Problem Set #10
PAI 723
Professor John McPeak

Name: KEY

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). <u>The present value of benefits due to reduced soil erosion resulting from **either program** is estimated to be 5 million dollars</u>. 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

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

BC:

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

Agroforesty better, NPV

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?

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

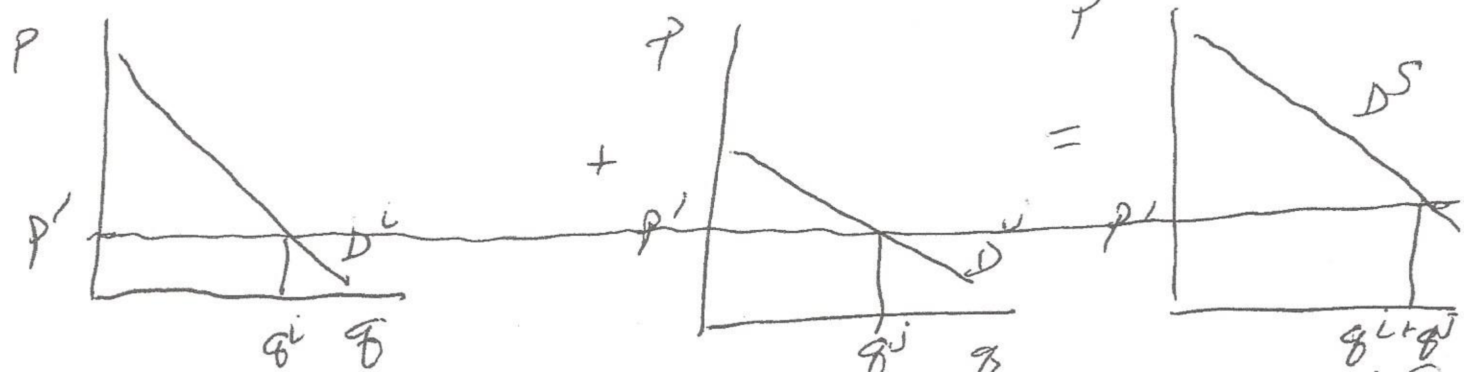
+ .2272 + 0.4132 + 0.7513(.25) = 2.8282

0.1878

Now Bund Constructn is the better choice

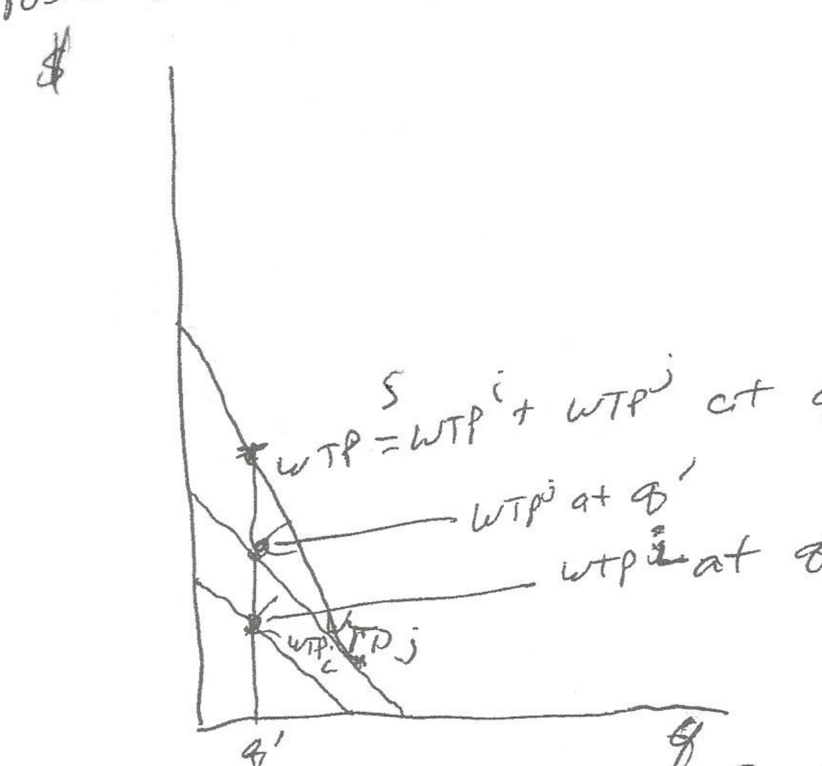
4) Illustrate how deriving the demand curve for a public good differs from deriving the demand curve for a private good. Describe how this difference reflects the difference between the definition of a public good and a private good.

