2. National Insurance Associates carries an investment portfolio of a variety of stocks, bonds, and other investment alternatives. Currently $200,000 of funds from a new client are available and must be used for new investment opportunities. The four stocks that National is considering for this client and the relevant financial data are as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Stock | Acme | Bravo | Centaur | Delta |
| Price per share | $100 | $50 | $80 | $40 |
| Annual rate of return | 0.11 | 0.09 | 0.08 | 0.10 |
|  beta  | 1.6 | 1.3 | 1.0 | 1.5 |

 Beta is a measure of risk of a stock. Typically, a high beta indicates that the return on a stock is volatile. Thus, a low beta is desirable. The beta for a portfolio of stocks is computed by multiplying the beta for each stock by the dollars invested in that stock, adding these together and dividing by the total dollars invested. For example, if $50,000 were put into each of the four stocks, the beta for the portfolio would be:

***Total beta*** *for portfolio =1.6(50,000) + 1.3(50,000) + 1.0(50,000) + 1.5(50,000) = 270,000*

***Average beta (or simply beta)***  *= 270,000/200,000 = 1.35*

National's top management has stipulated the following investment guidelines:

 1. The annual rate of return for the portfolio must be at least 9%.

 2. No one stock can account for more than $80,000

Linear programming is to be used to develop an investment portfolio that minimizes risk.

a) Carefully define the decision variables.

b) Set up the linear program.

c) Suppose one additional restriction is placed on the problem: The number of shares of stocks Bravo and Centaur (combined) must be no more than 50% of the number of shares of stocks Acme and Delta (combined). How would the linear program be changed if this restriction were added? Be specific.