a. If the Fed reduces the money supply, then the aggregate demand curve shifts down, as in Figure 9–8. This result is based on the quantity equation $MV = PY$, which tells us that a decrease in money $M$ leads to a proportionate decrease in nominal output $PY$ (assuming that velocity $V$ is fixed). For any given price level $P$, the level of output $Y$ is lower, and for any given $Y$, $P$ is lower.

![Figure 9–8](image)

b. In the short run, we assume that the price level is fixed and that the aggregate supply curve is flat. As Figure 9–9 shows, in the short run, the leftward shift in the aggregate demand curve leads to a movement from point A to point B—output falls but the price level doesn't change. In the long run, prices are flexible. As prices fall, the economy returns to full employment at point C.

If we assume that velocity is constant, we can quantify the effect of the 5-percent reduction in the money supply. Recall from Chapter 4 that we can express the quantity equation in terms of percentage changes:

$$\%\Delta in M + \%\Delta in V = \%\Delta in P + \%\Delta in Y.$$  

If we assume that velocity is constant, then the $\%\Delta$ in $V = 0$. Therefore,

$$\%\Delta in M = \%\Delta in P + \%\Delta in Y.$$  

We know that in the short run, the price level is fixed. This implies that the $\%\Delta$ in $P = 0$. Therefore,

$$\%\Delta in M = \%\Delta in Y.$$  

Based on this equation, we conclude that in the short run a 5-percent reduction in the money supply leads to a 5-percent reduction in output. This is shown in Figure 9–9.
In the long run we know that prices are flexible and the economy returns to its natural rate of output. This implies that in the long run, the $\%\Delta$ in $Y = 0$. Therefore,

$$\%\Delta \text{ in } M = \%\Delta \text{ in } P.$$ 

Based on this equation, we conclude that in the long run a 5-percent reduction in the money supply leads to a 5-percent reduction in the price level, as shown in Figure 9–9.

c. Okun’s law refers to the negative relationship that exists between unemployment and real GDP. Okun’s law can be summarized by the equation:

$$\%\Delta \text{ in Real GDP} = 3\% - 2 \times [\Delta \text{ in Unemployment Rate}].$$

That is, output moves in the opposite direction from unemployment, with a ratio of 2 to 1. In the short run, when output falls, unemployment rises. Quantitatively, if velocity is constant, we found that output falls 5 percentage points relative to full employment in the short run. Okun’s law states that output growth equals the full employment growth rate of 3 percent minus two times the change in the unemployment rate. Therefore, if output falls 5 percentage points relative to full-employment growth, then actual output growth is −2 percent. Using Okun’s law, we find that the change in the unemployment rate equals 2.5 percentage points:

$$-2 = 3 - 2 \times [\Delta \text{ in Unemployment Rate}]$$

$$[-2 - 3]/[-2] = [\Delta \text{ in Unemployment Rate}]$$

$$2.5 = [\Delta \text{ in Unemployment Rate}]$$

In the long run, both output and unemployment return to their natural rate levels. Thus, there is no long-run change in unemployment.
d. The national income accounts identity tells us that saving $S = Y - C - G$. Thus, when $Y$ falls, $S$ falls (assuming the marginal propensity to consume is less than one). Figure 9–10 shows that this causes the real interest rate to rise. When $Y$ returns to its original equilibrium level, so does the real interest rate.

\[
\begin{align*}
&\text{Figure 9–10} \\
&\text{Real interest rate} \\
&\text{Investment, Saving} \\
&I(r) \\
&S_2 \quad S_1 \\
&r_2 \quad r_1
\end{align*}
\]

2. a. Total planned expenditure is

\[PE = C(Y - T) + I + G.\]

Plugging in the consumption function and the values for investment $I$, government purchases $G$, and taxes $T$ given in the question, total planned expenditure $PE$ is

\[PE = 200 + 0.75(Y - 100) + 100 + 100 = 0.75Y + 325.\]

This equation is graphed in Figure 10–8.

\[
\begin{align*}
&\text{Figure 10–8} \\
&PE \\
&PE = 0.75Y + 325 \\
&Y = PE
\end{align*}
\]

Income, output

3

\[
\begin{align*}
&Y^* = 1,300 \\
&Y
\end{align*}
\]
b. To find the equilibrium level of income, combine the planned-expenditure equation derived in part (a) with the equilibrium condition \( Y = PE \):

\[
Y = 0.75Y + 325 \\
Y = 1,300.
\]

The equilibrium level of income is 1,300, as indicated in Figure 10–8.

c. If government purchases increase to 125, then planned expenditure changes to \( PE = 0.75Y + 350 \). Equilibrium income increases to \( Y = 1,400 \). Therefore, an increase in government purchases of 25 (i.e., \( 125 - 100 = 25 \)) increases income by 100. This is what we expect to find, because the formula for the government-purchases multiplier is \( 1/(1 - MPC) \), the \( MPC \) is 0.75, and the government-purchases multiplier therefore has a numerical value of 4.

d. An income level of 1,600 represents an increase of 300 over the original level of income. The government-purchases multiplier is \( 1/(1 - MPC) \): the \( MPC \) in this example equals 0.75, so the government-purchases multiplier is 4. This means that government purchases must increase by 75 (to a level of 175) for income to increase by 300.

3. a. When taxes do not depend on income, a one-dollar increase in income means that disposable income increases by one dollar. Consumption increases by the marginal propensity to consume \( MPC \). When taxes do depend on income, a one-dollar increase in income means that disposable income increases by only \( (1 - t) \) dollars. Consumption increases by the product of the \( MPC \) and the change in disposable income, or \( (1 - t)MPC \). This is less than the \( MPC \). The key point is that disposable income changes by less than total income, so the effect on consumption is smaller.

b. When taxes are fixed, we know that \( \Delta Y/\Delta G = 1/(1 - MPC) \). We found this by considering an increase in government purchases of \( \Delta G \); the initial effect of this change is to increase income by \( \Delta G \). This in turn increases consumption by an amount equal to the marginal propensity to consume times the change in income, \( MPC \times \Delta G \). This increase in consumption raises expenditure and income even further. The process continues indefinitely, and we derive the multiplier above.

When taxes depend on income, we know that the increase of \( \Delta G \) increases total income by \( \Delta G \); disposable income, however, increases by only \( (1 - t) \Delta G \)—less than dollar for dollar. Consumption then increases by an amount \( (1 - t)MPC \times \Delta G \). Expenditure and income increase by this amount, which in turn causes consumption to increase even more. The process continues, and the total change in output is

\[
\Delta Y = \Delta G \left[ 1 + (1 - t)MPC + [(1 - t)MPC]^2 + [(1 - t)MPC]^3 + \ldots \right] \\
= \Delta G \left[ 1/(1 - (1 - t)MPC) \right].
\]

Thus, the government-purchases multiplier becomes \( 1/(1 - (1 - t)MPC) \) rather than \( 1/(1 - MPC) \). This means a much smaller multiplier. For example, if the marginal propensity to consume \( MPC \) is 3/4 and the tax rate \( t \) is 1/3, then the multiplier falls from \( 1/(1 - 3/4) \), or 4, to \( 1/(1 - (1 - 1/3)(3/4)) \), or 2.