3-1 Lines and Angles

Teks Focus

Foundational to TEKS (6)(A) Verify theorems about angles formed by the intersection of lines and line segments, including vertical angles, and angles formed by parallel lines cut by a transversal and prove equidistance between the endpoints of a segment and points on its perpendicular bisector and apply these relationships to solve problems.

TEKS (1)(F) Analyze mathematical relationships to connect and communicate mathematical ideas.

Additional TEKS (1)(A)

Vocabulary

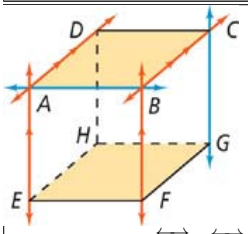
- **Alternate exterior angles** – nonadjacent exterior angles that lie on opposite sides of a transversal
- **Alternate interior angles** – nonadjacent interior angles that lie on opposite sides of a transversal
- **Corresponding angles** – angles that lie on the same side of a transversal and in corresponding positions
- **Parallel lines** – coplanar lines that do not intersect. The symbol ∥ means "is parallel to."
- **Parallel planes** – planes that do not intersect
- **Same-side interior angles** – interior angles that lie on the same side of a transversal
- **Skew lines** – noncoplanar lines that are not parallel and do not intersect
- **Transversal** – a line that intersects two or more coplanar lines at distinct points
- **Analyze** – closely examine objects, ideas, or relationships to learn more about their nature.

ESSENTIAL UNDERSTANDING

- Not all lines and not all planes intersect.
- When a line intersects two or more lines, the angles formed at the intersection points make special angle pairs.

take note

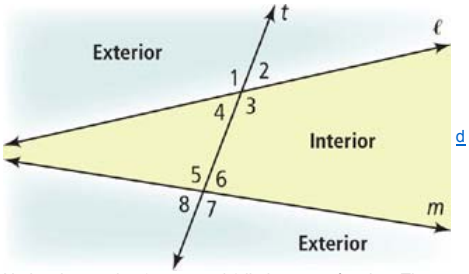
Key Concept Parallel and Skew

Definition	Symbols	Diagram
Parallel lines are coplanar lines that do not intersect. The symbol ∥ means "is parallel to."	$\overleftrightarrow{AE} \parallel \overleftrightarrow{BF}$ $\overleftrightarrow{AD} \parallel \overleftrightarrow{BC}$	
Skew lines are noncoplanar; they are not parallel and do not intersect.	$\overleftrightarrow{AB}$ and $\overleftrightarrow{CG}$ are skew.	
Parallel planes are planes that do not intersect.	plane *ABCD* ∥ plane *EFGH*	Use arrows to show $\overleftrightarrow{AE} \parallel \overleftrightarrow{BF}$ and $\overleftrightarrow{AD} \parallel \overleftrightarrow{BC}$

take note

Key Concept Definition of Transversal

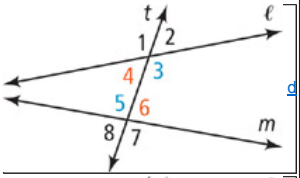
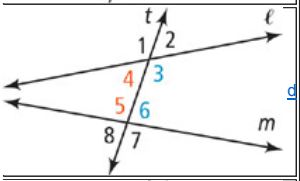
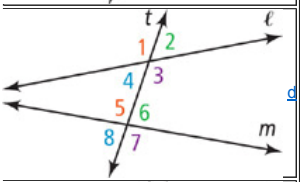
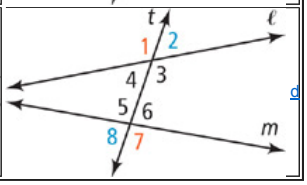
A **transversal** is a line that intersects two or more coplanar lines at distinct points. The diagram below shows the eight angles formed by a transversal *t* and two lines *ℓ* and *m*.



Notice that angles 3, 4, 5, and 6 lie between *ℓ* and *m*. They are *interior* angles. Angles 1, 2, 7, and 8 lie outside of *ℓ* and *m*. They are *exterior* angles.

take note

Key Concept Angle Pairs Formed by Transversals

Definition	Example	
Alternate interior angles are nonadjacent interior angles that lie on opposite sides of the transversal.	∠4 and ∠6 ∠3 and ∠5	
Same-side interior angles are interior angles that lie on the same side of the transversal.	∠4 and ∠5 ∠3 and ∠6	
Corresponding angles lie on the same side of the transversal and in corresponding positions.	∠1 and ∠5 ∠4 and ∠8 ∠2 and ∠6 ∠3 and ∠7	
Alternate exterior angles are nonadjacent exterior angles that lie on opposite sides of the transversal.	∠1 and ∠7 ∠2 and ∠8	

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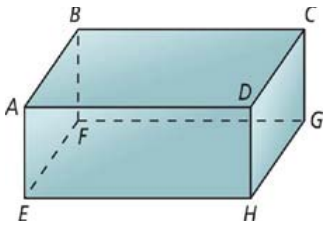
Problem 1

Identifying Nonintersecting Lines and Planes

In the figure, assume that lines and planes that appear to be parallel are parallel.



