

MAX 5000 X1 + 4000 X2
 SUBJECT TO
 2) 10 X1 + 15 X2 <= 150
 3) 20 X1 + 10 X2 <= 160
 4) 30 X1 + 10 X2 >= 135
 END

LP OPTIMUM FOUND AT STEP 2

OBJECTIVE FUNCTION VALUE

1) 50500.00

VARIABLE	VALUE	REDUCED COST
X1	4.500000	0.000000
X2	7.000000	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	150.000000
3)	0.000000	175.000000
4)	70.000000	0.000000

NO. ITERATIONS= 2

RANGES IN WHICH THE BASIS IS UNCHANGED:

VARIABLE	CURRENT COEF	OBJ COEFFICIENT RANGES	
		ALLOWABLE INCREASE	ALLOWABLE DECREASE
X1	5000.000000	3000.000000	2333.333252
X2	4000.000000	3500.000000	1500.000000

ROW	CURRENT RHS	RIGHTHAND SIDE RANGES	
		ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	150.000000	90.000000	70.000000
3	160.000000	140.000000	40.000000
4	135.000000	70.000000	INFINITY

THE TABLEAU

ROW (BASIS)	X1	X2	SLK 2	SLK 3	SLK 4	
1 ART	0.000	0.000	150.000	175.000	0.000	50500.000
2 X2	0.000	1.000	0.100	-0.050	0.000	7.000
3 X1	1.000	0.000	-0.050	0.075	0.000	4.500
4 SLK 4	0.000	0.000	-0.500	1.750	1.000	70.000

MAX 30 X1 - 10 X2 + 20 X3 - 8 X4
 SUBJECT TO
 2) X1 - 2 X2 + 4 X3 + X4 <= 7
 3) - 4 X1 + X2 - 3 X3 + 2 X4 >= 3
 4) - 2 X1 - X3 + X4 = 1
 5) X1 + 2 X2 + 3 X3 + X4 >= 12
 END

LP OPTIMUM FOUND AT STEP 2

OBJECTIVE FUNCTION VALUE

1) 19.16667

VARIABLE	VALUE	REDUCED COST
X1	2.833333	0.000000
X2	1.250000	0.000000
X3	0.000000	11.500000
X4	6.666667	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	4.833333
3)	0.250000	0.000000
4)	0.000000	-12.666667
5)	0.000000	-0.166667

NO. ITERATIONS= 2

RANGES IN WHICH THE BASIS IS UNCHANGED:

VARIABLE	OBJ COEFFICIENT RANGES		
	CURRENT COEF	ALLOWABLE INCREASE	ALLOWABLE DECREASE
X1	30.000000	1.000000	7.666667
X2	-10.000000	0.666667	INFINITY
X3	20.000000	11.500001	INFINITY
X4	-8.000000	0.500000	5.750000

ROW	RIGHTHAND SIDE RANGES		
	CURRENT RHS	ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	7.000000	1.000000	16.999998
3	3.000000	0.250000	INFINITY
4	1.000000	8.499999	0.125000
5	12.000000	INFINITY	1.000000

A	B	C
x=	4.5	
y=	7	
z	=5000*B1+4000*B2	
CON1	=10*B1+15*B2	150
CON2	=20*B1+10*B2	160
CON3	=30*B1+10*B2	135

Microsoft Excel 9.0 Answer Report
Worksheet: [Book1]Sheet1
Report Created: 1/4/02 11:28:10 AM

Target Cell (Max)

Cell Name	Original Value	Final Value
\$B\$4 z	0	50500

Adjustable Cells

Cell Name	Original Value	Final Value
\$B\$1 x	0	4.5
\$B\$2 y	0	7

Constraints

Cell Name	Cell Value	Formula	Status	Slack
\$B\$6 CON1	150	\$B\$6<=\$C\$6	Binding	0
\$B\$7 CON2	160	\$B\$7<=\$C\$7	Binding	0
\$B\$8 CON3	205	\$B\$8>=\$C\$8	Not Binding	70
\$B\$1 x	4.5	\$B\$1>=0	Not Binding	4.5
\$B\$2 y	7	\$B\$2>=0	Not Binding	7

Microsoft Excel 9.0 Sensitivity Report

Worksheet: [Book1]Sheet1

Report Created: 1/4/02 11:28:11 AM

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$B\$1	x	4.5	0	5000	3000	2333.333333
\$B\$2	y	7	0	4000	3500	1500

