



# AIRPLANES!



**If you've ever wondered...**

- What are the main parts of an airplane?
- What makes an airplane fly?
- How is an airplane controlled?
- What is the instrument panel?

**...then this guide is for you!**

You'll find answers to these questions, experiments that show you how airplane wings work, and puzzles inside.

If you want to learn more about aviation, check out the resource list.

HAVE FUN!



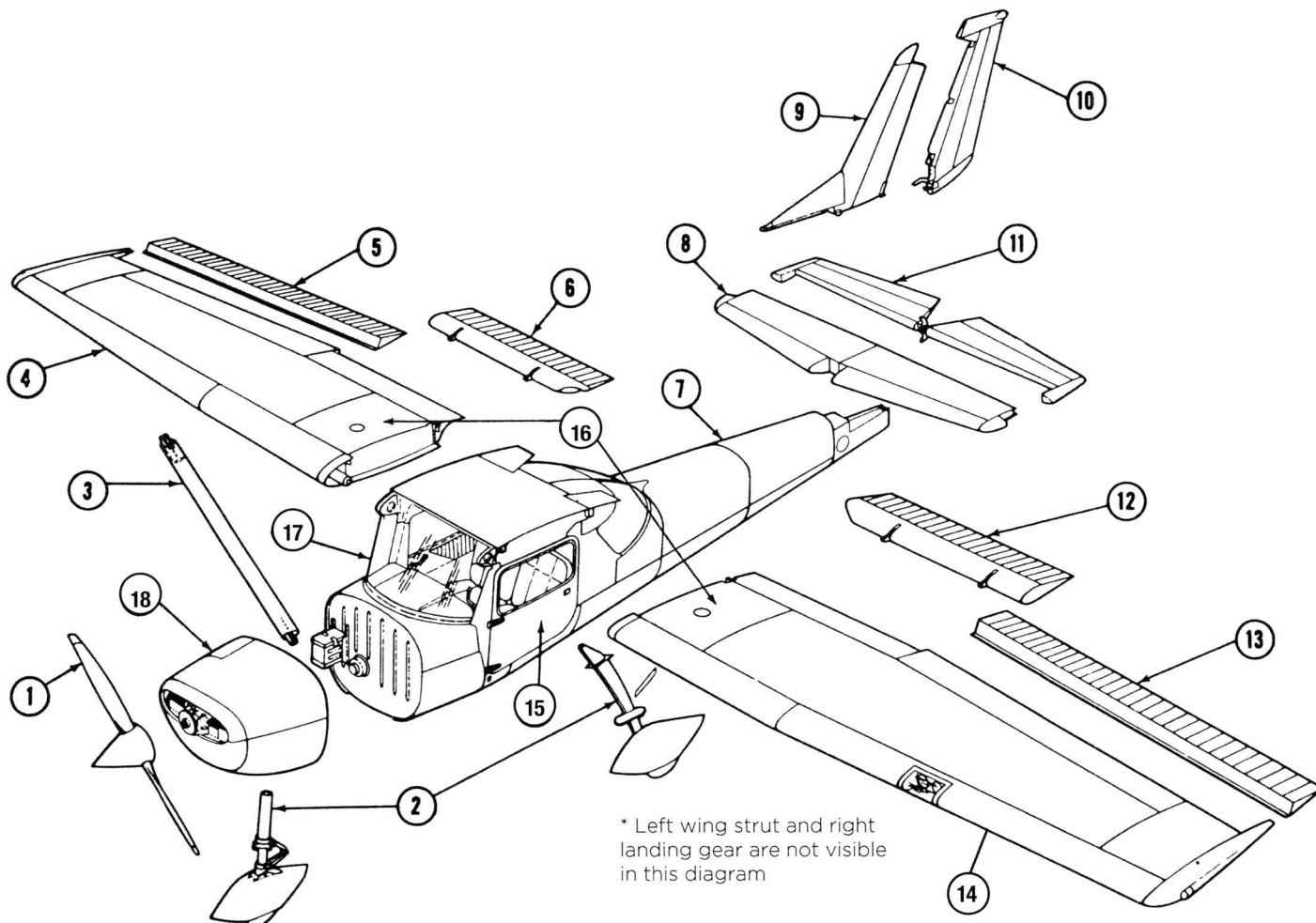
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## THE MAIN PARTS OF AN AIRPLANE

