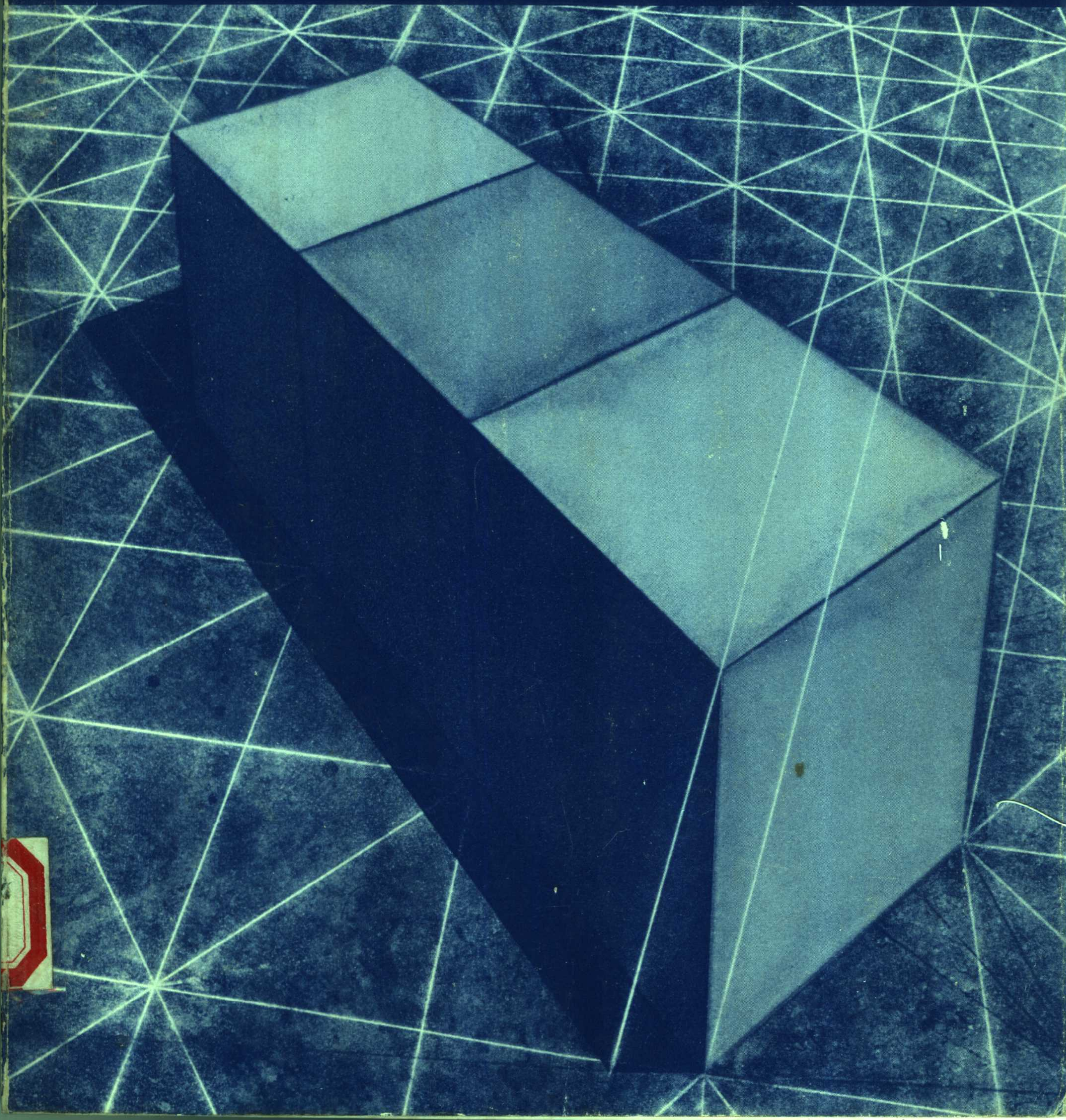
SOLUTIONS MANUAL
TO ACCOMPANY
FINITE MATHEMATICS
FOR MANAGEMENT, LIFE AND SOCIAL SCIENCES
FOURTH EDITION

RAYMOND A. BARNETT
MICHAEL R. ZIEGLER



SOLUTIONS MANUAL

To accompany Raymond A. Barnett and Michael R. Ziegler
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PREFACE

"It is by solving problems that mathematics keeps alive."
—DAVID HILBERT

This supplement accompanies *Finite Mathematics for Management, Life, and Social Sciences*, Fourth Edition, by Raymond A. Barnett and Michael R. Ziegler.

