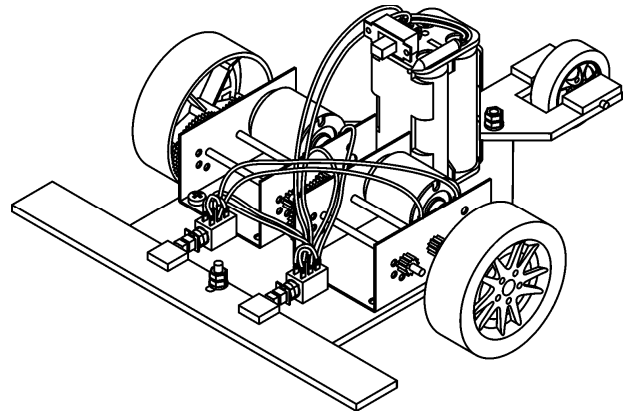


EXPLORER

DESCRIPTION

The *EXPLORER* is a small autonomous vehicle, that changes its direction of travel when it bumps into an object.

The *EXPLORER* is driven by two independent motors, each through its own gearbox. The front of the *EXPLORER* has a bumper bar, which is used to actuate either one or both of the DPDT (Double Pole - Double Throw) push slide switches.



Each DPDT switch controls the rotation of the wheel on the opposite side. When either DPDT is triggered, the corresponding wheel drives backwards, to get the *EXPLORER* away from the object. The freely swinging trailing wheel introducing a random element to the direction it turns, as well as providing stability. A flashing light indicates the approach of the *EXPLORER*.

1. COMPONENTS REQUIRED

1.1 COMPONENTS SUPPLIED

1.1.1 The following parts are supplied in the kit:

1x	4AA Battery holder	1x	Flashing light
2x	52 mm diameter Wheels	4x	3x5mm long wood screws
2x	54 mm diameter Rubber Tyres	2x	M3x20mm long Bolts
1x	30 mm diameter wheel	4x	M3 Nuts
2x	Push slide switch (DPDT)	4x	Washers 3.0mm ID x 0.5 thick
1x	Sliding switch (small)	1x	Spanner
1.1.2	2x <i>MULTI-RATIO kits for kits:</i>		
2x	Multi-ratio Gearbox case	4x	50Tx10T Spur gears (white/2.4mm hole)
2x	4.5V Electric Motor (round)	2x	50Tx10T Spur gear (yellow/2.6mm hole)
4x	2.5 dia x120 mm long steel rod	4x	12T Pinion gears 2.4 hole
2x	3mm ID, 8.0 OD, 1.0 thick Washer	2x	10T Pinion gears 1.9 hole
4x	2.6x 4 self-tapping screws		

1.2 ADDITIONAL REQUIREMENTS

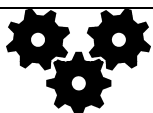
- 1.2.1 The 2.3mm, 2.6mm and 3.5mm diameter drill bits, and AA batteries, are available from us.
- 1.2.2 The following material needs to be supplied by the designer: fine electric wire and the material for the various body components. NOTE: We used 3.0 millimetre thick acrylic sheet. PVC sheet or other materials could also be used (for plastic sheet refer to the Yellow Pages under the heading "Plastics Fabricators")

2. DESIGN CONSIDERATIONS

The prototype *EXPLORER* we built is shown here, but the concept has scope for variation.

2.1 PLANNING

The *EXPLORER* consists of a platform on which the components are mounted.



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Before starting construction, the student needs to plan and lay out all the components (gear cases, battery holder and push slide switches) on a sheet of paper or suitable computer program, and work out the size and shape of the platform, bumper bar and trailing wheel carrier. For the vehicle to work well, the designer must look at the vehicle as a complete unit, and not just as separate parts.

The design needs to take a number of factors into account. Some of the things to consider during the design stage are listed below.

2.2 THE PLATFORM:

- 2.2.1 Ideally both gearboxes should be located with their driving shafts in line, and side-by-side. For ease of construction, or for a narrower chassis, the gears should be assembled on the outside of the gear case.
- 2.2.2 The push slide switches must be located on the platform's front, as close together as is practical (we suggest about 45mm apart). This is necessary, as the push slide switch requires a certain amount of pressure to work – by being located close to the bumper bar's centre, the bumper bar is able to exert more leverage on the switch.
- 2.2.3 Locate the battery holder centrally and just behind the gear cases. The location of this battery holder (rearward) limits the range of movement of the Trailing wheel carrier.

