A. **Multiple Choice Questions.** Circle the letter corresponding to the best answer. (1 points each.)

1. Over the past year, productivity grew 2.0%, the capital stock grew 1.0%, and labor grew 1.0%. If the elasticities of output with respect to capital and labor are 0.2 and 0.8, respectively, how much did output grow?
   - a. 1.0%
   - b. 2.0%
   - **c. 3.0%**
   - d. 4.0%

2. If capital and labor each grow by 5.0% in a year, the elasticities of output with respect to capital and labor sum to one, and productivity grows 2.0% in the year, by how much does output grow during the year?
   - a. 2.0%
   - b. 3.0%
   - c. 5.0%
   - **d. 7.0%**

3. Total factor productivity growth is that part of economic growth due to:
   - b. Capital growth minus labor growth.
   - c. Capital growth multiplied by labor growth.
   - **d. Neither capital growth nor labor growth.**

4. Over the past year, output grew 4.0%, capital grew 2.0%, and labor grew 1.0%. If the elasticities of output with respect to capital and labor are 0.3 and 0.7, respectively, how much did productivity grow?
   - a. 2.0%
   - **b. 2.7%**
   - c. 3.0%
   - d. 3.3%
5. The per-worker production function in the Solow model assumes:
   a. Constant returns to scale and increasing marginal productivity of capital.
   b. Constant returns to scale and diminishing marginal productivity of capital.
   c. Increasing returns to scale and diminishing marginal productivity of capital.
   d. Decreasing returns to scale and diminishing marginal productivity of capital.

6. In a steady state:
   a. Both consumption-per-worker and the capital-to-labor ratio are constant.
   b. Consumption-per-worker is constant but the capital-to-labor ratio can change.
   c. Capital and labor are inversely related to one another by definition.
   d. Consumption-per-worker can change but the capital-to-labor ratio is constant.

7. Steady-state investment-per-worker is positively related to the capital-to-labor ratio because the higher the capital-to-labor ratio:
   a. The lower the capital depreciation rate.
   b. The greater the amount of resources available for capital investment.
   c. The more investment-per-worker is required to replace depreciating capital.
   d. The less the economy needs to equip new workers with the same high level of capital.

8. The Solow model demonstrates that:
   a. In the absence of productivity growth, economic growth will turn negative in the long run.
   b. In the absence of productivity growth, economic growth will reach a steady state of zero per-capita growth in the long run.
   c. Productivity growth must exceed the rate of growth in the population to avoid a steady state in the long run.
   d. Productivity growth will inevitably decline due to diminishing marginal productivity.

9. An earthquake destroys a 20% of the capital stock. How would you expect this to affect the capital-to-labor ratio in the long run? There would be:
   a. A rightward movement along the saving-per-worker curve and an increase in the capital-to-labor ratio.
   b. No change in the long-run capital-to-labor ratio.
   c. A downward shift in the saving-per-worker curve and a decrease in the capital-to-labor ratio.
   d. A leftward movement along the saving-per-worker curve and a decrease in the capital-to-labor ratio.

10. An increase in the saving rate in a steady-state economy would cause:
    a. A rightward movement along the saving-per-worker curve and an increase in the capital-to-labor ratio.
    b. An upward shift in the saving-per-worker curve and an increase in the capital-to-labor ratio.
    c. A downward shift in the saving-per-worker curve and an increase in the capital-to-labor ratio.
    d. A leftward movement along the saving-per-worker curve and a decrease in the capital-to-labor ratio.
B. Answer BOTH of the following questions in the space below. (10 points each.)

1. **Solow Growth Model.** Between 1950 and 1975, France experienced economic growth rates that were 2 percentage points faster than those in the United States despite a slower labor force growth rate. Both countries had the same production function, saving rate, depreciation rate, and rate of technological change.

   a. Based only on this information, use a single Solow Growth Model diagram to clearly and accurately show how this could happen.
b. Provide a brief economic explanation of what you have shown in your diagram above.

The U.S. and France have the same production function, saving rate, depreciation rate, and rate of technological change so in a Solow Model diagram they will share a common production function and saving function. However, because France has slower labor force growth than the U.S., the French balanced investment line is flatter than the U.S. balanced investment line.

France’s steady state at $A_F$ is at a higher capital-to-labor ratio than is the U.S.’s steady state at $A_{US}$. Consequently, if both France and the U.S. were at their steady states, income-per-worker in France would be higher than in the U.S., i.e., $(Y/N)_F > (Y/N)_{US}$.

