pg. 120 6. x_4 enters. θ-ratios are $\frac{5}{2}$ (for x_3), $\frac{5}{2}$ (for x_2), and 3 (for x_5). There is a choice of exiting variables.

If x_3 exits:

	x_1	x_2	x_3	x_4	x_5	
x_4	$\frac{10}{9}$	0	$\frac{5}{3}$	1	0	$\frac{5}{2}$
x_2	$\frac{7}{18}$	1	$-\frac{5}{3}$	0	0	0
x_5	$\frac{385}{81}$	0	$-\frac{10}{27}$	0	1	$\frac{1}{9}$
	$\frac{86}{9}$	0	$\frac{25}{3}$	0	0	$\frac{89}{6}$

If x_2 exits:

	x_1	x_2	x_3	x_4	x_5	
x_3	$-\frac{7}{30}$	$-\frac{3}{5}$	1	0	0	0
x_4	$\frac{3}{2}$	1	0	1	0	$\frac{5}{2}$
x_5	$\frac{14}{3}$	$-\frac{2}{9}$	0	0	1	$\frac{1}{9}$
	$\frac{23}{2}$	5	0	0	0	$\frac{89}{6}$

Both tableaux satisfy the optimality criterion and both indicate that the solution

$x_1 = 0$, $x_2 = 0$, $x_3 = 0$, $x_4 = \frac{5}{2}$, $x_5 = \frac{1}{9}$ is optimal.

pg. 120 8. The row labels of this tableau (in proper order) are x_5, x_6, x_1. After x_2 enters and x_5 exits we get tableau (2):

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	
x_2	0	1	$\frac{1}{2}$	0	$\frac{3}{4}$	0	$-\frac{1}{4}$	3
x_6	0	0	$\frac{1}{2}$	1	$-\frac{1}{4}$	1	$-\frac{1}{4}$	9
x_1	1	0	0	$\frac{1}{2}$	$-\frac{1}{4}$	0	$\frac{1}{4}$	3
	0	0	$-\frac{1}{2}$	-1	$\frac{5}{4}$	0	$\frac{5}{4}$	17

Tableau (3):

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	
x_2	0	1	$\frac{1}{2}$	0	$\frac{3}{4}$	0	$-\frac{1}{4}$	3
x_6	-2	0	$\frac{1}{2}$	0	$\frac{1}{4}$	1	$-\frac{3}{4}$	3
x_4	2	0	0	1	$-\frac{1}{2}$	0	$\frac{1}{2}$	6
	2	0	$-\frac{1}{2}$	0	$\frac{3}{4}$	0	$\frac{7}{4}$	23

pg. 120 8. (continued) x_3 enters. Again there is a choice of exiting variable. If x_2 exits, we get:

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	
x_3	0	2	1	0	$\frac{3}{2}$	0	$-\frac{1}{2}$	6
x_6	-2	-1	0	0	$-\frac{1}{2}$	1	$-\frac{1}{2}$	0
x_4	2	0	0	1	$-\frac{1}{2}$	0	$\frac{1}{2}$	6
	2	1	0	0	$\frac{3}{2}$	0	$\frac{3}{2}$	26

If, starting from tableau (3), x_3 enters and x_6 exits, we get:

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	
x_2	2	1	0	0	$\frac{1}{2}$	-1	$\frac{1}{2}$	0
x_3	-4	0	1	0	$\frac{1}{2}$	2	$-\frac{3}{2}$	6
x_4	2	0	0	1	$-\frac{1}{2}$	0	$\frac{1}{2}$	6
	0	0	0	0	1	1	1	26

Both of these indicate that
$x_1 = 0,\ x_2 = 0,\ x_3 = 6,\ x_4 = 6,\ x_5 = 0,\ x_6 = 0,\ x_7 = 0$ is optimal.

pg. 121 14. The canonical problem on page 2 of the solutions to problem set 2, in tableau form, is Tableau (1):

	x_1	x_2	x_3	x_4	x_5	x_6	
x_4	1	1	1	1	0	0	12
x_5	3	3	1	0	1	0	24
x_6	6	4	3	0	0	1	60
	-4	-3	-2	0	0	0	0

Tableau (2):

	x_1	x_2	x_3	x_4	x_5	x_6	
x_4	0	0	$\frac{2}{3}$	1	$-\frac{1}{3}$	0	4
x_1	1	1	$\frac{1}{3}$	0	$\frac{1}{3}$	0	8
x_6	0	-2	1	0	-2	1	12
	0	1	$-\frac{2}{3}$	0	$\frac{4}{3}$	0	32

Tableau (3)

	x_1	x_2	x_3	x_4	x_5	x_6	
x_3	0	0	1	$\frac{3}{2}$	$-\frac{1}{2}$	0	6
x_1	1	1	0	$-\frac{1}{2}$	$\frac{1}{2}$	0	6
x_6	0	-2	0	$-\frac{3}{2}$	$-\frac{3}{2}$	1	6
	0	1	0	1	1	0	36

The farmer should plant 6 acres of corn and 6 acres of oats.

