

Name: _____ Pledge (sign): _____

Env Studies 201 Test #2

Point Total: 100 pts possible

- 10 pts 1. The IPAT equation is a simplification of some important factors involved in the use and potential degradation of natural resources. Explain the IPAT equation and use it to briefly outline the concerns of the *neo-Malthusians* and *Technologists*.

The IPAT equation is $I = PAT$, stating that the environmental impact, I , of human activities is a product of three main factors: population, P , affluence, A , and technological factors, T . The first two variables are fairly obvious: impact is a product of the global population and the average per-capita use of natural resources. The third factor, "technology" (including social arrangements), can have a negative or positive effect; examples include the increased production of pollution or the more efficient use of water in irrigation.

Neo-Malthusians are concerned that the combined effects of the first two terms (population and affluence) will overwhelm any technological attempts to reduce environmental impact. Many neo-Malthusians believe we are already beyond the carrying capacity of the Earth, and that the situation will become worse with continued population and economic growth, leading to ever-accelerating resource use. They believe that continued depletion of critical natural resources such as clean water, fertile soil and energy sources will lead to widespread societal conflict and collapse: a dramatic decrease in global population and average affluence levels. Drastic action is needed now and in the near future to prevent this from occurring.

Technologists believe that 'human capital,' such as inventions and social institutions, are sufficient to support the current and future populations indefinitely. They believe that as countries grow their economies, the demographic transition will stabilize global population at a manageable level and that increased resources will be used to clean up the environment. Basically, they believe that human inventiveness is equal to the task of either finding adequate substitutes for natural resources as they are depleted, or using them more efficiently to avoid the depletion of irreplaceable resources. They do not foresee widespread societal collapse as a result of the scarcity of natural resources, and are concerned that too much concern with conserving natural resources will needlessly stunt economic growth.

- 10 pts 2. Explain the concept of sustainability in terms of flow rates, as outlined by the authors of *Limits to Growth*.

The human economic engine requires an input in natural resources (material, energy) and results in an output of waste (trash, pollution). As envisioned by Meadows *et al*, sustainability is achieved as long as:

- the rate of *natural resource extraction* does not exceed the rate of its regeneration by natural processes; and
- the rate of *waste production* does not exceed the rate at which it can be assimilated (degraded to harmless chemicals) by the environment.

If the rate of extraction of renewable resources exceeds the rate of regeneration, then those resources will be depleted and will eventually disappear; the services provided by such resources would eventually need to be replaced or we would have to do without those services. In the case of nonrenewable resources, such as fossil fuels, ANY rate of extraction is not sustainable in the long term; the services provided by them must eventually be replaced by renewable resources. Finally, if the rate of waste discharge exceeds the rate of its assimilation, then the concentrations of toxic waste will increase as long as that situation holds; eventually, these pollutants would build up to intolerable levels.

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

The hydrogen economy is a hypothetical large-scale system in which elemental hydrogen (ie, H_2) is the primary form of energy storage. A method of hydrogen *production* would be needed: the fuels and energy sources used to produce the element would power the hydrogen economy. Although natural gas is currently the most economical source of hydrogen, many proponents of the hydrogen economy envision that water electrolysis as the method of production in the future, using clean and renewable energy sources. Other important components of the hydrogen economy include methods for storage and distribution, and fuel cells to convert hydrogen into electricity. Both hydrogen production and its use in fuel cells are scalable and can be decentralized in the energy network. Transportation powered by fuel cells is usually considered to be an important component of the hydrogen economy.

- 10 pts 4. Peter Rossett claims that the Green Revolution—which is credited with increasing global food productivity—actually increases world hunger. This seems counterintuitive; what is the logic behind Rossett's assertion?

Basically, the reason is that, even though food productivity increased, the food isn't getting into the hands of the starving and undernourished of the world. The Green Revolution increased food productivity by using high-yield seeds that required increased inputs of fertilizer, water and pesticide use. These methods of agriculture are expensive and are beyond the means of most poor farmers. Increased food productivity decreased food prices—decreasing profit margins—at the same time as it made it harder for rural farmers to compete against "agribusiness." Their earning power decreased, they lost their farms and the ability to both buy and grow food for their families. The seeds produced by the Green Revolution are also more easily harvested by mechanical means, reducing the need for manual laborers on the farms and further increasing unemployment among the poor. These effects balanced out the increased availability of food due to increased production and lower prices.

- 10 pts 5. Rachel Carson believes that severe environmental degradation results from what is now called *the pesticide treadmill*. What is the pesticide treadmill, and—according to Carson—how does it increase degradation?

A pesticide puts selective pressure on the affected species to evolve an immunity to the pesticide; insects can be particularly effective at doing so given their short generation times. As the pest develops an immunity, the grower may apply the pesticide in ever greater quantities before ultimately deciding to use a new type of pesticide and begin the process anew. Thus, pesticides in ever greater numbers and quantities are being released into the environment; this is the pesticide treadmill.