In addition, if France and the U.S. were at their steady states, then their respective rates of economic growth would be equal to their respective rates of labor force growth and France would be growing more slowly than the U.S., i.e., $(\Delta Y/Y)_F = (\Delta N/N)_F < (\Delta Y/Y)_{US} = (\Delta N/N)_{US}$.

Therefore, if France is indeed growing faster than the U.S., i.e., if $(\Delta Y/Y)_F > (\Delta Y/Y)_{US}$, it must be because France is in a transition period with an initial capital-to-labor ratio below its steady state level, e.g., $(K/N)_{F1} < (K/N)_{F}$. The U.S. may also be below its steady state capital-to-labor ratio but France would have to be further below its steady state capital-to-labor ratio than the U.S. is below its steady state capital-to-labor ratio.

This is likely the case because a large part of France’s capital stock was destroyed during World War 2.
2. **Solow Growth Model.** In 1990, the Iraqi economy was operating at its potential level. However, as a consequence of the Gulf War in 1991, a substantial portion of Iraq’s capital stock was destroyed. In addition, the imposition of U.N. sanctions made it much more difficult to import spare parts for the repair and maintenance of its capital equipment, causing depreciations rates to increase. The war had a much larger effect on Iraq’s capital stock than did the sanctions.

   a. Based only on this information, use a Solow Growth Model diagram to clearly and accurately show:

   1. Iraq’s initial economic situation in 1990.

   2. The effects these 2 events had on Iraq’s capital-to-labor ratio and its level of income-per-worker.

   3. Iraq’s initial and final steady states.
b. Provide a brief economic explanation of the changes you showed in your diagram above as well as any adjustment process that occurs during the transition period from Iraq’s initial situation to its final steady state. Be sure to discuss what happens to the level of income-per-worker and to the rate of economic growth during both the transition period and at the long-run equilibriums.

Iraq was initially at steady state A in 1990 with a capital-to-labor ratio at \((K/N)_A\) and income-per-worker at \((Y/N)_A\). The rate of economic growth would be equal to the rate of labor force growth, i.e., \(\Delta Y/Y = \Delta N/N\).

Two separate events happened in 1991.

First, the war destroyed some of Iraq’s capital stock. This would immediately lower Iraq’s actual capital-to-labor ratio from \((K/N)_A\) to \((K/N)_1\) and reduce its actual income-per-worker from \((Y/N)_A\) to \((Y/N)_1\) as the economy moved down along its production function.

Second, the U.N. economic sanctions increased the depreciation rate of Iraq’s capital stock, rotating the balanced investment line up from \((I_b/N)_0\) to \((I_b/N)_1\). This reduces the equilibrium capital-to-labor ratio from \((K/N)_A\) to \((K/N)_B\). In turn, Iraq’s equilibrium income-per-worker would be reduced from \((Y/N)_A\) to \((Y/N)_B\).

Because the war had a much larger effect on Iraq’s capital stock than did the sanctions, the actual capital-to-labor ratio is below the new, lower, equilibrium capital-to-labor ratio, i.e., \((K/N)_1 < (K/N)_B\).

The economy is actually at a capital-to-labor ratio of \((K/N)_1\). At this capital-to-labor ratio, actual saving-per-worker and actual investment-per-worker are greater than balanced investment-per-worker, i.e., \(S/N = I/N > I_b/N\). Thus, the economy is actually investing more than is necessary to keep the capital-to-labor ratio constant. As a result, the capital-to-labor ratio will increase. This will continue until the capital-to-labor ratio has risen to \((K/N)_B\) where \(S/N = I_b/N\). At \((K/N)_B\), income-per-worker will be \((Y/N)_B\).

During this transition period when the capital-to-labor ratio is rising, income-per-worker is also increasing along the production function. This means that income growth is greater than labor force growth, i.e., \(\Delta Y/Y > \Delta N/N\).

In the long-run, however, when the economy has achieved its new steady state at \(B\), economic growth will be equal to labor force growth, i.e., \((\Delta Y/Y)_B = (\Delta N/N)_A\). Because labor force growth has not changed, this is the same rate of economic growth that existed at steady state \(A\), i.e., \((\Delta Y/Y)_B = (\Delta Y/Y)_A\).