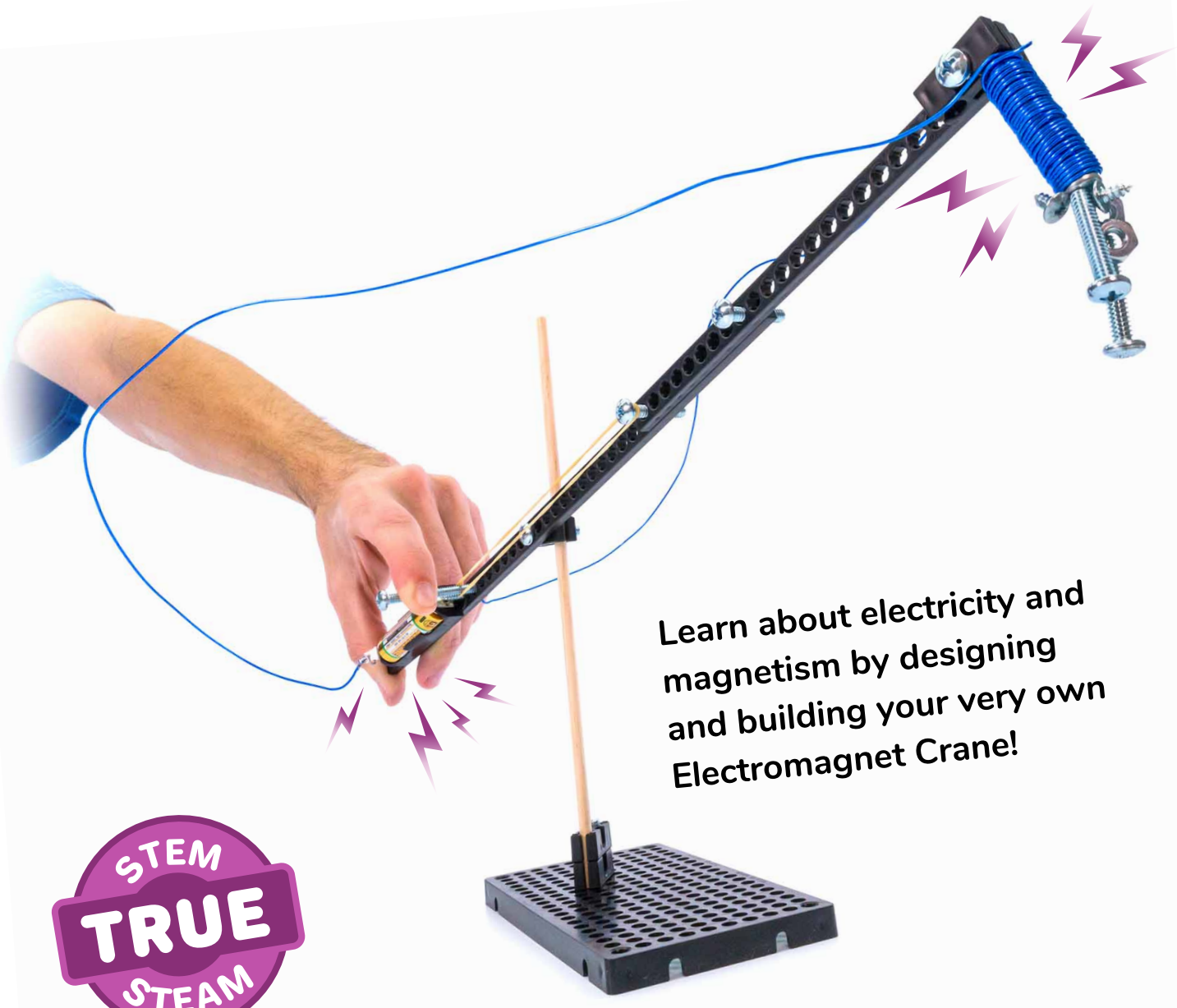
Go Guide

Electromagnet Crane 2.0



Learn about electricity and magnetism by designing and building your very own Electromagnet Crane!

