

# SOLAR MECHANICS

**WARNING:**  
CHOKING HAZARD - Small parts.  
Not for Children under 3 years.

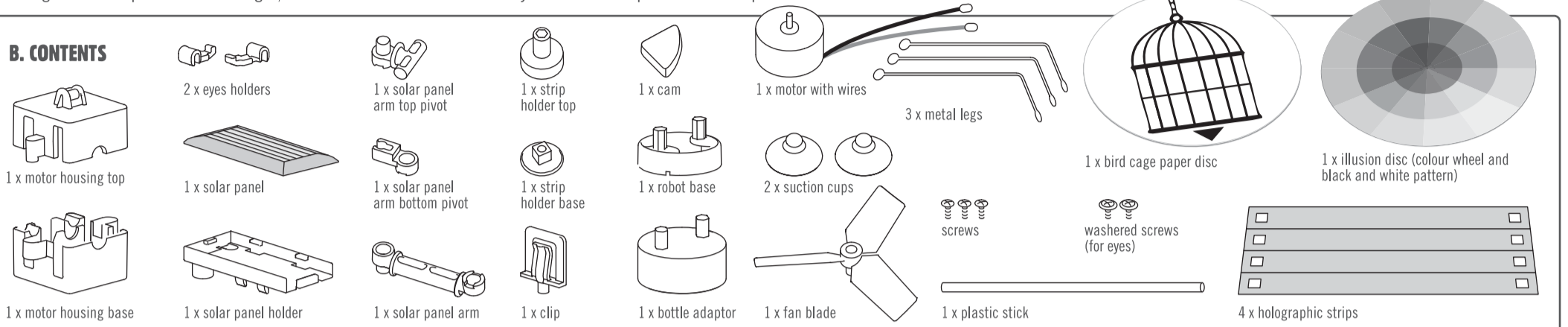
To Parents: Read all instructions before providing guidance to your children.

GREEN SCIENCE

## A. SAFETY MESSAGES

1. Adult supervision and assistance are required at all times.
2. This kit is intended for children aged 8 years or older.
3. This kit and its finished product contain small parts which may cause choking if misused. Keep away from children under 3 years old.
4. Do not attempt to take the solar panel apart.
5. Never look directly at the Sun as you could damage your eyes.
6. If using a desk lamp as a source of light, be aware that this will be hot. Only use a desk lamp under adult supervision.

## B. CONTENTS



Also required, but not included in this kit: small crosshead screwdriver, empty plastic drinks bottle.

## C. ASSEMBLY - SOLAR POWERED MOTOR MODULE

You need to build the solar powered motor module first. This is the base unit on which you make various projects from section D onwards.

1. Insert two washed screws into the eyes holders. Identify the motor housing top, and slot the two eyes into it.
2. Identify the motor housing base. With the wires uppermost, slot the motor into the motor housing base so that the motor's spindle sticks out through the front of the housing.
3. Place the motor housing top over the base. Make sure the wires from the motor protrude through the slits on either side of the housing. Secure the two parts of the housing with two screws.
4. Examine the solar panel. On the flat underside, there are + and - signs at one end. Slide the panel, this end first, into the panel holder until you hear a click.
5. On the underside of the solar panel holder are two connections for wires with screw holes. Position the holder with the solar panel itself facing down, and with these connections facing towards you. The motor has two wires connected to it, one red, one black, each with a metal tab in the end. Slide the tab on the black wire into the right-hand connector. Secure it with one of the screws. Slide the tab on the red wire into the left-hand connector, and secure it with a screw.
6. Push the pin on the solar panel arm top pivot into one end of the solar panel arm. Click the cylinder on the pivot into the underside of the solar panel holder.
7. Push the pin on the solar panel arm bottom pivot into the other end of the solar panel arm.
8. Click the completed solar panel arm onto the top of the motor housing.

### OPERATION OF THE SOLAR-POWERED MOTOR MODULE

Put your solar-powered motor module in the sunshine. Twist and tilt the solar panel so that the panel faces the Sun. This allows the panel to collect as much sunlight as possible. The motor should start running. You will need to adjust the solar panel like this for each of the projects below.