Pesticides cause degradation because many of them take a long time to degrade and so they are spread widely, where they affect nontarget organisms (including humans) who have not developed an immunity to them. Their extended use also decreases biodiversity in the soil ecosystem, decreasing its fertility.

6. The most recent issue of *Scientific American* has an article about doping in sports titled “The Doper’s Dilemma.” In it, the authors use Game Theory to approach the problem of the widespread use of performance-enhancing drugs (PEDs) in some competitive sports. The authors of the study state that the decision of an athlete to dope (or not) is an example of the Prisoner’s Dilemma (PD); hence the title of the article.

- 11 pts (a) Describe the PD in a little detail as it applies to the “doping game,” in terms of the choices facing a competitive athlete in a world where the competition might (or might not) be using PEDs. An athlete has two choices: to use PEDs or not. The competition has the same choice, so there are four possible outcomes:
1. no athletes use PEDs (this is the Pareto Optimum)
 2. the athlete uses PEDs but the competition does not
 3. the athlete does not use PEDs but the competition does
 4. all athletes use PEDs (this is the rational result)

If there are no penalties for the use of PEDs, or if the risk of detection is very low, then the athlete will always be better off with the decision to use PEDs, no matter what the competition decides to do. So the rational (self-serving) choice of the athlete is to use PEDs. However, all athletes will come to the same conclusion and hence, if they act rationally, all athletes will use PEDs.

- 11 pts (b) The PD predicts the “tragedy of the commons.” What is the common property resource that is being degraded by an athlete’s decision to use PEDs? The inspirational, entertainment and educational value of a fair and equal competition is the “commons” that is being degraded. The Pareto Optimum would be if NO athlete would choose to use PEDs, while the rational result is that all athletes do so. The point of game theory is to change the reward structure, to provide incentives and/or disincentives (ie penalties) to avoid this situation. Among other things, game theory provides a quantitative measure of amount of (dis)incentive necessary to achieve the Pareto Optimum.

7. Genetically modified (GM) food: the promise and the peril.

- 8 pts (a) List four important advantages of using GM crops for food.
- Can increase food productivity per acre (less productive land needed to grow food)
 - Can theoretically decrease pesticide use
 - Can increase nutritional value of food
 - Can make marginal lands productive
 - Can increase shelf life (better storage/distribution)

- 8 pts (b) List four significant concerns about GM crops.
- Gene escape, a form of biological invasion that reduces biodiversity
 - Health risk (allergic reaction)
 - Uncontrolled pest use
 - Patenting and technology transfer issues
 - Expensive seed, further increasing trend to industrial agriculture
 - Ethical issues
 - Labeling issues

12 pts 8. The following two questions concern Annie Leonard's *The Story of Stuff*; **choose one** and answer it in detail and be complete. Circle the question you choose to answer.

- (a) The author is disturbed by an overly-cheap radio. Why?

She is concerned about *externalities*, hidden costs that are not reflected in the accounting spreadsheets that determine the price and profit margins of the radio. The price "wouldn't even pay the rent for the shelf space it occupied until I came along, let alone part of the staff guy's salary that helped me pick it out, or the multiple ocean cruises and truck rides pieces of this radio went on. That's how I realized, I didn't pay for the radio. So who did pay?"

These externalities are borne by society as a whole and include natural resource degradation—air and water pollution produced and the loss of raw materials used in the radio's manufacture and distribution—as well as the human suffering to provide cheap labor. "Well, these people paid with the loss of their natural resource base. These people paid with the loss of their clean air, with increasing asthma and cancer rates. Kids in the Congo paid with their future—30% of the kids in parts of the Congo now have had to drop out of school to mine coltan, a metal we need for our disposable electronics. These people even paid, by having to cover their own health insurance. All along this system, people pitched in so I could get this radio for \$4.99. And none of these contributions are recorded in any accounts book. That is what I mean by the company owners externalize the true costs of production."

- (b) What is the *golden arrow* and what is its significance in terms of natural resource depletion?

The full name is the 'golden arrow of consumption.' It is presented as the main driver for the materials economy, which include the following steps:

- (1) extraction of raw materials (natural resources);
- (2) production;
- (3) distribution; and
- (4) use and disposal.

According to Leonard, there are serious problems with all these steps. The extraction rate of materials is too large, depleting the stock of renewable resources in a way that is unsustainable; production gives us toxic pollution as a byproduct, and discharges it at a rate faster than it can be assimilated into the environment, increasing our exposure to it; distribution involves a lot of social injustice in terms of underpaid workers both domestic and abroad, and produces more pollution due to transportation; and disposal fills our landfills and produces more pollution from incinerators too quickly because the products are designed to have short lifetimes.

A consumer society is aimed at increasing the rate of consumption as the main method of growing the economy, through strategies such as perceived and planned obsolescence and using low prices that ignore negative externalities. This increases the rate of consumption, increasing along with it the rate of environmental degradation and the rich-poor income gap.