pg. 121 16. After introducing slack variables x_4 and x_5 into the standard problem on page 410 of Kolman and Beck, we arrive at tableau 1 :

	x_1	x_2	x_3	x_4	x_5	
x_4	4	4	2	1	0	80
x_5	2	3	2	0	1	50
	-300	-500	-400	0	0	0

Tableau 2 :

	x_1	x_2	x_3	x_4	x_5	
x_4	$\frac{4}{3}$	0	$-\frac{2}{3}$	1	$-\frac{4}{3}$	$\frac{40}{3}$
x_2	$\frac{2}{3}$	1	$\frac{2}{3}$	0	$\frac{1}{3}$	$\frac{50}{3}$
	$\frac{100}{3}$	0	$-\frac{200}{3}$	0	$\frac{500}{3}$	$\frac{25000}{3}$

Tableau 3

	x_1	x_2	x_3	x_4	x_5	
x_4	2	1	0	1	-1	30
x_3	1	$\frac{3}{2}$	1	0	$\frac{1}{2}$	25
	100	100	0	0	200	10000

pg. 121 19. x_4 and x_5 are slack variables.

Tableau 1

	x_1	x_2	x_3	x_4	x_5	
x_4	1	2	-1	1	0	6
x_5	1	-3	-3	0	1	10
	-2	-3	1	0	0	0

Tableau 2

	x_1	x_2	x_3	x_4	x_5	
x_2	$\frac{1}{2}$	1	$-\frac{1}{2}$	$\frac{1}{2}$	0	3
x_5	$\frac{5}{2}$	0	$-\frac{9}{2}$	$\frac{3}{2}$	1	19
	$-\frac{1}{2}$	0	$-\frac{1}{2}$	$\frac{3}{2}$	0	9

Due to the non-positive coefficients in the x_3 column and x_2, x_5 rows, x_3 may increase to an arbitrarily large value without ever being blocked by a constraint. That is, given any $M \geq 0$: $x_1 = 0$, $x_2 = 3 + \frac{1}{2}M$, $x_3 = M$, $x_4 = 0$, $x_5 = 19 + \frac{9}{2}M$ is a feasible solution (although if $M > 0$, it is not basic). And due to the negative coefficient in the x_3 column and objective row, the objective value may be made arbitrarily large by choosing a sufficiently large value of M. When $x_1 = 0$, $x_2 = 3 + \frac{1}{2}M$, $x_3 = M$, we have $z = 2x_1 + 3x_2 - x_3 = 9 + \frac{1}{2}M$. This problem is therefore unbounded above.

pg. 122 22. x_4 and x_5 are slack variables.

In tableau form the problem is:

	x_1	x_2	x_3	x_4	x_5	
x_4	-1	2	-7	1	0	6
x_5	1	1	-3	0	1	15
	1	-3	-1	0	0	0

It is not necessary to follow the usual procedure of looking for an optimal solution by entering x_2 and exiting x_4. Examination of the x_3 column shows that the problem is unbounded above. Referring to the standard problem given in Kolman and Beck, $x_1 = 0$, $x_2 = 0$, $x_3 = M$ is feasible for any $M \geq 0$ and the objective value at this point is $-x_1 + 3x_2 + x_3 = M$.

pg. 122 23. x_5, x_6, and x_7 are slack variables.

Tableau 1

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	
x_5	2	-1	-1	1	1	0	0	2
x_6	1	-1	1	-1	0	1	0	5
x_7	3	1	0	5	0	0	1	12
	-3	-3	1	-1	0	0	0	0

Tableau 2

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	
x_5	5	0	-1	6	1	0	1	14
x_6	4	0	1	4	0	1	1	17
x_2	3	1	0	5	0	0	1	12
	6	0	1	14	0	0	3	36

$\underbrace{-3 \quad -3}$ a choice of entering variables. x_2 was arbitrarily chosen to enter

pg. 131 6. x_3, x_4, x_5 are slack variables.

Tableau 1

	x_1	x_2	x_3	x_4	x_5	
x_3	2	1	1	0	0	6
x_4	-2	1	0	1	0	0
x_5	1	-1	0	0	1	0
	-5	-3	0	0	0	0

Tableau 2

	x_1	x_2	x_3	x_4	x_5	
x_3	0	3	1	0	-2	6
x_4	0	-1	0	1	2	0
x_1	1	-1	0	0	1	0
	0	-8	0	0	5	0

pg. 131 6. (cont'd)

Tableau 3

	x_1	x_2	x_3	x_4	x_5	
x_2	0	1	$\frac{1}{3}$	0	$-\frac{2}{3}$	2
x_4	0	0	$-\frac{1}{3}$	1	$\frac{4}{3}$	2
x_1	1	0	$\frac{1}{3}$	0	$\frac{1}{3}$	2
	0	0	$\frac{2}{3}$	0	$-\frac{1}{3}$	16

Tableau 4

	x_1	x_2	x_3	x_4	x_5	
x_2	0	1	$\frac{1}{2}$	$\frac{1}{2}$	0	3
x_5	0	0	$-\frac{1}{4}$	$\frac{3}{4}$	1	$\frac{3}{2}$
x_1	1	0	$\frac{1}{4}$	$-\frac{1}{4}$	0	$\frac{3}{2}$
	0	0	$\frac{1}{4}$	$\frac{1}{4}$	0	$\frac{33}{2}$