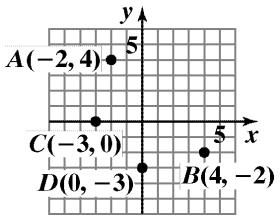
# Chapter 1
# Equations and Inequalities

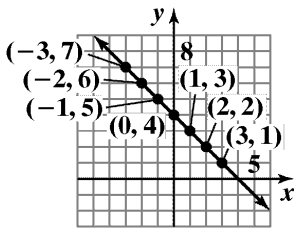
**Section 1.1**

**Check Point Exercises**

**1.**




**2.**




$y = 4 - x$

$x = -3,\ y = 7$

$x = -2,\ y = 6$

$x = -1,\ y = 5$

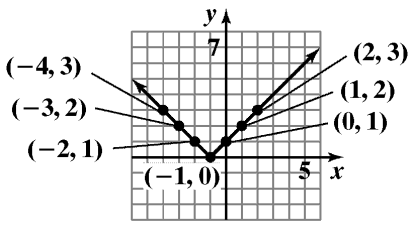
$x = 0,\ y = 4$

$x = 1,\ y = 3$

$x = 2,\ y = 2$

$x = 3,\ y = 1$

**3.**




$y = |x + 1|$

$x = -4,\ y = 3$

$x = -3,\ y = 2$

$x = -2,\ y = 1$

$x = -1,\ y = 0$

$x = 0,\ y = 1$

$x = 1,\ y = 2$

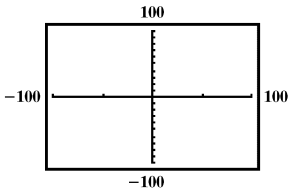
$x = 2,\ y = 3$

**4.** The meaning of a $[-100,100,50]$ by $[-100,100,10]$ viewing rectangle is as follows:

$$[\ \overbrace{-100}^{\substack{\text{minimum}\\ x\text{-value}}}\ ,\ \overbrace{100}^{\substack{\text{maximum}\\ x\text{-value}}}\ ,\ \overbrace{50}^{\substack{\text{distance}\\ \text{between}\\ x\text{-axis}\\ \text{tick}\\ \text{marks}}}\ ]$$

by

$$[\ \overbrace{-100}^{\substack{\text{minimum}\\ y\text{-value}}}\ ,\ \overbrace{100}^{\substack{\text{maximum}\\ y\text{-value}}}\ ,\ \overbrace{10}^{\substack{\text{distance}\\ \text{between}\\ y\text{-axis}\\ \text{tick}\\ \text{marks}}}\ ]$$




**5. a.** The graph crosses the $x$-axis at $(-3, 0)$.
Thus, the $x$-intercept is $-3$.
The graph crosses the $y$-axis at $(0, 5)$.
Thus, the $y$-intercept is 5.

**b.** The graph does not cross the $x$-axis.
Thus, there is no $x$-intercept.
The graph crosses the $y$-axis at $(0, 4)$.
Thus, the $y$-intercept is 4.

**c.** The graph crosses the $x$- and $y$-axes at the origin $(0, 0)$.
Thus, the $x$-intercept is 0 and the $y$-intercept is 0.

**6. a.** $d = 4n + 5$

$d = 4(15) + 5 = 65$

65% of marriages end in divorce after 15 years when the wife is under 18 at the time of marriage.

**b.** According to the line graph, 60% of marriages end in divorce after 15 years when the wife is under 18 at the time of marriage.

