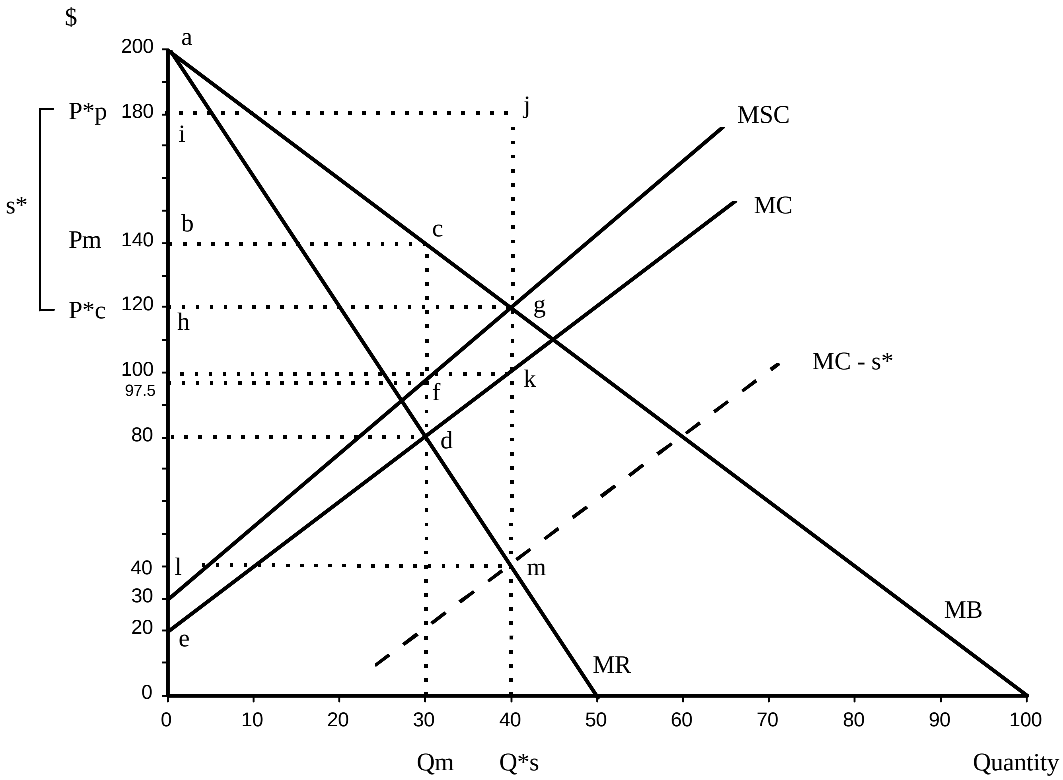
Suggested Solutions to Problem Set 1*

Part A

1.



a) <u>Social Optimum</u>

MSC = MC + MEC = (20 + 2Q) + (10 + 0.25Q) = 30 + 2.25Q

Social Equilibrium => MSC = MB => Point g => 30 + 2.25Q = 200 - 2Q => 40 => $Q^*_S = 40$
Total External Cost , TEC, at Q^*_S => Area ekgl => 40 (10 + 20)(1/2) = 600 => TEC = 600

b) <u>Monopolist 's Equilibrium</u>

Total Revenues TR = PQ = (200 - 2Q)Q = 200Q - $2Q^2$.

Marginal Revenue MR = $\frac{\partial TR}{\partial Q}$ = 200 - 4Q

Equilibrium Quantity => MR = MC => Point d => 200 - 4Q = 20 + 2Q => 30 => Qm = 30.
Equilibrium Price => 200 - 2(Qm) => 200 - 60 => 140 => Pm = 140
Deadweight Loss => Area cgf => (140 - 97.5)(40-30)(1/2) = 212.5 => DWL = 212.5
Total external Cost => Area elfd => (30)(10 +17.5)(1/2) = 412.5 =>TEC = 412.5

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* Part A was prepared by G. Malick, while part B was prepared by S. Marceau.

c) Welfare under the monopolist

Consumer's Surplus => Area abc => (200 - 140)(30)(1/2) = 900 => CS = 900
Producer's Surplus => Area bcde => (30)(120 + 60)(1/2) = 2,700 => PS = 2,700

d & e) Correction of the externality

The government wants to shift the MC curve so that it intersects the MR at the desired optimal level of output Q^*_S.

