# Answers and Solution Hints to Practice Exercises

## Chapter 1

**Lesson 1.1**

1. (3) 2. (4) 3. (2) 4. (4) 5. (3) 6. (4) 7. (1) 8. (3) 9. 7 10. 37 11. 48 12. 3 13. 134 14. 20 15. 142

**Lesson 1.2**

1. (2) 2. (2) 3. (2) 4. 21, 21, 31; 21, 26, 26 5. $\frac{16}{3}$ 6. 10 7. 119

**Lesson 1.3**

1. (3) 2. (1) 3. (3) 4. (3) 5. 110 6. 77 7. 70 8. 63 9. 45 10. 150 11. 143 12. 17

**Lesson 1.4**

1. (2) 2. (2) 3. (1) 4. (2)
5. Subtract $m\angle MOW$ from angles 1 and 2 to obtain $\angle TOM \cong \angle BOW$.
6. Since halves of congruent segments ($\overline{AC} \cong \overline{BD}$) are congruent, $\overline{AE} \cong \overline{BE}$ so $\triangle AED$ is isosceles.
7. Subtracting corresponding sides of $AB = CD$ and $DE = BF$ makes $\overline{CE} \cong \overline{AF}$. Because $\triangle ADF$ is equilateral, $\overline{AF} \cong \overline{AD}$. Using the transitive property, $\overline{CE} \cong \overline{AD}$.
8. Since supplements of congruent angles are congruent, $\angle BAC \cong \angle BCA$. Because halves of congruent angles are congruent, $\angle 3 \cong \angle 4$.
9. First show $\overline{JR} \cong \overline{KT}$: $\overline{MR} \cong \overline{MT}$ (definition of midpoint) and $\overline{KT} \cong \overline{MT}$; $\overline{MR} \cong \overline{KT}$. It is also given that $\overline{JR} \cong \overline{MR}$. Using the transitive property, $\overline{JR} \cong \overline{KT}$. From the Given, $\overline{SJ} \cong \overline{SK}$. Use the Addition Property: $SJ + JR = SK + KT$ so $\overline{SR} \cong \overline{ST}$.

**Lesson 1.5**

1. (2) 2. (3) 3. (4) 4. (4) 5. (2) 6. (3) 7. $\sim x \wedge y$ 8a. F b. T c. F d. F e. T 9a. T b. T c. F d. T e. F
10a. (1) $\sim(p \wedge q)$ (2) $\sim p \vee \sim q$





10b.

| $p$ | $q$ | $\sim(p \wedge q)$ | $\sim p \vee \sim q$ |
|---|---|---|---|
| T | T | F | F |
| T | F | T | T |
| F | T | T | T |
| F | F | T | T |

c. Yes, since they all have the same truth values.

**Lesson 1.6**

1. (3) 2. (4) 3. (4) 4. (3) 5. (3) 6. (3) 7. (4) 8. (4) 9. (3) 10. (2) 11. (3) 12. (2) 13. (1) 14. (3) 15. (4) 16. (1) 17. (3) 18. (3)
19. $\sim r \leftrightarrow \sim s$
20. a. $q \rightarrow \sim p$ b. $p \rightarrow \sim q$
21. a. $q \rightarrow \sim p$ b. $\sim p \rightarrow q$ c. $\sim(p \rightarrow \sim q)$
22. a. $p \rightarrow \sim q$ b. (2)
23. a. If a triangle is isosceles, then it has two congruent sides.
 b. If a triangle does not have two congruent sides, then it is not isosceles.
 c. A triangle is isosceles if and only if it has two congruent sides.
24. a. $\sim p \rightarrow \sim q$ b. $p \rightarrow \sim q$ c. $q \rightarrow p$

## Chapter 2

**Lesson 2.1**

1. (3) 2. (4) 3. (3) 4. (3) 5. (4) 6. 140 7. 29 8. 50 9. 30
10. a. Because $p \parallel q$, corresponding angles 1 and 2 are congruent so $m\angle 2 = 90$ and $m \perp q$.
 b. If a line is perpendicular to one of two parallel lines, then it is also perpendicular to the other line.
11. $\angle 1 \cong \angle 3$ (alternate interior angles formed by parallel lines); $\angle 2 \cong \angle 4$ (corresponding angles formed by parallel lines); $\angle 1 \cong \angle 2$ (definition of angle bisector) so $\angle 3 \cong \angle 4$ (transitive property).

**Lesson 2.2**

1. (3)
2. (1)
3. Yes, since $x = 31$, $(3x + 5)° = 98°$ and $98° + 82° = 180°$, so same side exterior angles are supplementary.
4. $\angle 1 \cong \angle 3$ (given); $\angle 2 \cong \angle 3$ (definition of angle bisector); $\angle 1 \cong \angle 3$ (transitive property). Because corresponding angles are congruent, $\overleftrightarrow{AD} \parallel \overleftrightarrow{BC}$.

5. $\overline{TC} \parallel \overline{HK}$ (lines perpendicular to the same line are parallel); $\angle 1 \cong \angle 2$ (congruent alternate interior angles formed by parallel lines); $\angle 2 \cong \angle 3$ (definition of angle bisector); $\angle 1 \cong \angle 3$ (transitive property); $\angle 3 \cong \angle 4$ (congruent corresponding angles formed by parallel lines); $\angle 1 \cong \angle 4$ (transitive property).

**Lesson 2.3**

**1.** (2) **2.** (2) **3.** (2) **4.** (1) **5.** (2) **6.** (3) **7.** (1) **8.** (3) **9.** (4) **10.** (1) **11.** (3) **12.** (4) **13.** 270 **14.** 25 **15.** 53 **16.** 20 **17.** 97

**Lesson 2.4**

**1.** (4) **2.** (1) **3.** (2) **4.** (1) **5.** (3) **6.** (3) **7.** (3) **8.** (3) **9.** 1,980 **10.** 8 **11.** 15

## CHAPTER 3

**Lesson 3.1**

**1.** (4) **2.** (1) **3.** (1) **4.** (2)

**5.** $\angle ABD \cong \angle CBD$ (definition of angle bisector), $\overline{BD} \cong \overline{BD}$, $\angle BAD \cong \angle BCD$ (given) so $\triangle ABD \cong \triangle CBD$ by AAS $\cong$ AAS.

**6.** $\angle B \cong \angle E$ (right angles are congruent), $\overline{AC} \cong \overline{DF}$ (addition property), $\angle ACB \cong \angle EFD$ (congruent alternate interior angles) so $\triangle ABC \cong \triangle DEF$ by AAS $\cong$ AAS.

**7.** $\overline{AM} \parallel \overline{TH}$ so $\angle AMR \cong \angle HTS$ (congruent alternate interior angles); $\overline{RA} \cong \overline{SH}$ (given); $\overline{RA} \parallel \overline{SH}$ so $\angle ARM \cong \angle HST$ (congruent alternate exterior angles). Thus, $\triangle ARM \cong \triangle HST$ by AAS $\cong$ AAS.

**8.** $\angle 3 \cong \angle 4$ (complements of congruent angles are congruent), $\overline{AD} \cong \overline{AD}$, $\angle EAD \cong \angle FAD$ (definition of angle bisector) so $\triangle AED \cong \triangle AFD$ by ASA $\cong$ ASA.

**9.** $\overline{AB} \cong \overline{AB}$ (Hyp) and $\overline{BD} \cong \overline{AE}$ (Leg) so right $\triangle AEB \cong$ right $\triangle BDA$ by HL $\cong$ HL.

**10.** $\angle AEC \cong \angle BDC$ (all right angles are congruent), $\angle C \cong \angle C$, and $\overline{CE} \cong \overline{CD}$ (given) so $\triangle AEC \cong \triangle BDC$ by ASA $\cong$ ASA.

**11.** $\angle A \cong \angle C$ (given), $\overline{AB} \cong \overline{BC}$ (given), and $\angle B \cong \angle B$ so $\triangle AEB \cong \triangle CDB$ by ASA $\cong$ ASA.

**12.** $\angle B \cong \angle B$, $\overline{BD} \cong \overline{BE}$ (given), and $\angle AEB \cong \angle CDB$ (all right angles are congruent) so $\triangle ABE \cong \triangle CBD$ by ASA $\cong$ ASA.

**13.** Using the addition property, $\overline{DEB} \cong \overline{AEC}$; $\angle 1 \cong \angle 2$; $\overline{BC} \cong \overline{BC}$ so $\triangle DBC \cong \triangle ACB$ by SAS $\cong$ SAS.

**14.** $\overline{AB} \cong \overline{DC}$ and $m\angle 1 = m\angle 2$ (given); $\angle ABE \cong \angle DCE$ (all right angles are congruent); $m\angle ABE + m\angle 1 = m\angle DCE + m\angle 2$ so $\angle ABC \cong \angle DCB$ (addition property); $\overline{BC} \cong \overline{BC}$; $\triangle ABC \cong \triangle DCB$ by SAS $\cong$ SAS.





**Lesson 3.2**

**1.** Draw $\overline{AD}$ (two points determine a line). $\triangle ADB \cong \triangle ADC$ by SSS $\cong$ SSS so $\angle B \cong \angle D$ by CPCTC.

**2.**

| Statement | | Reason |
|---|---|---|
| 1. $\overline{MP} \cong \overline{ST}$ | Side | 1. Given. |
| 2. $\overline{MP} \parallel \overline{ST}$ | | 2. Given. |
| 3. $\angle MPL \cong \angle STR$ | Angle | 3. If two lines are parallel, then their corresponding angles are congruent. |
| 4. $\overline{PL} \cong \overline{RT}$ | Side | 4. Given. |
| 5. $\triangle RST \cong \triangle LMP$ | | 5. SAS postulate. |
| 6. $\angle SRT \cong \angle MLP$ | | 6. CPCTC. |
| 7. $\overline{RS} \parallel \overline{LM}$ | | 7. Two lines are parallel if a pair of corresponding angles are congruent. |

**3.** $\angle H \cong \angle K$ and $\angle IJH \cong \angle LJK$ (vertical angles are congruent); $\overline{HK}$ bisects $\overline{IL}$ (given) so $\overline{IJ} \cong \overline{LJ}$; $\triangle IJH \cong \triangle LJK$ by AAS $\cong$ AAS so $\overline{HJ} \cong \overline{KJ}$ by CPCTC. Thus, $\overline{IL}$ bisects $\overline{HK}$ (reverse of the definition of segment bisector).

**4.** $\overline{BD} \cong \overline{BD}$, $\angle ADB \cong \angle CDB$ (given), $\overline{AD} \cong \overline{CD}$ (sides of an equilateral triangle are congruent); $\triangle ADB \cong \triangle CDB$ by SAS $\cong$ SAS so $\angle ABD \cong \angle CBD$ by CPCTC. Thus, $\overline{BD}$ bisects $\angle ABC$ (reverse of the definition of angle bisector).

