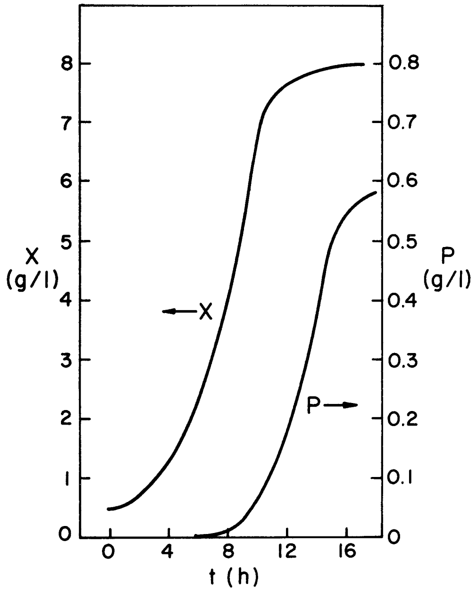

Figure 9.4. Data for Example 9.2. Data are for the production of a secondary product in batch culture.

Solution The first step in using either graphical approach is to differentiate the data in the batch growth curve to yield *dX/dt* and *dP/dt*. The differentiation of experimental data can magnify errors present in the original data, so the values of *dX/dt* and *dP/dt* must be interpreted cautiously.

For the graphical approach illustrated in Fig. 9.5, we have plotted $1/(dX/dt)$ versus X and $1/(dP/dt)$ versus P, which corresponds to eqs. 9.24b and 9.26b. For $\theta_1 = 7$ h (that is, 700 1/100 1/h), we must determine what value of X_1 will satisfy

$$\theta_1 = (X_1 - X_0)\left(\frac{1}{dX/dt}\right)\bigg|_{X_1}$$

or

$$7 \text{ h} = X_1\left(\frac{1}{dX/dt}\right)\bigg|_{X_1}$$

Since a sterile feed is to be used, $X_0 = 0$.

By trial and error, we find on the graph that $X_1 = 7.2$ g/l corresponds to $1/(dX_1/dt) = 0.95$ h/g/l or 7.2 g/l · 0.95 h/g/l = 6.84 h.

Given the accuracy with which Fig. 9.5 can be read, this is an acceptable solution. The product concentration that corresponds to $X_1 = 7.2$ g/l is determined from the batch growth curve. As illustrated, $X_1 = 7.2$ g/l is achieved at 9.4 h after inoculation; at the same time, the value for P_1 is 0.08 g/l.

The effect of the second stage on the process is determined by using eq. 9.26b and noting that again $\theta_2 = 7$ h. Thus,