Solution   *Section* **1.6 – Inequalities**

Exercise

Find: $(-3, 0) \cap [-1, 2]$

Solution

$(-3, 0) \cap [-1, 2] = [-1, 0)$

Exercise

Find: $(-3, 0) \cup [-1, 2]$

Solution

$(-3, 0) \cup [-1, 2] = (-3, 2]$

Exercise

Find: $(-4, 0) \cap [-2, 1]$

Solution

$(-4, 0) \cap [-2, 1] = [-2, 0)$

Exercise

Find: $(-4, 0) \cup [-2, 1]$

Solution

$(-4, 0) \cup [-2, 1] = (-4, 1]$

Exercise

Find: $(-\infty, 5) \cap [1, 8)$

Solution

$(-\infty, 5) \cap [1, 8) = [1, 5)$

Exercise

Find: $(-\infty, 5) \cup [1, 8)$

Solution

   $(-\infty, 5) \cup [1, 8) = (-\infty, 8)$

Exercise

Solve $-3x + 5 > -7$

Solution

   $-3x > -7 - 5$

   $-3x > -12$

   $\dfrac{-3}{-3}x < \dfrac{-12}{-3}$

   $\therefore$ *Solution*: $x < 4$ $(-\infty, 4)$

Exercise

Solve $2 - 3x \le 5$

Solution

   $-3x \le 3$ *Divide by – 3 both sides*

   $\dfrac{-3}{-3}x \ge \dfrac{3}{-3}$

   $\therefore$ *Solution*: $x \ge -1$ *or* $[-1, \infty)$

Exercise

Solve $4 - 3x \le 7 + 2x$

Solution

   $4 - 3x - 4 \le 7 + 2x - 4$

   $-3x \le 3 + 2x$

   $-3x - 2x \le 3 + 2x - 2x$

   $-5x \le 3$

   $\therefore$ *Solution*: $x \ge -\dfrac{3}{5}$ *or* $\left[-\dfrac{3}{5}, \infty\right)$

Exercise

Solve the inequality equation $\quad 5x + 11 < 26$

<u>Solution</u>

$\quad 5x < 15$

$\quad \therefore$ **Solution**: $\quad \underline{x < 3}$ $\quad$ *or* $(-\infty,\ 3)$

Exercise

Solve the inequality equation $\quad 3x - 8 \geq 13$

<u>Solution</u>

$\quad 3x \geq 21$

$\quad \therefore$ **Solution**: $\quad \underline{x \geq 7}$ $\quad$ *or* $[7,\ \infty)$

Exercise

Solve the inequality equation $\quad -9x \geq 36$

<u>Solution</u>

$\quad -\dfrac{9x}{9} \geq \dfrac{36}{9}$

$\quad -x \geq 4$

$\quad \therefore$ **Solution**: $\quad \underline{x \leq -4}$ $\quad$ *or* $(-\infty,\ -4]$

Exercise

Solve the inequality equation $\quad -4x \leq 64$

<u>Solution</u>

$\quad -\dfrac{4x}{4} \leq \dfrac{64}{4}$

$\quad -x \leq 16$

$\quad \therefore$ **Solution**: $\quad \underline{x \geq -16}$ $\quad$ *or* $[-16,\ \infty)$

Exercise

Solve the inequality equation $\quad 8x - 11 \leq 3x - 13$

<u>Solution</u>

$\quad 5x \leq -2$

$\therefore$ *Solution*: $\underline{x \le -\dfrac{2}{5}}$ *or* $\left(-\infty, \ -\dfrac{2}{5}\right]$

Exercise

Solve the inequality equation $\quad 18x + 45 \le 12x - 8$

<u>Solution</u>

$6x \le -53$

$\therefore$ *Solution*: $\underline{x \le -\dfrac{53}{6}}$ $\qquad$ *or* $\left(-\infty, \ -\dfrac{53}{6}\right]$

Exercise

Solve the inequality equation $\quad 4(x+1) + 2 \ge 3x + 6$

<u>Solution</u>

$4x + 4 + 2 \ge 3x + 6$

$\therefore$ *Solution*: $\underline{x \ge 0}$ $\quad$ *or* $[0, \ \infty)$

Exercise

Solve the inequality equation $\quad 8x + 3 > 3(2x+1) + x + 5$

<u>Solution</u>

$8x + 3 > 6x + 3 + x + 5$

$8x + 3 > 7x + 8$

$\therefore$ *Solution*: $\underline{x > 5}$ $\quad$ *or* $(5, \ \infty)$

Exercise

Solve the inequality equation $\quad 2x - 11 < -3(x + 2)$

<u>Solution</u>

$2x - 11 < -3x - 6$

$5x < 5$

$\therefore$ *Solution*: $\underline{x < 1}$ $\quad$ *or* $(-\infty, \ 1)$

Exercise

Solve the inequality equation $\quad -4(x+2) > 3x+20$

Solution

$-4x - 8 > 3x + 20$

$-7x > 28$

$-x > 4$

$\therefore$ *Solution*: $\quad \underline{x < -4} \quad or \quad (-\infty, -4)$

Exercise

Solve the inequality equation $\quad 1 - (x+3) \geq 4 - 2x$

Solution

$1 - x - 3 \geq 4 - 2x$

$-x - 2 \geq 4 - 2x$

$x \geq 6$

$\therefore$ *Solution*: $\quad \underline{x \geq 6} \quad or \quad [6, \infty)$

Exercise

Solve the inequality equation $\quad 5(3-x) \leq 3x - 1$

Solution

$15 - 5x \leq 3x - 1$

$-8x \leq -16$

$-x \leq -2$

$\therefore$ *Solution*: $\quad \underline{x \geq 2} \quad or \quad [2, \infty)$

Exercise

Solve the inequality equation $\quad \dfrac{x}{4} - \dfrac{1}{2} \leq \dfrac{x}{2} + 1$

Solution

$4 \times \quad \dfrac{x}{4} - \dfrac{1}{2} \leq \dfrac{x}{2} + 1$

$x - 2 \leq 2x + 4$

$-x \leq 6$

$\therefore$ *Solution*: $\quad \underline{x \geq -6} \quad or \quad [-6, \infty)$

Exercise

Solve the inequality equation $\dfrac{3x}{10} + 1 \geq \dfrac{1}{5} - \dfrac{x}{10}$

Solution

$10 \times \quad \dfrac{3x}{10} + 1 \geq \dfrac{1}{5} - \dfrac{x}{10}$

$3x + 10 \geq 2 - x$

$4x \geq -8$

$\therefore$ ***Solution***: $\quad \underline{x \geq -2 \mid} \quad or \quad [-2,\ \infty)$