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
\$B\$6	CON1	150	150	150	90	70
\$B\$7	CON2	160	175	160	140	40
\$B\$8	CON3	205	0	135	70	1E+30

Microsoft Excel 9.0 Limits Report

Worksheet: [Book1]Sheet1

Report Created: 1/4/02 11:28:11 AM

Cell	Target Name	Value
\$B\$4	z	50500

Cell	Adjustable Name	Value	Lower Limit	Target Result	Upper Limit	Target Result
\$B\$1	x	4.5	2.166666667	38833.33333	4.5	50500
\$B\$2	y	7	5.00222E-12	22500	7	50500

Question 54 (p. 121 of the text)

Olé Oil produces three products: heating oil, gasoline and jet fuel. The average octane levels must be at least 4.5 for heating oil, 8.5 for gas and 7.0 for jet fuel. To produce these products Olé purchases two types of crude oil: Crude 1 (at \$12 per barrel) and Crude 2 (at \$10 per barrel). Each day, at most 10,000 barrels of each type of oil can be purchased.

Before crude can be used to produce products for sale, it must be distilled. Each day, at most 15,000 barrels of oil can be distilled. It costs 10 cents to distill a barrel of oil. The result of distillation is as follows:

1. Each barrel of Crude 1 yields 0.6 barrels of naphtha, 0.3 barrels of distilled 1, 0.1 barrels of distilled 2.
2. Each barrel of Crude 2 yields 0.4 barrels of naphtha, 0.2 barrels of distilled 1, 0.4 barrels of distilled 2.

Distilled naphtha can be used to produce only jet fuel or gasoline. Distilled oil can be used to produce heating oil, or it can be sent through a catalytic cracker (at a cost of 15 cents per barrel). Each day, at most 5000 barrels of distilled oil can be sent through the cracker.

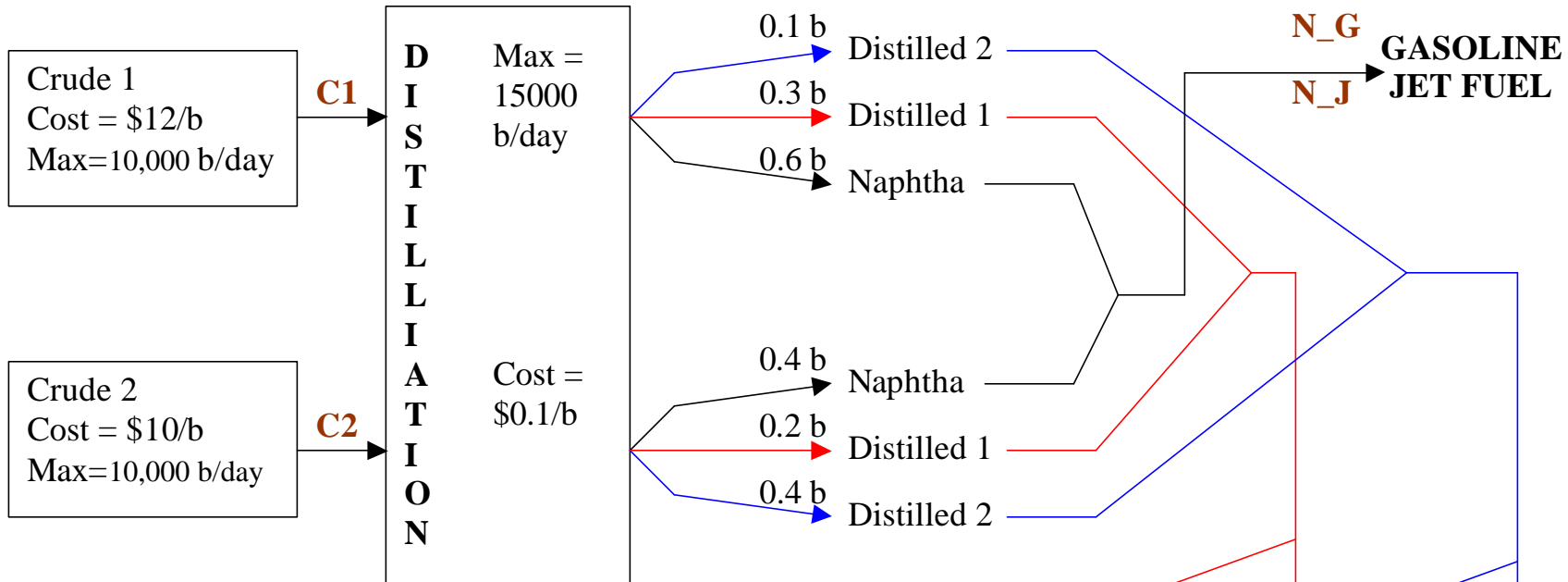
1. Each barrel of distilled 1 sent through the cracker yields 0.8 barrels of cracked 1, and 0.2 barrels of cracked 2.
2. Each barrel of distilled 2 sent through the cracker yields 0.7 barrels of cracked 1, and 0.3 barrels of cracked 2.

