

WORKSHEET A ANSWER KEY: RESEARCH OF EARLY GLIDERS AND THE IDEA OF FLIGHT.

Using a computer or the lesson your teacher provided on The History of Early Flight, research and answer the following questions in as much detail as possible:

1. The idea of flight had its strongest proponent in Leonardo da Vinci (1452-1519), what were his ideas based on? Explain his contribution to the idea of flight.

Leonardo da Vinci believed that Imitating the way birds glide rather than human powered wing motion was the way to go if any sustained flight for any extended period was expected. His next step would be not imitating nature at all but designing and building winged gliders exclusively by and for human use in mind. Sensing the difficulties involved in accomplishing the great dream of flying with human-powered machines, Leonardo started to study gliding flight more thoroughly. In the glider designed by him, the flier's position is conceived in such a way as to allow him to balance himself by adequately moving the lower part of his body. The wings, an imitation of the wings of bats and of large birds, are fixed in their innermost section (closest to the person) and mobile in their outer section. The latter in fact can be flexed by the flier by means of a control cable maneuvered through handles. Leonardo had developed this solution after having studied the structure of birds' wings and having observed that the inner part of their wings moved more slowly than the outer part and that, therefore, the function of this part was to sustain rather than to push forward.

2. Daniel Bernoulli's work made our understanding of the physical nature of flight possible. Explain in your own words his findings. *The basis of flight, or at least the description of it which we call 'physical law', had also been around for a long time before Wright, Bleriot et al. The description is due to **Daniel Bernoulli**.*

Bernoulli's principle helps explain that an aircraft can achieve lift because of the shape of its wings. They are shaped so that that air flows faster over the top of the wing and slower underneath. Fast moving air equals low air pressure while slow moving air equals high air pressure. The high air pressure underneath the wings will therefore push the aircraft up through the lower air pressure.

3. Who is named "Father of Aerial Navigation" and how did he obtain this title?

Sir George Cayley has been described as the 'Father of Aerial Navigation'. One hundred years before the Wright Brothers he had developed the first proper understanding of the principles of flight and constructed a series of models to prove his ideas. In 1853, fifty years before the first powered flight was made at Kitty Hawk, the first man-carrying glider flight was made across Brompton dale in the north of England by Cayley's coachman.

Cayley defined the form of the present day aeroplane by breaking away from the previous ideas of how powered flight would be achieved. The drawing he made on a silver disc in 1799 shows a machine with a fixed wing, a fuselage, and a tail. It also had separate systems to provide lift, propulsion and control. Cayley later tried to develop the 'prime mover' that he realized would be needed for powered flight, but unfortunately his gunpowder engines were not reliable.

4. Although known for being able to advance the science of aviation and the art of flying, Otto Lilienthal's work had one major weakness, flight control. Explain his success/failures with gliders and their construction.

Lilienthal was able to make a glider fly, but he had problems with the control of where the glider would go. He hadn't placed into the construction, the concept of turning the glider. It wasn't until the Wright Brothers put into practice the ability for a person to lay on the glider and direct it with the motion of their hips.

5. What was the "Katydid" and why did its design not work? *The Katydid was a glider made with several wings stacked on top of each other. The weight was too much for the glider to fly.*
6. Up to the point of the Wright brothers, there was no accurate accepted scientific body of knowledge about manned flight. They proposed problems that needed to be addressed.
 - For people to fly, they must first comprehend the physical principles involved. Only then could they mechanically reproduce bird's flight. What are the physical principles involved? *Lift, Drag, Thrust, and weight. The Wright brothers had done extensive research on earlier flight attempts and altered their plans accordingly. Knowing that weight and flight control were the biggest weaknesses so far. They thought of the ability for a pilot to lay on the glider guiding it with their hips. The Katydid, was found to be a failure due to excessive weight of the multiple wings stacked onto one another.*
 - The issue of lift and equilibrium needed to be solved. How did they solve them? *Wing surface needed to remain rigid while the body was allowed to twist and turn much the same as the wing tips of the birds he observed. Wilbur thought, that the incorporation of a similar technique would allow an aircraft operator to control the air pressure on either side of a planes' wing, making sustained, controllable flight possible. The Wright brothers would later call this concept, "wing warping." The invention of "wing warping," to achieve equilibrium, would lead directly to the Aileron principle still used by modern aircraft*
 - A three-dimensional control system was needed. What was meant by that? *One of the major breakthroughs of the Wright brothers was the ability to control and maneuver their aircraft. Think of the fact that we live in a three dimensional world, it is necessary to control the orientation, of a flying aircraft in all three dimensions. The first aircraft to achieve complete active control was the 1902 glider. In flight, any aircraft will rotate about its center of gravity, the part where most of the weight of the aircraft is located. We can define a three dimensional system through the center of gravity (where the majority of mass is) with each part of the system perpendicular to the other two parts. We can then define the orientation of the aircraft by the amount of rotation of the parts of the aircraft along these principal parts.*
 - The pilot needed sufficient training and skill to fly the machine and not destroy it. Who will be flying your glider on the day of reckoning and why did you choose this person out of your group?
Answers may vary
 - The vehicle needed to be strong enough to support a person.
The glider needed to have a dimension that would be capable of holding a certain amount of weight per square foot. The wing span needed to be longer than the body of the glider in order to hold the amount of weight needed to make the glider.
 - Since doing this research, are there some things you have thought of trying? Are there things you know NOT to do to your glider? List any notes here.
Answers may vary.