**c.** The mathematical model overestimates the actual percentage shown in the graph by 5%.

**Concept and Vocabulary Check 1.1**

**1.** *x*-axis

**2.** *y*-axis

**3.** origin

**4.** quadrants; four

**5.** *x*-coordinate; *y*-coordinate

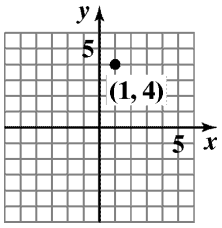
**6.** solution; satisfies

**7.** *x*-intercept; zero

**8.** *y*-intercept; zero

**Exercise Set 1.1**

**1.**

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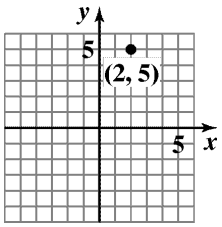
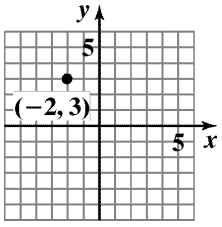
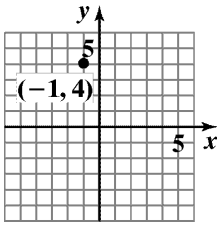


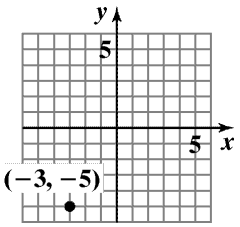

**3.**



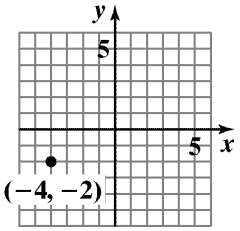

**4.**



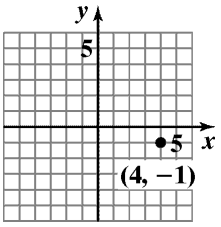

**5.**




**6.**




**7.**

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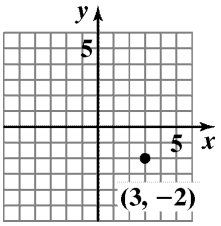
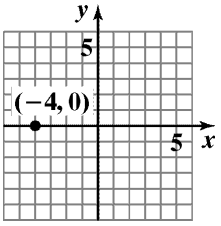
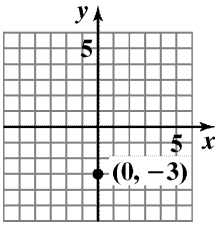


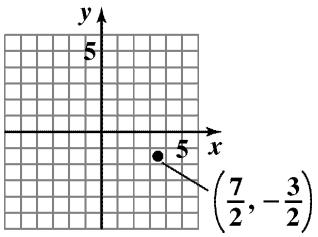

**9.**



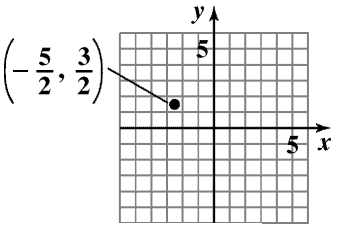

**10.**



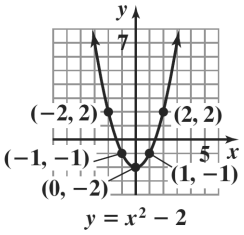
**11.**




**12.**




**13.**




$x = -3$, $y = 7$

$x = -2$, $y = 2$

$x = -1$, $y = -1$

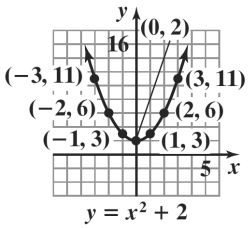
$x = 0$, $y = -2$

$x = 1$, $y = -1$

$x = 2$, $y = 2$

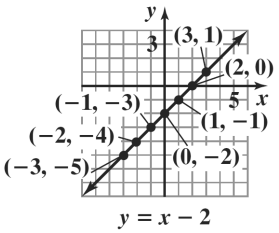
$x = 3$, $y = 7$

**14.**




$x = -3$, $y = 11$
$x = -2$, $y = 6$
$x = -1$, $y = 3$
$x = 0$, $y = 2$
$x = 1$, $y = 3$
$x = 2$, $y = 6$
$x = 3$, $y = 11$

