Suggested Solutions for Problem Set 3

1. *Coase Theorem:*

   A) Both Kara and Rugi like to maximize their benefits. This can be achieved by setting their marginal benefits equal to zero. Kara would like to play 80 hours a week and Rugi would like to study 40 hours a week. Given the time constraint, this allocation is not possible.

   B) Rugi will buy 200/7 hours. If the landlord sides with Rugi, Kara pays Rugi for 360/7 hours. The rate is just over $57 per hour: $57 1/7. There are a number of correct answers to how much Rugi charges Kara, depending on how nasty Rugi wants to be. If he wants to stick it to her, he will charge her $57 1/7 * 360/7. If he wants to be nice, he will just charge her $57 1/7 * 80/7, so both are right answers. Rugi's benefits are 200 - 5Qr, and Kara's are 160 - 2Qk. Then we know that Qr + Qk = 80, so you can solve it by setting 200 - 5 (80 - Qk) = 160 - 2 Qk. You'll get Qk = 360/7.

Another way to solve the problem is to turn one of the marginal benefits into the other one’s “marginal cost” curve by inverting it around Q=80. For example, as Kara has to compensate Rugi by at least Rugi’s MB for every hour she buys from Rugi, Rugi’s MB should be Kara’s MC. In the graph to the right we’ve generated the “marginal cost to Kara” curve (on the right) which works out to be 200-5(80-Qk) = −200 + 5Qk. There are only 80 hours available so we can stop drawing his curve at that point. A different intuition behind the same graph is to remember that there are 80 hours available and draw Rugi’s MB curve from right to left, so that Kara’s Q axis goes from 0 – 80 (left to right) while Rugi’s Q axis is the opposite, going from 80 at Kara’s 0 to 0 at Kara’s 80. Both give the same graph.

Finally, Rugi has two choices. If he’s greedy he will get charge Kara for all her time. If he’s nice he will just charge her for the time in which he would otherwise be studying.
One last issue to be careful of is that when you convert Rugi’s MB function into Kara’s MC function, you can’t simply take the negative of Rugi’s MB function. Unfortunately in this example the two procedures seem to give the same result: doing it the wrong way $[-(200 + 5Q) = -200 – 5Q]$ just happens to give you the same result as doing it the right way $[200 – 5(80-Q) = -200 – 5Q]$. However, most of the time you will get the wrong answer when you just take the inverse of the MB function. For studying, remember to use the “$Q_k + Q_r = 80$” approach, or else the graphical device of drawing a “Rugi” axis where $Q_r = 0$ is the same point as $Q_k = 80$, with Rugi’s benefits running the other direction (i.e. increasing as Kara’s decrease.) Make sure that you end up with the above graph! To solve the question using that graph, you will end up with the same mathematical formula as in the “$Q_k + Q_r = 80$” approach anyway.

C) Most probably, Kara will be thrown out of the library. We could add the people’s preferences together and see that they don’t mind if she plays for 40 hours (just like Rugi), but there will still be considerable logistical problems. For example, maybe the 20 people can’t instantly agree on the 40 hours to let Kara have the library. Also, more people may use the library than the 20 people who are in the library at one given time. Getting all of these people together to set up times during which it’s ok for Kara to play would involve significant transaction costs. Make sure that you think about the question before you jump into the math. If you want to do the math, you can solve for Kara’s hours of playing by $20(200-5(80-Q_k))=160-2Q_k)$, but talk about the intuition behind doing so. You were asked about the “likely outcome,” and we accepted answers both with and without math. You were marked down only if you didn’t mention the transaction costs anywhere AND if you showed incorrect math.

D) In this case, transaction costs are not exactly zero. It may be costly (in terms of time, say) for the 20 people to get together and force her to stop.
2. *Technology Adoption:*

A) Since we have the production function, and we know that they need 4 units of heat, we can solve for \( e \), which gives us \( e=16 \). Using this and the formula we have for \( h \), we can solve for values of “\( a \”).

\[
a_1 = \frac{16}{0.75} = 21 \frac{1}{3}
\]

\[
a_0 = \frac{16}{0.5} = 32
\]

Now, we can use this to calculate the net benefit/loss of switching to the new stoves as follows:

We know \( \text{cost} = pa^*(a) + 1^*T + Fi \) where \( Fi=0 \) for traditional stoves.