**5.** $\triangle AEB \cong \triangle CFD$ by HL$\cong$ HL so $\angle EAB \cong \angle FCD$ by CPCTC. Since alternate interior angles are congruent, $\overline{AB} \parallel \overline{CD}$.

**6.** $\overline{DF} \cong \overline{BE}$ (given); $\overline{DF} \parallel \overline{BE}$ so $\angle DFA \cong \angle BEC$ (congruent alternate interior angles); $\overline{AE} \cong \overline{CF}$ so $\overline{AF} \cong \overline{CE}$ (addition property). $\triangle DFA \cong \triangle CEB$ by SAS $\cong$ SAS so $\angle DAF \cong \angle BCE$ by CPCTC. Since alternate interior angles are congruent, $\overline{AD} \parallel \overline{BC}$.

**7.** $\triangle RSP \cong \triangle TSW$ by SAS $\cong$ SAS since $\overline{RS} \cong \overline{TS}$, $\angle PRS \cong \angle WST$, and $\overline{RP} \cong \overline{SW}$. By CPCTC, corresponding angles $RSP$ and $WTS$ are congruent, making $\overline{SP} \parallel \overline{TW}$.

**8.** $\triangle TLS \cong \triangle SWT$ by Hy-Leg $\cong$ Hy-Leg, since $\overline{ST} \cong \overline{ST}$ (hypotenuse) and, from the given, $\overline{TL} \cong \overline{SW}$ (leg). Hence, $\overline{SL} \cong \overline{TW}$ by CPCTC.

**9.** $\overline{TL}$ and $\overline{SW}$ are altitudes (given); $\angle SWR \cong \angle TLR$ (altitudes form right angles, and all right angles are congruent); $\angle R \cong \angle R$ (reflexive property); $\overline{RS} \cong \overline{RT}$ (given); $\triangle SWR \cong \triangle TLR$ (AAS); $\overline{RW} \cong \overline{RL}$ (CPCTC).

**10.** Since $\overline{CM} \cong \overline{MP}$ (given), $\angle BMC \cong \angle AMP$ (vertical angles are congruent), and $\overline{BM} \cong \overline{AM}$ (median divides a segment into two congruent segments, $\triangle AMP \cong \triangle BMC$ by SAS $\cong$ SAS. By CPCTC, $\angle P \cong \angle BCM$ so $\overline{AP} \parallel \overline{CB}$ (if alternate interior angles are congruent, the lines are parallel).

**Lesson 3.3**

| | | | | |
|---|---|---|---|---|
| **1.** (1) | **3.** (3) | **5.** (1) | **7.** (2) | **9.** 32 |
| **2.** (2) | **4.** (3) | **6.** (3) | **8.** (2) | **10.** 6 |

**11.** Isosceles since $\angle ABD \cong \angle ADB$.

**12.** Since $\angle 2 \cong \angle 4$, $\overline{AD} \cong \overline{CD}$; $\angle BDA \cong \angle BDC$ (given); $\overline{BD} \cong \overline{BD}$. Thus, $\overline{AB} \cong \overline{CB}$ by CPCTC so $\triangle ADC$ is isosceles.

**13.** Since $\overline{AB} \cong \overline{BC}$ (given), $\angle BAC \cong \angle BCA$; $\angle 1 \cong \angle 3$ (given) so, by the subtraction property, $\angle 2 \cong \angle 4$. Using the converse of the Base Angles Theorem, $\overline{AD} \cong \overline{CD}$ so $\triangle ADC$ is isosceles.

**14.** $\overline{BD} \cong \overline{BE}$ (given) so $\angle BDE \cong \angle BED$ and $\angle ADB \cong \angle CEB$ (supplements of congruent angles are congruent). Using the subtraction property, $\overline{AD} \cong \overline{CE}$. $\triangle ADB \cong \triangle CEB$ (SAS $\cong$ SAS). By CPCTC, $\overline{AB} \cong \overline{BC}$ so $\triangle ABC$ is isosceles.

**15.** $\overline{DG} \cong \overline{CG}$, $\overline{AD} \cong \overline{FC}$, and $\overline{BC} \cong \overline{BED}$ (given); $\angle ACB \cong \angle FDE$ (Base Angles Theorem); $\overline{AC} \cong \overline{FD}$ (addition property); $\triangle ABC \cong \triangle FED$ (SAS $\cong$ SAS); $\angle B \cong \angle E$ (CPCTC).

**16.** Since $\overline{GE} \cong \overline{GF}$, $\angle GEF \cong \angle GFE$ and $\angle AED \cong \angle BFC$ (vertical angles are congruent); $\overline{DE} \cong \overline{CF}$ (given); $\angle ADE \cong \angle BCF$ (supplements of congruent angles are congruent) so $\triangle DAE \cong \triangle CBF$ (ASA $\cong$ ASA).

**17.** $m\angle 1 = m\angle 2 + m\angle C$. Because $\overline{DB} \cong \overline{BC}$, $m\angle 2 = m\angle C$ so $m\angle 1 = 2m\angle C$. Since $\overline{AD} \cong \overline{DB}$, $m\angle 1 = m\angle A$. Using the substitution property, $m\angle A = 2m\angle C$.

**18.** $\angle BRT \cong \angle STR$ (congruent alternate interior angles); $\angle BRT \cong \angle SRT$ (definition of angle bisector); $\angle SRT \cong \angle STR$ so $\overline{RT} \cong \overline{TS}$; $\overline{MR} \cong \overline{MT}$ (definition of midpoint); $\overline{SM} \cong \overline{SM}$ so $\triangle TSM \cong \triangle RSM$ (SSS $\cong$ SSS). By CPCTC, $\angle RMS \cong \angle TMS$. Thus, $\overline{SM} \cong \overline{RT}$ (segments intersect to form congruent adjacent angles).

**19.** $\triangle RBS \cong \triangle ASR$ (HL $\cong$ HL) so $\overline{SB} \cong \overline{RA}$ and $\angle BSR \cong \angle ARS$ (CPCTC). Using the converse of the Base Angles Theorem, $\overline{TS} \cong \overline{TR}$ and, by the subtraction property, $\overline{TB} \cong \overline{TA}$.

**20.** Given: Isosceles $\triangle ABC$, $\overline{AB} \cong \overline{AC}$, altitudes $\overline{CX}$ and $\overline{AY}$. Prove: $\overline{CX} \cong \overline{AY}$. Show $\triangle AXC \cong \triangle CYA$ by AAS $\cong$ AAS. Then $\overline{CX} \cong \overline{AY}$ by CPCTC.

**Lesson 3.4**

**1. a.** $\triangle RLS \cong \triangle RLT$ (Hy-Leg).

**b.** $SL \cong TL$ and $\angle SLR \cong \angle TLR$ (CPCTC); $\angle SLW \cong \angle TLW$ (supplements of congruent angles are congruent); $\overline{LW} \cong \overline{LW}$ (reflexive property); $\triangle SLW \cong \triangle TLW$ (SAS); $\angle SWL \cong \angle TWL$ (CPCTC); $\overline{WL}$ bisects $\angle SWT$ (definition of bisector).

**2.** $\triangle KQM \cong \triangle LQN$ (SAS $\cong$ SAS). By CPCTC, $\angle K \cong \angle L$ and $\overline{KM} \cong \overline{L}$[illegible] Then $\triangle KPM \cong \triangle LRN$ (ASA $\cong$ ASA) so $\overline{PM} \cong \overline{NR}$ by CPCTC.

**3. a.** $\triangle ABE \cong \triangle ADE$ (HL $\cong$ HL).

**b.** $\angle EAB \cong \angle EAD$ by CPCTC; $\overline{AEC} \cong \overline{AEC}$. $\triangle ABC \cong \triangle ADC$ (SAS $\cong$ SAS) so $\angle 3 \cong \angle 4$ by CPCTC.

**4.** $\triangle ABC \cong \triangle ADB$ (ASA $\cong$ ASA) so $\overline{AB} \cong \overline{AD}$ by CPCTC. Then $\triangle ABE \cong \triangle ADE$ (SAS $\cong$ SAS) so $\angle 1 \cong \angle 2$ by CPCTC.





**5.** $\triangle AFD \cong \triangle DFE$ (AAS); $\overline{FD} \cong \overline{FE}$ (CPCTC); $\overline{BF} \cong \overline{BF}$ (reflexive property); right triangle $FDB \cong$ right triangle $FEB$ (Hy-Leg); $\angle FBD \cong \angle FEB$ (CPCTC); $\overline{BF}$ bisects $\angle DBE$ (definition of bisector).

**6.** $\triangle BDF \cong \triangle BEF$ by SSS $\cong$ SSS. By CPCTC, $\angle BDF \cong \angle BEF$, so $\angle ADF \cong \angle CEF$ (supplements of congruent angles are congruent). Also, $\angle AFD \cong \angle CFE$ (vertical angles are congruent). $\triangle AFD \cong \triangle CFE$ by ASA $\cong$ ASA. Then $\overline{AF} \cong \overline{CF}$ by CPCTC, so $\triangle AFC$ is isosceles.

**7. a.** $\triangle ADF \cong \triangle CEF$ (HL $\cong$ HL).

**b.** By CPCTC, $\overline{DF} \cong \overline{EF}$ and $\angle A \cong \angle C$; $\overline{AB} \cong \overline{BC}$ and, using the subtraction property, $\overline{DB} \cong \overline{BE}$. Since $\overline{BF} \cong \overline{BF}$, $\triangle BDF \cong \triangle BEF$ (SSS $\cong$ SSS). Then $\angle BFD \cong \angle BFE$ (CPCTC) so $\overline{BF}$ bisects $\angle DFE$.

**8.** Because $\overline{AB} \cong \overline{AC}$, $\angle 1 \cong \angle 2$ so $\angle ABD \cong \angle ACE$ (supplements of congruent angles are congruent). Then $\triangle ABD \cong \triangle ACE$ (SAS $\cong$ SAS) and, by CPCTC, $\angle D \cong \angle E$. Thus, $\triangle DFB \cong \triangle EGC$ (AAS $\cong$ AAS) so $\overline{DF} \cong \overline{EG}$.

**9.** First prove $\triangle BCF \cong \triangle DCF$: $\angle FBC \cong \angle FDC$ (given), $\angle BFC \cong \angle DFC$ (definition of angle bisector), and $\overline{CGF} \cong \overline{CGF}$, so $\triangle BCF \cong \triangle DCF$ by AAS $\cong$ AAS. Prove $\triangle ACG \cong \triangle ECG$: $\overline{BC} \cong \overline{CD}$ (by CPCTC) and $\overline{AB} \cong \overline{ED}$ (given), so, using the addition property, $\overline{AC} \cong \overline{CE}$ (side); by CPCTC, $\angle ACG \cong \angle ECG$ (angle); $\overline{CG} \cong \overline{CG}$ (side). Therefore, $\triangle ACG \cong \triangle ECG$ by SAS $\cong$ SAS.

**Lesson 3.5**

| | | | |
|---|---|---|---|
| **1.** (4) | **4.** (3) | **7.** (1) | **10.** (3) |
| **2.** (2) | **5.** (2) | **8.** (2) | **11.** (2) |
| **3.** (1) | **6.** (3) | **9.** (1) | **12.** (1) |

**13.** $16 \nless 7 + 8$

**14.** $m\angle S = 51$ so $\overline{AT}$ is the shortest side.

**15.** $m\angle A = m\angle ACB > m\angle F$ so $m\angle A > m\angle F$. In $\triangle ADF$, $DF > AD$.

**16.** $m\angle CAB = m\angle B$ and $m\angle ASF > m\angle B$, $m\angle ASF > m\angle CAB$ and $m\angle CAB > m\angle FAS$ so $m\angle ASF > m\angle FAS$. In $\triangle ASF$, $AF > FS$.

**17.** $m\angle 1 > m\angle A$ and $m\angle 1 = m\angle 2$ so $m\angle 2 > m\angle A$. In $\triangle ADE$, $AD > ED$.

**18.** By the Base Angles Theorem, $m\angle CAB = m\angle CBA$ and $m\angle 1 = m\angle 2$ so, using the subtraction property, $m\angle 3 = m\angle 4$. Since $m\angle AED > m\angle 4$, $m\angle AED > m\angle 3$, making $AD > DE$.

**19.** Since $AD > BD$, $m\angle 3 > m\angle 2$, $m\angle 1 = m\angle 2$, and, by substition, $m\angle 3 > m\angle 1$. But $m\angle 4 > m\angle 3$, so $m\angle 4 > m\angle 1$, making $AC > DC$.

**Lesson 3.6**

**1.** Assume $\overline{AT} \perp \overline{CD}$. Then $\triangle ABT$ contains two right angles, which is impossible. Since the assumption that $\overline{AT} \perp \overline{CD}$ is false, $\overline{AT}$ is *not* perpendicular to $\overline{CD}$ as this is the only other possibility.

**2.** Assume $\overline{AB} \cong \overline{BC}$. Since $\angle 1 \cong \angle 2$, $\overline{AD} \cong \overline{CD}$ so $\triangle ABD \cong \triangle CBD$ by SSS $\cong$ SSS. By CPCTC, $\angle ABD \cong \angle CBD$. Since this contradicts the Given that $\overline{BD}$ does not bisect $\angle ABC$, the assumption that $\overline{AB} \cong \overline{BC}$ is false, $\overline{AB} \ncong \overline{BC}$ as this is the only other possibility.

3. Assume $\overline{JK} \cong \overline{ML}$. Then $\triangle JLM \cong \triangle MKJ$ by Hy-Leg $\cong$ Hy-Leg, so $\angle AJM \cong \angle AMJ$ by CPCTC. Since $\overline{AJ} \cong \overline{AM}$ contradicts the Given that $\triangle JAM$ is scalene, $\overline{JK} \not\cong \overline{ML}$.
4. Given: Scalene triangle $ABC$ with $M$ the midpoint of $\overline{AB}$, $\overline{MX} \perp \overline{AC}$, and $\overline{MY} \perp \overline{BC}$. Prove: $\overline{MX} \not\cong \overline{MY}$. Assume $\overline{MX} \cong \overline{MY}$. Right triangles $AXM$ and $BYM$ are congruent by Hy-Leg $\cong$ Hy-Leg, so $\angle A \cong \angle B$. Since $\overline{AC} \cong \overline{BC}$ contradicts the Given that $\triangle ABC$ is scalene, $\overline{MX} \not\cong \overline{MY}$.
5. Assume $\overline{AC}$ bisects $\angle BAD$. Then $\angle BAC \cong \angle DAC$. Because $\overline{BC} \parallel \overline{AD}$, $\angle DAC \cong \angle C$. By the transitive property, $\angle BAC \cong \angle C$ so $\overline{AB} \cong \overline{BC}$ (converse of the Base Angles Theorem). But this contradicts the Given that $\triangle ABC$ is not isosceles. Hence, the assumption that $\overline{AC}$ bisects $\angle BAD$ is false, so $\overline{AC}$ does *not* bisect $\angle BAD$.
6. Assume $\overline{BE} \cong \overline{EC}$. Since $\overline{AB} \cong \overline{AC}$ and $\overline{AE} \cong \overline{AE}$, $\triangle AEB \cong \triangle AEC$ by SSS $\cong$ SSS. By CPCTC, $\angle AEB \cong \angle AEC$, so $\angle BED \cong \angle CED$ (supplements of congruent angles are congruent). Because $\overline{ED} \cong \overline{ED}$, $\triangle BED \cong \triangle CED$, so $\overline{BD} \cong \overline{CD}$ by CPCTC. But this contradicts the Given that $\overline{BD} \not\cong \overline{CD}$. Hence the assumption that $\overline{BE} \cong \overline{EC}$ is false, so $\overline{BE} \not\cong \overline{EC}$.
7. Assume $\overline{PO} \cong \overline{OQ}$. Then $\triangle PON \cong \triangle QOM$ (SAS $\cong$ SAS) and $\angle P \cong \angle Q$ by CPCTC. Since alternate interior angles are congruent, $\overline{MQ} \parallel \overline{PN}$. But this contradicts the Given that $\overline{MQ}$ is *not* parallel to $\overline{PN}$. Hence, the assumption that $\overline{PO} \cong \overline{OQ}$ is false, so $\overline{PO} \not\cong \overline{OQ}$.
8. Assume $\overline{AB} \parallel \overline{DE}$. Then $\angle B \cong \angle D$. Since $\overline{DE} \cong \overline{CE}$, $\angle D \cong \angle DCE$. By transitivity, $\angle B \cong \angle DCE$. Since $\angle ABC \cong \angle DCE$, $\angle B \cong \angle ACB$, implying $\overline{AC} \cong \overline{AB}$. But this contradicts the Given ($AC > AB$). Hence, $\overline{AB}$ is *not* parallel to $\overline{DE}$.

## Chapter 4

**Lesson 4.1**

| | | | | |
|---|---|---|---|---|
| **1.** (1) | **4.** (4) | **7.** (4) | **10.** (3) | **13.** 54 |
| **2.** (4) | **5.** (3) | **8.** (3) | **11.** (3) | |
| **3.** (1) | **6.** (2) | **9.** (1) | **12.** 120 | |

14. $\overline{EB} \cong \overline{AB}$. Since opposite sides of a parallelogram are congruent, $\overline{AB} \cong \overline{CD}$. Thus, $\overline{EB} \cong \overline{CD}$. Vertical angles $EFB$ and $DFC$ are congruent. Because $\overline{ABE} \parallel \overline{CD}$, $\angle EBF \cong \angle DCF$. Then $\triangle EFB \cong \triangle DFC$ (AAS $\cong$ AAS) and $\overline{EF} \cong \overline{FD}$ by CPCTC.
15. $\angle E \cong \angle H$ and $\angle EAF \cong \angle HCG$ (supplements of congruent angles). Because $\overline{AB} \cong \overline{CD}$ and $\overline{BF} \cong \overline{DG}$, $\overline{AF} \cong \overline{CG}$ (subtraction property). Thus, $\triangle EAF \cong \triangle HCG$ (AAS $\cong$ AAS) and $\overline{EF} \cong \overline{HG}$ by CPCTC.
16. **a.** $\angle CDK \cong \angle ADK$ and $\angle ADK \cong \angle CKD$ (congruent alternate interior angles) so $\angle CDK \cong \angle CKD$ (transitive property) and $\overline{CK} \cong \overline{CD}$ (converse of Base Angles Theorem).
    **b.** $\overline{BK} \cong \overline{AB}$ and $\overline{AB} \cong \overline{CD}$ so $\overline{BK} \cong \overline{CD}$. Because $\overline{CK} \cong \overline{CD}$ (from part a), $\overline{BK} \cong \overline{CK}$, so $K$ is the midpoint of $\overline{BC}$.





17. Since $AD > DC$, $m\angle 2 > m\angle 1$. Because $\overline{AB} \parallel \overline{CD}$, $m\angle 3 = m\angle 2$ and by substitution, $m\angle 3 > m\angle 1$.
18. $m\angle 1 > m\angle ACB$ and $m\angle ACB = m\angle 2$ so $m\angle 1 > m\angle 2$.
19. $\triangle AED \cong \triangle CFB$ by SAS $\cong$ SAS. By CPCTC, $\overline{AD} \cong \overline{BC}$ and $\angle DAE \cong \angle BCF$ so $\overline{AD} \parallel \overline{BC}$. Since quadrilateral $ABCD$ has a pair of sides that are both congruent and parallel, $ABCD$ is a parallelogram.
20. $\overline{LD} \cong \overline{BM}$ and $\angle DLM \cong \angle BML$ so $\angle ALF \cong \angle CMB$ (supplements of congruent angles are congruent). $\triangle ALD \cong \triangle CMB$ by SAS $\cong$ SAS. By CPCTC, $\overline{AD} \cong \overline{BC}$ and $\angle DAL \cong \angle BCM$ so $\overline{AD} \parallel \overline{BC}$. Since quadrilateral $ABCD$ has a pair of sides that are both congruent and parallel, $ABCD$ is a parallelogram.
21. $\triangle BAL \cong \triangle DCM$ by ASA $\cong$ ASA. By CPCTC, $\overline{BL} \cong \overline{DM}$ and $\angle ALB \cong \angle CMD$ so $\overline{BL} \parallel \overline{DM}$. Since quadrilateral $BMDL$ has a pair of sides that are both congruent and parallel, $BMDL$ is a parallelogram.
22.

| Statement | | Reason |
|---|---|---|
| 1. $\overline{NJ}$ and $\overline{DU}$ bisect each other at $K$. | | 1. Given. |
| 2. $\overline{DK} \cong \overline{UK}$. | *Side* | 2. Definition of segment bisector. |
| 3. $\angle DKN \cong \angle UKJ$. | *Angle* | 3. Vertical angles are congruent. |
| 4. $\overline{NK} \cong \overline{JK}$. | *Side* | 4. Same as 2. |
| 5. $\triangle DKN \cong \triangle UKJ$. | | 5. SAS $\cong$ SAS. |
| 6. $\angle 1 \cong \angle 2$ and $\overline{DN} \cong \overline{UJ}$. | | 6. CPCTC. |
| 7. $\overline{AD} \parallel \overline{UQ}$. | | 7. If two lines form congruent alternate interior angles, the lines are parallel. |
| 8. $N$ is the midpoint of $\overline{DA}$; $J$ is the midpoint of $\overline{QU}$. | | 8. Given. |
| 9. $\frac{1}{2}(AD) = DN$ and $\frac{1}{2}(UQ) = UJ$. | | 9. Definition of the midpoint of a line segment. |
| 10. $AD = 2(DN)$ and $UQ = 2(UJ)$. | | 10. Multiplication property. |
| 11. $\overline{AD} \cong \overline{UQ}$. | | 11. Doubles of congruent segments are congruent. |
| 12. $QUAD$ is a parallelogram. | | 12. If one pair of sides of a quadrilateral are both parallel and congruent, then the quadrilateral is a parallelogram. |

23. **a.** $\triangle FGC \cong \triangle EGA$ (SAS $\cong$ SAS). By CPCTC, $\angle 3 \cong \angle 4$. $\triangle ABC \cong \triangle CDA$ (AAS $\cong$ AAS) so $\overline{BC} \cong \overline{DA}$ (CPCTC).
    **b.** Because $\angle 3 \cong \angle 4$, $\overline{BC} \parallel \overline{DA}$. Since quadrilateral $ABCD$ has a pair of sides that are both congruent and parallel, $ABCD$ is a parallelogram.

**Lesson 4.2**

| | | | | |
|---|---|---|---|---|
| 1. (2) | 3. (1) | 5. (2) | 7. (2) | 9. (8, −1) |
| 2. (4) | 4. (3) | 6. (3) | 8. (2) | 10. $k=-3, x=7$ |

11. Midpoint $\overline{MT}$ = midpoint $\overline{AH} = \left(\frac{5}{2}, 3\right)$. Since the diagonals bisect each other, *MATH* is a parallelogram.

12. a. $CA = CT = \sqrt{68}$.

b. Midpoint $\overline{AT} = \left(\frac{6+0}{2}, \frac{4+(-2)}{2}\right) = (3, 1)$ so point $S(3, 1)$ is the midpoint of $\overline{AT}$. Slope of $\overline{AT} = 1$ and slope of $\overline{CS} = -1$ so $\overline{CS} \perp \overline{AT}$.

13. Midpoint $\overline{AC} = (-1, 2)$ and midpoint $\overline{BD} = (1, 10)$. Since diagonals do not bisect each other, *ABCD* is not a parallelogram.

14. a. Slope $\overline{NS}$ = slope $\overline{TS} = \frac{1}{2}$ so points *N*, *T*, and *S* are collinear.

b. Midpoint of $\overline{NS} = \left(\frac{-2+10}{2}, \frac{-1+5}{2}\right) = T(4, 2)$ so $\overline{YT}$ is a median to side $\overline{NS}$. Slope $\overline{NS} = \frac{1}{2}$ and slope of $\overline{YT} = -2$ so $\overline{YT} \perp \overline{NS}$ and, as a result, $\overline{YT}$ is an altitude to side $\overline{NS}$.

15. a. Slope $\overline{BC} = -\frac{1}{2}$ and slope $\overline{AC} = 2$ so $\overline{BC} \perp \overline{AC}$. Thus, $\angle C$ is a right angle so $\triangle ABC$ is a right triangle.

b. Hypotenuse $AB = 10$. The midpoint of $\overline{AB}$ is $M(8, 3)$ and $CM = 5$ so $CM = \frac{1}{2}AB$.

16. a. Slope $\overline{AB} = \frac{3}{2}$ and slope $\overline{AC} = -\frac{2}{3}$ so $\overline{AB} \perp \overline{AC}$. Thus, $\angle A$ is a right angle so $\triangle ABC$ is a right triangle.

b. The midpoint of hypotenuse $\overline{BC}$ is $M(4, 3)$. Since $AM = BM = CM = \sqrt{26}$, all three vertices of the triangle are equidistant from point *M*.

**Lesson 4.3**

| | | | |
|---|---|---|---|
| 1. (4) | 4. (3) | 7. (4) | 10. (3) |
| 2. (4) | 5. (4) | 8. (2) | 11. (2) |
| 3. (2) | 6. (1) | 9. (2) | 12. 17 |





13. Show slope $\overline{MA}$ = slope $\overline{TH} = \frac{7}{3}$ and slope $\overline{AT}$ = slope $\overline{MH} = -\frac{3}{7}$, so *MATH* is a parallelogram. Since the slopes of adjacent sides are negative reciprocals, *MATH* contains four right angles and is, therefore, a rectangle. Use the distance formula to show that a pair of adjacent sides are congruent.

14. Because midpoint $\overline{AC}$ = midpoint $\overline{BD} = \left(3, -\frac{1}{2}\right)$, *ABCD* is a parallelogram. Since $AB = \sqrt{117}$ and $BC = \sqrt{90}$, $AB \neq BC$, so *ABCD* is *not* a rhombus.

15. Slope $\overline{AB}$ = slope $\overline{CD} = \frac{3}{8}$, so $\overline{AB} \parallel \overline{CD}$. Slope $\overline{BC}$ = slope $\overline{AD} = \frac{5}{2}$ so $\overline{BC} \parallel \overline{AD}$ and *ABCD* is a parallelogram. Since the slopes of adjacent sides are not negative reciprocals, adjacent sides are not perpendicular so *ABCD* is *not* a rectangle.

16. Since midpoint $\overline{RC}$ = midpoint $\overline{ET} = \left(\frac{9}{2}, 6\right)$, *RECT* is a parallelogram. As diagonal $RC$ = diagonal $ET = \sqrt{125}$, parallelogram *RECT* is a rectangle. Because $RE = 10$ and $RT = 5$, $RE \neq RT$ so rectangle *RECT* is *not* a square.

17. $DE = EF = FG = DG = \sqrt{20}$ so *DEFG* is a rhombus.

18. $TE = EA = AM = TM = \sqrt{58}$ so *TEAM* is a rhombus. Since the slope of $\overline{TE} = \frac{7}{3}$ and the slope of $\overline{TM} = \frac{3}{7}$, $\overline{TE} \not\perp \overline{TM}$ because their slopes are not negative reciprocals. Thus, rhombus *TEAM* is *not* a square.

19. a. Show midpoint $\overline{AC} \neq$ midpoint $\overline{BD}$.

b. If *P*, *Q*, *R*, and *S* are the midpoints of $\overline{AB}$, $\overline{BC}$, $\overline{CD}$, and $\overline{AD}$, respecitvely, show midpoint $\overline{PR}$ = midpoint $\overline{QS}$.

20. $\triangle RQU \cong \triangle AMD$ (AAS ≅ AAS) so $\angle 1 \cong \angle 2$ by CPCTC. Using the addition property, $\angle QUA \cong \angle ADQ$. If the opposite angles of a quadrilateral are congruent, the quadrilateral is a parallelogram. Hence, *QUAD* is a parallelogram.

21. $\triangle ABL \cong \triangle BCM$ by SSS ≅ SSS, so $\angle ABL \cong \angle BCM$. Since $\overline{AB} \parallel \overline{CD}$, angles *ABL* and *BCM* are supplementary and congruent, making each a right angle, so *ABCD* is a square.

22. $\triangle VWT \cong \triangle SXT$ by ASA ≅ ASA since $\angle WTV = \angle XTS$ (vertical angles), $\overline{VT} \cong \overline{ST}$ (rhombus is equilateral, $\angle WVT \cong \angle XST$ (subtract corresponding sides of the two equations $m\angle RSX \cong m\angle RVW$ and $m\angle RST = m\angle TVR$). By CPCTC, $\overline{TX} \cong \overline{TW}$.

**23.** Use an indirect proof. Assume $ABCD$ is a rectangle. Then $\triangle BAD \cong \triangle CDA$ (SAS). $\angle 1 \cong \angle 2$ (PCPTC), contradicting the Given.
**24.** $ABCD$ is a square (given); $\angle B$ and $\angle D$ are right angles (a square contains four right angles); $\overline{AB} \cong \overline{AD}$ (adjacent sides of a square are congruent); $\angle 1 \cong \angle 2$ (given); $\overline{AE} \cong \overline{AF}$ (converse of the Base Angles Theorem); $\triangle ABE \cong \triangle ADF$ (Hy-Leg); $\overline{BE} \cong \overline{DF}$ (CPCTC).
**25.** $\triangle ABE \cong \triangle ADF$ by AAS ≅ AAS since $\angle B \cong \angle D$, $\angle BEA \cong \angle DFA$ (by subtracting corresponding sides of the two equations $m\angle BEF = m\angle DFE$ and $m\angle 1 = m\angle 2$), and $\overline{EA} \cong \overline{FA}$ (since $\angle 1 \cong \angle 2$). By CPCTC, $\overline{AB} \cong \overline{AD}$. Since an adjacent pair of sides of rectangle $ABCD$ are congruent, $ABCD$ is a square.
**26.** **a.** $\triangle ABP \cong \triangle DCN$ (HL ≅ HL)
**b.** So $\angle APB \cong \angle DNC$ by CPCTC. In $\triangle PEN$, $\overline{PE} \cong \overline{NE}$ (converse of Base Angles Theorem). Subtracting corresponding sides of $\overline{AP} \cong \overline{DN}$ and $\overline{PE} \cong \overline{NE}$ gives $\overline{AE} \cong \overline{DE}$.
**27.** Since a rhombus is equilateral, $\overline{BC} \cong \overline{CD}$. A diagonal of a rhombus bisects its angles so $\angle ACB \cong \angle ACD$. Because supplements of congruent angles are congruent, $\angle BCE \cong \angle DCE$. $\triangle BCE \cong \triangle DCE$ (SAS ≅ SAS) so $\overline{BE} \cong \overline{DE}$ by CPCTC.
**28.** Since $\overline{AD} \cong \overline{DB}$ and $\overline{CD} \cong \overline{ED}$, the diagonals of quadrilateral $AEBC$ bisect each other so $AEBC$ is a parallelogram. Because $\angle C$ is a right angle, $AEBC$ is a rectangle.

**Lesson 4.4**

**1.** (2) **2.** (2) **3.** (4) **4.** (2) **5.** (3)

**6.** Since slope $\overline{JK} = \frac{1}{2}$, slope $\overline{KL} = -\frac{4}{7}$, slope $\overline{LM} = \frac{1}{2}$, and slope $\overline{JM} = -2$, $\overline{JK} \parallel \overline{LM}$ and $\overline{KL} \nparallel \overline{JM}$ so $JKLM$ is a trapezoid. Since $KL = \sqrt{65}$ and $JM = \sqrt{45}$, $KL \neq JM$ so $JKLM$ is *not* an isosceles trapezoid.
**7.** Show slope $\overline{JA}$ = slope $\overline{KE} = 0$, slope $\overline{AK} \neq$ slope $\overline{JE}$, and $JK = AE = 5a$, so $JAKE$ is an isosceles trapezoid.
**8.** **a.** Show slope $\overline{BC}$ = slope $\overline{AD} = 1$, and slope $\overline{AB} \neq$ slope $\overline{CD}$.
**b.** $h = 3, k = 2$.
**c.** Since slope $\overline{AB} \times$ slope $\overline{BE} = -1$, $\angle ABE$ is a right angle, so $ABED$ is a rectangle.
**9.** Since parallel lines are everywhere equidistant, $\overline{BE} \cong \overline{CF}$. $\triangle AEB \cong \triangle DCF$ by SAS ≅ SAS. By CPCTC, $\overline{AB} \cong \overline{CD}$, so trapezoid $ABCD$ is isosceles.
**10.** $\triangle RSW \cong \triangle WTR$ by SAS. By CPCTC, $\angle TRW \cong \angle SWR$, so $\overline{RP} \cong \overline{WP}$ (converse of the Base Angles Theorem), and $\triangle RPW$ is isosceles.
**11.** $\triangle AGB \cong \triangle DCF$ by SAS ≅ SAS since $\overline{BG} \cong \overline{CF}$, $\angle BGA \cong \angle CFD$ (Base Angles Theorem), and $\overline{AG} \cong \overline{DF}$ (addition property). By CPCTC, $\overline{AB} \cong \overline{CD}$, so trapezoid $ABCD$ is isosceles.





**12.** Since $\angle 1 \cong \angle 2$, $\overline{BK} \cong \overline{BA}$. $\overline{BA} \cong \overline{CD}$ so $\overline{BK} \cong \overline{CD}$ by the transitive property. Similarly, $\angle 1 \cong \angle CDA$ so $\angle 2 \cong \angle CDA$, making $\overline{BK} \parallel \overline{CD}$. Since the same pair of sides of $BKDC$ are both parallel and congruent, $BKDC$ is a parallelogram.
**13.** Use an indirect proof.

| Statement | | Reason |
|---|---|---|
| 1. Trapezoid $ROSE$ with $\overline{OS} \parallel \overline{RE}$, and diagonals $\overline{RS}$ and $\overline{EO}$ intersection at point $M$. | | 1. Given. |
| 2. Diagonals $\overline{RS}$ and $\overline{EO}$ bisect each other. | | 2. Assume this is true. |
| 3. $\overline{OM} \cong \overline{EM}$ | Side | 3. A bisector divides a segment into two congruent segments. |
| 4. $\angle OMR \cong \angle SMR$. | Angle | 4. Vertical angles are congruent. |
| 5. $\overline{RM} \cong \overline{SM}$. | Side | 5. A bisector divides a segment into two congruent segments. |
| 6. $\triangle ORM \cong \triangle SEM$. | | 6. SAS ≅ SAS. |
| 7. $\angle ORM \cong \angle ESM$. | | 7. CPCTC |
| 8. $\overline{OR} \parallel \overline{SE}$. | | 8. If two lines are cut by a transversal and alternate interior angles are congruent, the lines are parallel. |
| 9. Satement 8 contradicts the given. | | 9. A trapezoid has exactly one pair of parallel sides. |
| 10. Statement 2 is false. | | 10. A statement that leads to a contradiction is false. |
| 11. $\overline{RS}$ and $\overline{EO}$ do *not* bisect each other. | | 11. The opposite of a false statement is true. |

**Lesson 4.5**

**1.** (3) **2.** (4) **3.** 23 **4.** 45
**5.** $EF = 19$ and $RT = 38$
**6.** **a.** $\triangle DEB \cong \triangle CEF$ by SAS ≅ SAS so $\overline{BD} \cong \overline{CF}$. Since $\overline{AD} \cong \overline{BD}$, $\overline{AD} \cong \overline{CF}$. Angles $BDE$ and $CFE$ are congruent by CPCTC, which makes $\overline{AD} \parallel \overline{CF}$ so $ADFC$ is a parallelogram. Since opposite sides of a parallelogram are parallel, $\overline{DE} \parallel \overline{AC}$.
**b.** By definition of midpoint, $DE = \frac{1}{2}DF$. Since opposite sides of a parallelogram have the same length, $DF = AC$. Using substitution property, $DE = \frac{1}{2}AC$.

7. $DE = \frac{1}{2}BC$, $DF = \frac{1}{2}AB$ so $\frac{1}{2}AB = \frac{1}{2}BC$. Using the multiplication property, $\overline{AB} \cong \overline{BC}$ so $\triangle ABC$ is isosceles.
8. By the Base Angles Theorem, $\angle PLM \cong \angle PML$. Since $\overline{LM}$ is a median, $\overline{LM} \cong \overline{AD}$, so $\angle PLM \cong \angle APL$ and $\angle PML \cong \angle DPM$. By the transitive property, $\angle APL \cong \angle DPM$. Show $\triangle LAP \cong \triangle MDP$ by SAS. By CPCTC, $\angle A \cong \angle D$, so trapezoid $ABCD$ is isosceles.
9. In $\triangle WST$, since $B$ and $C$ are midpoints, $\overline{BC} \parallel \overline{WT}$ and $BC = \frac{1}{2}WT$.

   Since $RSTW$ is a parallelogram, $\angle AWB \cong \angle CSB$ so $\triangle AWB \cong \triangle CSB$ by ASA $\cong$ ASA. As $\overline{AB} \cong \overline{BC}$, $AB + BC = \frac{1}{2}WT + \frac{1}{2}WT$ so $\overline{AC} \cong \overline{WT}$. Since extensions of parallel lines are parallel, $\overline{AC} \parallel \overline{WT}$. Because $WACT$ has one pair of sides that are both congruent and parallel, it is a parallelogram.
10. The diagonals of a parallelogram bisect each other so $\overline{AX} \cong \overline{CX}$ and $\overline{BX} \cong \overline{DX}$. Because it is given that $E$, $F$, $G$, and $H$ are midpoints of $\overline{AX}$, $\overline{BX}$, $\overline{CX}$, and $\overline{DX}$, respectively, $\overline{EX} \cong \overline{GX}$ and $\overline{FX} \cong \overline{HX}$ so $EFGH$ is a parallelogram. Since $EF = \frac{1}{2}AB$, $FG = \frac{1}{2}BC$, and $\overline{AB} \cong \overline{BC}$ (a rhombus is equilateral), $\overline{EF} \cong \overline{FG}$ so $EFGH$ is a rhombus.
11. Given rectangle $ABCD$, points $P$, $Q$, $R$, and $S$ are the midpoints of $\overline{AB}$, $\overline{BC}$, $\overline{CD}$, and $\overline{AD}$, respectively. Draw diagonal $\overline{BD}$. $\overline{PS} \parallel \overline{QR}$ and $\overline{PS} \cong \overline{QR}$ since each segment is parallel to, and one-half the length of, $\overline{BD}$. Thus, $PQRS$ is a parallelogram. Since $\triangle PAS \cong \triangle PBQ$ by SAS $\cong$ SAS, $\overline{PS} \cong \overline{QR}$, which makes $PQRS$ a rhombus.

**Lesson 4.6**

1. Slope $\overline{AB}$ = slope $\overline{CD} = 0$ so $\overline{AB} \parallel \overline{CD}$. Slope $\overline{AD} \neq$ slope $\overline{BC}$ so $\overline{AD} \nparallel \overline{BC}$. Therefore, $ABCD$ is a trapezoid. $AD = BC = \sqrt{a^2 - 2ab + b^2 + c^2}$ so $ABCD$ is an isosceles trapezoid.
2. Using $Y(a, b)$, $S(3a, b)$, $N(2a, 0)$, $YN = SN = \sqrt{a^2 + b^2}$.
3. Midpoint $\overline{QS}$ = midpoint $\overline{RT} = \left(\frac{a+c}{2}, \frac{b}{2}\right)$.
4. For rectangle $A(0, 0)$, $B(0, b)$, $C(d, b)$, and $D(d, 0)$, $AC = BC = \sqrt{b^2 + d^2}$
5. a. $AB = BC = \sqrt{4r^2 + 4s^2}$.

   b. If $L(-r, s)$ is the midpoint of $\overline{AB}$ and $M(r, s)$ is the midpoint of $\overline{BC}$, then $AM = CL = \sqrt{9r^2 + s^2}$.





6. a. $C(t, t)$

   b. $AC = BC = t\sqrt{2}$. Slope $\overline{BD} \times$ slope $\overline{AC} = -1 \times 1 = -1$.
7. Midpoint $\overline{MT}$ = midpoint $\overline{AH} = \left(\frac{s}{2}, \frac{t}{2}\right)$

   Show $MT \neq AH$.
8. a. $h = a - b$, $k = c$.

   b. Show $AC = BD = \sqrt{(a-b)^2 + c^2}$.
9. a. $y = \sqrt{a^2 - b^2}$.

   b. Slope $\overline{AC} = \frac{y}{a+b}$ and slope $\overline{BD} = \frac{y}{b-a}$. Lines are perpendicular if the product of their slopes is $-1$:

   $$\text{Slope } \overline{AC} \times \text{slope } \overline{BD} = \frac{y}{a+b} \times \frac{y}{b-a} = \frac{\left(\sqrt{a^2-b^2}\right)^2}{-(a^2-b^2)} = -1$$
10. $AB = CD = s$ and $BC = AD = \sqrt{t^2 + s^2}$ so $ABCD$ is a parallelogram but *not* a rhombus because it is not equilateral.

## Chapter 5

**Lesson 5.1**

| | | | | | |
|---|---|---|---|---|---|
| 1. (3) | 4. (4) | 7. (1) | 10. −22 | 13. 75 | 16. 21 |
| 2. (3) | 5. (3) | 8. −6 | 11. 5 | 14. 36 | 17. 84 |
| 3. (1) | 6. (4) | 9. 20 | 12. 25 | 15. 48 | 18. 45 |

**Lesson 5.2**

| | | | | | |
|---|---|---|---|---|---|
| 1. (2) | 4. (3) | 7. (2) | 10. (3) | 13. 65 | 16. 10 |
| 2. (3) | 5. (4) | 8. (2) | 11. (3) | 14. 319 | 17. 40 |
| 3. (4) | 6. (3) | 9. (1) | 12. 24 | 15. 12 ft | 18. 15 |

19. a. 2

    b. $\frac{1}{2}h$

    c. 1
20. a. $\frac{80}{x} = \frac{15}{171 - x}$

    b. 144
21. Because $\angle S \cong \angle A$ (opposite angles of a parallelogram are congruent) and $\angle 1 \cong \angle 2$ (all right angles are congruent), $\triangle SKT \sim \triangle ALT$.

**22.** Since $\angle A \cong \angle 1$ (all right angles are congruent) and $\angle ABD \cong \angle CDE$ (congruent alternate interior angles), $\triangle BAD \sim \triangle DEC$ so $\frac{EC}{AD} = \frac{CD}{BD}$.

Since $\overline{AB} \cong \overline{CD}$, $\frac{EC}{AD} = \frac{AB}{BD}$.

**23.** Since $\overline{AG} \cong \overline{AE}$, $\angle AGH \cong \angle AEH$. $\overline{AC}$ bisects $\angle FAB$, so $\angle GAH \cong \angle EAH$. Because $\overline{AB} \parallel \overline{CD}$, $\angle AEH \cong \angle CDH$ and $\angle EAH \cong \angle DCH$. By the transitive property, $\angle AGH \cong \angle CDH$ and $\angle GAH \cong \angle DCH$, so $\triangle AHG \sim \triangle CHD$.

**24.** Show $\triangle RMN \sim \triangle RAT$. $\angle RMN \cong \angle A$, and $\angle RNM \cong \angle T$. Write $\frac{MN}{AT} = \frac{RN}{RT}$. By the converse of the Base Angles Theorem, $NT = MN$. Substitute $NT$ for $MN$ in the proportion.

**25.** Show $\triangle SQP \sim \triangle WRP$. $\angle SPQ \cong \angle WPR$ (angle). Since $\overline{SR} \cong \overline{SQ}$, $\angle SRQ \cong \angle SQR$. $\angle SRQ \cong \angle WRP$ (definition of angle bisector). By the transitive property, $\angle SQR \cong \angle WRP$ (angle).

**26.** Show $\triangle PMQ \sim \triangle MKC$. Right triangle $MCK \cong$ right triangle $PMQ$. Since $\overline{TP} \cong \overline{TM}$, $\angle TPM \cong \angle TMP$.

**27.** Show $\triangle PMT \sim \triangle JKT$. Since $\overline{MP} \cong \overline{MQ}$, $\angle MPQ \cong \angle MQP$. Since $\overline{JK} \parallel \overline{MQ}$, $\angle J \cong \angle MQP$ so, by the transitive property, $\angle J \cong \angle MPQ$ (angle). $\angle K \cong \angle QMT$ (congruent alternate interior angles). $\angle QMT \cong \angle PMT$ (since $\triangle MTP \cong \triangle MTQ$ by SSS). By the transitive property, $\angle K \cong \angle PMT$ (angle). Write the proportion $\frac{PM}{JK} = \frac{PT}{JT}$.

Substitute $TQ$ for $PT$ (see the Given) in the proportion.

**28.** a. $\angle C \cong \angle A$ and $\angle 2 \cong \angle 6$ so $\triangle FEC \sim \triangle DFA$.

b. $\angle 4$ is complementary to $\angle 1$ and $\angle C$ is complementary to $\angle 1$ so $\angle 4 \cong \angle C$; $\angle 2 \cong \angle 6$ so $\triangle EDF \sim \triangle DFA$.

c. $\triangle FEC \sim \triangle EDF$. If two triangles are similar to the same triangle, then they are similar to each other.

**Lesson 5.3**

| | | | | |
|---|---|---|---|---|
| **1.** (4) | **3.** (2) | **5.** (1) | **7.** 160 | **9.** 117 in$^2$ |
| **2.** (2) | **4.** (3) | **6.** (3) | **8.** 45 in$^2$ | |

**Lesson 5.4**

| | | | | | |
|---|---|---|---|---|---|
| **1.** (3) | **3.** (1) | **5.** (2) | **7.** 3 | **9.** 6 | **11.** 9 |
| **2.** (2) | **4.** (4) | **6.** 6 | **8.** 25 | **10.** 28 | **12.** 13.7 |

**13.** Since $\angle ACB \cong \angle DCE$ (vertical angles are congruent) and $\frac{AC}{EC} = \frac{BC}{DC}$ (given), $\triangle ABC \sim \triangle DEC$ (SAS Similarity Theorem) so $\angle B \cong \angle D$ since corresponding angles of similar triangles are congruent.





**14.** Since $\overline{BCE} \cong \overline{FD}$, $\frac{BF}{AF} = \frac{CD}{AD}$ (if a line parallel to one side of a triangle intersects the other two sides, then it divides those sides proportionally). Since $\angle 1 \cong \angle 2$ and $\angle 1 \cong \angle ECD$, $\angle 2 \cong \angle ECD$ so $\overline{CD} \cong \overline{ED}$ and, by substitution, $\frac{BF}{AF} = \frac{ED}{AD}$.

**15.** Points $S$ and $T$ are midpoints so $\overline{TS} \parallel \overline{JK}$ and $TS = \frac{1}{2}KJ$. Because $\overline{RS} \cong \overline{RS}$, $\angle KRS \cong \angle TSR$ (congruent alternate interior angles), and $\overline{KR} \cong \overline{TS}$ (since $KR = \frac{1}{2}KJ$ and $TS = \frac{1}{2}KJ$), $\triangle KRS \cong \triangle TSR$ (SAS $\cong$ SAS) so $\angle 1 \cong \angle 2$ by CPCTC.

**16.** In right triangle $KHT$, hypotenuse $TK = 10$. Since $\frac{TK}{SK} = \frac{10}{5} = 2$ and $\frac{KH}{RH} = \frac{6}{3} = 2$, $\frac{TK}{SK} = \frac{KH}{RH}$. Because the sides that include congruent right angles $RHK$ and $SKT$ are in proportion, $\triangle RHK \sim \triangle SKT$ by the SAS Similarity Theorem.

**Lesson 5.5**

**1.** Show $\triangle AEH \sim \triangle BEF$. $\angle BEF \cong \angle HEA$ and $\angle EAH \cong \angle EBF$ (halves of equals are equal).

**2.** First prove the proportion $\frac{JY}{XZ} = \frac{YX}{ZL}$ by proving $\triangle JYX \sim \triangle XZL$. To prove these triangles are similar, show $\angle JYX \cong \angle XZL$ and $\angle J \cong \angle ZXL$. Since $KYXZ$ is a parallelogram, $KZ = YX$, so $\frac{JY}{XZ} = \frac{YX}{ZL} = \frac{KZ}{ZL}$. In the proportion $\frac{JY}{XZ} = \frac{KZ}{ZL}$, cross-multiplying gives the desired product.

**3.** Show $\triangle EIF \sim \triangle HIG$. Since $\overline{EF}$ is a median, $\overline{EF} \parallel \overline{AD}$, so $\measuredangle FEI \cong \measuredangle GHI$ and $\measuredangle EFI \cong \measuredangle HGI$.

**4.** Rewrite the product as $\frac{RW}{RV} = \frac{TW}{SV}$. Prove $\triangle RSV \sim \triangle RTW$. Since $RVW$ bisects $\angle SRT$ (given), $\angle SRV \cong \angle TRW$ (angle). Since $\overline{TW} \cong \overline{TV}$ (given), $\angle TVW \cong \angle W$. Also, $\angle RVS \cong \angle TVW$ (vertical angles are congruent). By the transitive property, $\angle RVS \cong \angle W$ (angle). Hence, $\triangle RSV \sim \triangle RTW$ by the AA similarity postulate.

5. a. $\overline{EF} \parallel \overline{AC}$, $\measuredangle ACF \cong \measuredangle GFE$ since parallel lines form congruent alternate interior angles. Similarly, since $\overline{DE} \parallel \overline{AB}$, $\measuredangle AFC \cong \measuredangle EGF$. Hence, $\triangle CAF \sim \triangle FEG$.
   b. $\triangle CAF \sim \triangle CDG$. By the transitive property, $\triangle CDG \sim \triangle FEG$, so $\frac{DG}{EG} = \frac{GC}{GF}$, implying $DG \times GF = EG \times GC$.
6. Draw right triangle $ABC$ with altitude $\overline{CH}$ drawn to hypotenuse $\overline{AB}$. Prove $AC \times BC = AB \times CH$ by showing $\triangle ABC \sim \triangle ACH$, using $\angle A \cong \angle A$ right $\angle ACB \cong$ right $\angle AHC$.

## CHAPTER 6

**Lesson 6.1**

| | | | | |
|---|---|---|---|---|
| **1.** (1) | **4.** (4) | **7.** (1) | **10.** 13 | **13.** $9\sqrt{5} + 15$ |
| **2.** (4) | **5.** (1) | **8.** $8\sqrt{5}$ | **11.** 25 | **14a.** 4 |
| **3.** (2) | **6.** (1) | **9.** 11.8 | **12.** $3\sqrt{3}$ | **b.** $4\sqrt{5}$ |

**Lesson 6.2**

| | | | | |
|---|---|---|---|---|
| **1.** (4) | **6.** (2) | **11.** (3) | **16.** 168 cm$^2$ | **21a.** 3.8 |
| **2.** (3) | **7.** (1) | **12.** (2) | **17.** 36, 48 | **b.** 13.2 |
| **3.** (4) | **8.** (3) | **13.** 127.3 | **18.** 5 | **22.** 41.7 |
| **4.** (3) | **9.** (3) | **14.** 308 | **19.** 14.3 | **23.** 9.4 |
| **5.** (1) | **10.** (3) | **15.** 14.9 | **20.** 2.8 | **24.** 8.4 |

**Lesson 6.3**

| | | | |
|---|---|---|---|
| **1.** (3) | **5.** (4) | **9.** (1) | **13.** 42 cm$^2$ |
| **2.** (3) | **6.** (1) | **10.** (4) | **14.** 6.9 |
| **3.** (2) | **7.** (3) | **11.** (4) | **15.** $G(-2, 11)$ or $G(-2,-3)$ |
| **4.** (1) | **8.** (3) | **12.** $50\sqrt{3}$ in$^2$ | **16.** 22 |

**Lesson 6.4**

| | | | |
|---|---|---|---|
| **1.** (2) | **6.** 68.7° | **11.** 19.0 | **15.** 76.8 |
| **2.** (1) | **7.** 28° | **12.** 57 | **16a.** 129.7 |
| **3.** (2) | **8.** 15.5 | **13a.** 2 | **b.** 57.5 |
| **4.** (2) | **9.** 60° | **b.** 70.5° | **17.** 210 |
| **5.** (2) | **10.** 136 | **14.** 86.6 | |





## CHAPTER 7

**Lesson 7.1**

| | | | |
|---|---|---|---|
| **1.** (1) | **3.** (2) | **5.** 120 | **7.** 142 |
| **2.** (2) | **4.** (3) | **6.** 80 | **8.** 80 |

9. Since $OXEY$ is a square, $\overline{OX} \perp \overline{OT}$, $\overline{OY} \perp \overline{PJ}$, $OX = OY$, so $\overline{QT} \cong \overline{JP}$. Subtracting corresponding sides of m$\overset{\frown}{QT}$ = m$\overset{\frown}{JP}$ and m$\overset{\frown}{PT}$ = m$\overset{\frown}{PT}$ gives $\overset{\frown}{QP} \cong \overset{\frown}{JT}$.
10. Since $\overline{DE} \cong \overline{FG}$, $\overline{PB} \cong \overline{PC}$, right triangle $APB \cong$ right triangle $ACP$ by Hy-Leg $\cong$ Hy-Leg. By CPCTC, $\angle BAP \cong \angle CAP$, so $\overline{PA}$ bisects $\angle FAD$.
11. a. Since $\overset{\frown}{AD} \cong \overset{\frown}{BC}$, $\angle AOD \cong \angle BOC$ so $\triangle AOE \cong \triangle BOF$ by SAS $\cong$ SAS.
    b. Because points $E$ and $F$ are midpoints of radii $\overline{OD}$ and $\overline{OC}$, $\overline{DE} \cong \overline{CF}$ (halves of congruent segments are congruent); $\angle ADE \cong \angle BCF$ (CPCTC from part a); $\overline{AD} \cong \overline{BC}$ (congruent arcs have congruent chords). Thus, $\triangle ADE \cong \triangle BCF$ by SAS $\cong$ SAS, so $\angle DAE \cong \angle CBF$ by CPCTC.

**Lesson 7.2**

| | | | |
|---|---|---|---|
| **1.** (1) | **5.** (4) | **9.** 25.5 | **13.** 6 |
| **2.** (4) | **6.** (1) | **10.** 11 | **14.** 13 |
| **3.** (2) | **7.** (2) | **11.** $x = 10, y = 13$ | |
| **4.** (3) | **8.** (4) | **12.** 17 in | |

15. Draw $\overline{OB}$ and radius $\overline{OA}$. Assume $\overline{OB}$ is perpendicular to $\overline{PA}$. Since $\overline{OA}$ is also perpendicular to $\overline{PA}$, $\triangle OAB$ contains two right angles, which is impossible. Hence, the assumption that $\overline{OB}$ is perpendicular to $\overline{PA}$ is false. Thus, $\overline{OB}$ is *not* perpendicular to $\overline{PA}$ as this is the only other possibility.
16. Since congruent circles have congruent radii, $\overline{OA} \cong \overline{O'B}$; $\angle OAC \cong \angle O'BC$ (right angles are congruent); $\angle OCA \cong \angle O'CB$ (vertical angles are congruent). Thus, $\triangle OAC \cong \triangle O'BC$ by AAS $\cong$ AAS. By CPCTC, $\overline{OC} \cong \overline{O'C}$.

**Lesson 7.3**

| | | | | |
|---|---|---|---|---|
| **1.** (1) | **4.** (2) | **7.** (1) | **10.** $\frac{4}{3}\pi$ | **13.** 12.6 |
| **2.** (2) | **5.** (1) | **8.** (1) | **11.** 9.43 | **14a.** 54.6 |
| **3.** (2) | **6.** (4) | **9.** (3) | **12.** 94 | **b.** 2,752 |

## Lesson 7.4

| | | | | |
|---|---|---|---|---|
| **1.** (1) | **7.** (3) | **13.** 50 | **19.** 35 | **c.** 15 |
| **2.** (2) | **8.** (1) | **14.** 22 | **20.** 90 | **d.** 135 |
| **3.** (3) | **9.** (4) | **15.** 60 | **21.** 6.8 | **24a.** 30 |
| **4.** (2) | **10.** (3) | **16.** 20 | **22.** 2:1 | **b.** 75 |
| **5.** (3) | **11.** 64 | **17.** 70 | **23a.** 90 | **25.** 25 |
| **6.** (2) | **12.** 66 | **18.** 80 | **b.** 120 | |

**26.** $m\overset{\frown}{GF} = 30$, $m\angle BHD = 65$, $m\angle BDG = 75$, $m\angle GDE = 55$, $m\angle C = 35$, $m\angle BOD = 100$

**27.** In $\triangle APB$, $\overline{PDA} \cong \overline{PCB}$, so $\angle PAB \cong \angle PBA$. Inscribed angles $DAC$ and $CBD$ intercept the same arc, so they are congruent. Using the subtraction property, $\angle FAB \cong \angle FBA$. It follows that $\overline{AF} \cong \overline{BF}$ (converse of the Base Angles Theorem).

**28.** In $\triangle PBD$, $\overline{PAB} \cong \overline{PCD}$ so $\angle B \cong \angle D$. Since congruent inscribed angles intercept congruent arcs, $\overset{\frown}{ACD} \cong \overset{\frown}{CAB}$. Subtracting $\overset{\frown}{AC}$ from both $\overset{\frown}{ACD}$ and $\overset{\frown}{CAB}$ makes $\overset{\frown}{AB} \cong \overset{\frown}{CD}$, so $\overline{AB} \cong \overline{CD}$. Thus, $\triangle AEB \cong \triangle CFD$ by AAS $\cong$ AAS. By CPCTC, $\overline{AE} \cong \overline{CF}$.

## Lesson 7.5

| | | | | |
|---|---|---|---|---|
| **1.** (2) | **4.** (1) | **7.** (1) | **10.** 10 | **13.** 6 |
| **2.** (4) | **5.** (2) | **8.** (1) | **11.** 5.5 | **14.** 12 |
| **3.** (3) | **6.** (1) | **9.** 12 | **12.** 16 | **15.** 10 |

**16.** Inscribed angles $A$ and $C$ intercept the same arc, $\overset{\frown}{BD}$, so they are congruent. Inscribed angles $B$ and $D$ intercept the same arc, $\overset{\frown}{AC}$, so they too are congruent. Hence, $\triangle AEB \sim \triangle CED$ by the AA Similarity Postulate.

**17.** $\triangle KLP \sim \triangle KJM$ since right triangle $KLP \cong$ right triangle $KJM$ and $\angle LKP \cong \angle MKJ$ (they intercept congruent arcs).

**18.** Show $\triangle KLP \sim \triangle KJM$. Right triangle $KLP \cong$ right triangle $KJM$. Vertical angles are congruent so $\angle KPL \cong \angle JPM$. Since $\overline{JP} \cong \overline{JM}$, $\angle JPM \cong \angle JMK$ so, by the transitive property $\angle KPL \cong \angle JMK$.

**19.** Show $\triangle HBW \sim \triangle MBL$. Because $m\angle ABW$ and $m\angle H$ are each equal to one-half the measure of the same arc, $\angle H \cong \angle ABW$. Since $ABLM$ is a parallelogram, $\overline{AB} \parallel \overline{ML}$, so $\angle ABW \cong \angle BML$. By the transitive property of congruence, $\angle H \cong \angle BML$ (angle). Angle $HBW$ is contained in both triangles. Hence, $\angle HBW \cong \angle MBL$ (angle). Therefore, $\triangle HBW \sim \triangle MBL$, so $\dfrac{BL}{BW} = \dfrac{BM}{BH}$.

**20.** Show $\triangle BCD \sim \triangle ABE$. Because $m\angle DBC$ and $m\angle A$ are each equal to one-half the measure of the same arc, $\angle DBC \cong \angle A$. Angle $ABE$ is a right angle, since a diameter is perpendicular to a chord at the point of tangency. Since $\overline{AB} \cong \overline{CD}$ and interior angles on the same side of the transversal are supplementary, $\angle DCB$ is a right angle, which means that $\angle DCB \cong \angle ABE$. Therefore, $\triangle BCD \sim \triangle ABE$, so $\dfrac{BD}{AE} = \dfrac{CD}{BE}$.

**21.** Show $\triangle CDA \sim \triangle BAF$. Since $\overline{BGF} \parallel \overline{CDE}$, $\angle C \cong \angle ABF$. Since $B$ is the midpoint of $\overset{\frown}{AD}$, $\overset{\frown}{AB} \cong \overset{\frown}{BD}$ so $\angle CAD \cong \angle F$ (inscribed angles that intercept congruent arcs are congruent) and the required pair of triangles are similar. Because the lengths of corresponding sides of similar triangles are in proportion, $\dfrac{CD}{BA} = \dfrac{CA}{BF}$ and, as a result, $CD \times BF = CA \times BA$.

**22.** Show $\triangle MPN \sim \triangle QPR$. Angles $MPN$ and $QPR$ are congruent; $\angle M \cong \angle NPT$ since they are each measured by one-half of the measure of the same arc; for the same reason, $\angle Q \cong \angle RPS$. Since $\angle NPT \cong \angle RPS$, $\angle M \cong \angle Q$, which makes $\triangle MPN \sim \triangle QPR$. Because the lengths of corresponding sides of similar triangles are in proportion, $\dfrac{MN}{QR} = \dfrac{PN}{PR}$, and, as a result, $MN \times PR = PN \times QR$.

**23.** Show $\triangle WTK \sim \triangle JTW$. Since $\angle T$ is contained in both triangles, $\angle WTK \cong \angle JTW$ (angle). Because $m\angle NTJ$ and $m\angle JWT$ are equal to one-half of the measure of the same arc, $\angle JWT \cong \angle NTJ$. It is given that $\overline{TK}$ bisects $\angle NTW$, which means that $\angle NTJ \cong \angle JTW$. Hence, $\angle JTW \cong \angle JWT$. It is also given that $\overline{WK} \cong \overline{WT}$, so $\angle K \cong \angle JTW$. Since $\angle JTW \cong \angle JWT$ and $\angle K \cong \angle JTW$, by the transitive property of congruence, $\angle K \cong \angle JWT$ (angle). Then $\triangle WTK \sim \triangle JTW$, so $\dfrac{JT}{TW} = \dfrac{TW}{TK}$. Setting the cross-products equal gives $(TW) \times (TW) = JT \times TK$ or, equivalently, $(TW)^2 = JT \times TK$.

**24.** Show $\triangle OAP \sim \triangle OEB$. Right angles $OAP$ and $OEB$ are congruent. Because a diameter perpendicular to a chord bisects the arcs of the chord, $\overset{\frown}{AD} \cong \overset{\frown}{BD}$ so angles $AOP$ and $BOE$ are congruent, and the required pair of triangles are similar.

**25.** **a.** 36
**b.** 39

**26.** **a.** $m\angle CAD = \dfrac{1}{2}m\overset{\frown}{CBD}$ and $m\angle CEA = \dfrac{1}{2}(m\overset{\frown}{AC} + m\overset{\frown}{BD})$. Because $\overline{AC} \cong \overline{BC}$, $\overset{\frown}{AC} \cong \overset{\frown}{BC}$, so by substition, $m\angle CEA = \dfrac{1}{2}(m\overset{\frown}{BC} + m\overset{\frown}{BD}) = \dfrac{1}{2}m\overset{\frown}{CBD}$. Because $m\angle CAD = \dfrac{1}{2}m\overset{\frown}{CBD}$ and $m\angle CEA = \dfrac{1}{2}m\overset{\frown}{CBD}$, $\angle CAD \cong \angle CEA$.

b. $\angle CAD \cong \angle CEA$ (from part a) and $\angle ACD \cong \angle ACE$ (reflexive property of congruence), so $\triangle CDA \sim \triangle ACE$ by AA $\cong$ AA. Thus, $\frac{CD}{AC} = \frac{AC}{CE}$ and, as a result, $(AC)^2 = CE \times CD$.

## CHAPTER 8

**Lesson 8.1**

1. (1) 2. (1) 3. (3) 4. (3) 5. (3) 6. (4) 7. (2) 8. (3) 9. (3) 10. (2) 11. (4)

12. If a transformation is an isometry, then it is a line reflection. Counterexample: A *translation* is an isometry, but it is not a reflection.
13. a. $\triangle HOC$
    b. Direct

**Lesson 8.2**

1. (2) 2. (4) 3. (3) 4. (4) 5. (3) 6. (2) 7. (1) 8. (4) 9. (3) 10. (1)

**Lesson 8.3**

1. (4) 2. (3) 3. (1) 4. (4) 5. (4) 6. (2) 7. (4) 8. (2) 9. (1) 10. (4)

11. Reflection in $\overline{EMB}$.
12. $(x, y)\ (x - 7, y + 9)$
13. Glide reflection (a reflection in the $x$-axis followed by a translation)
14. Reflection in point $M$
15. $(-7, 6)$
16. $(4, -4)$
17. $P'(-1, 5)$
18. a. Graph $ABCD$ and $A'B'C'D'$, where $A'(-2, 6)$, $B'(-7, 8)$, $C'(-9, 3)$, and $D'(-4, 1)$.
    b. 29
19. $A'(-1, 1)$, $B'(4, -2)$, $C'(3, -5)$, $D'(-2, -2)$. Show midpoint $\overline{A'C'}$ = midpoint $\overline{B'D'} = (1, -2)$.
20. a. $h = 5$, $k = 3$
    b. 22.5
    c. 90
21. a. Graph $\triangle P'E'N'$ where $P'(-1, 2)$, $E'(-3, 0)$, and $N'(-6, 4)$.
    b. Graph $\triangle P''E''N''$ where $P''(5, -1)$, $E''(7, -3)$, and $N''(10, 1)$.
22. a. Graph $\triangle S'A'M'$ where $S'(4, 3)$, $A'(-5, 3)$, and $M'(-2, -4)$.
    b. Graph $\triangle S''A''M''$ where $S''(6, 8)$, $A''(6, -10)$, and $M''(-8, -4)$; 1:4





**Lesson 8.4**

1. (1) 2. (3) 3. (1) 4. (2) 5. (4) 6. (3) 7. (2) 8. (3) 9. (4) 10. (1) 11. (1) 12. (2) 13. (4) 14. (4) 15. (3) 16. (3) 17. (1) 18. (1) 19. $(-5, 1)$ 20. $P'(5, -4)$

21. $T_{3,2} \circ r_{y\text{-axis}} (\triangle RUN) \rightarrow \triangle GEM$
22. $(3, 4)$
23. Graph $A''(0, -5)$ and $B''(-2, 0)$; reflection in the origin.
24. a. Graph $A'(2, -1)$, $B'(2, 6)$, $C'(4, 3)$.
    b. $r_{y=x}$
25. a. Graph $A'(0, 0)$, $B'(-1, 8)$, $C'(-4, 8)$. Choice (1).
    b. Graph $A''(0, 0)$, $B''(8, 5)$, $C''(8, 8)$. Choice (4).
26. a. $E$
    b. $\overline{DE}$
    c. $C$

## CHAPTER 9

**Lesson 9.1**

1. (4) 2. (4) 3. (2) 4. (3) 5. (1) 6. (2) 7. (1) 8. $x = 2$ 9. $y = 2$ 10. $y = 3$ 11. $x = -4$ 12. $x = \pm 2$ 13. $x = -2, x = 8$ 14. $y = -5, y = 3$

**Lesson 9.2**

1. (2) 2. (4) 3. (2) 4. (1) 5. (1) 6. (1) 7. (3) 8. (2) 9. (3) 10. (4) 11. (2) 12. (3) 13. (1) 14. (1) 15. (3) 16a. 0 b. 2 17. 2 18. 4 19. 4

20. 1
21. a. $x = 1, x = 5$
    b. Circle with center at (3, 2) and radius of $n$ units
    c. 2
22. b. 3
23. b. (1) 2 (2) 0 (3) 4

**Lesson 9.3**

1. (3) 2. (4) 3. (1) 4. (3) 5. (2) 6. (4) 7b. 1 c. (2)

### Lesson 9.4

1. (2) 2. (4) 3. (4) 4. (2) 5. (3)

6. a. $y - 5 = -\frac{2}{3}(x + 3)$
   b. (0, 3)
7. $y = 3x + 4$
8. a. $y - 1 = \frac{3}{2}(x - 1)$
   b. 10
9. a. $y + 6 = -\frac{2}{3}(x - 1)$
   b. $y = \frac{3}{2}x$
   c. $y = x + \frac{4}{3}$
10. a. $y = x + 1$
    b. Show (8, 9) satisfies the equation in part a.
11. a. $m = 2$
    b. $y = 2x - 1$
    c. (2)
12. a. $y = -x + 14$
    b. (7, 3)
13. a. $A'(8, 8)$; $y = x$
    b. $B'(3, 6)$
    c. Midpoint $\overline{AA'} = (5, 5)$ and midpoint $\overline{BB'} = (4.5, 4.5)$. Since the diagonals do not have the same midpoint, $ABA'B'$ is *not* a parallelogram.
14. a. $y = \frac{1}{3}x + \frac{10}{3}$
    b. Slope $\overline{PM} = \frac{1}{3}$ and slope $\overline{QR} = -3$. Since slopes are negative reciprocals, the line segments are perpendicular.
    c. Because $\triangle PQR$ is isosceles.
15. a. $y = -x + 6$
    b. Show (5, 1) satisfies the equation in part a.
16. a. $y = -x + 4$
    b. $y = 4$
    c. $x = 0$
17. a. $y = 5x - 4$
    b. $y = 5x - 27$
    c. Lines have the same slope so they are parallel.





### Lesson 9.5

1. (4) 3. (4) 5. (1) 7. (1) 9. (3)
2. (2) 4. (2) 6. (2) 8. (1) 10. (3)

11. $(x - 2)^2 + (y + 3)^2 = 25$
12. a. Show $AB = BC = CD = AD = 10$. Because $ABCD$ is equilateral, it is a rhombus.
    b. $(x - 8)^2 + (y - 1)^2 = 100$
13. a. $x^2 + y^2 = 25$
    b. $y = \frac{3}{4}x + \frac{25}{4}$, $y$-intercept is $\frac{25}{4}$.
14. a. $y = 2$
    b. $(x - 2)^2 + (y + 2)^2 = 16$. One point.
15. b. $y = \frac{4}{3}x - 9$
16. a. $(x - 3)^2 + (y - 2)^2 = n^2$
    b. $x = 1, x = 5$
    c. (1) 0, (2) 2
17. a. Graph circle $B$: $(x - 5)^2 + (y + 3)^2 = 9$
    b. Graph circle $C$: $(x - 5)^2 + (y - 3)^2 = 9$. Area $\triangle ABC = 15$ square units.
18. b. $(x + 1)^2 + (y - 1)^2 = 16$
    c. $y = -2x - 1$
19. (4, 3), (0, 5)
20. (3, 2), (0, –1)
21. (10, –3), (8, –5)
22. (1, 3), (–7, 7)
23. (–4, –1), (1, 4)
24. (–4, 0), (1, 5)
25. (2, –3), (6, 5)
26. $x = 7$

## Chapter 10

### Lesson 10.1

1. (3) 2. (1) 3. (1) 4. (1) 5. (4) 6. (2)

7. a. 84 $cm^2$
   b. 42 $cm^3$
8. a. 504 $in^2$
   b. $336\sqrt{3}$ $in^3$
9. a. $120\pi$ $in^2$
   b. 1,131.0 $in^3$
10. a. $260\pi$ $cm^2$
    b. 2,654.6 $cm^3$
11. 720 $cm^2$

12. 288 $in^3$
13. $612\pi$
14. 1,584 $in^2$
15. 7.25
16. 76.9
17. 45
18. 4.5 ft
19. $V = 288\pi$ $in^3$, SA = $168\pi$ $in^2$
20. 47

**Lesson 10.2**

1. (2) 2. (4) 3. (1) 4. (1) 5. (3)
6. 720 $cm^2$, 1,728 $cm^3$
7. a. 868 $cm^2$
   b. 1,499.8 $cm^3$
8. $128\pi$ $in^3$
9. 765.2 $cm^3$
10. 1,082.8 $ft^3$
11. $\frac{512\pi}{3}$ $in^3$
12. 9,600 $ft^3$
13. a. 720 $cm^2$
    b. 1,260 $cm^3$
14. 2,160 $cm^2$
15. 10,936 $cm^3$
16. a. 20 in
    b. $V = 1{,}176\pi$ $in^3$
17. 40 $in^3$, 95 $in^3$

**Lesson 10.3**

1. (4) 3. (1) 5. (2) 7. (3)
2. (1) 4. (2) 6. (3) 8. (3)
9. a. 5-inch box
   b. No. The surface area of the box is approximately 1.04 $ft^2$.
10. 13.5
11. 103 $in^3$
12. 3.75
13. 2,752 $in^3$
14. 3,654 $cm^2$
15. 576 $cm^3$
16. 353 $mm^3$
17. 12.3 $in^3$



# Glossary of Geometry Terms

## A

**Acute angle** An angle whose degree measure is less than 90 and greater than 0.

**Acute triangle** A triangle with three acute angles.

**Adjacent angles** Two angles with the same vertex, a common side, and no interior points in common.

**Altitude** In a triangle, a segment that is perpendicular to the side to which it is drawn.

**Angle** The union of two rays that have the same endpoint.

**Angle of rotational symmetry** The smallest positive angle through which a figure with rotational symmetry can be rotated to coincide with itself. For a regular $n$-polygon, this angle is $\frac{360}{n}$.

**Apothem** The radius of the inscribed circle of a regular polygon.

**Arc** A part of a circle whose endpoints are two distinct points of the circle. If the degree measure of the arc is less than 180, the arc is a **minor arc**. If the degree measure of the arc is greater than 180, the arc is a **major arc**. A **semicircle** is an arc whose degree measure is 180.

## B

**Biconditional** A statement of the form "$p$ if and only if $q$" where statement $p$ is the hypothesis of a conditional statement and statement $q$ is the conclusion. A biconditional represents the conjunction of a conditional statement and its converse. It is true only when both parts of the biconditional have the same truth values.

**Bisect** To divide into two congruent parts.

## C

**Center of a regular polygon** The point in the interior of the polygon that is equidistant from each of the vertices. It is also the common center of its inscribed and circumscribed circles.

**Center-radius equation of circle** The equation $(x - h)^2 + (y - k)^2 = r^2$ where $(h, k)$ is the center of a circle with radius $r$.

**Central angle of a circle** An angle whose vertex is at the center of a circle and whose sides contain radii.

**Central angle of a regular polygon** An angle whose vertex is the center of the polygon and whose sides are drawn to consecutive vertices of the polygon.

**Centroid of a triangle** The point of intersection of its three medians.

**Chord of a circle** A line segment whose endpoints are points on a circle.

**Circle** The set of points $(x, y)$ in the plane that are a fixed distance $r$ from a given point $(h, k)$ called the *center*. An equation of the circle is

$$(x - h)^2 + (y - k)^2 = r^2$$

**Circumcenter of a triangle** The center of the circle that can be circumscribed about a triangle. It can be located by finding the point of intersection of the perpendicular bisectors of two of its sides.