Instructions: Please answer all questions in the blue books. You may not use notes, books, or calculators. Please show your work. There are 11 questions, for a total of 100 points. Questions vary in their level of difficulty. Partial credit will be given for partially correct answers. Good luck!

Note: Several of the questions on the test ask you to write essays. Your essays should be short and focused. You will lose points on these essays for including irrelevant information or for going on in an undisciplined fashion. You might want to write out rough drafts of your essays in another exam book.

1.) [2 points] The growth rate of world population right now is
   a) between 1.5% and 2.5% per year.
   b) between 0.5% and 1.5% per year.
   c) between -0.5% and 0.5% per year.

Please write the letter corresponding to your answer in the exam book!

2) [3 points] In a certain country, GDP per capita is growing at 2% per year and population is growing at 1% per year. Energy use is growing at 2% per year. Energy expenditures account for 10% of GDP. At what annual rate is the energy intensity of output growing?

3) [15 points] The quantity of fish in a lake grows according to the equation:

\[ G_t = S_t \times (100 - S_t) \]

Where \( S_t \) is the stock of fish at the beginning of period \( t \) and \( G_t \) is the amount of fish that grows during period \( t \), both measured in tons. Every period, a fraction \( \phi \) of the beginning of period stock is harvested.

A) [10 points] Solve for the value of \( \phi \) that maximizes the harvest in steady state.

B) [5 points] Draw a diagram showing how it is possible for same steady state harvest to result from two different levels of \( \phi \). Indicate which of the two values of \( \phi \) would be "better" from an economic point of view, and briefly explain why.
4) [10 points] A researcher has examined environmental Kuznets curves for a large number of different pollutants. For each pollutant, she has measured the income level corresponding to the peak of the curve. What characteristics of a pollutant are likely to determine the income value corresponding to the peak of the Kuznets curve? We discussed at least one in class, but you should be able to think of more. For each characteristic of the pollutant, you should be sure to say whether it moves the peak toward a higher or lower level of income. Your essay should discuss two or three different characteristics.

5) [10 points] The accompanying diagram shows the Lorenz curve for a certain country. Just in case the figure is unclear, here is a verbal description of it: there are two straight line segments. One goes from the origin to the point (.5, .25). The other goes from the point (.25,.5) to the point (1,1). Average income per capita in the country is $100.

Draw a histogram (or bar chart) showing the distribution of income in the country. The horizontal axis should show income, and the vertical axis should show the fraction of the population in the country that has that income.

6) [10 points] A large quantity of a valuable natural resource is discovered in a poor country. Under what conditions is the presence of this resource likely to lead to rapid economic growth?
7) [10 points] This question asks you to reproduce figure 6.5 from the textbook. Consider two countries, A and B. Country A has higher health and higher income per capita. There are two functions that relate health (h) and income (y): The h(y) function shows how increases in income produce better health. The y(h) function shows how better health produces higher income. The “health view” assumes that differences between countries have their roots in the health environment – that is things other than income that affect health. The “income view” assumes differences between countries have their roots in aspects of production that are unrelated to health. Draw two panels in which the “data” of income and health in countries A and B are the same, but in one of which the h(y) and y(h) curves represent the health view and the other of which the curves represent the income view. Be sure to label which panel is which, and please label the curves as well!

8) [10 points] A newly discovered chapter of the Weil textbook discusses the relationship between a quality called “Factor X” and economic growth. Weil finds excellent data on the average level of Factor X for all the countries in the world.

Weil also finds evidence of how Factor X affects the economy. Specifically, he finds data from experiments in which scientists were able to raise the level of Factor X among the workers of a specific factory. They found that an increase of 10% in the quantity of Factor X that is present among the workers of a firm leads to an increase of 5% in the output produced by that firm.

Looking at a cross-country data on the average level Factor X and GDP per capita, Weil finds that there is no correlation between the two.

A) [5 points] If you look at two countries that are the same in other respects (capital, human capital, technology, institutions, etc.), would you expect the one with higher Factor X to have higher, lower, or the same level of output per capita as the country with lower Factor X?

B) [5 points] You look at two countries with different levels of Factor X. You have no information about how they compare in other dimensions. Do you expect the one with higher Factor X to have a higher, lower, or equal level of output per capita than the one with lower Factor X?
9) [10 points] Consider a Solow model in which there is no technological progress, population growth, or flows of capital between countries. The production function in per capita terms is

\[ y = A k^{\alpha} h^{1-\alpha} \]

Assume that \( \alpha = 1/3 \).

Country X has twice the level of productivity of country Z. The two countries have the same rates of depreciation.

A) [5 points] If the two countries have the same investment rate, what will the ratio of GDP per capita be in steady state?

B) [5 points] If the two countries have the same levels of steady state GDP per capita, what is the ratio of their investment rates?

10) [10 points] Shortly after she takes office in January, 2009, President Hillary Clinton proposes the “pharmaceutical free trade act.” The law mandates that if a pharmaceutical company sells a drug in both the United States and another country, the version of the drug (packaging, labeling, etc.) would have to be identical. Furthermore, there would be no restrictions on the re-import of drugs from other countries to the United States (and vice versa). Discuss the implications of this law for pharmaceutical prices, and for the welfare of US and foreign consumers in the short and long run.

11) [10 points] The textbook discusses how population density might affect growth via culture. Ignoring this channel, discuss some other ways in which the density of population might affect a country’s level of income. To be more concrete, think about two countries with equal populations, one of which has a smaller area than the other. Distinguish between positive and negative channels, and discuss under what circumstances you would expect different ones to be operative. Please do not give a laundry list of every possible channel that might be relevant. You should focus only on reasonably important channels.