

Answers for Chapter 1

Exercise 3 Solutions of equations

- | | | | | |
|------------|------------|-------------|-------------|-------------|
| 1. 12 | 4. any no. | 7. ± 13 | 10. ± 7 | 13. 3 |
| 2. 10 | 5. 42 | 8. 3 or -2 | 11. 24 | 14. any no. |
| 3. any no. | 6. ± 5 | 9. 0 or 1 | 12. 6 | 15. 3 |

Exercise 4 Addition

1. (DNMS stands for "Does not make sense.")
- | | | | | |
|----------|--------|--------|--------|--------|
| (a) 12 | (d) 13 | (g) 21 | (j) 6 | (m) 45 |
| (b) DNMS | (e) 14 | (h) 7 | (k) 18 | |
| (c) 11 | (f) 21 | (i) 10 | (l) 0 | (n) 45 |
- (o) Because the same numbers are being added, and the fact that the order is different doesn't matter.
- | | | |
|---------|---------|----------|
| (p) 190 | (q) 435 | (r) 4950 |
|---------|---------|----------|
2. Multiply $6 \cdot 2$ to get 12
3. $16 \cdot 2 = 32$
- | | | | | |
|----------|-------|--------|-------|-------|
| 4. (a) 8 | (c) 3 | (e) 17 | (g) 2 | (i) 0 |
| (b) 7 | (d) 3 | (f) 19 | (h) 0 | (j) 2 |
5. Subtraction
- | | | | |
|-------------|----------|----------|-----------|
| 6. (a) True | (c) True | (e) True | (g) False |
| (b) True | (d) True | (f) True | |
- | | | | |
|-----------|-------|------|---------|
| 7. (a) 37 | 8. 28 | 9. 0 | 10. -83 |
| (b) 97 | | | |
11. $C + 9 = 20$, where C is the number you need.

Exercise 5 Subtraction

1. (a) $7 = 3 + 4$ (d) $5 = 2 + 3$ (g) $5 = 5 + 0$
 (b) $13 = 6 + 7$ (e) $5 = 3 + 2$ (h) $* 5 = 6 + (-1)$
 (c) $5 = 1 + 4$ (f) $5 = 4 + 1$ (i) $123 = 57 + 66$

2. (a) 8 (d) 9 (g) 158 (j) 3
 (b) 8 (e) 23 (h) 19
 (c) 4 (f) 0 (i) 0

3. (a) False (c) True (e) False
 (b) True (d) True

4. .
 (a) 12 (b) 6

5. $x + 30 = 532$ or $x = 532 - 30$ where x is the number of pears for the neighbors.

Exercise 8 Multiplication

1. (a) 8 (c) 36 (e) 48 (g) 30
 (b) 24 (d) 48 (f) 18 (h) 60

2. a) 1, 2, 3, 6 b) 1, 2, 4, 8 c) 1, 2, 3, 4, 6, 12 d) 1, 2, 3, 5, 6, 10, 15, 30
 e) 1, 2, 3, 4, 6, 8, 12, 16, 24, 32, 48, 96 f) 140

3. a) 1, 7 b) 1, 3, 9 c) 1, 2, 7, 14 d) 1, 2, 3, 4, 6, 8, 12, 24 e) 1, 17
 f) 1 g) 1, 2, 4, 8, 16 h) 1, 2, 5, 10, 25, 50 i) 1, 2, 3, 4, 6, 8, 12, 16, 24, 32, 48, 96 j) 1, 37 k) 1, 47

4. a) 87 b) 28 c) -3

5. $0.42L = 7.00$ where L is the number of letters you can write. Answer: 16.
 (Round down—you can mail $2/3$ of a letter.)

Exercise 9 More multiplication

1. (a) $4 \cdot 2$ (b) $5 \cdot 7$ (c) $10 \cdot 1$ (d) $8 \cdot 23$

2. (a) True
 (b) True (d) True (f) False
 (c) True (e) True (g) True

3. Multiply 15 by 0.25

4. No difference

5. a) 20 b) $22\frac{1}{2}$ c) 0

6. $2000v = 24000$ where v is the number of vacations you can take.