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.

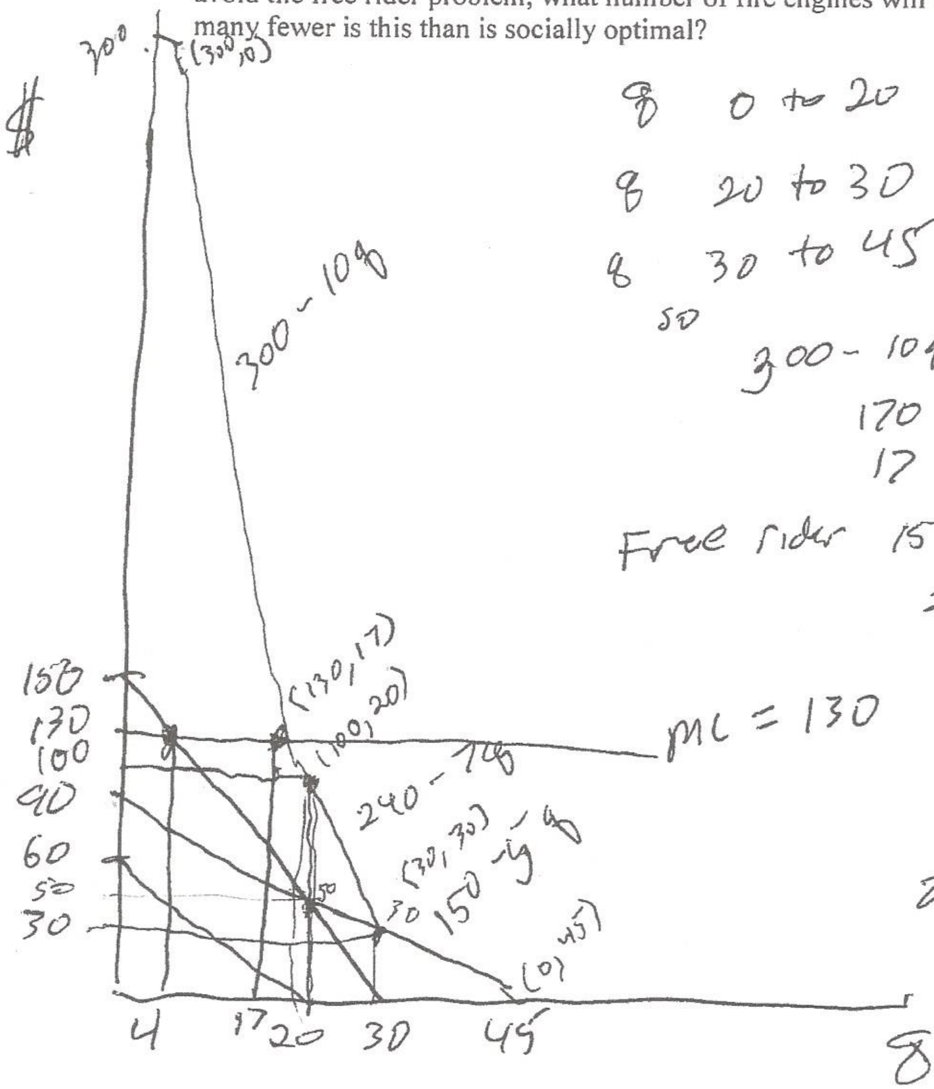
a. There are three people who live in a town. We are considering the demand for the number of fire engines, where q is the number of fire engines protecting all three. Elmo's demand is defined by 90-2*q. Grover's is defined by 60-3*q. Zoe's is defined by 150-5*q. At q=17, what is total willingness to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

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 is socially optimal