Gasoline Blending

A refinery takes four raw gasolines, blends them, and produces three types of fuel.

Data about raw gasolines

Raw gas	Octane rating	Available (barrels/day	Cost ($/barrel)	Selling price ($/b)
1	68	4000	31.02	36.85
2	86	5050	33.15	36.85
3	91	7100	36.35	38.95
4	99	4300	38.75	38.95

Data about blended fuels

Fuel type	Min octane rating	Selling price ($/barrel)	Demand pattern
1	95	45.15	≤ 10000 barrels/day
2	90	42.95	Any amt can be sold
3	85	40.99	≥ 15000 barrels/day

The LINGO model:

```
MODEL: ! GASOLINE BLENDING PROBLEM;

SETS:
    RAW/1..4/:OCTANE,AVAIL,COST,PRAW,Y;
    FUEL/1..3/:MINOCT,PRICE,DEMAND;
    BLEND(RAW,FUEL):X;
ENDSETS

DATA:
!   attributes of raw gasolines;
    OCTANE= 68 86 91 95;
    AVAIL= 4000 5050 7100 4300;
    COST= 31.02 33.15 36.35 38.75;
    PRAW= 36.35 36.35 38.95 38.95;  ! selling price of raw gas;
!   attributes of blended fuel types;
    MINOCT= 95 90 85;
    PRICE= 45.15 42.95 40.99;
    DEMAND= 10000 0 15000;
ENDDATA
```



```
MAX= @SUM(RAW(I): (PRAW(I)-COST(I))*Y(I)
    + @SUM(FUEL(J): (PRICE(J)-COST(I))*X(I,J)));

    ! minimum octane requirement for each fuel;
@FOR(FUEL(J):
    @SUM(RAW(I): OCTANE(I)*X(I,J)) >=
                    MINOCT(J)*@SUM(RAW(I): X(I,J));
);
    !maximum production of fuel #1;
    @SUM(RAW(I): X(I,1)) <= DEMAND(1);
    !minimum production of fuel #3;
    @SUM(RAW(I): X(I,3)) >= DEMAND(3);

    ! availability of raw gasolines;
@FOR(RAW(I):
    @SUM(FUEL(J): X(I,J)) + Y(I) <= AVAIL(I);
);
END
```


The LINDO model generated by LINGO:

```
MAX     14.13 X( 1, 1) + 11.93 X( 1, 2) + 9.97 X( 1, 3) + 12 X( 2, 1)
     + 9.8 X( 2, 2) + 7.84 X( 2, 3) + 8.8 X( 3, 1) + 6.6 X( 3, 2)
     + 4.64 X( 3, 3) + 6.4 X( 4, 1) + 4.2 X( 4, 2) + 2.24 X( 4, 3)
     + 5.33 Y( 1) + 3.2 Y( 2) + 2.6 Y( 3) + .2 Y( 4)
SUBJECT TO
2]- 27 X( 1, 1) - 9 X( 2, 1) - 4 X( 3, 1) >=   0
3]- 22 X( 1, 2) - 4 X( 2, 2) + X( 3, 2) + 5 X( 4, 2) >=   0
4]- 17 X( 1, 3) + X( 2, 3) + 6 X( 3, 3) + 10 X( 4, 3) >=   0
5]  X( 1, 1) + X( 2, 1) + X( 3, 1) + X( 4, 1) <=   10000
6]  X( 1, 3) + X( 2, 3) + X( 3, 3) + X( 4, 3) >=   15000
7]  X( 1, 1) + X( 1, 2) + X( 1, 3) + Y( 1) <=   4000
8]  X( 2, 1) + X( 2, 2) + X( 2, 3) + Y( 2) <=   5050
9]  X( 3, 1) + X( 3, 2) + X( 3, 3) + Y( 3) <=   7100
10]  X( 4, 1) + X( 4, 2) + X( 4, 3) + Y( 4) <=   4300
END
```

The solution found by LINGO:

Primal solution

Variable	Value	Reduced Cost
X(1, 3)	2820.370	0.0000000
X(2, 3)	5050.000	0.0000000
X(3, 3)	7100.000	0.0000000
X(4, 1)	4270.370	0.0000000
X(4, 3)	29.62963	0.0000000
Y(1)	1179.630	0.0000000

Dual solution

Row	Slack or Surplus	Dual Price
2	0.0000000	-0.3259259
3	0.0000000	-0.3000000
4	0.0000000	-0.3259259
5	5729.630	0.0000000
6	0.0000000	-0.9007407
7	0.0000000	5.330000
8	0.0000000	9.066667
9	0.0000000	7.496296
10	0.0000000	6.400000

Range analysis

Ranges in which the basis is unchanged:

Objective Coefficient Ranges

Variable	Current Coefficient	Allowable Increase	Allowable Decrease
Y(1)	5.330000	6.600000	2.432000
Y(2)	3.200000	5.866667	INFINITY
Y(3)	2.600000	4.896296	INFINITY
Y(4)	0.2000000	6.200000	INFINITY
X(1, 1)	14.13000	INFINITY	0.0
X(1, 2)	11.93000	3.080000	2.566667
X(1, 3)	9.970000	0.0	8.800000
X(2, 1)	12.00000	0.0	INFINITY
X(2, 2)	9.800000	0.4666667	INFINITY
X(2, 3)	7.840000	INFINITY	0.0
X(3, 1)	8.800000	0.0	INFINITY
X(3, 2)	6.600000	0.5962963	INFINITY
X(3, 3)	4.640000	INFINITY	0.0
X(4, 1)	6.400000	INFINITY	0.0
X(4, 2)	4.200000	0.7000000	INFINITY
X(4, 3)	2.240000	0.0	INFINITY

Righthand Side Ranges

Row	Current RHS	Allowable Increase	Allowable Decrease
2	0.0	0.0	31850.00
3	0.0	0.0	25951.85
4	0.0	76150.00	800.0000
5	10000.00	INFINITY	5729.630
6	15000.00	3185.000	47.05882
7	4000.000	INFINITY	1179.630
8	5050.000	44.44444	3538.889
9	7100.000	34.78261	5013.043
10	4300.000	5729.630	4270.370