Week 7: Systems Applications & Inequalities

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Session 7 Quiz

7.1: Systems Word Problems Mixture, Motion, Break-Even

7.2: Systems of Inequalities

7.3: Linear Modeling & Fit-by-Eye

Session 7 Quiz: Systems Applications & Inequalities

Quick Reference: Key Formulas

Mixture Problems

$(\text{concentration}_1)(\text{volume}_1) + (\text{concentration}_2)(\text{volume}_2) = (\text{concentration}_{\text{final}})(\text{volume}_{\text{final}})$

Motion Problems

distance = rate $\times$ time $\quad (d = rt)$

Break-Even Problems

Total Cost = Total Revenue

Residuals

Residual = Actual value - Predicted value

7.1 Problem 1: Mixture Problem

A chemist needs to prepare 100 mL of a 16 mg/mL saline solution.

She has solution "A", which is a 10 mg/mL solution.

She has solution "B", which is a 20 mg/mL solution.

How much of each should she mix?

A = mL of solution A
B = mL of solution B

$$10\frac{mg}{mL}\cdot A\,mL + 20\frac{mg}{mL}\cdot B\,mL = 16\frac{mg}{mL}\cdot 100\,mL$$
$$A\,mL + B\,mL = 100\,mL$$

System:

$$\begin{cases} 10A+20B=1600 \\ A+B=100 \end{cases} \Rightarrow \begin{cases} A+2B=160 \\ A=100-B \end{cases}$$

$$100-B+2B=160$$
$$-100 \qquad -100$$

$$B=60$$
$$A=100-60=40$$

40 mL of solution A
60 mL of solution B

7.1 Problem 2: Motion Problem

Two cars leave the same parking lot at the same time.

They travel in opposite directions.

Car A travels at 50 mph.

Car B travels at 70 mph.

After how many hours will they be 240 miles apart?

A = distance traveled by car A (in miles)
B = distance traveled by car B (in miles)
t = time (in hours)

$A \text{ miles} + B \text{ miles} = 240 \text{ miles}$

$A \text{ miles} = 50 \frac{\text{miles}}{\cancel{\text{hr}}} \cdot t \cancel{\text{hr}}$

$B \text{ miles} = 70 \frac{\text{miles}}{\cancel{\text{hr}}} \cdot t \cancel{\text{hr}}$

System:

$$\begin{cases} A + B = 240 \\ A = 50t \\ B = 70t \end{cases}$$

$50t + 70t = 240$
$120t = 240$
$t = \frac{240}{120} = 2$

2 hours

7.1 Problem 3: Break-Even Problem

A sandwich shop makes sandwiches.

The costs include a fixed cost of $6000 per month,

plus a cost of $2 per sandwich to produce.

The revenue from each sandwich is $8.

How many sandwiches must be sold to break even?

s = number of sandwiches produced

$$\text{cost} = 6000 + 2s$$
$$\text{revenue} = 8s$$

$$\text{cost} = \text{revenue}$$
$$6000 + 2s = 8s$$
$$-2s \quad -2s$$
$$\frac{6000}{6} = \frac{6s}{6}$$
$$1000 = s$$

