

# Build Your Own Electric Vehicle

## Where to Purchase Materials

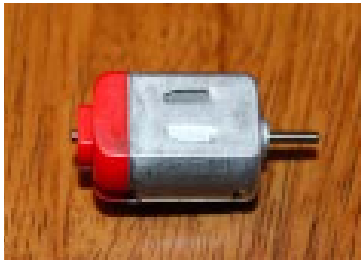
**Note:** Most of these materials can be purchased using a kit such as the EUDAX 6 set DC Motor Kit. This is available on Amazon here:

<https://www.amazon.ca/EUDAX-Rectangular-Electric-Electronic-Propeller/dp/B077WWS63B>



## Materials Required

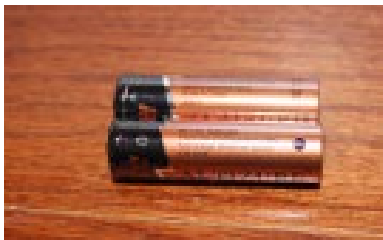
- Mini electric 1.5V-3V 24,000 RPM motor



- Pulley Gear



- Rechargeable AA lithium-ion batteries



- Four wheels



- AA battery holder case



- One (1) on/off switch (optional). You can also make your own!



- Four small cylinders (block beads are suggested as their block shape makes for easier gluing)



- Four small gears (so that the wheels don't go back and forth) – two per axle)



- One piece of construction paper (yellow if you'd like your vehicle to be a school bus!)
- Photocopy of the template attached to this plan (optional)
- One small cap



- One elastic band



- One small gauge wire (approx. 23.5 cm)



- One 70 mL toothpaste tube (approx. 15.5 cm l x 3.75 cm w x 4.5 cm h box), or other recycled box/materials. You will have to be mindful of how long your axles are to determine the length of your electric vehicle.



- Two steel axles



## Tools

- Glue gun
- Soldering iron
- Glue stick

## Construction Plan: Building your Electric Vehicle!

### Before you begin:

- These instructions are for designing a school bus. Modify as required if another design is used.

### Part A: Frontal Axle Assembly

**Step 1:** Place the wheel on a table. Insert one of the steel axles into the wheel until the end of the axle is flush with the opposite side of the wheel.

**Step 2:** Slide a spacer onto the free end of the axle.

**Step 3:** Slide your cylinder onto the free end of the axle

**Step 4:** Slide the other cylinder and then another spacer.

**Step 5:** Lastly, slide the free end of the axle into the other wheel until the end of the axle is flush with the opposite side of the wheel.



## Part B: Rear Axle Assembly

**Step 1:** Place the wheel on a table. Insert one of the steel axles into the wheel.



**Step 2:** Insert one gear next to the wheel.

**Step 3:** Slide your cylinder on top. This is one side of the axle. Next add your other cylinder, then one of the small gears, the pulley gear, and then the other wheel.

**Step 4:** Make sure the wheels can spin smoothly.



## Part C: Attaching the Paper Template to the Body of the Vehicle

**Step 1:** Take your construction paper and place it over the template (attached to this construction plan). You should be able to see the template come through. Cut the outline of the template out. Then trace the fold lines.

**Tip:** The dotted lines on the side are cut lines.



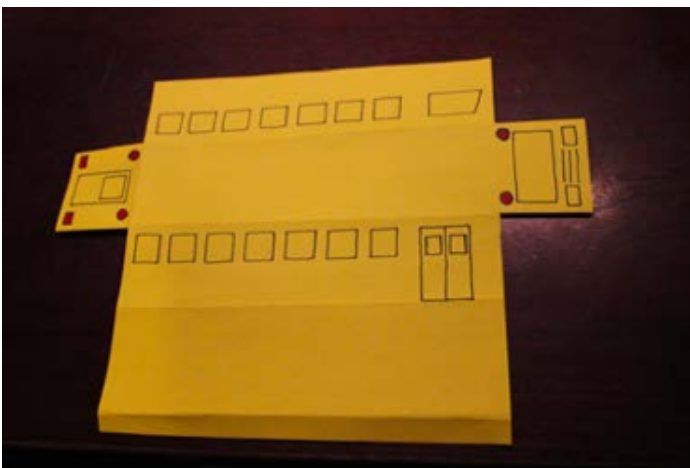
**Step 2:** You'll notice on the template the tabs that are outlined. Fold the paper at those tab lines.



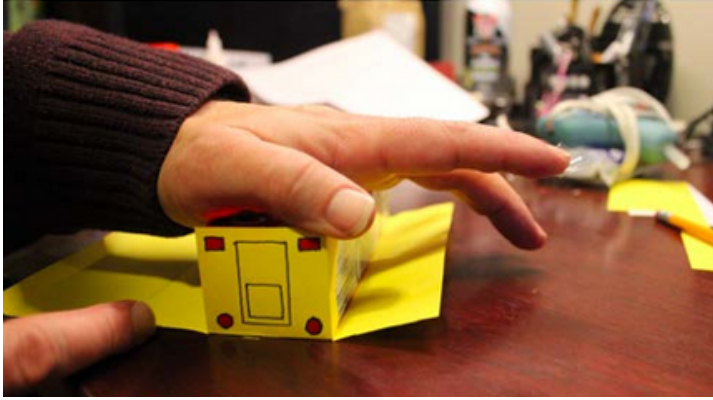
**Step 3:** Place the toothpaste container in the middle section of your cut-out, noting the two sides that come out for the front and back. Do not glue it yet!



**Step 4:** Once you are happy with how the paper will wrap around the box, take the template off, and decorate it as you wish.



**Step 5:** Place your paper design on a table with the toothpaste container in the middle. Begin folding your template around the toothpaste container. It is suggested you place it around your vehicle fully and you are happy with it before you start gluing. Once you are happy with it, take your glue gun and start gluing it to the container. The tighter you wrap the container, the more streamlined it will be.

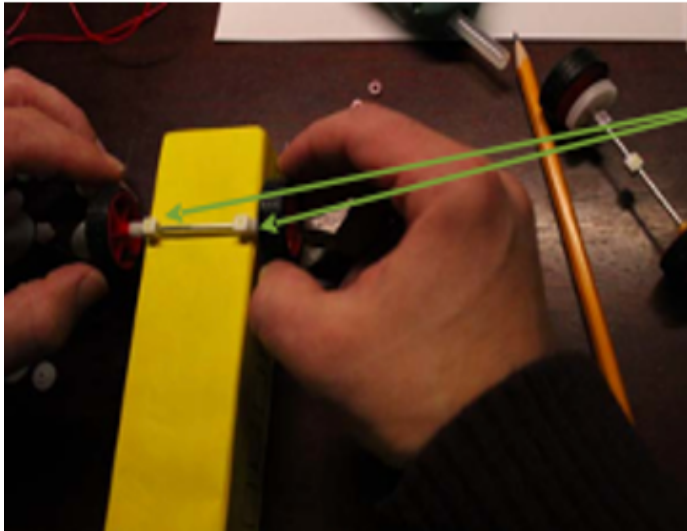


**Tip:** Consider the weight of your electric vehicle while making this part. If it's lighter, you can use a small pulley on the motor to make the car go faster. If the car is heavier, you will need to put the elastic directly on the shaft of the motor. The weight of the car depends on your pulley ratio between your axle pulley and motor pulley. Think of the way the gearing ratio works on a bicycle.

## Part D: Attaching Axle Assemblies to the Electric Vehicle Body

**Step 1:** Heat up your glue gun.

**Step 2:** When your glue gun is hot, take your rear axle and position it to about 4.5 cm from the end of the toothpaste container. Ensure you glue the cylinders and not the steel axle or the wheels won't spin.



Glue  
here!

**Step 3:** Place two large dabs of hot glue near the edges of the electric vehicle body. While it is hot, place the two cylinders into the hot glue. Press down firmly for a few seconds while the glue cools.



**Tip:** Consider the weight of your electric vehicle while making this part. If it's lighter, you can use a small pulley on the motor to make the car go faster. If the car is heavier, you will need to put the elastic directly on the shaft of the motor. The weight of the car depends on your pulley ratio between your axle pulley and motor pulley. Think of the way the gearing ratio works on a bicycle.

## Part E: Motor, Battery Pack and Switch Instructions

**Tip:** As you are doing the steps below, make sure that the wires never touch each other to make a complete circuit. This can cause the battery short.

**Step 1:** Take the motor and put the small cap on the motor shaft. This will help the elastic stay on it later steps.



**Step 2:** Place the batteries into the battery pack.

**Step 3:** Strip the red wire attached to the battery pack, feed it through the hole of the centre post switch. Take the soldering iron and solder the wires to the post. If you don't have a soldering iron, twist them together and feed it through the hold of the centre post switch. The wire must make a metal connection.



**Step 4:** Take your small gauge lead wire and strip the ends to expose the copper. You can do this by using wire strippers, scissors, or a knife. Be careful not to cut the copper wires inside when taking the outer sheath off.

