Ken & Larry Ice Cream

from Intro to O.R. by Hillier & Lieberman (7th ed) p. 296

Ken and Larry, Inc., supplies its ice cream parlors with three flavors of ice cream: **chocolate**, **vanilla**, and **banana**.

Because of extremely hot weather and a high demand for its products, the company has run short of its supply of ingredients: **milk**, **sugar**, & **cream**. Hence, they will not be able to fill all the orders received from their retail outlets, the ice cream parlors.

Owing to these circumstances, the company has decided to choose the amount of each product to produce that will maximize total profit, given the constraints on supply of the basic ingredients.

	Chocolate	Vanilla	Banana	Available
Milk	0.45	0.5	0.4	200 gallons
Sugar	0.5	0.4	0.4	150 pounds
Cream	01	0.15	0.2	60 gallons
Profit $/gal.	1.00	0.90	0.95	

The LP formulation for this problem has variables **C**, **V**, and **B** representing gallons of chocolate, vanilla, and banana ice cream produced, respectively.

```
MAXIMIZE  C+0.9V+0.95B
ST
    0.45C + 0.50V + 0.40B <= 200  ! milk
    0.50C + 0.40V + 0.40B <= 150  ! sugar
    0.10C + 0.15V + 0.20B <= 60   ! cream
END
```

LINDO model

```
        OBJECTIVE FUNCTION VALUE
        1)      341.2500

  VARIABLE        VALUE          REDUCED COST
         C         0.000000          0.037500
         V       300.000000          0.000000
         B        75.000000          0.000000

       ROW   SLACK OR SURPLUS     DUAL PRICES
         2)        20.000000          0.000000
         3)         0.000000          1.875000
         4)         0.000000          1.000000
```

RANGES IN WHICH THE BASIS IS UNCHANGED:

OBJ COEFFICIENT RANGES

VARIABLE	CURRENT COEF	ALLOWABLE INCREASE	ALLOWABLE DECREASE
C	1.000000	0.037500	INFINITY
V	0.900000	0.050000	0.012500
B	0.950000	0.021429	0.050000

RIGHTHAND SIDE RANGES

ROW	CURRENT RHS	ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	200.000000	INFINITY	20.000000
3	150.000000	10.000000	30.000000
4	60.000000	15.000000	3.750000

a. What is the optimal profit and the optimal solution?

b. Suppose the profit per gallon of banana changes to $1.00. Will the optimal solution change, and what can be said about the effect on total profit?

c. Suppose the profit per gallon of banana changes to 92 cents. Will the optimal solution changes, and what can be said about the effect on total profit?

d. Suppose the company discovers that 3 gallons of cream have gone sour and so must be thrown out. Will the optimal solution change, and what can be said about the effect on the total profit?

e. Suppose that the company has the opportunity to buy an additional 15 pounds of sugar at a total cost of $15. Should they buy it? Explain!

THE TABLEAU

ROW	BASIS	C	V	B	SLK 2	SLK 3	SLK 4	
1	ART	0.038	0.00	0.00	0.00	1.875	1.000	341.250
2	SLK 2	-0.350	0.00	0.00	1.00	-2.000	2.000	20.000
3	V	3.000	1.00	0.00	0.00	10.000	-20.000	300.000
4	B	-1.750	0.00	1.00	0.00	-7.500	20.000	75.000

Chocolate ice cream is not included in the optimal production plan. If one gallon of chocolate ice cream were to be produced, how would it change the quantity

…of vanilla ice cream produced?
…of banana ice cream produced?
…of milk used?
…of sugar used?
…of cream used?

(use substitution rates in the tableau!)

In (d), you were asked about the effect on profit of a reduction in the quantity of available cream due to spoilage. That is, the effect of an increase in the unused cream (slack in the available cream constraint). According to the substitution rates in the tableau, what would be the effect of this spoilage on the quantity

…of vanilla ice cream produced?

…of banana ice cream produced?

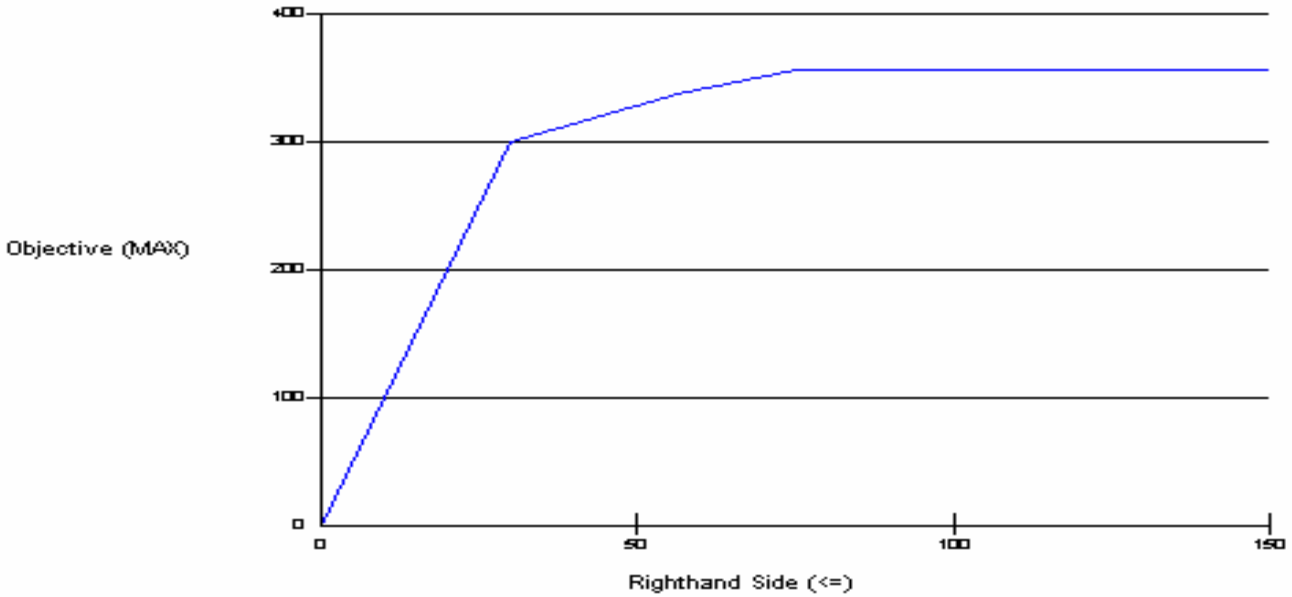
…of milk used?

…of sugar used?

The right-hand-side of row #4 (available cream) was changed to zero, and then parametric analysis performed with the right-hand-side increasing to 150 gallons, with the results below.

RIGHTHANDSIDE PARAMETRICS REPORT FOR ROW: 4

VAR OUT		VAR IN	PIVOT ROW	RHS VAL	DUAL PRICE BEFORE PIVOT	OBJ VAL
				0.0000	10.0000	0.000
SLK	3		V 4	30.0000	10.0000	300.000
	C		B 3	56.2500	1.42857	337.500
	V	SLK	4 4	75.0000	1.00000	356.250
				150.000	0.0000	356.250



Using LINDO's report, indicate on the graph above the slope of each linear segment and the coordinates of each break-point (profit & gallons of cream).