PART A

(1/1 point)

Mr. Snowman, the mayor of Little Gotham, faces a serious snow storm in the coming days. He has two snow removal machines, and needs to remove snow from three different roads. He has 24 hours to remove 15 inches of snow from Road 1, 24 inches of snow from Road 2, and 18 inches of snow from Road 3. (Unusual for different amounts of snow to have to be removed from different roads, but that is the problem that Mr. Snowman faces.) In addition, each machine removes snow at a different rate on the three roads.

Machine 1 can remove one inch an hour from Road 1; it removes 1.2 inches an hour from Road 2; it removes two inches an hour from Road 3. Machine 2 can remove two inches an hour from Road 1, three inches an hour from Road 2 and three inches an hour from Road 3. The optimization problem is to remove as much snow as possible in 24 hours using the two machines.

The decision variables are:

- x_{rm}: the number of hours that road r is cleaned by machine m.

Mr. Snowman tries to model it as a linear program. He gives the following formulation. As his assistant, you are concerned that some of the inequalities have been reversed. Which of the following is the best response?

$$
\begin{array}{lrcl}
\max & x_{11} + 2x_{12} + 1.2x_{21} + 3x_{22} + 2x_{31} + 3x_{32} & & \\
\text{s.t.:} & & & \\
(1) & x_{11} + x_{21} + x_{31} & \leq & 24 \\
(2) & x_{12} + x_{22} + x_{32} & \leq & 24 \\
(3) & x_{11} + 2x_{12} & \leq & 15 \\
(4) & 1.2x_{21} + 3x_{22} & \leq & 24 \\
(5) & 2x_{31} + 3x_{32} & \leq & 18 \\
(6) & x_{11}, x_{12}, x_{21}, x_{22}, x_{31}, x_{32}, & \geq & 0
\end{array}
$$

- (●) The linear program is correct ✔
- ( ) Linear inequalities (1) and (2) should be changed to $\geq$
- ( ) Linear inequalities (3), (4), and (5) should be changed to $\geq$
- ( ) Linear inequalities (1), (2), (3), (4), and (5) should all be changed to $\geq$

You have used 1 of 2 submissions

PART B

(1/1 point)

Model the Linear Program above using Julia. (Recall that tutorials of how to use Julia and JuMP are provided in Recitation 0.) If you are having difficulty using Julia, you would get credit for modeling this problem using spreadsheet optimization.

How many inches of snow are removed by the 2 machines? Provide a rounded (not truncated) answer with 2 digits to the right of the decimal point.

57 ✔

57

You have used 1 of 3 submissions

PART C

(1/1 point)

Consider now that the mayor wants to remove the snow as soon as possible.

Hint: Let z be the earliest time that machines m_1 and m_2 have both finished. The objective is to minimize z.

Mr. Snowman tries to model it as a linear program. He gives the following formulation. As his assistant, you are concerned that some of the inequalities have been reversed. Which of the following is the best response?

$$
\begin{array}{lrcl}
 & \min z & & \\
\text{s.t.:} & & & \\
(1) & x_{11} + x_{21} + x_{31} & \geq & z \\
(2) & x_{12} + x_{22} + x_{32} & \geq & z \\
(3) & x_{11} + 2x_{12} & = & 15 \\
(4) & 1.2x_{21} + 3x_{22} & = & 24 \\
(5) & 2x_{31} + 3x_{32} & = & 18 \\
(6) & x_{11}, x_{12}, x_{21}, x_{22}, x_{31}, x_{32}, z & \geq & 0
\end{array}
$$

- The linear program is correct
- Linear inequalities (1) and (2) should be changed to $\leq$ ✔
- Linear inequalities (3), (4), and (5) should be changed to $\geq$
- Linear inequalities (3), (4), and (5) should be changed to $\leq$

You have used 1 of 2 submissions

PART D

(1/1 point)

Model the Linear Program above using Julia. You may use spreadsheet optimization here if you used it in part B.

What is the minimum time needed to remove the snow? Use 2 digits to the right of the decimal point. (The answer should be rounded, not truncated.)

13.33 ✔

13.33

You have used 1 of 3 submissions