2.3 TRAILING WHEEL CARRIER:

- 2.3.1 The trailing wheel carrier outer edges must be designed to prevent the Carrier from swinging too far, or the carrier can "jackknife". NOTE: The Carrier's outer edges act as restrictors against the battery holder.
- 2.3.2 Adequate clearance needs to be provided, to allow the wheel to turn freely. A spacer may be necessary on one side of the wheel to centralise it within the carrier.

2.4 BUMPER BAR:

- 2.4.1 The front edge may be straight or curved.
- 2.4.2 The rear edge of the bumper should be just touching the switches buttons, and be at right angles to the centre line of the Platform.
- 2.4.3 The length of the slot (the swivel point) should be equal to or slightly longer than the travel of the switch's slide.

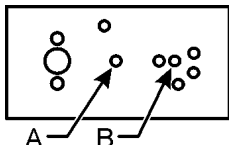
NOTE: If required, the front face of the bumper bar may be extended vertically. This could be used to prevent the bumper bar of the *EXPLORER* passing under an object that is too low.

3. ASSEMBLING THE GEARBOXES

The *MULTI-RATIO GEARBOX* kit provides a choice of 3 gear ratios to choose from. Before starting assembly, the desired gear ratio must be chosen to suit the usage, as this defines the parts to be used and the assembling procedure.

NOTE: take care when assembling the gearbox, to assemble the gears to the correct side, as the supplied motor only fits on one side of the gearcase.

3.1 GEARBOX OPTIONS

<u>GEARBOX STAGE / Reduction ratio</u>	<u>OUTPUT SHAFT</u>	<u>RATIO</u>	
Single reduction	Hole A	1:5	
Double reduction	Hole B	1:25	
Triple reduction	Hole A	1:125	

<u>Standard Motor (S18) - Rated at 4.5V</u>	<u>Performance</u>
3 Volts: ie. Powered by 2xAA batteries	6,500 rpm ##
6 Volts: ie. Powered by 4xAA batteries	12,600 rpm ##
Torque	17.9 g.cm

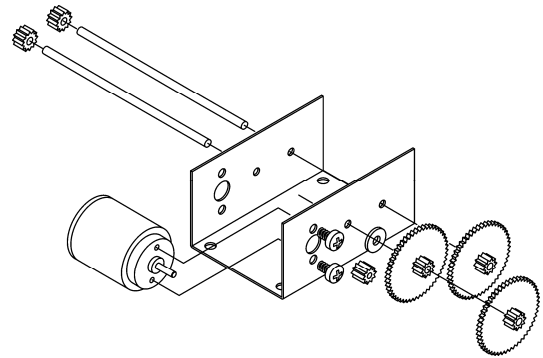
Motor speeds quoted are approximate rpms under load

WARNING: Using a higher voltage increases the speed of the motor, but can reduce the life of the motor.

3.2 ASSEMBLING THE GEARBOX

GENERAL:

- for this Gearbox, the holes marked 'A' & 'B' in the drawings are to be used - the available gears will not function if fitted to any other holes
- the 10T pinion gear (which has a 1.9mm hole) is press fit on to the electric motor's 2.0mm shaft
- the 12T pinion gears are used as locators.
- the white spur and 12T pinion gears (which have a 2.4mm hole) are press fit on to the 2.5mm shafts while the yellow spur gear is free wheeling on the shaft and has a 2.6 diameter hole.
- the outside two 50T spur gears (ie one on each shaft) must be white 50T gears, and are press fit, while the inner (closer to the case) is a yellow 50T, which is free spinning .
- the gears can be assembled onto the shaft/s with a help of small hammer.



3.2.1 GEARBOX SELECTION

Before starting assembly:

- determine the desired gearbox ratio – as this will define which output shaft will be used as the axle
- define the length of the axle shaft, and cut (and de-burr) the steel rod to that length.

3.2.2 ASSEMBLY PROCEDURE:

Assemble the steel rods, and all the gears, to the gearcase - as shown in the appropriate drawing– Single, Double or Triple reduction. Also refer to the exploded diagram.

SINGLE REDUCTION

- Fit the shaft to the hole nearest the motor (Hole A), add the 12T pinion gear (locator), with the 1.0mm washer between the case and the (white) 50T spur gear.