For traditional stoves: \(.5(32)+200=216\)

For Lakech stoves: \(.5(21.3)+150+80=240.6\)

Net cost= \(.5(21.3-32)+30=24.6 \) [alternatively: \(240.6-216=24.6\)]

People will not adopt the Lakech stove because its net cost is more. For everyone to adopt the new stoves, the necessary Lekech stove subsidy would have to be 24.6. This would make net costs of both stoves the same, leaving people indifferent between the two. Alternatively, the fuel input price would have to increase to 2.8. This number is found by solving \( Pa(10.7)=30 \), which is just changing .5 in the above formula to \( Pa \) and solving for the new input price.

B) Using the formula for \( Z \) given in the question, we can solve for:

\[
Z_1 = 0.25*(16/0.75)*150 = 800
\]

\[
Z_0 = 0.50*(16/0.50)*200 = 3200
\]

Net gain in pollution reduction = 2400

We can calculate the value of pollution reduction using the formula given in part B:

Value of pollution reduction = \([(3200-500)/50]-[(800-500)/50]\)=48
Adding the savings from pollution, the net gains from adopting a Lakech stove = 0.5(10 2/3)-30+48 = $23

II. Essay question:

A. a good answer will be short, but can include:

- Cut sulfur dioxide (SO2) emissions by 73 percent, from current emissions of 11 million tons to a cap of 4.5 million tons in 2010, and 3 million tons in 2018.

- Cut emissions of nitrogen oxides (NOx) by 67 percent, from current emissions of 5 million tons to a cap of 2.1 million tons in 2008, and to 1.7 million tons in 2018.

- Cutting mercury emissions by 69 percent, - the first-ever national cap on mercury emissions. Emissions will be cut from current emissions of 48 tons to a cap of 26 tons in 2010, and 15 tons in 2018.

- Emission caps will be set to account for different air quality needs in the East and the West

This is modeled after the “Clean Air Act” of 1990. The 1990 Clean Air Act Amendments, proposed and signed into law by President George H.W. Bush, have significantly reduced air pollution, especially through the innovative "cap-and-trade" acid rain control program. The acid rain program has been a resounding success, cutting annual sulfur dioxide emissions in the first phase by 50 percent below allowed levels. Emissions were reduced faster than required, and at far less cost. Industry compliance has been nearly 100 percent, and the program only requires a handful of EPA employees to operate. This approach is vastly more effective, and cheaper – two-thirds cheaper – than the traditional "command-and-control" approach.
• **Cap and trade programs:** allows more economic flexibility since it allows for those who value it more to pay for it while it also controls for the total amount of pollution [which would be achieved under command program]. In practice, cap-and-trade systems have proved faster, cheaper and less vulnerable to legal stalling tactics than the "command and control".

• **Command and control programs:** There are usually less adverse tax interaction effects in CAC programs achieving the same reduction. The performance of all pollution abatement instruments is seriously compromised for pollutants with highly differential spatial or temporal effects, but much less so with CAC programs. Also, regulated sources often prefer CAC because they usually have to pay more under this than economic incentive programs although the social costs are less.

C) This question is open to different interpretations. You can argue both ways, and as long as you use correct evidence, and a coherent argument, it should be fine. Some points you may want to include are:

Sulfur dioxide disperses regionally and globally, whereas mercury is deposited locally, in addition to being dispersed regionally and globally. Thus, cap and trade programs might not work as well for mercury as they do for sulfur dioxide trading. Standards set a ceiling on ambient levels of sulfur dioxide; emissions trading cannot result in pollution levels above this ceiling. There is no analogous ceiling for mercury in the National Ambient Air Quality Standards, and nothing in Clear Skies would establish one. So potentially, the Clear Skies Act initiative does not solve the problem of hot spots, and it may even exacerbate the situation. Maybe there should be a part of the initiative specifically dealing with problems of hot spots, and not subject them to a one-size-fits all design.

In class, Dr. Millock talked about the Los Angeles air market, which used a cap & trade program but split the area covered into two parts (coastal and
inland) and didn’t allow trading between areas. This limited the concentration of pollution in the inland area. Similar possibilities exist for other hot spots: instead of simply setting a national target, smaller areas can be defined within which trading is allowed. That will allow regulators to limit the buildup in those particular areas.

A counterargument, in which the authors contend that hot spot problems simply don’t occur, can be found at: