Problem Set #8
PAI 723
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Name: KEY

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 3	2 4
	2 cows	(8-2) 6 0	(6-2) 4 (3-1) 2	(4.5-2) $2\frac{1}{2}$ $2\frac{1}{2}$

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, H1 2

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

H1 plays 2, gets a payoff of $2\frac{1}{2}$
H2 plays 2, gets a payoff of $2\frac{1}{2}$

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 1/2	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 H2 plays 1 and gets 1, H1 plays 2 and gets 5

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

It increase it from $(2\frac{1}{2}, 2\frac{1}{2}) = 5$ to $(5+1) = 6$.

g) Does this outcome improve in the Pareto sense on the outcome of the original game? Why or why not. $(2\frac{1}{2} \to 5)$

NO it does not. It makes one player better off but the other is made worse off $(2\frac{1}{2} \to 1)$.

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 the case of a uniform quota at 1 cow per herder we have Herder 1 with 1 cow and gets 3, Herder 2 has one cow and gets 3.

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

Yes, since under this policy each herder gets 3 with one cow compared to $2\frac{1}{2}$ with 2 cows each. At least one person (in this case both) are 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 an externality on the coal burning plant since payoffs to coal plant are not changed by laundry's actions. Coal plant is imposing an externality (negative) on laundry since laundry 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 is CP plays "High" gets 14, Laundry plays "Low" and 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 of coal plant is to play High no matter what Laundry plays it will not help Laundry to have first mover status in this case.

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?

$100 - q = 10 + q$

$90 = 2q$

$q = 45$

$100 - 45 = 10 + 45 = 55$

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

b. What is the socially optimal equilibrium price quantity pair if production of the good imposes an externality defined by $MC^E = 0.5*q$?

$MC^S = MC^P + MC^E$

$MC^S = (10+q) + (.5q) = 10 + \frac{3}{2}q$

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

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

$q = 36$ $\quad p = 100 - 36 = 64$

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

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?

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

- or -

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

$64 = 10 + 36 + T$

$64 - 46 = T = \$18$

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 with a specific tax of 18 on consumers and on producers.