Let's call "x" the amount by which the MC curve should change.

$MC(Q^*_S) + x = MR(Q^*_S)$
$(20 + 2 Q^*_S) + x = (200 - 4 Q^*_S)$

But we know that $Q^*_S = 40$. Therefore,

20 + 2(40) + x = 200 - 4 (40)
100 + x = 40
x = - 60

The MC must shift down by 60. That is, the government should impose the monopolist a unit subsidy of 60 per unit produced. Hence, s* = 60. This seems to be strange, how come we end up subsidizing a polluter ? The intuition for this is simple. The monopolist restricts output and increases the price of the good. In this particular example, the monopolist's equilibrium output (Qm = 30) is less than the social optimum ($Q^*_S = 40$), so imposing a tax on the polluter is not a solution because it would move the monopolist's output further away from the social optimum. Thus, in order to move towards the social optimum, we actually need to increase the monopolist's output. We achieve this by subsidizing the monopolist.

The new monopolist equilibrium occurs at point m, where the monopolist will produce the desired optimal level of output. The new market price faced by consumers is determined by the demand $P^*_C = 200 - 2(40) = 120$. The effective price received by producers is the market price plus the subsidy $P^*_P = P^*_C + s^* = 120 + 60 = 180$.

f & g) Welfare implications of the government's policy

Government Expenses => $s^* Q^*_S$ => Area hijg => (60)(40) = 2,400

Old Consumer Surplus => Area abc => (200 - 140)(30)(1/2) = 900
New Consumer Surplus => Area ahg => (200 - 120)(40)(1/2) = 1,600
Change in Consumer Surplus => Area hbcg => 1,600 - 900 = 700

Old Producer Surplus => Area bcde => (30)(120 + 60)(1/2) = 2,700
New Producer Surplus => Area ijke => (40)(80 + 160)(1/2) = 4,800
Change in Producer Surplus => Area bcdkji => 4,800 - 2,700 = 2,100

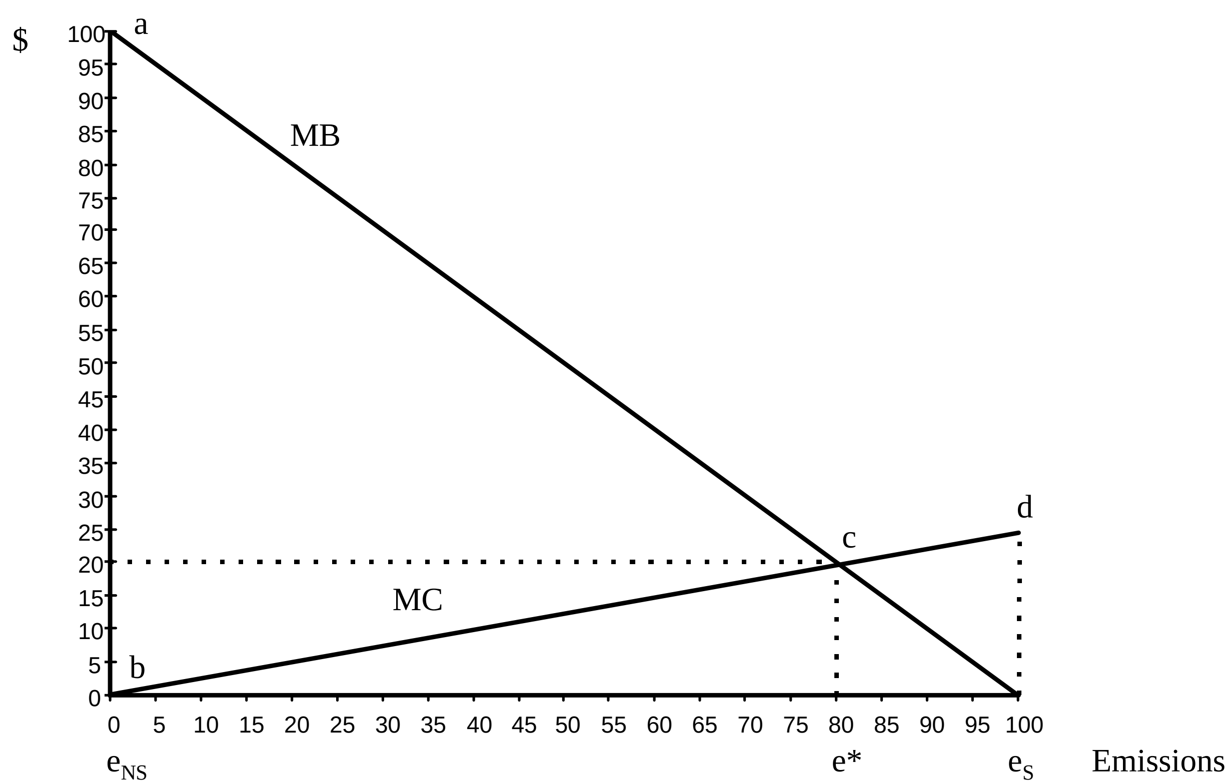
Old Total external Cost => Area elfd => (30)(10 +17.5)(1/2) = 412.5
New Total External Cost => Area elgk => (40)(10 + 20)(1/2) = 600
Change in Total External Cost => Area dfgk => 600 - 412.5 = 187.5

