이원일차연립방정
(System of Two Linear Equations in Two Variables)

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$$\left\{ \begin{array}{l} \\ \\ \end{array} \right.$$

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$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ \end{cases}$$

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$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

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$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

One solution :

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$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

One solution :

$$a_1b_2 \neq a_2b_1$$ proof

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$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

One solution :

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No solutions :

Start End

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One solution :

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No solutions :

$$a_1b_2 = a_2b_1$$

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$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

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No solutions :

$$a_1b_2 = a_2b_1 \text{ and}$$

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$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

One solution :

$$a_1b_2 \neq a_2b_1$$ proof

No solutions :

$$a_1b_2 = a_2b_1 \text{ and } a_1c_2 \neq a_2c_1$$ proof

Start End

$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

One solution :

$$a_1b_2 \neq a_2b_1$$ proof

No solutions :

$$a_1b_2 = a_2b_1 \quad \text{and} \quad a_1c_2 \neq a_2c_1$$ proof

Infinitely many solutions :

Start End

$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

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$$a_1b_2 = a_2b_1 \ \text{ and } \ a_1c_2 \neq a_2c_1$$ proof

Infinitely many solutions :

$$a_1b_2 = a_2b_1$$

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No solutions :

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$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

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One solution : $a_1 b_2 \neq a_2 b_1$

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One solution : $a_1 b_2 \neq a_2 b_1$

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$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

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One solution : $a_1 b_2 \neq a_2 b_1$

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One solution : $a_1 b_2 \neq a_2 b_1$

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$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

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One solution : $a_1b_2 \neq a_2b_1$

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$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1b_2x + b_1b_2y + c_1b_2 = 0 \\ a_2b_1x + b_2b_1y + c_2b_1 = 0 \end{cases} \quad \begin{cases} a_1a_2x + b_1a_2y + c_1a_2 = 0 \\ a_2a_1x + b_2a_1y + c_2a_1 = 0 \end{cases}$$

$$\begin{cases} (a_1b_2 - a_2b_1)x + (c_1b_2 - c_2b_1) = 0 \\ \end{cases}$$

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One solution : $a_1 b_2 \neq a_2 b_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 b_2 x + b_1 b_2 y + c_1 b_2 = 0 \\ a_2 b_1 x + b_2 b_1 y + c_2 b_1 = 0 \end{cases} \qquad \begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$\begin{cases} (a_1 b_2 - a_2 b_1)x + (c_1 b_2 - c_2 b_1) = 0 \\ (b_1 a_2 - b_2 a_1)y + (c_1 a_2 - c_2 a_1) = 0 \end{cases}$$

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One solution : $a_1 b_2 \neq a_2 b_1$

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$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 b_2 x + b_1 b_2 y + c_1 b_2 = 0 \\ a_2 b_1 x + b_2 b_1 y + c_2 b_1 = 0 \end{cases} \quad \begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$\begin{cases} (a_1 b_2 - a_2 b_1)x + (c_1 b_2 - c_2 b_1) = 0 \\ (b_1 a_2 - b_2 a_1)y + (c_1 a_2 - c_2 a_1) = 0 \end{cases}$$

$$a_1 b_2 - a_2 b_1 \neq 0,$$

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One solution : $a_1 b_2 \neq a_2 b_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 b_2 x + b_1 b_2 y + c_1 b_2 = 0 \\ a_2 b_1 x + b_2 b_1 y + c_2 b_1 = 0 \end{cases} \quad \begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$\begin{cases} (a_1 b_2 - a_2 b_1)x + (c_1 b_2 - c_2 b_1) = 0 \\ (b_1 a_2 - b_2 a_1)y + (c_1 a_2 - c_2 a_1) = 0 \end{cases}$$

$$a_1 b_2 - a_2 b_1 \neq 0, a_1 b_2 \neq a_2 b_1$$

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One solution : $a_1 b_2 \neq a_2 b_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 b_2 x + b_1 b_2 y + c_1 b_2 = 0 \\ a_2 b_1 x + b_2 b_1 y + c_2 b_1 = 0 \end{cases} \quad \begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$\begin{cases} (a_1 b_2 - a_2 b_1)x + (c_1 b_2 - c_2 b_1) = 0 \\ (b_1 a_2 - b_2 a_1)y + (c_1 a_2 - c_2 a_1) = 0 \end{cases}$$

$$a_1 b_2 - a_2 b_1 \neq 0, a_1 b_2 \neq a_2 b_1$$

$$x = -\frac{c_1 b_2 - c_2 b_1}{a_1 b_2 - a_2 b_1}, y = -\frac{a_1 c_2 - a_2 c_1}{a_1 b_2 - a_2 b_1}$$

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No solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 \neq a_2 c_1$

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proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ \end{cases}$$

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$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

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$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ \end{cases}$$

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No solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 \neq a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

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No solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 \neq a_2 c_1$

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$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0$

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No solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 \neq a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0 \ , \ (b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

Home Start End

No solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 \neq a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0$, $(b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$

$$(b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

No solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 \neq a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0 \ , \ (b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$(b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$\begin{cases} a_1 b_2 - a_2 b_1 = 0 \\ \end{cases}$$

No solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 \neq a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

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$$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0 \ , \ (b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$(b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$\begin{cases} a_1 b_2 - a_2 b_1 = 0 \\ a_1 c_2 - a_2 c_1 \neq 0 \end{cases}$$

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No solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 \neq a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0 \ , \ (b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$(b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$\begin{cases} a_1 b_2 - a_2 b_1 = 0 \\ a_1 c_2 - a_2 c_1 \neq 0 \end{cases} \quad \begin{cases} a_1 b_2 = a_2 b_1 \\ \end{cases}$$

