

Name: _____ Pledge: _____

Env Studies 201 Test #2

Point Total: 100 pts possible

6 pts 1. (a) What is the 'IPAT' identity?

The equation, $I = P \cdot A \cdot T$, describes how population, P , per-capita consumption level, A , and technological advances, T , interact to influence our impact, I , on natural resources. It is not generally valued for its value in quantitative assessment of environmental degradation so much as its value in describing two major ways that we can deplete natural resources: through overpopulation or through increased affluence.

6 pts (b) Using the IPAT identity, explain how one may argue that Earth's carrying capacity can be increased.

A central tenet of technologists is that the impact of increased population on natural resources (ie by increasing population levels) can be mitigated by improved technology. In this view, the term T can be seen as an efficiency term: improvements in technology reduces our environmental impact by enabling us to use natural resources more efficiently. Thus, technological advances would allow the Earth to support a greater number of people: in the IPAT equation, decreasing the value of T (by improving technology) allows an increased value of P (population) for equivalent impact I .

Alternately, you can increase carrying capacity by decreasing affluence level, something that is unlikely to happen. Again, in IPAT: decreasing A allows an increase in P for the same impact I .

6 pts 2. (a) Define 'sustainable development.'

The definition given by the Brundtland commission is the standard one: 'sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.' The key component is simultaneously satisfying both intra- and inter-generational needs.

6 pts (b) Is sustainable development, as conceived by the Brundtland Commission, compatible with the idea of limitless economic growth? Why or why not? Be brief.

It all depends on whether you believe that the Earth's carrying capacity—even if elastic—has a finite limit. If so, then limitless economic growth is not sustainable. Or, as the Brundtland Commission stated in *Our Common Future*,

Growth has no set limits in terms of population or resource use beyond which lies ecological disaster. Different limits hold for the use of energy, materials, water, and land. Many of these will manifest themselves in the form of rising costs and diminishing returns, rather than in the form of any sudden loss of a resource base. The accumulation of knowledge and the development of technology can enhance the carrying capacity of the resource base. But ultimate limits there are, and sustainability requires that long before these are reached, the world must ensure equitable access to the constrained resource and reorient technological efforts to relieve the pressure.

8 pts 3. What is 'the hydrogen economy?' Be brief but complete.

Elemental hydrogen (H₂) is a clean fuel: it can be burned without producing many of the pollutants (such as carbon dioxide or carbon monoxide) emitted in the combustion of fossil fuels. More importantly, however, it is used cleanly in hydrogen-based fuel cells, which produce electricity when provided with a steady stream of hydrogen and oxygen. They produce only water as the by-product. Fuel cells can be used to provide energy for homes and electric cars in a decentralized energy network.

But hydrogen is not available in its elemental form: it must be produced in some fashion. Hydrogen production requires an energy input, so hydrogen is better seen as an energy *carrier* rather than an energy source. Energy is used to make hydrogen, which is distributed to the fuel cells much as we currently have an energy grid to distribute electricity. So a hydrogen economy consists of three parts: hydrogen generating stations, a hydrogen distribution network, and fuel cells to produce electricity for transport and for homes and industry.

8 pts 4. (a) According to Paul Ehrlich, is population growth sustainable? Describe his reasoning.

Ehrlich, a Malthusian, believes in the concept of a finite carrying capacity. ANY positive rate of population growth will eventually exceed this capacity, so he does not think it sustainable. He believes that zero growth rate will occur by one of two ways: by voluntary control of birth rate, or by involuntary increase in death rate due to overshoot/collapse.

8 pts (b) What did Julian Simon say about this? What are his reasons?

Julian Simon believed that Earth's carrying capacity is infinite. His reasons are twofold: (i) faith in technology to overcome any resource limitation, and (ii) belief in the principle of substitutability. Simon uses traditional economic reasoning: as a resource becomes limited, its price rises, spurring innovation until an alternative is cheaper. Thus, even though a nonrenewable resource such as oil might run out, it will be replaced by an alternative. Simon cites as support of his position that most quality of life indicators—such as life expectancy, commodity prices, leisure time—have been steadily improving throughout human history.

8 pts 5. In "The End of Cheap Oil," Campbell and Laherrère state that there are 850 Gbo left in all the existing oil fields of the world. How did they arrive at this number?

The authors added P50—the 'proved and probable'—estimates of reserves in existing fields. There will be uncertainty in any estimate of oil remaining, so geologists attach probability values to their estimates. A P50 estimate translates as follows: there is a 50% chance that there is at least as much oil as the estimate states. The key characteristic of P50 estimates is that they may be added: the sum of two P50 estimates provides an P50 estimate for the total amount of oil in both fields. Thus, adding P50 estimates for all the fields in the world provides an (approximate) P50 estimate for global oil reserves in known fields. The estimate of 850 Gbo is thus a P50 estimate.

- 8 pts 6. In *Silent Spring*, which helped invigorate and popularize the environmental movement, Rachel Carson lamented the indiscriminate use of DDT and other synthetic pesticides. And yet Paul Muller won the Nobel Prize for his discovery of the insecticidal properties of DDT. Comment on the pros and cons of the use of DDT and similar products.