Exercise 13 Primes and factors

1. 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

2. .
 (a) 1, 24, 2, 12, 3, 8, 4, 6
 (b) 1, 30, 2, 15, 3, 10, 5, 6
 (c) 1, 50, 2, 25, 5, 10
 (d) 1, 98, 2, 49, 7, 14
 (e) 1, 200, 2, 100, 4, 50, 5, 40, 10, 20
 (f) 1, 420, 2, 210, 3, 140, 4, 105, 5, 84, 6, 70, 7, 60, 10, 42, 12, 35, 15, 28, 20, 21

3. .
 (a) $24 = 1 \cdot 24 = 2 \cdot 12 = 3 \cdot 8 = 4 \cdot 6$
 (b) $30 = 1 \cdot 30 = 2 \cdot 15 = 3 \cdot 10 = 5 \cdot 6$
 (c) $50 = 1 \cdot 50 = 2 \cdot 25 = 5 \cdot 10$
 (d) $98 = 1 \cdot 98 = 2 \cdot 49 = 7 \cdot 14$
 (e) $200 = 1 \cdot 200 = 2 \cdot 100 = 4 \cdot 50 = 5 \cdot 40 = 10 \cdot 20$
 (f) $420 = 1 \cdot 420 = 2 \cdot 210 = 3 \cdot 140 = 4 \cdot 105 = 5 \cdot 84 = 6 \cdot 70 = 7 \cdot 60 =$
 $10 \cdot 42 = 12 \cdot 35 = 15 \cdot 28 = 20 \cdot 21$
 (a) $24 = 2 \cdot 2 \cdot 2 \cdot 3 = 2^3 \cdot 3$
 (b) $30 = 2 \cdot 3 \cdot 5$
 (c) $50 = 2 \cdot 5 \cdot 5 = 2 \cdot 5^2$
 (d) $98 = 2 \cdot 7 \cdot 7 = 2 \cdot 7^2$

(e) $200 = 2 \cdot 2 \cdot 2 \cdot 5 \cdot 5 = 2^3 5^2$
 (f) $420 = 2 \cdot 2 \cdot 3 \cdot 5 \cdot 7 = 2^2 \cdot 3 \cdot 5 \cdot 7$

4. Many possibilities: take any three prime numbers and multiply them to get such a number.
5. Many possibilities: take any even number between 200 and 300 for example.
6. No, because each division has a remainder of 1.

Exercise 14 Division

1. (a) 3 (c) 3 (e) 5 (g) $11/6$ or $1\frac{5}{6}$
 (b) 3 (d) 5 (f) 44 (h) $15/4$ or $3\frac{3}{4}$

2. .

- | | | | |
|-----------|----------|-----------|---------------|
| (a) | (c) True | (e) False | (und(f) False |
| (b) False | (d) True | fined) | |

3. a) 15 b) 5 c) $2\frac{2}{5}$

4. There are infinitely many such pairs: x and y must be the same number.

Exercise 14 Exponentiation

1. (a) $2^4 = 16$ (c) $5^2 = 25$ (e) $2^6 = 64$
 (b) $3^3 = 27$ (d) $7^3 = 343$ (f) $3^5 = 243$

2. .

- | | |
|-------------------------------------|--|
| (a) $6 \times 6 = 36$ | (d) $10 \times 10 \times 10 \times 10 \times 10 = 100,000$ |
| (b) $9 \times 9 = 81$ | (e) $3 \times 3 \times 3 \times 3 = 81$ |
| (c) $10 \times 10 \times 10 = 1000$ | (f) $2 \times 2 \times 2 \times 2 \times 2 \times 2 = 64$ |

3. .