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No solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 \neq a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0 \ , \ (b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$(b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$\begin{cases} a_1 b_2 - a_2 b_1 = 0 \\ a_1 c_2 - a_2 c_1 \neq 0 \end{cases} \quad \begin{cases} a_1 b_2 = a_2 b_1 \\ a_1 c_2 \neq a_2 c_1 \end{cases}$$

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Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

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Infinitely many solutions : $a_1b_2 = a_2b_1$ and $a_1c_2 = a_2c_1$

proof

Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ \end{cases}$$

Home Start End

Infinitely many solutions : $a_1b_2 = a_2b_1$ and $a_1c_2 = a_2c_1$

proof

$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ \end{cases}$$

Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

Home Start End

Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0$$

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Infinitely many solutions : $a_1b_2 = a_2b_1$ and $a_1c_2 = a_2c_1$

proof

$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1a_2x + b_1a_2y + c_1a_2 = 0 \\ a_2a_1x + b_2a_1y + c_2a_1 = 0 \end{cases}$$

$$(b_1a_2 - b_2a_1)y + (c_1a_2 - c_2a_1) = 0 \ , \ (b_1a_2 - b_2a_1)y = -(c_1a_2 - c_2a_1)$$

Home Start End

Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0 \ , \ (b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$(b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0 \ , \ (b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$(b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$\begin{cases} a_1 b_2 - a_2 b_1 = 0 \\ \end{cases}$$

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Infinitely many solutions : $a_1b_2 = a_2b_1$ and $a_1c_2 = a_2c_1$

proof

$$\begin{cases} a_1x + b_1y + c_1 = 0 \\ a_2x + b_2y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1a_2x + b_1a_2y + c_1a_2 = 0 \\ a_2a_1x + b_2a_1y + c_2a_1 = 0 \end{cases}$$

$$(b_1a_2 - b_2a_1)y + (c_1a_2 - c_2a_1) = 0 \ , \ (b_1a_2 - b_2a_1)y = -(c_1a_2 - c_2a_1)$$

$$(b_1a_2 - b_2a_1)y = -(c_1a_2 - c_2a_1)$$

$$\begin{cases} a_1b_2 - a_2b_1 = 0 \\ a_1c_2 - a_2c_1 = 0 \end{cases}$$

Home Start End

Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0 \ , \ (b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$(b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

$$\begin{cases} a_1 b_2 - a_2 b_1 = 0 \\ a_1 c_2 - a_2 c_1 = 0 \end{cases} \quad \begin{cases} a_1 b_2 = a_2 b_1 \\ \end{cases}$$

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Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

$$\begin{cases} a_1 a_2 x + b_1 a_2 y + c_1 a_2 = 0 \\ a_2 a_1 x + b_2 a_1 y + c_2 a_1 = 0 \end{cases}$$

$$(b_1 a_2 - b_2 a_1) y + (c_1 a_2 - c_2 a_1) = 0 \ , \ (b_1 a_2 - b_2 a_1) y = -(c_1 a_2 - c_2 a_1)$$

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$$\begin{cases} a_1 b_2 - a_2 b_1 = 0 \\ a_1 c_2 - a_2 c_1 = 0 \end{cases} \quad \begin{cases} a_1 b_2 = a_2 b_1 \\ a_1 c_2 = a_2 c_1 \end{cases}$$

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if $a_1 \neq 0$

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if $a_1 \neq 0$, then

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if $a_1 \neq 0$, then $\forall y$

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Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

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$$\text{if } a_1 \neq 0, \text{ then } \forall y, \left(-\frac{b_1}{a_1} y - \frac{c_1}{a_1}, y\right)$$

Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

proof

$$\begin{cases} a_1 x + b_1 y + c_1 = 0 \\ a_2 x + b_2 y + c_2 = 0 \end{cases}$$

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if $a_1 \neq 0$, then $\forall y$, $\left(-\frac{b_1}{a_1} y - \frac{c_1}{a_1}, y\right)$ are solutions.

Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

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if $a_1 \neq 0$, then $\forall y$, $\left(-\frac{b_1}{a_1} y - \frac{c_1}{a_1}, y\right)$ are solutions.

if $b_1 \neq 0$

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if $a_1 \neq 0$, then $\forall y$, $\left(-\frac{b_1}{a_1} y - \frac{c_1}{a_1}, y \right)$ are solutions.

if $b_1 \neq 0$, then

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Infinitely many solutions : $a_1 b_2 = a_2 b_1$ and $a_1 c_2 = a_2 c_1$

proof

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if $a_1 \neq 0$, then $\forall y$, $\left(-\frac{b_1}{a_1} y - \frac{c_1}{a_1}, y\right)$ are solutions.

if $b_1 \neq 0$, then $\forall x$

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if $a_1 \neq 0$, then $\forall y$, $\left(-\frac{b_1}{a_1} y - \frac{c_1}{a_1}, y\right)$ are solutions.

if $b_1 \neq 0$, then $\forall x$, $\left(x, -\frac{a_1}{b_1} x - \frac{c_1}{b_1}\right)$

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$(b_1 a_2 - b_2 a_1)y + (c_1 a_2 - c_2 a_1) = 0$, $(b_1 a_2 - b_2 a_1)y = -(c_1 a_2 - c_2 a_1)$

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if $a_1 \neq 0$, then $\forall y$, $\left(-\frac{b_1}{a_1} y - \frac{c_1}{a_1}, y\right)$ are solutions.

if $b_1 \neq 0$, then $\forall x$, $\left(x, -\frac{a_1}{b_1} x - \frac{c_1}{b_1}\right)$ are solutions.

Github:
https://min7014.github.io/math20210130001.html

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