STEM TRUE STEAM

You Are Here

Choose how you would like to complete this activity.
Download documents & videos at teachergeek.com/electromagnetcrane

Go Guide

Start here! Build your Crane, evolve your design, and begin the In-The-Bucket Challenge!

Optional Lab

-Magnetic Materials Lab (Ages 8+)

Optional Challenges

-Space Mining Challenge*
-Clip Hanger Challenge
-Super Sort Challenge

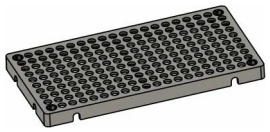
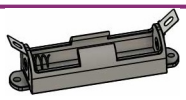
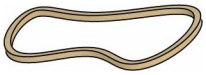
*See Page 13

Go Guide Electromagnet Crane 2.0

Supplies

CRANE PARTS

These are the parts you need to build one Electromagnetic Crane, plus some extras, so you can make your own unique designs.

Name	Qty	Picture
Hole Plates SKU 1821-32	1	
Strips 30 cm (1 in) SKU 1821-31	5	
Slide Stop 8 cm (3 in) SKU 1821-49	1	
Blocks SKU 1821-34	5	
String 90 cm (36 in) SKU 1823-47	1	
Battery Holder Single AA SKU 1821-62	1	
Wire Roll 5 m (16.4 ft) SKU 1823-47	1	
Screws 50 mm (2 in) SKU 1821-27	3	
Screws 25 mm (1 in) SKU 1821-22	8	
Mini-Hub Screws 16 mm (5/8 in) SKU 1821-19	4	
Nuts #10 SKU 1821-25	10	
Rubber Bands Small SKU 1821-39	2	
Dowels 30 cm (12 in) SKU 1821-20	2	

Maker Cart Users: We recommend using Aluminum Wire for this activity (not included with Maker Carts until summer 2021).

MATERIALS YOU SUPPLY

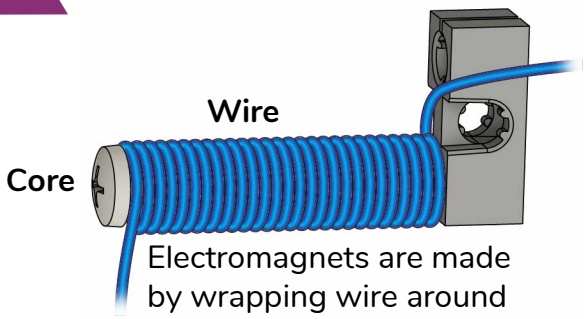
- **Phillips Screwdriver**
- **Pliers** (optional)
- **AA Battery**
- **Bowl**
- **Aluminum Foil** (optional)
- **Any two of: rice, beans, small candies, crumpled paper, etc.** (for challenge on Page 13)
- **Recycling Bin Materials** (optional – to incorporate into your designs)

Optional Tools

Modify materials to make even more creative designs with the **Maker Tool Set** SKU 1823-84

Prepare the Parts

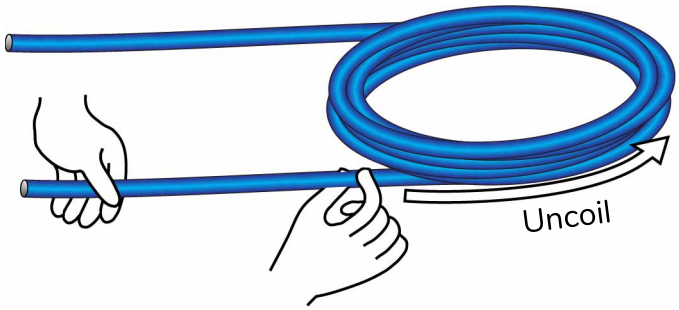
Get your wire and core ready – they'll become your magnet.