- | | |
|----------------|-------------|
| (a) $x = 3$ | (d) $x = 3$ |
| (b) $x = 5$ | (e) $x = 5$ |
| (c) $3^x = 27$ | (f) $x = 2$ |

4. $7^4 = 2,401$

Exercise 16 Order of operations

1. (a) 16 (e) -147 (i) 12
(b) 37 (f) 5 (j) 7
(c) 28 (g) 13 (k) 20
(d) 28 (h) 5 (l) 15
- (a) 38 (e) 110 (i) 1
(b) 50 (f) 4 (j) 11
(c) 11 (g) 12 (k) 13
(d) 7 (h) 8 (l) 72

2. a) $x = 8$ b) $x = 2$

3. $3+4(20-2^3\div 2) = 3+4(20-8\div 2) = 3+4(20-4) = 3+4(16) = 3+64 = 67$

Exercise 17 Basic laws

1. (a) $7 + 5 = 3 + 9$ (d) $10 + 11 = 15 + 6$ (g) $10 + 20 = 30 + 0$
(b) $2 + 11 = 10 + 3$ (e) $15 + 5 = 7 + 13$
(c) $3 + 9 = 10 + 2$ (f) $7 + 12 = 10 + 9$ (h) $13 + 6 = 13 + 6$

2. .

- (a) 20 (c) 30 (e) 24
(b) 20 (d) 25 (f) 200

3. The answer is the same either way.

(a) $(6)4 = 2(12) = 24$ (b) $2 \times (15) = (6) \times 5 = 30$ (c) $4 \times (7) = (4) \times 7 = 28$

4. .

- (a) 60 (b) 300 (c) 1000

5. You check..

6. .

- (a) $2(12) = 10 + 14 = 24$
(b) $(7)3 = 18 + 3 = 21$
(c) $3(11) = 21 + 12 = 33$
(d) $(10)5 = 45 + 5 = 50$
(e) $5(12) = 50 + 10 = 60$

- | | |
|-----------------------------|-----------------------------|
| (a) $5 \cdot 3 + 2 \cdot 3$ | (g) $5(2 + 1)$ |
| (b) $4 \cdot 7 + 4 \cdot 2$ | (h) $(3 + 2) \times 7$ |
| (c) $2 \cdot 8 + 2 \cdot 1$ | (i) $(2 + 3) \times 1$ |
| (d) $6 \cdot 3 + 2 \cdot 3$ | (j) $(5 + 4) \cdot 3$ |
| (e) $3 \cdot 7 + 2 \cdot 7$ | (k) $1 \cdot 3 + 4 \cdot 3$ |
| (f) $4(2 + 3)$ | |

$$(l) *(4 + 3)(5 + 2) = (4 + 3)5 + (4 + 3)2 = 4 \cdot 5 + 3 \cdot 5 + 4 \cdot 2 + 3 \cdot 2$$

7. .

- (a) $(3 + 4) + 5 = 7 + 5 = 12$, $3 + (4 + 5) = 3 + 9 = 12$
 (b) $2 + (8 + 3) = 2 + 11 = 13$, $(2 + 8) + 3 = 10 + 3 = 13$
 (c) $3 + (7 + 2) = 3 + 9 = 12$, $(3 + 7) + 2 = 10 + 2 = 12$
 (d) $10 + (5 + 6) = 10 + 11 = 21$, $(10 + 5) + 6 = 15 + 6 = 21$
 (e) $(7 + 8) + 5 = 15 + 5 = 20$, $7 + (8 + 5) = 7 + 13 = 20$
 (f) $7 + (3 + 9) = 7 + 12 = 19$, $(7 + 3) + 9 = 10 + 9 = 19$
 (g) $10 + (20 + 0) = 10 + 20 = 30$, $30 + 0 = 30$

8. a) Any number works. b) $x = 1$

9. No, because 23 is prime and its only factorization is $1 \cdot 23$ (and 1 is not a prime).

Exercise 18 Properties of zero and one

- All the products are zero
- a) 6 b) 54 c) 1 d) 1 e) 1 f) 3 g) 2 h) 966
- a) $x = 9$ b) Any number works c) $x = 0$ or $x = 1$
- Division by zero is not allowed because the check leads to a contradiction; namely, that two different numbers are equal, an impossibility.