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

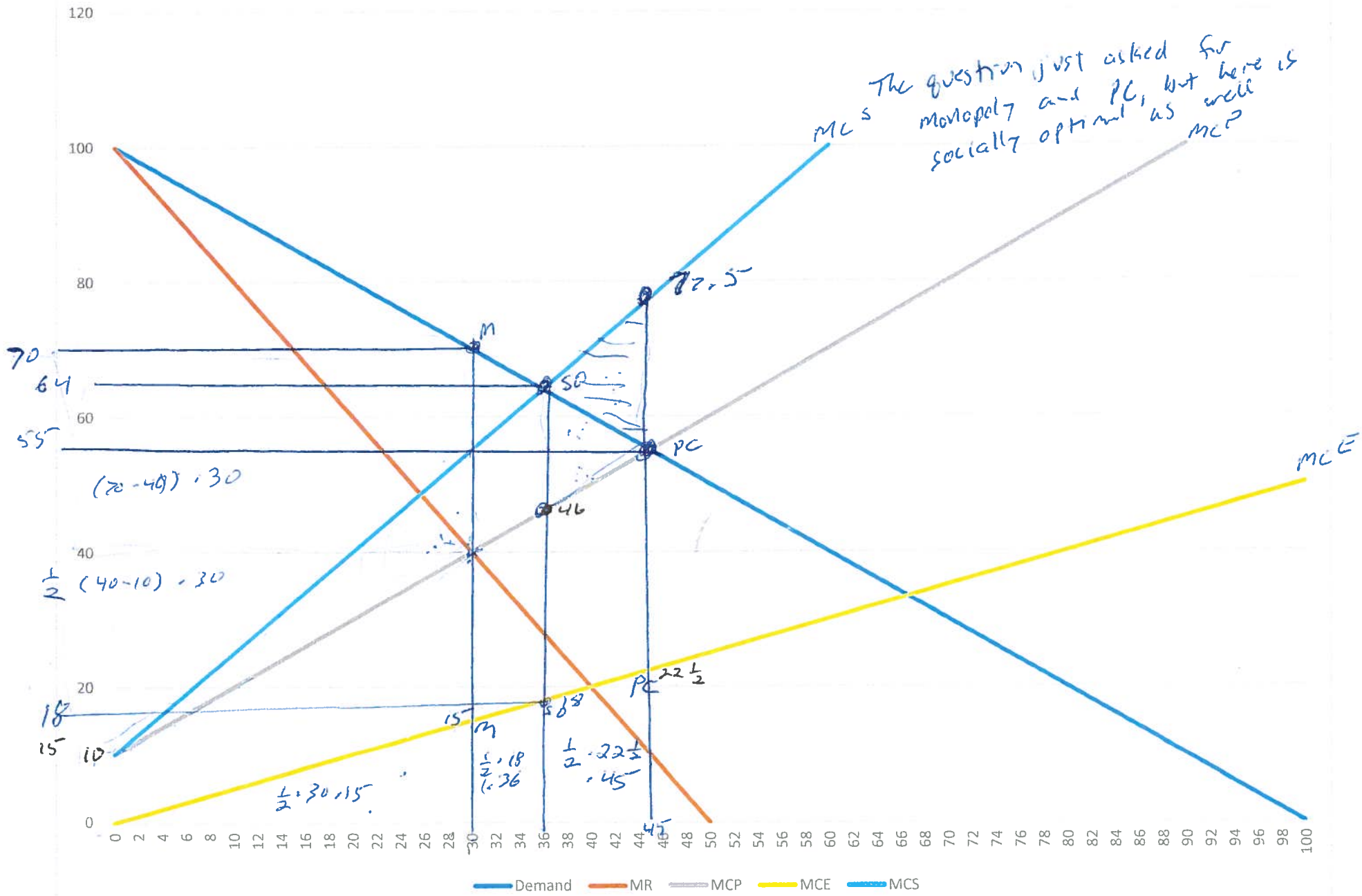
$MR = 100 - 2q$

$100 - 2q = 10 + q$

$90 = 3q$

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

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


The question just asked for monopoly and PC, but here is socially optimal as well
MCS
MCP
MCE
72.5
70
64
55
M
SO
PC
46
(70-40) · 30
1/2 (40-10) · 30
22 1/2
18
15
1/2 · 30 · 15
1/2 · 18 · 36
1/2 · 22 1/2 · 45
Demand
MR
MCP
MCE
MCS

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

not asked, but here for completeness

	Perfectly Competitive	Socially Optimal	Monopoly
Consumer Surplus	(1/2)*45*(55-10) =1012.5	(1/2)*(100-64)*36 =648	(1/2)*(100-70)*30 =450
Producer Surplus	(1/2)*45*(55-10) =1012.5	(64-46)*36 +(1/2)*(46-10)*36 =1296	(70-40)*30+(1/2)*(40-10)*30 =1350
Negative Externality	(1/2)*22.5*45 = 506.25	(1/2)*18*36 =324	(1/2)*30*15 =225
Total Social Welfare	1518.75	1620	1575

DWL of Perfect Competition with a negative externality is 1620-1518.75=101.25 or

MCS (q=45) = .5*[(10+1.5*45)-55)*(45-36)]=.5*[(77.5-55)*9]=.5*22.5*9=101.25

This is going above and beyond, but if you wondered, here is the outcome over the range of 30 to 45.

Q	P	CS	MCP	MR	PS	EXT	TSW
30	70	$450.00	40	40	$1,350.00	$225.00	$1,575.00
31	69	$480.50	41	38	$1,348.50	$240.25	$1,588.75
32	68	$512.00	42	36	$1,344.00	$256.00	$1,600.00
33	67	$544.50	43	34	$1,336.50	$272.25	$1,608.75
34	66	$578.00	44	32	$1,326.00	$289.00	$1,615.00
35	65	$612.50	45	30	$1,312.50	$306.25	$1,618.75
36	64	$648.00	46	28	$1,296.00	$324.00	$1,620.00
37	63	$684.50	47	26	$1,276.50	$342.25	$1,618.75
38	62	$722.00	48	24	$1,254.00	$361.00	$1,615.00
39	61	$760.50	49	22	$1,228.50	$380.25	$1,608.75
40	60	$800.00	50	20	$1,200.00	$400.00	$1,600.00
41	59	$840.50	51	18	$1,168.50	$420.25	$1,588.75
42	58	$882.00	52	16	$1,134.00	$441.00	$1,575.00
43	57	$924.50	53	14	$1,096.50	$462.25	$1,558.75
44	56	$968.00	54	12	$1,056.00	$484.00	$1,540.00
45	55	$1,012.50	55	10	$1,012.50	$506.25	$1,518.75