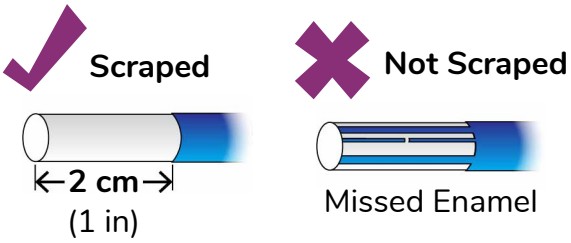
Electromagnets are made by wrapping wire around a magnetic core.

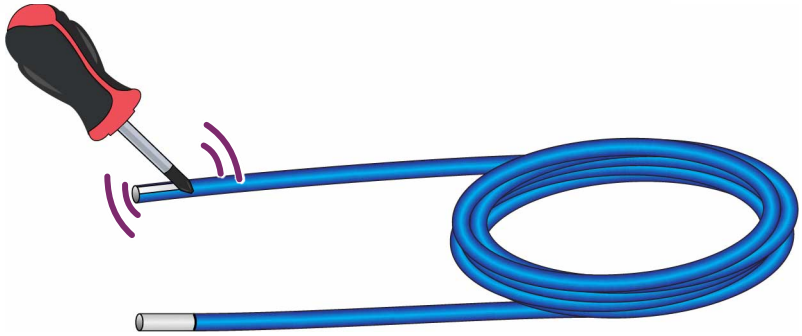
Prepare Your Wire

1 **Carefully uncoil both ends** of the wire. Don't tangle it!



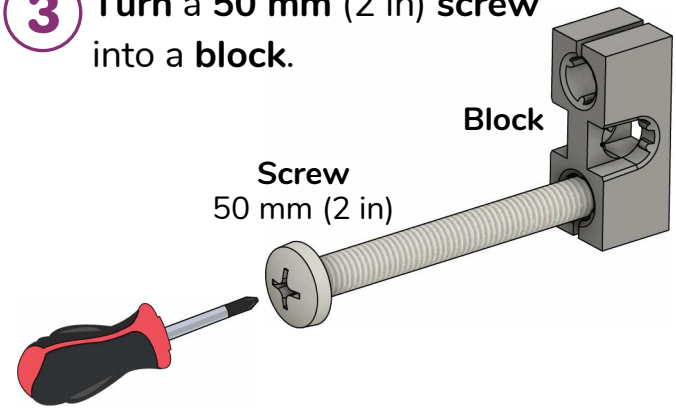
2 **Scrape 2 cm** (1 in) of **enamel** off **both ends** of the wire.



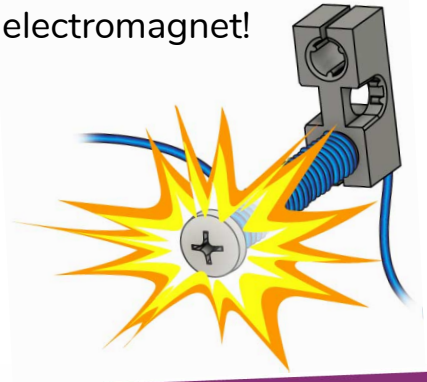


Make the Core

3 **Turn** a **50 mm** (2 in) **screw** into a **block**.



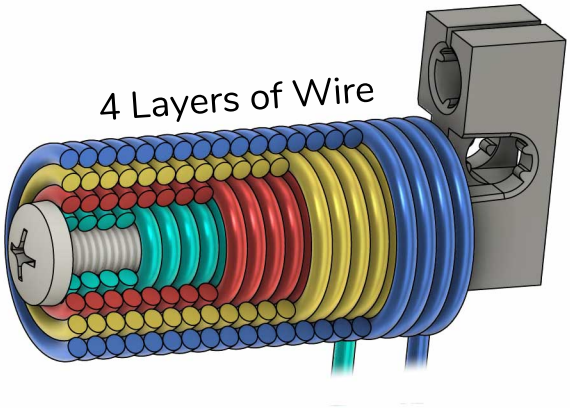
Your wire and core are ready!
Next, you'll make them into an electromagnet!