Exercise 20 Variables and formulas

- a) \$16.05 b) \$53.50 c) \$107 d) \$19.21
- You get the same result, because $p + .07p = 1p + .07p = 1.07p$ (by the property of 1, the distributive law and arithmetic)
- a) 21 b) 17 c) 26
- $E = 10h$ where E is her earnings. (You can use any letter.)
- $E = 12r$ where E is his earnings.

6. $E = 500w + 1000$, where E is his earnings.

Exercise 25 Terminology

1. a) $2a, 7b, 9c^3$ b) x, y c) $m, 2, 3pq$ d) $3x^2, 5x, -6$
2. a) a and $2a$ are like terms; k and $3k$ are like terms; x and $7x$ are like terms
 b) 6 and 2 are like terms; $9x$ and $4x$ are like terms; there are no other sets of like terms
 c) $3p$ and $2p$ are like terms; $10r$ and r are like terms
3. a) $3a + 4k + 8x$ b) $8 + 13x + 3x^2 + 5x^3$ c) $5p + 9q + 11r$
4. a) 4, a and x b) 9, x^2 and y (or 9, x, x, y) c) $x - 1$ and $x - 5$ d) 4, $x + 2$ and $2x + 3$
5. a) $a(b + c)$ b) $(1 + a), x$ c) $2(a + b + c)$
6. a) $ab + ac$ b) $x + ax$ (or $1x + ax$) c) $2a + 2b + 2c$
7. Many answers are possible; for example, $2x + y + 3x + 6y$
8. Again, there are many possibilities; for example, $x^3, 3x^3, 3x^3; x^2, 4x^2; x, x, x, x; 1, 2, 5$

Exercise 29 Equations

1. equivalence (commutative law for addition)
2. conditional (0 is a solution)
3. equivalence commutative and associative laws for addition, arithmetic)
4. conditional (1 and 2 are solutions)
5. conditional ((8 is a solution)
6. conditional (1 is a solution)
7. equivalence (notation: x^2 means xx)
8. contradiction
9. conditional (0 is a solution)
10. equivalence (commutative law for multiplication)
11. equivalence (distributive law and arithmetic: $4x + 9x = (4 + 9)x = 13x = (7 + 6)x = 7x + 6x$)
12. contradiction
13. Various correct answers
14. Various correct answers

Exercise 32 Simplifying expressions

1. $7a + 3a = 10a$
2. $9x + y + 5x = 14x + y$
3. $2x + 3x^2 + 4x = 6x + 3x^2$
4. $1 + 2b + 3b + 5 = 5b + 6$
5. $8c + 9d + 4 + 2c + 7d^2 = 10c + 9d + 7d^2 + 4$
6. $2x + 3y + 9x + 7y = 11x + 10y$
7. $4 + 5x + 6 + 7x = 12x + 10$
8. $18 + 19x + 20 = 19x + 38$
9. $a + b + c + a = 2a + b + c$
10. $x + 2x + 3x^2 = 3x + 3x^2$
11. $x^2 + 5x + 2x + 3x^2 = 7x + 4x^2$
12. $8x^2 + x - x + 5x^2 = 13x^2$
13. $5a + 3b + 9c + 10a + c + 3 + b = 15a + 4b + 10c + 3$
14. $7x^2 - 10x + 19 + 10x + 57 = 7x^2 + 76$
15. $x + 2y + 4x^2 + 6y^2 + 9y + x^2 = x + 11y + 5x^2 + 6y^2$
16. $2 + k + 4 + m + 8 + r = k + m + r + 14$
17. $x^2 + 2x^2 + 6x^2 + x = x + 9x^2$
18. $1 + 1y^2 + 2 + 3y^2 = 4y^2 + 3$
19. $2r + 9y + 50r + 2000y = 52r + 2009y$
20. $27x + 46y + 3 + y^2 + 123x + 17y = 150x + 63y + y^2 + 3$