Exercise

Solve $\quad 6x - (2x + 3) \geq 4x - 5$

Solution

$6x - 2x - 3 \geq 4x - 5$

$4x - 3 \geq 4x - 5$

$4x - 4x \geq 3 - 5$

$0 \geq -2 \quad (true)$

$\therefore$ ***Solution***: $\mathbb{R} \ (-\infty,\ \infty)$

Exercise

Solve $\quad \dfrac{2x - 5}{-8} \leq 1 - x$

Solution

$(-8)\dfrac{2x-5}{-8} \geq (-8)(1-x)$

$2x - 5 \geq -8 + 8x$

$2x - 8x \geq -8 + 5$

$-6x \geq -3$

$\dfrac{-6}{-6}x \leq \dfrac{-3}{-6}$

$\therefore$ ***Solution***: $\quad \underline{x \leq \dfrac{1}{2} \mid} \qquad \left(-\infty,\ \dfrac{1}{2}\right]$

Exercise

Solve the inequality equation $\quad 1 - \dfrac{x}{2} > 4$

Solution

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$2\times \quad 1-\dfrac{x}{2}>4$

$2-x>8$

$-x>6$

$\therefore$ *Solution*: $\quad \underline{x<-6}$ $\quad or \quad \left(-\infty,\ -6\right)$

Exercise

Solve the inequality equation $\quad 7-\dfrac{4}{5}x<\dfrac{3}{5}$

Solution

$5\times \quad 7-\dfrac{4}{5}x<\dfrac{3}{5}$

$35-4x<3$

$-4x>-32$

$\therefore$ *Solution*: $\quad \underline{x<8}$ $\quad or \quad \left(-\infty,\ 8\right)$

Exercise

Solve the inequality equation $\quad \dfrac{x-4}{6}\geq \dfrac{x-2}{9}+\dfrac{5}{18}$

Solution

$18\times \quad \dfrac{x-4}{6}\geq \dfrac{x-2}{9}+\dfrac{5}{18}$

$3x-12\geq 2x-4+5$

$3x-12\geq 2x+1$

$\therefore$ *Solution*: $\quad \underline{x\geq -13}$ $\quad or \quad \left[-13,\ \infty\right)$

Exercise

Solve the inequality equation $\quad \dfrac{4x-3}{6}+2\geq \dfrac{2x-1}{12}$

Solution

$12\times \quad \dfrac{4x-3}{6}+2\geq \dfrac{2x-1}{12}$

$8x-6+24\geq 2x-1$

$8x+18\geq 2x-1$

$6x\geq -19$

$\therefore$ *Solution*: $\quad \underline{x\geq -\dfrac{19}{6}}$ $\qquad or \quad \left[-\dfrac{19}{6},\ \infty\right)$

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Exercise

Solve the inequality equation $\quad 4(3x-2)-3x < 3(1+3x)-7$

Solution

$12x - 8 - 3x < 3 + 9x - 7$

$9x - 8 < 9x - 4$

$-8 < -4 \quad$ *True*

$\therefore$ *Solution*: $\quad \mathbb{R} \mid$

Exercise

Solve the inequality equation $\quad 3(x-8)-2(10-x) < 5(x-1)$

Solution

$3x - 24 - 20 + 2x < 5x - 5$

$5x - 44 < 5x - 5$

$-44 < -5 \quad$ *True*

$\therefore$ *Solution*: $\quad \mathbb{R} \mid$

Exercise

Solve the inequality equation $\quad 8(x+1) \le 7(x+5)+x$

Solution

$8x + 8 \le 7x + 35 + x$

$8x + 8 \le 8x + 35$

$8 \le 35$

$\therefore$ *Solution*: $\quad \mathbb{R} \mid$

Exercise

Solve the inequality equation $\quad 4(x-1) \ge 3(x-2)+x$

Solution

$4x - 4 \ge 3x - 6 + x$

$4x - 4 \ge 4x - 6$

$-4 \ge -6 \quad$ *True*

$\therefore$ *Solution*: $\quad \mathbb{R} \mid$

Exercise

Solve the inequality equation $\quad 7(x+4)-13>12+13(3+x)$

Solution

$7x+28-13>12+39+13x$

$7x+15>51+13x$

$-6x>36$

$\therefore$ *Solution*: $\quad \underline{x<-9\ }\quad$ *or* $\ (-\infty,\ -9)$

Exercise

Solve the inequality equation $\quad -2\big[7x-(2x-3)\big]<-2(x+1)$

Solution

$-2(7x-2x+3)<-2x-2$

$-2(5x+3)<-2x-2$

$-10x-6<-2x-2$

$-8x<4$

$\therefore$ *Solution*: $\quad \underline{x>\dfrac{1}{2}\ }\quad$ *or* $\ \left(\dfrac{1}{2},\ \infty\right)$

Exercise

Solve the inequality equation $\quad 6-\dfrac{2}{3}(3x-12)\le\dfrac{2}{5}(10x+50)$

Solution

$15\times\quad 6-\dfrac{2}{3}(3x-12)\le\dfrac{2}{5}(10x+50)$

$90-10(3x-12)\le6(10x+50)$

$90-30x+120\le60x+300$

$210-30x\le60x+300$

$-90x\le90$

$\therefore$ *Solution*: $\quad \underline{x\ge-1\ }\quad$ *or* $\ [-1,\ \infty)$

Exercise

Solve the inequality equation $\quad \dfrac{2}{7}(7-21x)-4<10-\dfrac{3}{11}(11x-11)$

Solution

$77 \times$ $\frac{2}{7}(7-21x)-4 < 10-\frac{3}{11}(11x-11)$

$22(7-21x)-308 < 770-21(11x-11)$

$154-462x-308 < 770-231x+231$

$-462x-154 < -231x+1,001$

$-231x < 1,155$

$-x < 5$

$\therefore$ *Solution*: $\underline{x > 5}$ *or* $(5, \infty)$

Exercise

Solve the inequality equation $3\big[3(x+5)+8x+7\big]+5\big[3(x-6)-2(3x-5)\big] < 2(4x+3)$

Solution

$3(3x+15+8x+7)+5(3x-18-6x+10) < 8x+6$

$3(11x+22)+5(-3x-8) < 8x+6$

$33x+66-15x-40 < 8x+6$

$18x+26 < 8x+6$

$10x < -20$

$\therefore$ *Solution*: $\underline{x < -2}$ *or* $(-\infty, -2)$

Exercise

Solve the inequality equation $5\big[3(2-3x)-2(5-x)\big]-6\big[5(x-2)-2(4x-3)\big] < 3x+19$

Solution

$5(6-9x-10+2x)-6(5x-10-8x+6) < 3x+19$

$5(-7x-4)-6(-3x-4) < 3x+19$

$-35x-20+18x+24 < 3x+19$

$-17x+4 < 3x+19$

$-20x < 15$

$\therefore$ *Solution*: $\underline{x > -\dfrac{3}{4}}$ *or* $\left(-\dfrac{3}{4}, \infty\right)$

Exercise

Solve the inequality equation $0 \le 3x-1 \le 10$

Solution

$$0 + 1 \le 3x - 1 + 1 \le 10 + 1$$
$$1 \le 3x \le 11$$

∴ *Solution*: $\underline{\dfrac{1}{3} \le x \le \dfrac{11}{3}}$

Exercise

Solve the inequality equation $\quad 0 \le 1 - 3x \le 10$

Solution

$$-1 \le -3x \le 9$$
$$-\dfrac{1}{3} \le -x \le 3$$

∴ *Solution*: $\underline{-3 \le x \le \dfrac{1}{3}}$

Exercise

Solve the inequality equation $\quad 0 \le 2x + 6 \le 54$

Solution

$$-6 \le 2x \le 48$$

∴ *Solution*: $\underline{-3 \le x \le 24}$

Exercise

Solve the inequality equation $\quad -3 \le \dfrac{2}{3}x - 5 \le -1$

Solution

$$-3 \le \dfrac{2}{3}x - 5 \le -1$$
$$-3 + 5 \le \dfrac{2}{3}x - 5 + 5 \le -1 + 5$$
$$2 \le \dfrac{2}{3}x \le 4$$
$$2\dfrac{3}{2} \le \dfrac{3}{2}\dfrac{2}{3}x \le \dfrac{3}{2}4$$

∴ *Solution*: $\underline{3 \le x \le 6}$

Exercise

Solve $-6 \le 6x + 3 \le 21$

$$-6 - 3 \le 6x + 3 - 3 \le 21 - 3$$

$$-9 \le 6x \le 18$$

$$-\frac{9}{6} \le \frac{6}{6}x \le \frac{18}{6}$$

∴ *Solution*: $-\frac{3}{2} \le x \le 3$ $\qquad \left[-\frac{3}{2}, \ 3 \right]$

Exercise

Solve the inequality equation: $1 \le 2x + 3 < 11$

$$1 - 3 \le 2x + 3 - 3 < 11 - 3$$

$$-2 \le 2x < 8$$

$$-\frac{2}{2} \le \frac{2}{2}x < \frac{8}{2}$$

∴ *Solution*: $-1 \le x < 4$

Exercise

Solve the inequality equation $|x| < 2$

∴ *Solution*: $-2 < x < 2$

Exercise

Solve the inequality equation $|x| \ge 2$

∴ *Solution*: $x \le -2 \quad x \ge 2$

Exercise

Solve the inequality equation $|x - 2| < 1$

$$-1 < x - 2 < 1$$

∴ *Solution*: $\underline{1 < x < 3}$

Exercise

Solve the inequality equation $\left|x-1\right| < 4$

Solution

$$-4 < x - 1 < 4$$

∴ *Solution*: $\underline{-3 < x < 5}$

Exercise

Solve the inequality equation $\left|x+2\right| \geq 1$

Solution

$$x + 2 \leq -1 \qquad x + 2 \geq 1$$
$$x \leq -3 \qquad x \geq -1$$

∴ *Solution*: $\underline{x \leq -3 \quad x \geq -1}$

Exercise

Solve the inequality equation $\left|x+1\right| \geq 4$

Solution

$$x + 1 \leq -4 \qquad x + 1 \geq 4$$
$$x \leq -5 \qquad x \geq 3$$

∴ *Solution*: $\underline{x \leq -5 \quad x \geq 3}$

Exercise

Solve the inequality equation $\left|3x+5\right| < 17$

Solution

$$-17 < 3x + 5 < 17$$
$$-22 < 3x < 12$$

∴ *Solution*: $\underline{-11 < x < 4}$

Exercise

Solve the inequality equation $\quad |5x - 2| < 13$

<u>*Solution*</u>

$-13 < 5x - 2 < 13$

$-11 < 5x < 15$

$\therefore$ *Solution*: $\quad \underline{-\dfrac{11}{5} < x < 3}$

Exercise

Solve the inequality equation $\quad |5x - 2| \geq 13$

<u>*Solution*</u>

$$5x - 2 \leq -13 \qquad 5x - 2 \geq 13$$

$$5x \leq -11 \qquad\quad 5x \geq 15$$

$$x \leq -\frac{11}{5} \qquad\quad x \geq 3$$

$\therefore$ *Solution*: $\quad \underline{x \leq -\dfrac{11}{5} \quad x \geq 3}$