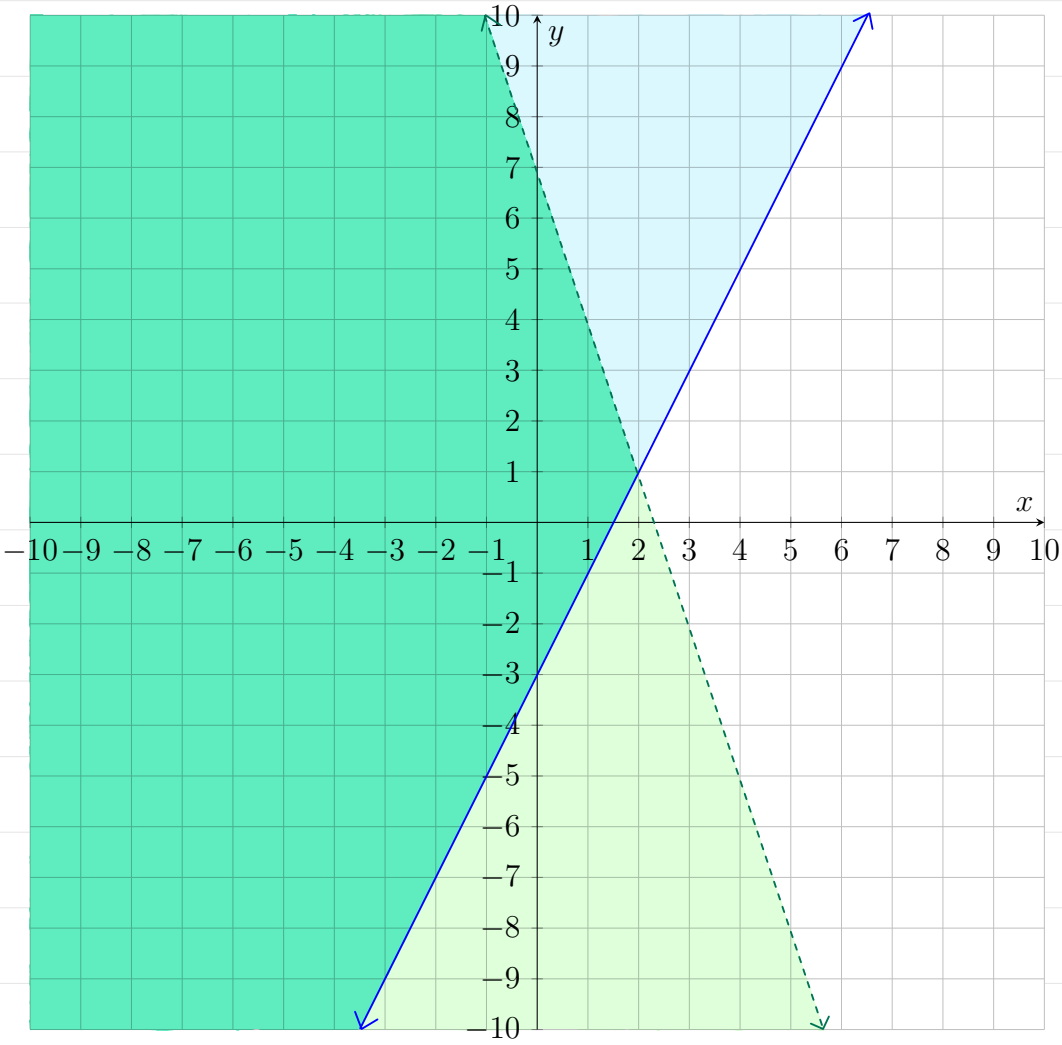
1000 sandwiches

7.2 Problem 4: Basic System

Graph the system of inequalities:

$y \geq 2x - 3$ (in blue)

$y < -3x + 7$ (in green)

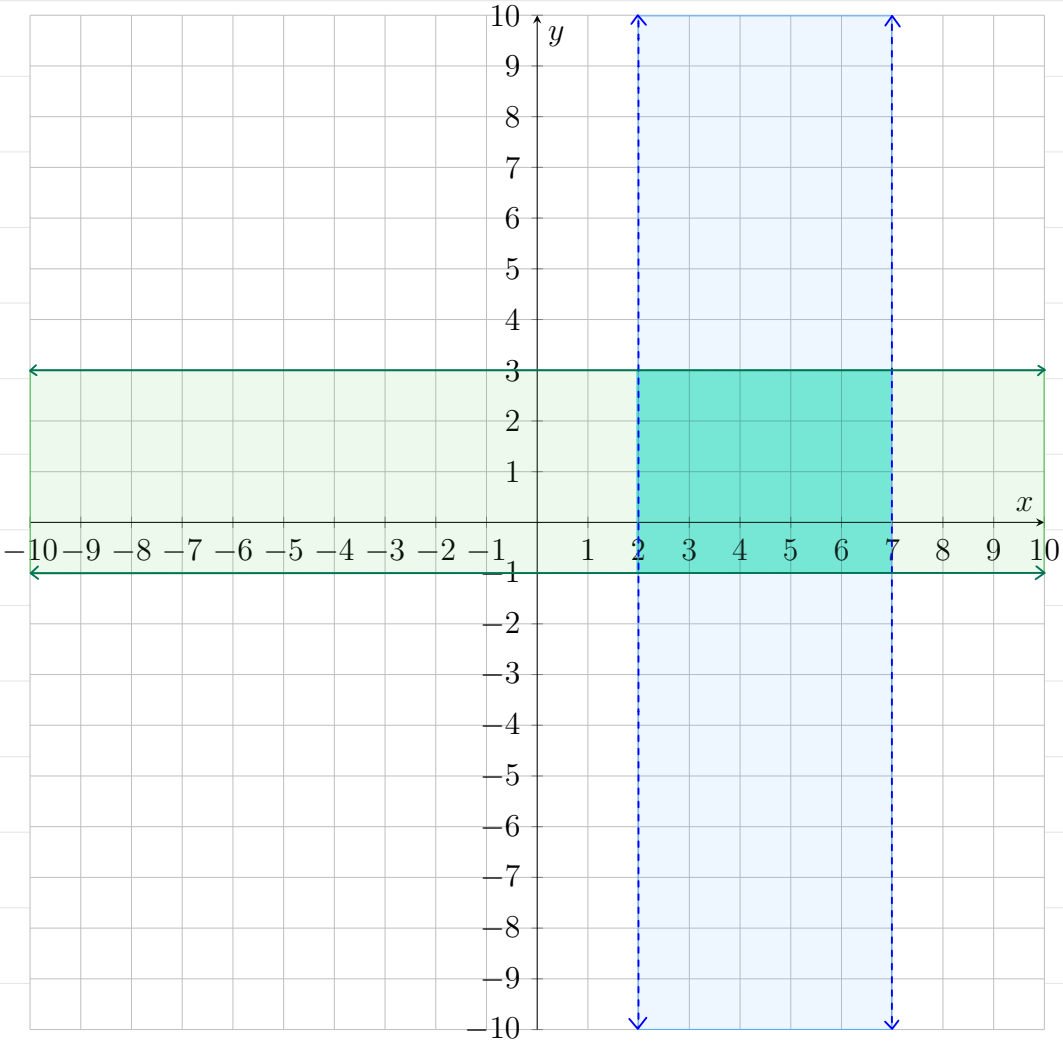


7.2 Problem 5: Bounded Inequalities

Graph the system of compound inequalities:

$2 < x < 7$ (in blue)

$-1 \leq y \leq 3$ (in green)



7.2 Problem 6: Inequality Application

A bakery makes cookies and brownies.

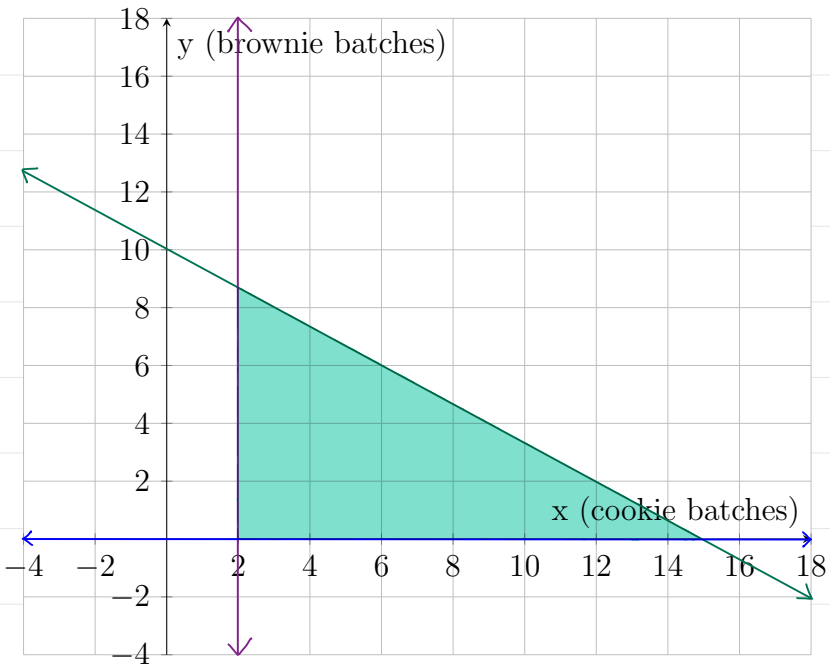
Each cookie batch requires 2 hours of labor.

Each brownie batch requires 3 hours of labor.

The bakery has <u>at most</u> 30 hours of labor per day.

They must make <u>at least</u> 2 cookie batches per day.

Write and graph a system of inequalities.



$x\ \frac{\text{cookie batches}}{} \cdot 2\ \frac{\text{hrs}}{\text{cookie batch}} + y\ \frac{\text{brownie batches}}{} \cdot 3\ \frac{\text{hrs}}{\text{brownie batch}} \leq 30\ \text{hrs}$

System:

$$\begin{cases} 2x+3y \leq 30 \\ x \geq 2 \\ y \geq 0 \end{cases}$$

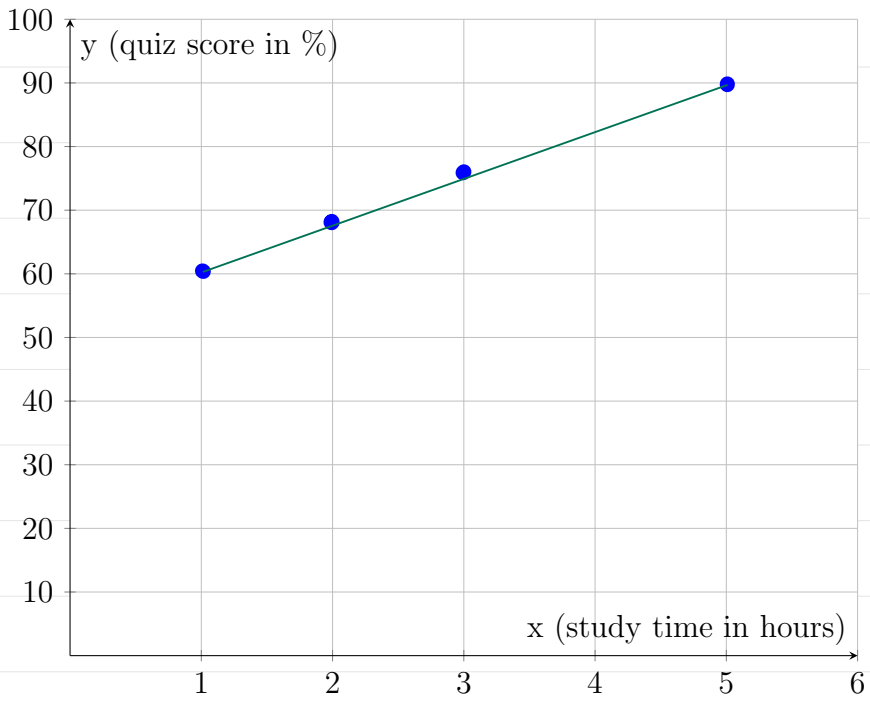
7.3 Problem 7: Study Time and Quiz Score

A teacher tracks student study time and quiz scores.

Study Time (hours)	Quiz Score (%)
1	60
2	68
3	76
4	83
5	90
X	Y

Part A

Plot the points. (in blue)



Part B

Find the equation of the line of best fit. (in green)

Points: $(1, 60)$ and $(5, 90)$

Slope: $m = \frac{90-60}{5-1} = \frac{30}{4} = \frac{15}{2}$

$$y - 60 = \frac{15}{2}(x - 1)$$

$+60 \qquad +60$

$$y = \frac{15}{2}x - \frac{15}{2} + 60$$

$$-\frac{15}{2} + 60 = -\frac{15}{2} + \frac{120}{2} = \frac{120-15}{2} = \frac{105}{2} = 52.5$$

$$\boxed{y = \frac{15}{2}x + \frac{105}{2}} \quad \text{or} \quad y = 7.5x + 52.5$$

$$2\overline{)15.0} = 7.5 \qquad 2\overline{)105.0} = 52.5$$

Part C

Calculate the residual for $x = 3$ hours of study time:

Actual $= 76$

$$\text{Predicted} = \frac{15}{2}(3) + \frac{105}{2} = \frac{45}{2} + \frac{105}{2} = \frac{150}{2} = 75$$

$$\text{Residual} = 76 - 75 = 1$$

$$2\overline{)150} = 75$$

$$\boxed{\text{Residual} = 1\%}$$

Part D

Use your model to predict the quiz score for someone who studies 8 hours.

Is this prediction reasonable? Why or why not?

$$y = \frac{15}{2}(8) + \frac{105}{2} = \frac{15 \cdot 4 \cdot 2}{2} + \frac{105}{2} = 60 + 52.5 = 112.5$$

$$\boxed{\begin{array}{l} 112.5\% \\ \text{Not reasonable} \end{array}}$$

because cannot (usually) get above 100%