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DOUBLE REDUCTION

- Start by fitting the first shaft to the hole nearest the motor (Hole A), add the 12T pinion gear (locator), with the 1.0mm washer between the case and the (white) 50T spur gear
- Add the second shaft to Hole B, and add the 12T pinion gear (locator) and the (white) 50T spur gear.

•

TRIPLE REDUCTION

- Start by fitting the first shaft to the hole nearest the motor (Hole A), add the 12T pinion gear (locator), with the 1.0mm washer between the case and one (yellow) 50T spur gear
- Add the second shaft to Hole B, and add the 12T pinion gear (locator) and one (white) 50T spur gear.
- Install a (white) 50T Spur gear on the shaft nearest the motor.
- for the THIRD reduction ratio, this shaft is the output shaft.

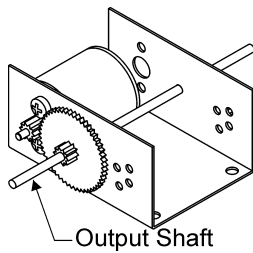
3.2.3 ASSEMBLING THE MOTOR

- Press the 10T pinion onto the motor shaft. Stop when the worm gear is 3mm from the motor's body.

HINT: Place the gear on the bench, insert the motor shaft into the pinion gear's hole and gently tap the end of the shaft (where it exits the motor) with a small hammer.

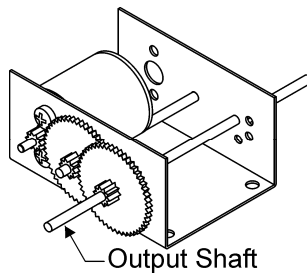
WARNING: Don't just push the motor down by hand, as this can push the motor armature out of its bearings and jam the motor.

- Secure the motor to the gearbox case using the two self-tapping screws.
- Solder a suitable length of wire to each of the motor's terminals. The length will be dictated by the planned location of the Gearbox and the other components

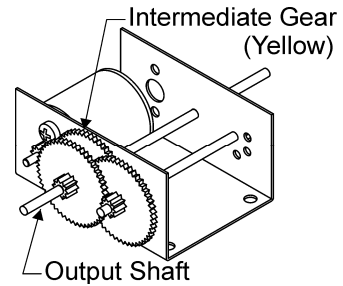


SINGLE REDUCTION

(Low ratio = high output shaft speed)



DOUBLE REDUCTION



TRIPLE REDUCTION

(High ratio = low output shaft speed)

4. ASSEMBLING THE *EXPLORER*

When drilling holes, the following is worth noting: a 3.5mm drill bit is used for bolts, a 2.3 mm drill is for drilling the pilot holes for the 2.6mm self tapping screws, as well as providing an interference fit for the 2.5 steel rod, and a 2.6mm drill bit is used for pilot holes for the 3mm wood screws, which are used to attach the gear boxes to the platform, or for the holes that need a loose fit for the steel rod. Thus for the trailing wheel the central hole should be 2.6 mm diameter.

4.1 THE PLATFORM

4.1.1 Four small holes (2 for each gear case) are drilled in the platform, to match diagonal holes in the gear cases. The 3x5mm wood screws should be inserted from the top of the gear cases and secured to the platform. Do not over tighten the screws.

