Cargo Loading

You are in charge of loading cargo ships for an International Cargo Company (ICC) at a major East Coast port. You have been asked to prepare a loading plan for an ICC freighter bound for Africa. An agricultural commodities dealer would like to transport the following products aboard this ship:

Commodity	Tons Available	Volume per Ton (cu.ft.)	Profit per Ton ($)
1	4,000	40	70
2	3,000	25	50
3	2,000	60	60
4	1,000	50	80

You can elect to load any or all of the available commodities. However, the ship has three cargo holds with the following capacity restrictions:

Cargo Hold	Weight Capacity (tons)	Volume Capacity (cu.ft.)
Forward	3,000	100,000
Center	5,000	150,000
Rear	2,000	120,000

More than one type of commodity can be placed in the same cargo hold. However, because of balance considerations, the weight in the forward cargo hold must be within 10 percent of the weight in the rear cargo hold, and the center cargo hold must be between 40 percent and 60 percent of the total weight on board.

a. Determine a profit-maximizing loading plan for the commodities. What is the maximum profit and the loading plan that achieves it?

b. Suppose each one of the cargo holds could be expanded. Which holds and which forms of expansion (weight or volume) would allow ICC to increase its profits on this trip, and what is the marginal value of each form of expansion?