Summary of Welfare Changes:

Government Expenses	- 2,400.0
Change in Consumer Surplus	+ 700.0
Change in Producer Surplus	+ 2,100.0
Change in Total External Cost	- 187.5
Net effect of subsidy	212.5

The subsidy has a net benefit of 212.5, which is equal to the deadweight loss found before (part b). Hence, the subsidy eliminates the inefficiency created by the externality.

2.



a) The smokers want to maximize their total benefits, so they would prefer $e_S = 100$. The non-smoking group wants to minimize costs due to pollution, so they would prefer $e_{NS} = 0$. We are concerned about maximizing the social welfare. The social optimum is at point c, where MC = MB =>100 - e = .25 e => e* = 80.

b) When e = 0, the deadweight loss (DWL) is given by the area abc = (100)(80)(1/2) = 4,000. When e = 100, the DWL is given by the area cde_S = (20)(25)(1/2) = 250. When e = 80, we are at the social optimal and by definition the DWL = 0. The maximum welfare (attained at e*) is given by the area abc = (100)(80)(1/2) = 4,000.

c) The smokers will have the right to be located at e_S = 100. If a movement from e_S to e* could be negotiated, the non-smokers will benefit by area e*cde_S = (20)(20+25)(1/2) = 450, so they would be willing to pay the smokers as much as 450 in order to secure this change. On the other hand, the smokers' benefits are reduced by area e*e_Sc = (20)(20)(1/2) = 200, so they would be willing to accept no less than 200 to reduce emissions from e_S to e*. Hence, the maximum gains from trade (if realized) are 450 - 200 = 250. The distribution of these gains will depend on the bargaining power of each group.

d) In this case the non-smokers have the right to be at e_{NS} = 0. A movement from e_{NS} to e* will increase the non-smokers cost by area bce* = (20)(80)(1/2) = 800, so they would be willing to accept no less than 800 as compensation for moving from e_{NS} to e*. On the other hand, the smokers' benefits will increase by area bace* = (80)(100+20)(1/2) = 4,800, so they would be willing to pay as much as 4,800 to secure this change in emissions from e_{NS} to e*. Hence, the maximum gains from trade (if realized) are 4,800 - 800 = 4,000. Again, the distribution of these gains depends on the bargaining power of each group.

e) Problems with property rights and high transaction costs (See Coase).

EEP101/ECON125 Spring 99
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Part B

Note: Your essay didn't have to be as long as mine to be good.

Essay 1: "The EPA's Dangerous Lead Standard"

Mr. Brown has written an emotionally and morally charged article concerning the Environmental Protection Agency's proposal to lower the standard for lead-based paint contamination in and around certain buildings. The EPA's approach to the matter appears - at first sight to an economist at least - to be more rational, weighing the costs of cleaning up contaminated sites with the benefits.