4.1.2 Assemble the battery holder to the platform using a hot glue gun or other suitable adhesive.

4.1.3 Assemble the two driving wheels to their shafts.

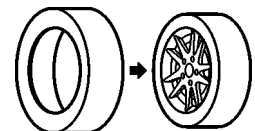
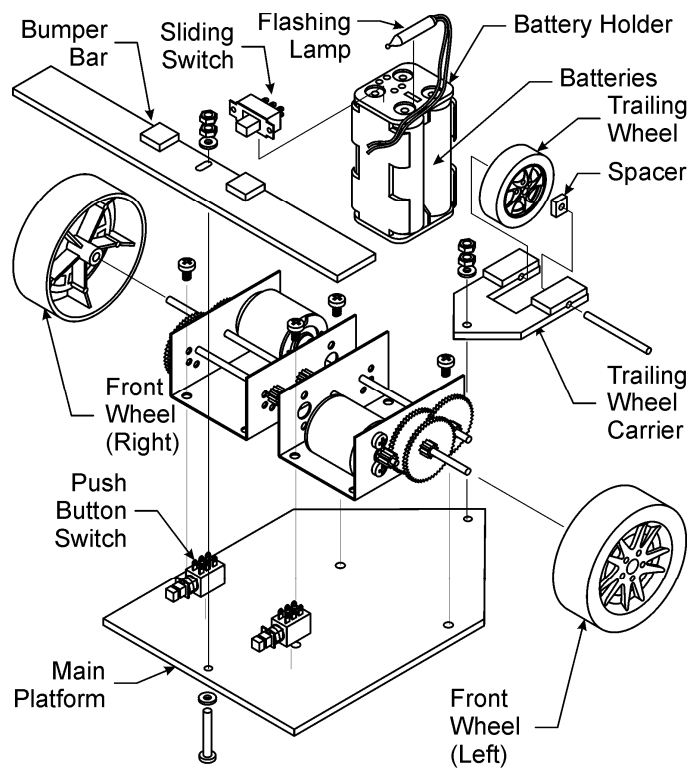
Note: before assembling the wheels to the gear box shafts, the following needs to be carried out:

- Remove the plastic tyre from the 52mm wheel
- Push the 54mm rubber tyre onto the wheel rim.

This tyre provides much more traction than the plastic tyre. On polished surfaces the plastic tyres may spin, and not provide sufficient pressure to activate the push slide switch.

4.1.4 The Bumper bar is attached to the platform using a centrally located bolt. Use a 20mm long M3 bolt, two nuts (one acts as a lock nut) and two washers so that the bar can swing freely. Note that a slot is required to allow the bumper fore and aft movement.

4.1.5 When the bumper bar is in the forward-most position in the slot and at right angles to the centre line of the *EXPLORER*, clamp the bumper bar to the platform. While the bumper bar



is clamped, using hot glue secure the Push slide switches to the platform, placing their centres approximately 45mm apart. The end of each slide should be just touching the bumper bar.

NOTE: The wiring of the switches should be carried out before the switches are set in place. For the wiring refer the wiring diagram in Section 5.

4.1.6 Use hot glue to secure the sliding switch ("on/off" switch) and flashing light on top of the battery compartment.

4.2 TRAILING WHEEL CARRIER

4.2.1 The Trailing Wheel Carrier will take the 2.5mm diameter shaft, with one hole drilled to provide an interference fit. For acrylic use a 2.6mm drill bit and for PVC use a 2.3mm drill bit for interference. Assemble the wheel, spacer and shaft to the carrier.

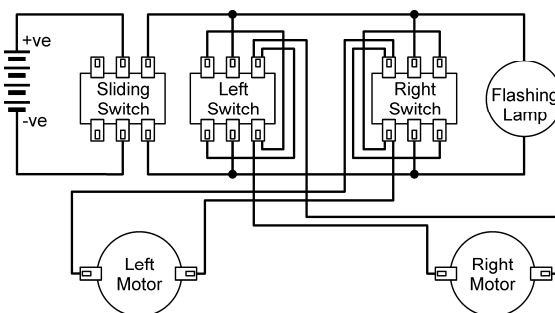
4.2.2 Assemble the Trailing Wheel Assembly to the Platform using one M3 x 20 bolt, a pair of nuts (one nut acts as a lock nut) and a pair of washers. Check that the Trailing wheel turns freely regardless of the Carrier's position relative to the Platform.

5. WIRING

5.1 When soldering wires, strip a short piece of insulation from the end of the wire, twist the strands and "tin" them. This is done by using a hot soldering iron to apply solder to the ends.

5.2 Connect the wires to the motors, but do not solder them yet. Push the sliding switch to the "on" position. Check for the direction of rotation of both the wheels. The *EXPLORER* should move "forward". If not, swap the wires until both wheels turn in the same (forward) direction. When that is correct, solder the wires in place.

