (t=0, t=1, t=2, t=3). The present value of benefits due to reduced soil erosion resulting from **either program** is estimated to be 5 million dollars. The discount rate is given as 10%.

Program One: Agroforestry. This tree planting project will cost 3 million dollars in the current year (t=0). The trees will provide a benefit in addition to combating soil erosion in the form of marketable seeds. This benefit is estimated to be 0.5 million dollars in the first year after they are planted (t=1), 1 million dollars in the second year after they are planted (t=2), and 0.5 million dollars in the third year after they are planted (t=3). After this time the trees will no longer produce seeds, thus this benefit will come to an end.

Program Two: Bund construction. Bunds are an anti soil erosion measure that involves building dirt and stone rows across steeply sloped land to reduce soil erosion. Bund construction will take two years, the current year (t=0) and next year (year 1). It will cost 1 million dollars each year to construct these bunds.

a. Which program is superior in NPV terms?

AF:

	B	C
t=0	5	3
t=1	$0.5/1.1$	
t=2	$1.0/1.1^2$	
t=3	$0.5/1.1^3$	

$NPV_{AF} = (5-3) + \frac{0.5}{1.1} + \frac{1}{1.1^2} + \frac{0.5}{1.1^3}$

$+ .8264 + .3757$

3.202

$NPV_B = (5-1) - \frac{1}{1.1} = 3.091$

Agroforestry better,, NPV

BC:

	B	C
t=0	5	1
t=1		$\frac{1}{1.1}$
t=2		
t=3		

b. Does your answer change if the benefits of the marketable seeds is lower than predicted in the original scenario, and is instead 0.25 million when t=1, 0.5 million when t=2, and 0.25 million when t=3?

$NPV_{AF} = (5-3) + \frac{0.25}{1.1} + \frac{0.5}{1.1^2} + \frac{0.25}{1.1^3}$

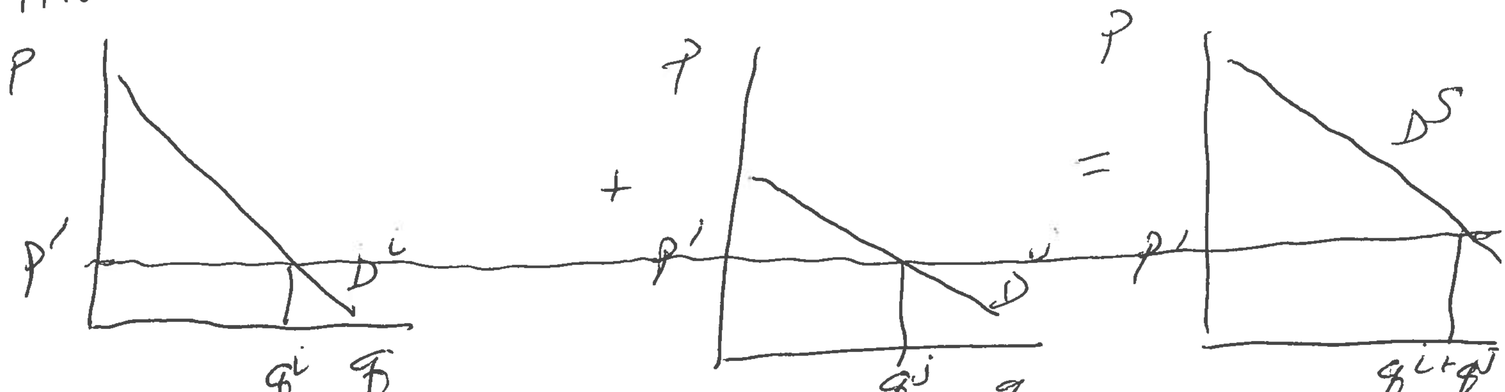
$+ .2272 + 0.4132 + 0.7513(.25) = 2.8282$

0.1878

now Bund Constructn is the better choice

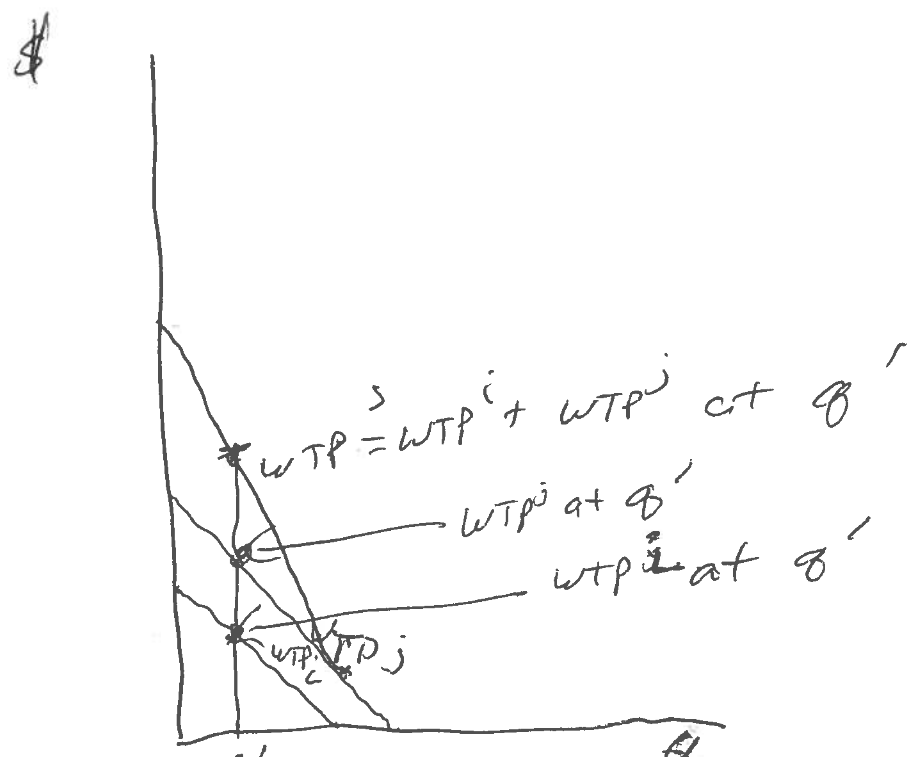
4) Illustrate how deriving the demand curve for a public good differs from deriving the demand curve for a private good. Describe how this difference reflects the difference between the definition of a public good and a private good.