The costs of cleaning up a contaminated site can be readily assessed by firms that specialize in environmental control and cleanup. The benefits are much more elusive. Lead exposure can cause developmental problems in children. These problems will impose costs on society that it would not have incurred had there been no contamination. . Thus, the benefits of cleaning up are the costs we avoid. For example, having to teach more children in special education classes rather than regular classes. That's where the $8 346 figure comes in. Suppose a site contaminated to 3000 ppm causes 10 kids to lose 10 IQ points. The social costs of that contamination would be 10×10×$8346 = $834 600. A less contaminated site may cause only 5 kids to lose 2 IQ points. The social costs from not cleaning up that site would be $83 460.

The government is considering a new policy. This policy is the lowering of the standard for lead-based paint soil contamination[1]. It will implement that policy if the benefits outweigh the costs. Let the benefits be the savings to property owners from not having to clean up their properties. Let the costs be the increase in "environmental" costs outlined above (diminished intelligence, health, etc.). Under these circumstances, the costs of lowering the standard are given by the area under the MEC curve between 400 and 2000 ppm in figure 1. The benefits are given by the area under the MAC curve between 400 and 2000 ppm. If total costs equal total benefits at 2000 ppm, then the new standard is to the right of E* and too much pollution is allowed.

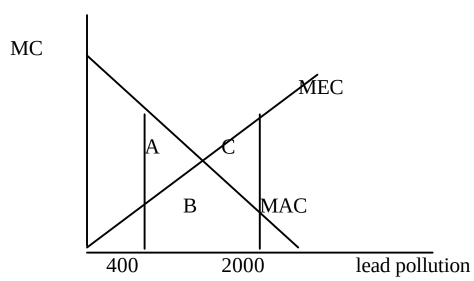

Figure 1

Change in total external cost = B+C

Change in total abatement costs = A+B

At 1999 ppm, the benefits exceed the costs. That does not mean 1999 ppm is an economically advisable level of pollution. Two policies are being compared: a standard at 400

[1] Incidentally, lead-based paint is no longer legal in the US. The law will not affect the number of contaminated sites. It will affect the number of existing sites that are labeled as hazardous.

ppm and one at 2000 ppm. Choosing 2000 ppm as the alternative policy is arbitrary. The government should, instead, be trying to maximize social welfare, i.e., the net gain. This is where MEC = MAC. Thus, while 400 ppm is too strict, 2000 ppm is not strict enough.

One could examine the EPA analysis from another angle. The socially optimal level of cleanup is where the marginal cost of cleaning up equals the marginal benefit. In figure 2, this is at X*; leaving X - X* pollution. This is not the point the EPA used to set their standard. They chose the 2000 ppm standard at the point where total costs equal total benefits. That is, they chose the point where the area under the marginal cost curve equals the area under the marginal benefit curve. At any level of cleanup less than X*, total benefits are greater than total costs. Thus, the level of cleanup associated with 2000 ppm must be to the right of X*, leaving us with the startling conclusion that the new lower standard is still too high!

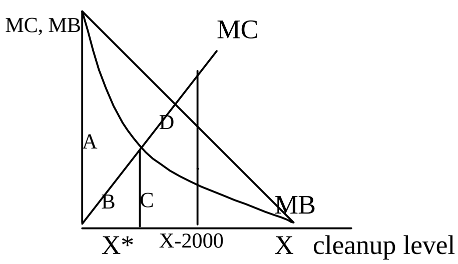

Figure 2

Total cleanup cost at 2000 ppm = B+C+D

Total benefit from cleaning up at 2000 ppm = A+B+C

The question can also be addressed using the basic externality model. We can associate the $8346 with the marginal external cost. Note, however, that we won't read that number off the curve. It is an amount that the EPA would use as a reference for calculating costs, as we showed in the simple example above. To get the curve, you also need to know the relationship between the level of contamination and lost intelligence. In this framework, the marginal cost of lead contamination depends on how much public health is affected, and that marginal external cost increases with the amount of pollution.

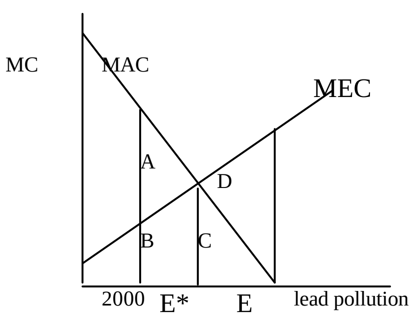

Figure 3

Total cost of reducing pollution to 2000 ppm = A+B+C

Total benefit of reducing pollution to 2000 ppm = B+C+D

The social optimum is where the marginal cost of lead contamination is equal to the marginal abatement. The total cost of reducing lead contamination from its current level (E) is the area under the MAC curve between E and E*. The total cost if that pollution reduction doesn't take place, i.e., the benefits of pollution reduction, is the area under the MEC curve between E and E*. When total costs are equal to total benefits, too little pollution is allowed.

The "total vs. marginal" issue is one flaw in the EPA analysis. It is not the only one. A less trivial error is the failure to include all the other social costs associated with lead-based paint in housing. The Agency's own documents state that there are harmful effects to individuals of all ages from excessive exposure. In addition to lower intelligence, they list "learning disabilities, behavioral problems, stunted growth, permanent hearing and visual impairment, and other damage to the brain and nervous system." The $8 346 does not take into account these impacts[2]. Nor does it take into account the emotional distress, the additional amenities/services required and the extra time costs of parents who raise these children. Nor does it take into account the lost potential of these children (that is, how much more they may have contributed to their community and the economy). Lead may also get into the ecosystem and harm the organisms in it. However, the impact on the ecosystem of the particular lead problem at hand is unknown.

Another pitfall in the analysis - Mr Brown falls into this one as well - is in not recognizing part of the reason for the "environmental injustice". Lead-based paint hazards are more likely to manifest themselves in poor, inner-city communities. It is also reasonable to expect rent and housing prices to be lower. Individuals will often accept some risk in their lives or their work in exchange for money (or some other form of compensation). In this circumstance, residents may have decided to take on some risk to their and their children's health in exchange for affordable housing. This frees up resources in the household's budget for other things, such as food and school supplies. The benefits from these other items may outweigh the uncertain costs associated with living in these areas. Only if prices in both lead-contaminated and lead-free areas were the same could we talk about true environmental injustice.

One may argue, to the contrary, that these families are experiencing cognitive dissonance. That is, they are aware of the costs of excessive lead exposure, but don't believe they will ever have to face those costs. One may also argue that it is not in the social interest that the members of one group (the poor) be forced to give up their health in exchange for affordable housing. Moreover, the diminished intelligence of the children whose parents accepted that trade-off will perpetuate the income inequality.

So far as income inequality and perceived injustice are bad for society, and so far as cognitive dissonance leads to irrational decisions, there is reason for government involvement. The EPA's new standard is too low and it should go back to the drawing board. Having granted this, I still maintain that some part of the external costs in question is "internalized" through prices.[3]

In most likelihood, the 2000 ppm is not the right level. So why would the EPA propose it? Lobbying on the part of owners who want to sell their property may be one explanation. Mr. Brown mentions that it would be easier for sellers to put contaminated sites on the market under

[2] If I could show that no caring parent would, in good conscience, accept $8346 in exchange for one of their child's IQ points, I would have proven my point.

[3] Call it a partial application of the Coase theorem, if you will.

the lower standard. How is it easier? Under the stricter norm, potential buyers would have discounted their prices by the expected cleanup costs. Under the 400 ppm rule, these costs could be quite high. Hence, the price for the property would have to be quite low. With a lower standard, cleanup costs would be less. Sellers can now get a higher price and may be much more willing to sell.

This isn't all bad. Individuals would benefit from the increased supply of property and sellers would benefit from finally being able to sell some of their unwanted assets. And, liability rules that make past and current property owners responsible for damages ensure the possibility of a cleanup at heavily (>2000 ppm) contaminated sites.

To summarize, I would disagree with Mr. Brown in his mistrust of cost-benefit analysis as a policy tool to enlighten environmental policy. I would agree with him in mistrusting the EPAs use of that tool in this situation. The EPA analysis was incomplete and used inappropriate criteria (total cost = total benefit) in fixing the level of the standard. Finally, both sides fail to recognize that part of the problem may already have been accounted for in the market.

Essay 2: "A Ban on Smoking in California's Public Bars"

Smokers do not generally account for the full harm they may be inflicting on others through second-hand smoke. Moreover, difficulties arise when the market attempts to come to a negotiated solution that is satisfactory to both smokers and non-smokers because of the large number of parties involved and because property rights to clean air are not well assigned. Thus, the State of California imposed a ban on smoking in public bars to deal with the externality arising from smoking in these areas.

