

Name: _____ Pledge (sign): _____

Env Studies 201 Test #2

Point Total: 100 pts possible

- 6 pts 1. What is *Agenda 21*? Answer briefly (1-3 sentences).

Agenda 21, adopted at the Rio Summit in 1992, began the process of implementing sustainable development on a global scale. It made various recommendations to governments of first and third world nations and established the UN Commission on Sustainable Development to monitor progress toward sustainability.

- 6 pts 2. Jesse Ausubel argues that 'resources are elastic.' By way of explanation, recast his argument in terms of the 'IPAT' equation.

$I = P \cdot A \cdot T$, where I is environmental impact, P is population level, A is affluence (ie, per capita consumption) and T is a factor for 'technology' (good and bad) that basically factors in the efficiency of resource use. Ausubel's basic argument is that the Earth's resources can be increased — or 'stretched' — through increases in efficiency accompanying technological advances. That means that the resource could potentially also accommodate a higher population level. In terms of the IPAT equation, a sustainable environmental *impact* (I) can be maintained even in the face of increasing *population* (P) by technological advances that decrease the T term.

- 8 pts 3. Lester Brown described some of the problems of future food production. List them (as many as you can).

Here are some problems Brown mentions that might cause food production to lag population growth in the future:

- depleted fisheries due to overharvesting
- loss of productive land through soil erosion
- loss of productive land through desertification
- lack of new productive land to keep pace with increasing population
- conversion of existing productive land to non-agricultural purposes (eg urban sprawl)
- depleting ground water supplies for irrigation
- global climate change

12 pts 4. Characterize each of the following as a 'Malthusian' or a 'technologist,' and briefly justify your choice.

(a) Julian Simon

Simon is a Technologist who argues that human ingenuity is the 'ultimate resource' and that natural resources are not limited in any meaningful sense, due to the principle of substitution and the market pressure to develop those substitutes.

(b) Gro Brundtland

Brundtland was the head of the World Commission on Environmental and Development that promoted global sustainable development. Although either case can be argued, on balance Brundtland appears to be more Malthusian than Technologist. On the one hand, she believed in the power of technology to help achieve sustainability: in *Our Common Future* she states 'the accumulation of knowledge and the development of technology can enhance the carrying capacity of the resource base,' echoing Technologist Jesse Ausubel. But her very next sentence declares that 'ultimate limits there are' to our natural resources. By inference, economic growth cannot proceed forever, since there are limits to the carrying capacity (and population) that can exist comfortably and sustainably on Earth. Brundtland also states that 'sustainable development can be pursued more easily when population size is stabilized at a level consistent with the productive capacity of the ecosystem,' a very Malthusian sentiment.

8 pts 5. What is the 'pesticide treadmill?'

The pesticide treadmill refers to the escalating nature of chemical warfare on insects, weeds, and other pests. Repeated and prolonged exposure to a particular pesticide exerts, through natural selection, pressure for the affected organisms to evolve *pest resistance*. As has been well documented, pests will always develop pesticide resistance over time—it is just a question of when. As resistance increases, application rates also tend to increase, which just accelerates the development of better resistance. Eventually that particular pesticide is abandoned as ineffective and another is adopted, and the process begins again.

10 pts 6. What is a 'Hubbert curve' and what is its significance for our global oil resources?

A Hubbert curve is a bell-shaped curve of production of some limited, non-renewable resource (such as oil) as a function of time. Global oil production can be analyzed by fitting a Hubbert curve to the production data, which allows one to make a prediction of peak global oil production. After the peak, all oil fields will be running at full capacity and will fail to meet demand—unless demand falls—so that oil prices will begin a long increase.

- 8 pts 7. Rather than the more common 'high yield varieties,' Peter Rossett and his colleagues at Food First often use the phrase 'high response varieties' (HRVs) to describe seeds developed in the Green Revolution. What is the reason for their distinction?

In order to supply higher yield, the seeds developed by the Green Revolution require more intensive agricultural 'inputs,' in particular irrigation and petrochemical fertilizers. They also typically require more pesticides, particularly if grown as a monoculture. Thus, Food First's term emphasizes that the new seeds 'respond' to these more intensive—and environmentally damaging—agricultural practices.

- 10 pts 8. (a) With respect to the global human economy, what is *overshoot* and how is it caused? Answer in some detail.

