

# Physics - Paper Air Car Project

**Purpose:** To design, construct and demonstrate the transfer of energy in a paper car powered only by a rubber band and propeller.

## Instructions

**Materials** for car construction: (**only** these materials may be used)

One sheet of legal-sized paper (color optional)

Three standard paper clips

One large butterfly paper clip

One plastic soda straw

Two large index cards or poster board

Narrow masking tape

Rubber bands

White glue (optional)

## Tools

Pencil, drawing compass (or round object to trace),  
pliers that can cut wire, and scissors

## Construction of Paper Air Car's Components

### Part A. Body

Step 1 on diagram sheet. Place your pencil along the long edge of the sheet of legal-size paper and roll the paper around the pencil to form a narrow tube. Tape the tube so that it doesn't unroll and then remove the pencil. This is the body tube of your car.

Step 2 on diagram sheet. Front hook construction: Pull apart the 2 loops on one of the standard paper clips until the loops are about 30 degrees apart. Slip one of the loops inside one end of the body tube. This will provide a connection for the rubber bands at the front of the car.

### Part B. Propeller

Step 1 on diagram sheet. Fold one index card at the center to make two 12.7 by 10.2 cm rectangles. Open the fold and cut along the crease. Then cut one of the rectangles into two 12.7 by 5.1 cm rectangles. One of these will be your propeller. (Save the other one for repairs, or for future Air cars or bookmarks.) Pierce a small hole in the center of your propeller with the point of your compass or a pin and put it aside for now.

Step 2 on diagram sheet - the Motor Mount. Fold the remaining 12.7 by 10.2 cm card so that the 12.7 cm edges meet. You should now have a double-thick 12.7 by 5.1 cm rectangle. Now fold the double thick card so that the 5.1 cm edges meet. When you open the fold, you should have two 6.4 by 5.1 cm rectangles...each of which is two layers thick. Crease each of the rectangles

around 4 millimeters from the last crease you made. Then fold the card at the creases. Your card should now look like an "M". Finally, trim the edges of the mount as shown in the diagram.

### **Part C. The Wheels**

Using your compass, draw two large circles ( $r = 4.5$  cm) in the opposite corners of your remaining index card. These circles will be your rear wheels. Now draw 2 smaller circles ( $r = 2.1$  cm) in the blank area between the large circles. These circles will be your front wheels. Make a small pinhole in the EXACT center of each circle, and then cut out the circles VERY carefully. Make the edges as smooth as possible...this will help to avoid wobbly and "wookety-wookety" wheels!

### **Part D. Axles and Propeller Shaft**

Steps 1-4 on diagram sheet.

1. To make your axles and propeller shaft, gently unfold all of the remaining paper clips. (Unfold them as if you were to open a pocketknife). Use the pliers to straighten out the paperclips as much as you can...the straighter the better! Be careful not to twist the clips, because they may weaken or break. The longest wire (from the butterfly clip) will be the rear axle; the other two are the propeller shaft and the front axle.

2. Set the straightened wires aside momentarily. Take the soda straw and cut it in half. Then cut one of the pieces in half also. These will be used for the tube for the propeller shaft and the axle tubes.

3. Check to see that the straightened butterfly clip extends about 1.5 - 2.0 cm beyond the ends of the longest tube, and that the straightened standard paper clips extend 1.5 - 2.0 cm past the ends of their tubes also. Clip the excess wire to produce the proper length.

4. Bend the axles and propeller shaft on one end as shown, slip them through their tubes, then bend them on the other end ...which will trap them in their tubes.

## **Paper Air Car Assembly**

### **Part A. AXLES**

1. Stick the ends of the front axle through the holes in the center of the smaller wheels and tape the L-shaped sections of the axle to the outside of each wheel. Be sure to rub the tape firmly, so that you attach the wire to the wheel stably and strongly. Repeat this step with the large, rear wheels and their axle.

2. Now tape the axle tubes to the body tube as shown on the diagram page. Make sure they are secure and at 90° (right) angles to the body tube. Line them up squarely or your car will turn improperly or lean and wobble.

### Part B. Motor

1. First you should assemble the motor by attaching the propeller to the end of the propeller shaft. Stick the double-L end of the propeller shaft through the hole in the propeller. Tape the L-shaped section of the wire to the back of the propeller...Making SURE the tape sticks very tightly to the wire and the propeller.

2. Tape the propeller tube to the motor mount. To prevent the propeller from scraping against the motor mount, make sure the propeller tube extends about 1 cm beyond the rear edge of the motor mount.

3. Securely tape the motor mount to the rear end of the body tube of your car.

### Part C. Power Supply

1. Rubber bands provide the power for the Air car. You can either use one very long rubber band or link several smaller ones together. When the car is assembled, the rubber bands should be long enough to hang about 2 cm below the line from the propeller tube to the front hook.

2. Hook the rubber band to the curved end of the propeller shaft and to the front hook.

### FINAL ADJUSTMENTS:

Add a twist to the ends of the propeller so that it will screw into the air as it moves and push the car forward. Wind the propeller about 100 turns and place the car on the floor. Release the propeller a split second before you release the car itself.

### Troubleshooting your car

If your car won't go, do not despair! Resist the urge to ask your teacher immediately for help. Surely you can do better than an old lady physics teacher! Compare yours to others in the classroom. There are a number of correctable things that can be adjusted or fixed to make the car perform as you desire! Check the axle connections for secure, straight attachment. Check the propeller and the wheels for nagging friction sources or wobbly connections...tweak your design and before you know it...you will be racing your Air Car around the room!