**Tip:** Make sure to strip enough of the sheath off so that it can go through the attachment holes.

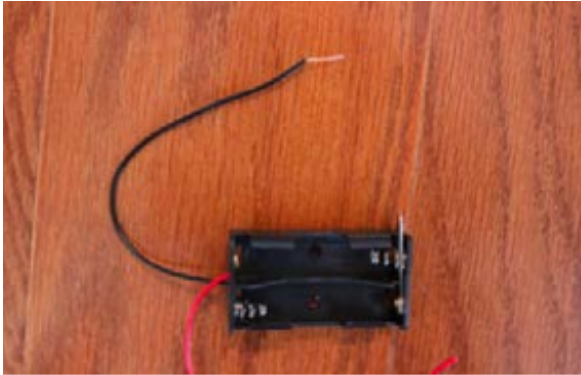




**Step 5:** Attach one end of the red, small gauge wire to the other post of the switch.

**Step 6:** Bring the other end of the small gauge wire to the motor, just to make sure it is long enough. **Do not** attach the motor just yet.

**Step 7:** Take the black wire from the battery pack and remove the sheath (repeat step 4).

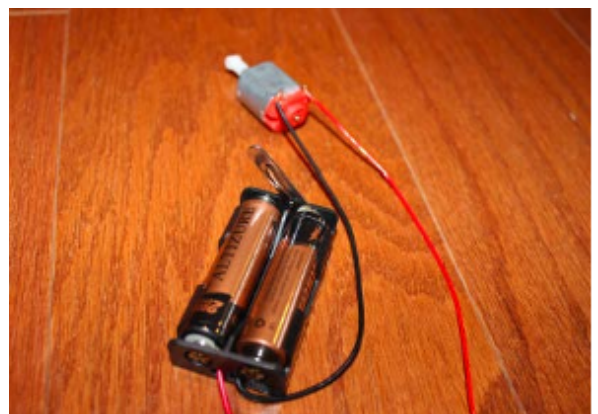
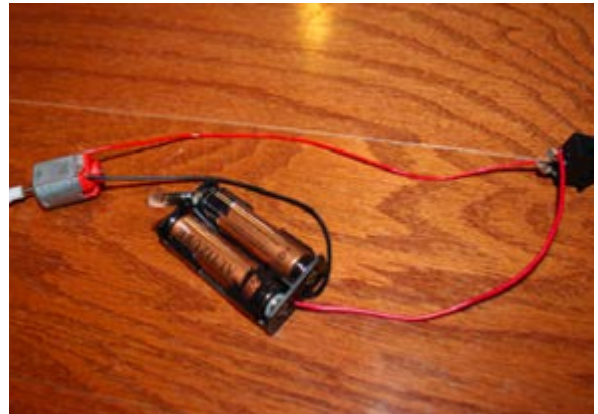
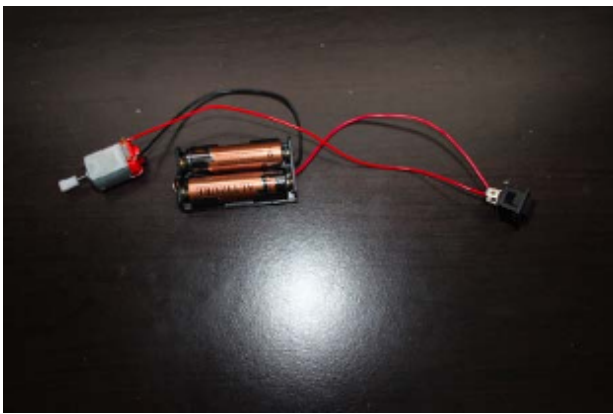
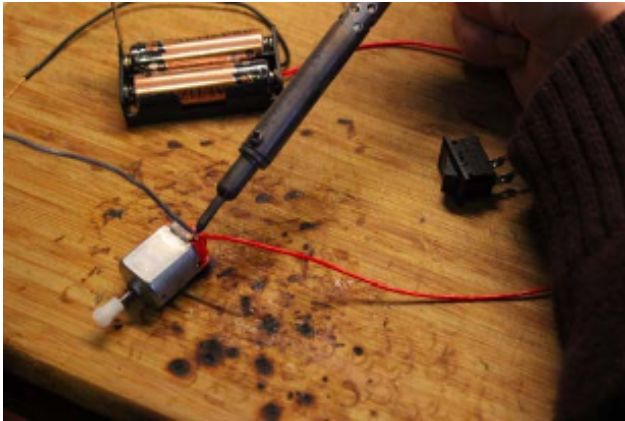


