

# Carroll Senior High School **Physics - Paper Air Car Project 2011.**

Name: \_\_\_\_\_ DUE: \_\_\_\_\_

**Purpose:** To design, construct and demonstrate the transfer of energy in a paper car powered only by a rubber band and propeller. Each individual student must make a car. If you are not going to be in class on the due date, you must bring the car in early and ask someone else to run it for you for the contest.

This project is NOT optional and WILL be counted as a test grade in the third six weeks. There is no substitute assignment for building and running the car. The car will be graded primarily on the quality of the car's construction and performance.

## **Requirements and grades possible:**

1. 3pics @ 2 points each = **6points**. Pictures of car and you - 3 pictures of **you with your car during construction and preliminary testing at home**.
2. **4 points**. A detailed description of the all the energy conversions in the car.
3. Car construction points (only with specified materials):

**Zero points** = No car or finished parts!

**40 points** = If parts are ready to assemble, but not put together before class.

**65 points** = If car is poorly-constructed and falls apart on the way to class or before it can be run, BUT you DO bring in a completed car.

**80 points** = If car is well-built and makes a minimum run of 2 meters (net distance)  
If car is well-built and travels extra meters, each additional meter is 3 points extra up to a total of 15 points added = **95 points**

**So...**a well-built car that goes a net distance of 7meters (2+5) (this is close to the distance along the length of the classroom) and is turned in with pictures and conversions as described above can make a 105 on the project.

Net distance = gross distance - distance from a straight center line. You will get 3 trials and your distance will be the best of the trials.

The cars are to be constructed OUTSIDE of class and be ready to run when you arrive. If you need to do some tweaking of the design or repairs during class between trials - that is acceptable.

**The only allowable construction materials** are those listed below in the instructions.

You must clearly and permanently write your name on the larger wheels when you finish construction of your car...a car with no name cannot be allowed to perform. Once the car has run, it becomes the property of your teacher. You may not take it home.

We will provide you with one set of materials, but if you need more (due to loss, extra car construction, breakage, or just ruining of the materials) you will need to provide them yourself. Good Luck and have fun!

KJL 2011

## **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 light weight poster board
- Narrow masking tape
- Rubber bands

**Tools** Pencil, drawing compass (or round object to trace),

Pliers that can cut and bend wire, and scissors

White glue (optional). Hot glue and super glue are not allowed. Tape works best because it can be lifted and re-taped if necessary!

**Construction of Paper Air Car's Components [described in words here, but *be sure to look at the diagram sheet as you work, also*]**

### **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 ...This will trap them in their tubes.

## Assembling the Paper Air Car

### Part A. AXLES

1. Stick the ends of the front axle through the holes in the center of the smaller wheels and tape the double L-shaped sections of the axle to the outside of each wheel. It is better to bend the double L's in opposite directions on the two wheels for better balance. Be sure to rub the tape down firmly, so that you strongly attach the wire to the wheel making the connection very straight and stable. 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  $90^\circ$  (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 double 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 and doesn't hit the wheels as it spins.
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 edges 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 physics teacher! Compare yours to your friends' as well as those 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!