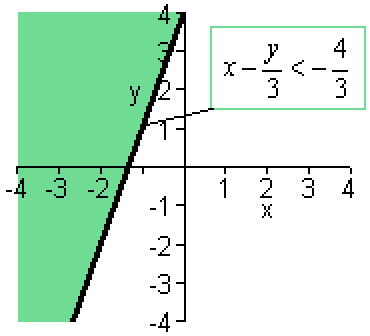
Chapter 4 Inequalities and Linear Programming

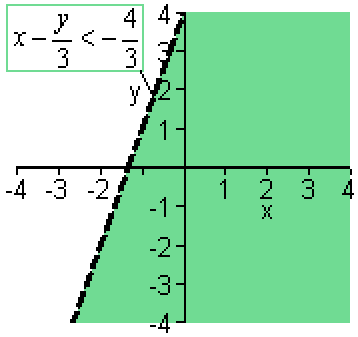
1. Graph the inequality.

$$x - \frac{y}{3} < \frac{-4}{3}$$

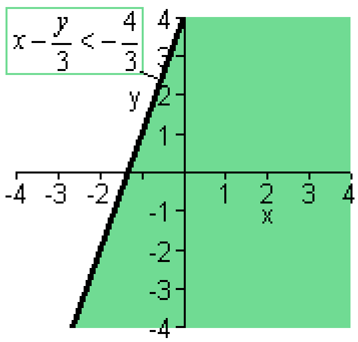
A)



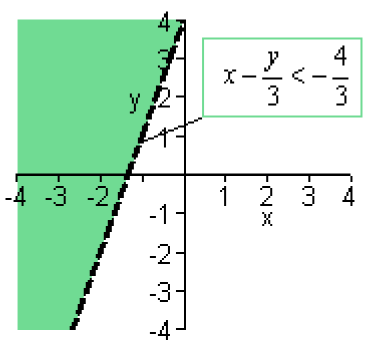
B)



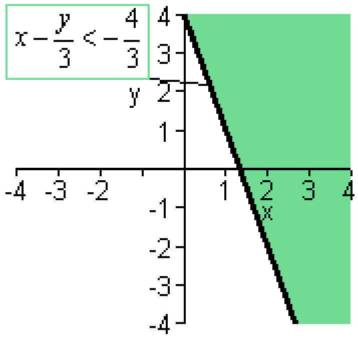
C)



D)



E)

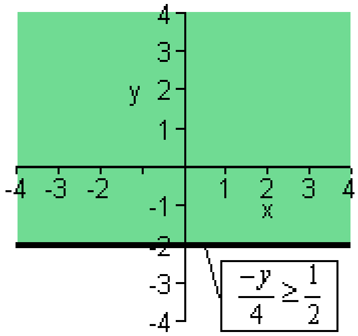


Ans: D

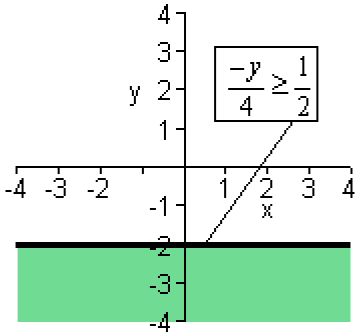
2. Graph the inequality.

$$\frac{-y}{4} \geq \frac{1}{2}$$

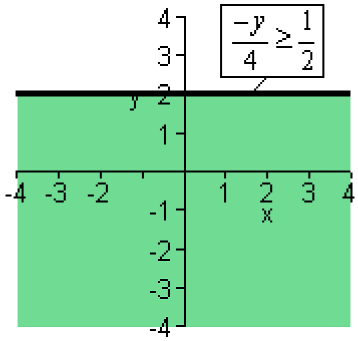
A)



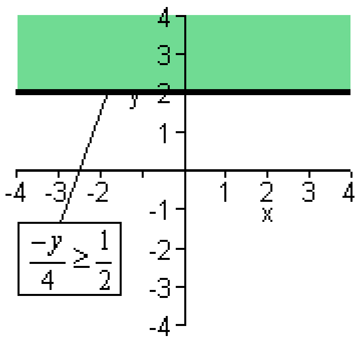
B)



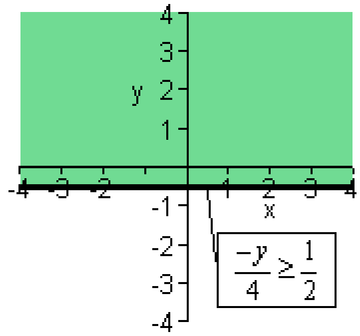
C)



D)



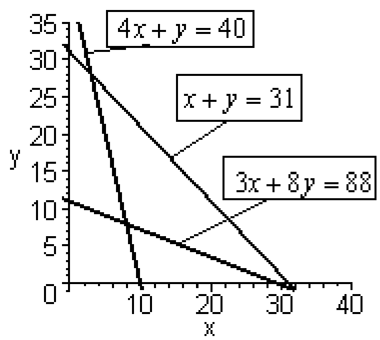
E)



Ans: B

3. The graph of the boundary equations for the system of inequalities is shown with that system. Locate the solution region and find the corners.

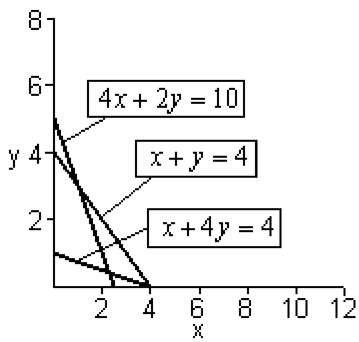
$$\begin{cases} x + y \leq 31 \\ 4x + y \leq 40 \\ 3x + 8y \geq 88 \\ x \geq 0, y \geq 0 \end{cases}$$



A) $(3,28),(8,8)$
B) $(3,28),(8,8),(32,-1)$
C) $(3,28),(0,31),(0,11),(8,8)$
D) $(0,31),(32,-1),(0,0)$
E) $(0,31),(32,-1),(8,8)$
Ans: C

4. The graph of the boundary equations for the system of inequalities is shown with that system. Locate the solution region and find the corners.

$$\begin{cases} x + 4y \geq 4 \\ 4x + 2y \geq 10 \\ x + \ \ y \geq \ \ 4 \\ x \geq 0 \\ y \geq 0 \end{cases}$$

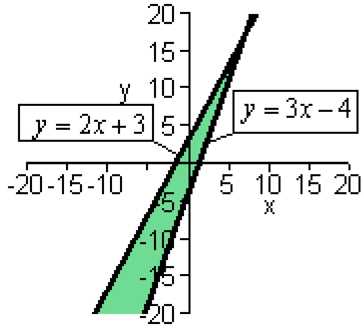


A) (0,5) (4,0) (1,3)
B) (0,5) (4,0) (2,0.5)
C) (0,0) (0,5) (4,0)
D) (0,4) (1,3) (4,0)
E) (0,4) (2,0.5) (4,0)
Ans: A

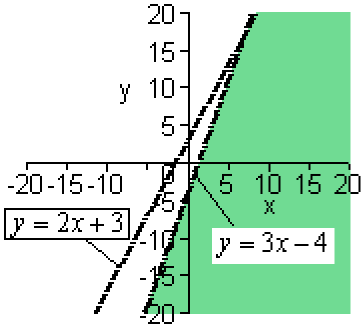
5. Graph the solution of the system of inequalities.

$$\begin{cases} y > 3x - 4 \\ y < 2x + 3 \end{cases}$$

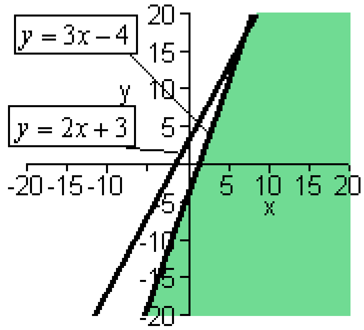
A)



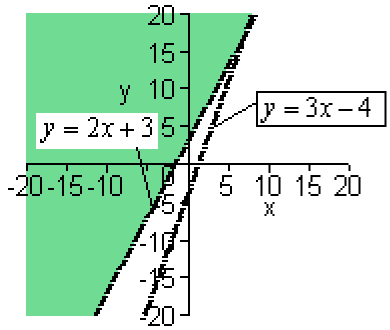
B)



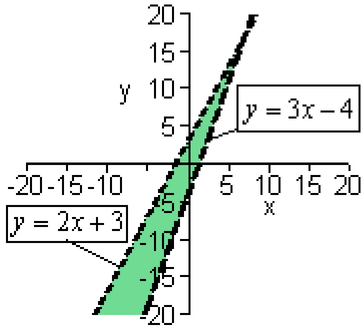
C)



D)



E)

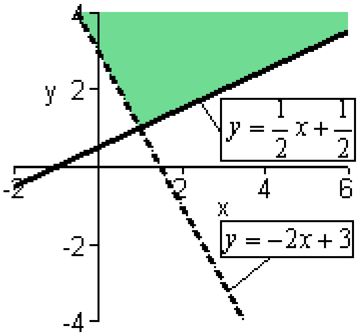


Ans: E

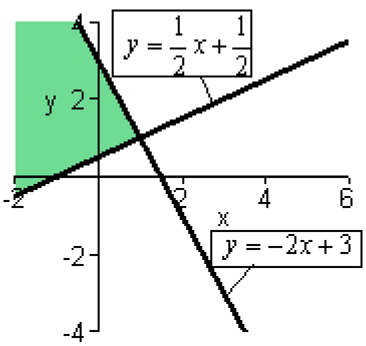
6. Graph the solution of the system of inequalities.

$$\begin{cases} 2x + y < 3 \\ x - 2y \geq -1 \end{cases}$$

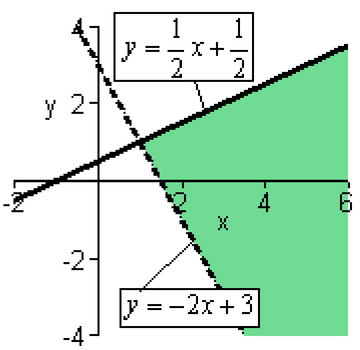
A)



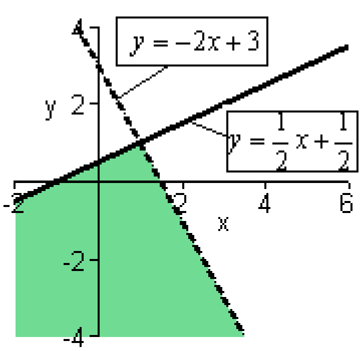
B)



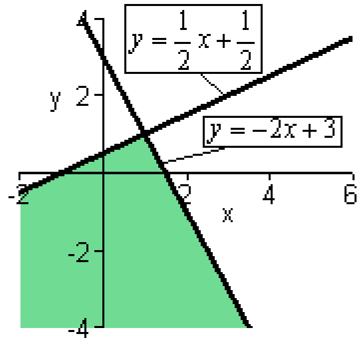
C)



D)



E)

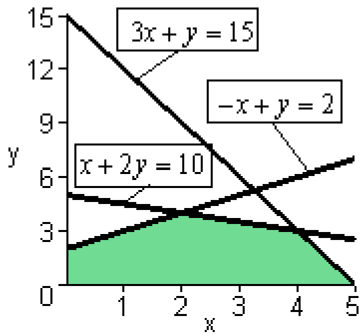


Ans: D

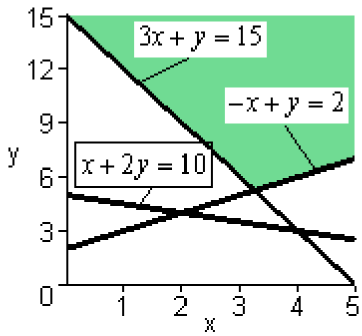
7. Graph the solution of the system of inequalities.

$$\begin{cases} -x + y \leq 2 \\ x + 2y \geq 10 \\ 3x + y \geq 15 \\ x > 0, y > 0 \end{cases}$$

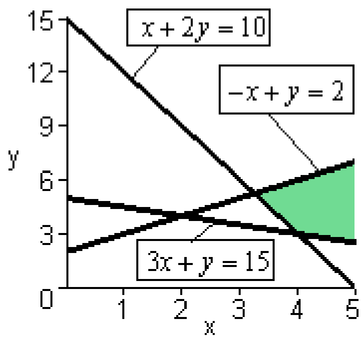
A)



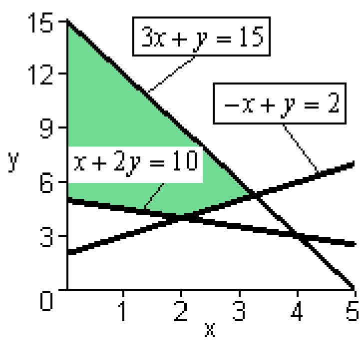
B)



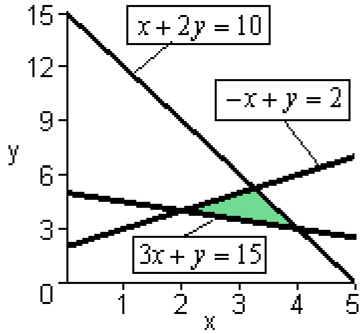
C)



D)



E)

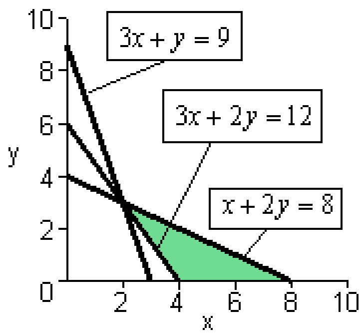


Ans: C

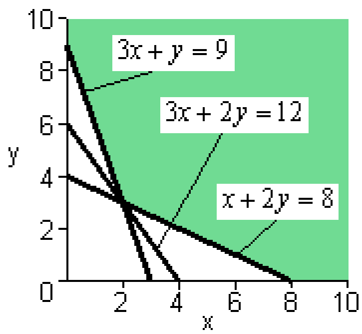
8. Graph the solution of the system of inequalities.

$$\begin{cases} 3x + y \geq 9 \\ 3x + 2y \geq 12 \\ x + 2y \geq 8 \\ x > 0, y > 0 \end{cases}$$

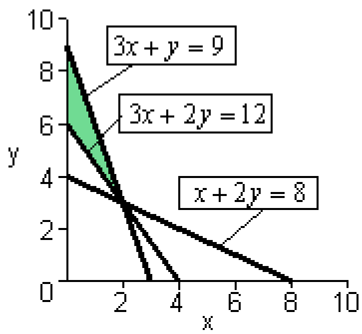
A)



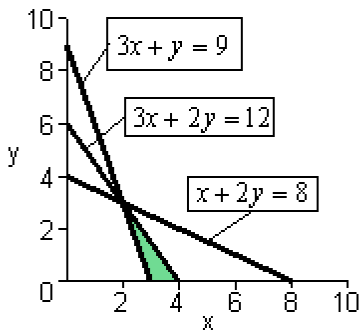
B)



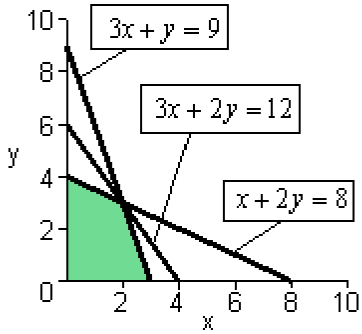
C)



D)



E)

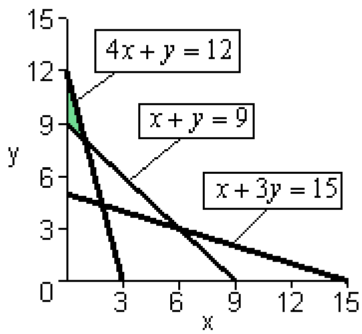


Ans: B

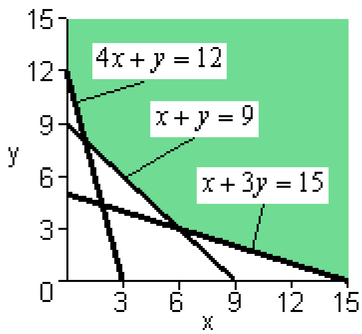
9. Graph the solution of the system of inequalities.

$$\begin{cases} 4x + y \geq 12 \\ x + y \leq 9 \\ x + 3y \leq 15 \\ x > 0, y > 0 \end{cases}$$

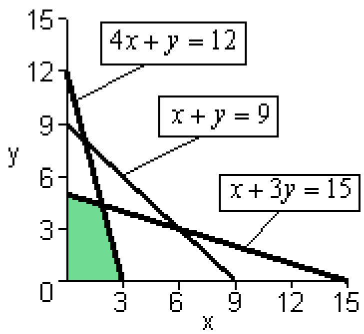
A)



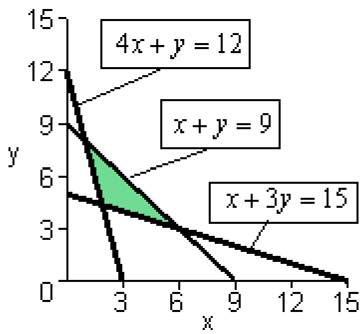
B)



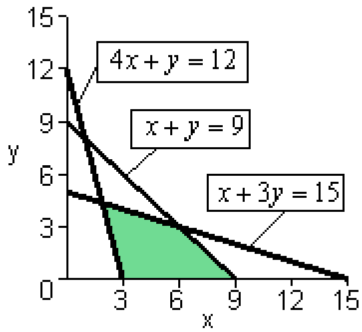
C)



D)



E)

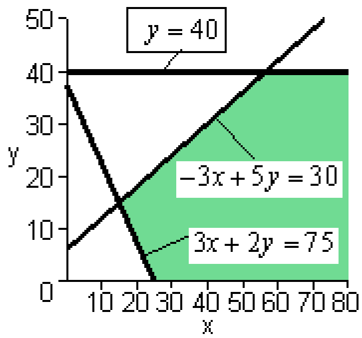


Ans: E

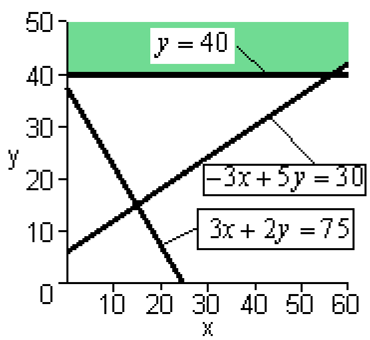
10. Graph the solution of the system of inequalities.

$$\begin{cases} 3x+2y \le 75 \\ -3x+5y \le 30 \\ y \le 40 \\ x > 0, y > 0 \end{cases}$$

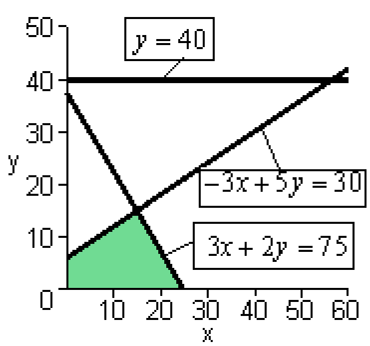
A)



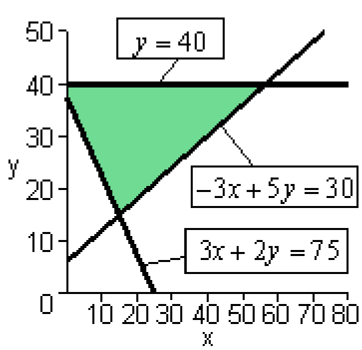
B)



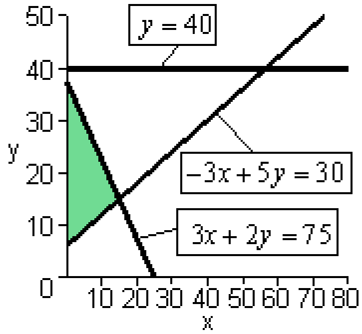
C)



D)



E)



Ans: C

11. The Wellbuilt Company produces two types of wood chippers, economy and deluxe. The deluxe model requires 5 hours to assemble and 1/2 hour to paint, and the economy model requires 2 hours to assemble and 1 hour to paint. The maximum number of assembly hours available is 23 per day, and the maximum number of painting hours available is 9 per day. Let *x* represent the number of deluxe models and *y* represent the number of economy models. Write the system of inequalities that describes the constraints on the number of each type of wood chipper produced.

A) $\begin{cases} 5x + 0.5y \le 23 \\ 2x + \quad y \le 9 \\ x \ge 0,\ y \ge 0 \end{cases}$

B) $\begin{cases} 5x + \quad y \le 9 \\ 0.5x + 2y \le 23 \\ x \ge 0,\ y \ge 0 \end{cases}$

C) $\begin{cases} 5x + 2y \le 23 \\ 0.5x + \quad y \le 9 \\ x \ge 0,\ y \ge 0 \end{cases}$

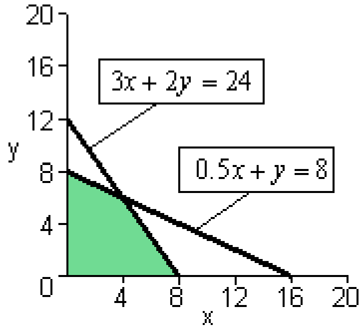
D) $\begin{cases} 5x + 0.5y < 23 \\ 2x + \quad y < 9 \\ x > 0,\ y > 0 \end{cases}$

E) $\begin{cases} 5x + 2y < 23 \\ 0.5x + \quad y < 9 \\ x > 0,\ y > 0 \end{cases}$

Ans: C

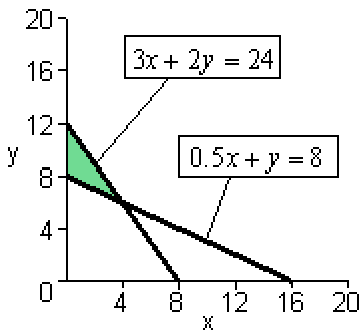
12. The Wellbuilt Company produces two types of wood chippers, economy and deluxe. The deluxe model requires 3 hours to assemble and 1/2 hour to paint, and the economy model requires 2 hours to assemble and 1 hour to paint. The maximum number of assembly hours available is 24 per day, and the maximum number of painting hours available is 8 per day. Let *x* represent the number of deluxe models and *y* represent the number of economy models. Graph the solution of the system of inequalities and find the corners of the solution region.

A)



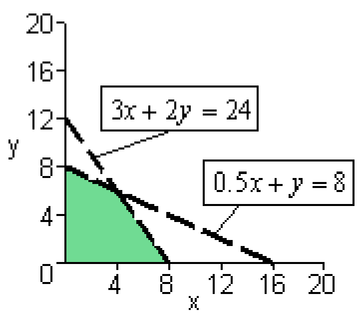
corners: (0,0), (8,0), (4,6), (0,8)

B)



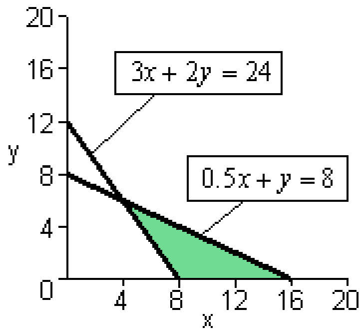
corners: (0,12), (4,6), (0,8)

C)



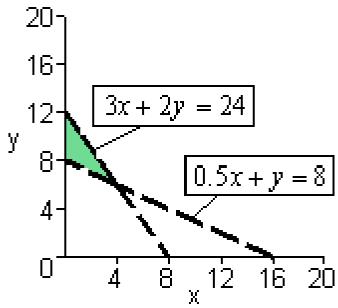
corners: (0,0), (8,0), (2,9), (0,8)

D)



corners: (8,0), (4,6), (16,0)

E)



corners: (0,12), (2,9), (0,8)

Ans: A

13. An experiment that involves learning in animals requires placing white mice and rabbits into separate, controlled environments, environment I and environment II. The maximum amount of time available in environment I is 500 minutes, and the maximum amount of time available in environment II is 100 minutes. The white mice must spend 15 minutes in environment I and 45 minutes in environment II, and the rabbits must spend 40 minutes in environment I and 35 minutes in environment II. Write a system of inequalities that describes the constraints on the number of each type of animal used in the experiment. Let *x* denote the number of white mice and *y* denote the number of rabbits.

A)
$$\begin{cases} 40x + 15y \le 500 \\ 35x + 45y \le 100 \\ x \ge 0, y \ge 0 \end{cases}$$

B)
$$\begin{cases} 15x + 40y \le 500 \\ 45x + 35y \le 100 \\ x \ge 0, y \ge 0 \end{cases}$$

C)
$$\begin{cases} 40x + 15y \le 500 \\ 35x + 45y \le 100 \\ x \ge 0, y \ge 0 \end{cases}$$

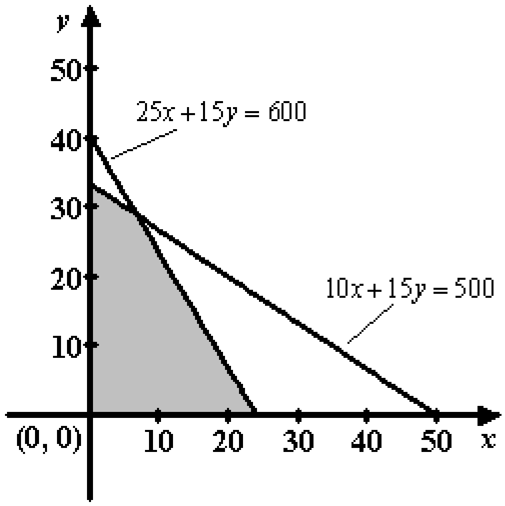
D)
$$\begin{cases} 40x + 15y \le 100 \\ 35x + 45y \le 500 \\ x \ge 0, y \ge 0 \end{cases}$$

E)
$$\begin{cases} 15x + 45y \le 100 \\ 40x + 35y \le 500 \\ x \ge 0, y \ge 0 \end{cases}$$

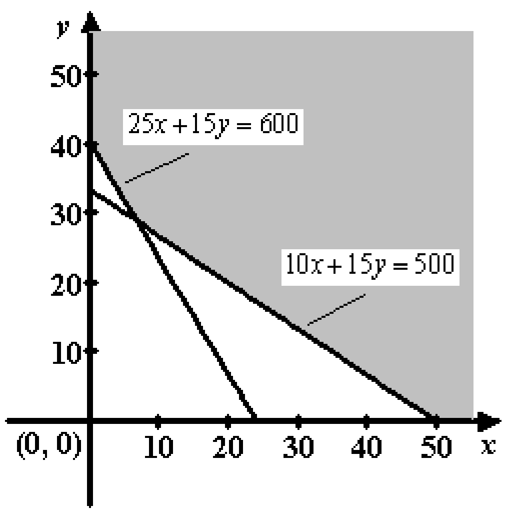
Ans: B

14. Suppose that an experiment that involves learning in animals requires placing white mice and rabbits into separate, controlled environments, environment I and environment II. The maximum amount of time available in environment I is 500 minutes, and the maximum amount of time available in environment II is 600 minutes. The white mice must spend 10 minutes in environment I and 25 minutes in environment II, and the rabbits must spend 15 minutes in environment I and 15 minutes in environment II. Let *x* represent number of white mice and *y* represent number of rabbits. Determine the system of inequalities that describes the constraints on the number of each type of animal used in the experiment. Then graph the solution of the system of inequalities.

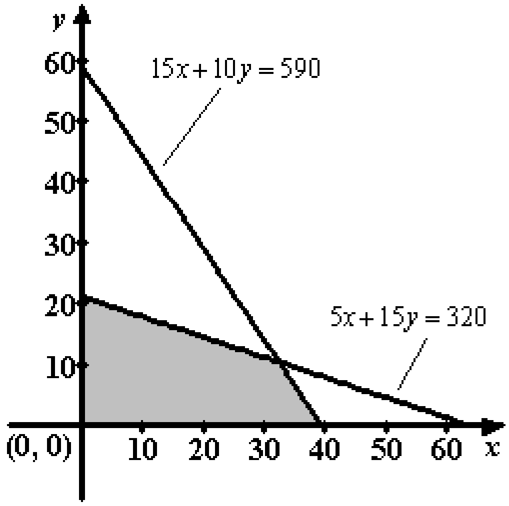
A)



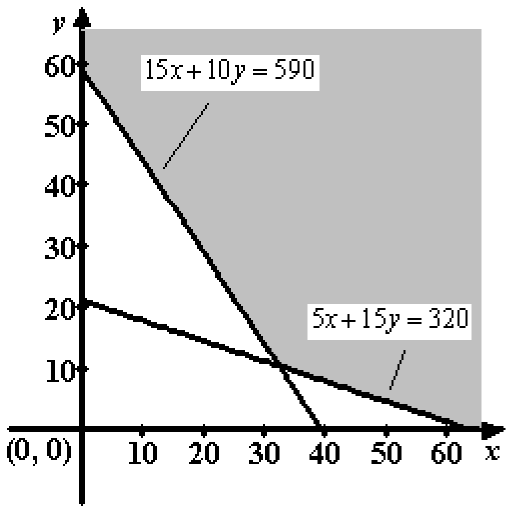
B)



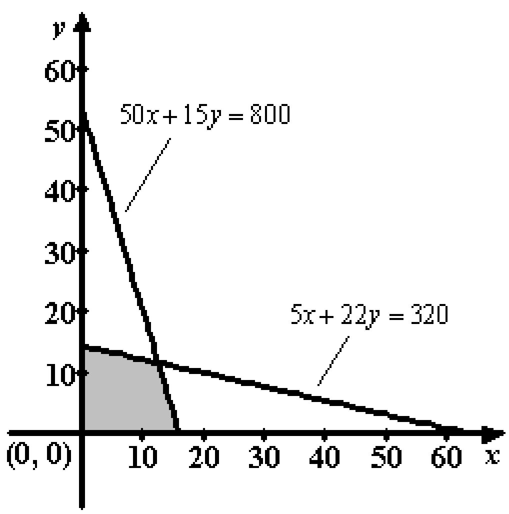
C)


y
60
50
40
30
20
10
15x + 10y = 590
5x + 15y = 320
(0, 0)
10 20 30 40 50 60 x

D)


y
60
50
40
30
20
10
15x + 10y = 590
5x + 15y = 320
(0, 0)
10 20 30 40 50 60 x

E)


y
60
50
40
30
20
10
50x + 15y = 800
5x + 22y = 320
(0, 0)
10 20 30 40 50 60 x

Ans: A

15. A company manufactures two types of electric hedge trimmers, one of which is cordless. The cord-type trimmer requires 1 hours to make, and the cordless model requires 3 hours. The company has only 800 work hours to use in manufacturing each day, and the packaging department can package only 300 trimmers per day. Let *x* represent the number of cord type models and *y* represent the number of cordless models. Write the inequalities that describe the constraints on the number of each type of hedge trimmer produced.

A) $\begin{cases} x+3y \le 300 \\ x+\ \ y \le 800 \\ x \ge 0;\ y \ge 0 \end{cases}$

B) $\begin{cases} x+\ \ y \ge 300 \\ x+3y \le 800 \\ x \ge 0;\ y \ge 0 \end{cases}$

C) $\begin{cases} x+3y \ge 300 \\ x+\ \ y \le 800 \\ x \ge 0;\ y \ge 0 \end{cases}$

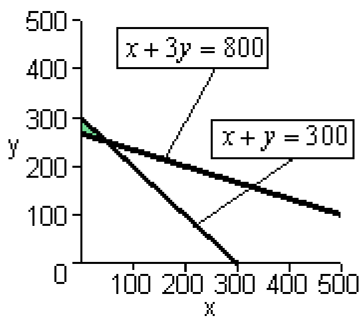
D) $\begin{cases} x+\ \ y \le 300 \\ x+3y \le 800 \\ x \ge 0;\ y \ge 0 \end{cases}$

E) $\begin{cases} x+\ \ y \le 300 \\ x+3y \le 800 \\ x \ge 0;\ y \ge 0 \end{cases}$

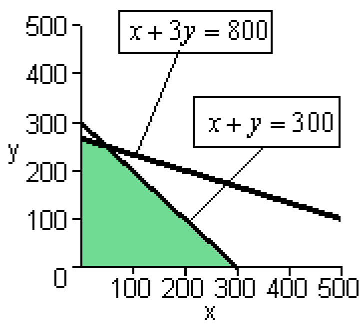
Ans: D

16. A company manufactures two types of electric hedge trimmers, one of which is cordless. The cord-type trimmer requires 1 hours to make, and the cordless model requires 3 hours. The company has only 800 work hours to use in manufacturing each day, and the packaging department can package only 300 trimmers per day. Let *x* represent the number of cord type models and *y* represent the number of cordless models. Graph the solution of the system of inequalities.

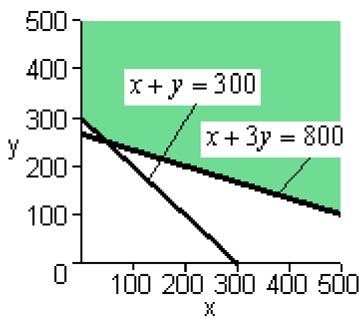
A)



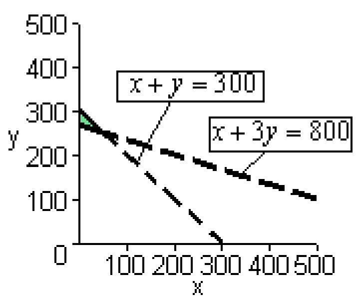
B)



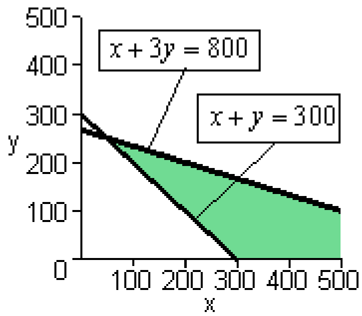
C)



D)



E)



Ans: B

17. Apex Motors manufactures luxury cars and sport utility vehicles. The most likely customers are high-income men and women, and company managers want to initiate an advertising campaign targeting these groups. They plan to run 1-minute spots on business/investment programs, where they can reach 7 million women and 4 million men from their target groups. They also plan 1-minute spots during sporting events, where they can reach 2 million women and 12 million men from their target groups. Apex feels that the ads must reach at least 36 million women and at least 24 million men who are prospective customers. Let *x* represent the number of minutes of business/investment program commercials and *y* represent the number of minutes of sporting events commercials. Write the inequalities that describe the constraints on the number of each type of 1-minute spots needed to reach these target groups.

A) $\begin{cases} 7x + 2y \geq 24 \\ 4x + 12y \geq 36 \\ x \geq 0;\ y \geq 0 \end{cases}$

B) $\begin{cases} 7x + 2y \leq 36 \\ 4x + 12y \leq 24 \\ x \geq 0;\ y \geq 0 \end{cases}$

C) $\begin{cases} 7x + 4y \leq 36 \\ 2x + 12y \leq 24 \\ x \geq 0;\ y \geq 0 \end{cases}$

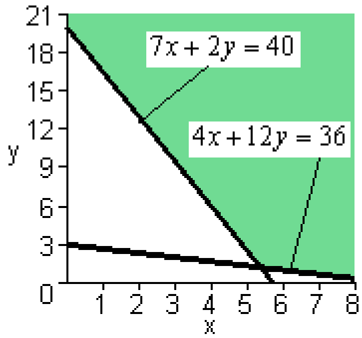
D) $\begin{cases} 7x + 4y \geq 24 \\ 2x + 12y \geq 36 \\ x \geq 0;\ y \geq 0 \end{cases}$

E) $\begin{cases} 7x + 2y \geq 36 \\ 4x + 12y \geq 24 \\ x \geq 0;\ y \geq 0 \end{cases}$

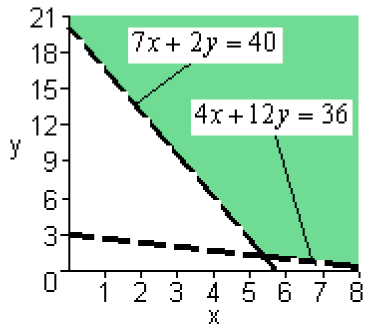
Ans: E

18. Apex Motors manufactures luxury cars and sport utility vehicles. The most likely customers are high-income men and women, and company managers want to initiate an advertising campaign targeting these groups. They plan to run 1-minute spots on business/investment programs, where they can reach 7 million women and 4 million men from their target groups. They also plan 1-minute spots during sporting events, where they can reach 2 million women and 12 million men from their target groups. Apex feels that the ads must reach at least 40 million women and at least 36 million men who are prospective customers. Let *x* represent the number of minutes of business/investment program commercials and *y* represent the number of minutes of sporting events commercials. Graph the region determined by the constraint inequalities.

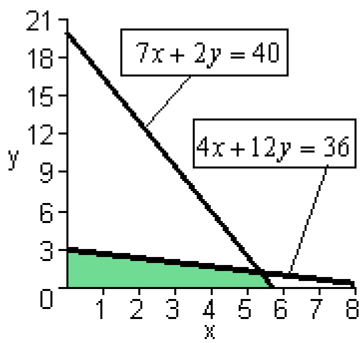
A)



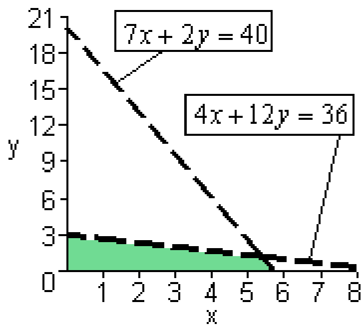
B)



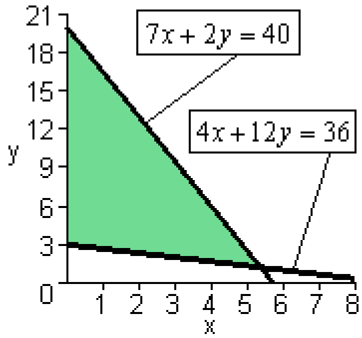
C)



D)


7x + 2y = 40
4x + 12y = 36
21
18
15
12
9
6
3
0
y
1 2 3 4 5 6 7 8
x

E)


7x + 2y = 40
4x + 12y = 36
21
18
15
12
9
6
3
0
y
1 2 3 4 5 6 7 8
x

Ans: A

19. The Video Star Company makes two different models of DVD players, which are assembled on two different assembly lines. Line 1 can assemble 36 units of the Star model and 42 units of the Prostar model per hour, and Line 2 can assemble 150 units of the Star model and 40 units of the Prostar model per hour. The company needs to produce at least 290 units of the Star model and 210 units of the Prostar model to fill an order. Let *x* represent the number of assembly hours for Line 1 and *y* represent the number of assembly hours for Line 2. Write the inequalities that describe the production constraints on the number of each type of DVD player needed to fill the order.

A) $\begin{cases} 36x + 42y \ge 290 \\ 150x + 40y \ge 210 \\ x \ge 0,\ y \ge 0 \end{cases}$

B) $\begin{cases} 36x + 42y \le 290 \\ 150x + 40y \le 210 \\ x \ge 0,\ y \ge 0 \end{cases}$

C) $\begin{cases} 36x + 150y \ge 290 \\ 42x + 40y \ge 210 \\ x \ge 0,\ y \ge 0 \end{cases}$

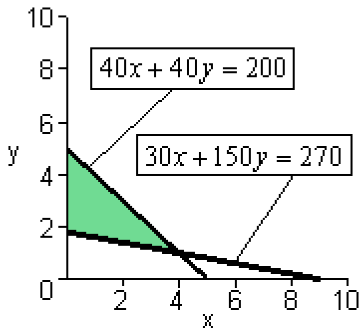
D) $\begin{cases} 42x + 150y \ge 290 \\ 36x + 40y \ge 210 \\ x \ge 0,\ y \ge 0 \end{cases}$

E) $\begin{cases} 36x + 150y \le 290 \\ 42x + 40y \le 210 \\ x \ge 0,\ y \ge 0 \end{cases}$

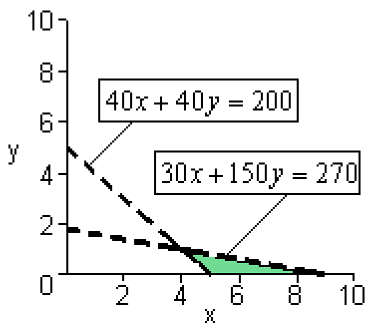
Ans: C

20. The Video Star Company makes two different models of DVD players, which are assembled on two different assembly lines. Line 1 can assemble 30 units of the Star model and 40 units of the Prostar model per hour, and Line 2 can assemble 150 units of the Star model and 40 units of the Prostar model per hour. The company needs to produce at least 270 units of the Star model and 200 units of the Prostar model to fill an order. Let x represent the number of assembly hours for Line 1 and y represent the number of assembly hours for Line 2. Graph the region determined by the constraint inequalities.

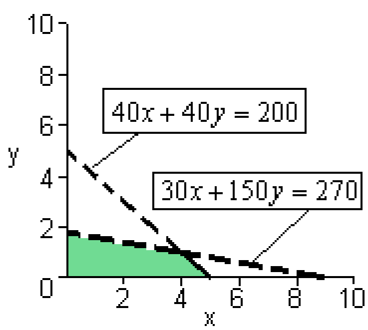
A)



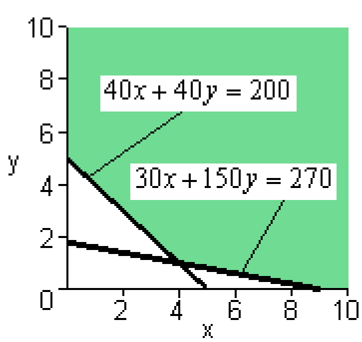
B)



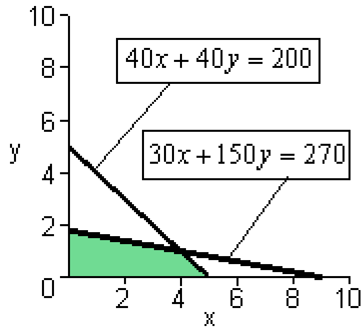
C)



D)



E)



Ans: D

21. Suppose that in a hospital ward, the patients can be grouped into two general categories depending on their condition and the amount of solid foods they require in their diet. A combination of two diets is used for solid foods because they supply essential nutrients for recovery. The table below summarizes the patient groups and their minimum daily requirements. Let *x* represent number of servings of Diet A and *y* represent number of servings of Diet B. Write the inequalities that describe how many servings of each diet are needed to provide the nutritional requirements.

	Diet A	Diet B	Daily Requirement
Group 1	10 oz per serving	1 oz per serving	30 oz
Group 2	5 oz per serving	1 oz per serving	16 oz

A)

$$10x - y \ge 30$$
$$5x - y \ge 16$$
$$x \ge 0, y \ge 0$$

B)

$$10x + y \le 30$$
$$5x + y \le 16$$
$$x \ge 0, y \ge 0$$

C)

$$10x + y \ge 30$$
$$5x + y \ge 16$$
$$x \ge 0, y \ge 0$$

D)

$$10x + 30y \ge 1$$
$$5x + 16y \ge 1$$
$$x \ge 0, y \ge 0$$

E)

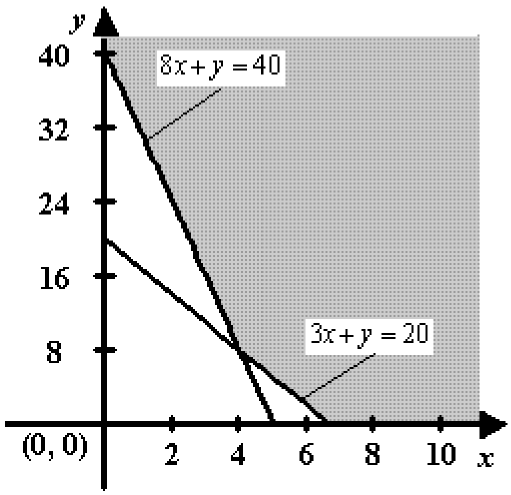
$$10x - 30y \le 1$$
$$5x - 16y \le 1$$
$$x \ge 0, y \ge 0$$

Ans: C

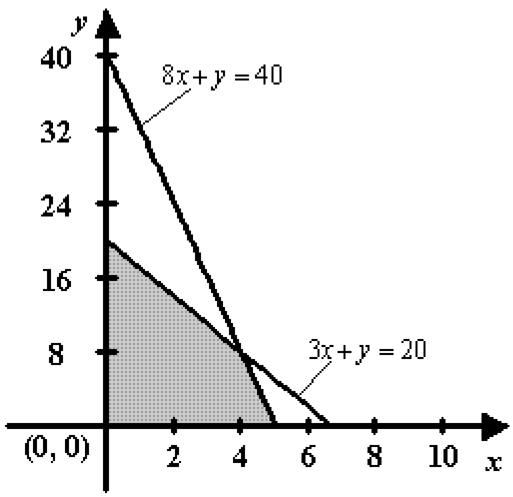
22. Suppose that in a hospital ward, the patients can be grouped into two general categories depending on their condition and the amount of solid foods they require in their diet. A combination of two diets is used for solid foods because they supply essential nutrients for recovery. The table below summarizes the patient groups and their minimum daily requirements. Let *x* represent the number of servings of *A* and y represent the number of servings of *B*. Determine the inequalities that describe how many servings of each diet are needed to provide the nutritional requirements and then graph the region determined by these constraint inequalities.

	Diet A	Diet B	Daily Requirement
Group 1	8 oz per serving	1 oz per serving	40 oz
Group 2	3 oz per serving	1 oz per serving	20 oz

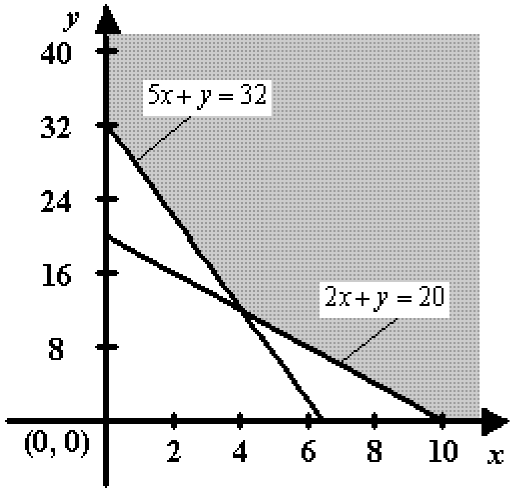
A)



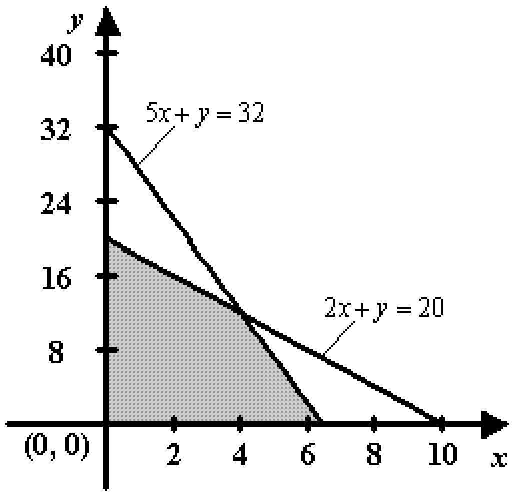
B)



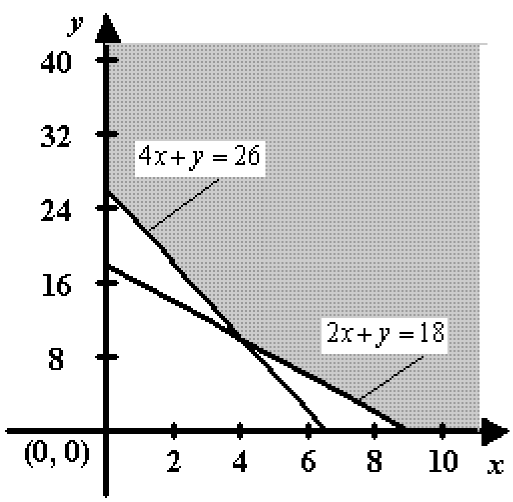
C)


y
40
32
24
16
8
(0, 0)
2
4
6
8
10
x
5x + y = 32
2x + y = 20

D)


y
40
32
24
16
8
(0, 0)
2
4
6
8
10
x
5x + y = 32
2x + y = 20

E)


y
40
32
24
16
8
(0, 0)
2
4
6
8
10
x
4x + y = 26
2x + y = 18

Ans: A

23. A sausage company makes two different kinds of hot dogs, regular and beef. Each pound of beef hot dogs requires 0.76 lb of beef and 0.2 lb of spices, and each pound of regular hot dogs requires 0.18 lb of beef, 0.31 lb of pork, and 0.21 lb of spices. Suppliers can deliver at most 1020 lb of beef, at most 600 lb of pork, and at least 500 lb of spices. Let *x* represent the number of pounds of regular meat and *y* represent the number of pounds of beef. Write the inequalities that describe how many pounds of each type of hot dog can be produced.

A) $\begin{cases} 0.18x + 0.76y \geq 1020 \\ 0.21x + 0.20y \leq 500 \\ 0.31x \geq 600 \\ x \geq 0,\ y \geq 0 \end{cases}$

B) $\begin{cases} 0.76x + 0.20y \leq 1020 \\ 0.18x + 0.21y \geq 500 \\ 0.31x \leq 600 \\ x \geq 0,\ y \geq 0 \end{cases}$

C) $\begin{cases} 0.76x + 0.18y \leq 1020 \\ 0.20x + 0.31y \leq 600 \\ 0.21x \geq 500 \\ x \geq 0,\ y \geq 0 \end{cases}$

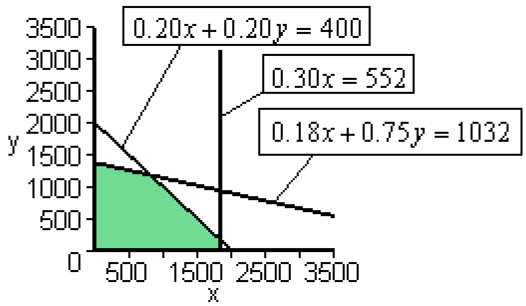
D) $\begin{cases} 0.76x + 0.20y \leq 1020 \\ 0.18x + 0.21y \leq 500 \\ 0.31x \leq 600 \\ x \geq 0,\ y \geq 0 \end{cases}$

E) $\begin{cases} 0.18x + 0.76y \leq 1020 \\ 0.21x + 0.20y \geq 500 \\ 0.31x \leq 600 \\ x \geq 0,\ y \geq 0 \end{cases}$

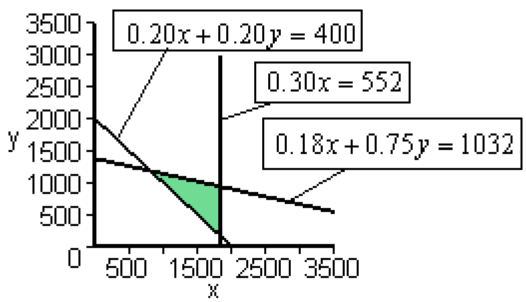
Ans: E

24. A sausage company makes two different kinds of hot dogs, regular and all beef. Each pound of all-beef hot dogs requires 0.75 lb of beef and 0.2 lb of spices, and each pound of regular hot dogs requires 0.18 lb of beef, 0.3 lb of pork, and 0.2 lb of spices. Suppliers can deliver at most 1032 lb of beef, at most 552 lb of pork, and at least 400 lb of spices. Let *x* represent the number of pounds of regular meat and *y* represent the number of pounds of all beef. Graph the region determined by the constraint inequalities.

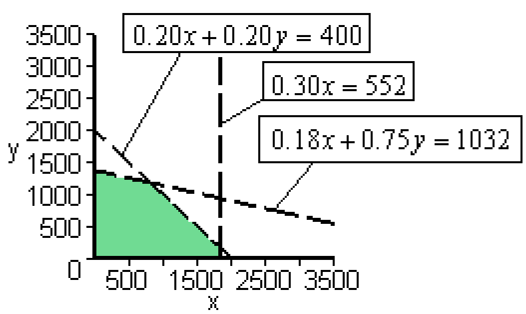
A)



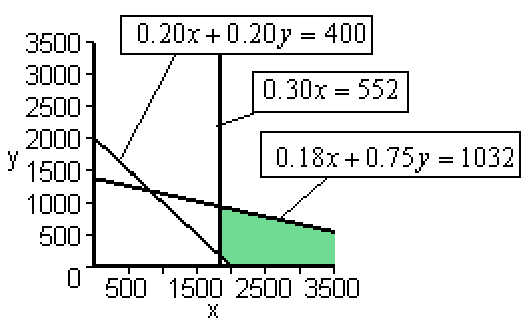
B)



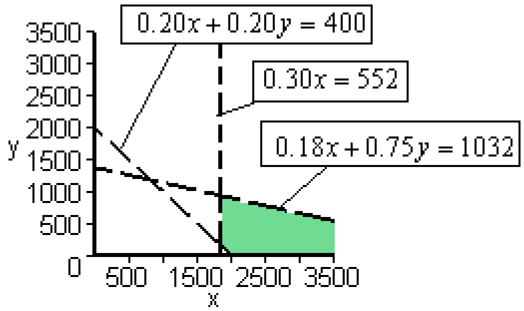
C)



D)



E)



Ans: B

25. A cereal manufacturer makes two different kinds of cereal, Senior Citizen's Feast and Kids Go. Each pound of Senior Citizen's Feast requires 0.7 lb of wheat and 0.3 lb of vitamin-enriched syrup, and each pound of Kids Go requires 0.5 lb of wheat, 0.3 lb of sugar, and 0.2 lb of vitamin-enriched syrup. Suppliers can deliver at most 2800 lb of wheat, at most 800 lb of sugar, and at least 1000 lb of the vitamin-enriched syrup. Let *x* represent the number of pounds of Senior Citizen's cereal and *y* represent the number of pounds of Kids Go cereal. Write the inequalities that describe how many pounds of each type of cereal can be made.

A) $\begin{cases} 0.7x + 0.5y \le 2800 \\ 0.3x + 0.2y \ge 1000 \\ 0.3y \le 800 \\ x \ge 0,\ y \ge 0 \end{cases}$

B) $\begin{cases} 0.7x + 0.3y \le 2800 \\ 0.5x + 0.2y \le 1000 \\ 0.3x \ge 800 \\ x \ge 0,\ y \ge 0 \end{cases}$

C) $\begin{cases} 0.7x + 0.5y \le 2800 \\ 0.3x + 0.2y \ge 1000 \\ 0.3x \le 800 \\ x \ge 0,\ y \ge 0 \end{cases}$

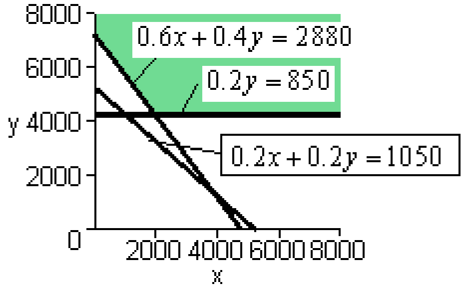
D) $\begin{cases} 0.7x + 0.3y \ge 2800 \\ 0.5x + 0.2y \ge 1000 \\ 0.3x \le 800 \\ x \ge 0,\ y \ge 0 \end{cases}$

E) $\begin{cases} 0.7x + 0.5y \ge 2800 \\ 0.3x + 0.2y \le 1000 \\ 0.3y \ge 800 \\ x \ge 0,\ y \ge 0 \end{cases}$

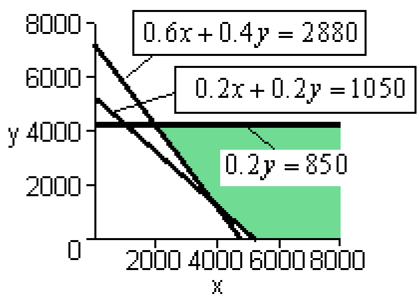
Ans: A

26. A cereal manufacturer makes two different kinds of cereal, Senior Citizen's Feast and Kids Go. Each pound of Senior Citizen's Feast requires 0.6 lb of wheat and 0.2 lb of vitamin-enriched syrup, and each pound of Kids Go requires 0.4 lb of wheat, 0.2 lb of sugar, and 0.2 lb of vitamin-enriched syrup. Suppliers can deliver at most 2880 lb of wheat, at most 850 lb of sugar, and at least 900 lb of the vitamin-enriched syrup. Let *x* represent the number of pounds of Senior Citizen's cereal and *y* represent the number of pounds of Kids Go cereal. Graph the region determined by the constraint inequalities.

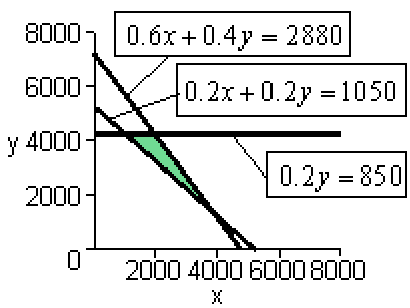
A)



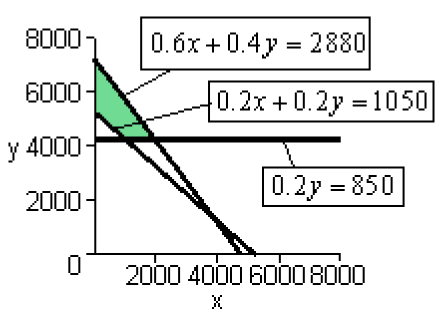
B)



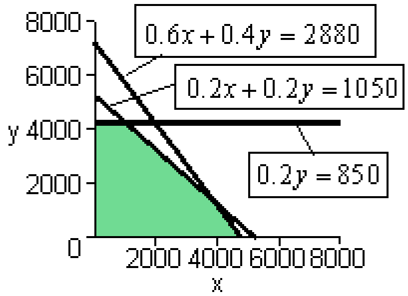
C)



D)

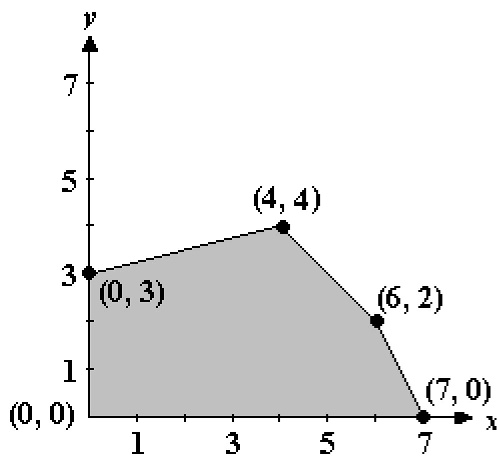


E)



Ans: C

27. Use the given feasible region determined by the constraint inequalities to find the maximum and minimum of the objective function $C = 7x + 10y$.



A) maximum value of C: 68 at $(4, 4)$; minimum value of C: 30 at $(0,3)$

B) maximum value of C: 68 at $(4, 4)$; minimum value of C: 49 at $(7,0)$

C) maximum value of C: 62 at $(6, 2)$; minimum value of C: 0 at $(0, 0)$

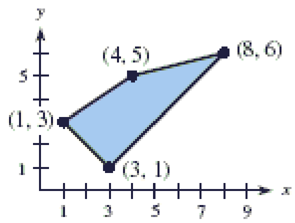
D) maximum value of C: 68 at $(4, 4)$; minimum value of C: 0 at $(0, 0)$

E) maximum value of C: 62 at $(6, 2)$; minimum value of C: 30 at $(0,3)$

Ans: D

28. Use the given feasible region determined by the constraint inequalities to find the maximum and minimum of the given objective function (if they exist).

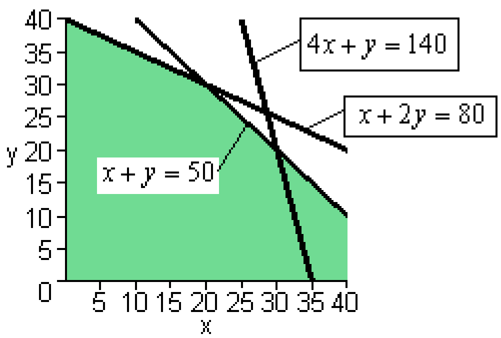
$C = 3x + 6y$



A) max: 132, min: 36
B) max: 66, min: 15
C) max: 42, min: 21
D) max: 60, min: 15
E) do not exist
Ans: D

29. The graph of the feasible region is shown. Locate the corners of the feasible region in order to find the maximum of the given objective function (if it exists).

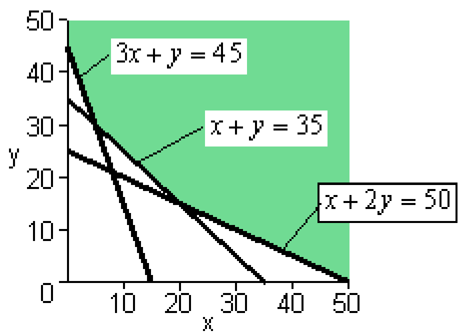
$f = 2x + 7y$



A) 70
B) 280
C) 200
D) 100
E) does not exist
Ans: B

30. The graph of the feasible region is shown. Locate the corners of the feasible region in order to find the minimum of the given objective function (if it exists).

$g = x + 3y$



A) 50
B) 45
C) 65
D) 135
E) does not exist
Ans: A

31. Solve the following linear programming problem.

Maximize $f = x + 3y$ subject to

$$\begin{aligned} x + 4y &\le 12 \\ y &\le 2 \\ x + y &\le 9 \\ x \ge 0,\ y &\ge 0 \end{aligned}$$

A) 27
B) 9
C) 10
D) 13
E) 11
Ans: E

32. Solve the following linear programming problem.

Maximize $f = 9x + 3y$ subject to

$$\begin{aligned} x + 2y &\le 20 \\ x + y &\le 12 \\ 4x + y &\le 36 \\ x \ge 0, y &\ge 0 \end{aligned}$$

A) 30
B) 84
C) 36
D) 108
E) 90
Ans: B

33. Solve the following linear programming problem.

Minimize $g = 22x + 16y$ subject to

$$\begin{aligned} 8x + 5y &\ge 100 \\ 12x + 25y &\ge 360 \\ x \ge 0, y &\ge 0 \end{aligned}$$

A) 660
B) 344
C) 302
D) 480
E) 352
Ans: C

34. Solve the following linear programming problem.

Minimize $g = 55x + 95y$ subject to

$$\begin{aligned} 11x + 15y &\ge 225 \\ x + 3y &\ge 27 \\ x \ge 0, y &\ge 0 \end{aligned}$$

A) 1485
B) 825
C) 2565
D) 1205
E) 855
Ans: D

35. Solve the following linear programming problem.

Maximize $f = 4x + 7y$ subject to

$$\begin{aligned} 2x + 4y &\geq 8 \\ 3x + \ \ y &\leq 7 \\ x \geq 0, y &\leq 4 \end{aligned}$$

A) 23
B) 32
C) 20
D) 35
E) 15
Ans: E

36. Solve the following linear programming problem.

Minimize $g = 6x + 8y$ subject to

$$\begin{aligned} 4x - 5y &\geq 50 \\ -x + 2y &\geq \ \ 4 \\ x + \ \ y &\leq 80 \\ x \geq 0, y &\geq 0 \end{aligned}$$

A) 540
B) 452
C) 464
D) 480
E) 416
Ans: E

37. The Wellbuilt Company produces two types of wood chippers, economy and deluxe. The deluxe model requires 3 hours to assemble and $\frac{1}{2}$ hour to paint, and the economy model requires 2 hours to assemble and 1 hour to paint. The maximum number of assembly hours available is 24 per day, and the maximum number of painting hours available is 8 per day. If the profit on the deluxe model is $17 per unit and the profit on the economy model is $12 per unit, find the maximum profit.

A) $113
B) $148
C) $150
D) $96
E) $140
Ans: E

38. A candidate wishes to use a combination of radio and television advertisements in her campaign. Assume that each 1-minute spot on television reaches to 0.0885 million people and that each 1-minute spot on radio reaches to 0.0075 million. The candidate feels she must reach at least 2.625 million people, and she must buy total of at least 80 minutes of advertisements. How many minutes of each medium should be used to minimize costs if television costs $\$500$ per minute and radio costs $\$125$ per minute? Round your answer to nearest integer if necessary.
   A) Minimum cost is $\$19,375$ with 55 minutes of TV time and 25 minutes of radio time.
   B) Minimum cost is $\$19,375$ with 25 minutes of TV time and 55 minutes of radio time.
   C) Minimum cost is $\$21,250$ with 30 minutes of TV time and 50 minutes of radio time.
   D) Minimum cost is $\$21,250$ with 50 minutes of TV time and 30 minutes of radio time.
   E) Minimum cost is $\$17,500$ with 20 minutes of TV time and 60 minutes of radio time.
   Ans: B

39. At one of its factories, a jeans manufacturer makes two styles: #891 and #917. Each pair of style-891 takes 10 minutes to cut out and 20 minutes to assemble and finish. Each pair of style-917 takes 10 minutes to cut out and 30 minutes to assemble and finish. The plant has enough workers to provide at most 7500 minutes per day for cutting and at most 19,500 minutes per day for assembly and finishing. The profit on each pair of style-891 is $4.00 and the profit on each pair of style-917 is $8.50. Find the maximum daily profit.
   A) $5525.00
   B) $3000.00
   C) $6375.00
   D) $4800.00
   E) $4600.00
   Ans: A

40. A farm co-op has 6001 acres available to plant with corn and soybeans. Each acre of corn requires 9 gallons of fertilizer/herbicide and 3/4 hour of labor to harvest. Each acre of soybeans requires 3 gallons of fertilizer/herbicide and 1 hour of labor to harvest. The co-op has available at most 40,500 gallons of fertilizer/herbicide and at most 5250 hours of labor for harvesting. Find the maximum profit if the profits per acre are $60 for corn and $45 for soybeans.
   A) $236,250.00
   B) $315,105.00
   C) $315,000.00
   D) $326,287.50
   E) $332,502.00
   Ans: D

41. A farm co-op has 6008 acres available to plant with corn and soybeans. Each acre of corn requires 9 gallons of fertilizer/herbicide and 3/4 hour of labor to harvest. Each acre of soybeans requires 3 gallons of fertilizer/herbicide and 1 hour of labor to harvest. The co-op has available at most 40,500 gallons of fertilizer/herbicide and at most 5250 hours of labor for harvesting. Find the maximum profit if the profits per acre are $60 for corn and $40 for soybeans.
    A) $315,240.00
    B) $315,000.00
    C) $210,000.00
    D) $300,960.00
    E) $320,002.00
    Ans: A

42. A farm co-op has over 6000 acres available to plant with corn and soybeans. The farm co-op's maximum profit for planting 6000 acres is $315,175 and the maximum profit for 6008 acres is $315,440. What is the profit value of each additional acre of land? This value is called the shadow price of an acre of land.
    A) $132.50
    B) $29.44
    C) $37.86
    D) $265.00
    E) $33.13
    Ans: E

43. A farm co-op has 6000 acres available to plant with corn and soybeans. Each acre of corn requires 9 gallons of fertilizer/herbicide and 3/4 hour of labor to harvest. Each acre of soybeans requires 3 gallons of fertilizer/herbicide and 1 hour of labor to harvest. The co-op has available at most 40,501 gallons of fertilizer/herbicide and at most 5250 hours of labor for harvesting. Find the maximum profit if the profits per acre are $75 for corn and $55 for soybeans.
    A) $288,750.00
    B) $390,000.00
    C) $405,003.33
    D) $412,504.70
    E) $374,996.67
    Ans: C

44. A farm co-op has 6000 acres available to plant with corn and soybeans. Each acre of corn requires 9 gallons of fertilizer/herbicide and 3/4 hour of labor to harvest. Each acre of soybeans requires 3 gallons of fertilizer/herbicide and 1 hour of labor to harvest. The co-op has available at most 40,508 gallons of fertilizer/herbicide and at most 5250 hours of labor for harvesting. Find the maximum profit if the profits per acre are $70 for corn and $55 for soybeans.
    A) $288,750.00
    B) $386,270.00
    C) $394,200.55
    D) $363,730.00
    E) $375,000.00
    Ans: B

45. A farm co-op has over 40,500 gallons of fertilizer/herbicide available to use when planting corn and soybeans. The farm co-op's maximum profit for using 40,500 gallons of fertilizer/herbicide is $315,003 and the maximum profit for 40,508 gallons is $315,036. What is the profit value of each additional gallon of fertilizer/herbicide (that is, the **shadow price** of a gallon of fertilizer/herbicide)?
   A) $4.71
   B) $4.12
   C) $3.67
   D) $33.00
   E) $16.50
   Ans: B

46. In a laboratory experiment, two separate foods are given to experimental animals. Each food contains essential ingredients, A and B, for which the animals have a minimum requirement, and each food also has an ingredient C, which can be harmful to the animals. The table below summarizes this information.

	Food 1	Food 2	Required
Ingredient A	12 units/g	5 units/g	41 units
Ingredient B	7 units/g	10 units/g	31 units
Ingredient C	2 units/g	1 unit/g	

Determine how many grams of foods 1 and 2 should be given in order to satisfy the requirements for A and B while minimizing the amount of ingredient C ingested. Also determine the minimum amount of ingredient C ingested.
   A) 1 gram of food 1 and 3 grams of food 2 satisfy the minimum requirements for A and B while minimizing the amount of ingredient C to 7 grams.
   B) 3 grams of food 1 and 1 gram of food 2 satisfy the minimum requirements for A and B while minimizing the amount of ingredient C to 7 grams.
   C) 11 grams of food 1 and 3 grams of food 2 satisfy the minimum requirements for A and B while minimizing the amount of ingredient C to 8 grams.
   D) 4 grams of food 1 and 1 gram of food 2 satisfy the minimum requirements for A and B while minimizing the amount of ingredient C to 9 grams.
   E) 2 grams of food 1 and 1 grams of food 2 satisfy the minimum requirements for A and B while minimizing the amount of ingredient C to 6 grams.
   Ans: B

47. The Janie Gioffre Drapery Company makes three types of draperies at two different locations. At location I, it can make 10 pairs of deluxe drapes, 20 pairs of better drapes, and 13 pairs of standard drapes per day. At location II, it can make 20 pairs of deluxe drapes, 50 pairs of better drapes, and 6 pairs of standard drapes per day. The company has orders for 2000 pairs of deluxe drapes, 4200 pairs of better drapes, and 1200 pairs of standard drapes. If the daily costs are $500 per day at location I and $825 per day at location II, how many days should Janie schedule at each location in order to fill the orders at minimum cost? Find the minimum cost.
    A) Minimum cost of $165,000 occurs with 0 days at location I and 200 days at location II.
    B) Minimum cost of $100,000 occurs with 200 days at location I and 0 days at location II.
    C) Minimum cost of $84,500 occurs with 70 days at location I and 60 days at location II.
    D) Minimum cost of $96,500 occurs with 160 days at location I and 20 days at location II.
    E) Minimum cost of $87,750 occurs with 60 days at location I and 70 days at location II.
    Ans: E

48. Two foods contain only proteins, carbohydrates, and fats. Food A costs $1.10 per pound and contains 30% protein and 50% carbohydrates. Food B costs $1.65 per pound and contains 20% protein and 75% carbohydrates. What combination of these two foods provides at least 1 pound of protein, $2\frac{1}{2}$ pounds of carbohydrates, and $\frac{1}{4}$ pound of fat at the lowest cost?
    A) Minimum cost of $5.50 occurs on the line between (2,2) and (5,0).
    B) Minimum cost of $8.25 occurs with 0 pounds of food A and 5 pounds of food B.
    C) Minimum cost of $4.40 occurs on the line between (2,2) and (5,0).
    D) Minimum cost of $4.40 occurs with 2 pounds of food A and 2 pounds of food B.
    E) Minimum cost of $10.45 occurs with 5 pounds of food A and 3 pounds of food B.
    Ans: A

49. A sausage company makes two different kinds of hot dogs, regular and all beef. Each pound of all-beef hot dogs requires 0.75 lb of beef and 0.2 lb of spices, and each pound of regular hot dogs requires 0.18 lb of beef, 0.3 lb of pork, and 0.2 lb of spices. Suppliers can deliver at most 1020 lb of beef, at most 600 lb of pork, and at least 500 lb of spices. If the profit is $0.70 on each pound of all-beef hot dogs and $0.30 on each pound of regular hot dogs, how many pounds of each should be produced to obtain maximum profit? What is the maximum profit?
    A) Maximum profit of $950.00 with 2000 lbs of regular and 500 lbs of all beef.
    B) Maximum profit of $1216.00 with 2000 lbs of regular and 880 lbs of all beef.
    C) Maximum profit of $1664.00 with 880 lbs of regular and 2000 lbs of all beef.
    D) Maximum profit of $1150.00 with 1500 lbs of regular and 1000 lbs of all beef.
    E) Maximum profit of $1350.00 with 1000 lbs of regular and 1500 lbs of all beef.
    Ans: B

50. A cereal manufacturer makes two different kinds of cereal, Senior Citizen's Feast and Kids Go. Each pound of Senior Citizen's Feast requires 0.6 lb of wheat and 0.2 lb of vitamin-enriched syrup, and each pound of Kids Go requires 0.4 lb of wheat, 0.2 lb of sugar, and 0.2 lb of vitamin-enriched syrup. Suppliers can deliver at most 2800 lb of wheat, at most 800 lb of sugar, and at least 1000 lb of the vitamin-enriched syrup. If the profit is $0.90 on each pound of Senior Citizen's Feast and $1.00 on each pound of Kids Go, find the number of pounds of each cereal that should be produced to obtain maximum profit. Find the maximum profit.
    A) Maximum profit of $4600.00 when 4000 lbs of Senior Citizen's Feast and 1000 lbs of Kids Go are produced.
    B) Maximum profit of $4900.00 when 1000 lbs of Senior Citizen's Feast and 4000 lbs of Kids Go are produced.
    C) Maximum profit of $5600.00 when 4000 lbs of Senior Citizen's Feast and 2000 lbs of Kids Go are produced.
    D) Maximum profit of $6000.00 when 2000 lbs of Senior Citizen's Feast and 4000 lbs of Kids Go are produced.
    E) Maximum profit of $5800.00 when 2000 lbs of Senior Citizen's Feast and 4000 lbs of Kids Go are produced.
    Ans: E

51. A contractor builds two types of homes. The Carolina requires one lot, $160,000 capital, and 160 worker-days of labor, whereas the Savannah requires one lot, $240,000 capital, and 160 worker-days of labor. The contractor owns 300 lots and has $48,000,000 available capital and 43,200 worker-days of labor. The profit on the Carolina is $40,500 and the profit on the Savannah is $51,500. Use the corner points of the feasible region to find how many of each type of home should be built to maximize profit. Find the maximum possible profit.
    A) Maximum profit of $13,245,000 obtained by building 60 Carolina homes and 210 Savannah homes.
    B) Maximum profit of $12,150,000 obtained by building 300 Carolina homes and 0 Savannah homes.
    C) Maximum profit of $11,595,000 obtained by building 210 Carolina homes and 60 Savannah homes.
    D) Maximum profit of $21,235,000 obtained by building 270 Carolina homes and 200 Savannah homes.
    E) Maximum profit of $18,400,000 obtained by building 200 Carolina homes and 200 Savannah homes.
    Ans: C

52. Convert the constraint inequalities $3x+4y\le 12$ and $2x+3y\le 10$ to equations containing slack variables.
    A) $3x+4y+s1=12$ and $2x+3y+s2=10$
    B) $3x+4y+s1+s2=12$ and $2x+3y+t1+t2=10$
    C) $3x+3y+s1=12$ and $2x+4y+s2=10$
    D) $3x+4y+s1+s2=12$ and $2x+3y+s1+s2=10$
    E) $2x+4y+s1+s2=12$ and $3x+3y+s1+s2=10$
    Ans: A

53. Set up the simplex matrix used to solve the linear programming problem. Assume all variables are nonnegative.

Maximize $f = 3x + 5y + 12z$ subject to

$$\begin{aligned} 3x + 3y + 4z &\le 70 \\ x + 5y + z &\le 45 \\ 6x + y + z &\le 48 \end{aligned}$$

A)
$$\begin{array}{ccccccc} x & y & z & s_1 & s_2 & s_3 & f \end{array}$$
$$\left(\begin{array}{ccccccc|c} 3 & 3 & 4 & 1 & 0 & 0 & 0 & 70 \\ 1 & 5 & 1 & 0 & 1 & 0 & 0 & 45 \\ 6 & 1 & 1 & 0 & 0 & 1 & 0 & 48 \\ 3 & 5 & 12 & 0 & 0 & 0 & 1 & 0 \end{array}\right)$$

B)
$$\begin{array}{ccccccc} x & y & z & s_1 & s_2 & s_3 & f \end{array}$$
$$\left(\begin{array}{ccccccc|c} 3 & 3 & 4 & 1 & 0 & 0 & 0 & 70 \\ 1 & 5 & 1 & 0 & 1 & 0 & 0 & 45 \\ 6 & 1 & 1 & 0 & 0 & 1 & 0 & 48 \\ -3 & -5 & -12 & 0 & 0 & 0 & 1 & 0 \end{array}\right)$$

C)
$$\begin{array}{ccccccc} x & y & z & s_1 & s_2 & s_3 & f \end{array}$$
$$\left(\begin{array}{ccccccc|c} 3 & 1 & 6 & 1 & 0 & 0 & 0 & 70 \\ 3 & 5 & 1 & 0 & 1 & 0 & 0 & 45 \\ 4 & 1 & 1 & 0 & 0 & 1 & 0 & 48 \\ 3 & 5 & 12 & 0 & 0 & 0 & 1 & 0 \end{array}\right)$$

D)
$$\begin{array}{ccccccc} x & y & z & s_1 & s_2 & s_3 & f \end{array}$$
$$\left(\begin{array}{ccccccc|c} 4 & 3 & 3 & 1 & 0 & 0 & 0 & 48 \\ 1 & 5 & 1 & 0 & 1 & 0 & 0 & 45 \\ 1 & 1 & 6 & 0 & 0 & 1 & 0 & 70 \\ -12 & -5 & -3 & 0 & 0 & 0 & 1 & 0 \end{array}\right)$$

E)
$$\begin{array}{ccccccc} x & y & z & s_1 & s_2 & s_3 & f \end{array}$$
$$\left(\begin{array}{ccccccc|c} 3 & 4 & 3 & 1 & 0 & 0 & 0 & 45 \\ 5 & 1 & 1 & 0 & 1 & 0 & 0 & 48 \\ 1 & 1 & 6 & 0 & 0 & 1 & 0 & 70 \\ -5 & -12 & -3 & 0 & 0 & 0 & 1 & 0 \end{array}\right)$$

Ans: B

54. A simplex matrix for a standard maximization problem is given. Write the values of *all* the variables (use $x_1, x_2, x_3, \ldots$ and $s_1, s_2, s_3, \ldots$) and of the objective function *f*.

$$\left[\begin{array}{rrrrrrr|r} 2 & 1 & 1 & 1 & 0 & 0 & 0 & 14 \\ -2 & 0 & -1 & -2 & 0 & 1 & 0 & 4 \\ 4 & 0 & 2 & -1 & 1 & 0 & 0 & 9 \\ -2 & 0 & 5 & 7 & 0 & 0 & 1 & 28 \end{array}\right]$$

A) $x_1 = 7,\ x_2 = 14,\ x_3 = 4,\ s_1 = 14,\ s_2 = 4,\ s_3 = 9,\ f = 28$

B) $x_1 = 0,\ x_2 = 14,\ x_3 = 0,\ s_1 = 14,\ s_2 = 4,\ s_3 = 9,\ f = 28$

C) $x_1 = 0,\ x_2 = 9,\ x_3 = 4,\ s_1 = 0,\ s_2 = 14,\ s_3 = 0,\ f = 28$

D) $x_1 = 0,\ x_2 = 14,\ x_3 = 0,\ s_1 = 0,\ s_2 = 9,\ s_3 = 4,\ f = 28$

E) $x_1 = 0,\ x_2 = 9,\ x_3 = 4,\ s_1 = 28,\ s_2 = 0,\ s_3 = 14,\ f = 0$

Ans: D

55. A simplex matrix for a standard maximization problem is given. Indicate whether or not the solution shown is complete (optimal). If the solution is not complete, find the next pivot or indicate that no solution exists.

$$\left[\begin{array}{rrrrrrr|r} 2 & 1 & 1 & 1 & 0 & 0 & 0 & 14 \\ -2 & 0 & -1 & -2 & 0 & 1 & 0 & 2 \\ 4 & 0 & 2 & -1 & 1 & 0 & 0 & 9 \\ -2 & 0 & 5 & 7 & 0 & 0 & 1 & 30 \end{array}\right]$$

A) next pivot: 4 in R_3C_1

B) next pivot: –2 in R_4C_1

C) next pivot: 2 in R_1C_1

D) optimal solution

E) no solution

Ans: A

56. A simplex matrix for a standard maximization problem is given. Write the values of *all* the variables (use $x_1, x_2, x_3, \ldots$ and $s_1, s_2, s_3, \ldots$) and of the objective function *f*.

$$\left[\begin{array}{ccccccc|c} 1 & 0 & -3 & 4 & -4 & 0 & 0 & 17 \\ 0 & 1 & -4 & 2 & 5 & 0 & 0 & 100 \\ 0 & 0 & -1 & -6 & -3 & 1 & 0 & 40 \\ 0 & 0 & 6 & -1 & -3 & 0 & 1 & 385 \end{array}\right]$$

A) $x_1 = 17,\ x_2 = 100,\ x_3 = 40,\ s_1 = 0,\ s_2 = 0,\ s_3 = 0,\ f = 385$
B) $x_1 = 0,\ x_2 = 0,\ x_3 = 40,\ s_1 = 17,\ s_2 = 100,\ s_3 = 0,\ f = -385$
C) $x_1 = 0,\ x_2 = 100,\ x_3 = 17,\ s_1 = 40,\ s_2 = 0,\ s_3 = 0,\ f = -385$
D) $x_1 = 0,\ x_2 = 0,\ x_3 = 17,\ s_1 = 100,\ s_2 = 40,\ s_3 = 0,\ f = 385$
E) $x_1 = 17,\ x_2 = 100,\ x_3 = 0,\ s_1 = 0,\ s_2 = 0,\ s_3 = 40,\ f = 385$
Ans: E

57. A simplex matrix for a standard maximization problem is given. Indicate whether or not the solution shown is complete (optimal). If the solution is not complete, find the next pivot or indicate that no solution exists.

$$\left[\begin{array}{ccccccc|c} 1 & 0 & -3 & 4 & -4 & 0 & 0 & 15 \\ 0 & 1 & -4 & 2 & 6 & 0 & 0 & 130 \\ 0 & 0 & -1 & -6 & -3 & 1 & 0 & 44 \\ 0 & 0 & 6 & 7 & -4 & 0 & 1 & 395 \end{array}\right]$$

A) next pivot: 6 in R_4C_3
B) next pivot: –4 in R_4C_5
C) next pivot: 6 in R_2C_5
D) optimal solution
E) no solution
Ans: C

58. A simplex matrix for a standard maximization problem is given. Write the values of *all* the variables (use $x_1, x_2, x_3, \ldots$ and $s_1, s_2, s_3, \ldots$) and of the objective function *f*.

$$\left[\begin{array}{ccccccc|c} 0 & 20 & -6 & 1 & 0 & -3 & 0 & 4 \\ 0 & 5 & -6 & 0 & 1 & -2 & 0 & 2 \\ 1 & -1 & 0 & 0 & 0 & 4 & 0 & 8 \\ 0 & -9 & -12 & 0 & 0 & 10 & 1 & 45 \end{array}\right]$$

A) $x_1 = 4,\ x_2 = 0,\ x_3 = 0,\ s_1 = 2,\ s_2 = 8,\ s_3 = 0,\ f = 45$

B) $x_1 = 0,\ x_2 = 4,\ x_3 = 2,\ s_1 = 0,\ s_2 = 0,\ s_3 = 8,\ f = -45$

C) $x_1 = 8,\ x_2 = 4,\ x_3 = 2,\ s_1 = 0,\ s_2 = 0,\ s_3 = 0,\ f = -45$

D) $x_1 = 8,\ x_2 = 0,\ x_3 = 0,\ s_1 = 4,\ s_2 = 2,\ s_3 = 0,\ f = 45$

E) $x_1 = 4,\ x_2 = 2,\ x_3 = 0,\ s_1 = 8,\ s_2 = 0,\ s_3 = 0,\ f = 45$

Ans: D

59. A simplex matrix for a standard maximization problem is given. Indicate whether or not the solution shown is complete (optimal). If the solution is not complete, find the next pivot or indicate that no solution exists.

$$\left[\begin{array}{ccccccc|c} 0 & 20 & -8 & 1 & 0 & -3 & 0 & 7 \\ 0 & 5 & -8 & 0 & 1 & -2 & 0 & 4 \\ 1 & -1 & 0 & 0 & 0 & 4 & 0 & 6 \\ 0 & -9 & -12 & 0 & 0 & 10 & 1 & 40 \end{array}\right]$$

A) next pivot: –12 in R_4C_3

B) next pivot: –8 in R_1C_3

C) next pivot: 5 in R_2C_2

D) optimal solution

E) no solution

Ans: E

60. A simplex matrix is given. In this case the solution is complete, so identify the maximum value of *f* and a set of values of the variables that gives this maximum value. If multiple solutions may exist, indicate this and locate the next pivot.

$$\left[\begin{array}{ccccccc|c} 0 & 1 & 0 & -3 & -1 & -4 & 0 & 11 \\ 1 & 0 & 0 & -2 & -1 & -5 & 0 & 19 \\ 0 & 0 & 1 & -1 & 2 & 1 & 0 & 29 \\ 0 & 0 & 0 & 4 & 1 & 2 & 1 & 180 \end{array}\right]$$

A) The maximum value of f is 180 when $x_1 = 19,\ x_2 = 11,$ and $x_3 = 29.$

B) The maximum value of f is 180 when $x_1 = 11,\ x_2 = 19,$ and $x_3 = 29.$

C) The maximum value of f is 180 when $x_1 = 29,\ x_2 = 19,$ and $x_3 = 11.$

D) The maximum value of f is 180 when $x_1 = 19$ and $x_2 = 11.$ Since multiple solutions

E) The maximum value of f is 180 when $x_1 = 11$ and $x_2 = 19.$ Since multiple solutions

Ans: A

61. A simplex matrix is given. In this case, the solution is complete, so identify the maximum value of *f* and a set of values for the variables that gives this maximum value. If multiple solutions may exist, indicate this and locate the next pivot.

$$\left[\begin{array}{cccccc|c} 0 & 1 & 2 & 1 & 0 & 0 & 28 \\ 1 & 0 & 6 & 1 & 0 & 0 & 51 \\ 0 & 0 & -1 & -2 & 1 & 0 & 16 \\ 0 & 0 & 4 & 0 & 0 & 1 & 89 \end{array}\right]$$

A) The maximum value of f is 89 when $x_1 = 51,\ x_2 = 28,$ and $x_3 = 0.$

B) The maximum value of f is 89 when $x_1 = 28,\ x_2 = 51,$ and $x_3 = 16.$

C) The maximum value of f is 89 when $x_1 = 51$ and $x_2 = 16.$ Since multiple solutions a

D) The maximum value of f is 89 when $x_1 = 51$ and $x_2 = 28.$ Since multiple solutions a

E) The maximum value of f is 89 when $x_1 = 28$ and $x_2 = 51.$ Since multiple solutions a

Ans: D

62. Use the simplex method to maximize the given function. Assume all variables are nonnegative.

Maximize $f = 9x + 10y$ subject to

$$14x + 14y \le 98$$
$$8x + 10y \le 112$$

A) maximum: 63 at $x = 0$, $y = 7$
B) maximum: 133 at $x = 7$, $y = 7$
C) maximum: 70 at $x = 0$, $y = 7$
D) maximum: 300 at $x = 0$, $y = 30$
E) maximum: 10 at $x = 0$, $y = 1$
Ans: C

63. Use the simplex method to maximize the given function. Assume all variables are nonnegative.

Maximize $f = 2x + 7y$ subject to

$$2x + 5y \le 31$$
$$x + 5y \le 28$$
$$x + y \le 12$$

A) maximum: 31 at $x = 5$, $y = 3$
B) maximum: 41 at $x = 3$, $y = 5$
C) maximum: 27 at $x = 4$, $y = 3$
D) maximum: 32 at $x = 2$, $y = 4$
E) maximum: 59 at $x = 5$, $y = 7$
Ans: B

64. Use the simplex method to maximize the given function. Assume all variables are nonnegative.

Maximize $f = 13x + 5y + 3z$ subject to

$$2x + y + z \le 50$$
$$x + 3y \le 20$$
$$y + z \le 15$$

A) maximum: 190 at $x = 10$, $y = 0$, $z = 20$
B) maximum: 289 at $x = 20$, $y = 1$, $z = 8$
C) maximum: 334 at $x = 24$, $y = 2$, $z = 4$
D) maximum: 165 at $x = 10$, $y = 1$, $z = 10$
E) maximum: 290 at $x = 20$, y = 0, $z = 10$
Ans: E

65. Use the simplex method to maximize the given function. Assume all variables are nonnegative.

Maximize $f = 26x_1 + 32x_2 + 19x_3 + 18x_4$ subject to

$$12x_1 + 16x_2 + 20x_3 + 8x_4 \le 884$$
$$5x_1 + 10x_2 + 10x_3 + 5x_4 \le 465$$
$$10x_1 - 5x_2 + 8x_3 + 5x_4 \le 280$$

A) maximum: 1346 at $x_1 = 10,\ x_2 = 0,\ x_3 = 24,\ x_4 = 35$

B) maximum: 966 at $x_1 = 15,\ x_2 = 0,\ x_3 = 0,\ x_4 = 32$

C) maximum: 1858 at $x_1 = 35,\ x_2 = 24,\ x_3 = 0,\ x_4 = 10$

D) maximum: 2472 at $x_1 = 46,\ x_2 = 26,\ x_3 = 12,\ x_4 = 12$

E) maximum: 2026 at $x_1 = 15,\ x_2 = 26,\ x_3 = 12,\ x_4 = 32$

Ans: C

66. The simplex matrix shown below indicates that an optimal solution has been found ($f = 95$ when $x = 50,\ y = 0$) but that a second solution is possible. Find the second solution.

$$\begin{array}{ccccc|c} x & y & s1 & s2 & f & \\ \hline 1 & \frac{1}{2} & 5 & 0 & 0 & 50 \\ 0 & \frac{1}{2} & -3 & 1 & 0 & 20 \\ \hline 0 & 0 & 5 & 0 & 1 & 95 \end{array}$$

A) The maximum is 95 at $x = 50,\ y = 40$.

B) The maximum is 95 at $x = 30,\ y = 20$.

C) The maximum is 95 at $x = 50,\ y = 20$.

D) The maximum is 95 at $x = 30,\ y = 60$.

E) The maximum is 95 at $x = 30,\ y = 40$.

Ans: E

67. Use the simplex method to maximize the function (if possible) subject to the given constraints. If there is no solution, indicate this; if multiple solutions exist, give one solution.

Maximize $f = 10x + 17y$ subject to

$$\begin{aligned} -5x + \quad y &\le 24 \\ 2x - 3y &\le 7 \end{aligned}$$

A) maximum: 408 at x =0, y = 24
B) maximum: 240 at x = 0, y = 24
C) maximum: 170 at x = 24, y = 0
D) maximum: 240 at x = 24, y = 0
E) no solution
Ans: E

68. Use the simplex method to maximize the function (if possible) subject to the given constraints. If there is no solution, indicate this; if multiple solutions exist, give one solution.

Maximize $f = 9x + 6y$ subject to

$$\begin{aligned} 4x + 3y &\le 24 \\ 10x + 9y &\le 190 \end{aligned}$$

A) maximum: 54 at x = 6, y = 0
B) maximum: 117 at x = 9, y = 6
C) maximum: 84 at x = 8, y = 2
D) maximum: 66 at x = 4, y = 5
E) no solution
Ans: A

69. At one of its factories, a jeans manufacturer makes two styles: #891 and #917. Each pair of style-891 takes 10 minutes to cut out and 20 minutes to assemble and finish. Each pair of style-917 takes 10 minutes to cut out and 30 minutes to assemble and finish. The plant has enough workers to provide at most 7500 minutes per day for cutting and at most 19,500 minutes per day for assembly and finishing. The profit on each pair of style-891 is $4.50 and the profit on each pair of style-917 is $6.50. How many pairs of each style should be produced per day to obtain maximum profit? Find the maximum daily profit.

A) 350 pairs of style #891 and 400 pairs of style #917 for a maximum profit of $4175.(

B) 300 pairs of style #891 and 450 pairs of style #917 for a maximum profit of $4275.(

C) 299 pairs of style #891 and 399 pairs of style #917 for a maximum profit of $3939.(

D) 225 pairs of style #891 and 375 pairs of style #917 for a maximum profit of $3450.(

E) 310 pairs of style #891 and 300 pairs of style #917 for a maximum profit of $3345.(

Ans: B

70. A car rental agency has a budget of $1.8 million to purchase at most 100 new cars. The agency will purchase either compact cars at $15,000 each or luxury cars at $30,000 each. From past rental patterns, the agency decides to purchase at most 50 luxury cars and expects an annual profit of $8000 per compact car and $13,500 per luxury car. How many of each type of car should be purchased in order to obtain the maximum profit while satisfying budgetary and other planning constraints? Find the maximum profit.
    A) 50 compact cars and 40 luxury cars for a maximum profit of $940,000
    B) 70 compact cars and 50 luxury cars for a maximum profit of $1,235,000
    C) 80 compact cars and 20 luxury cars for a maximum profit of $910,000
    D) 75 compact cars and 30 luxury cars for a maximum profit of $1,005,000
    E) 60 compact cars and 45 luxury cars for a maximum profit of $1,087,500

    Ans: C

71. An ice cream company is planning its production for next week. Demand for premium and light ice creams continues to outpace the company's production capacities. Two resources used in ice cream production are in short supply for next week. The mixing machine will be available for only for only 120 hours, and only 24,000 gallons of high grade milk will be available. One hundred gallons of premium ice-cream requires 0.3 hour of mixing and 90 gallons of milk. One hundred gallons of light ice cream requires 0.5 hour of mixing and 70 gallons of milk. If company earns a profit of $\$125$ per hundred gallons on both of its ice creams, how many gallons of premium and of light ice cream should company produce next week to maximize profit? How much profit will result?
    A) The company should produce 15,000 gallons of premium and 15,000 gallons of light ice cream to maximize the profit. The resultant maximum profit is $\$18,750$.
    B) The company should produce 15,000 gallons of premium and 15,000 gallons of light ice cream to maximize the profit. The resultant maximum profit is $\$37,500$.
    C) The company should produce 15,000 gallons of premium and 15,000 gallons of light ice cream to maximize the profit. The resultant maximum profit is $\$33,333$.
    D) The company should produce 12,500 gallons of premium and 17,500 gallons of light ice cream to maximize the profit. The resultant maximum profit is $\$37,500$.
    E) The company should produce 12,500 gallons of premium and 17,500 gallons of light ice cream to maximize the profit. The resultant maximum profit is $\$15,625$.

    Ans: B

72. Tire Corral has $6000 available per month for advertising. Newspaper ads cost $100 each and can occur a maximum of 21 times per month. Radio ads cost $300 each and can occur a maximum of 28 times per month at this price. Each newspaper ad reaches 7000 men over 20 years of age, and each radio ad reaches 8750 of these men. The company wants to maximize the number of ad exposures to this group. How many of each ad should it purchase? What is the maximum possible number of exposures?

A) 15 newspaper ads and 20 radio ads for a maximum exposure of 280,000 people

B) 20 newspaper ads and 15 radio ads for a maximum exposure of 271,250 people

C) 22 newspaper ads and 12 radio ads for a maximum exposure of 259,000 people

D) 21 newspaper ads and 13 radio ads for a maximum exposure of 260,750 people

E) 18 newspaper ads and 15 radio ads for a maximum exposure of 257,250 people

Ans: D

73. A medical clinic performs three types of medical tests that use the same machines. Tests A, B, and C take 15 minutes, 30 minutes, and 1 hour, respectively, with respective profits of $\$50, \$80,$ and $\$120$. The clinic has 4 machines available. One person is qualified to do test A, two to do test B, and one to do test C. If the clinic has a rush of customers for these tests, how many of each type should it schedule in a 9-hour day to maximize its profit?

A) 36 *A* tests; 36 *B* tests; 36 *C* tests; maximum profit $9000

B) 36 *A* tests; 36 *B* tests; 18 *C* tests; maximum profit $6840

C) 36 *A* tests; 36 *B* tests; 9 *C* tests; maximum profit $5760

D) 36 *A* tests; 18 *B* tests; 9 *C* tests; maximum profit $4320

E) 18 *A* tests; 18 *B* tests; 9 *C* tests; maximum profit $3420

Ans: C

74. A woman has a building with 26 one-bedroom apartments, 40 two-bedroom apartments, and 60 three-bedroom apartments available to rent to students. She has set the rent at $600 per month for the one-bedroom units, $900 per month for the two-bedroom units, and $1150 per month for the three-bedroom units. She must rent to one student per bedroom, and zoning laws limit her to at most 250 students in this building. There are enough students available to rent all the apartments. How many of each type of apartment should she rent to maximize her monthly revenue? Find the maximum possible monthly revenue.

A) Maximum revenue is $92,500 by renting 25 1-BR, 35 2-BR, and 40 3-BR apartmen

B) Maximum revenue is $96,450 by renting 22 1-BR, 35 2-BR, and 45 3-BR apartmen

C) Maximum revenue is $109,750 by renting 29 1-BR, 40 2-BR, and 49 3-BR apartme

D) Maximum revenue is $101,800 by renting 30 1-BR, 42 2-BR, and 40 3-BR apartme

E) Maximum revenue is $106,800 by renting 26 1-BR, 40 2-BR, and 48 3-BR apartme

Ans: E

75. Patio Iron makes wrought iron outdoor dining tables, chairs, and stools. Each table uses 8 feet of a standard-width wrought iron, 2 hours of labor for cutting and assembly, and 2 hours of labor for detail and finishing work. Each chair uses 6 feet of the wrought iron, 2 hours of cutting and assembly labor, and 1.5 hours of detail and finishing labor. Each stool uses 1 foot of the wrought iron, 1.5 hours for cutting and assembly, and 0.5 hour for detail and finishing work, and the daily demand for stools is at most 16. Each day Patio Iron has available at most 108 feet of wrought iron, 50 hours for cutting and assembly, and 40 hours for detail and finishing. If the profits are $61 for each dining table, $46 for each chair, and $36 for each stool, how many of each item should be made each day to maximize profit? Find the maximum profit.

A) 7 tables, 6 chairs, and 16 stools per day for a maximum daily profit of $1279
B) 6 tables, 5 chairs, and 18 stools per day for a maximum daily profit of $1244
C) 5 tables, 4 chairs, and 18 stools per day for a maximum daily profit of $1137
D) 8 tables, 5 chairs, and 16 stools per day for a maximum daily profit of $1294
E) 8 tables, 6 chairs, and 15 stools per day for a maximum daily profit of $1304

Ans: A

76. Form the matrix associated with the given minimization problem and find its transpose.

Minimize $g = 3y_1 + 3y_2$ subject to

$$4y_1 + y_2 \geq 7$$
$$4y_1 + 4y_2 \geq 13$$

A) $\left[\begin{array}{cc|c} 4 & 1 & 7 \\ 4 & 4 & 13 \\ 3 & 3 & g \end{array}\right]$

B) $\left[\begin{array}{cc|c} 4 & 4 & g \\ 1 & 13 & 3 \\ 7 & 4 & 3 \end{array}\right]$

C) $\left[\begin{array}{cc|c} 1 & 4 & 7 \\ 4 & 4 & 13 \\ 3 & 3 & g \end{array}\right]$

D) $\left[\begin{array}{cc|c} 4 & 4 & 3 \\ 1 & 4 & 3 \\ 7 & 13 & g \end{array}\right]$

E) $\left[\begin{array}{cc|c} 4 & 3 & 4 \\ 4 & 3 & 1 \\ 13 & 7 & g \end{array}\right]$

Ans: D

77. Write the dual maximization problem. Be sure to rename the variables.

Minimize $g = 3y_1 + 2y_2$ subject to

$$3y_1 + y_2 \geq 8$$
$$4y_1 + 4y_2 \geq 14$$

A) Maximize $f = 8x_1 + 14x_2$
Constraints: $3x_1 + 4x_2 \leq 3;\ x_1 + 4x_2 \leq 2;\ x_1 \geq 0;\ x_2 \geq 0$

B) Maximize $f = 3x_1 + 2x_2$
Constraints: $3x_1 + x_2 \leq 8;\ 4x_1 + 4x_2 \leq 14;\ x_1 \geq 0;\ x_2 \geq 0$

C) Maximize $f = 4x_1 + 3x_2$
Constraints: $x_1 + 4x_2 \leq 2;\ 8x_1 + 14x_2 \leq 3;\ x_1 \geq 0;\ x_2 \geq 0$

D) Maximize $f = 2x_1 + 3x_2$
Constraints: $3x_1 + x_2 \leq 8;\ 4x_1 + 4x_2 \leq 14;\ x_1 \geq 0;\ x_2 \geq 0$

E) Maximize $f = 14x_1 + 8x_2$
Constraints: $3x_1 + 2x_2 \leq 3;\ x_1 + 4x_2 \leq 4;\ x_1 \geq 0;\ x_2 \geq 0$

Ans: A

78. Find the transpose of the matrix associated with the given minimization problem. y

Minimize $g = 9y_1 + 11y_2$ subject to

$$y_1 + 3y_2 \geq 22$$
$$4y_1 + 3y_2 \geq 28$$

A) $\left[\begin{array}{cc|c} 1 & 3 & 22 \\ 4 & 3 & 28 \\ 9 & 11 & g \end{array}\right]$

B) $\left[\begin{array}{cc|c} 1 & 4 & 9 \\ 3 & 3 & 11 \\ 22 & 28 & g \end{array}\right]$

C) $\left[\begin{array}{cc|c} 1 & 3 & 28 \\ 4 & 3 & 22 \\ 11 & 9 & g \end{array}\right]$

D) $\left[\begin{array}{cc|c} 9 & 1 & 4 \\ 11 & 3 & 3 \\ 28 & 22 & g \end{array}\right]$

E) $\left[\begin{array}{cc|c} 4 & 3 & 28 \\ 1 & 3 & 22 \\ 9 & 11 & g \end{array}\right]$

Ans: B

79. Write the dual maximization problem. Be sure to rename the variables.

Minimize $g = 9y_1 + 10y_2$ subject to

$$y_1 + 2y_2 \geq 23$$
$$4y_1 + 3y_2 \geq 28$$

A) Maximize $f = 9x_1 + 10x_2$
Constraints: $x_1 + 2x_2 \leq 23;\ 4x_1 + 3x_2 \leq 28;\ x_1 \geq 0;\ x_2 \geq 0$

B) Maximize $f = 10x_1 + 9x_2$
Constraints: $x_1 + 2x_2 \leq 28;\ 4x_1 + 3x_2 \leq 23;\ x_1 \geq 0;\ x_2 \geq 0$

C) Maximize $f = 28x_1 + 23x_2$
Constraints: $9x_1 + x_2 \leq 4;\ 10x_1 + 2x_2 \leq 3;\ x_1 \geq 0;\ x_2 \geq 0$

D) Maximize $f = 9x_1 + 10x_2$
Constraints: $4x_1 + 3x_2 \leq 28;\ x_1 + 2x_2 \leq 23;\ x_1 \geq 0;\ x_2 \geq 0$

E) Maximize $f = 23x_1 + 28x_2$
Constraints: $x_1 + 4x_2 \leq 9;\ 2x_1 + 3x_2 \leq 10;\ x_1 \geq 0;\ x_2 \geq 0$

Ans: E

80. Suppose a primal minimization problem and its dual maximization problem were solved by using the simplex method on the dual problem. The final simplex matrix is given. Find the solution of the minimization problem. Use y_1, y_2, y_3 as the variables and g as the function.

$$\left[\begin{array}{ccccccc|c} 0 & 0 & 1 & \frac{2}{5} & \frac{5}{3} & \frac{4}{15} & 0 & 15 \\ 1 & 0 & 0 & -\frac{1}{5} & \frac{11}{3} & \frac{1}{5} & 0 & 19 \\ 0 & 1 & 0 & \frac{3}{5} & -\frac{2}{3} & \frac{2}{3} & 0 & 23 \\ 0 & 0 & 0 & 12 & 16 & 20 & 1 & 554 \end{array}\right]$$

A) $g = 554,\ y_1 = 19,\ y_2 = 23,\ y_3 = 15$

B) $g = 554,\ y_1 = 15,\ y_2 = 19,\ y_3 = 23$

C) $g = 554,\ y_1 = 12,\ y_2 = 16,\ y_3 = 20$

D) $g = 554,\ y_1 = 16,\ y_2 = 20,\ y_3 = 12$

E) $g = 12,\ y_1 = 16,\ y_2 = 20,\ y_3 = 554$

Ans: C

81. Suppose a primal minimization problem and its dual maximization problem were solved by using the simplex method on the dual problem. The final simplex matrix is given. Find the solution of the maximization problem. Use x_1, x_2, x_3 as the variables and f as the function.

$$\left[\begin{array}{ccccccc|c} 0 & 0 & 1 & \frac{2}{5} & \frac{5}{3} & \frac{4}{15} & 0 & 17 \\ 1 & 0 & 0 & -\frac{1}{5} & \frac{11}{3} & \frac{1}{5} & 0 & 18 \\ 0 & 1 & 0 & \frac{3}{5} & -\frac{2}{3} & \frac{2}{3} & 0 & 22 \\ 0 & 0 & 0 & 13 & 15 & 20 & 1 & 524 \end{array}\right]$$

A) $f = 524,\ x_1 = 13,\ x_2 = 15,\ x_3 = 20$

B) $f = 524,\ x_1 = 17,\ x_2 = 18,\ x_3 = 22$

C) $f = 17,\ x_1 = 18,\ x_2 = 22,\ x_3 = 524$

D) $f = 524,\ x_1 = 18,\ x_2 = 22,\ x_3 = 17$

E) $f = 524,\ x_1 = 20,\ x_2 = 15,\ x_3 = 13$

Ans: D

82. Solve both the primal and dual problems with the simplex method. Use f to represent the dual objective function.

Minimize $g = 6y_1 + 28y_2$ subject to

$$\begin{aligned} 2y_1 + y_2 &\geq 11 \\ y_1 + 3y_2 &\geq 11 \\ y_1 + 4y_2 &\geq 16 \end{aligned}$$

A) Primal: $y_1 = 16,\ y_2 = 0,\ g = 96$
Dual: $x_1 = 0,\ x_2 = 0,\ x_3 = 6,\ f = 96$

B) Primal: $y_1 = 6,\ y_2 = 4,\ g = 96$
Dual: $x_1 = 0,\ x_2 = 0,\ x_3 = 28,\ f = 96$

C) Primal: $y_1 = 0,\ y_2 = 0,\ g = 448$
Dual: $x_1 = 6,\ x_2 = 4,\ x_3 = 28,\ f = 448$

D) Primal: $y_1 = 6,\ y_2 = 28,\ g = 448$
Dual: $x_1 = 0,\ x_2 = 16,\ x_3 = 0,\ f = 448$

E) Primal: $y_1 = 14,\ y_2 = 0,\ g = 168$
Dual: $x_1 = 6,\ x_2 = 0,\ x_3 = 0,\ f = 168$

Ans: A

83. Write the dual maximization problem.
Minimize $g = 20y_1 + 5y_2$ subject to
$7y_1 - 2y_2 \geq 15$
$5y_1 + y_2 \geq 18$
A) Maximize $f = 15x_1 + 18x_2$ subject to
$7x_1 + 5x_2 \leq 20$
$-2x_1 + x_2 \leq 5$
B) Minimize $f = 15x_1 + 18x_2$ subject to
$7x_1 + 5x_2 \geq 20$
$-2x_1 + x_2 \geq 5$
C) Minimize $g = 20y_1 + 5y_2$ subject to
$7x_1 + 5x_2 \leq 15$
$-2x_1 + x_2 \leq 18$
D) Maximize $g = 20y_1 + 5y_2$ subject to
$7x_1 + 5x_2 \leq 15$
$-2x_1 + x_2 \leq 18$
E) Maximize $g = 20y_1 + 5y_2$ subject to
$7y_1 - 2y_2 \leq 15$
$5y_1 + y_2 \leq 18$
Ans: A

84. Solve the following minimization problem by solving the primal problem with the simplex method.
Minimize $g = 10y_1 + 4y_2$ subject to
$3y_1 - 2y_2 \geq 9$
$2y_1 + y_2 \geq 13$
A) Minimum: $g = 72$ at $y_1 = 6, y_2 = 3$
B) Minimum: $g = 62$ at $y_1 = 5, y_2 = 3$
C) Minimum: $g = 58$ at $y_1 = 5, y_2 = 2$
D) Minimum: $g = 52$ at $y_1 = 4, y_2 = 3$
E) Minimum: $g = 50$ at $y_1 = 5, y_2 = 3$
Ans: B

85. A minimization problem is given solve its dual problem with the simplex method.
Minimize $g = 8y_1 + 4y_2$ subject to
$3y_1 - 2y_2 \geq 19$
$2y_1 + y_2 \geq -8$

A) Minimum: $f = 52$ at $x_1 = 5, x_2 = 3$
B) Maximum: $f = 56$ at $x_1 = 6, x_2 = 2$
C) Maximum: $f = 44$ at $x_1 = 5, x_2 = 1$
D) Maximum: $f = 48$ at $x_1 = 5, x_2 = 2$
E) Maximum: $f = 36$ at $x_1 = 5, x_2 = 2$

Ans: D

86. Use the simplex method.

Minimize $g = 10y_1 + 9y_2 + 11y_3$ subject to

$$\begin{aligned} y_1 \quad + \quad\quad 2y_3 &\geq 10 \\ y_1 + y_2 \quad\quad &\geq 12 \\ 2y_1 + 2y_2 + y_3 &\geq 8 \end{aligned}$$

A) $g = 108$ at $y_1 = 0,\ y_2 = 12,\ y_3 = 0$
B) $g = 109$ at $y_1 = 10,\ y_2 = 2,\ y_3 = 0$
C) $g = 118$ at $y_1 = 1,\ y_2 = 9,\ y_3 = 9$
D) $g = 108$ at $y_1 = 1,\ y_2 = 9,\ y_3 = 9$
E) $g = 118$ at $y_1 = 10,\ y_2 = 2,\ y_3 = 0$

Ans: E

87. Use the simplex method.

Minimize $g = 24x + 33y + 36z$ subject to

$$\begin{aligned} x + 2y + 3z &\geq 48 \\ 2x + 2y + 3z &\geq 70 \\ 2x + 3y + 4z &\geq 96 \end{aligned}$$

A) $g = 839$ when $x = 6,\ y = 6,\ z = 9$
B) $g = 864$ when $x = 0,\ y = 0,\ z = 24$
C) $g = 852$ when $x = 24,\ y = 33,\ z = 36$
D) $g = 871$ when $x = 6,\ y = 0,\ z = 0$
E) $g = 828$ when $x = 0,\ y = 33,\ z = 0$

Ans: B

88. A primal maximization problem is given. Form the dual minimization problem.

Maximize $f = 29x_1 + 13x_2$ subject to

$$4x_1 + 19x_2 \le 60$$
$$3x_1 + 5x_2 \le 119$$

A) Minimize $g = 29y_1 + 13y_2$ subject to

$$4y_1 + 3y_2 \ge 60$$
$$19y_1 + 5y_2 \ge 119$$
$$y_1 \ge 0,\ y_2 \ge 0$$

B) Minimize $g = 60y_1 + 119y_2$ subject to

$$4y_1 + 3y_2 \ge 29$$
$$19y_1 + 5y_2 \ge 13$$
$$y_1 \ge 0,\ y_2 \ge 0$$

C) Minimize $g = 29x_1 + 13x_2$ subject to

$$4y_1 + 19y_2 \ge 60$$
$$3y_1 + 5y_2 \ge 119$$
$$y_1 \ge 0,\ y_2 \ge 0$$

D) Minimize $g = 60y_1 + 119y_2$ subject to

$$4y_1 + 3y_2 \le 29$$
$$19y_1 + 5y_2 \le 13$$
$$y_1 \ge 0,\ y_2 \ge 0$$

E) Minimize $g = 60x_1 + 119x_2$ subject to

$$4y_1 + 19y_2 \le 29$$
$$3y_1 + 5y_2 \le 13$$
$$y_1 \ge 0,\ y_2 \ge 0$$

Ans: B

89. A primal maximization problem is given. Solve both the primal and dual problems with the simplex method.

Maximize $f = 28x_1 + 12x_2$ subject to

$$7x_1 + 12x_2 \le 50$$
$$2x_1 + 6x_2 \le 116$$

A) Primal: $f = 350$ at $x_1 = 0,\ x_2 = 1$
Dual: $g = 350$ at $y_1 = 0,\ y_2 = 2$

B) Primal: $f = 175$ at $x_1 = \frac{12}{7},\ x_2 = \frac{1}{7}$
Dual: $g = 175$ at $y_1 = 2,\ y_2 = 0$

C) Primal: $f = 166$ at $x_1 = 5,\ x_2 = 0$
Dual: $g = 166$ at $y_1 = 0,\ y_2 = 1$

D) Primal: $f = 200$ at $x_1 = \frac{50}{7},\ x_2 = 0$
Dual: $g = 200$ at $y_1 = 4,\ y_2 = 0$

E) Primal: $f = 290$ at $x_1 = 0,\ x_2 = 5$
Dual: $g = 290$ at $y_1 = 0,\ y_2 = 3$

Ans: D

90. Use technology to solve the problem.

Minimize $w = 48y_1 + 22y_2 + 10y_3$ subject to

$$4y_1 + 2y_2 + y_3 \ge 30$$
$$12y_1 + 4y_2 + 3y_3 \ge 60$$
$$2y_1 + 3y_2 + y_3 \ge 40$$

A) 332 at $y_1 = 10,\ y_2 = 0,\ y_3 = 0$

B) 315 at $y_1 = 1,\ y_2 = 0,\ y_3 = 10$

C) 320 at $y_1 = 0,\ y_2 = 10,\ y_3 = 10$

D) 299 at $y_1 = 48,\ y_2 = 22,\ y_3 = 10$

E) 330 at $y_1 = 10,\ y_2 = 0,\ y_3 = 10$

Ans: C

91. Use Excel or another technology to solve the following optimization problem.
Minimize $g = 140y_1 + 110y_2 + 135y_3 + 45y_1$ subject to

$$\begin{aligned} 3y_1 + 2y_2 + y_3 + y_4 &\geq 75 \\ 4y_1 + 5y_2 + y_3 &\geq 70 \\ 4y_1 + 3y_2 + y_3 &\geq 100 \\ 5y_1 + 2y_2 + y_3 &\geq 175 \end{aligned}$$