Overshoot occurs when the scale of human activities exceeds the limits imposed by the Earth's natural resources—ie, when the 'ecological footprint' of human activity is greater than the 'carrying capacity' of the Earth. Basically that means that the rates of resource extraction and/or waste generation exceed those that can be indefinitely maintained by Earth's ecosystems. However, those limits can be exceeded over the short term; examples of overshoot are: harvesting resources such as timber or fish faster than they can be replenished or generating pollutants, such as atmospheric carbon dioxide, faster than they can be assimilated.

More generally, as explained in *Limits to Growth*, overshoot is caused by three factors: (i) growth in resource demand; (ii) the presence of physical limits to those resources; and (iii) delayed perception and/or action as the limits are being approached. Growth in the pressure on natural resources to support human activities is caused by population growth and increased affluence. The limits are imposed by the finite resources supplied by Earth's ecosystems: a finite availability of renewable and nonrenewable goods and services. Finally, the delay in response to our approach to these limits is due to a number of factors, such as: delayed perception of the nature of value of these limits due to imperfect understanding of the natural world and our effects on it; delayed or nonexistence price signals from economies that only imperfectly reflect the state of our natural resource based; and the lack of political will to implement policy measures to make our activities more sustainable.

- 8 pts (b) According to the authors of *Limits to Growth*, what are the two possibilities following overshoot? Explain each.

The two possibilities are (i) *oscillation* and (ii) *collapse*. By definition, overshoot cannot be maintained indefinitely—ultimately the ecological footprint must decrease to match the capacities of Earth's systems. If the overshoot did not *diminish* the carrying capacity, then our ecological footprint will oscillate and eventually settle at this value. However, there is the possibility that human activities can seriously erode carrying capacity, degrading the rates at which the Earth can supply our resources or assimilate our waste. This would result in a drastic drop—a collapse—in the scale of human activity. This collapse would likely be accompanied by a decrease in population level and/or living quality, such as occurred on a smaller scale on Easter Island.

- 12 pts 9. In the Hydrogen Economy, is hydrogen an energy *source* or an energy *carrier*? Explain your answer in a detail. In your answer, be sure to describe the major sources of hydrogen production.

The Hydrogen Economy is based on the production, distribution and use of elemental hydrogen (H₂) to supply energy. Since elemental hydrogen exists only in trace amounts, it must be produced somehow. This production will require energy. Thus, hydrogen is an *energy carrier*: it essentially 'stores' energy used in its production until the hydrogen is used to generate energy in a fuel cell or by combustion.

The major sources of hydrogen are the fossil fuels (particularly natural gas) and water. The major fossil fuels—oil, natural gas or coal—can all be used as chemical feedstock in elemental hydrogen production. Currently the most economical method of hydrogen production is by the steam reformation of methane, the most abundant component of natural gas. High purity elemental hydrogen can be produced by the electrolysis of water; all that is needed is a source of electricity. The electricity for hydrolysis can be generated by burning fossil fuels (so this is a second way in which fossil fuels can yield hydrogen), by nuclear fission, by water or wind turbines, or from solar energy.

- 12 pts 10. According to Garrett Hardin, why does Adam Smith's 'invisible hand' fail when applied to common pool resources? Answer in some detail.

Garrett Hardin popularized the 'tragedy of the commons' that may occur with free access to common pool resources (CPRs). A CPR is a limited resource to which a large number of people have full and unrestricted access. Use of the resource by any one individual provides him with the benefits of that use, but the cost of that use is shared by all potential users. CPRs are exhaustible resources, unlike 'public goods.'

Adam Smith's 'invisible hand' refers to situations in which individuals act in their own self-interest and the result is a better situation for society as a whole (eg, a Pareto Optimum). However, rational self-interest fails for true CPRs: no matter what the decisions of the other users of the resource, an individual will always be better off by maximizing his or her own use of that resource. Unfortunately, everyone—acting 'rationally'—comes to the same conclusion, so the resource will be overused and ruined.

Hardin illustrated this behavior with the parable of the publicly-owned pasture: every herdsman on the pasture who is guided by self-interest will elect to increase his herd until the pasture is ruined for all. It doesn't even matter if some herdsmen realize the problem: the others will still expand their use of the resource until it is exhausted or ruined. Thus, in such cases, purely rational behavior does NOT lead to a better result for society as a whole.

The tragedy of the commons is often used as an argument for privatization of CPRs (usually by economists) or for strong governmental control of access to CPRs (usually by environmentalists). Hardin referred to this latter option as 'mutual coercion mutually agreed upon.'