If there is no sunshine, you can use a desk lamp with a 60-watt incandescent light bulb (not a fluorescent energy saving bulb) to provide light so you can test the projects (ask an adult to help you do this as the lamp could get hot). Do not use the solar panel outdoors when it is raining as water may damage the solar panel and motor.

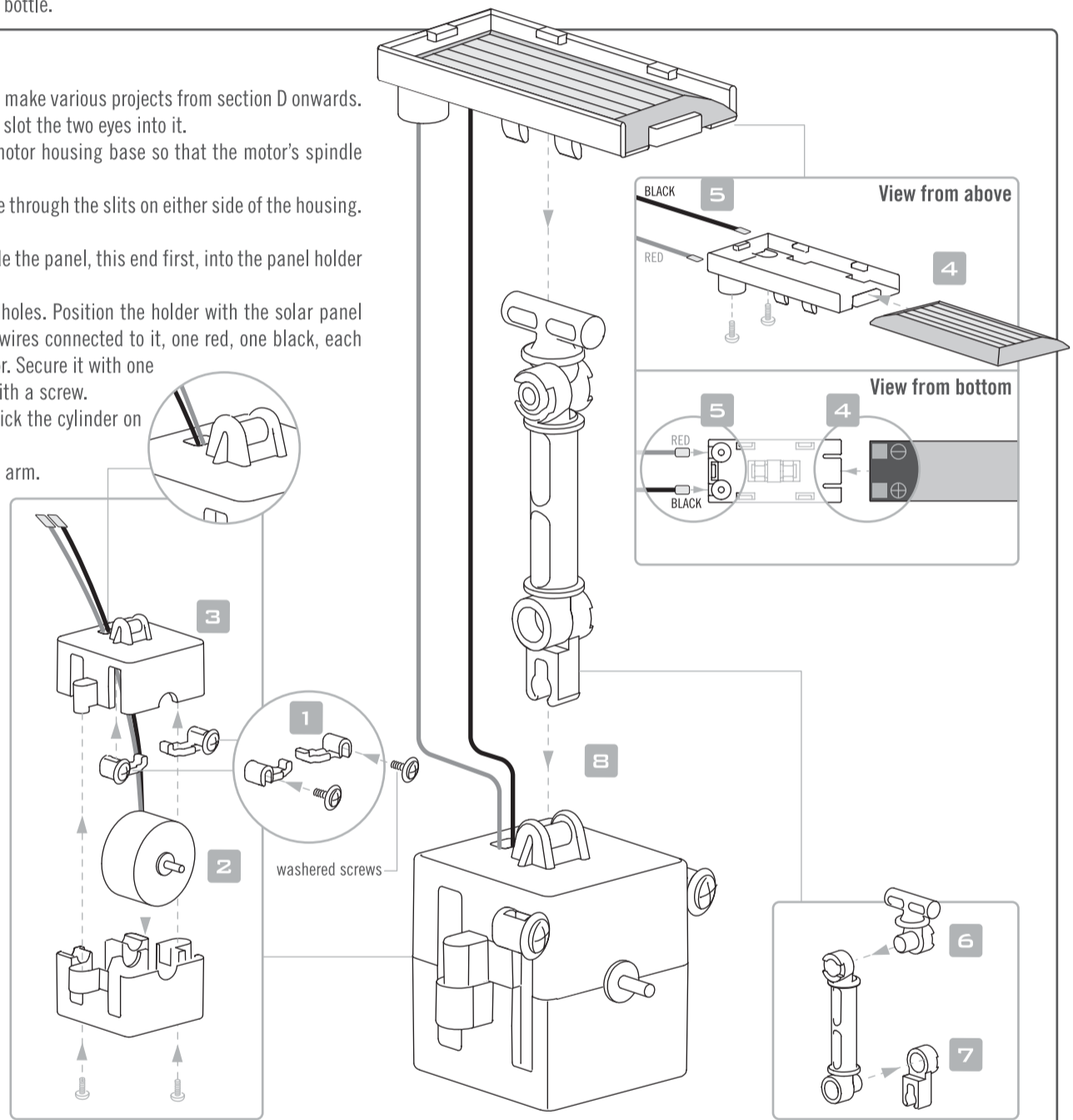
### HOW IT WORKS

The solar cell turns light from the Sun (called solar energy) into electricity. The electricity makes the motor operate. The brighter the sunshine, the more electricity is made and the faster the motor will spin.

