MATH 150 — Systems of Linear Equations

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Learning Objectives

- Solve 2×2 systems by substitution and elimination
- Classify systems as consistent, inconsistent, or dependent
- Solve 3×3 systems using elimination
- Set up and solve applied word problems using systems

For each system, state the method you will use (substitution or elimination) before solving. Always check your answer in both original equations.

1. Solve by substitution.

$$\begin{cases} y = 2x - 3 \\ 3x + y = 12 \end{cases}$$

Answer: _____

2. Solve by elimination.

$$\begin{cases} 2x + 3y = 13 \\ 5x - 3y = 1 \end{cases}$$

Answer: _____

3. Solve by elimination. Multiply first to align coefficients.

$$\begin{cases} 3x + 2y = 16 \\ 4x - 3y = -1 \end{cases}$$

Answer: _____

4. Classify the system without solving: consistent (unique), inconsistent, or dependent.

$$\begin{cases} 2x - 4y = 8 \\ x - 2y = 4 \end{cases}$$

Answer: _____

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5. Classify: consistent (unique), inconsistent, or dependent.

$$\begin{cases} x + 2y = 5 \\ 2x + 4y = 9 \end{cases}$$

Answer: _____

6. Solve the 3×3 system.

$$\begin{cases} x + y + z = 6 \\ 2x - y + z = 3 \\ x + 2y - z = 4 \end{cases}$$

Answer: _____

7. Set up and solve. A mix of 40 liters contains 25% acid and 60% acid solutions. How many liters of each are needed?

$$x + y = 40, \quad 0.25x + 0.60y = 0.40 \times 40$$

Answer: _____

8. Solve by substitution.

$$\begin{cases} 4x - y = 7 \\ y = 3x - 2 \end{cases}$$

Answer: _____

9. Solve the system. Two numbers sum to 28 and their difference is 6. Find the numbers.

$$\begin{cases} x + y = 28 \\ x - y = 6 \end{cases}$$

Answer: _____

10. Solve using any method.

$$\begin{cases} 3x + 4y = -5 \\ 6x - 2y = 10 \end{cases}$$

Answer: _____

Problems 4–5: classification problems — students often forget to check for proportionality. Problem 6: 3×3 system — connect to augmented matrix row reduction.

Solutions

1. Solve by substitution.

$$\begin{cases} y = 2x - 3 \\ 3x + y = 12 \end{cases}$$

→ *Substitute y = 2x–3 into 3x+y=12: 3x+(2x–3)=12.*
→ *5x–3=12 → 5x=15 → x=3.*
→ *y = 2(3)–3 = 3. Solution: (3, 3).*

Answer: $x = 3,\ y = 3$

2. Solve by elimination.

$$\begin{cases} 2x + 3y = 13 \\ 5x - 3y = 1 \end{cases}$$

→ *Add the equations (3y and –3y cancel): 7x = 14 → x = 2.*
→ *Substitute x=2 into eq1: 4+3y=13 → 3y=9 → y=3.*
→ *Solution: (2, 3).*

Answer: $x = 2,\ y = 3$

3. Solve by elimination. Multiply first to align coefficients.

$$\begin{cases} 3x + 2y = 16 \\ 4x - 3y = -1 \end{cases}$$

→ *Multiply eq1 by 3: 9x+6y=48. Multiply eq2 by 2: 8x–6y=–2.*
→ *Add: 17x=46 → x=46/17.*
→ *From eq1: 3(46/17)+2y=16 → 2y=16–138/17=134/17 → y=67/17.*

Answer: $x = \frac{46}{17},\ y = \frac{52}{17}$

4. Classify the system without solving: consistent (unique), inconsistent, or dependent.

$$\begin{cases} 2x - 4y = 8 \\ x - 2y = 4 \end{cases}$$

→ *Divide eq1 by 2: x – 2y = 4 — identical to eq2.*
→ *The two equations are the same line.*
→ *System is dependent (consistent) → infinitely many solutions: x = 2y+4.*

Answer: Dependent — infinitely many solutions

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5. Classify: consistent (unique), inconsistent, or dependent.

$$\begin{cases} x + 2y = 5 \\ 2x + 4y = 9 \end{cases}$$

→ *Multiply eq1 by 2: 2x+4y=10. Compare with eq2: 2x+4y=9.*
→ *10 ≠ 9 → contradiction → no solution (parallel lines).*

Answer: Inconsistent — no solution

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6. Solve the 3×3 system.

$$\begin{cases} x + y + z = 6 \\ 2x - y + z = 3 \\ x + 2y - z = 4 \end{cases}$$

→ *From eq1+eq2: 3x+2z=9. From eq1+eq3: 2x+3y=10.*
→ *Eliminate y using eq2+eq3: 3x+2z=7 — combine with above to get x=1.*
→ *Back-substitute: z=3, y=2. Check: 1+2+3=6 ✓.*

Answer: $x = 1,\ y = 2,\ z = 3$

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7. Set up and solve. A mix of 40 liters contains 25% acid and 60% acid solutions. How many liters of each are needed?

$$x + y = 40, \quad 0.25x + 0.60y = 0.40 \times 40$$

→ *x = liters of 25% solution, y = liters of 60% solution.*
→ *x+y=40 and 0.25x+0.60y=16.*
→ *From eq1: x=40–y. Substitute: 0.25(40–y)+0.60y=16.*
→ *10+0.35y=16 → y=40/3. x=80/3.*

Answer: $x = \frac{80}{3} \approx 26.7 \text{ L},\ y = \frac{40}{3} \approx 13.3 \text{ L}$

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8. Solve by substitution.

$$\begin{cases} 4x - y = 7 \\ y = 3x - 2 \end{cases}$$

→ *Substitute y=3x–2 into 4x–y=7: 4x–(3x–2)=7.*
→ *x+2=7 → x=5. y=3(5)–2=13.*

Answer: $x = 5,\ y = 13$

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9. Solve the system. Two numbers sum to 28 and their difference is 6. Find the numbers.

$$\begin{cases} x + y = 28 \\ x - y = 6 \end{cases}$$

→ *Add the equations: 2x=34 → x=17.*
→ *Substitute: 17+y=28 → y=11.*
→ *Check: 17–11=6 ✓.*

Answer: $x = 17,\ y = 11$

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10. Solve using any method.

$$\begin{cases} 3x + 4y = -5 \\ 6x - 2y = 10 \end{cases}$$

→ *Multiply eq1 by 2: 6x+8y=–10. Subtract eq2: 10y=–20 → y=–2.*
→ *3x+4(–2)=–5 → 3x=3 → x=1.*

Answer: $x = 1,\ y = -2$