Exercise

Solve the inequality equation $\quad |2(x-1) + 4| \leq 8$

<u>*Solution*</u>

$-8 \leq 2x - 2 + 4 \leq 8$

$-8 \leq 2x + 2 \leq 8$

$-10 \leq 2x \leq 6$

$\therefore$ *Solution*: $\quad \underline{-5 \leq x \leq 3}$

Exercise

Solve the inequality equation $\quad |3(x-1) + 2| \leq 20$

<u>*Solution*</u>

$-20 \leq 3x - 3 + 2 \leq 20$

$-20 \leq 3x - 1 \leq 20$

$-19 \leq 3x \leq 21$

$\therefore$ *Solution*: $\quad \underline{-\dfrac{19}{3} \leq x \leq 7}$

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Exercise

Solve the inequality equation $\left|\dfrac{2x+6}{3}\right| > 2$

Solution

$|2x+6| > 6$

$2x+6 < -6$	$2x+6 > 6$
$2x < -12$	$2x > 0$
$x < -6$	$x > 0$

$\therefore$ *Solution*: $\underline{\ x < -6 \quad x > 0\ }$

Exercise

Solve the inequality equation $\left|\dfrac{3x-3}{4}\right| < 6$

Solution

$\dfrac{3}{4}|x-1| < 6$

$|x-1| < 8$

$-8 < x-1 < 8$

$\therefore$ *Solution*: $\underline{\ -7 < x < 9\ }$

Exercise

Solve the inequality equation $\left|\dfrac{2x+2}{4}\right| \geq 2$

Solution

$\dfrac{1}{2}|x+1| \geq 2$

$|x+1| \geq 4$

$x+1 \leq -4$	$x \geq 3$

$\therefore$ *Solution*: $\underline{\ x \leq -4 \quad x \geq 3\ }$

Exercise

Solve the inequality equation $\left|\dfrac{3x-3}{9}\right| \leq 1$

Solution

$$\frac{1}{3}|x - 1| \le 1$$

$$|x - 1| \le 3$$

$$-3 \le x - 1 \le 3$$

$\therefore$ **Solution**: $\underline{-2 \le x \le 4}$ |

Exercise

Solve the inequality equation $\qquad \left|3 - \frac{2x}{3}\right| > 5$

Solution

$$\frac{1}{3}|9 - 2x| > 5$$

$$|9 - 2x| > 15$$

$9 - 2x < -15$	$9 - 2x > 15$
$-2x < -24$	$-2x > 6$
$x > 12$	$x < -3$

$\therefore$ **Solution**: $\underline{x < -3 \quad x > 12}$ |

Exercise

Solve the inequality equation $\qquad \left|3 - \frac{3x}{4}\right| < 9$

Solution

$$\frac{3}{4}|4 - x| < 9$$

$$|4 - x| < 12$$

$$-12 < 4 - x < 12$$

$$-16 < -x < 8$$

$$16 > x > -8$$

$\therefore$ **Solution**: $\underline{-8 < x < 16}$ |

Exercise

Solve the inequality equation $\qquad |x - 2| < -1$

Solution

Impossible, since Absolute value can't be negative.

$\therefore$ No **Solution**

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Exercise

Solve the inequality equation $|x + 2| < -3$

Solution

Impossible, since Absolute value can't be negative.

∴ No *Solution*

Exercise

Solve the inequality equation $|x + 6| > -10$

Solution

∴ *Solution:* $\mathbb{R}$ |

Exercise

Solve the inequality equation $|x + 2| > -8$

Solution

∴ *Solution:* $\mathbb{R}$ |

Exercise

Solve the inequality equation $|x + 2| + 9 \leq 16$

Solution

$|x + 2| \leq 5$

$-5 \leq x + 2 \leq 5$

∴ *Solution*: $-7 \leq x \leq 3$ |

Exercise

Solve the inequality equation $|x - 2| + 4 \geq 5$

Solution

$|x - 2| \geq 1$

$\begin{array}{ll} x - 2 \leq -1 & x - 2 \geq 1 \\ x \leq 1 & x \geq 3 \end{array}$

∴ *Solution*: $x \leq 1 \quad x \geq 3$ |

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Exercise

Solve the inequality equation $\quad 2|2x - 3| + 10 > 12$

Solution

$$2|2x - 3| > 2$$

$$|2x - 3| > 1$$

$2x - 3 < -1$	$2x - 3 > 1$
$2x < 2$	$2x > 4$
$x < 1$	$x > 2$

$\therefore$ *Solution*: $\quad x < 1 \quad x > 3$

Exercise

Solve the inequality equation $\quad 3|2x - 1| + 2 < 8$

Solution

$$3|2x - 1| < 6$$

$$|2x - 1| < 2$$

$$-2 < 2x - 1 < 2$$

$$-1 < 2x < 3$$

$\therefore$ *Solution*: $\quad -\dfrac{1}{2} < x < \dfrac{3}{2}$

Exercise

Solve the inequality equation $\quad -4|1 - x| < -16$

Solution

$$|1 - x| > 4$$

$1 - x < -4$	$1 - x > 4$
$-x < -5$	$-x > 3$
$x > 5$	$x < -3$

$\therefore$ *Solution*: $\quad x < -3 \quad x > 5$

Exercise

Solve the inequality equation $\quad -2|5 - x| < -6$

Solution

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$$|5 - x| > 3$$

$$5 - x < -3 \qquad 5 - x > 3$$
$$-x < -8 \qquad -x > -2$$
$$x > 8 \qquad x < 2$$

$\therefore$ *Solution*: $\underline{x < 2 \qquad x > 8}$

Exercise

Solve the inequality equation $\qquad 3 \le |2x - 1|$

Solution

$$|2x - 1| \ge 3$$

$$2x - 1 \le -3 \qquad 2x - 1 \ge 3$$
$$2x \le -2 \qquad 2x \ge 4$$
$$x \le -1 \qquad x \ge 2$$

$\therefore$ *Solution*: $\underline{x \le -1 \qquad x \ge 2}$

Exercise

Solve the inequality equation $\qquad 9 \le |4x + 7|$

Solution

$$|4x + 7| \ge 9$$

$$4x + 7 \le -9 \qquad 4x + 7 \ge 9$$
$$4x \le -16 \qquad 4x \ge 2$$
$$x \le -4 \qquad x \ge \frac{1}{2}$$

$\therefore$ *Solution*: $\underline{x \le -4 \qquad x \ge \dfrac{1}{2}}$

Exercise

Solve the inequality equation: $12 < \left| -2x + \frac{6}{7} \right| + \frac{3}{7}$

Solution

$(7)12 < \left| -(7)2x + (7)\frac{6}{7} \right| + (7)\frac{3}{7}$ \qquad *Multiply by 7 both sides*

$$84 < |-14x + 6| + 3$$

$$81 < |-14x + 6|$$

$$\left|-14x+6\right|>81$$

$$-14x+6<-81 \qquad -14x+6>81$$
$$-14x<-81-6 \qquad -14x>81-6$$
$$-14x<-87 \qquad -14x>75$$
$$x>\frac{87}{14} \qquad x<-\frac{75}{14}$$

$\therefore$ *Solution*: $\underline{x<-\frac{75}{14} \quad x>\frac{87}{14}}$ $\qquad \left(-\infty, -\frac{75}{14}\right)\cup\left(\frac{87}{14}, \infty\right)$

Exercise

Solve the inequality equation: $4+\left|3-\frac{x}{3}\right|\geq 9$

Solution

$$\left|3-\frac{x}{3}\right|\geq 9-4$$

$$\left|3-\frac{x}{3}\right|\geq 5$$

$$\left|(3)3-(3)\frac{x}{3}\right|\geq (3)5$$

$$\left|9-x\right|\geq 15$$

$$9-x\leq -15 \qquad 9-x\geq 15$$
$$-x\leq -24 \qquad -x\geq 6$$
$$x\geq 24 \qquad x\leq -6$$

$\therefore$ *Solution*: $\underline{x\leq -6 \quad x\geq 24}$ $\left(-\infty, -6\right]\cup\left[24, \infty\right)$