5.3 Connect the flashing light and sliding switch.



WIRING DIAGRAM

6. TESTING

6.1 ELECTRICAL TESTING

6.1.1 After the batteries are inserted, move the sliding switch to the "ON" position. Check that all of the following occur:

- the flashing light flashes
- the *EXPLORER* moves forward when the bumper is in its forward position
- when one side (and in turn the other side) of the bumper bar is pushed, the opposite side wheel reverses direction

6.1.1 If any of the above are not achieved, check the following:

- do the batteries have adequate charge
- is the wiring connected as per wiring diagram
- check that there are no solder bridges between the terminals
- bare wire ends do not touch

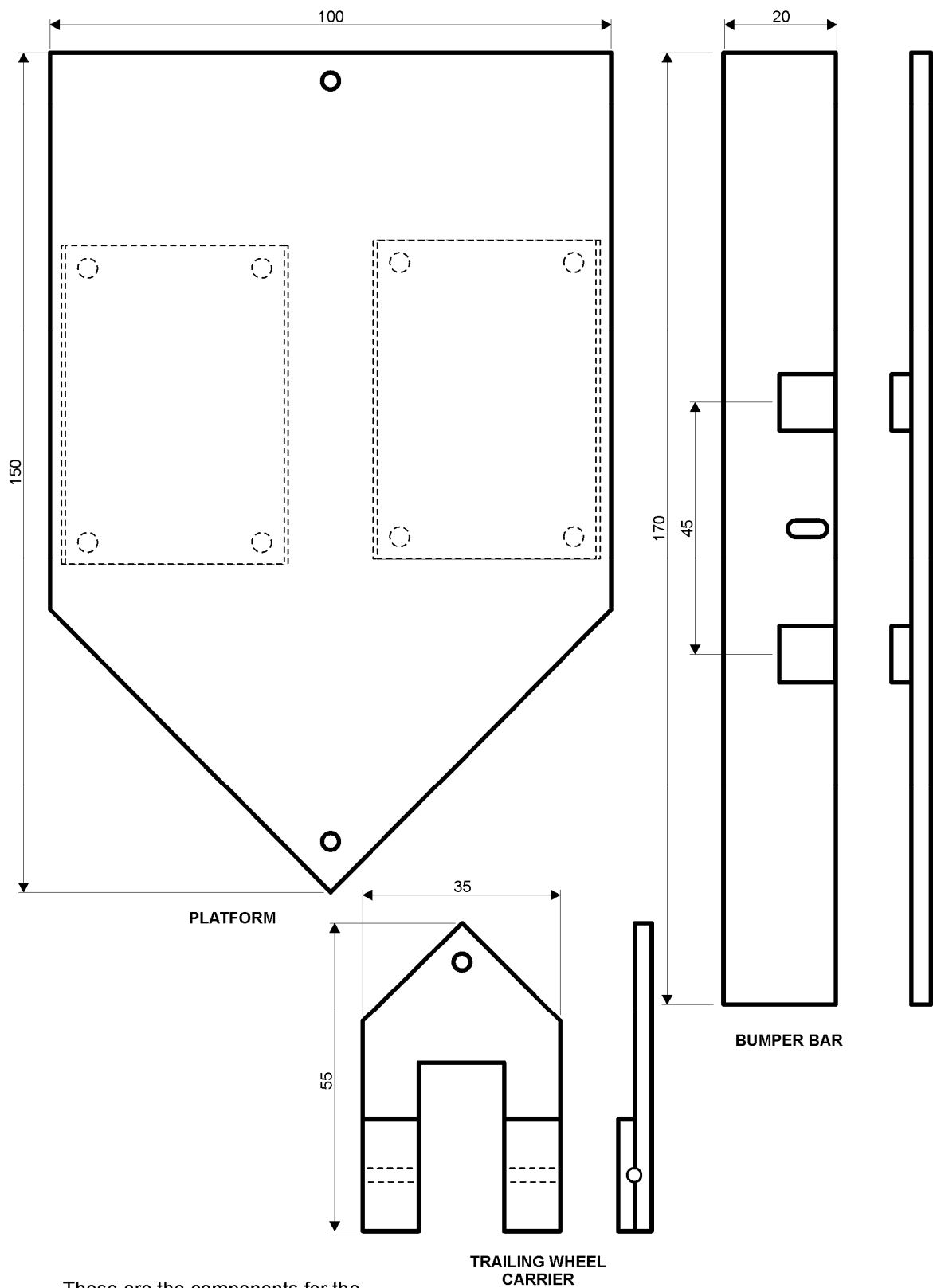
6.2 MECHANICAL TESTING