1. Propeller
2. Landing gear\*
3. Right wing strut\*
4. Right wing
5. Right wing aileron
6. Right wing flap
7. Fuselage
8. Horizontal stabilizer
9. Vertical stabilizer
10. Rudder
11. Elevator
12. Left wing flap
13. Left wing aileron
14. Left wing
15. Door
16. Fuel tanks
17. Windshield
18. Engine cowling



## PARTS OF AN AIRPLANE THAT MAKE IT FLY

**Propeller** – A propeller is a rotating blade on the front of the airplane. The engine turns the propeller, which creates thrust to move the airplane forward through the air.

**Wings** – Wings are the parts of airplanes that provide lift. They also support the weight of the airplane and its contents while in flight.

**Flaps** – Flaps are the movable sections of an airplane's wings that are closest to the fuselage. They move in the same direction on both wings at the same time and, by creating drag and lift, enable the airplane to fly more slowly when approaching to land.

## PARTS OF AN AIRPLANE THAT HELP CONTROL DIRECTION OF FLIGHT

**Ailerons** – Ailerons are the movable sections on the outer edge of the airplane's wings. The right and left ailerons move in opposite directions (when one goes up, the other goes down). They are used to help bank the airplane in the direction of a turn and control movement around the **longitudinal axis** (an invisible line through the airplane from the nose to the tail). See picture below.

**Rudder** – The rudder is the movable, vertical section of the tail that controls lateral (side-to-side) movement around the **vertical axis** (an invisible line through the airplane from top to bottom). When the rudder moves in one direction, the aircraft nose moves the same direction. See picture below.

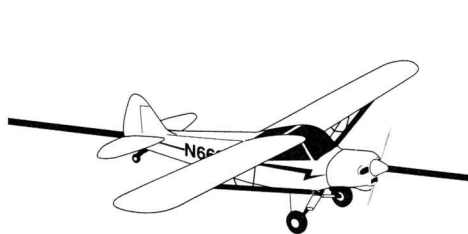
**Elevator** – The elevator is the movable, horizontal section of the tail that causes the airplane to climb and descend. When the elevator moves up, the nose of the airplane will point up or vice versa. This movement is around the **lateral axis** (an invisible line that runs from wing tip to wing tip). See picture below.

## OTHER PARTS OF AN AIRPLANE

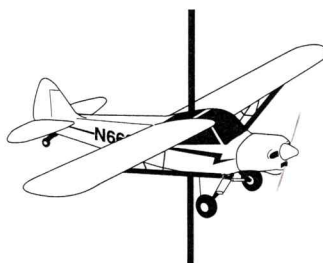
**Fuselage** – The fuselage is the central body of an airplane, designed to accommodate the pilot(s) and the passenger(s) and/or cargo.

**Cockpit** – The cockpit is the area at the front of the fuselage where the pilot sits and controls the airplane.

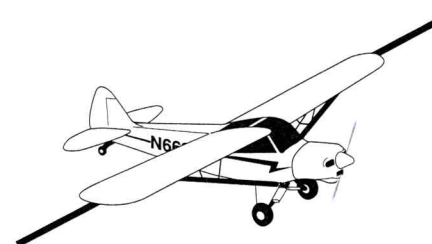
**Landing gear** – The landing gear is underneath the airplane and supports it while on the ground. The landing gear usually includes two main wheels and a nose- or tailwheel.



Longitudinal axis



Vertical axis



Lateral axis

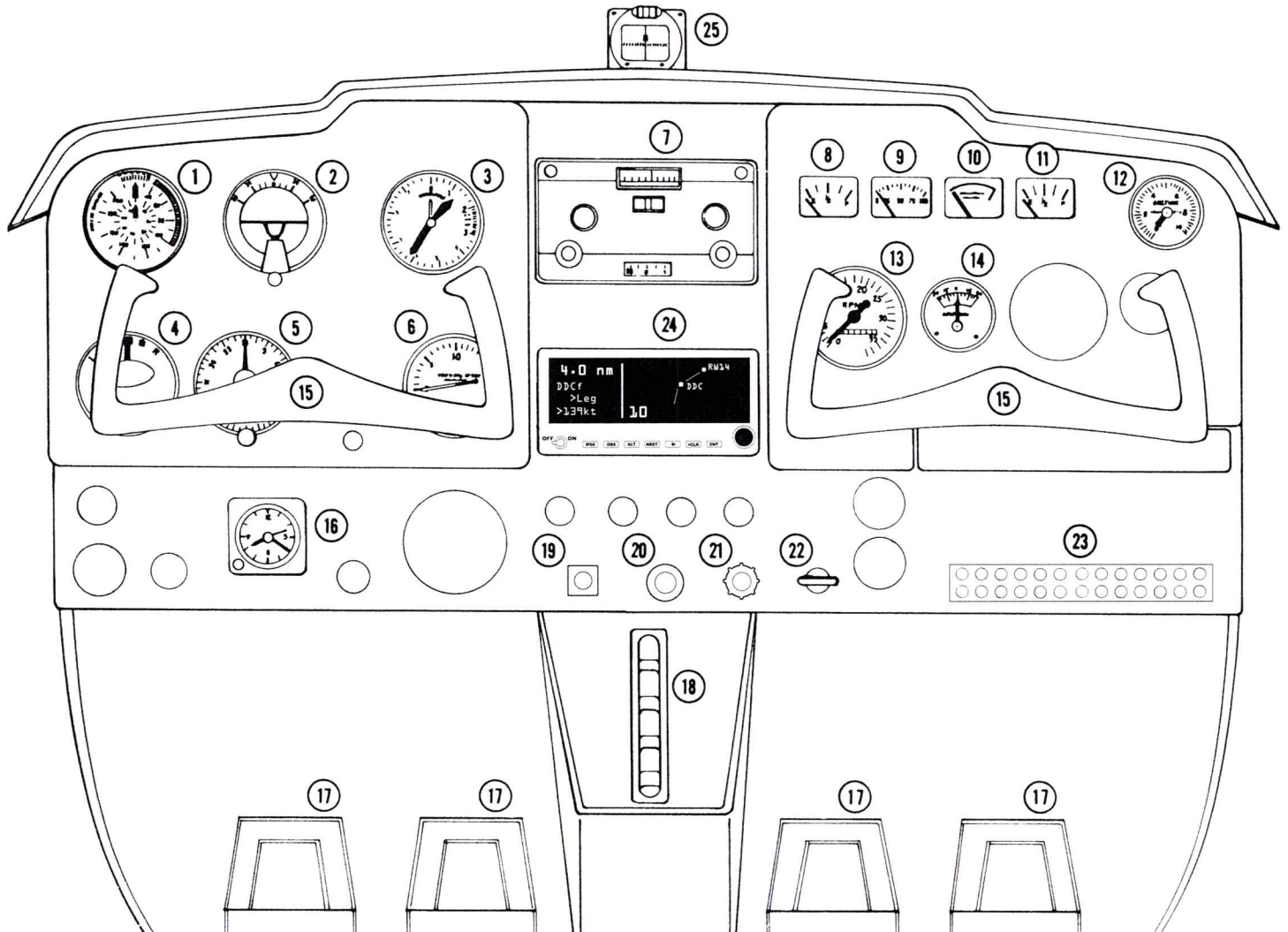
## AIRCRAFT BASICS

*Did you learn these new words?*

1. The “body” of an airplane: F\_\_\_\_\_
2. The “hood” that covers the engine: ENGINE C\_\_\_\_\_
3. The flight control on the horizontal part of the tail that raises or lowers the nose: E\_\_V\_\_\_\_\_
4. Like on a boat, the flight control on the vertical part of the tail that moves the airplane’s nose right or left: R\_\_\_E\_
5. The role of the airplane’s tail is to balance and steady its flight. That’s why its horizontal part and its vertical part are both called a: S\_\_B\_\_\_Z\_\_
6. Near the tip of the wing, the flight control that banks the wing for a turn is an: A\_\_\_R\_\_
7. Also on each wing is a F\_\_\_\_. When lowered for takeoff and landing, it changes the shape of the wing to create lift at slower airspeeds.
8. On a high-wing airplane, a pole-like structure that provides additional support to the wing is a S\_\_\_T.



## INSTRUMENT PANEL



- |   |   |                              |
|---|---|------------------------------|
| 1. Airspeed indicator                               | 10. Oil temperature gauge                                       | 16. Clock                    |
| 2. Attitude indicator                               | 11. Fuel gauge (right tank)                                     | 17. Rudder pedals and brakes |
| 3. Altimeter  | 12. Suction gauge (monitors vacuum pump for flight instruments) | 18. Trim tab control         |
| 4. Turn coordinator                                 | 13. Tachometer (measures revolutions per minute of propeller)   | 19. Carburetor heat control  |
| 5. Heading indicator                                | 14. Battery-generator indicator                                 | 20. Throttle control         |
| 6. Vertical speed (rate-of-climb/descent) indicator | 15. Control wheel (dual)  | 21. Fuel-air mixture control |
| 7. Navigation/communication radio                   |   | 22. Wing flaps control       |
| 8. Fuel gauge (left tank)                           |   | 23. Circuit breaker panel    |
| 9. Oil pressure gauge                               |   | 24. GPS receiver             |
|   |   | 25. Magnetic compass         |

## WHAT MAKES AN AIRPLANE FLY?

An airplane's movement is affected by the *four forces of flight*:

**THRUST**—A force created by the engine-driven propeller turning through the air that helps move the airplane forward



**LIFT**—A force created by air flowing over and under a wing that keeps an airplane airborne

**DRAG**—A force that opposes thrust and the forward motion of the airplane that is caused by friction and other aerodynamic forces

**WEIGHT**—A force created by gravity that pulls the airplane toward earth—the heavier the weight, the greater the force

### FILL IN THE BLANKS

1. The engine and the propeller move an airplane forward by creating \_\_\_\_\_.
2. Air flowing over and under the wings generates \_\_\_\_\_, which makes an airplane conquer gravity and fly.
3. \_\_\_\_\_ is air resistance created by an airplane's parts as it flies through the air.
4. \_\_\_\_\_ is the combined load of the airplane, crew, passengers, cargo, and fuel that pulls the airplane downward.

## WINGS

Here are some experiments to demonstrate how airplane wings work:

The force that lifts an airplane and holds it up comes in part from the air that flows swiftly over and under its wings.

**Bernoulli's principle** states that an increase in the velocity of any fluid is always accompanied by a decrease in pressure. Air is a fluid. If you can cause the air to move rapidly on one side of a surface, the pressure on that side of the surface is less than that on its other side.

**Bernoulli's principle** works with an airplane wing. In motion, air hits the leading edge (front edge) of the wing. Some of the air moves under the wing, and some of it goes over the top. Due to complex aerodynamic principles, the air moving over the top of the curved wing travels faster than the air moving under the wing. Therefore the air pressure on top of the wing is less than that on the bottom of the wing.

You can see **Bernoulli's principle** in action by experimenting with a strip of paper.

### Materials

- Strip of notebook paper or newspaper, about two inches wide and 10 inches long
- A book
- Paper clips

Make a wing by placing one end of the strip of paper between the pages of the book so that the other end hangs over the top of the book. Move the book swiftly through the air, or blow across the top of the strip of paper. It flutters upward. Hold the book in the breeze of an electric fan so the air blows over the top of the paper.

Take the strip of paper out of the book. Grasp one end of the paper and set it against your chin, just below your mouth. Hold it in place with your thumb and blow over the top of the strip. The paper rises. Try the same thing after you have fastened a paper clip on the end of the strip. See how many paper clips you can lift in this way.

Hold the strip of paper in your hands and run around the room. It doesn't matter whether you move the air over the strip of paper by blowing or whether you move the paper rapidly through the air—either way, it rises.

## HOW IS AN AIRPLANE CONTROLLED?

From this activity, you will learn how control surfaces—the moving parts on the wing and tail—affect which way an airplane turns and moves through the air.

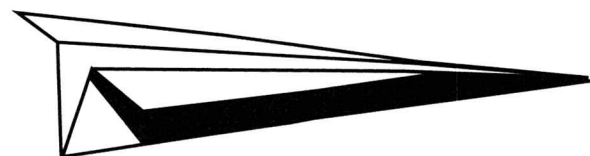
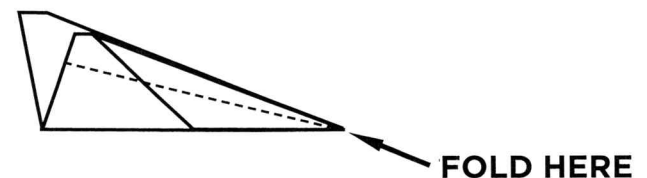
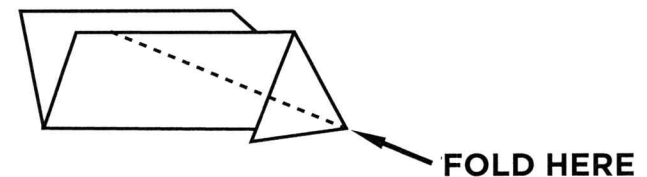
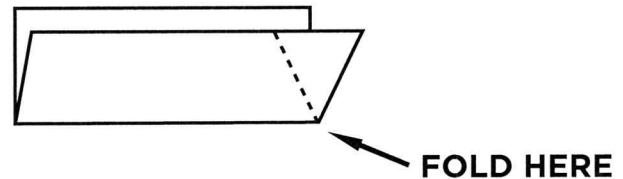
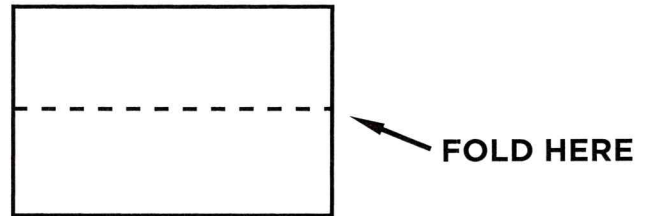
### Materials

- Sheet of paper
- Paper clips

### Folded Paper Airplane

1. Fold paper in half lengthwise and crease.
2. Fold down the corner of one side so the edge is even with the folded side of your original crease. Flip paper over and repeat to form a point.
3. Fold down the angled edge on one side so it is even with your original fold. Flip and repeat. You should now have a more narrow point.
4. Make a fourth fold that brings your new top edge even with the bottom of your original fold. Flip and repeat.
5. Push up the wings so they are perpendicular to the body of your airplane. Now throw your airplane!

**Tip:** If it seems “nose heavy,” use paperclips near the rear of the airplane to add weight and help keep the nose up. You may need two or three paper clips.





## CONTROL SURFACES

### Control Surfaces – Up and Down

Once you have gotten your airplane to fly relatively straight, gently tear the back edge of each wing to create elevators. One-half to three-quarters of an inch should be enough.

Bend your elevators up slightly and see what impact it has on the flight path. Bend them down and try again.

**Tip:** Having the elevators in the down position should cause the airplane to descend faster. Having them up should help your airplane climb and/or stay airborne longer.

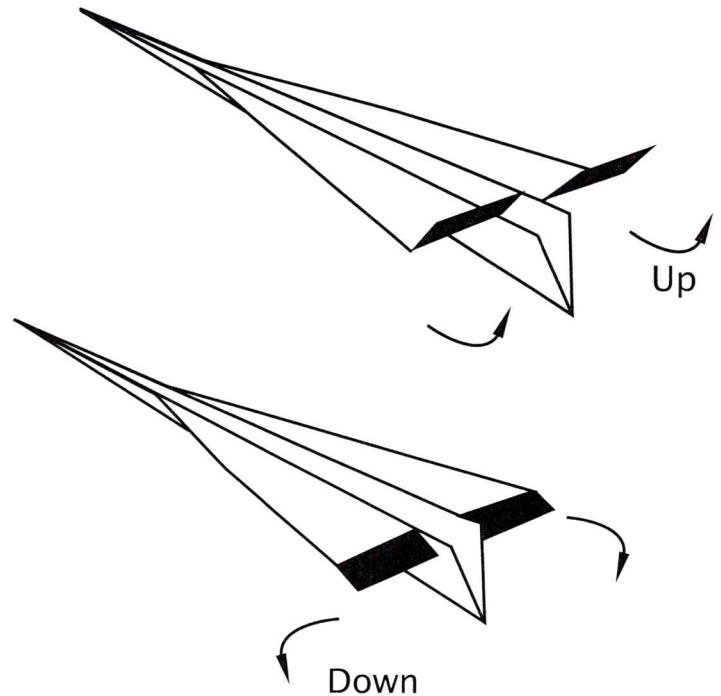
Look for modest changes in float direction. The average paper airplane only stays airborne for a few seconds.

When the pilot wants the airplane to climb, he moves the airplane controls so that the elevators tilt up in the same way that you folded back the edges of your glider. The air hitting the elevators pushes the tail of the airplane down, tilting the nose upward, so the airplane can climb.

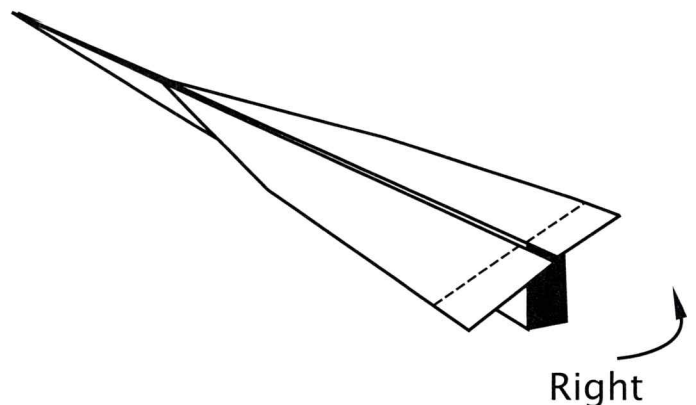
### Control Surfaces – Right and Left

Now try the rudder or vertical fin. Tearing your elevators should have left you with a one-half to three-quarters inch portion of your airplane's body that can be folded left or right. Try folding it slightly left or right and test the impact on your airplane's flight path. Left or right folds should send your airplane left or right, respectively.

#### Up and Down



#### Right and Left



## PARTS OF AN AIRPLANE — WORD FIND

**Find these words:**

- Propeller
- Cockpit
- Fuselage
- Ailerons
- Rudder
- Elevator
- Wings
- Airplane
- Flaps
- Landing gear

