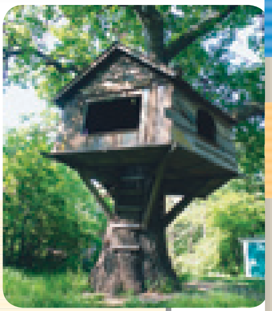
3.1 Identify Pairs of Lines and Angles



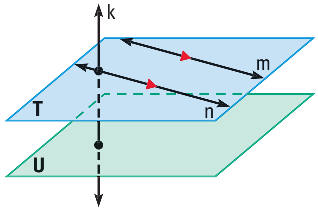
Before You identified angle pairs formed by two intersecting lines.

Now You will identify angle pairs formed by three intersecting lines.

Why? So you can classify lines in a real-world situation, as in Exs. 40–42.

Key Vocabulary
- parallel lines
- skew lines
- parallel planes
- transversal
- corresponding angles
- alternate interior angles
- alternate exterior angles
- consecutive interior angles

Two lines that do not intersect are either *parallel lines* or *skew lines*. Two lines are **parallel lines** if they do not intersect and are coplanar. Two lines are **skew lines** if they do not intersect and are not coplanar. Also, two planes that do not intersect are **parallel planes**.



Lines *m* and *n* are parallel lines ($m \parallel n$).

Lines *m* and *k* are skew lines.

Planes *T* and *U* are parallel planes ($T \parallel U$).

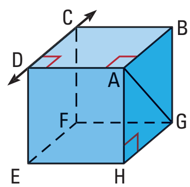
Lines *k* and *n* are intersecting lines, and there is a plane (not shown) containing them.

Small directed triangles, as shown on lines *m* and *n* above, are used to show that lines are parallel. The symbol $\parallel$ means "is parallel to," as in $m \parallel n$.

Segments and rays are parallel if they lie in parallel lines. A line is parallel to a plane if the line is in a plane parallel to the given plane. In the diagram above, line *n* is parallel to plane *U*.

EXAMPLE 1 Identify relationships in space

Think of each segment in the figure as part of a line. Which line(s) or plane(s) in the figure appear to fit the description?



a. Line(s) parallel to $\overleftrightarrow{CD}$ and containing point *A*

b. Line(s) skew to $\overleftrightarrow{CD}$ and containing point *A*

c. Line(s) perpendicular to $\overleftrightarrow{CD}$ and containing point *A*

d. Plane(s) parallel to plane *EFG* and containing point *A*

Solution

a. $\overleftrightarrow{AB}$, $\overleftrightarrow{HG}$, and $\overleftrightarrow{EF}$ all appear parallel to $\overleftrightarrow{CD}$, but only $\overleftrightarrow{AB}$ contains point *A*.

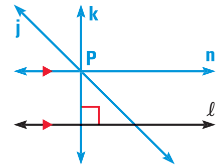
b. Both $\overleftrightarrow{AG}$ and $\overleftrightarrow{AH}$ appear skew to $\overleftrightarrow{CD}$ and contain point *A*.

c. $\overleftrightarrow{BC}$, $\overleftrightarrow{AD}$, $\overleftrightarrow{DE}$, and $\overleftrightarrow{FC}$ all appear perpendicular to $\overleftrightarrow{CD}$, but only $\overleftrightarrow{AD}$ contains point *A*.

d. Plane *ABC* appears parallel to plane *EFG* and contains point *A*.

PARALLEL AND PERPENDICULAR LINES Two lines in the same plane are either parallel or intersect in a point.

Through a point not on a line, there are infinitely many lines. Exactly one of these lines is parallel to the given line, and exactly one of them is perpendicular to the given line.

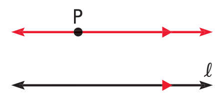


Animated Geometry at classzone.com

POSTULATES *For Your Notebook*

POSTULATE 13 Parallel Postulate

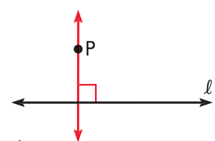
If there is a line and a point not on the line, then there is exactly one line through the point parallel to the given line.



There is exactly one line through P parallel to ℓ.

POSTULATE 14 Perpendicular Postulate

If there is a line and a point not on the line, then there is exactly one line through the point perpendicular to the given line.



There is exactly one line through P perpendicular to ℓ.