Exercise 33 Parentheses

1. .
 - (a) $(1 + 5) + (8 - 4) = 1 + 5 + 8 - 4 = 10$
 - (b) $2(8 - 3) = 10$
 - (c) $\{(1 + 9) + \{[2 + (6 + 4)] + (8 + 1)\}\} = 1 + 9 + 2 + 6 + 4 + 8 + 1 = 31$
 - (d) $\{4 + 2[4 - (5 - 3)]\} + 7 = 4 + 2[4 - (5 - 3)] + 7 = 15$
 - (e) $[3 + 4(3 - 1)]2 = 22$
 - (f) $(1 + 2 + (3 + 4) + (5 + 6) + (7 + 8) + (9 + 10))$ DNMS

- (g) $4 \cdot (5 \cdot 5) = 4 \cdot 5 \cdot 5 = 100$
- (h) $(8 + 2) \cdot (8 \cdot 2) = (8 + 2) \cdot 8 \cdot 2 = 160$
- (i) $(2 \cdot 2)(5 \cdot 5)(2 \cdot 5) = 2 \cdot 2 \cdot 5 \cdot 5 \cdot 2 \cdot 5 = 1000$
- (j) $\{2[2(2 \cdot 2)]\}\{5[5(5 \cdot 5)]\} = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 5 \cdot 5 \cdot 5 \cdot 5 = 10\,000$

2. .

- (a) $2 + 3(x) = 3x + 2$
- (b) $(2 + 3)x = 5x$
- (c) $(4 \cdot x)(2 \cdot x) = 8x^2$
- (d) $x\{x[x(x)]\} = x^4$
- (e) $(1x + 1x)x = 2x^2$
- (f) $(2)(4)(x)(x) = 8x^2$
- (g) $(5 + 5)(x + x) = 20x$
- (h) $[2 + (2 + 2)][x + (x + x)] = 24x$
- (i) $3x \cdot (7 + 3) + (3 + 7) + 3x = 33x + 10$
- (j) $x\{x + [x(x)]\} = x^3 + x^2$

Exercise 34 Laws and properties of numbers

1. .

- (a) Commutative law for addition
- (b) Distributive law
- (c) Distributive law
- (d) Associative law for multiplication
- (e) Associative law for addition
- (f) Commutative law for addition
- (g) Associative law for addition
- (h) Arithmetic, property of zero
- (i) Arithmetic, property of 1

2. The equivalences are a, d, e, f, i

Chapter exercises

1. The equations in parts a, d, e, h and j are true.
2. All the parentheses can be left out. In (j), if the 1 were any other number the parentheses would be needed.
3. The equations in parts a, b, c, d, e, i, j and k are true.

4. .

- | | | | |
|----------|----------|-------------------------------------|--------------------|
| (a) 6 | (g) 17 | (m) 17 | (r) $1\frac{2}{3}$ |
| (b) DNMS | (h) 17 | (n) DNMS | (s) 15 |
| (c) 10 | (i) 17 | (o) $\frac{5}{3}$ or $1\frac{2}{3}$ | (t) 0 |
| (d) DNMS | (j) DNMS | (p) 2 | (u) DNMS |
| (e) DNMS | (k) 4 | (q) 1 | |
| (f) DNMS | (l) 2 | | |

5. .

- | | | | |
|----------------------------------|----------------------------------|------------------------|-------------------|
| (a) 3 | (g) $\frac{7}{3} = 2\frac{1}{3}$ | (m) DNMS | (s) 55 |
| (b) 21 | (h) 35 | (n) 16 | (t) $\frac{1}{4}$ |
| (c) 1 | (i) 8 | (o) -7 | (u) DNMS |
| (d) DNMS | (j) 7 | (p) DNMS | |
| (e) $\frac{4}{3} = 1\frac{1}{3}$ | (k) 5 | (q) $9 - 3(4 - 2) + 7$ | |
| (f) 2 | (l) DNMS | (r) DNMS | |

6. .

- (a) $4a + 9a = (4 + 9)a = 13a$ (D, arith)
- (b) $9b - 4b = (9 - 4)b = 5b$ (D, arith)
- (c) $8x + 2x = (8 + 2)x = 10x$ (D, arith)
- (d) $5x - 2x = (5 - 2)x = 3x$ (D, arith)
- (e) $6x + x = 6x + 1x = (6 + 1)x = 7x$ (P1, D, arith)
- (f) $3x + x = 3x + 1x = (3 + 1)x = 4x$ (P1, D, arith)
- (g) $17x + x = 17x - 1x = (17 - 1)x = 16x$ (P1, D, arith)
- (h) $5x - x = 5x - 1x = (5 - 1)x = 4x$ (P1, D, arith)
- (i) $7x - x = 7x - 1x = (7 - 1)x = 6x$ (P1, D, arith)
- (j) $xx = x^2$ (Not)
- (k) $x + x + x = 1x + 1x + 1x = (1 + 1 + 1)x = 3x$ (P1, D, arith)
- (l) $2x + 3x + 5x = (2 + 3 + 5)x = 10x$ (D, arith)
- (m) $4t + 9t - 2t = (4 + 9 - 2)t = 11t$ (D, arith)
- (n) $8r + 5r - r = 8r + 5r - 1r = (8 + 5 - 1)r = 12r$ (P1, D, arith)
- (o) $5x + x + x = 5x + 1x + 1x = (5 + 1 + 1)x = 7x$ (P1, D, arith)
- (p) $x + x - x = 1x + 1x - 1x = (1 + 1 - 1)x = 1x = x$ (P1, D, arith)
- (q) $(x + x) - x = (1x + 1x) - 1x = [(1 + 1)x] - 1x = 2x - 1x = (2 - 1)x = 1x = x$ (P1, D (twice), arith)
- (r) $x + (x - x) = 1x - (1x - 1x) = 1x - [(1 - 1)x] = 1x - 0x = (1 - 0)x = 1x = x$ (P1, D, arith)

- | | | |
|--------------------|-------------------|---------------------|
| (a) $10x + 13p$ | (f) $15x$ | (k) $40x + 32y$ |
| (b) $10x + 8y$ | (g) $6x + 9y$ | (l) $5g + 12x + y$ |
| (c) $3x$ | (h) $6m + n + 30$ | (m) DNMS |
| (d) $10x + 4t$ | (i) $10m + 7n$ | (n) $10x + 24y - 8$ |
| (e) $8t + 10x + 6$ | (j) $8x + 5y$ | (o) $w + x + y + z$ |

7. .

- | | | | |
|---------|---------|---------|--------|
| (a) Yes | (f) Yes | (k) No | (p) No |
| (b) Yes | (g) No | (l) No | (q) No |
| (c) No | (h) Yes | (m) No | (r) No |
| (d) No | (i) Yes | (n) No | |
| (e) No | (j) Yes | (o) Yes | |

8. .

- | | | | |
|--------|---------|---------|---------|
| (a) No | (f) Yes | (k) Yes | (p) Yes |
| (b) No | (g) Yes | (l) No | |
| (c) No | (h) Yes | (m) No | |
| (d) No | (i) Yes | (n) Yes | |
| (e) No | (j) No | (o) No | |

9. .

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|---------|---------|----------|---------|
| (a) Yes | (f) Yes | (k) Yes | (p) Yes |
| (b) No | (g) Yes | (l) dnms | |
| (c) No | (h) No | (m) Yes | |
| (d) Yes | (i) No | (n) Yes | |
| (e) Yes | (j) No | (o) Yes | |

10. .

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|---------|---------|---------|---------|
| (a) Yes | (f) Yes | (k) Yes | (p) Yes |
| (b) Yes | (g) No | (l) Yes | |
| (c) No | (h) No | (m) Yes | |
| (d) No | (i) No | (n) No | |
| (e) Yes | (j) No | (o) Yes | |

11. The expressions equivalent to $x(y + z)$ are d, f, g, i, k (a repetition of g (by mistake)), and n..

12. The expressions equivalent to $u(v + w)$ are a, f, g, h, i, k, n.
13. The expressions equivalent to $p(q + w)$ are a, b, d, e, f, g, k, l, m, n, o.
14. The expressions equivalent to $ab + ac$ are a, b, f, o, q.
15. The expressions equivalent to $m(n + p)$ are d, f, , g, h, i, k, n.
16. The expressions equivalent to $rs + rt$ are a, b, d, e, f, g, m, n, o.
17. The expressions equivalent to $a(c - b)$ are a, b, e, f, h, l, o.
18. In the expressions with only numbers. some parentheses could be removed if they were replaced by multiplication symbols (for example, if an expression had $2(7)$ this could be replaced by $2 \cdot 7$. These are listed in the answers below with an asterisk (*). Also, in some expressions some parentheses can be removed but not others. The answers for these are listed with double asterisks (**).
 Parentheses can be omitted in
 8, parts b, d, i, j
 9, parts a, c, e*, o*
 10, parts a*, f, g*, m, n, o*
 11, parts a, b*, d*, e, f**, h*, i*
 12, parts a, c, e
 13, parts a, c, e, o
 14, parts f, g, m, n, o
 15, parts d, p
 16, parts a, c, e, h (only because of the zero), i**, o
 17, parts a**, f, g, m, n, o
 18, parts a** (only because of the zero), b, d, e, f**, h, i,
19. .
- | | | | |
|---------|----------------------|---------------------------|----------------------|
| (a) Not | (d) D, C+ | (g) D, C \times , arith | (j) not |
| (b) P0 | (e) C \times , not | (h) P1, c \times , D | |
| (c) D | (f) not, C+ | (i) not | (k) D \times , not |
20. (a) not, P) (c) C+, P1 (e) C \times (twice),
 (b) D (d) D, not not
- (f) Typo on paper copy; should be $2(p) + p(q) + 0$ (okay on web). D, C+, C $2(q) + p(q) + 0$, P0
 Omit all after f. (They're wrong.)
21. (a) No. Counterexample: $x = 2, y = 3, z = 4$.
 (b) No: Counterexample: $x = 2, y = 3, z = 4$.

- (c) No: Counterexample: $x = 2, y = 3, z = 4$.
 - (d) Yes: $C \times$
 - (e) No: Counterexample: $x = 2, y = 3, z = 3$.
 - (f) Yes: $P0$
 - (g) Yes: D
 - (h) No: Counterexample: $x = 2, y = 3, z = 4$.
 - (i) Yes: $P0$
 - (j) No: Counterexample: $x = 2, y = 3, z = 4$.
 - (k) Typo on paper—duplicates g. Should be $yx + xz$ Yes: $D, C \times$
 - (l) No: Counterexample: $x = 2, y = 3, z = 4$
 - (m) No: Counterexample: $x = 2, y = 3, z = 4$
 - (n) Yes: $C+$
- 22.
- (a) No: Counterexample: $u = 2, v = 3, w = 4$
 - (b) No: Counterexample: $u = 2, v = 3, w = 4$
 - (c) No: Counterexample: $u = 2, v = 3, w = 4$
 - (d) No: Counterexample: $u = 2, v = 3, w = 4$
 - (e) No: Counterexample: $u = 2, v = 3, w = 3$
 - (f) Yes: $C \times$
 - (g) Yes: D , not
 - (h) Yes: $C+, C \times, P0$
 - (i) Yes: $P0$
 - (j) No: Counterexample: $u = 2, v = 3, w = 4$
 - (k) Yes: D
 - (l) No: Counterexample: $u = 2, v = 3, w = 4$
 - (m) No: Counterexample: $u = 2, v = 3, w = 4$
 - (n) Yes: $C+$
 - (o) No: Counterexample: $u = 2, v = 3, w = 4$
 - (p) No: Counterexample: $u = 2, v = 3, w = 4$
- 23.
- (a) Yes: D
 - (b) Yes: $D, P0$
 - (c) No: counterexample $p = 2, q = 3, w = 4$
 - (d) Yes: $P1$
 - (e) Yes: $P1$

- (f) Yes: D, $C \times$, P0
 - (g) Yes: D, $C+$
 - (h) No: counterexample $p = 2, q = 3, w = 4$
 - (i) No: counterexample $p = 2, q = 3, w = 4$
 - (j) No: counterexample $p = 2, q = 3, w = 4$
 - (k) Yes: D, $C \times$
 - (l) Yes: P0, P1 (3 times)
 - (m) Yes: $C \times$, not
 - (n) Yes: D, not
 - (o) Yes: $C+$, $C \times$
24. (a) No: counterexample: $x = 4, y = 3, z = 5$
- (b) Yes: D, P0
 - (c) No: counterexample: $x = 4, y = 3, z = 5$
 - (d) No: counterexample: $x = 4, y = 3, z = 5$
 - (e) Yes: D, not
 - (f) Yes: not
 - (g) No: counterexample: $x = 4, y = 3, z = 5$
 - (h) No: counterexample: $x = 4, y = 3, z = 5$
 - (i) No: counterexample: $x = 4, y = 3, z = 5$
 - (j) No: counterexample: $x = 4, y = 3, z = 5$
 - (k) Yes: P) (twice)
 - (l) Yes: P1 (twice)
 - (m) No: counterexample: $x = 4, y = 3, z = 5$
 - (n) No: counterexample: $x = 4, y = 3, z = 5$
 - (o) Yes: $C \times$
25. (a) Yes (f) Yes (k) No (p) No
- (b) Yes (g) No (l) No (q) Yes
- (c) No (h) No (m) No (r) No
- (d) No (i) No (n) No
- (e) No (j) Yes (o) Yes

26. (a) No (e) No (i) Yes (m) No
 (b) No (f) Yes (j) No (n) Yes
 (c) No (g) Yes (k) Yes (o) No
 (d) Yes (h) Yes (l) No
27. (a) Yes (e) Yes (i) No (m) Yes
 (b) No (f) Yes (j) No (n) Yes
 (c) No (g) No (k) No (o) Yes
 (d) Yes (h) No (l) dnms
28. (a) Yes (e) Yes (i) No (m) No
 (b) Yes (f) Yes (j) No (n) No
 (c) No (g) No (k) No (o) Yes
 (d) No (h) No (l) Yes

29. Parentheses are used in pairs to show that what's inside gets calculated (if possible) before being combined with anything outside. (If you have $x + x$, for example, you could replace it by $2x$. If you have $x + y$ there's no way of simplifying it.) If more than one pair of parentheses is used, sometimes we make the expression easier to read by using square brackets like these—[] or curly brackets like these—{ }. The expression may still be a challenge to read, but it's easier to check what the pairs are. (Make sure the number of left parentheses. is the same as the number of right parentheses. If not, the expression is meaningless. An expression may have more parentheses than needed, which is not wrong in itself, but makes things more complicated than necessary..

In some places in Exercises ?? through ?? there are extra parentheses. Indicate which parentheses these are.

30. Find a number to replace x that makes the equation true.

- (a) $1 + x = 9$ (e) $7 + x = 7$
 (b) $7 + x = 12$ (f) $x + 23 = 67$
 (c) $10 = x + 2$ (g) $x + x = 2x$
 (d) $x + 3 = 7$

31. In each problem replace x by a number that gives a true equation.

(a) $10 - x = 4$

(b) $x - 5 = 4$

(c) $5 - x = 7$

(d) $x - 1 = 0$

(e) $8 - x = 5$

(f) $8 - x = 8$

(g) $8 - x = 0$

(h) $56,987 - x = 0$

(i) $123,567 - x = 123,567$

(j) $876543 - x = 875543$