Exercise

Solve the inequality equation: $\left|x-2\right|<5$

Solution

$$-5<x-2<5$$
$\therefore$ *Solution*: $\underline{-3<x<7}$

Exercise

Solve the inequality equation: $\left|2x+1\right|<7$

Solution

$$-7<2x+1<7$$

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$$-7-1 < 2x+1-1 < 7-1$$

$$-8 < 2x < 6$$

$$-\frac{8}{2} < \frac{2}{2}x < \frac{6}{2}$$

$\therefore$ *Solution*: $\underline{-4 < x < 3}$

Exercise

Solve the inequality equation: $|5x+2|-2 < 3$

Solution

$$|5x+2| < 5$$

$$-5 < 5x+2 < 5$$

$$-7 < 5x < 3$$

$\therefore$ *Solution*: $\underline{-\frac{7}{5} < x < \frac{3}{5}}$ $\left(-\frac{7}{5},\ \frac{3}{5}\right)$

Exercise

Solve the inequality equation: $|2-7x|-1 > 4$

Solution

$$|2-7x| > 5$$

$2-7x < -5$	$2-7x > 5$
$-7x < -7$	$-7x > 3$
$x > 1$	$x < -\frac{3}{7}$

$\therefore$ *Solution*: $\underline{x < -\frac{3}{7} \quad x > \frac{1}{14}}$ $\left(-\infty,\ -\frac{3}{7}\right) \cup (1,\ \infty)$

Exercise

Solve the inequality equation: $|3x-4| < 2$

Solution

$$-2 < 3x-4 < 2$$

$$-2+4 < 3x-4+4 < 2+4$$

$$2 < 3x < 6$$

$\therefore$ *Solution*: $\underline{\frac{2}{3} < x < 2}$ $\left(\frac{2}{3},\ 2\right)$

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Exercise

Solve the inequality equation: $|2x+5| \geq 3$

Solution

$$2x+5 \leq -3 \qquad\qquad 2x+5 \geq 3$$

$$2x \leq -8 \qquad\qquad 2x \geq -2$$

$$x \leq -4 \qquad\qquad x \geq -1$$

$\therefore$ **Solution**: $\underline{x \leq -4 \quad x \geq -1}$ | $(-\infty, \ -4] \cup [-1, \ \infty)$

Exercise

Solve $\quad |12-9x| \geq -12$

Solution

$\therefore$ **Solution** set: $(-\infty, \ \infty)$ because the absolute value always greater than any negative number.

Exercise

Solve $\quad |6-3x| < -11$

Solution

$\therefore$ **No solution**, because the absolute value cannot be less than any negative number

Exercise

Solve the inequality equation $\quad |7+2x| < 0$

Solution

$\therefore$ **No solution**, because the absolute value cannot be any negative number

Exercise

Solve: $\quad x^2 - 7x + 10 > 0$

Solution

$$x^2 - 7x + 10 > 0$$

$$(x-5)(x-2) > 0$$

$$\underline{x = 2, \ 5}$$

$\therefore$ **Solution**: $\underline{x < 2 \quad x > 5}$ | $(-\infty, 2) \cup (5, \infty)$

	0	2		5	
	+		−		+

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Exercise

Solve: $2x^2 - 9x \le 18$

Solution

$2x^2 - 9x - 18 \le 0$

$(2x + 3)(x - 6) \le 0$

∴ *Solution*: $-\dfrac{3}{2} \le x \le 6$ $\left[-\dfrac{3}{2},\ 6\right]$
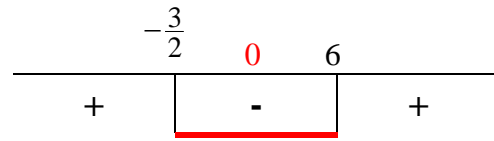
Exercise