If, however, the State of California imposed the ban to deal with the externality arising to employees, the Coase Theorem may be more applicable because the number of employees is small in each bar, and they would only need to negotiate with the bar owners. The employees may compensate an owner for disallowing smoking by accepting lower wages. Alternatively, they may request higher wages in exchange for compromising their health by working in a smoky bar. This solution of relatively high wages for workers in bars that allow smoking and lower wages for workers in bars that disallow smoking does not depend on the distribution of property rights.[4]

Even if the ban was imposed to give patrons a smoke-free environment, the market may come to some solution even without negotiation. If the harm to non-smokers is high enough, they

[4] The law had been criticized for its ambiguity. Bar owners aren't required to actually kick out patrons that smoke, as long as they indicate that they are breaking the law. That meets the owners' obligation for being compliant with the law. An employee may decide to waive his/her right, i.e., not request that it be legally enforced, in exchange for the aforementioned compensating wage. This flexibility makes the right transferable and enforceable. Thus, the law may have deliberately incorporated this ambiguity.

should be willing to pay a premium for a non-smoking environment. This would give bar owners an incentive to voluntarily set and operate smoke-free bars. This kind of market segregation can make all sides happier.

That we have not seen such solutions come about on a significant scale may be due to the low bargaining power of bar workers and poorly defined property rights. These poorly defined rights make it difficult to know who should pay the bribe and who should get it. The ensuing gridlock has left smokers with right and society with a deadweight loss. The ban does less than resolve the issue of who owns the right. Whereas it is clearly consistent with non-smokers having the right, it does not explicitly make that right transferable. It doesn't eliminate the loss; it merely switches it for another. In figure 4, the deadweight loss before the law was area B. With the law, it is area A. With the apparent transfer of ownership, the loss has also been transferred: from non-smokers to smokers.

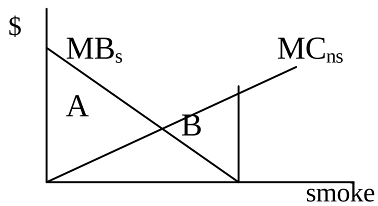

Figure 4

DWL when smokers have the right = B

DWL when non-smokers have the right = A

Yet, smokers were already being made to internalize part of the externality through cigarette taxes. The positive impact on government revenues is probably more important than the negative impact of the level of the externality created. This is not a trivial fact. Revenues from this corrective tax support lower distortionary taxes in other areas of the economy.[5]

While the tax on cigarettes addresses the externality problem caused by all smokers, it is non-specific. That is, it doesn't address the issue at hand: second-hand smoke in public areas. Similarly, subsidies to help people quit, or for programs that help people quit, are non-specific. The tax in the case at hand would have to apply only in public areas. For example, in addition to a cover-charge, you may pay an additional fee when you go to a bar if you want to smoke. After paying the fee, you may get a ticket or hand stamp that shows you have a "permit" to produce second hand smoke. This fee-based approach would be easier to monitor and enforce than a cigarette-based maximum (i.e., than a standard).

Since the issue is one of air quality, clean air standards for bars have been proposed. In order to comply with the standard, bar operators would only have to curtail the amount of smoking, not necessarily eliminate it. Alternatively, they could install sufficiently effective ventilation systems. Owners may object to such a large expense that doesn't directly benefit them. This also leaves open the question of how to determine who can smoke and who can't. The easiest way to do this is through prices and fees. Owners will go along with this as long as they

[5] This is sometimes referred to as a "double dividend". Externality taxes reduce deadweight loss arising from the externality and reduce the deadweight loss that arises from taxation in markets with no externality.

get to keep part of the revenue. Yet, the appropriate fee eliminates the need for a standard to begin with.

To summarize, in the absence of government intervention, the externality associated with second-hand smoke in public areas implies that total social welfare is not as high as it could be. Similarly, a complete smoking ban brings society away from the social optimum. The difference between the two situations lies with who gets the surplus (or pays the costs).

Whereas specific fees and taxes could be effective, the market is capable, in principle, of resolving the issue. Governments can assist the market by clarifying who holds the property right to clean air, specifying what the nature of the property right, reducing transaction costs and facilitating the voluntary transfer of those rights.