**Step 8:** Now take both the red and black wires and at the same time touch each terminal to the motor. Test to see if your motor comes on. **Important! Do not let the red and black wires touch or you can fry the batteries!**

**Step 9:** Once you know your motor turns on, turn the switch to the off position.

**Step 10:** If the motor works, switch the wires to the opposite terminals. Does it make the motor go in the opposite direction? If so, this is called reverse polarity. At this point, determine which direction you want your motor to turn- this will determine the direction you should mount the motor on your car so that it moves forward. Think about if you want to have the motor push the car (front wheel drive) or pull the car (rear wheel drive).

**Step 11:** Connect those wires to the motor in the desired way of your choosing.



## Part F: Attaching the Motor, Battery, and Switch to the Vehicle

**Step 1:** Position the motor towards the back of the vehicle's body, just above the rear axle, with the side that has the pulley. Do not glue it yet, you want to have an idea of the position of the motor first.

**Step 2:** Position the battery pack in the middle, with the switch up at the front. Take a pencil and mark the position of each spot once you are happy with it.

**Step 3:** With your glue gun, place a large amount of glue on the spot marked for the motor and place the motor on top.

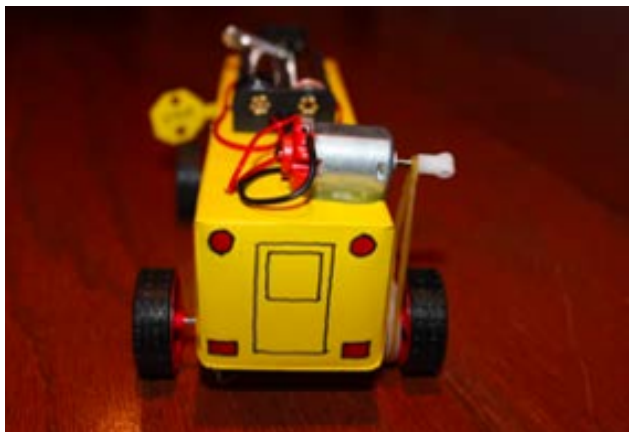
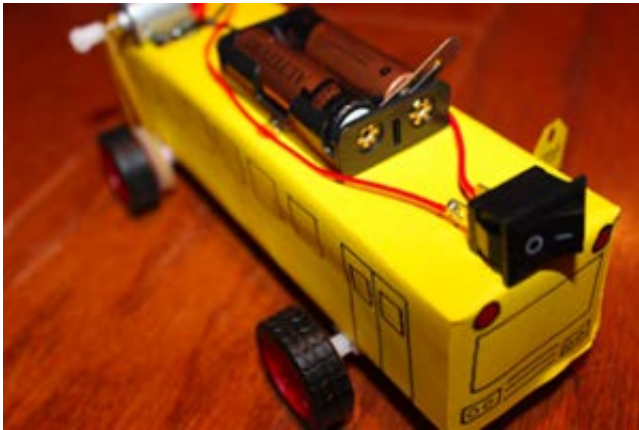


**Step 4:** Do the same for the battery pack and switch. Make sure the glue has hardened.

**Step 5:** Take your elastic and wrap it around the wheel pulley on the rear axle to the motor shaft. Tip: You don't want one with too much tension because it puts a strain on the motor, and you could break the parts that you've glued.



**Step 6:** Voila! Your electric vehicle is finished! You may want to have one learner on the opposite end to catch the vehicle as you race them. Turn the switch on and watch it go! If you are using rear wheel drive, you may want to pick up the rear axle and then turn the power on so that the wheels don't run away from you.



## Learner Assessment

When each group has completed designing their EV, consider doing a race with the learners. Design a racetrack in your classroom. You can make the track flat or have hills (best if the track is straight). Allow the class to use the EV Scoring Sheet found at the end of the EV Construction Plan.