Solve the inequality: $x^2 - 5x + 4 > 0$

Solution

$x^2 - 5x + 4 > 0$

$x = 1,\ 4$

∴ *Solution*: $x < 1 \quad x > 4$ $(-\infty, 1) \cup (4, \infty)$

Exercise

Solve $x^2 + x - 2 > 0$

Solution

$x^2 + x - 2 = 0 \quad \rightarrow x = -2, 1$

∴ *Solution*: $x < -2 \quad x > 1$ $(-\infty, -2) \cup (1, \infty)$

Exercise

Solve $x^2 - 4x + 12 < 0$

Solution

$x^2 - 4x + 12 = 0$

$x = \dfrac{4 \pm \sqrt{16 - 48}}{2}$

$= \dfrac{4 \pm \sqrt{-32}}{2}$ *Complex number*

∴ No *Solution*

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Exercise

Solve the inequality equation $\qquad x^2 + 7x > 0$

Solution

$$x^2 + 7x = 0$$
$$x(x+7) = 0$$
$$\underline{x = 0, \ -7}$$

$\therefore$ *Solution*: $\qquad \underline{x < -7 \quad x > 0}$

Exercise

Solve the inequality equation $\qquad x^2 - 49 < 0$

Solution

$$x^2 - 49 = 0$$
$$\underline{x = \pm 7}$$

$\therefore$ *Solution*: $\qquad \underline{-7 < x < 7}$

Exercise

Solve the inequality equation $\qquad x^2 - 5x \geq 0$

Solution

$$x^2 - 5x = 0$$
$$x(x-5) = 0$$
$$\underline{x = 0, \ 5}$$

$\therefore$ *Solution*: $\qquad \underline{x \leq 0 \quad x \geq 5}$

Exercise

Solve the inequality equation $\qquad x^2 - 16 \leq 0$

Solution

$$x^2 - 16 = 0$$
$$x^2 = 16$$
$$\underline{x = \pm 4}$$

$\therefore$ *Solution*: $\qquad \underline{-4 \leq x \leq 4}$

Exercise

Solve the inequality equation $\quad x^2 + 7x + 10 < 0$

Solution

$$x^2 + 7x + 10 = 0$$

$$x = \frac{-7 \pm \sqrt{49 - 40}}{2}$$

$$= \frac{-7 \pm 3}{2}$$

$$= \begin{cases} \dfrac{-7-3}{2} = -5 \\ \dfrac{-7+3}{2} = -2 \end{cases}$$

$\therefore$ *Solution*: $\quad \underline{-5 < x < 2}$

Exercise

Solve the inequality equation $\quad x^2 - 3x \geq 28$

Solution

$$x^2 - 3x - 28 = 0$$

$$x = \frac{3 \pm \sqrt{121}}{2}$$

$$= \begin{cases} \dfrac{3-11}{2} = -4 \\ \dfrac{3+11}{2} = 7 \end{cases}$$

$\therefore$ *Solution*: $\quad \underline{x \leq -4 \quad x \geq 7}$

Exercise

Solve the inequality equation $\quad x^2 + 5x + 6 < 0$

Solution

$$x^2 + 5x + 6 = 0$$

$$x = \frac{-5 \pm 1}{2}$$

$$= \begin{cases} \dfrac{-5-1}{2} = -3 \\ \dfrac{-5+1}{2} = -2 \end{cases}$$

$\therefore$ *Solution*: $\quad \underline{-3 < x < -2}$

Exercise

Solve the inequality equation $\quad x^2 < -x + 30$

Solution

$$x^2 + x - 30 = 0$$

$$x = \frac{-1 \pm 11}{2}$$

$$= \begin{cases} \dfrac{-1-11}{2} = -6 \\ \dfrac{-1+11}{2} = -5 \end{cases}$$

$\therefore$ **Solution**: $\quad \underline{-6 < x < -5}$

Exercise

Solve: $x^3 - 3x^2 - 9x + 27 < 0$

Solution

$$x^3 - 3x^2 - 9x + 27 = 0$$
$$x^2(x-3) - 9(x-3) = 0$$
$$(x-3)(x^2 - 9) = 0$$

$$\rightarrow \begin{cases} x - 3 = 0 \rightarrow \underline{x = 3} \\ x^2 - 9 = 0 \rightarrow x^2 = 9 \rightarrow \underline{x = \pm 3} \end{cases}$$

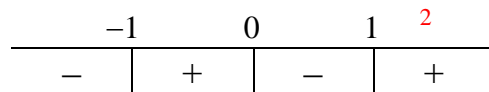$\therefore$ **Solution**: $\quad \underline{x < -3} \quad \underline{(-\infty, -3)}$

$$\begin{array}{ccccc} -\infty & -3 & & 3 & \infty \\ \hline & - & + & & + \end{array}$$

Exercise

Solve $\quad x^3 - x > 0$

Solution

$$x(x^2 - 1) = 0$$

$$\rightarrow \begin{cases} x = 0 \\ x^2 - 1 = 0 \rightarrow x^2 = 1 \rightarrow x = \pm 1 \end{cases}$$

$\therefore$ **Solution**: $\quad \underline{-1 < x < 0 \quad x > 1} \qquad \underline{(-1, 0) \cup (1, \infty)}$

$$\begin{array}{ccccccc} & -1 & & 0 & & 1 & 2 \\ \hline & - & + & & - & & + \end{array}$$

Exercise

$x^3 + 3x^2 \leq x + 3$

Solution

$x^3 + 3x^2 - x - 3 = 0$

$x^2(x+3) - (x+3) = 0$

$(x+3)(x^2 - 1) = 0$

$\begin{cases} x+3 = 0 \to x = -3 \\ x^2 - 1 = 0 \to x^2 = 1 \to x = \pm 1 \end{cases}$

∴ **Solution**: $\underline{-1 < x < 0 \quad x > 1}$ | $\left(-\infty, \ -3\right] \cup \left[-1, \ 1\right]$

Exercise

Solve $x^3 + x^2 \geq 48x$

Solution

$x^3 + x^2 - 48x = 0$

$x\left(x^2 + x - 48\right) = 0$

$x = 0 \qquad x^2 + x - 48 = 0$

$x = \dfrac{-1 \pm \sqrt{1+192}}{2}$

∴ **Solution**: $\underline{\dfrac{-1-\sqrt{193}}{2} < x < 0 \quad x > \dfrac{-1+\sqrt{193}}{2}}$ | $\left[\dfrac{-1-\sqrt{193}}{2}, \ 0\right] \cup \left[\dfrac{-1+\sqrt{193}}{2}, \ \infty\right)$

Exercise

Solve the inequality equation $x^3 - x^2 - 16x + 16 < 0$

Solution

$x^2(x-1) - 16(x-1) = 0$

$(x-1)\left(x^2 - 16\right) = 0$

$\underline{x = 1, \ \pm 4}$

∴ **Solution**: $\underline{x < -4 \quad 1 < x < 4}$

Exercise

Solve the inequality equation $x^3 + x^2 - 9x - 9 > 0$

Solution

$x^2(x+1) - 9(x+1) = 0$

$(x+1)(x^2 - 9) = 0$

$\underline{x = -1, \ \pm 3}$

	−3		−1	**0**	3	
	−	+		−		+

$\therefore$ **Solution**: $\quad \underline{-3 < x < -1 \quad x > 3}$

Exercise

Solve the inequality equation $x^3 + 3x^2 - 4x - 12 \geq 0$

Solution

$x^2(x+3) - 4(x+3) = 0$

$(x+3)(x^2 - 4) = 0$

$\underline{x = -3, \ \pm 2}$

	−3		−2	**0**	2	
	−	+		−		+

$\therefore$ **Solution**: $\quad \underline{-3 < x < -2 \quad x > 2}$

Exercise

Solve the inequality equation $x^4 - 20x^2 + 64 \leq 0$

Solution

$x^4 - 20x^2 + 64 = 0$

$x^2 = \dfrac{20 \pm \sqrt{400 - 256}}{2}$

$= \begin{cases} \dfrac{20 - 12}{2} = 4 \\[2mm] \dfrac{20 + 12}{2} = 16 \end{cases}$

	−4		−2	**0**	2		4	
+		−		+		−		+

$\begin{cases} x^2 = 4 \ \rightarrow \ \underline{x = \pm 2} \\ x^2 = 16 \ \rightarrow \ \underline{x = \pm 4} \end{cases}$

$\therefore$ **Solution**: $\quad \underline{-4 \leq x \leq -2 \quad 2 \leq x \leq 4}$

Exercise

Solve the inequality equation $\qquad x^4 - 10x^2 + 9 \geq 0$

Solution

$x^4 - 10x^2 + 9 = 0$

$\begin{cases} x^2 = 1 \quad \rightarrow \quad \underline{x = \pm 1} \\ x^2 = 9 \quad \rightarrow \quad \underline{x = \pm 3} \end{cases}$

$\therefore$ *Solution*: $\qquad \underline{x \leq -3 \quad -1 \leq x \leq 1 \quad x \geq 3}$