A) Minimum is 5035 at $y_1 = 35,\ y_2 = 0,\ y_3 = 1,\ y_4 = 0$
B) Minimum is 4485 at $y_1 = 35,\ y_2 = -5,\ y_3 = 1,\ y_4 = 0$
C) Minimum is 4350 at $y_1 = 35,\ y_2 = -5,\ y_3 = 0,\ y_4 = 0$
D) Minimum is 4900 at $y_1 = 35,\ y_2 = 0,\ y_3 = 0,\ y_4 = 0$
E) Minimum is 3850 at $y_1 = 0,\ y_2 = 35,\ y_3 = 0,\ y_4 = 0$
Ans: D

92. CDF Appliances has assembly plants in Atlanta and Fort Worth where they produce a variety of kitchen appliances, including a 12-cup coffee maker and a cappuccino machine. In each hour at the Atlanta plant, 160 of the 12-cup models and 200 of the cappuccino machines can be assembled and the hourly cost is $700. In each hour at the Fort Worth plant, 800 of the 12-cup models and 200 of the cappuccino machines can be assembled and the hourly cost is $2160. CDF Appliances expects orders each week for at least 64,000 of the 12-cup models and at least 40,000 of the cappuccino machines. How many hours per week should each plant be operated in order to provide inventory for the orders at minimum cost? Find the minimum cost.
A) Minimum of $134,800 per week when Atlanta plant is operated for 100 hours and the Fort Worth plant is operated for 30 hours.
B) Minimum of $170,400 per week when Atlanta plant is operated for 120 hours and the Fort Worth plant is operated for 40 hours.
C) Minimum of $376,500 per week when Atlanta plant is operated for 75 hours and the Fort Worth plant is operated for 150 hours.
D) Minimum of $340,000 per week when Atlanta plant is operated for 100 hours and the Fort Worth plant is operated for 125 hours.
E) Minimum of $213,000 per week when Atlanta plant is operated for 150 hours and the Fort Worth plant is operated for 50 hours.
Ans: E

93. Nekita Corporation assembles cell phones and camera cell phones at two different factories within the same city. During each hour at the first factory, 15 cell phones and 30 camera cell phones can be assembled at a cost of $130/hour. During each hour at the second factory, 10 cell phones and 60 camera cell phones can be assembled at a cost of $150/hour. If Nekita expects weekly orders for at least 15,000 cell phones and at least 45,000 camera cell phones, how many hours per week should it schedule at each location to be able to fill the orders at minimum cost? What is the minimum cost?
A) Minimum of $153,750 when assembly is scheduled for 750 hours at the first factory and 375 hours at the second factory.
B) Minimum of $148,750 when assembly is scheduled for 625 hours at the first factory and 450 hours at the second factory.
C) Minimum of $147,750 when assembly is scheduled for 675 hours at the first factory and 400 hours at the second factory.
D) Minimum of $155,350 when assembly is scheduled for 520 hours at the first factory and 585 hours at the second factory.
E) Minimum of $146,750 when assembly is scheduled for 725 hours at the first factory and 350 hours at the second factory.
Ans: A

94. A pork producer is considering two types of feed that contain the necessary ingredients for the nutritional requirements for fattening hogs. Brand X contains 2 units of ingredient A per pound and 14 units of ingredient B per pound, Brand Y contains 14 units of ingredient A per pound and 2 units of ingredient B per pound. The nutritional requirements for he hogs are are at least 62 units of ingredient A and at least 146 units of ingredient B. If brand X costs 50 cents per pound and brand Y costs 85 cents per pound, how many pounds of each brand should be bought to satisfy the nutritional requirements at minimum cost?
A) 15 lbs of brand X and 2 lbs of brand Y meets the needs at minimum cost.
B) 10 lbs of brand X and 2 lbs of brand Y meets the needs at minimum cost.
C) 15 lbs of brand X and 3 lbs of brand Y meets the needs at minimum cost.
D) 3 lbs of brand X and 10 lbs of brand Y meets the needs at minimum cost.
E) 10 lbs of brand X and 3 lbs of brand Y meets the needs at minimum cost.
Ans: E

95. Two factories produce three different types of kitchen appliances. The following table summarizes the production capacities, the numbers of each type of appliance ordered, and the daily operating costs for the factories. How many days should each factory operate to fill the orders at minimum cost? Find the minimum cost.

	Factory 1	Factory 2	Number Ordered
Appliance 1	80/day	20/day	1600
Appliance 2	10/day	10/day	500
Appliance 3	50/day	20/day	1900
Daily cost	$11,500	$21,000	

A) Minimum cost of $860,000 using 20 days at Factory 1 and 30 days at Factory 2.
B) Minimum cost of $230,000 using 20 days at Factory 1 and 0 days at Factory 2.
C) Minimum cost of $535,000 using 10 days at Factory 1 and 20 days at Factory 2.
D) Minimum cost of $840,000 using 0 days at Factory 1 and 40 days at Factory 2.
E) Minimum cost of $612,500 using 35 days at Factory 1 and 10 days at Factory 2.
Ans: B

96. In a laboratory experiment, two separate foods are given to experimental animals. Each food contains essential ingredients, A and B, for which the animals have a minimum requirement, and each food also has an ingredient C, which can be harmful to the animals. The table below summarizes this information.

	Food 1	Food 2	Required
Ingredient A	8 units/g	3 units/g	35 units
Ingredient B	7 units/g	14 units/g	42 units
Ingredient C	2 units/g	1 unit/g	

How many grams of foods 1 and 2 will satisfy the requirements for A and B and minimize the amount of ingredient C that is ingested? Also what is the minimum amount of ingredient C ingested?
A) 1 gram of food 1 and 4 grams of food 2 satisfy the minimum requirements for A and B while minimizing the amount of ingredient C to 9 grams.
B) 4 grams of food 1 and 1 gram of food 2 satisfy the minimum requirements for A and B while minimizing the amount of ingredient C to 9 grams.
C) 11 grams of food 1 and 4 grams of food 2 satisfy the minimum requirements for A and B while minimizing the amount of ingredient C to 10 grams.
D) 5 grams of food 1 and 1 gram of food 2 satisfy the minimum requirements for A and B while minimizing the amount of ingredient C to 11 grams.
E) 3 grams of food 1 and 1 gram of food 2 satisfy the minimum requirements for A and B while minimizing the amount of ingredient C to 8 grams.
Ans: B

97. A political candidate wishes to use a combination of radio and TV advertisements in her campaign. Research has been shown that each 1-minute spot on TV reaches 0.9 million people and that each 1 -minute spot on radio reaches 0.6 million. The candidate feels she must reach 63 million people, and she must buy at least 81 minutes of advertisements. How many minutes of each medium should be used if TV costs $\$450$ per minute, radio costs $\$90$ per minute, and the candidate wishes to minimize costs?
   A) Minimum cost is $\$13,050$ using 10 minutes of TV time and 95 minutes of radio time.
   B) Minimum cost is $\$47,250$ using 105 minutes of TV time and 0 minutes of radio time.
   C) Minimum cost is $\$47,250$ using 0 minutes of TV time and 105 minutes of radio time.
   D) Minimum cost is $\$9,450$ using 0 minutes of TV time and 105 minutes of radio time.
   E) Minimum cost is $\$9,450$ using 105 minutes of TV time and 0 minutes of radio time.
   Ans: D

98. The James MacGregor Mining Company owns three mines: I, II, and III. Three grades of ore, A, B, and C, are mined at these mines. For each grade of ore, the number of tons per week available from each mine and the number of tons per week required to fill orders are given in the following table.

		I	II	III	Required Tons/Week
Ore	A	10	10	10	90
Grades	B	0	10	10	50
	C	10	0	10	60
Cost/day		$6400	$8000	$13,000	

Find the number of days that the company should operate each mine so that orders are filled at minimum cost. Find the minimum cost.

   A) Minimum cost is $54,800 obtained by operating mine I for 2 days, mine II for 2 days, and mine III for 2 days.
   B) Minimum cost is $95,200 obtained by operating mine I for 3 days, mine II for 3 days, and mine III for 4 days.
   C) Minimum cost is $83,800 obtained by operating mine I for 2 days, mine II for 4 days, and mine III for 3 days.
   D) Minimum cost is $75,600 obtained by operating mine I for 4 days, mine II for 3 days, and mine III for 2 days.
   E) Minimum cost is $80,600 obtained by operating mine I for 4 days, mine II for 2 days, and mine III for 3 days.
   Ans: D

99. Three factories each dump waste water containing three different types of pollutants into a river. State regulations require the factories to treat their waste in order to reduce pollution levels. The table shows the possible percent reduction of each pollutant at each site and the cost per ton to process the waste.

	Factory 1	Factory 2	Factory 3
Pollutant 1	75%	45%	20%
Pollutant 2	65%	30%	15%
Pollutant 3	10%	15%	5%
Cost/ton	$50	$23	$8

If the state requires a reduction of at least 65 tons per day of pollutant 1, at least 40 tons per day of pollutant 2, and at least 20 tons per day of pollutant 3, find the number of tons of waste that must be treated each day at each site so that the state's requirements are satisfied and the treatment costs are minimized. Find the minimum cost.

A) The minimum cost is $3410 per day when Factory #2 and Factory #3 each process 110 tons and Factory #1 does not process any.
B) The minimum cost is $2920 per day when Factory #1 and Factory #2 each process 40 tons and Factory #3 does not process any.
C) The minimum cost is $3100 per day when Factory #2 and Factory #3 each process 100 tons and Factory #1 does not process any.
D) The minimum cost is $1540 per day when Factory #1 and Factory #2 each process 20 tons and Factory #3 produces 10 tons.
E) The minimum cost is $2550 per day when Factory #2 and Factory #3 each process 50 tons and Factory #1 produces 20 tons.

Ans: C

100. Assume that each nurse works 8 consecutive hours at the Beaver Medical Center. The center has the following staffing requirements for each 4-hour work period.

Work Period	*Nurses Needed*
1 (7 a.m.–11 a.m.)	32
2 (11 a.m.–3 p.m.)	12
3 (3 p.m.–7 p.m.)	17
4 (7 p.m.–11 p.m.)	25
5 (11 p.m.–3 a.m.)	17
6 (3 a.m.–7 a.m.)	9

If y_1 represents the number of nurses starting in period 1, y_2 the number starting in period 2, and so on, write the linear programming problem that will minimize the total number of nurses needed. (Note that the nurses who begin work in period 6 work periods 6 and 1 for their 8-hour shift.)

A) Minimize $N = y_1 + y_2 + y_3 + y_4 + y_5 + y_6$
Constraints: $y_1 \geq 32,\ y_1 + y_2 \geq 12,\ y_2 + y_3 \geq 17,$
$y_3 + y_4 \geq 25,\ y_4 + y_5 \geq 17,\ y_5 + y_6 \geq 9$

B) Minimize $N = y_1 + y_2 + y_3 + y_4 + y_5 + y_6$
Constraints: $y_1 + y_6 \geq 32,\ y_1 + y_2 \geq 12,\ y_2 + y_3 \geq 17,$
$y_3 + y_4 \geq 25,\ y_4 + y_5 \geq 17,\ y_5 + y_6 \geq 9$

C) Minimize $N = y_1 + y_2 + y_3 + y_4 + y_5 + y_6$
Constraints: $y_1 + y_6 \leq 32,\ y_1 + y_2 \leq 12,\ y_2 + y_3 \leq 17,$
$y_3 + y_4 \leq 25,\ y_4 + y_5 \leq 17,\ y_5 + y_6 \leq 9$

D) Minimize $N = y_1 + y_2 + y_3 + y_4 + y_5 + y_6$
Constraints: $y_1 \leq 32,\ y_1 + y_2 \leq 12,\ y_2 + y_3 \leq 17,$
$y_3 + y_4 \leq 25,\ y_4 + y_5 \leq 17,\ y_5 + y_6 \leq 9$

E) Minimize $N = y_1 + y_2 + y_3 + y_4 + y_5 + y_6$
Constraints: $y_1 \geq 32,\ y_1 + y_2 \geq 12,\ y_2 + y_3 \geq 17,$
$y_3 + y_4 \geq 25,\ y_4 + y_5 \geq 17,\ y_6 \geq 9$

Ans: B

101. Assume that each nurse works 8 consecutive hours at the Beaver Medical Center. The center has the following staffing requirements for each 4-hour work period.

Work Period	*Nurses Needed*
1 (7–11)	40
2 (11–3)	20
3 (3–7)	25
4 (7–11)	30
5 (11–3)	11
6 (3–7)	6

If y_1 represents the number of nurses starting in period 1, y_2 the number starting in period 2, and so on, write and solve the linear programming problem that will minimize the total number of nurses needed. (Note that the nurses who begin work in period 6 work periods 6 and 1 for their 8-hour shift.)

A) The minimum is 76 nurses with 35 nurses starting in period 1, 5 nurses starting in period 2, 25 nurses starting in period 3, 5 nurses starting in period 4, and 6 nurses starting in period 5 (no nurses need to start in period 6).

B) The minimum is 76 nurses with 35 nurses starting in period 1, 25 nurses starting in period 3, and 5 nurses starting in period 4, 6 nurses starting in period 5, and 5 nurses starting in period 6 (no nurses need to start in period 2).

C) The minimum is 76 nurses with 40 nurses starting in period 1, 25 nurses starting in period 3, and 5 nurses starting in period 4, and 6 nurses starting in period 5 (no nurses need to start in periods 2 and 6).

D) The minimum is 81 nurses with 40 nurses starting in period 1, 25 nurses starting in period 3, and 5 nurses starting in period 4, and 11 nurses starting in period 5 (no nurses need to start in periods 2 and 6).

E) The minimum is 71 nurses with 40 nurses starting in period 1, 20 nurses starting in period 3, and 5 nurses starting in period 4, and 6 nurses starting in period 5 (no nurses need to start in periods 2 and 6).

Ans: C

102. Express the inequality $4x-6y\geq 10$ as a "$\leq$" constraint.

A) $4x-6y\leq 10$

B) $-4x+6y\leq -10$

C) $-4x+6y\leq 10$

D) $4x+6y\leq -10$

E) $-4x-6y\leq -10$

Ans: B

103. State the following problem in a form for which the simplex matrix can be formed (that is, as a maximization problem with "$\le$" constraints).

Maximize $f = 2x + 3y$ subject to

$$\begin{aligned} 6x + 4y &\le 28 \\ -5x + y &\ge 2 \\ x \ge 0, y &\ge 0. \end{aligned}$$

A)

Maximize $f = 2x + 3y$ subject to

$$\begin{aligned} 6x + 4y &\le 28 \\ 5x - y &\le -2 \\ x \ge 0, y &\ge 0. \end{aligned}$$

B)

Maximize $f = 2x + 3y$ subject to

$$\begin{aligned} 6x + 4y &\le 28 \\ 5x - y &\le -2 \\ x \le 0, y &\le 0. \end{aligned}$$

C)

Maximize $f = 2x + 3y$ subject to

$$\begin{aligned} 6x + 4y &\le 28 \\ -5x + y &\le 2 \\ x \ge 0, y &\ge 0. \end{aligned}$$

D)

Maximize $f = 2x + 3y$ subject to

$$\begin{aligned} 6x + 4y &\le 28 \\ -5x + y &\le 2 \\ x \le 0, y &\le 0. \end{aligned}$$

E)

Maximize $f = 2x + 3y$ subject to

$$\begin{aligned} 6x + 4y &\le 28 \\ 5x - y &\le 2 \\ x \ge 0, y &\ge 0. \end{aligned}$$

Ans: A

104. Form the simplex matrix for the problem given below.

Maximize $f = 3x + 2y$ subject to

$$\begin{aligned} 8x + 4y &\le 28 \\ -4x + y &\ge 2 \\ x \ge 0, y &\ge 0. \end{aligned}$$

A)
$$\begin{array}{ccccc|c} x & y & s_1 & s_2 & f & \\ \hline 8 & 4 & 1 & 0 & 0 & 28 \\ -4 & 1 & 0 & 1 & 0 & 2 \\ \hline -3 & -2 & 0 & 0 & 1 & 0 \end{array}$$

B)
$$\begin{array}{ccccc|c} x & y & s_1 & s_2 & f & \\ \hline 8 & 4 & 1 & 0 & 0 & 28 \\ 4 & -1 & 0 & 1 & 0 & -2 \\ \hline -3 & -2 & 0 & 0 & 1 & 0 \end{array}$$

C)
$$\begin{array}{ccccc|c} x & y & s_1 & s_2 & f & \\ \hline 8 & 4 & 1 & 0 & 0 & -3 \\ 4 & -1 & 0 & 1 & 0 & -2 \\ \hline 28 & -2 & 0 & 0 & 1 & 0 \end{array}$$

D)
$$\begin{array}{ccccc|c} x & y & s_1 & s_2 & f & \\ \hline 8 & 4 & 1 & 1 & 0 & 28 \\ -4 & 1 & 0 & 0 & 0 & 2 \\ \hline 3 & 2 & 0 & 0 & 1 & 0 \end{array}$$

E)
$$\begin{array}{ccccc|c} x & y & s_1 & s_2 & f & \\ \hline 8 & 4 & 1 & 0 & 0 & 3 \\ 4 & -1 & 0 & 1 & 0 & 2 \\ \hline 28 & -2 & 0 & 0 & 1 & 0 \end{array}$$

Ans: B

105. State the given problem in a form from which the simplex matrix can be formed (that is, as a maximization problem with "$\le$" constraints).

Minimize $g = 40x + 35y$ subject to

$$x + y \le 118$$
$$-x + y \le 30$$
$$-6x + 3y \ge 8$$
$$x \ge 0, y \ge 0$$

A) Maximize $g = -40x - 35y$

Subject to: $x + y \le -118,\ -x + y \le -30,\ -6x + 3y \le -8,\ x \ge 0,\ y \ge 0$

B) Maximize $-g = 40x + 35y$

Subject to: $-x - y \le 118,\ x - y \le 30,\ -6x - 3y \le 8,\ x \ge 0,\ y \ge 0$

C) Maximize $g = 40x + 35y$

Subject to: $x - y \le -118,\ -x + y \le 30,\ -6x + 3y \le 8,\ x \ge 0,\ y \ge 0$

D) Maximize $-g = -40x - 35y$

Subject to: $x + y \le 118,\ -x + y \le 30,\ 6x - 3y \le -8,\ x \ge 0,\ y \ge 0$

E) Maximize $-g = 40x - 35y$

Subject to: $x - y \le 118,\ -x - y \le 30,\ -6x - 3y \le 8,\ x \ge 0,\ y \ge 0$

Ans: D

106. Form the simplex matrix, and identify the first pivot entry.

Minimize $g = 49x + 26y$ subject to

$$\begin{aligned} x + y &\le 105 \\ -x + y &\le 12 \\ -2x + 4y &\ge 2 \\ x \ge 0,\ y &\ge 0 \end{aligned}$$

A)
$$\begin{array}{c} \begin{matrix} x & y & s_1 & s_2 & s_3 & -g \end{matrix} \\ \left[\begin{array}{cccccc|c} 1 & 1 & 1 & 0 & 0 & 0 & 105 \\ -1 & 1 & 0 & 1 & 0 & 0 & 12 \\ 2 & -4 & 0 & 0 & 1 & 0 & -2 \\ 49 & 26 & 0 & 0 & 0 & 1 & 0 \end{array}\right] \end{array} \text{ next pivot: } -4$$

B)
$$\begin{array}{c} \begin{matrix} x & y & s_1 & s_2 & s_3 & -g \end{matrix} \\ \left[\begin{array}{cccccc|c} -1 & -1 & 1 & 0 & 0 & 0 & -105 \\ 1 & -1 & 0 & 1 & 0 & 0 & -12 \\ 2 & -4 & 0 & 0 & 1 & 0 & -2 \\ -49 & -26 & 0 & 0 & 0 & 1 & 0 \end{array}\right] \end{array} \text{ next pivot: } 2$$

C)
$$\begin{array}{c} \begin{matrix} x & y & s_1 & s_2 & s_3 & -g \end{matrix} \\ \left[\begin{array}{cccccc|c} -1 & -1 & 1 & 0 & 0 & 0 & -105 \\ 1 & -1 & 0 & 1 & 0 & 0 & -12 \\ -2 & 4 & 0 & 0 & 1 & 0 & 2 \\ -49 & -26 & 0 & 0 & 0 & 1 & 0 \end{array}\right] \end{array} \text{ next pivot: -2}$$

D)
$$\begin{array}{c} \begin{matrix} x & y & s_1 & s_2 & s_3 & -g \end{matrix} \\ \left[\begin{array}{cccccc|c} 1 & 1 & 1 & 0 & 0 & 0 & 105 \\ -1 & 1 & 0 & 1 & 0 & 0 & 12 \\ -2 & 4 & 0 & 0 & 1 & 0 & 2 \\ 49 & 26 & 0 & 0 & 0 & 1 & 0 \end{array}\right] \end{array} \text{ next pivot: } 4$$

E)
$$\begin{array}{c} \begin{matrix} x & y & s_1 & s_2 & s_3 & -g \end{matrix} \\ \left[\begin{array}{cccccc|c} 1 & 1 & 1 & 0 & 0 & 0 & 105 \\ -1 & 1 & 0 & 1 & 0 & 0 & 12 \\ 2 & -4 & 0 & 0 & 1 & 0 & -2 \\ -49 & -26 & 0 & 0 & 0 & 1 & 0 \end{array}\right] \end{array} \text{ next pivot: } -26$$

Ans: A

107. The final simple matrix for a minimization problem is given below. Find the solution.

$$\begin{array}{ccccccc|c} x & y & z & s_1 & s_2 & s_3 & -f & \\ \hline 0 & 1 & 0 & \frac{7}{3} & \frac{1}{3} & -\frac{3}{4} & 0 & 7 \\ 0 & 0 & 1 & \frac{3}{4} & -\frac{1}{3} & \frac{8}{3} & 0 & 11 \\ 1 & 0 & 0 & -\frac{5}{4} & \frac{3}{4} & \frac{5}{4} & 0 & 8 \\ \hline 0 & 0 & 0 & 7 & \frac{5}{4} & 3 & 1 & -100 \end{array}$$

A) The minimum of f is 100 when $x = 7, y = 11, z = 8$.

B) The minimum of f is 100 when $x = 8, y = 7, z = 11$.

C) The minimum of f is 100 when $x = 8, y = 7, z = 11$.

D) The minimum of f is 100 when $x = 11, y = 8, z = 7$.

E) The minimum of f is 100 when $x = 11, y = 8, z = 7$.

Ans: C

108. Use the simplex method to find the optimal solution.

Maximize $f = x + 2y$ subject to

$$\begin{aligned} -x + 2y &\leq 63 \\ -7x + 4y &\geq 16 \\ x \geq 0, y &\geq 0 \end{aligned}$$

A) $x = 55,\ y = 4;$ maximum of $f = 8$

B) $x = 63,\ y = 16;$ maximum of $f = 8$

C) $x = 22,\ y = 42.5;$ maximum of $f = 107$

D) $x = 33,\ y = 26;$ maximum of $f = 78$

E) $x = 28,\ y = 31;$ maximum of $f = 114$

Ans: C

109. Use the simplex method to find the optimal solution.

Minimize $f = 3x + 2y$ subject to

$$x \le 18$$
$$y \le 18$$
$$x + y \ge 26$$
$$x \ge 0, y \ge 0$$

A) minimum: 70 at $x = 18,\ y = 8$
B) minimum: 64 at $x = 10,\ y = 17$
C) minimum: 71 at $x = 17,\ y = 10$
D) minimum: 61 at $x = 7,\ y = 20$
E) minimum: 60 at $x = 8,\ y = 18$
Ans: E

110. Use the simplex method to find the optimal solution.

Minimize $f = 4x + y$ subject to

$$-x + y \le 4$$
$$3x + y \ge 12$$
$$x + y \le 22$$
$$x \ge 0, y \ge 0$$

A) minimum: 36 at $x = 8,\ y = 4$
B) minimum: 14 at $x = 2,\ y = 6$
C) minimum: 24 at $x = 5,\ y = 4$
D) minimum: 11 at $x = 1,\ y = 7$
E) minimum: 21 at $x = 4,\ y = 5$
Ans: B

111. Use the simplex method to find the optimal solution.

Maximize $f = 9x + 3y$ subject to

$$-x + 2y \le 20$$
$$-3x + 2y \le -36$$
$$x + y \le 22$$
$$x \ge 0, y \ge 0$$

A) maximum: 162 when $x = 16,\ y = 6$
B) maximum: 195 when $x = 20,\ y = 5$
C) maximum: 138 when $x = 15,\ y = 1$
D) maximum: 198 when $x = 22,\ y = 0$
E) maximum: 225 when $x = 24,\ y = 3$
Ans: D

112. Use the simplex method, Excel, or another technology to find the solution of the problem given below. Assume all variables are nonnegative.

Maximize $f = -x + 4y + 8z$ subject to

$$\begin{aligned} x + y + z &\le 42 \\ -x + y + z &\ge 22 \\ x + y - z &\ge 18 \end{aligned}$$

A) Maximum is 216 at $x = 0, y = 30, z = 12$.
B) Maximum is 288 at $x = 0, y = 12, z = 30$.
C) Maximum is 183 at $x = 5, y = 27, z = 10$.
D) Maximum is 251 at $x = 5, y = 10, z = 27$.
E) Maximum is 220 at $x = 0, y = 29, z = 13$.
Ans: A

113. Use the simplex method, Excel, or another technology to solve.

Maximize $f = 8x + 7y + z$ subject to

$$\begin{aligned} 2x + 3y + z &\le 30 \\ x - 2y + z &\ge 20 \\ 2x + 5y + 2z &\ge 25 \\ x \ge 0, y \ge 0, z &\ge 0 \end{aligned}$$

A) maximum: 90 at $x = 10,\ y = 0,\ z = 10$
B) maximum: 38 at $x = 0,\ y = 2,\ z = 24$
C) maximum: 86 at $x = 2,\ y = 10,\ z = 0$
D) maximum: 168 at $x = 0,\ y = 24,\ z = 0$
E) maximum: 80 at $x = 0,\ y = 10,\ z = 10$
Ans: A

114. Use the simplex method, Excel, or another technology to solve.

Minimize $f = x + 2y + z$ subject to

$$\begin{aligned} x + 3y + 2z &\ge 42 \\ x + y + z &\ge 33 \\ x + y + z &\le 102 \\ x \ge 0, y \ge 0, z &\ge 0 \end{aligned}$$

A) minimum: 24 at $x = 33,\ y = 0,\ z = -9$
B) minimum: 36 at $x = 22,\ y = 2,\ z = 10$
C) minimum: 34 at $x = 19,\ y = 4,\ z = 7$
D) minimum: 33 at $x = 24,\ y = 0,\ z = 9$
E) minimum: 16 at $x = 0,\ y = 4,\ z = 11$
Ans: D

115. Use the simplex method, Excel, or another technology, to find the solution of the problem given below. Assume all variables are nonnegative.

Minimize $g = 480x_1 + 460x_2 + 440x_3 + 420x_4 + 530y_1 + 510y_2 + 490y_3 + 470y_4 - 9500$ sub

$x_1 + y_1 \geq 30$

$x_1 + x_2 + y_1 + y_2 \geq 90$

$x_1 + x_2 + x_3 + y_1 + y_2 + y_3 \geq 161$

$x_1 + x_2 + x_3 + x_4 + y_1 + y_2 + y_3 + y_4 \geq 191$

$x_1 \leq 40, x_2 \leq 40, x_3 \leq 40, x_4 \leq 40.$

A) The minimum is 79,290 when $x_1 = x_2 = 40, x_3 = x_4 = 30, y_1 = y_4 = 0, y_2 = 20,$ and $y_3 = 31.$
B) The minimum is 78,590 when $x_1 = x_2 = x_3 = 40, x_4 = 30, y_1 = y_4 = 0, y_2 = 10,$ and $y_3 = 31.$
C) The minimum is 125,590 when $x_1 = x_2 = x_3 = 40, x_4 = 30, y_1 = y_4 = 47, y_2 = 10,$ and $y_3 = 31.$
D) The minimum is 136,850 when $x_1 = x_2 = x_3 = x_4 = 40, y_1 = y_4 = 47, y_2 = 20,$ and $y_3 = 35.$
E) The minimum is 66,750 when $x_1 = x_2 = x_3 = x_4 = 30, y_1 = y_4 = 0, y_2 = 10,$ and $y_3 = 35.$

Ans: B

116. Suppose a sausage company makes two different kinds of hot dogs, regular and all beef. Each pound of all-beef hot dogs requires 0.75 lb of beef and 0.2 lb of spices, and each pound of regular hot dogs requires 0.18 lb of beef, 0.3 lb of pork, and 0.2 lb of spices. Suppliers can deliver at most 967.5 lb of beef, at most 600 lb of pork, and at least 486 lb of spices. If the profit is $0.60 on each pound of all-beef hot dogs and $0.40 on each pound of regular hot dogs, how many pounds of each should be produced to obtain maximum profit? What is the maximum profit?

A) Maximum profit is $1288 with 820 lbs of all-beef and 1990 lbs of regular hot dogs.
B) Maximum profit is $1332 with 820 lbs of all-beef and 2100 lbs of regular hot dogs.
C) Maximum profit is $1286 with 810 lbs of all-beef and 2000 lbs of regular hot dogs.
D) Maximum profit is $1524 with 2000 lbs of all-beef and 810 lbs of regular hot dogs.
E) Maximum profit is $1522 with 1990 lbs of all-beef and 820 lbs of regular hot dogs.

Ans: C

117. Nolan Industries manufactures water filters/purifiers that attach to a kitchen faucet. Each purifier consists of a housing unit that attaches to the faucet and a 60-day filter that is inserted into the housing. Past records indicate that on average the number of filters produced plus the number of housing units produced should be at least 500 per week. It takes 20 minutes to make and assemble each filter and 40 minutes for each housing. The manufacturing facility has up to 20,000 minutes per week for making and assembling these units, but due to certain parts' supply constraints, the number of housing units per week can be at most 400. If manufacturing costs (for material and labor) are $6.00 for each filter and $8.45 for each housing unit, how many of each should be produced to minimize weekly costs? Find the minimum cost.

A) Minimum cost of $3168.75 weekly when no filters and 375 housing units are produ

B) Minimum cost of $3312.50 weekly when 200 filters and 250 housing units are proc

C) Minimum cost of $2740.00 weekly when 175 filters and 200 housing units are proc

D) Minimum cost of $2890.00 weekly when 200 filters and 200 housing units are proc

E) Minimum cost of $3000.00 weekly when 500 filters and no housing units are produ

Ans: E

118. Johnson City Cooperage manufactures 30-gallon and 55-gallon fiber drums. Each 30-gallon drum takes 30 minutes to make, each 55-gallon drum takes 40 minutes to make, and the company has at most 10,000 minutes available each week. Also, workplace limitations and product demand indicate that the number of 55-gallon drums produced plus half the number of 30-gallon drums produced should be at least 160, and the number of 30-gallon drums should be at least twice the number of 55-gallon drums. If Johnson City Cooperage's manufacturing costs are $4.25 for each 30-gallon drum and $6.00 for each 55-gallon drum, how many of each drum should be made each week to satisfy the constraints at minimum cost? Find the minimum cost.

A) Minimum cost of $1151.25 when 165 30-gallon drums and 75 55-gallon drums are

B) Minimum cost of $1160.00 when 160 30-gallon drums and 80 55-gallon drums are

C) Minimum cost of $1236.25 when 65 30-gallon drums and 160 55-gallon drums are

D) Minimum cost of $1270.00 when 80 30-gallon drums and 155 55-gallon drums are

E) Minimum cost of $1177.50 when 150 30-gallon drums and 90 55-gallon drums are

Ans: B

119. A company manufactures commercial heating system components and domestic furnaces at its factories in Monaca, PA and Hamburg, NY. At the Monaca plant, no more than 1000 units per day can be produced, and the number of commercial components cannot exceed 100 more than half the number of domestic furnaces. At the Hamburg plant, no more than 850 units per day can be produced. The profit on each commercial component is $400 at the Monaca plant and $390 at the Hamburg plant. The profit on each domestic furnace is $200 at the Monaca plant and $215 at the Hamburg plant. If there is a rush order for 510 commercial components and 680 domestic furnaces, how many of each should be produced at each plant in order to maximize profits? Find the maximum profit. *Note: Assume that exactly enough units are produced to fill the rush order.*

A) Maximum profit is $364,000 with 180 heating components produced at Monaca an and 520 domestic furnaces produced at Monaca and 160 at Hamburg.

B) Maximum profit is $368,500 with 330 heating components produced at Monaca an and 160 domestic furnaces produced at Monaca and 520 at Hamburg.

C) Maximum profit is $344,500 with 180 heating components produced at Monaca an and 160 domestic furnaces produced at Monaca and 520 at Hamburg.

D) Maximum profit is $365,750 with 330 heating components produced at Monaca an and 520 domestic furnaces produced at Monaca and 160 at Hamburg.

E) Maximum profit is $355,250 with 180 heating components produced at Monaca an and 160 domestic furnaces produced at Monaca and 520 at Hamburg.

Ans: C

120. A manufacturer makes Portable Satellite Radios and Auto Satellite Radios at plants in Lakeland and Rockledge. At the Lakeland plant, at most 1800 radios can be produced, and the production of the Auto Satellite Radios can be at most 200 fewer than the production of the Portable Satellite Radios. At the Rockledge plant, at most 1200 radios can be produced. The profits on the Portable Satellite Radios are $103 at Lakeland and $93 at Rockledge, and the profits on the Auto Satellite Radios are $71 at Lakeland and $77 at Rockledge. If the manufacturer gets a rush order for 1500 Portable Satellite Radios and 1300 Auto Satellite Radios, how many of each should be produced at each location so as to maximize profits? Find the maximum profit.

A) Maximum profit of $256,950 when 1500 portable satellite radios and 250 auto sate 1100 auto satellite radios are produced at Rockledge.

B) Maximum profit of $230,200 when 1100 portable satellite radios and 300 auto sate 200 portable satellite radios and 1000 auto satellite radios are produced at Rockledg

C) Maximum profit of $288,025 when 1475 portable satellite radios and 200 auto sate 400 portable satellite radios and 1100 auto satellite radios are produced at Rockledg

D) Maximum profit of $274,600 when 1700 portable satellite radios and 100 auto sate 1200 auto satellite radios are produced at Rockledge.

E) Maximum profit of $304,900 when 1800 portable satellite radios are produced at th 250 portable satellite radios and 1250 auto satellite radios are produced at Rockledg

Ans: D

121. Suppose that three water purification facilities can handle at most 10 million gallons in a certain time period. Plant 1 leaves 20% of certain impurities, and costs $20,000 per million gallons. Plant 2 leaves 15% of these impurities and costs $30,000 per million gallons. Plant 3 leaves 10% impurities and costs $40,000 per million gallons. The desired level of impurities in the water from all three plants is at most 15%. If Plant 1 and Plant 3 combined must handle at least 6 million gallons, find the number of gallons each plant should handle so as to achieve the desired level of purity at minimum cost. Find the minimum cost.

A) Minimum cost is $120,000 with plants 1 and 3 each handling 2,000,000 gallons and plant 2 handling 0 gallons.
B) Minimum cost is $240,000 with plants 1 and 3 each handling 3,000,000 gallons and plant 2 handling 4,000,000 gallons.
C) Minimum cost is $300,000 with plants 1 and 3 each handling 4,000,000 gallons and plant 2 handling 2,000,000 gallons.
D) Minimum cost is $240,000 with plants 1 and 3 each handling 4,000,000 gallons and plant 2 handling 0 gallons.
E) Minimum cost is $180,000 with plants 1 and 3 each handling 3,000,000 gallons and plant 2 handling 0 gallons.

Ans: E

122. A chemical storage tank has a capacity of 200 tons. Currently, the tank contains 50 tons of a mixture that has 10% of a certain active chemical and 1.8% of other inert ingredients. The owners of the tank want to replenish the supply in the tank and will purchase some combination of two available mixes. Mix 1 contains 70% of the active chemical and 3% of the inert ingredients; its cost is $108 per ton. Mix 2 contains 30% of the active chemical and 1% of the inert ingredients; its cost is $48 per ton. The desired final mixture should have at least 40% of the active chemical and at most 2% of the inert ingredients. How many tons of each mix should be purchased to obtain the desired final mixture at minimum cost? Find the minimum cost. Note that at least 40% of the active chemical means

70%(mix 1) + 30% (mix 2) + 10% (mix on hand) ≥ 40% (mix 1 + mix 2 + mix on hand)
.

A) Minimum cost is $10,440 obtained by purchasing 70 tons of mix 1 and 60 tons of m

B) Minimum cost is $8880 obtained by purchasing 60 tons of mix 1 and 50 tons of mi

C) Minimum cost is $7680 obtained by purchasing 40 tons of mix 1 and 70 tons of mi

D) Minimum cost is $9360 obtained by purchasing 60 tons of mix 1 and 60 tons of mi

E) Minimum cost is $10,740 obtained by purchasing 75 tons of mix 1 and 65 tons of m

Ans: A

123. Suppose a ball manufacturer produces soccer balls, footballs, and volleyballs. The manager feels that restricting the types of balls produced could increase revenue. The following table gives the price of each ball, the raw materials cost, and the profit on each ball. The monthly profit must be at least $10,000, and the raw materials costs must be no more than $20,000. How many of each type of ball should be produced to maximize the revenue? What is the maximum revenue?

	Raw Materials Cost	Price per Ball	Profit per Ball
Footballs	$10	$30	$10
Soccer balls	12	25	8
Volley balls	8	20	8

A) The maximum revenue is $62,500 when 2000 volleyballs and no footballs or soccer balls are produced.
B) The maximum revenue is $62,500 when 2500 soccer balls and no footballs or volleyballs are produced.
C) The maximum revenue is $75,000 when 2500 footballs and no soccer balls or volleyballs are produced.
D) The maximum revenue is $60,000 when 2000 footballs and no soccer balls or volleyballs are produced.
E) The maximum revenue is $50,000 when 2000 soccer balls and no footballs or volleyballs are produced.

Ans: D