During the races, you will look for:

- The fastest EV
- The EV that travels the farthest
- The EV that can carry the most weight
- If you have hills on your track, what EVs could make it over?
- Best designed EV

### Extension Ideas

1. Get creative with the designs, how else could you design the body of the vehicle? Some ideas include using Lego, having it solar powered, etc. The possibilities are endless!
2. Use this as a conversation starter to talk about incorporating electric busses.
  - Check out this video on electric buses:

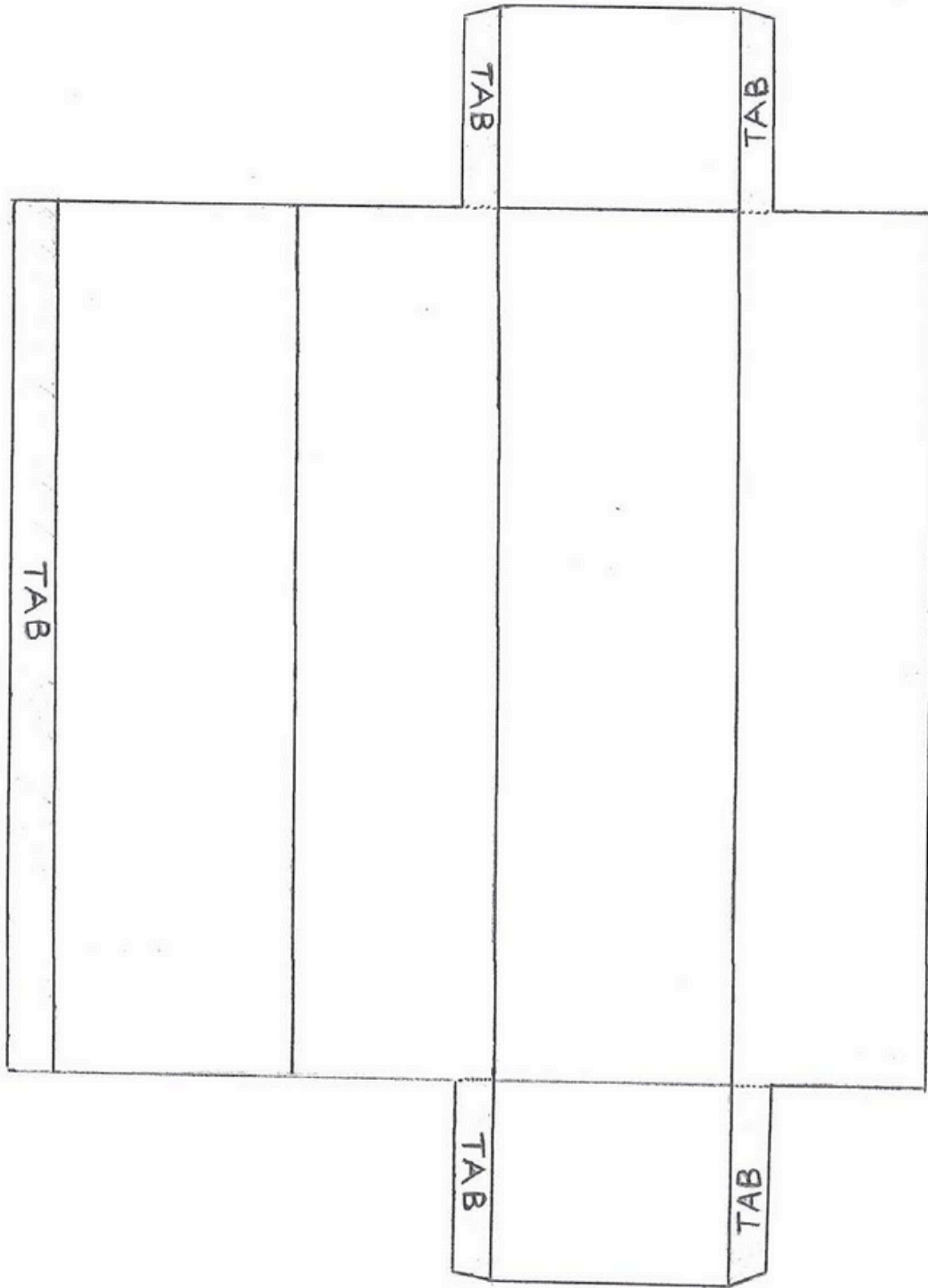
 [The e-Bus Revolution in Edmonton, Canada](#)

- Check out this website:

 [Three Nations Energy](#)



# School Bus Template



# Electric Vehicle Scoring Sheet



EV Name: \_\_\_\_\_

Group Member Names: \_\_\_\_\_

\_\_\_\_\_

Round	Time to Finish	Weight Carried	Distance Travelled	Finished?
1				
2				
3				

Modifications Made:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Trials made after modifications:**

Round	Time to Finish	Weight Carried	Distance Travelled	Finished?
1				
2				
3				

**Reflections:** How did the design modifications affect your results? Which design resulted in better results and why?

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