1. From 1950 to 2000, GDP per capita in the US grew from $11,921 to $32,629, while GDP per capita in Japan grew from $2216 to $24,772. Compute the annualized growth rate of GDP over this period for each country. Can you explain why Japan’s economy grew faster than that of the US during this period? (Hint: think about diminishing returns to capital.)

\[
\text{US: } (32629/11921)^{\frac{1}{50}} - 1 = 2.034\% \quad (0.02034)
\]

\[
\text{JP: } 4.946\% \quad (0.04946)
\]

Recall that Japan suffered a lot of destruction during WWII, making it likely that the capital stock in Japan was relatively small. Under this condition, the returns to capital would be high in light of the assumption of diminishing returns. Thus, Japan’s production function would likely have shifted up faster than the US’s as capital was accumulated.

2. Consider a primitive society in which population responds positively to the difference between output and the subsistence level of output. Starting from an initial point where the population is stable (i.e. not growing), suppose that the subsistence level of output falls owing to improvements in health care and medical treatment. Explain what happens, and why, to output, labor productivity and population in the short-run and long-run, assuming no capital accumulation or technological advances. Use a graph to illustrate your explanation.

Start from a point where population is stable, so that labor productivity equals subsistence output per person. Improvements in health care and medical treatment that lead a reduction in subsistence output cause the subsistence line to fall (rotate clockwise). Output per person (productivity) will then exceed subsistence per person, so the population will begin to grow. Ultimately, since returns to labor are diminishing, as population grows labor productivity will decline until it once again reaches subsistence levels. At that point, population growth will stop.

3. Over the past few decades, real output in many Asian countries, such as Singapore and Korea, has grown at extraordinarily high rates. Some economists claim that this growth has been caused solely by growth in labor and capital, and not by advances in technology. If these economists are correct, why might we expect this growth not to be sustainable?

Because of diminishing returns to labor and capital, growth in labor productivity owing to increases in these inputs would eventually cease. Continual technological improvements are necessary for sustainable growth.
4. Briefly define the following concepts, and explain how they are related to economic growth: a) the division of labor; and b) human capital.

*Division of labor:* The labor force is divided in its use as an input into production; i.e., individual workers tend to specialize in producing one thing or performing one task. Specialization increases labor productivity because of comparative advantage, and tends to increase the skills of workers. For given resources and technology, the division of labor increases labor productivity by moving the economy to its production frontier.

*Human capital:* Individualized knowledge, skills and abilities inherent in the labor force. This stock of knowledge, skill and ability makes workers more productive. Just as investing in physical capital leads to more production at the cost of current consumption, investment in human capital (education) increases productivity by increasing this stock of knowledge.

5. a) Consider two modern economies (in which the population is stable) that are identical in every respect except that households in economy A save more of their income than households in economy B. How will these economies differ in terms of the level of output, labor productivity, and the growth rates of output and productivity? Explain. b) Now consider countries C and D, both identical except that firms in country C allocate more scarce resources to research and development (which tends to lead to improved production methods) than those in country D. How will these countries differ in terms of the same variables above?

a) Country A saves more than country B, so it will accumulate capital at a faster rate than country B. Thus, country A will likely have higher income and labor productivity than country B. However, ultimately both countries will likely grow at similar rates because of diminishing marginal returns to capital. For example, suppose neither had technological improvements; then, both countries would stop growing eventually (zero growth), but country A would have higher output and productivity.

b) In this case, country C will likely grow faster than country D, even in the long-run.