6.2.1 Check and ensure that the bumper bar can move freely in all directions

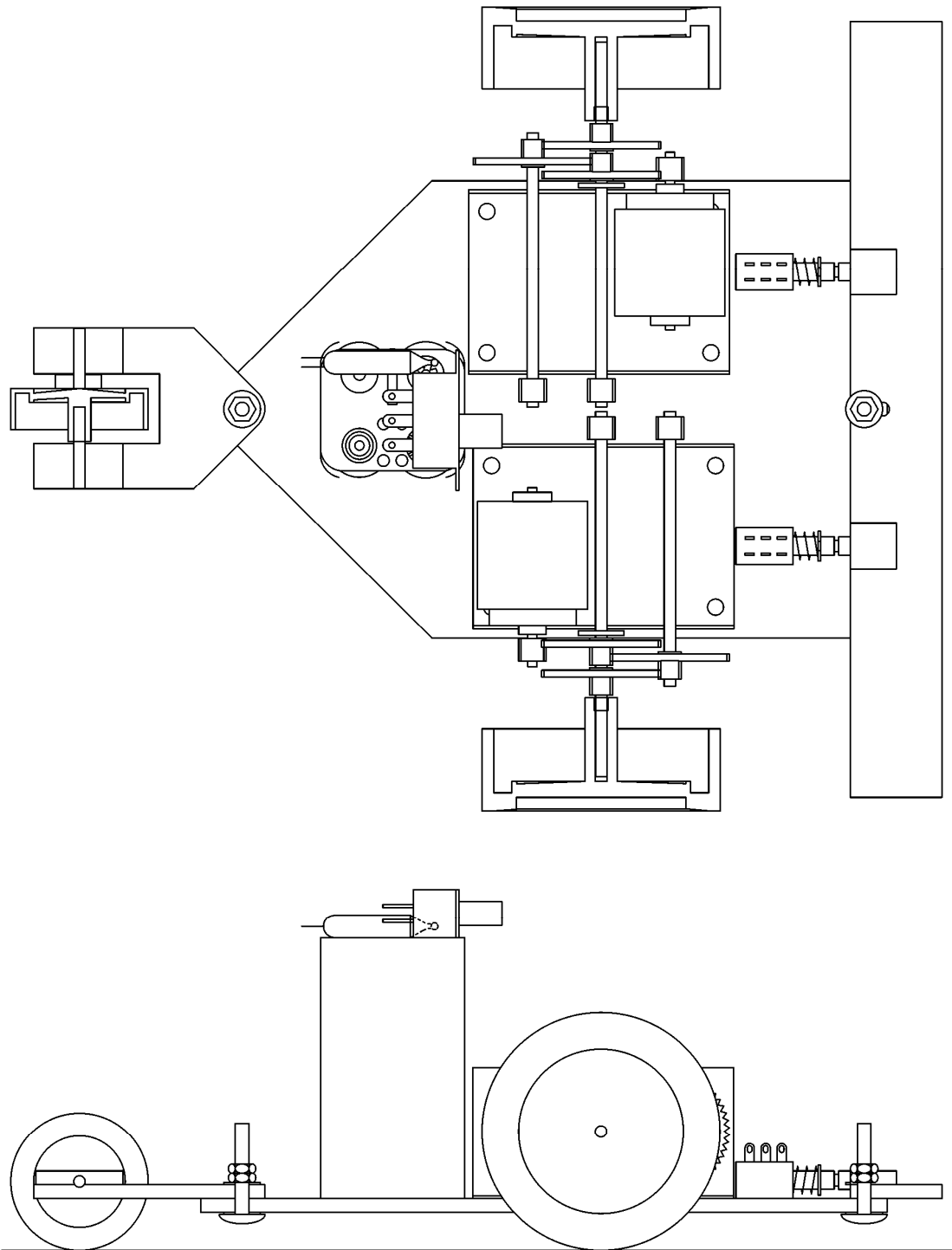
6.2.2 Check and ensure that the trailing wheel carrier and wheel can move freely

6.2.3 Turn the sliding switch to the "ON" position. Let the *EXPLORER* travel forward until it bumps into an object. The *EXPLORER* should back-up, change direction and proceed on its way.

You have successfully built your *EXPLORER*!!! Well done!



These are the components for the prototype vehicle built for the EXPLORER. The student may change this design as required. Hole sizes and unspecified dimensions are determined by the student.



This is the prototype vehicle built for the EXPLORER.
The student may change this design as required.