### TROUBLESHOOTING

If the motor doesn't run:

- Try giving the motor spindle a nudge to get it started.
- The sunlight may not be strong enough, or not hitting the solar panel straight on. Adjust the angle of the panel so that it directly faces the Sun. If it's cloudy you may have to wait until a sunnier day, or use a desk lamp to provide the light.
- Check that the wires are attached properly to the solar panel.



## D. MAKING AN ILLUSION SPINNER: COLOUR WHEEL AND THE BENHAM DISC (BLACK AND WHITE PATTERN)

1. Screw the bottle adaptor onto the top of an empty drinks bottle.
2. Push the pins on the bottle adaptor into the holes in the base of the motor housing.
3. Push the disc holder base onto the motor spindle.
4. There are two illusions to try — a colour wheel and a Benham Disc (the black and white pattern). Slot the spinner disc onto the square peg, with the side you want facing out.
5. Push the disc holder top onto the square peg.
6. If you prefer to mount the fan on a window rather than a bottle, unscrew the bottle and clip the suction cups into the rear of the motor housing.

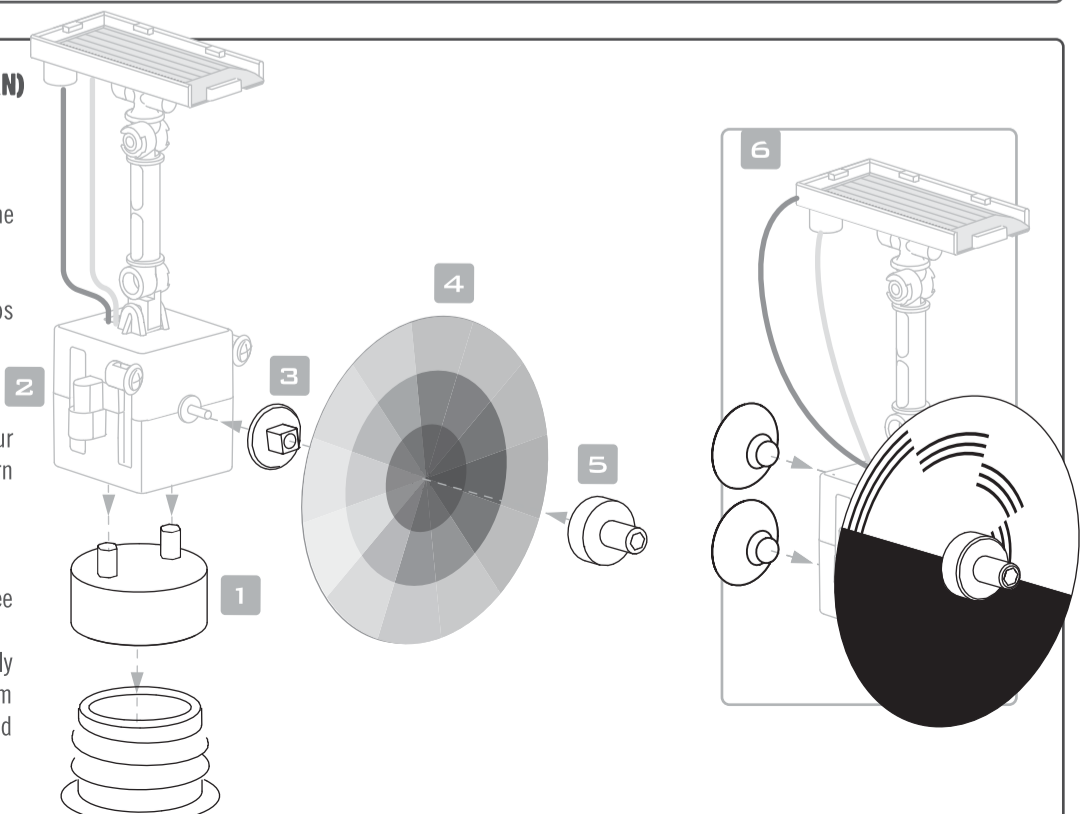
### OPERATION

Place the spinner in the sunshine. The motor will run and the illusion spinner will turn. If you have the colour wheel side outwards, the colours will disappear and the disc will turn grey! If viewing the black and white pattern side, the narrow lines will appear to be coloured! Interestingly, different people will see different colours too!