	−3		−1	**0**	1		3	
+		−		+		−		+

Exercise

Solve the inequality equation $\qquad \dfrac{x+4}{x-1} < 0$

Solution

Restriction: $\qquad x \neq 1$

$\dfrac{x+4}{x-1} = 0$

$\underline{x = -4}$

$\therefore$ *Solution*: $\qquad \underline{-4 < x < 1}$

	−4		1	
+		−		+

Exercise

Solve the inequality equation $\qquad \dfrac{x-2}{x+3} > 0$

Solution

Restriction: $\qquad x \neq -3$

$\dfrac{x-2}{x+3} = 0$

$\underline{x = 2}$

$\therefore$ *Solution*: $\qquad \underline{x < -3 \quad x > 2}$

	−3	**0**	2	
+		−		+

Exercise

Solve the inequality equation $\qquad \dfrac{x-5}{x+8} \geq 3$

Solution

Restriction: $\qquad x \neq -8$

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$$\frac{x-5}{x+8} - 3 = 0$$

$$x - 5 - 3x - 24 = 0$$

$$-2x = 29$$

$$x = -\frac{29}{2}$$

$$-\frac{29}{2} \quad \mathbf{0} \quad -8$$

+	−	+
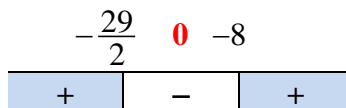
$\therefore$ *Solution*: $\quad x \le -\frac{29}{2} \quad x > -8$

Exercise

Solve the inequality equation $\quad \dfrac{x-4}{x+6} \le 1$

Solution

Restriction: $\quad x \ne -6$

$$\frac{x-4}{x+6} - 1 = 0$$

$$x - 4 - x - 6 = 0$$

$$-10 = 0 \ \times$$

$$-6 \quad \mathbf{0}$$

+	−
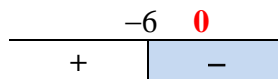
$\therefore$ *Solution*: $\quad x > -6$

Exercise

Solve the inequality equation $\quad \dfrac{x}{2x+7} \ge 4$

Solution

Restriction: $\quad x \ne -\dfrac{7}{2}$

$$\frac{x}{2x+7} - 4 = 0$$

$$x - 8x - 28 = 0$$

$$7x = -28$$

$$x = -4$$

$$-4 \quad \mathbf{0} \quad -\frac{7}{2}$$

+	−	+
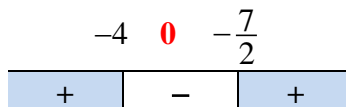
$\therefore$ *Solution*: $\quad x \le -4 \quad x > -\dfrac{7}{2}$

Exercise

Solve the inequality equation $\quad \dfrac{x}{3x-5} \le -5$

Solution

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Restriction: $x \neq \dfrac{5}{3}$

$\dfrac{x}{3x-5}+5=0$

$x+15x-25=0$

$16x=25$

$\underline{x=\dfrac{25}{16}}\,\bigg|$

∴ *Solution*: $\underline{\dfrac{25}{16}\le x<\dfrac{5}{3}}\,\bigg|$

(number line: points **0**, $\dfrac{25}{16}$, $\dfrac{5}{3}$; regions: $+$, $-$, $+$)
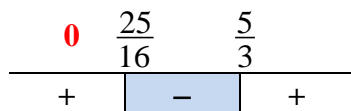
Exercise

Solve the inequality equation $\dfrac{x+2}{x-5}\le 2$

Solution

Restriction: $x \neq 5$

$\dfrac{x+2}{x-5}-2=0$

$x+2-2x+10=0$

$\underline{x=12}\,\big|$

(number line: points 5, **0**, 12; regions: $+$, $-$, $+$)

∴ *Solution*: $\underline{5\le x<12}\,\big|$

Exercise

Solve the inequality equation $\dfrac{3x+1}{x-2}\ge 4$

Solution

Restriction: $x \neq 2$

$\dfrac{3x+1}{x-2}-4=0$

$3x+1-4x+8=0$

$\underline{x=9}\,\big|$

(number line: points **0**, 2, 9; regions: $-$, $+$, $-$)

∴ *Solution*: $\underline{2\le x<9}\,\big|$

Exercise

Solve the inequality equation $\dfrac{x}{x-3}>0$

Solution

Restriction: $x \neq 3$

$$\frac{x}{x-3} = 0$$

$\underline{x = 0}|$

∴ *Solution*: $\underline{x < 0 \quad x > 3}\,|$ $\underline{(-\infty, 0) \cup (3, \infty)}\,|$

Exercise

Solve the inequality equation $\dfrac{x-3}{x+2} \geq 0$

Solution

Restriction: $x \neq -2$

$$\frac{x-3}{x+2} = 0$$

$\underline{x = 3}|$

∴ *Solution*: $\underline{x < -2 \quad x \geq 3}\,|$

Exercise

Solve the inequality equation $\dfrac{x-2}{x+2} \leq 2$

Solution

Restriction: $x \neq -2$

$$\frac{x-2}{x+2} - 2 = 0$$
$$x - 2 - 2x - 4 = 0$$
$$-x - 6 = 0$$
$\underline{x = -6}|$

∴ *Solution*: $\underline{x \leq -6 \quad x > -2}\,|$ $\underline{(-\infty, -6] \cup (-2, \infty)}\,|$

Exercise

Solve the inequality equation $\dfrac{x+2}{x-2} \geq 2$

Solution

Restriction: $x \neq 2$

$$\frac{x+2}{x-2} - 2 = 0$$
$$x + 2 - 2x + 4 = 0$$

$\underline{x = 6}$

∴ *Solution*: $\underline{2 < x \le 6}$

Exercise

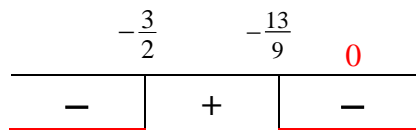Solve the inequality equation $\dfrac{x+2}{3+2x} \le 5$

Solution

Restriction: $x \ne -\dfrac{3}{2}$

$\dfrac{x+2}{3+2x} - 5 = 0$

$x + 2 - 15 - 10x = 0$

$-9x - 13 = 0$

$\underline{x = -\dfrac{13}{9}}$

∴ *Solution*: $\underline{x < -\dfrac{3}{2} \quad x > -\dfrac{13}{9}}$ $\underline{\left(-\infty,\ -\dfrac{3}{2}\right) \cup \left[-\dfrac{13}{9},\ \infty\right)}$

Exercise

Solve the inequality $\dfrac{x+6}{x-14} \ge 1$

Solution

Restriction: $x - 14 \ne 0 \Rightarrow \boxed{x \ne 14}$

$\dfrac{x+6}{x-14} - 1 = 0$

$x + 6 - x + 14 = 0$

$20 = 0 \quad (Implossible)$ No Solution

∴ *Solution*: $\underline{x > 14}$ $\underline{(14,\ \infty)}$
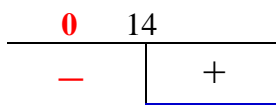
Exercise