The manual contains the solutions to the odd-numbered problems in each of the exercise sets, and the solutions to all of the problems in the Chapter Reviews. Each of the sections begins with a list of important terms and formulas, given under the heading "Things to Remember." While sufficient details are given for each solution, the first few solutions in each section are more detailed than the remaining ones.

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CHAPTER 0 PRELIMINARIES

EXERCISE 0-1

Things to remember:

1. $a \in A$ means "a is an element of set A."
2. $a \notin A$ means "a is not an element of set A."
3. $\emptyset$ means "the empty set or null set."
4. $S = \{x|P(x)\}$ means "S is the set of all x such that $P(x)$ is true."
5. $A \subseteq B$ means "A is a subset of B."
6. $A \subset B$ means "A is a proper subset of B," or A and B have exactly the same elements.
7. $A = B$ means "$A \subseteq B$ and $B \subseteq A$."
8. $A \cup B = A$ union $B = \{x|x \in A$ or $x \in B\}$.
9. $A \cap B = A$ intersection $B = \{x|x \in A$ and $x \in B\}$.
10. $A' =$ complement of $A = \{x \in U|x \notin A\}$, where U is a universal set.

---

1. T 3. T 5. T 7. T

9. $\{1, 3, 5\} \cup \{2, 3, 4\} = \{1, 2, 3, 4, 5\}$

11. $\{1, 3, 4\} \cap \{2, 3, 4\} = \{3, 4\}$

13. $\{1, 5, 9\} \cap \{3, 4, 6, 8\} = \emptyset$

15. $\{x|x - 2 = 0\}$
$x - 2 = 0$ is true for $x = 2$.
Hence, $\{x|x - 2 = 0\} = \{2\}$.

17. $x^2 = 49$ is true for $x = 7$ and -7.
Hence, $\{x|x^2 = 49\} = \{-7, 7\}$.

19. $\{x|x$ is an odd number between 1 and 9 inclusive$\} = \{1, 3, 5, 7, 9\}$.

21. $U = \{1, 2, 3, 4, 5\}$; $A = \{2, 3, 4\}$
Then $A' = \{1, 5\}$.

23. From the Venn diagram,
A has 40 elements.

25. A' has 60 elements.

27. $A \cup B$ has 60 elements
(35 + 5 + 20).

29. $A' \cap B$ has 20 elements
(common elements between A' and B).

31. $(A \cap B)'$ has 95 elements.
(Note that $A \cap B$ has 5 elements.)

33. $A' \cap B'$ has 40 elements.

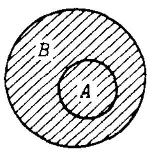
35. (A) $\{x | x \in R$ or $x \in T\}$
$= R \cup T$ ("or" translated as $\cup$, union)
$= \{1, 2, 3, 4\} \cup \{2, 4, 6\}$
$= \{1, 2, 3, 4, 6\}$

(B) $R \cup T = \{1, 2, 3, 4, 6\}$

37. $Q \cap R = \{2, 4, 6\} \cap \{3, 4, 5, 6\}$
$= \{4, 6\}$

$P \cup (Q \cap R) = \{1, 2, 3, 4\} \cup \{4, 6\}$
$= \{1, 2, 3, 4, 6\}$

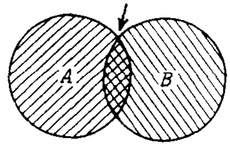
39. $A \cup B = B$ can be represented by the Venn diagram



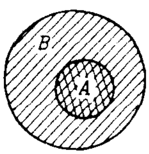
From the diagram we see that $A \cup B = B$. Thus, the given statement is *true*.

