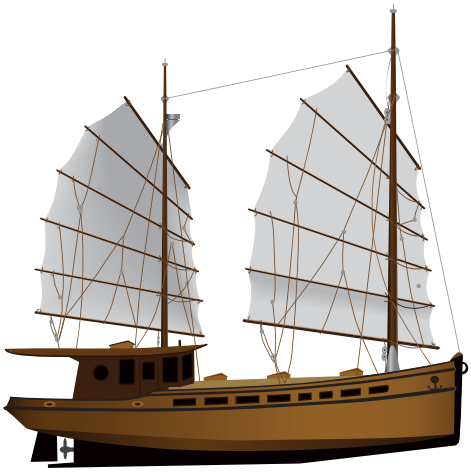
EXAMPLE 4 Analyzing Sail Designs

The sail design of a modern yacht is quite different from the sail design used during most of the past 5000 years. Why is that?

Ancient Egyptian Design

Viking Design



Classic Chinese Design

Modern Yacht

SOLUTION

The sail design of a modern yacht is different from the sail design used during most of the past 5000 years because of advancements in sail design. The following is a summary of some of the advancements.

To sail against the wind, a boat can sail at an angle to the wind and zigzag. This is called "tacking." Early sailboats with square sails were not very effective when sailing against the wind. They were most effective when sailing with the wind. The development of triangular sails enabled boats to sail against the wind more effectively. This was because the boats were able to tack at a smaller angle with the wind than with square sails.

When a triangular sail is positioned correctly, the air flow creates a pressure differential. This differential generates a force called the lift, which pulls a ship forward. A modern yacht like the one shown above has two sails—the mainsail and the jib. This design increases the pressure differential and generates more lift.

Checkpoint

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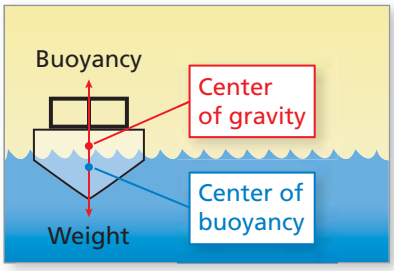

In an answer to the question, "Why doesn't a sailboat tip over?," the following explanation is given. "It's a balancing act between the boat's center of gravity and its center of buoyancy." Explain what this means.