### HOW IT WORKS

The colour wheel is made up of all the colours of the rainbow. When the wheel spins quickly, your eyes cannot see the individual colours. Instead, they mix together to make a single, light grey colour.

The black and white pattern: This pattern is called a Benham Disc. It's probably to do with how quickly light-sensitive cells called cones in your eye respond to changes from black to white. The changes make them see colour. As the disc spins, they see black and white in quick succession, but the delay between black and white is different for each set of lines, so you see different colours.



### E. MAKING A SOLAR VIBROBOT

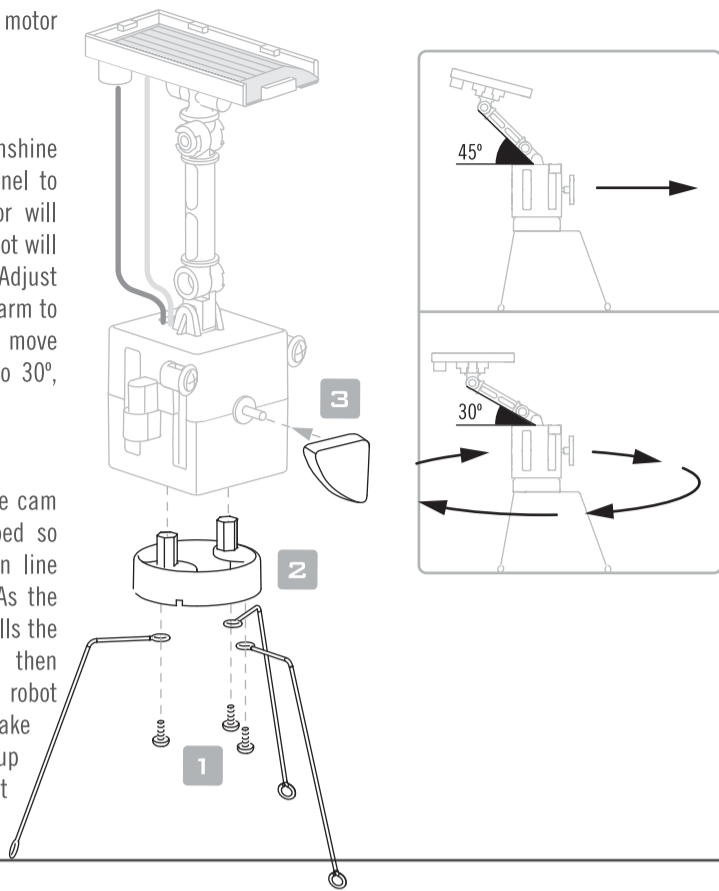
1. Attach the three metal legs to the robot base with screws.
2. Push the pegs on the robot base into the holes in the bottom of the motor module.
3. Push the cam onto the motor spindle.

#### OPERATION

Place the robot in the sunshine and adjust the solar panel to face the Sun. The motor will start running and the robot will vibrate and move along. Adjust the angle of the support arm to 45°, and the robot will move forward. Tilt the panel to 30°, and it will spin around.

#### HOW IT WORKS

When the motor runs, the cam spins. The cam is shaped so that its weight is not in line with the motor's shaft. As the rotor spins, its weight pulls the motor shaft one way then another. This makes the robot vibrate. The vibrations make the robot's legs jump up and down, so that it moves along.



### F. MAKING A COOLER FAN

1. Push the fan blade onto the motor shaft.
2. If you are going to mount the fan on a bottle, screw the bottle adaptor onto the top of an empty drinks bottle. Push the pins on the bottle adaptor into the holes in the base of the motor housing.
3. If you are going to mount the fan on a window, clip the two suction cups into the rear of the motor housing.

#### OPERATION

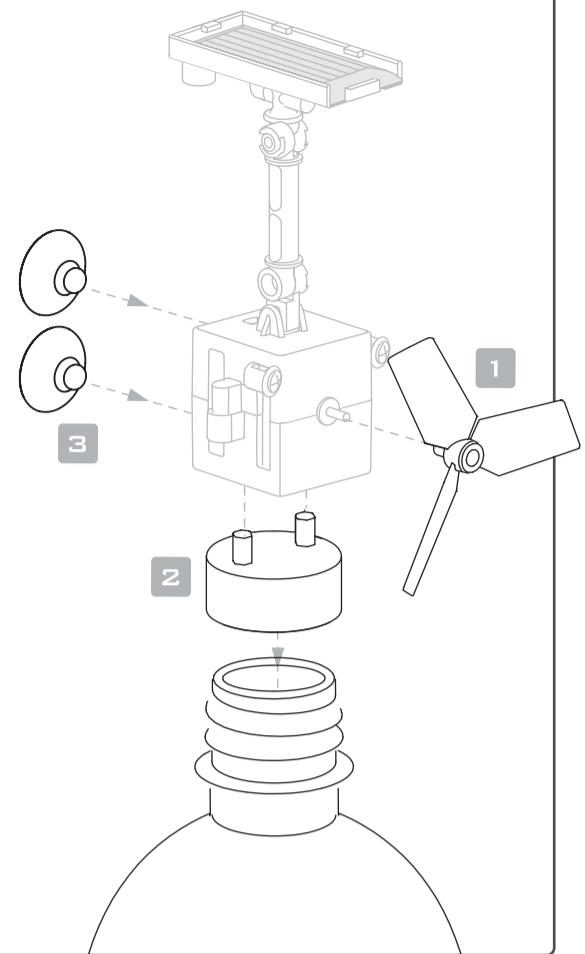
Push the suction cups onto a window through which the Sun is shining, or place the bottle where sunshine falls on the solar panel. Adjust the solar panel to face the Sun, and the fan will spin.

#### HOW IT WORKS

The solar panel turns sunlight into electricity, which makes the motor spin. The spinning fan pushes air along, making a breeze that keeps you cool.

#### TROUBLESHOOTING

If the fan blows the wrong way, you have the wires wrongly attached to the solar panel. Swap them over.

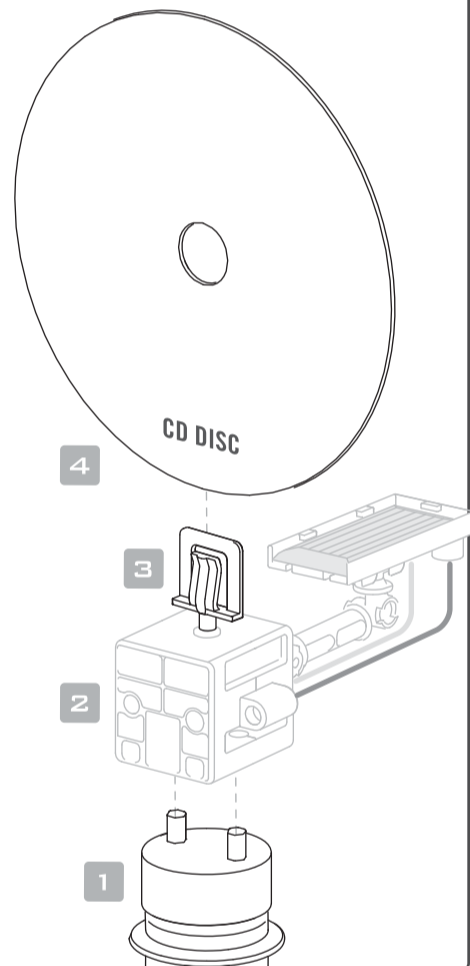


### G. MAKING A CD RAINBOW REFLECTOR

1. Screw the bottle adaptor onto the top of an empty drinks bottle.
2. Push the pins on the bottle adaptor into the holes in the rear of the motor housing, so that the motor housing is on its side.
3. Push the CD clip onto the motor spindle.
4. Push the edge of an old CD into the clip.