41. The given statement is always *true*. To understand this, see the following Venn diagram.

$A \cap B \subset B$



43. The given statement is *true*. To understand this, see the following Venn diagram.



$x \in A$

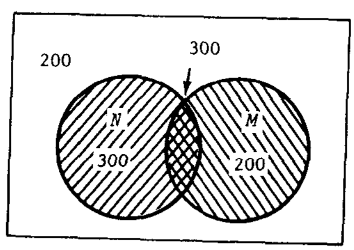
From the diagram we conclude that $x \in B$.

45. (A) Set $\{a\}$ has two subsets: $\{a\}$ and $\emptyset$
(B) Set $\{a, b\}$ has four subsets: $\{a, b\}$, $\emptyset$, $\{a\}$, $\{b\}$
(C) Set $\{a, b, c\}$ has eight subsets: $\{a, b, c\}$, $\emptyset$, $\{a\}$, $\{b\}$, $\{c\}$, $\{a, b\}$, $\{a, c\}$, $\{b, c\}$

Parts (A), (B), and (C) suggest the following formula:

The number of subsets in a set with n elements $= 2^n$.

47. The Venn diagram that corresponds to the given information is shown at the right. We can see that $N \cup M$ has 300 + 300 + 200 = 800 students.



49. $(N \cup M)'$ has 200 students [because $N \cup M$ has 800 students and $(N \cup M)' = 1000 - 800 = 200$.].

51. $N' \cap M$ has 200 students.

53. The number of commuters who listen to either news or music = number of commuters in the set $M \cup N$, which is 800.

55. The number of commuters who do not listen to either news or music = number of commuters in the set $(N \cup M)'$, which is $1000 - 800 = 200$.

57. The number of commuters who listen to music but not news = number of commuters in the set $N' \cap M$, which is 200.

59. The six two-person subsets that can be formed from the given set $\{P, V_1, V_2, V_3\}$ are:

$\{P, V_1\}$ $\{P, V_3\}$ $\{V_1, V_3\}$
$\{P, V_2\}$ $\{V_1, V_2\}$ $\{V_2, V_3\}$

61. From the given Venn diagram, $A \cap Rh = \{A+, AB+\}$.

63. Again, from the given Venn diagram, $A \cup Rh = \{A-, A+, B+, AB-, AB+, 0+\}$.

65. From the given Venn diagram, $(A \cup B)' = \{0+, 0-\}$.

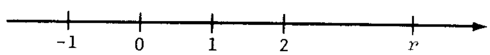
67. $A' \cap B = \{B-, B+\}$.

69. Statement (2): For every $a, b \in C$, aRb and bRa means that everyone in the clique relates to one another.

EXERCISE 0-2

Things to remember:

1. There is a one-to-one correspondence between the set of real numbers and the set of points on a line. A line with a real number associated with each point, and vice versa, as in the figure, is called a REAL NUMBER LINE or REAL LINE. The real number r associated with a given point is called the COORDINATE of the point. The point with coordinate 0 is called the ORIGIN. The arrow indicates the positive direction.



Let a, b, and c be real numbers. Then

2. If $a = b$, then (a) $a + c = b + c$
(b) $a - c = b - c$
(c) $ac = bc$
(d) $\frac{a}{c} = \frac{b}{c}$ $c \neq 0$

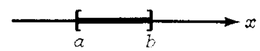
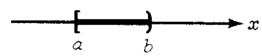
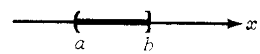
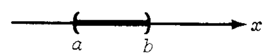
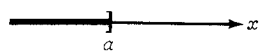
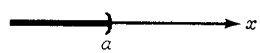
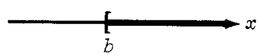
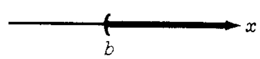
3. If $a > b$, then (a) $a + b > b + c$
(b) $a - c > b - c$

(c) $ac > bc$
(d) $\dfrac{a}{c} > \dfrac{b}{c}$ } if c is positive

(e) $ac < bc$
(f) $\dfrac{a}{c} < \dfrac{b}{c}$ } if c is negative

Note: Similar properties hold if each inequality is reversed, or if $>$ is replaced by $\geqslant$ and $<$ is replaced by $\leqslant$.