A Which segments are parallel to $\overline{AB}$?

$\overline{EF}$, $\overline{DC}$, and $\overline{HG}$

B Which segments are skew to $\overline{CD}$?

$\overline{BF}$, $\overline{AE}$, $\overline{EH}$, and $\overline{FG}$

C What are two pairs of parallel planes?

plane *ABCD* ∥ plane *EFGH*

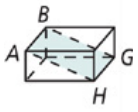
plane *DCG* ∥ plane *ABF*

D What are two segments parallel to plane *BCGF*?

$\overline{AD}$ and $\overline{DH}$

Think
Parallel lines are coplanar. Which planes contain $\overline{AB}$?

Planes *ABCD*, *ABFE*, and *ABGH* contain $\overline{AB}$. You need to visualize plane *ABGH*.

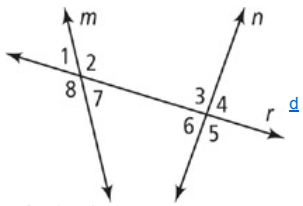


Problem 2

TEKS Process Standard (1)(F)

Identifying an Angle Pair

Multiple Choice Which is a pair of alternate interior angles?



A ∠1 and ∠3

B ∠6 and ∠7

C ∠2 and ∠6

D ∠4 and ∠8

Think
Which choices can you eliminate?

You need a pair of interior angles. ∠1, ∠4, and ∠8 are exterior angles. You can eliminate choices A and D.

∠2 and ∠6 are alternate interior angles because they lie on opposite sides of the transversal *r* and in between *m* and *n*. The correct answer is C.

Problem 3

TEKS Process Standard (1)(A)

Classifying an Angle Pair STEM

Architecture The photo below shows the Royal Ontario Museum in Toronto, Canada. Are angles 2 and 4 *alternate interior angles, same-side interior angles, corresponding angles*, or *alternate exterior angles*?

d

Angles 2 and 4 are alternate interior angles.

Think
How do the positions of ∠2 and ∠4 compare?

∠2 and ∠4 are both interior angles and they lie on opposite sides of a line.

PRACTICE and **APPLICATION EXERCISES**

Use the diagram to name each of the following. Assume that lines and planes that appear to be parallel are parallel.

1. a pair of parallel planes

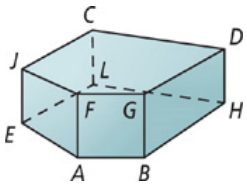
2. all lines that are parallel to $\overleftrightarrow{AB}$

3. all lines that are parallel to $\overleftrightarrow{DH}$

4. two lines that are skew to $\overleftrightarrow{EJ}$

5. all lines that are parallel to plane *JFAE*

6. a plane parallel to $\overleftrightarrow{LH}$



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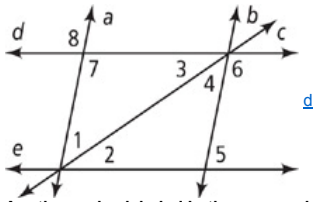
Identify all pairs of each type of angles in the diagram. Name the two lines and the transversal that form each pair.

7. corresponding angles

8. alternate interior angles

9. same-side interior angles

10. alternate exterior angles



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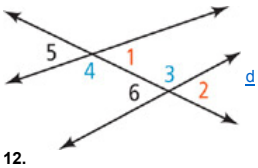
Are the angles labeled in the same color *alternate interior angles, same-side interior angles, corresponding angles*, or *alternate exterior angles*?

11.



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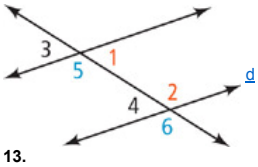
12.