#### OPERATION

Place the rainbow reflector in the sunshine (either outdoors or on a sunny window sill). Adjust the solar panel to face the Sun, and the CD will spin, making rainbow coloured patterns.



### H. MAKING A "BIRD-IN-A-CAGE" ILLUSION SPINNER

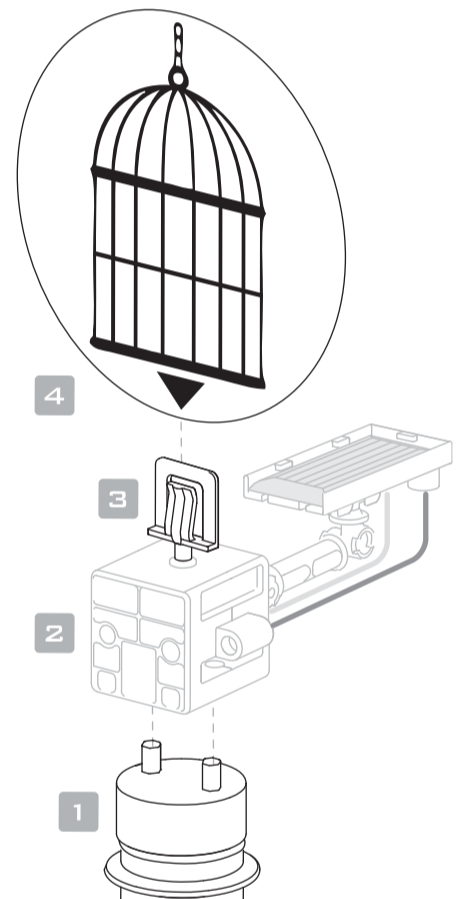
1. Screw the bottle adaptor onto the top of an empty drinks bottle.
2. Push the pins on the bottle adaptor into the holes in the rear of the motor housing, so that the motor housing is on its side.
3. Push the clip onto the motor spindle.
4. Slot the bird and cage card into the clip.

#### OPERATION

Place the rainbow reflector in the sunshine (either outdoors or on a sunny window sill). The motor will run and the disc will spin. Now the bird appears to be in the cage!

#### HOW IT WORKS

This is an optical illusion. As the disc spins you see the cage and the bird again and again in quick succession. Your eyes and brain remember what they see for a split second, and this makes the two pictures seem to blend into one, so the bird seems to be in the cage.

