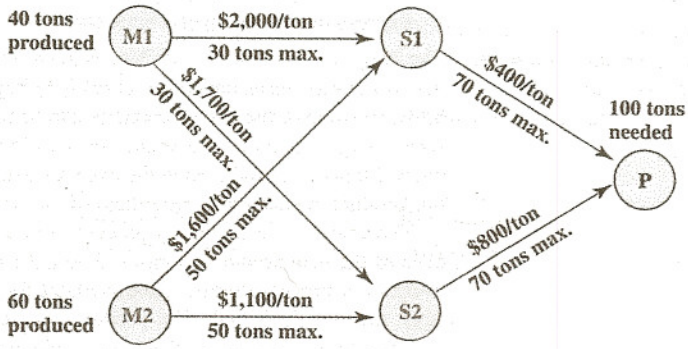
A decision now needs to be made about the shipping plan for how many units to ship from each factory to each customer.

*a.* Which category of linear programming problem does this problem fit? Why?

E* *b.* Formulate and solve a linear programming model for this problem on a spreadsheet.

*c.* Summarize this formulation in algebraic form.

4.16. The Fagersta Steelworks currently is working two mines to obtain its iron ore. This iron ore is shipped to either of two storage facilities. When needed, it then is shipped on to the company's steel plant. The diagram below depicts this distribution network, where M1 and M2 are the two mines, S1 and S2 are the two storage facilities, and P is the steel plant. The diagram also shows the monthly amounts produced at the mines and needed at the plant, as well as the shipping cost and the maximum amount that can be shipped per month through each shipping lane.




Management now wants to determine the most economical plan for shipping the iron ore from the mines through the distribution network to the steel plant.

*a.* Identify all the requirements that will need to be expressed in fixed-requirement constraints.

E* *b.* Formulate and solve a linear programming model for this problem on a spreadsheet.

*c.* Express this model in algebraic form.

4.17.* Al Ferris has $60,000 that he wishes to invest now in order to use the accumulation for purchasing a retirement annuity in five years. After consulting with his financial advisor, he has been offered four types of fixed-income investments, which we will label as investments *A*, *B*, *C*, and *D*.

Investments *A* and *B* are available at the beginning of each of the next five years (call them years 1 to 5). Each dollar invested in *A* at the beginning of a year returns $1.40 (a profit of $0.40) two years later (in time for immediate reinvestment). Each dollar invested in *B* at the beginning of a year returns $1.70 three years later.

Investments *C* and *D* will each be available at one time in the future. Each dollar invested in *C* at the beginning of year 2 returns $1.90 at the end of year 5. Each dollar invested in *D* at the beginning of year 5 returns $1.30 at the end of year 5.

Al wishes to know which investment plan maximizes the amount of money that can be accumulated by the beginning of year 6.

*a.* Although this is not a distribution-network problem, all its functional constraints can be expressed as fixed-requirement constraints. To do this, let $A_t$, $B_t$, $C_t$, and $D_t$ be the amounts invested in investments *A*, *B*, *C*, and *D*, respectively, at the beginning of year $t$ for each $t$ where the investment is available and will mature by the end of year 5. Also let $R_t$ be the number of available dollars *not* invested at the beginning of year $t$ (and so available for investment in a later year). Thus, the amount invested at the beginning of year $t$ *plus* $R_t$ must equal the number of dollars available for investment at that time. Write such an equation in terms of the relevant variables above for the beginning of each of the five years to obtain the five fixed-requirement constraints for this problem.

*b.* Formulate a complete linear programming model for this problem in algebraic form.

E* *c.* Formulate and solve this model on a spreadsheet.

4.18. The Metalco Company desires to blend a new alloy of 40 percent tin, 35 percent zinc, and 25 percent lead from several available alloys having the following properties: