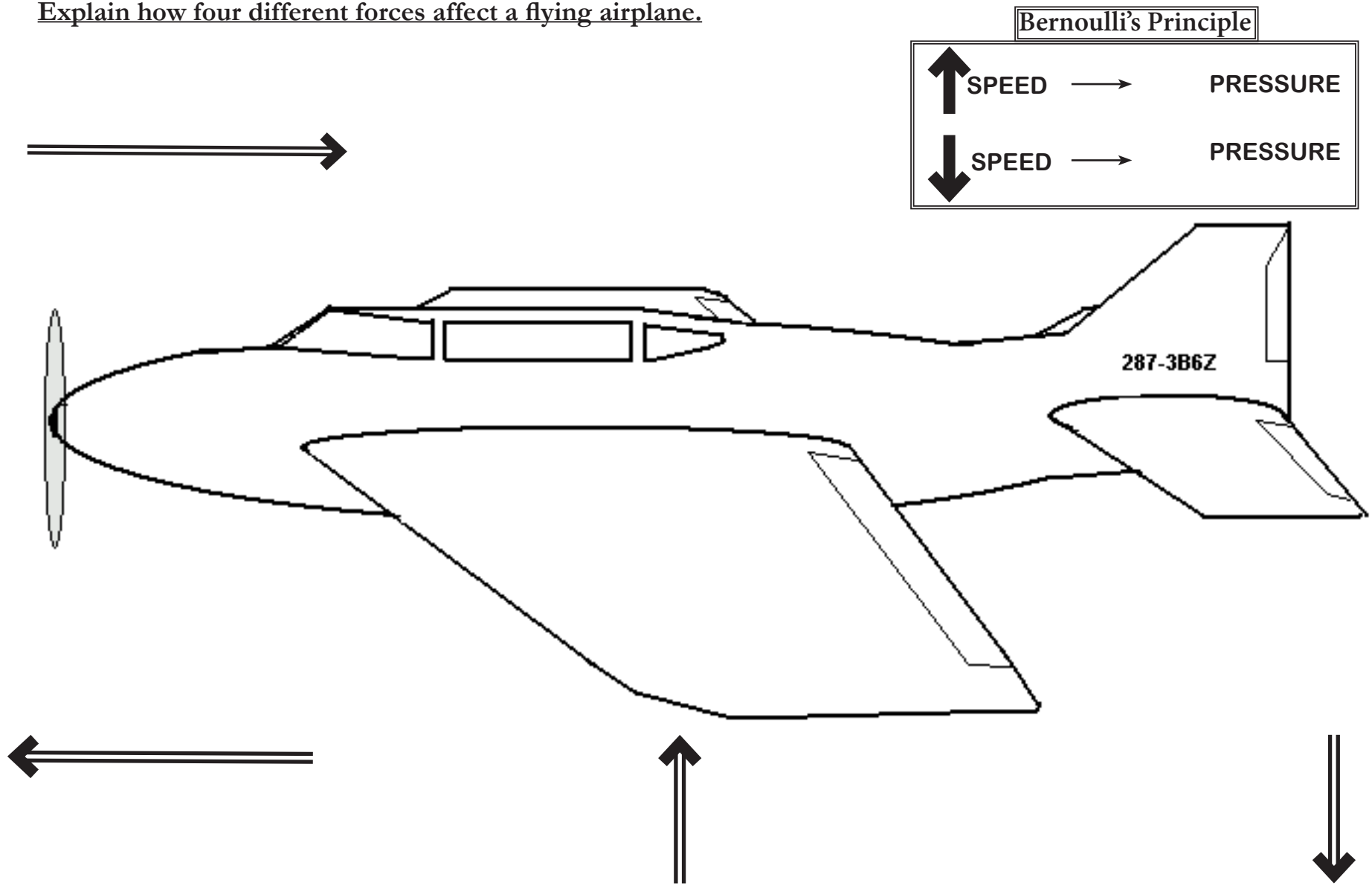
Explain how four different forces affect a flying airplane.



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Bernoulli's Principle

↑ SPEED	→	↓	PRESSURE
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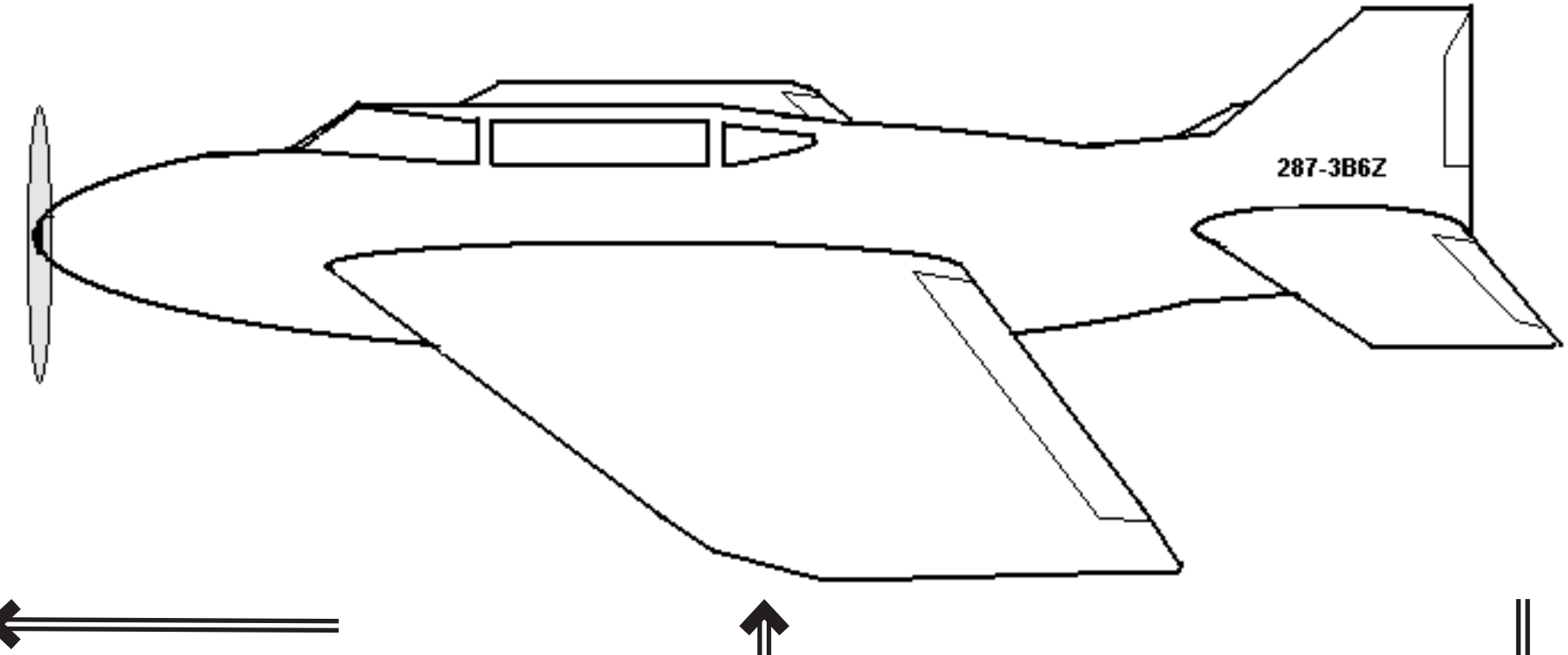

DRAG
Resistance of the air
It is greater if the plane is flying into the wind.

THRUST
Pushes the plane forward
Either a propeller or jet engine is used.

LIFT
Air moves faster over the wing.
The slower moving air underneath pushes the plane up

GRAVITY
Pulls the plane downward
Objects are pulled toward the center of the Earth.

Thrust

Thrust is what propels the airplane forward. Of course, on an airplane the thrust is coming from the engine, just as the engine propels your car forward.

Here are a few other ways to demonstrate thrust:

- Balloon: Blow it up and let it go. The air pressure escaping propels the balloon forward.
- Paper or styrofoam airplane: What causes the thrust? The force from your hand.
- Rubberband: The stretch in a rubber band propels either the rubberband or a toy that is launched from the rubberband.
- Remote control plane: This is a little more fun and a little closer to the real deal. It just happens to be a little more expensive as well. But like the plane's engine, the electrical power thrusts the plane forward.

Drag

Nothing demonstrates the drag of wind like the wind itself. Fly your paper or styrofoam in the direction the wind is coming from and compare to the direction it is going to.

Think: Airline captains announce to passenger's their estimated time of arrival once a flight has taken off? Why isn't the time of arrival the same as that listed on the ticket? Flight time will be longer or shorter depending on wind speed and direction.

Lift

The lift on a plane comes from Bernoulli's Principle. Bernoulli's Principle states that a liquid (or gas) has less pressure as it's velocity increases. Following are a number of demonstrations that show how Bernoulli's Principle works. After doing these projects with your student, we will come back to the airplane and see how Bernoulli gives pilots and their passengers the lift to get them flying.

Have your students guess what effect Bernoulli's Principle will have on the objects before they perform the demonstration.

Bernoulli's Toilet Paper Trick

Take a small square of toilet paper and fold it in half. Place it beneath your lips and blow.

Bernoulli's Tent

Fold a piece of paper in half and make a tent that is open on both ends. Blow through the tent.

Bernoulli's Pom Poms

You will need a large craft pom pom or small Styrofoam ball for this experiment. A ping pong ball will also work.

Put the pom pom in a small cup like a disposable bathroom cup or small dessert cup. Blow across the top.

Bernoulli's Bottles

You will need two empty light-weight plastic drinking bottles. Tie a string around the bottles and let them dangle at the same height.

Altneratives to drinking bottles could include:

- 2 blow up round balloons
- 2 disposable drinking cups

Whichever material you use, you need to tie the two objects to string or yarn and let them dangle.

Blow between the two objects.

Bernoulli's Straws

Place a drinking straw in a cup of water. Blow across the top of the straw.

Wind Sock or Solar Balloon (Really Cool)

It is fun to see this principle at work in wind sock or solar balloon that is open on both sides. By just blowing a small amount of air into the large container, it fills immediately.

Meet Mr. Bernoulli

So who is this Bernoulli character and did he invent airplanes? Nope, he lived a couple of hundred years before the Wright Brothers. You might want to investigate Daniel Bernoulli before we move on to figure out what his principle has to do with flying.

Bernoulli, Lift, And Aerodynamics

Bernoulli's Principle states that as a fluid medium (including air) moves faster, it has less pressure. So how is that going to get an airplane in the sky?

Would air (or anything else) move farther if it was going over a curved or a straight surface like those below?

A B

The straight line is the shortest distance and the curved line is the longer distance.

Now if two people started running, one on Line A and the other on Line B, and they both started at ended at the same time, who ran the fastest. (B who had a longer distance.)

Airplane wings are flat on the underside and curved on the top. When a plane is speeding down the runway before take off, wind is going above and below its wings. The air going above the wing must go faster because it has a further distance to travel because of the curve. If the air is going faster over the wing, will there be higher or lower pressure over the wing. (Less pressure.)

The lower pressure almost causes the plane to get "sucked" up into the sky.

Gravity

Of course the force of gravity is pulling the plane towards the surface of the Earth even as the lift as pulling it upward.

Does gravity act inside an airplane? Yes, if the stewardess drops a cup of water on you it will fall.

Gravity & Size

Would a large plane fall faster than a small plane? No. Gravity causes all objects to fall at the same speed regardless of weight or size. Certain objects (like a feather or parachute) will fall slower because of aerodynamics, not because of gravity.

Technology Information Pieces

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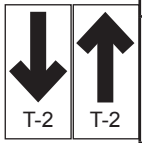
T-2

T-2

To Make Your **MatchCard** more durable:

1. Put the student MatchCard in a clear plastic page protector.

2. Laminate the information pieces. You can also make them sturdier by covering the paper with transparent tape prior to cutting the pieces out.

3. For more ideas on how to use the MatchCards, and for keeping a notebook for review, see the Instructor's Guide.

4. The complete Technology Unit Study provides the student worksheets, answer key, and teaching activities for this and 5 other objectives. See the website for more information.