Solve: $\dfrac{x-3}{x+4} \ge \dfrac{x+2}{x-5}$

Solution

Conditions: $x + 4 \ne 0 \to x \ne -4$ *and* $x - 5 \ne 0 \to x \ne 5$

$\dfrac{x-3}{x+4} - \dfrac{x+2}{x-5} = 0$ $\dfrac{0-3}{0+4} - \dfrac{0+2}{0-5} = \dfrac{-3}{4} - \dfrac{2}{-5} = \dfrac{-3}{4} + \dfrac{2}{5} = -$

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$$(x+4)(x-5)\left[\frac{x-3}{x+4}-\frac{x+2}{x-5}\right]=0$$

$$(x-5)(x-3)-(x+4)(x+2)=0$$

$$x^2-3x-5x+15-(x^2+2x+4x+8)=0$$

$$x^2-3x-5x+15-x^2-2x-4x-8=0$$

$$-14x+7=0$$

$$-14x=-7$$

$$x=\frac{-7}{-14}=\frac{1}{2}$$

$\therefore$ **Solution**: $x<-4$ $\frac{1}{2}\le x<5$ | $\left(-\infty,-4\right)\cup\left[\frac{1}{2},5\right)$

Exercise

Solve: $\dfrac{x-4}{x+3}-\dfrac{x+2}{x-1}\le 0$

Solution

Conditions: $x\ne -3$ and $x\ne 1$

$$\frac{x-4}{x+3}-\frac{x+2}{x-1}=0 \qquad\qquad \frac{0-4}{0+3}-\frac{0+2}{0-1}=-\frac{4}{3}+2 \;>0$$

$$(x+3)(x-1)\left[\frac{x-4}{x+3}-\frac{x+2}{x-1}\right]=0$$

$$(x-1)(x-4)-(x+3)(x+2)=0$$

$$x^2-5x+4-(x^2+5x+6)=0$$

$$x^2-5x+4-x^2-5x-6=0$$

$$-10x-2=0$$

$$x=-\frac{1}{5}$$

$\therefore$ **Solution**: $-3<x\le -\frac{1}{5}$ $x>1$ | $\left(-3,-\frac{1}{5}\right]\cup\left(1,\infty\right)$

Exercise

Solve: $\dfrac{2x-1}{x+3}\ge \dfrac{x+1}{3x+1}$

Solution

Conditions: $x\ne -3$ and $x\ne -\frac{1}{3}$

$$\frac{2x-1}{x+3} - \frac{x+1}{3x+1} \geq 0$$

$$(x+3)(3x+1)\frac{2x-1}{x+3} - (x+3)(3x+1)\frac{x+1}{3x+1} = 0$$

$$(3x+1)(2x-1) - (x+3)(x+1) = 0$$

$$6x^2 - 3x + 2x - 1 - \left(x^2 + x + 3x + 3\right) = 0$$

$$6x^2 - x - 1 - x^2 - 4x - 3 = 0$$

$$5x^2 - 5x - 4 = 0$$

$$x = \frac{5 \pm \sqrt{105}}{10} \to -.5 \quad 1.5$$

∴ **Solution**: $\quad x < -3 \quad \dfrac{5-\sqrt{105}}{10} \leq x < -\dfrac{1}{3} \quad x \geq \dfrac{5+\sqrt{105}}{10}$

$$\left(-\infty,\ -3\right) \cup \left[\frac{5-\sqrt{105}}{10},\ -\frac{1}{3}\right) \cup \left[\frac{5+\sqrt{105}}{10},\ \infty\right)$$

Exercise

Solve the inequality equation $\quad \dfrac{(x+1)(x-4)}{x-2} < 0$

Solution

Restriction: $x \neq 2$

$$\frac{(x+1)(x-4)}{x-2} = 0$$

$$x = -1,\ 4$$

∴ **Solution**: $\quad x < -1 \quad 2 < x < 4$

Exercise

Solve the inequality equation $\quad \dfrac{x(x-4)}{x+5} > 0$

Solution

Restriction: $x \neq -5$

$$\frac{x(x-4)}{x+5} = 0$$

$$x = 0,\ 4$$

∴ **Solution**: $\quad -5 < x < 0 \quad x > 4$
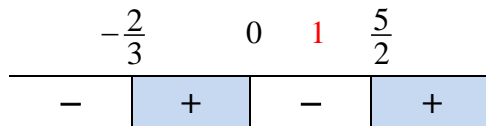
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Exercise

Solve the inequality equation $\dfrac{6x^2 - 11x - 10}{x} > 0$

Solution

Restriction: $x \neq 0$

$6x^2 - 11x - 10 = 0$

$x = \dfrac{11 \pm \sqrt{121 + 240}}{12}$

$= \begin{cases} \dfrac{11 - 19}{12} = -\dfrac{2}{3} \\ \dfrac{11 + 19}{12} = \dfrac{5}{2} \end{cases}$

$\therefore$ *Solution*: $-\dfrac{2}{3} < x < 0 \quad x > \dfrac{5}{2}$

$$\begin{array}{c c c c} -\dfrac{2}{3} & 0 & 1 & \dfrac{5}{2} \\ \hline - & + & - & + \end{array}$$
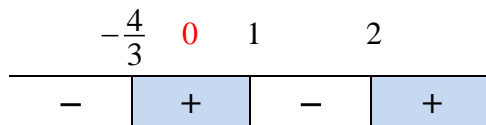
Exercise

Solve the inequality equation $\dfrac{3x^2 - 2x - 8}{x - 1} \geq 0$

Solution

Restriction: $x \neq 1$

$3x^2 - 2x - 8 = 0$

$x = \dfrac{2 \pm \sqrt{4 + 96}}{6}$

$= \begin{cases} \dfrac{2 - 10}{6} = -\dfrac{4}{3} \\ \dfrac{2 + 10}{6} = 2 \end{cases}$

$\therefore$ *Solution*: $-\dfrac{4}{3} \leq x < 1 \quad x \geq 2$

$$\begin{array}{c c c c} -\dfrac{4}{3} & 0 & 1 & 2 \\ \hline - & + & - & + \end{array}$$

Exercise

Solve the inequality equation $\dfrac{x^2 - 6x + 9}{x - 5} \leq 0$

Solution

Restriction: $x \neq 5$

$x^2 - 6x + 9 = 0$

$(x - 3)^2 = 0$

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$\underline{x = 3}$

$\therefore$ *Solution*: $\underline{x < 5}$

0	3	5
−	−	+

Exercise

Solve the inequality equation $\dfrac{x^2 + 10x + 25}{x+1} \le 0$

Solution

Restriction: $x \ne -1$

$x^2 + 10x + 25 = 0$

$(x+5)^2 = 0$

$\underline{x = -5}$

−5	−1	0
−	−	+

$\therefore$ *Solution*: $\underline{x < -1}$