

Aerodynamics

ANSWER KEY

Wright Flyer – Atrium

1. Observe the pilot flying the replica 1903 Wright Flyer hanging from the ceiling. What is unusual about the pilot's flying position?

The pilot is lying down. Wilbur and Orville Wright understood the importance of reducing aerodynamic drag, one of the forces of flight. Their early experimental gliders and their 1903 airplane all required the pilot to fly lying down so as to reduce drag and improve performance.

2. Look carefully at the control lever the pilot is grasping. What part of the airplane is attached to? What might it do?

The control lever is linked to the forward horizontal stabilizer. By moving the lever forward and back, the pilot could angle the stabilizer up or down. This allowed the stabilizer to be used to control pitch, the up-and-down movement that is one of the three axes of aircraft control.

Montgomery Gliders

3. How did the pilots of John Montgomery's first two gliders (the ones hanging from the ceiling) control their aircraft? What is different about the controls of the Evergreen glider below them?

Although Montgomery was one of the first aeronautical inventors to include moveable control surfaces on an aircraft, his Gull and Santa Clara gliders depended on the pilot shifting his body weight around in flight to maintain control. This was a popular means of controlling a glider in flight in the early days of aviation, but the three-axis control system developed by the Wright Brothers – and incorporated into Montgomery's later Evergreen glider – proved far safer, and is still used in nearly all airplanes and gliders today.

Wright Model B Simulator

4. Take the controls of the Wright Model B (Vin Fiz) simulator. How does the airplane turn left and right?

Airplanes turn by rolling in the direction that pilots wish to fly. The airplane continually turns in that direction until the pilot stops the turn by rolling the wings level again. The Wright Brothers discovered the importance of roll control in aircraft by observing birds in flight, and constructed their aircraft with bendable, or “warping”, wings to provide roll control.

5. Pitch the airplane’s nose up. What happens if pitch is increased too far?

The angle at which the wings meet the air is called the “angle of attack”. If an airplane or glider is pitched too steeply up – either by aerodynamic controls, or by flying too slowly for its configuration – the wing stops making the force of lift that keeps the aircraft in the air. The nose of the aircraft then drops suddenly in what is called an aerodynamic stall.

XH-44 Helicopter

6. Compare the yellow XH-44 helicopter replica with the UH-12 helicopter (carrying the stretchers) immediately above it. What is different about the rotors of the two helicopters?

The XH-44 does not have a tail rotor. Most helicopters, including the UH-12, have a single main rotor to create a lifting force, and use a small tail rotor mounted perpendicular to the plane of the main rotor to counteract torque and prevent the helicopter from spinning. The XH-44 had two main rotors on a single shaft that rotated in opposite directions. This eliminated the need for a tail rotor, but proved to make the helicopter more difficult to control.

Aerodynamics Exhibit (Behind Sky Portal/Google Earth Exhibit)

7. What two ingredients does a wing need to create lift?

Airspeed and angle of attack. Wings create lift by deflecting airflows downwards. The air then exerts an upward force on the wing, which is called lift. Total lift is a function of both airspeed and angle of attack; at lower airspeeds, a higher angle of attack is needed to ensure that lift is sufficient to keep an airplane or glider in the air.

8. Observe the video segment of a Boeing 747 conducting stall tests. What direction does the nose pitch when the wing stalls?

Sharply downwards. In the video, test pilots increase the 747's angle of attack until it exceeds a critical angle, usually about 18 degrees. At this angle, airflow separates from the top surface of the wing and lift is destroyed. In such a condition, a properly balanced aircraft will pitch downwards, increasing airspeed and helping the pilots to recover from the stall.

9. Adjust the engine power of the simulated Cessna 172. What happens when the throttle is advanced up to full power?

At full power the airplane begins to climb. In the simulation, pitch is fixed and cannot be changed. Under these circumstances, increasing or decreasing engine power has little effect on airspeed. Instead, changes to power cause the airplane to climb or descend.

10. What do you think is the most interesting aircraft that you saw at the Hiller Aviation Museum today, and why?

Each aircraft exhibited at the Museum was designed and built at a specific point in history with the goal of accomplishing a specific set of design objectives. The result is the tremendous diversity in sizes and shapes on display throughout the Museum's collection.