Pros: DDT is cheap to make and can be very effective (at least in the short term) at preventing the spread of malaria and other insect-borne diseases. DDT is not very toxic to humans—at least, compared to most other insecticides—and so is not too dangerous to manufacture or use. DDT also allows monoculture planting of high-yield crops, which can increase agricultural productivity. Increasing productivity allows us to support a larger population and/or to convert less land to agricultural use.

Cons: DDT—or any single pesticide—is not so effective at controlling pests over the long-term, due to the evolution of pesticide resistance among the target population (resulting in the so-called ‘pesticide treadmill’). DDT also lasts a long time in the environment and it accumulates in the fatty tissues of organisms. Its long lifetime ensures global distribution, so that areas that are far removed from application will have detectable levels of DDT. Since it biomagnifies in food webs, top predators (eg, fish, birds, polar bears) will have DDT in the bodies at concentrations as much as one million times higher than in the surroundings. This can cause profound ecosystem effects. At such high levels, even human health can be affected, especially sensitive populations such as infants who are exposed to DDT through breast milk.

- 8 pts 7. Describe Integrated Pest Management (IPM) in a little detail. According to its supporters, what are its advantages?

IPM consists of a variety of pest control tactics that are intelligently applied and coordinated into an effective strategy whose goal is to simultaneously minimize cost to consumers, society, and the environment. Two key aspects of IPM are that (i) it is often an integration of a number of approaches to pest control, and that (ii) constant monitoring of pest level and control method effectiveness are required for intelligent application and integration of control strategies.

IPM is an alternative to the calendar-based (and blind) application of broad-spectrum pesticides, whether they are needed or not. Although pesticides may form a part of IPM, they are only one control strategy, and they are applied more intelligently: they are applied only when the pest population rises to the level that is economically damaging, and their effectiveness is monitored. In this manner, less pesticide is applied, and the impact on non-target organisms is minimized, as is the probability of developing pesticide resistance. Moreover, more environmentally-friendly pesticides are used when possible.

Moreover, IPM tends to make more use of knowledge of the biology of the pest, as well as ecological relationships. Biological controls, such as sterilization, predator introduction or multicrop agriculture, are used more frequently.

When done well, the advantages of IPM are reduced cost to producers and better long-term pest control, while minimizing the ecological cost of agriculture.

- 8 pts 8. Lester Brown warns that food scarcity due to overpopulation is imminent. But Lappè and Collins have argued that world hunger is NOT due to overpopulation. What is their reasoning?

Brown worries about the upwards trend in population and the downwards trend in per-capita food productivity. In other words, Brown is worried because increases in food productivity have not kept pace with increases in population, at least for the past decade or so.

However, Lappè and Collins do not think that low food production is the reason that there is famine; in fact, they feel that there is plenty of food to feed the entire global population. The basic problem they identify is poverty: the industrialization of agriculture—the growth of large, ‘agribusiness’ operations—has deprived the poor of the opportunity to earn a living. Falling food prices and government policies in the developing world have deprived them of their profits and their land. The result is that they cannot grow or buy the food needed to feed their families.

8 pts 9. Jared Diamond states that 'Easter Island is Earth writ small.' List the ways in which our global situation resembles that of Easter Island, as well as the major differences.

Some similarities:

- A fixed, exhaustible natural resources base meant a finite carrying capacity for Easter Island. Exceeding that capacity resulted in societal collapse.
- There was a decline in natural resources occurred over generations, which is difficult to observe directly
- Much deforestation has occurred for non-essential uses.
- Deforestation resulted in loss of both materials (wood) and ecosystem services (controlling soil erosion)

Some differences:

- The Rapa Nui had no written historical records, so that tracking resource depletion over generations was difficult.
- The Rapa Nui's lack of scientific knowledge of ecosystems possibly means they did not realize the seriousness of their plight, or the importance of the forest ecosystem beyond the supply of wood.
- The Rapa Nui had a low level of technology.
- We have a greater diversity of resources, with increasing globalization/trade between nations.

12 pts 10. Why does Garrett Hardin oppose sending food to starving nations? Answer in some detail; include in your answer a definition of the 'tragedy of the commons.'

Hardin was a Malthusian—he not only felt that Earth's carrying capacity was finite but that we are close to exceeding that limit. He compared the situation of residents of the developed world to occupants of a lifeboat with only a limited amount of room.

For Hardin, the biggest problem with the developing countries was their rapid population growth. Sending them food—letting them onto the lifeboat—would only ensure that their population would continue to grow, eventually dragging us all down with them (unless, of course, we stopped sending them food).

Hardin popularized the concept of the *tragedy of the commons*. The idea is essentially that Adam Smith's 'invisible hand'—whereby self-serving behavior in a marketplace economy leads to better conditions for society as a whole—does not work for publicly-owned resources (public 'commons'). Self-serving behavior leads inexorably to destruction of the commons unless corrective action is taken, such as privatization or regulation.

Creation of a world food bank to feed the starving would create just such a public commons. Indeed, Hardin regarded the right to breed as another public common, one that would lead to overpopulation and societal collapse unless it were curtailed.