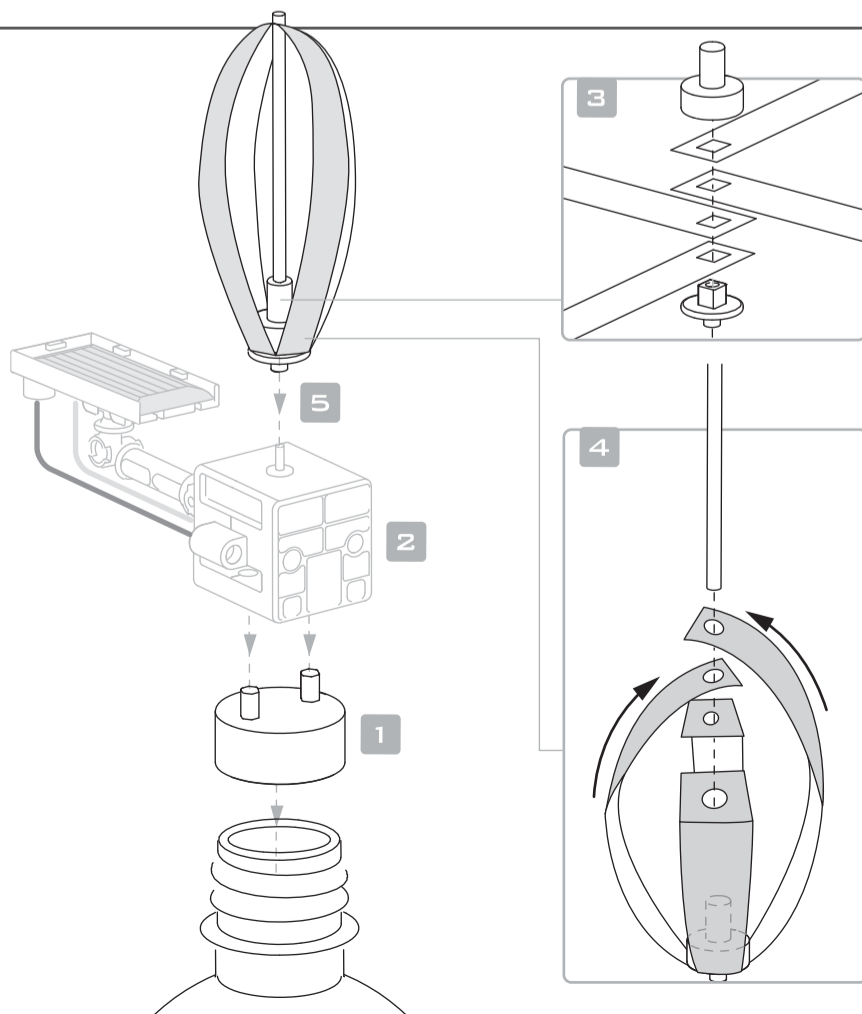


### I. MAKING A HOLOGRAPHIC SPINNER

1. Screw the bottle adaptor onto the top of an empty drinks bottle.
2. Push the pins on the bottle adaptor into the holes in the rear of the motor housing, so that the motor housing is on its side.
3. Slot the end of a holographic strip (with a square hole in it) over the square peg on the strip holder base. Add three more strips, with each one at 90° to the last. Push the strip holder top onto the square peg to keep the strips in place.
4. Fold the other ends of the strips together, lining up their holes. Push the plastic strip down through the holes and into the strip holder.
5. Push the strip holder base onto the motor spindle.

#### OPERATION

Place the holographic reflector in the sunshine. The motor will run and the illusion spinner will spin. It looks like a bubble which reflects beautiful holographic patterns in the sunshine!



### J. FUN FACTS

- Energy we get from the Sun is called solar energy. It's a renewable form of energy because the Sun keeps shining all the time.
- Most solar cells are made from a material called silicon. Most of the silicon used to make them comes from sand.
- Robot rovers that operate on Mars drive across the surface of Mars using electricity from solar cells.
- Of all the solar energy that the Sun gives out, only about one billionth of it (that's a thousandth of a millionth) hits the Earth!
- A 'micro vibrobot' is a tiny vibrobot. Micro vibrobots are often made by taking the vibrating alarm from an old mobile phone and sticking it on the head of a toothbrush.
- The colours that you see on a CD are caused by light bouncing round in the tiny pits on the CD. The pits work like tiny prisms, splitting the light into different colours.
- The bird-in-the-cage illusion is a simple optical toy that relies on persistence of vision. All sorts of optical toys, such as flick books, use the same effect. So do movies, which are made up of thousands of still pictures that you see in quick succession.

#### Questions & Comments

We value you as a customer and your satisfaction with this product is important to us. If you have comments or questions, or you find any part of this kit missing or defective, please do not hesitate to contact our distributor in your country. You will find the address printed on the package. You are also welcome to contact our Marketing Support Team: Email: [infodesk@4m-ind.com](mailto:infodesk@4m-ind.com), Fax (852) 25911566, Tel: (852) 28936241, Web site: [WWW.4M-IND.COM](http://WWW.4M-IND.COM)