4. The double inequality $a \leqslant x \leqslant b$ means that $a \leqslant x$ and $x \leqslant b$. Other variations, as well as a useful interval notation, are indicated in the following table.

INTERVAL NOTATION	INEQUALITY NOTATION	LINE GRAPH
$[a, b]$	$a \leqslant x \leqslant b$	
$[a, b)$	$a \leqslant x < b$	
$(a, b]$	$a < x \leqslant b$	
(a, b)	$a < x < b$	
$(-\infty, a]$	$x \leqslant a$	
$(-\infty, a)$	$x < a$	
$[b, \infty)$	$x \geqslant b$	
(b, ∞)	$x > b$	

Note: An endpoint on a line graph has a square bracket through it if it is included in the inequality and a parenthesis through it if it is not.

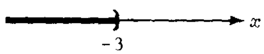
1.
$$\begin{aligned} 2m + 9 &= 5m - 6 \\ 2m + 9 - 9 &= 5m - 6 - 9 && \text{[using 2(b)]} \\ 2m &= 5m - 15 \\ 2m - 5m &= 5m - 15 - 5m && \text{[using 2(b)]} \\ -3m &= -15 \\ \frac{-3m}{-3} &= \frac{-15}{-3} && \text{[using 2(d)]} \\ m &= 5 \end{aligned}$$

3.
$$\begin{aligned} x + 5 &< -4 \\ x + 5 - 5 &< -4 - 5 && \text{[using 3(b)]} \\ x &< -9 \end{aligned}$$

5.
$$\begin{aligned} -3x &\geqslant -12 \\ \frac{-3x}{-3} &\leqslant \frac{-12}{-3} && \text{[using 3(f)]} \\ x &\leqslant 4 \end{aligned}$$

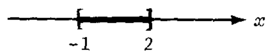
7.
$$\begin{aligned} -4x - 7 &> 5 \\ -4x &> 5 + 7 \\ -4x &> 12 \\ x &< -3 \end{aligned}$$

Graph of $x < -3$ is:



9.
$$\begin{aligned} 2 \leqslant x + 3 &\leqslant 5 \\ 2 - 3 \leqslant x &\leqslant 5 - 3 \\ -1 \leqslant x &\leqslant 2 \end{aligned}$$

Graph of $-1 \leqslant x \leqslant 2$ is:



11. $\frac{y}{7} - 1 = \frac{1}{7}$

Multiply both sides of the equation by 7. We obtain:

$$\begin{aligned} y - 7 &= 1 && \text{[using 2(c)]} \\ y &= 8 \end{aligned}$$

13. $\frac{x}{3} > -2$

Multiply both sides of the inequality by 3. We obtain:

$x > -6$ [using 3(c)]

15. $\frac{y}{3} = 4 - \frac{y}{6}$

Multiply both sides of the equation by 6. We obtain:

$$\begin{aligned} 2y &= 24 - y \\ 3y &= 24 \\ y &= 8 \end{aligned}$$

17.
$$\begin{aligned} 10x + 25(x - 3) &= 275 \\ 10x + 25x - 75 &= 275 \\ 35x &= 275 + 75 \\ 35x &= 350 \\ x &= \frac{350}{35} \\ x &= 10 \end{aligned}$$

19.
$$\begin{aligned} 3 - y &\leqslant 4(y - 3) \\ 3 - y &\leqslant 4y - 12 \\ -5y &\leqslant -15 \\ y &\geqslant 3 \end{aligned}$$

(note division by a negative number, -3)

21. $\frac{x}{5} - \frac{x}{6} = \frac{6}{5}$

Multiply both sides of the equation by 30. We obtain:

$$\begin{aligned} 6x - 5x &= 36 \\ x &= 36 \end{aligned}$$

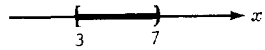
23. $\frac{m}{5} - 3 < \frac{3}{5} - m$ Multiply both sides of the inequality by 5. We obtain:

$$\begin{aligned} m - 15 &< 3 - 5m \\ 6m &< 18 \\ m &< 3 \end{aligned}$$

25.
$$\begin{aligned} 0.1(x - 7) + 0.05x &= 0.8 \\ 0.1x - 0.7 + 0.05x &= 0.8 \\ 0.15x &= 1.5 \\ x &= \frac{1.5}{0.15} \\ x &= 10 \end{aligned}$$

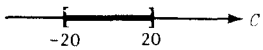
27.
$$\begin{aligned} 2 \leqslant 3x - 7 &< 14 \\ 7 + 2 \leqslant 3x &< 14 + 7 \\ 9 \leqslant 3x &< 21 \\ 3 \leqslant x &< 7 \end{aligned}$$

Graph of $3 \leqslant x < 7$ is:



29.
$$\begin{aligned} -4 \leqslant \frac{9}{5}C + 32 &\leqslant 68 \\ -36 \leqslant \frac{9}{5}C &\leqslant 36 \\ -36\left(\frac{5}{9}\right) \leqslant C &\leqslant 36\left(\frac{5}{9}\right) \\ -20 \leqslant C &\leqslant 20 \end{aligned}$$

Graph of $-20 \leqslant C \leqslant 20$ is:



31.
$$\begin{aligned} 3x - 4y &= 12 \\ 3x &= 12 + 4y \\ 3x - 12 &= 4y \\ y &= \frac{1}{4}(3x - 12) \\ &= \frac{3}{4}x - 3 \end{aligned}$$

33.
$$\begin{aligned} Ax + By &= C \\ By &= C - Ax \\ y &= \frac{C}{B} - \frac{Ax}{B} \end{aligned}$$

or $\quad y = -\left(\frac{A}{B}\right)x + \frac{C}{B}$

35.
$$\begin{aligned} F &= \frac{9}{5}C + 32 \\ \frac{9}{5}C + 32 &= F \\ \frac{9}{5}C &= F - 32 \\ C &= \frac{5}{9}(F - 32) \end{aligned}$$

37.
$$\begin{aligned} A &= Bm - Bn \\ A &= B(m - n) \\ B &= \frac{A}{m - n} \end{aligned}$$

39.
$$\begin{aligned} -3 \leqslant 4 - 7x &< 18 \\ -3 - 4 \leqslant -7x &< 18 - 4 \end{aligned}$$

and $-7 \leqslant -7x < 14$.

Dividing by -7, and recalling 3(f), we have

$1 \geqslant x > -2 \quad$ or $\quad -2 < x \leqslant 1$

The graph is:

41. Let x = number of \$6 tickets. Then the number of \$10 tickets = $8{,}000 - x$.

$6x + 10(8{,}000 - x) = 60{,}000$

Thus,

$$\begin{aligned} 6x + 80{,}000 - 10x &= 60{,}000 \\ -4x &= 60{,}000 - 80{,}000 \\ 4x &= 20{,}000 \\ x &= 5{,}000 \end{aligned}$$

Therefore, $x = 5{,}000$ \$6 tickets and $8{,}000 - x = 3{,}000$ \$10 tickets were sold.

43. Let x = amount invested at 10%. Then 12,000 - x is the amount invested at 15%.

Required total yield = 12% of \$12,000 = 0.12 • 12,000 = \$1,400. Thus,

$$\begin{aligned} 0.10x + 0.15(12{,}000 - x) &= 0.12 \cdot 12{,}000 \\ 10x + 15(12{,}000 - x) &= 12 \cdot 12{,}000 \quad \text{(multiply both sides by 100)} \\ 10x + 180{,}000 - 15x &= 144{,}000 \\ -5x &= -36{,}000 \\ x &= \$7{,}200 \end{aligned}$$

Thus, we get \$7,200 invested at 10% and 12,000 - 7,200 = \$4,800 invested at 15%.