Cracked oil can be used to produce gasoline and jet fuel but not to produce heating oil.

The octane levels of each type of oil is as follows: naphtha = 8; distilled 1 = 4; distilled 2 = 5; cracked 1 = 9; cracked 2 = 6.

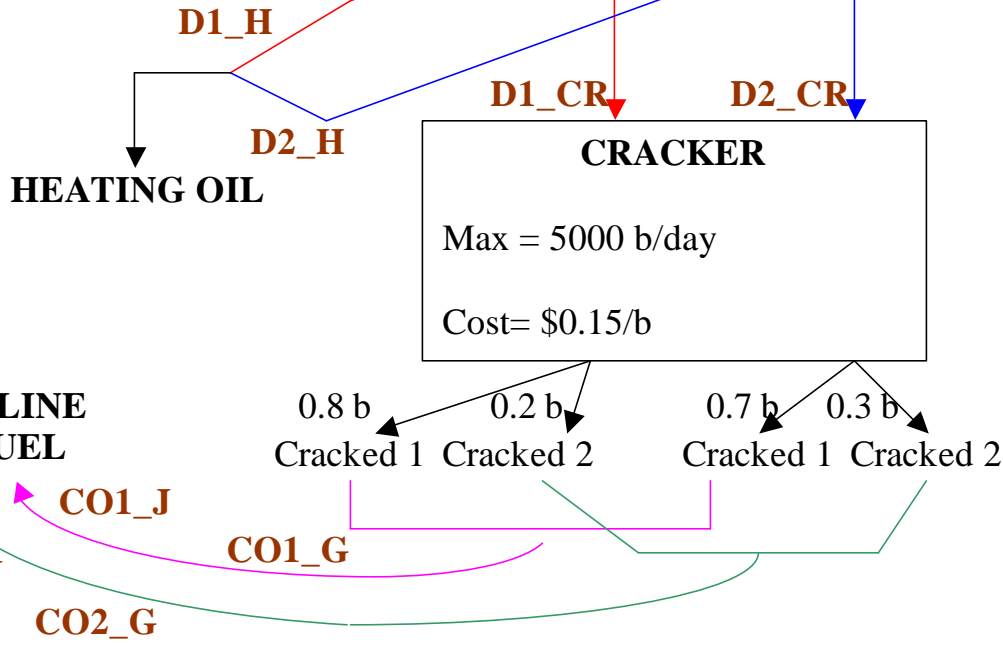
All heating oil produced can be sold at \$14 per barrel; all gasoline produced at \$18 per barrel; and all jet fuel produced at \$16 per barrel. Marketing considerations dictate that at least 3000 barrels of each product must be produced daily.

Formulate an LP to maximize Olé's daily profit.



	Octane No.	Prod/day	Sale Price
Gasoline G	≥8.5	≥3000	\$18/b
Jet Fuel J	≥7	≥3000	\$16/b
Heating Oil H	≥4.5	≥3000	\$14/b

OCTANE LEVELS	
Naphtha	8
Distilled 1	4
Distilled 2	5
Cracked 1	9
Cracked 2	6



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MAX      14 H + 16 J + 18 G - 12.1 C1 - 10.1 C2 - 0.15 D1_CR - 0.15 D2_CR
SUBJECT TO
DIST_CAP)   C1 + C2 <= 15000
CR1_LIM)    C1 <= 10000
CR2_LIM)    C2 <= 10000
MIN_OIL)    H >= 3000
MIN_JET)    J >= 3000
MIN_GAS)    G >= 3000
NAPHTA)    0.6 C1 + 0.4 C2 - N_G - N_J = 0
DIST_1)    0.3 C1 + 0.2 C2 - D1_CR - D1_H = 0
DIST_2)    0.1 C1 + 0.4 C2 - D2_CR - D2_H = 0
CRK_CAP)    D1_CR + D2_CR <= 5000
CR_OIL_1)   0.8 D1_CR + 0.7 D2_CR - CO1_G - CO1_J = 0
CR_OIL_2)   0.2 D1_CR + 0.3 D2_CR - CO2_G - CO2_J = 0
H_OIL)      H - D1_H - D2_H = 0
JET_FUEL)   J - N_J - CO1_J - CO2_J = 0
GASOLINE)   G - N_G - CO1_G - CO2_G = 0
GAS_OCT)    - 8.5 G + 8 N_G + 9 CO1_G + 6 CO2_G >= 0
JET_OCT)    - 7 J + 8 N_J + 9 CO1_J + 6 CO2_J >= 0
HOIL_OCT)   - 4.5 H + 4 D1_H + 5 D2_H >= 0
END

