9.07

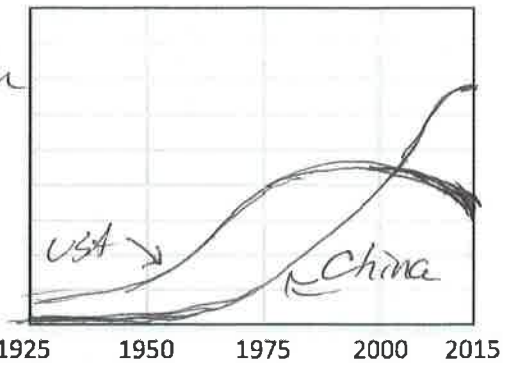
PSc-320 W2017 Schwartz Midterm Name_____

~~Please use last sheet for extra room for calculations.~~

1a) What is the present USA *per capita* CO_2 emissions? 16 T/person

1b) On the graph, show total annual *national* emissions of CO_2 for both USA and China. Label the two curves, so I can distinguish them. You don't have to put the scale on the y-axis, we can just focus on understanding the general behavior.

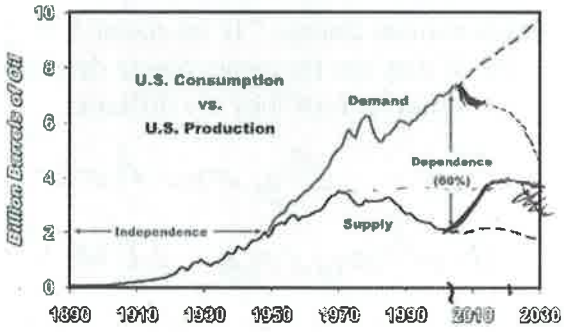
1c) Please comment on why the two graphs look different and what this means about each country's development.



China developed much later than the USA (industrial revolution) the emissions have dropped off (USA) + stabilized (china) because of 1) renewable energy + efficiency 2) economic stagnation

added later → 3) Cheap NG to replace coal for electricity

2) Please look at the graph at right, likely made around 2006.
   a) Please extend the graph to 2016.
   b) Please describe the cause behind the recent trends that you just updated



scarcity ⇒ Price ↑ leads to increased technology + risk (oil supply provides more oil) and conservation + efficiency (consume less)

c) What do you expect to happen in the coming 10 years? Extend the graph into the future and explain why you think this will happen.

I think oil production will stabilize because the price has dropped considerably. demand will go down (I'm an optimist) because of efficiency, electric cars + better city planning (mixed use)

3) I have a 4 kW air conditioner at my house in LA that I used last year for about 1000 hours (total running time). Then I had the system cleaned and tuned for a $1000 fee and the following year, total run time was only 400 hours to keep the house cool. Assume that the marginal electricity in California is NGCC.
   a) How much money did I save in electricity bills the first year?
   b) How much did my investment reduce my annual carbon emissions?
   c) With a $200/ton tax on CO_2, what would be the payback time for my $1000 upgrade?

$P = 4kW$ $t = 1000 hrs$ | $t = 400 hrs$

$E = P \cdot t = 4000 kWhrs$ | $E = 1600 kWhrs$

$Price = E \cdot 15\,¢/kWhr = \$600/year$ | $= \$240/year$

$CO_2 = \frac{1}{3} kg/kWhr \cdot E = 1.33 Tons\ CO_2$ | $= 0.53$ Tons CO_2

Saved $360/year on Electricity

Saved 800 kg = 0.8 Tons CO_2 ≈ $160 Carbon Tax

$Pay\ back\ time = \frac{Investment}{Yearly\ Savings} = \frac{\$1000}{\$520/year} \approx 1\ year\ 10\ months$

Total savings/year = $520/year

4) You hear someone say, "…when you burn diesel, the exhaust makes an ozone hole that causes climate change." Is the ozone hole problem the same as climate change?
   a) If they are the same, please describe the situation completely. If they are different, please briefly distinguish the two problems:
   describe how they are different:

No: Ozone hole is caused by refrigerants + aerosols destroying stratospheric ozone ⇒ increased UV + global sunburn.

CC is caused by GHG (mainly CO_2 + methane) which absorbs earth's ~~re~~ radiative IR leading to increased average global temps, ice melt, etc.

   b) How are we going to fix these problem and will it be difficult? Is there one fix – if so, please describe it. If there are different "fixes", please distinguish the two.

Ozone hole ⇒ ~~fuse~~ technical fix = ~~rep~~ alternative refrigerants + aerosols.

CC ⇒ GHG ~~Co~~ production is major result of economic growth (+ wealth accumulation) so there is still a technical fix (like renewable energy + efficiency) but there are also societal changes required

9:31

5) The economist says, "In order for the electricity market to work, the decision maker must bear the full cost."

a) What do we mean by "the market is working"? the capitalistic market balancing supply and demand

b) In electricity use, who is the "decision maker"? me, when I turn on an electric appliance & use electricity that I must pay for.

c) In electricity markets, please fully describe an important "external cost". Air pollution from burning NG (in California) causes CC + criteria pollutants result in deaths. I don't pay for these costs.

d) Is it important for the decision maker to be aware of the ~~full cost~~ Price in order for the market to work? (Bad wording) Explain how this sometimes plays out in electricity markets.

We don't know the market price of electricity when we are using it - and we are not even charged the market price. As a result, ~~we don't demand~~ consumption doesn't drop when the price increases. Thus, we can run into the limit of our ability to generate electricity without consumers even knowing

e) Describe an electricity-related environmental justice concern.

Poor people live near generation facilities and suffer from pollution + poor farmers live in low land Bangledesh that is flooding. These people, don't benefit from cheap electricity, suffer more & have little or no say in the

f) Explain how you could remedy these problems to make the electricity market work better using:

i) Regulations - ~~cut~~ law Coal or ~~regu~~ wasteful technologies or practice (incandescent lights) or require better filtered

ii) Market mechanisms

~~taxes~~ Carbon or pollution taxes, Carbon cap + Trade.

iii) Smart Grid – making the consumer aware of the present cost of electricity allows he/she to be charged for their decision, resulting in more people saving (for instance ~~more~~ Electricity)

9:35

9:24

6) Nuclear Power: Pros *and* Cons.

a) Nuclear power is largely carbon-free. Provide and support one <u>*more*</u> argument promoting nuclear power.

it's not coal - no soot + Mercury emissions, no coal miner deaths.

b) Common arguments against nuclear power are "long lived nuclear waste", and nuclear accidents such as Chernobyl. Please provide information that supports this as a legitimate concern, puts it in perspective, and/or dismisses it.

it's still way way safer than coal, NG, and even Solar.

c) Proliferation concerns: Please describe what we mean by proliferation concerns and the particular role of Plutonium and the reprocessing of spent nuclear fuel.

Plutonium is not naturally occuring, but is a fission by product resulting from U^{238} absorbing a neutron. Because it is chemically distinct from U^{238} it is easily purified (which U^{235} is not) and so could lead to a nuclear weapon if it fell into "wrong hands."

d) Costs. Please put the <u>financial</u> costs of nuclear in perspective and in particular describe the difference between the costs of keeping an old plant up and running versus building a new plant.

Nuclear is expensive - because of high capital costs + long building time = large initial debt. So building a new plant represents substantial financial risk. However, nuclear fuel is relatively inexpensive and plants are cheap to run. Hence once they are built, utilities <u>don't</u> want to shut them down (cash cow)