45. $\frac{\text{Car sold for in 1980}}{\text{Car sold for in 1965}} = \frac{\text{Consumer price index in 1980}}{\text{Consumer price index in 1965}}$

$$\frac{x}{3000} = \frac{247}{95} \quad \text{(refer to Table 2, Example 13)}$$

$$x = \frac{3000 \times 247}{95}$$

$$= \$7{,}800$$

47. Let x = number of rainbow trout in the lake. Then,

$$\frac{x}{200} = \frac{200}{8} \quad \text{(since proportions are the same)}$$

$$x = \frac{200}{8}(200)$$

$$x = 5000$$

49. $\text{IQ} = \frac{\text{Mental age}}{\text{Chronological age}}(100)$

$$\frac{\text{Mental age}}{9}(100) = 140$$

$$\text{Mental age} = \frac{140}{100}(9)$$

$$= 12.6 \text{ years}$$

EXERCISE 0-3

Things to remember:

1. A quadratic equation in one variable is an equation of the form

(A) $ax^2 + bx + c = 0$,

where x is a variable and a, b, and c are constants, $a \neq 0$.

2. Quadratic equations of the form $ax^2 + c = 0$ can be solved by the SQUARE ROOT METHOD. The solutions are:

$$x = \pm\sqrt{\frac{-c}{a}} \quad \text{provided } \frac{-c}{a} \geq 0;$$

otherwise, the equation has no real solutions.

3. If the left side of the quadratic equation (A) can be FACTORED,

$$ax^2 + bx + c = (px + q)(rx + s),$$

then the solutions of (A) are

$$x = \frac{-q}{p} \quad \text{or} \quad x = \frac{-s}{r}.$$

4. The solutions of (A) are given by the QUADRATIC FORMULA:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

The quantity $b^2 - 4ac$ is called the DISCRIMINANT and:

(i) (A) has two real solutions if $b^2 - 4ac > 0$;

(ii) (A) has one real solution if $b^2 - 4ac = 0$;

(iii) (A) has no real solutions if $b^2 - 4ac < 0$.

---

1. $x^2 - 4 = 0$
$x^2 = 4$
$x = \pm\sqrt{4} = \pm 2$

3. $2x^2 - 22 = 0$
$x^2 - 11 = 0$
$x^2 = 11$
$x = \pm\sqrt{11}$

5. $2u^2 - 8u - 24 = 0$
$u^2 - 4u - 12 = 0$
$(u - 6)(u + 2) = 0$

$u - 6 = 0$ or $u + 2 = 0$
$u = 6$ or $u = -2$

7. $x^2 = 2x$
$x^2 - 2x = 0$
$x(x - 2) = 0$

$x = 0$ or $x - 2 = 0$
$= 2$

9. $x^2 - 6x - 3 = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}, \quad a = 1,\ b = -6,\ c = -3$$

$$= \frac{-(-6) \pm \sqrt{(-6)^2 - 4(1)(-3)}}{2(1)}$$

$$= \frac{6 \pm \sqrt{48}}{2} = \frac{6 \pm 4\sqrt{3}}{2} = 3 \pm 2\sqrt{3}$$

11. $3u^2 + 12u + 6 = 0$

Since 3 is a factor of each coefficient, divide both sides by 3.

$u^2 + 4u + 2 = 0$

$$u = \frac{-b \pm \sqrt{b^2 - 4}}{2a}, \quad a = 1,\ b = 4,\ c = 2$$

$$= \frac{-4 \pm \sqrt{4^2 - 4(1)(2)}}{2(1)} = \frac{-4 \pm \sqrt{8}}{1} = \frac{-4 \pm 2\sqrt{2}}{2} = -2 \pm \sqrt{2}$$

13.
$$2x^2 = 4x$$
$$x^2 = 2x \quad \text{(divide both sides by 2)}$$
$$x^2 - 2x = 0 \quad \text{(solve by factoring)}$$
$$x(x - 2) = 0$$
$$x = 0 \quad \text{or} \quad x - 2 = 0$$
$$x = 2$$

15.
$$4u^2 - 9 = 0$$
$$4u^2 = 9 \quad \text{(solve by square root method)}$$
$$u^2 = \frac{9}{4}$$
$$u = \pm\sqrt{\frac{9}{4}} = \pm\frac{3}{2}$$

17.
$$8x^2 + 20x = 12$$
$$8x^2 + 20x - 12 = 0$$
$$2x^2 + 5x - 3 = 0$$
$$(x + 3)(2x - 1) = 0$$
$$x + 3 = 0 \quad \text{or} \quad 2x - 1 = 0$$
$$x = -3 \quad \text{or} \quad 2x = 1$$
$$x = \frac{1}{2}$$

19.
$$x^2 = 1 - x$$
$$x^2 + x - 1 = 0$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}, \; a = 1, \; b = 1, \; c = -1$$
$$= \frac{-1 \pm \sqrt{(1)^2 - 4(1)(-1)}}{2(1)} = \frac{-1 \pm \sqrt{5}}{2}$$

21.
$$2x^2 = 6x - 3$$
$$2x^2 - 6x + 3 = 0$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}, \; a = 2, \; b = -6, \; c = 3$$
$$= \frac{-(-6) \pm \sqrt{(-6)^2 - 4(2)(3)}}{2(2)}$$
$$= \frac{6 \pm \sqrt{12}}{4} = \frac{6 \pm 2\sqrt{3}}{4} = \frac{3 \pm \sqrt{3}}{2}$$

23.
$$y^2 - 4y = -8$$
$$y^2 - 4y + 8 = 0$$
$$y = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}, \; a = 1, \; b = -4, \; c = 8$$
$$= \frac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(8)}}{2(1)} = \frac{4 \pm \sqrt{-16}}{2}$$

Since $\sqrt{-16}$ is not a real number, there are no real solutions.

25.
$$(x + 4)^2 = 11$$
$$x + 4 = \pm\sqrt{11}$$
$$x = -4 \pm \sqrt{11}$$

27.
$$A = P(1 + r)^2$$
$$(1 + r)^2 = \frac{A}{P}$$
$$1 + r = \sqrt{\frac{A}{P}}$$
$$r = \sqrt{\frac{A}{P}} - 1$$

29. $d = \frac{3000}{p}$ and $s = 1000p - 500$

Let $d = s$. Then,

$\frac{3000}{p} = 1000p - 500$ or $3000 = 1000p^2 - 500p$ and $1000p^2 - 500p - 3000 = 0$.

Divide both sides by 500.

$$2p^2 - p - 6 = 0 \quad \text{(solve by factoring)}$$
$$(2p + 3)(p - 2) = 0$$
$$2p + 3 = 0 \quad \text{or} \quad p - 2 = 0$$
$$p = -\frac{3}{2} \quad \text{or} \quad p = 2$$

Since the price, p, must be positive, we have $p = \$2$ as the equilibrium point.

31. $v^2 = 64h$

For $h = 1$, $v^2 = 64(1) = 64$. Therefore, $v = 8$ ft/sec.

For $h = 0.5$, $v^2 = 64(0.5) = 32$. Therefore, $v = \sqrt{32} \approx 5.66$ ft/sec.

EXERCISE 0-4

Things to remember:

1. The graph of any equation of the form $Ax + By = C$ (standard form), where A, B, and C are constants (A and B not both zero) is a straight line. Every straight line in a cartesian coordinate system is the graph of an equation of this type.

2. The slope, m, of a line through the two points (x_1, y_1) and (x_2, y_2) is given by:

$$m = \frac{y_2 - y_1}{x_2 - x_1},$$

$$x_1 \neq x_2.$$