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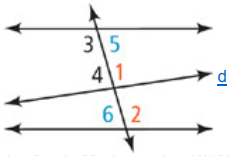
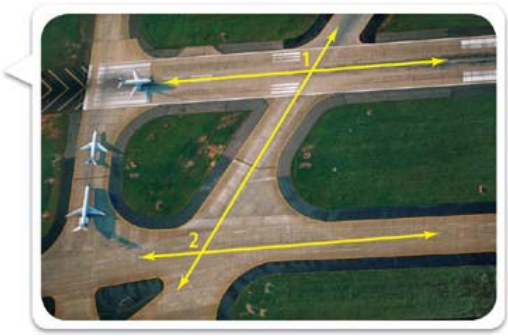
13.



d

14. Apply Mathematics (1)(A) The photo shows an overhead view of airport runways. Are ∠1 and ∠2 *alternate interior angles, same-side interior angles, corresponding angles*, or *alternate exterior angles*?

15. Apply Mathematics (1)(A) You and a friend are driving go-karts on two different tracks. As you drive on a straight section heading east, your friend passes above you on a straight section heading south. Are these sections of the two tracks *parallel, skew*, or *neither*? Explain.



How many pairs of each type of angles do two lines and a transversal form?

16. alternate interior angles

17. corresponding angles

18. alternate exterior angles

19. vertical angles

For Exercises 20–25, describe the statement as *true* or *false*. If false, explain. Assume that lines and planes that appear to be parallel are parallel.

20. $\overleftrightarrow{CB} \parallel \overleftrightarrow{HG}$

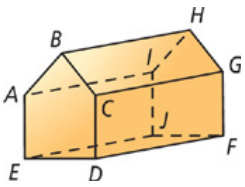
21. $\overleftrightarrow{ED} \parallel \overleftrightarrow{HG}$

22. plane *AED* ∥ plane *FGH*

23. plane *ABH* ∥ plane *CDF*

24. $\overleftrightarrow{AB}$ and $\overleftrightarrow{HG}$ are skew lines.

25. $\overleftrightarrow{AE}$ and $\overleftrightarrow{BC}$ are skew lines.



26.

a. Explain Mathematical Ideas (1)(G) Describe the three ways in which two lines may be related.

b. Give examples from the real world to illustrate each of the relationships you described in part (a).

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27. Create Representations to Communicate Mathematical Ideas (1)(E) The letter Z illustrates alternate interior angles. Find at least two other letters that illustrate pairs of angles presented in this lesson. Draw the letters. Then mark and describe the angles.

28. Apply Mathematics (1)(A) A rectangular rug covers the floor in a living room. One of the walls in the same living room is painted blue. Are the rug and the blue wall parallel? Explain.

For Exercises 29–32, determine whether each statement is *always, sometimes*, or *never* true.

29. Two planes that do not intersect are parallel.

30. Two lines that lie in parallel planes are parallel.

31. Two lines in intersecting planes are skew.

32. A line and a plane that do not intersect are skew.

33.

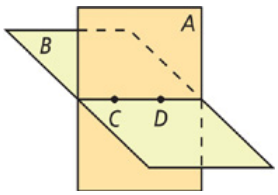
a. Connect Mathematical Ideas (1)(F) Suppose two parallel planes *A* and *B* are each intersected by a third plane *C*. Make a conjecture about the intersection of planes *A* and *C* and the intersection of planes *B* and *C*.

b. Find examples in your classroom to illustrate your conjecture in part (a).

Use the figure at the right for Exercises 34 and 35.

34. Do planes *A* and *B* have other lines in common that are parallel to $\overleftrightarrow{CD}$? Explain.

35. Create Representations to Communicate Mathematical Ideas (1)(E) Are there planes that intersect planes *A* and *B* in lines parallel to $\overleftrightarrow{CD}$? Draw a sketch to support your answer.



36. Create Representations to Communicate Mathematical Ideas (1)(E) A transversal *r* intersects lines ℓ and *m*. If ℓ and *r* form $\angle 1$ and $\angle 2$ and *m* and *r* form $\angle 3$ and $\angle 4$, sketch a diagram that meets the following conditions.

- $\angle 1 \cong \angle 2$
- $\angle 3$ is an interior angle.
- $\angle 4$ is an exterior angle.
- $\angle 3$ and $\angle 4$ are supplementary.
- $\angle 2$ and $\angle 4$ lie on opposite sides of *r*.

TEXAS Test Practice

37. How many pairs of parallel planes does a cereal box have?

A. 2

B. 3

C. 4

D. 6

38. Construct $\overline{MN}$ congruent to $\overline{XY}$.

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