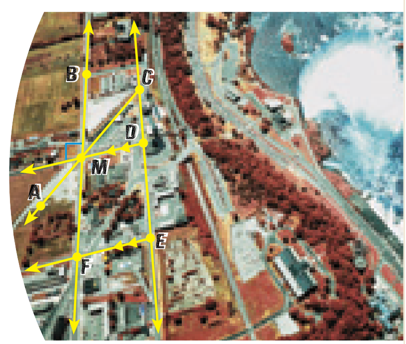
EXAMPLE 2 Identify parallel and perpendicular lines

PHOTOGRAPHY The given line markings show how the roads are related to one another.

a. Name a pair of parallel lines.

b. Name a pair of perpendicular lines.

c. Is $\overleftrightarrow{FE} \parallel \overleftrightarrow{AC}$? Explain.



Niagara Falls, New York

Solution

a. $\overleftrightarrow{MD} \parallel \overleftrightarrow{FE}$ **b.** $\overleftrightarrow{MD} \perp \overleftrightarrow{BF}$

c. $\overleftrightarrow{FE}$ is not parallel to $\overleftrightarrow{AC}$, because $\overleftrightarrow{MD}$ is parallel to $\overleftrightarrow{FE}$ and by the Parallel Postulate there is exactly one line parallel to $\overleftrightarrow{FE}$ through M.

2. Yes; since A is not on $\overleftrightarrow{MD}$ and $\overleftrightarrow{MD}$ is $\perp$ to $\overleftrightarrow{BF}$, the Perpendicular Postulate guarantees that there is exactly one line through a point perpendicular to a line, so $\overleftrightarrow{AC}$ can not be perpendicular to $\overleftrightarrow{BF}$ also.

✓ GUIDED PRACTICE for Examples 1 and 2

1. Look at the diagram in Example 1. Name the lines through point H that appear skew to $\overleftrightarrow{CD}$. $\overleftrightarrow{AH}$, $\overleftrightarrow{EH}$

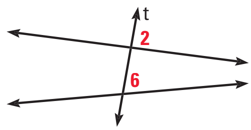
2. In Example 2, can you use the Perpendicular Postulate to show that $\overleftrightarrow{AC}$ is *not* perpendicular to $\overleftrightarrow{BF}$? *Explain* why or why not.

Differentiated Instruction

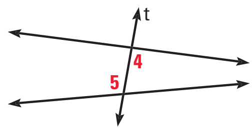
ANGLES AND TRANSVERSALS A **transversal** is a line that intersects two or more coplanar lines at different points.

KEY CONCEPT *For Your Notebook*

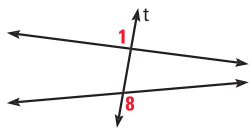
Angles Formed by Transversals



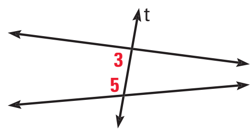
Two angles are **corresponding angles** if they have corresponding positions. For example, $\angle 2$ and $\angle 6$ are above the lines and to the right of the transversal *t*.



Two angles are **alternate interior angles** if they lie between the two lines and on opposite sides of the transversal.



Two angles are **alternate exterior angles** if they lie outside the two lines and on opposite sides of the transversal.



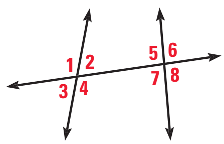
Two angles are **consecutive interior angles** if they lie between the two lines and on the same side of the transversal.

READ VOCABULARY
Another name for consecutive interior angles is **same-side interior angles**.

EXAMPLE 3 Identify angle relationships

Identify all pairs of angles of the given type.

a. Corresponding
b. Alternate interior
c. Alternate exterior
d. Consecutive interior



Solution

a. $\angle 1$ and $\angle 5$
$\angle 2$ and $\angle 6$
$\angle 3$ and $\angle 7$
$\angle 4$ and $\angle 8$

b. $\angle 2$ and $\angle 7$
$\angle 4$ and $\angle 5$

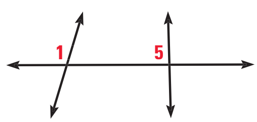
c. $\angle 1$ and $\angle 8$
$\angle 3$ and $\angle 6$

d. $\angle 2$ and $\angle 5$
$\angle 4$ and $\angle 7$

✓ GUIDED PRACTICE for Example 3

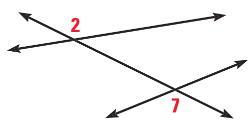
Classify the pair of numbered angles.

3.



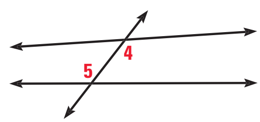
corresponding angles

4.



alternate exterior angles

5.



alternate interior angles

Differentiated Instruction