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LP OPTIMUM FOUND AT STEP 20

OBJECTIVE FUNCTION VALUE

1) 87150.00

VARIABLE	VALUE	REDUCED COST
H	3000.000000	0.000000
J	4300.000000	0.000000
G	7700.000000	0.000000
C1	5000.000000	0.000000
C2	10000.000000	0.000000
D1_CR	3500.000000	0.000000
D2_CR	1500.000000	0.000000
N_G	3850.000000	0.000000
N_J	3150.000000	0.000000
D1_H	0.000000	0.400000
D2_H	3000.000000	0.000000
CO1_G	3850.000000	0.000000
CO1_J	0.000000	4.000000
CO2_G	0.000000	8.000000
CO2_J	1150.000000	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
DIST_CAP)	0.000000	3.220000
CR1_LIM)	5000.000000	0.000000
CR2_LIM)	0.000000	1.560000
MIN_OIL)	0.000000	0.000000
MIN_JET)	1300.000000	0.000000
MIN_GAS)	4700.000000	0.000000
NAPHTA)	0.000000	-16.000000
DIST_1)	0.000000	-14.400000
DIST_2)	0.000000	-14.000000
CRK_CAP)	0.000000	4.650000
CR_OIL_1)	0.000000	-20.000000
CR_OIL_2)	0.000000	-16.000000
H_OIL)	0.000000	14.000000
JET_FUEL)	0.000000	16.000000
GASOLINE)	0.000000	-16.000000
GAS_OCT)	0.000000	-4.000000
JET_OCT)	2000.000000	0.000000
HOIL_OCT)	1500.000000	0.000000

NO. ITERATIONS= 20

RANGES IN WHICH THE BASIS IS UNCHANGED:

VARIABLE	CURRENT COEF	OBJ COEFFICIENT RANGES	
		ALLOWABLE INCREASE	ALLOWABLE DECREASE
H	14.000000	4.650000	7.800000
J	16.000000	1.999998	5.962963
G	18.000000	78.000000	1.999998
C1	-12.100000	1.560000	3.220000
C2	-10.100000	INFINITY	1.560000
D1_CR	-0.150000	15.599999	0.400000
D2_CR	-0.150000	0.400000	4.650000
N_G	0.000000	156.000000	1.600000
N_J	0.000000	1.600000	5.649123
D1_H	0.000000	0.400000	INFINITY
D2_H	0.000000	4.650000	0.400000
CO1_G	0.000000	156.000000	3.999996
CO1_J	0.000000	4.000000	INFINITY
CO2_G	0.000000	8.000000	INFINITY
CO2_J	0.000000	3.999996	8.000000

ROW	CURRENT RHS	RIGHTHAND SIDE RANGES	
		ALLOWABLE INCREASE	ALLOWABLE DECREASE
DIST_CAP	15000.000000	5000.000000	0.000000
CR1_LIM	10000.000000	INFINITY	5000.000000
CR2_LIM	10000.000000	5000.000000	0.000000
MIN_OIL	3000.000000	0.000000	INFINITY
MIN_JET	3000.000000	1300.000000	INFINITY
MIN_GAS	3000.000000	4700.000000	INFINITY
NAPHTA	0.000000	1300.000000	INFINITY
DIST_1	0.000000	0.000000	1500.000000
DIST_2	0.000000	0.000000	INFINITY
CRK_CAP	5000.000000	0.000000	1500.000000
CR_OIL_1	0.000000	2350.000000	1300.000000
CR_OIL_2	0.000000	1150.000000	2000.000000
H_OIL	0.000000	333.333344	0.000000
JET_FUEL	0.000000	285.714294	1300.000000
GASOLINE	0.000000	226.470581	76.470589
GAS_OCT	0.000000	1925.000000	650.000000
JET_OCT	0.000000	2000.000000	INFINITY
HOIL_OCT	0.000000	1500.000000	INFINITY