B	C	O	P	D	Q	Q	W	V	F	X	V	L	H
U	A	P	V	R	I	R	K	M	L	Z	Y	A	M
T	S	N	H	J	O	E	F	V	A	G	A	N	H
W	G	C	O	C	K	P	I	T	P	N	Q	D	G
F	R	M	S	P	T	S	E	P	S	Z	O	I	I
X	L	K	R	F	U	S	E	L	A	G	E	N	J
Y	A	I	L	E	R	O	N	S	L	U	F	G	K
E	Z	J	N	O	W	V	E	L	Q	E	Y	G	J
R	U	D	D	E	R	D	R	P	A	L	R	E	D
H	I	Q	N	T	U	O	C	B	I	A	I	A	E
G	F	A	V	E	T	O	O	C	R	B	C	R	K
B	D	X	W	A	H	N	W	D	P	X	M	F	I
Z	Y	C	V	I	T	S	I	H	L	L	G	J	L
M	A	E	F	G	R	R	N	Q	A	P	O	P	M
B	L	D	E	X	A	S	G	I	N	K	L	N	J
E	C	W	Y	U	T	Z	S	J	E	K	L	B	K

**Websites**

**[www.aopa.org](http://www.aopa.org)**

*Aircraft Owners & Pilots Association - thousands of pages of information from the world's largest civil aviation organization*

**[flightraining.aopa.org](http://flightraining.aopa.org)**

*AOPA Flight Training - the only magazine dedicated to student pilots*

**[www.nasa.gov/audience/forstudents/index.html](http://www.nasa.gov/audience/forstudents/index.html)**

*National Aeronautics and Space Administration - pages and links for students*

**[www.avkids.com](http://www.avkids.com)**

*National Business Aviation Association - "AvKids" program*

**[www.faa.gov/education](http://www.faa.gov/education)**

*Federal Aviation Administration - educational resources*

**[www.aviationeducation.org](http://www.aviationeducation.org)**

*National Coalition for Aviation Education - links to free materials*

**[www.scholastic.com/kids](http://www.scholastic.com/kids)**

*Scholastic - a global children's publishing and media company*

## ANSWER KEY

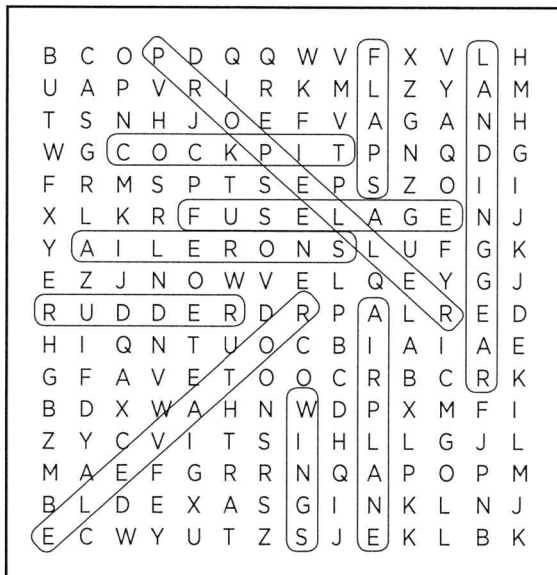
### Page 4

1. FUSELAGE
2. COWLING
3. ELEVATOR
4. RUDDER
5. STABILIZER
6. AILERON
7. FLAP
8. STRUT

### Page 6

1. THRUST
2. LIFT
3. DRAG
4. WEIGHT

### Page 10



## High Flight

Oh! I have slipped the surly bonds of earth  
And danced the skies on laughter-silvered wings;  
Sunward I've climbed, and joined the tumbling mirth  
Of sun-split clouds - and done a hundred things  
You have not dreamed of -  
wheeled and soared and swung  
High in the sunlit silence. Hov'ring there  
I've chased the shouting wind along, and flung  
My eager craft through footless halls of air.  
Up, up the long delirious, burning blue,  
I've topped the windswept heights with easy grace  
Where never lark, or even eagle flew -  
And, while with silent lifting mind I've trod  
The high unsurpassed sanctity of space,  
Put out my hand and touched the face of God.

*Pilot Officer John Gillespie Magee  
No. 412 Squadron, Royal Canadian Air Force*



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