**15.**




$x = -3$, $y = -5$

$x = -2$, $y = -4$

$x = -1$, $y = -3$

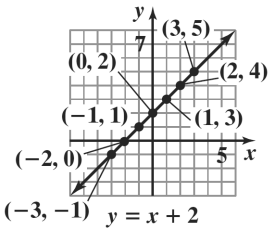
$x = 0$, $y = -2$

$x = 1$, $y = -1$

$x = 2$, $y = 0$

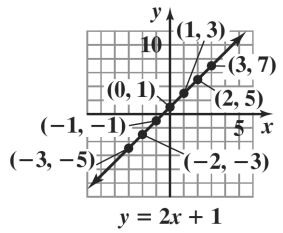
$x = 3$, $y = 1$

**16.**




$x = -3$, $y = -1$
$x = -2$, $y = 0$
$x = -1$, $y = 1$
$x = 0$, $y = 2$
$x = 1$, $y = 3$
$x = 2$, $y = 4$
$x = 3$, $y = 5$

**17.**




$x = -3,\ y = -5$

$x = -2,\ y = -3$

$x = -1,\ y = -1$

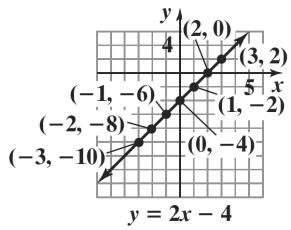
$x = 0,\ y = 1$

$x = 1,\ y = 3$

$x = 2,\ y = 5$

$x = 3,\ y = 7$

**18.**




$x = -3,\ y = -10$

$x = -2,\ y = -8$

$x = -1,\ y = -6$

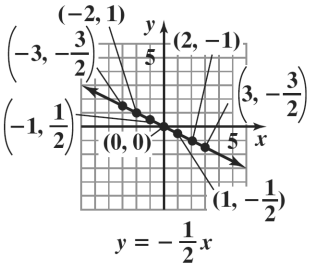
$x = 0,\ y = -4$

$x = 1,\ y = -2$

$x = 2,\ y = 0$

$x = 3,\ y = 2$

**19.**




$x = -3,\ y = \dfrac{3}{2}$

$x = -2,\ y = 1$

$x = -1,\ y = \dfrac{1}{2}$

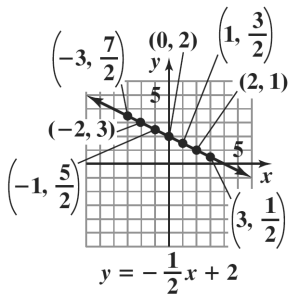
$x = 0,\ y = 0$

$x = 1,\ y = -\dfrac{1}{2}$

$x = 2,\ y = -1$

$x = 3,\ y = -\dfrac{3}{2}$

**20.**




$x = -3,\ y = \dfrac{7}{2}$

$x = -2,\ y = 3$

$x = -1,\ y = \dfrac{5}{2}$

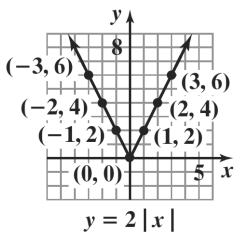
$x = 0,\ y = 2$

$x = 1,\ y = \dfrac{3}{2}$

$x = 2,\ y = 1$

$x = 3,\ y = \dfrac{1}{2}$

**21.**




$y = 2|x|$

$x = -3, y = 6$

$x = -2, y = 4$

$x = -1, y = 2$

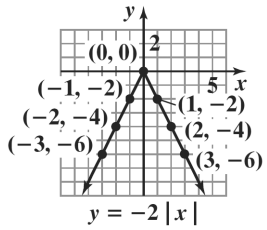
$x = 0, y = 0$

$x = 1, y = 2$

$x = 2, y = 4$

$x = 3, y = 6$

**22.**




$y = -2|x|$

$x = -3, y = -6$

$x = -2, y = -4$

$x = -1, y = -2$

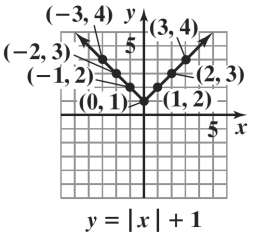
$x = 0, y = 0$

$x = 1, y = -2$

$x = 2, y = -4$

$x = 3, y = -6$

**23.**




$y = |x| + 1$

$x = -3, y = 4$

$x = -2, y = 3$

$x = -1, y = 2$

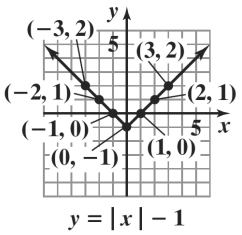
$x = 0, y = 1$

$x = 1, y = 2$

$x = 2, y = 3$

$x = 3, y = 4$

**24.**




$y = |x| - 1$

$x = -3, y = 2$

$x = -2, y = 1$

$x = -1, y = 0$

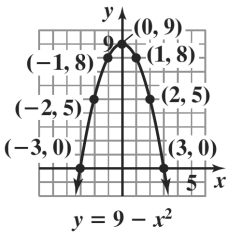
$x = 0, y = -1$

$x = 1, y = 0$

$x = 2, y = 1$

$x = 3, y = 2$

**25.**




$y = 9 - x^2$

$x = -3, y = 0$

$x = -2, y = 5$

$x = -1, y = 8$

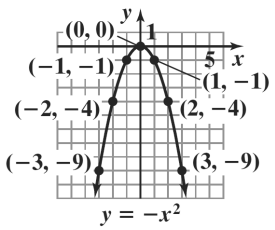
$x = 0, y = 9$

$x = 1, y = 8$

$x = 2, y = 5$

$x = 3, y = 0$

**26.**




$x = -3, y = -9$

$x = -2, y = -4$

$x = -1, y = -1$

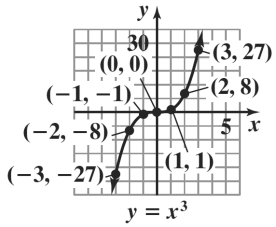
$x = 0, y = 0$

$x = 1, y = -1$

$x = 2, y = -4$

$x = 3, y = -9$

**27.**




$x = -3, y = -27$

$x = -2, y = -8$

$x = -1, y = 1$

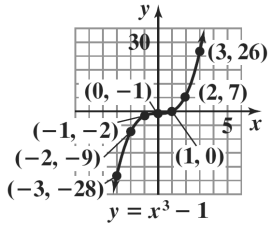
$x = 0, y = 0$

$x = 1, y = 1$

$x = 2, y = 8$

$x = 3, y = 27$

**28.**




$x = -3, y = -28$

$x = -2, y = -9$

$x = -1, y = -2$

$x = 0, y = -1$

$x = 1, y = 0$

$x = 2, y = 7$

$x = 3, y = 26$

**29.** (c) *x*-axis tick marks –5, –4, –3, –2, –1, 0, 1, 2, 3, 4, 5; *y*-axis tick marks are the same.

**30.** (d) *x*-axis tick marks –10, –8, –6, –4, –2, 0, 2, 4, 6, 8, 10; *y*-axis tick marks –4, –2, 0, 2, 4

**31.** (b); *x*-axis tick marks –20, –10, 0, 10, 20, 30, 40, 50, 60, 70, 80; *y*-axis tick marks –30, –20, –10, 0, 10, 20, 30, 40, 50, 60, 70

**32.** (a) *x*-axis tick marks –40, –20, 0, 20, 40; *y*-axis tick marks –1000, –900, –800, –700, . . . , 700, 800, 900, 1000

**33.** The equation that corresponds to $Y_2$ in the table is (c), $y_2 = 2 - x$. We can tell because all of the points $(-3, 5)$, $(-2, 4)$, $(-1, 3)$, $(0, 2)$, $(1, 1)$, $(2, 0)$, and $(3, -1)$ are on the line $y = 2 - x$, but all are not on any of the others.

**34.** The equation that corresponds to $Y_1$ in the table is (b), $y_1 = x^2$. We can tell because all of the points $(-3, 9)$, $(-2, 4)$, $(-1, 1)$, $(0, 0)$, $(1, 1)$, $(2, 4)$, and $(3, 9)$ are on the graph $y = x^2$, but all are not on any of the others.

**35.** No. It passes through the point $(0, 2)$.

**36.** Yes. It passes through the point $(0, 0)$.

**37.** $(2, 0)$

**38.** $(0, 2)$

**39.** The graphs of $Y_1$ and $Y_2$ intersect at the points $(-2, 4)$ and $(1, 1)$.

**40.** The values of $Y_1$ and $Y_2$ are the same when $x = -2$ and $x = 1$.

**41.** **a.** 2; The graph intersects the *x*-axis at (2, 0).

**b.** –4; The graph intersects the *y*-axis at (0,–4).

**42.** **a.** 1; The graph intersects the *x*-axis at (1, 0).

**b.** 2; The graph intersects the *y*-axis at (0, 2).

**43.** **a.** 1, –2; The graph intersects the *x*-axis at (1, 0) and (–2, 0).

**b.** 2; The graph intersects the *y*-axis at (0, 2).

**44.** **a.** 1, –1; The graph intersects the $x$-axis at (1, 0) and (–1, 0).

**b.** 1; The graph intersect the $y$-axis at (0, 1).

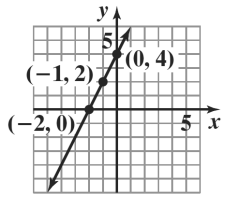
**45.** **a.** –1; The graph intersects the $x$-axis at (–1, 0).

**b.** none; The graph does not intersect the $y$-axis.

**46.** **a.** none; The graph does not intersect the $x$-axis.

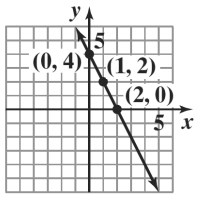
**b.** 2; The graph intersects the $y$-axis at (0, 2).

**47.**



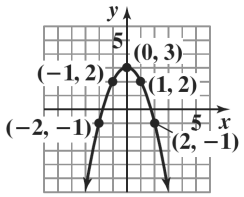

$y = 2x + 4$

**48.**



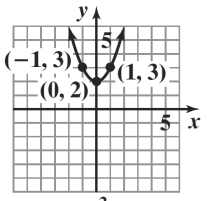

$y = 4 - 2x$

**49.**




$y = 3 - x^2$

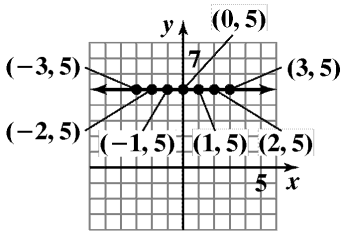
**50.**




$y = x^2 + 2$

**51.**

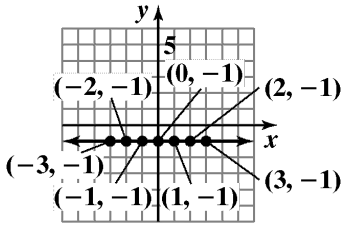
| $x$ | $(x, y)$ |
|---|---|
| –3 | (–3, 5) |
| –2 | (–2, 5) |
| –1 | (–1, 5) |
| 0 | (0, 5) |
| 1 | (1, 5) |
| 2 | (2, 5) |
| 3 | (3, 5) |




$y = 5$

**52.**

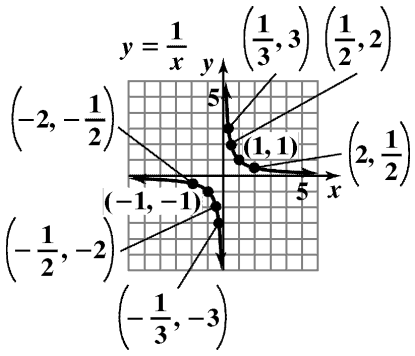
| $x$ | $(x, y)$ |
|---|---|
| –3 | (–3, –1) |
| –2 | (–2, –1) |
| –1 | (–1, –1) |
| 0 | (0, –1) |
| 1 | (1, –1) |
| 2 | (2, –1) |
| 3 | (3, –1) |




$y = -1$

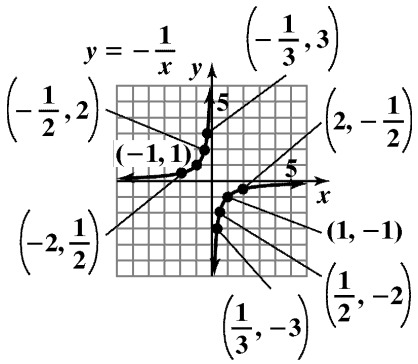
**53.**

| $x$ | $(x, y)$ |
|---|---|
| $-2$ | $\left(-2,-\frac{1}{2}\right)$ |
| $-1$ | $(-1,-1)$ |
| $-\frac{1}{2}$ | $\left(-\frac{1}{2},-2\right)$ |
| $-\frac{1}{3}$ | $\left(-\frac{1}{3},-3\right)$ |
| $\frac{1}{3}$ | $\left(\frac{1}{3},3\right)$ |
| $\frac{1}{2}$ | $\left(\frac{1}{2},2\right)$ |
| $1$ | $(1,1)$ |
| $2$ | $\left(2,\frac{1}{2}\right)$ |




**54.**

| $x$ | $(x, y)$ |
|---|---|
| $-2$ | $\left(-2,\frac{1}{2}\right)$ |
| $-1$ | $(-1,1)$ |
| $-\frac{1}{2}$ | $\left(-\frac{1}{2},2\right)$ |
| $-\frac{1}{3}$ | $\left(-\frac{1}{3},3\right)$ |
| $\frac{1}{3}$ | $\left(\frac{1}{3},-3\right)$ |
| $\frac{1}{2}$ | $\left(\frac{1}{2},-2\right)$ |
| $1$ | $(1,-1)$ |
| $2$ | $\left(2,-\frac{1}{2}\right)$ |




**55.** **a.** According to the line graph, 20% of seniors used marijuana in 2005.

**b.** 2005 is 25 years after 1980.
$M = -0.3n + 27$
$M = -0.3(25) + 27 = 19.5$
According to formula, 19.5% of seniors used marijuana in 2005. This underestimates the value in the graph by 0.5%.

**c.** According to the line graph, about 47% of seniors used alcohol in 2005.

**d.** 2005 is 25 years after 1980.
$A = -0.9n + 69$
$A = -0.9(25) + 69 = 46.5$
According to formula, 46.5% of seniors used alcohol in 2005. It is less than the estimate, although answers may vary.

**e.** The minimum for marijuana was reached in 1990.
According to the line graph, about 14% of seniors used marijuana in 1990.

**56.** **a.** According to the line graph, 50% of seniors used alcohol in 2000.

**b.** 2000 is 20 years after 1980.
$A = -0.9n + 69$
$A = -0.9(20) + 69 = 51$
According to formula, 51% of seniors used alcohol in 2000. This overestimates the value in the graph by 1%.

**c.** According to the line graph, about 22% of seniors used marijuana in 2000.

**d.** 2000 is 20 years after 1980.
$M = -0.3n + 27$
$M = -0.3(20) + 27 = 21$
According to formula, 21% of seniors used marijuana in 2000. It is less than the estimate, although answers may vary.

**e.** The maximum for alcohol was reached in 1980. According to the line graph, about 72% of seniors used alcohol in 1980.

**57.** At age 8, women have the least number of awakenings, averaging about 1 awakening per night.

**58.** At age 65, men have the greatest number of awakenings, averaging about 8 awakenings per night.

**59.** The difference between the number of awakenings for 25-year-old men and women is about 1.9.

**60.** The difference between the number of awakenings for 18-year-old men and women is about 1.1.

**61. – 66.** Answers will vary.

**67.** makes sense

**68.** does not make sense; Explanations will vary. Sample explanation: Most graphing utilities do not display numbers on the axes.

**69.** does not make sense; Explanations will vary. Sample explanation: These three points are not collinear.

**70.** does not make sense; Explanations will vary. Sample explanation: As the time of day goes up, the total calories burned will also go up.

**71.** false; Changes to make the statement true will vary. A sample change is: The product of the coordinates of a point in quadrant III is also positive.

**72.** false; Changes to make the statement true will vary. A sample change is: A point on the $x$-axis will have $y = 0$.

**73.** true

**74.** false; Changes to make the statement true will vary. A sample change is: $3(5) - 2(2) \neq -4$.

**75.** I, III

**76.** II, IV

**77.** IV

**78.** II

**79.** (a)

**80.** (d)

**81.** (b)

**82.** (c)

**83.** (b)

**84.** (a)

**85.** (c)

**86.** (b)

**87.**
$$\begin{aligned} 2(x-3)-17 &= 13-3(x+2) \\ 2(6-3)-17 &= 13-3(6+2) \\ 2(3)-17 &= 13-3(8) \\ 6-17 &= 13-24 \\ -11 &= -11, \text{ true} \end{aligned}$$

**88.**
$$\begin{aligned} 12\left(\frac{x+2}{4}-\frac{x-1}{3}\right) &= 12\left(\frac{x+2}{4}\right)-12\left(\frac{x-1}{3}\right) \\ &= 3(x+2)-4(x-1) \\ &= 3x+6-4x+4 \\ &= -x+10 \end{aligned}$$

**89.**
$$\begin{aligned} (x-3)\ \frac{3}{x-3}+9 &= (x-3)\ \frac{3}{x-3}\ +(x-3)(9) \\ &= 3+9x-27 \\ &= 9x-24 \end{aligned}$$

**Section 1.2**

**Check Point Exercises**

**1.** $4x+5=29$

$4x+5-5=29-5$

$4x=24$

$\frac{4x}{4}=\frac{24}{4}$

$x=6$

Check:

$4x+5=29$

$4(6)+5=29$

$24+5=29$

$29=29$ true

The solution set is $\{6\}$.

**2.** $4(2x+1)-29=3(2x-5)$

$8x+4-29=6x-15$

$8x-25=6x-15$

$8x-25-6x=6x-15-6x$

$2x-25=-15$

$2x-25+25=-15+25$

$2x=10$

$\frac{2x}{2}=\frac{10}{2}$

$x=5$

Check:

$4(2x+1)-29=3(2x-5)$

$4[2(5)+1]-29=3[2(5)-5]$

$4[10+1]-29=3[10-5]$

$4[11]-29=3[5]$

$44-29=15$

$15=15$ true

The solution set is $\{5\}$.

**3.** $\frac{x-3}{4}=\frac{5}{14}-\frac{x+5}{7}$

$28\cdot\frac{x-3}{4}=28\left(\frac{5}{14}-\frac{x+5}{7}\right)$

$7(x-3)=2(5)-4(x+5)$

$7x-21=10-4x-20$

$7x-21=-4x-10$

$7x+4x=-10+21$

$11x=11$

$\frac{11x}{11}=\frac{11}{11}$

$x=1$

Check:

$\frac{x-3}{4}=\frac{5}{14}-\frac{x+5}{7}$

$\frac{1-3}{4}=\frac{5}{14}-\frac{1+5}{7}$

$\frac{-2}{4}=\frac{5}{14}-\frac{6}{7}$

$-\frac{1}{2}=-\frac{1}{2}$

The solution set is $\{1\}$.

**4.** $\frac{5}{2x}=\frac{17}{18}-\frac{1}{3x}$, $x\neq 0$

$18x\cdot\frac{5}{2x}=18x\left(\frac{17}{18}-\frac{1}{3x}\right)$

$18\cdot\frac{5}{2x}=18x\cdot\frac{17}{18}-18x\cdot\frac{1}{3x}$

$45=17x-6$

$45+6=17x-6+6$

$51=17x$

$\frac{51}{17}=\frac{17x}{17}$

$3=x$

The solution set is $\{3\}$.