Private Good



Horizontal summation of q over all individuals q at a given p.

Public Good



vertical summation of individual WTP at a given unit of q.

5) Public goods.

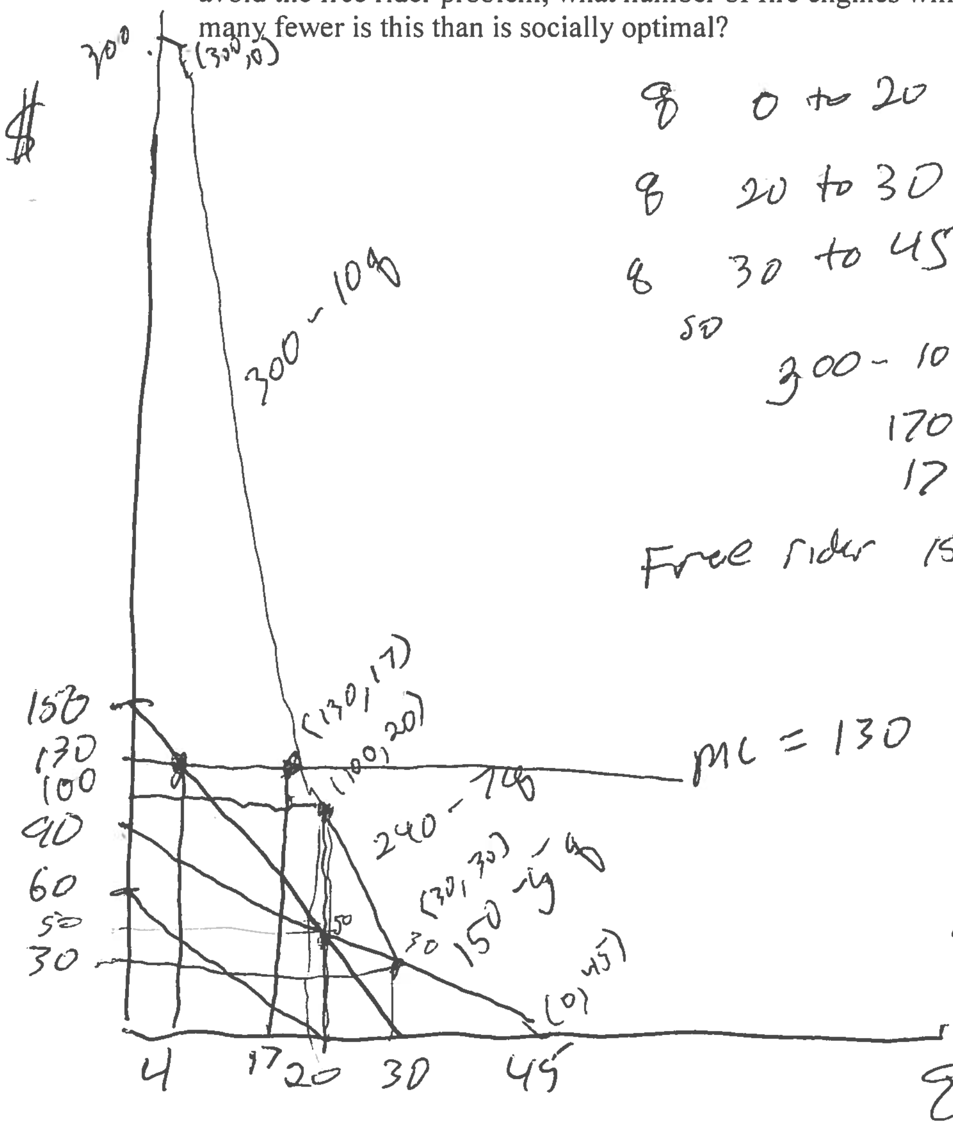
a. There are three people who live in a town. We are considering the demand for the number of fire engines, where q is the number of fire engines protecting all three. Elmo's demand is defined by 90-2*q. Grover's is defined by 60-3*q. Zoe's is defined by 150-5*q. At q=17, what is total willingness to pay on the societal demand curve for fire engines?

E=0 @ 45
G=0 @ 20
Z=0 @ 30

E: 90-2(17) = 56
G = 60-3(17) = 9
Z = 150-5(17) = 65
130 @ q=17

S: 300 - 10q
300 - 10(17)
300 - 170
130 @ q=17

b. If the marginal cost of a fire engine is constant at 130 and no effort is made to avoid the free rider problem, what number of fire engines will be provided? How many fewer is this than is socially optimal?



q 0 to 20 300-10q
q 20 to 30 240-7q
q 30 to 45 150-5q
50

300-10q = 130
170 = 10q
17 = q

Free rider 150-5q = 130
20 = 5q
q=4

Socially optimal is 17, Free riding on Zoe gives 4, 13 fewer than the socially optimal