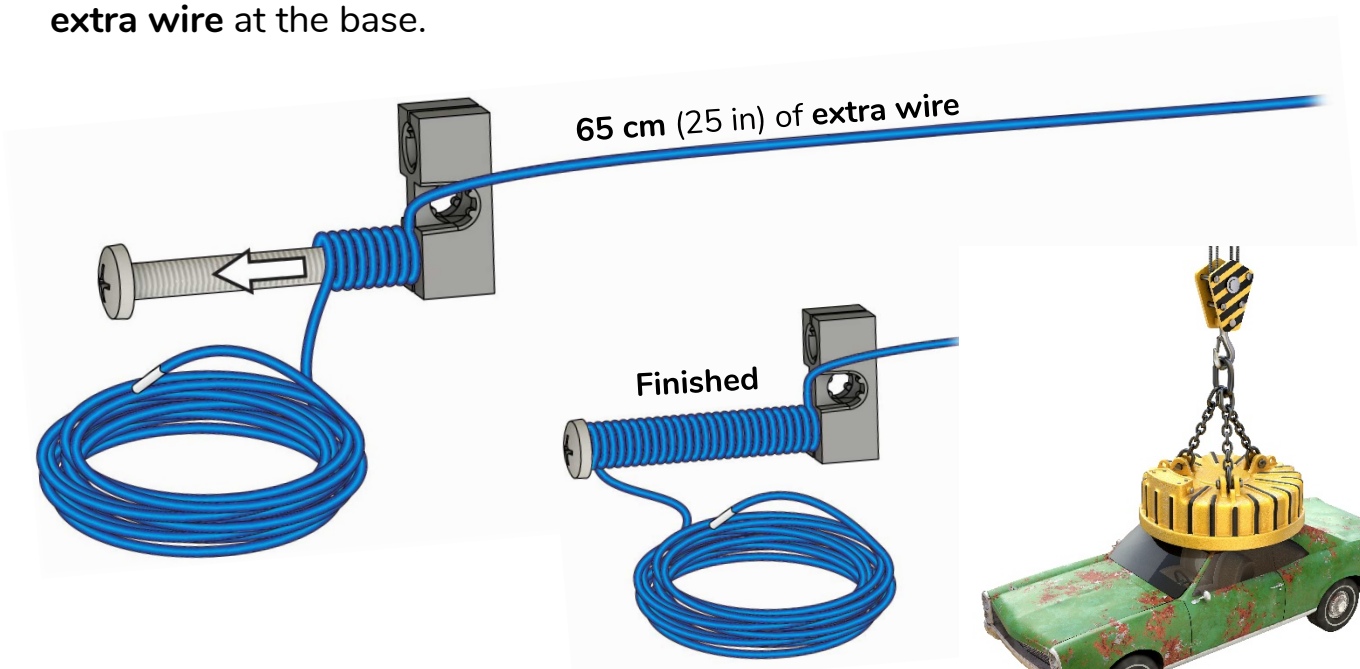
Wrap the First Layer

Your magnet will get four layers of wire wrapping. After you add each layer, you'll test your magnet.

Do you think more wraps will make your magnet stronger or weaker?

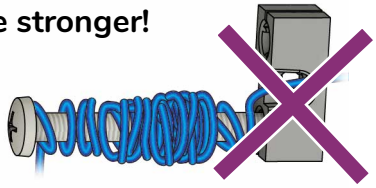


4 **Wrap** one layer of **wire** down the **screw**, leaving **50 cm** (20 in) of **extra wire** at the base.



Neatness Counts!

Don't make your magnet like this...
Neat magnets are stronger!

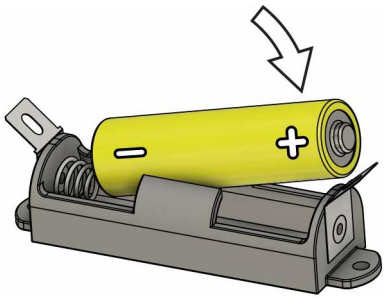


☑ **Your magnet is ready! Let's see how much it can pick up.**

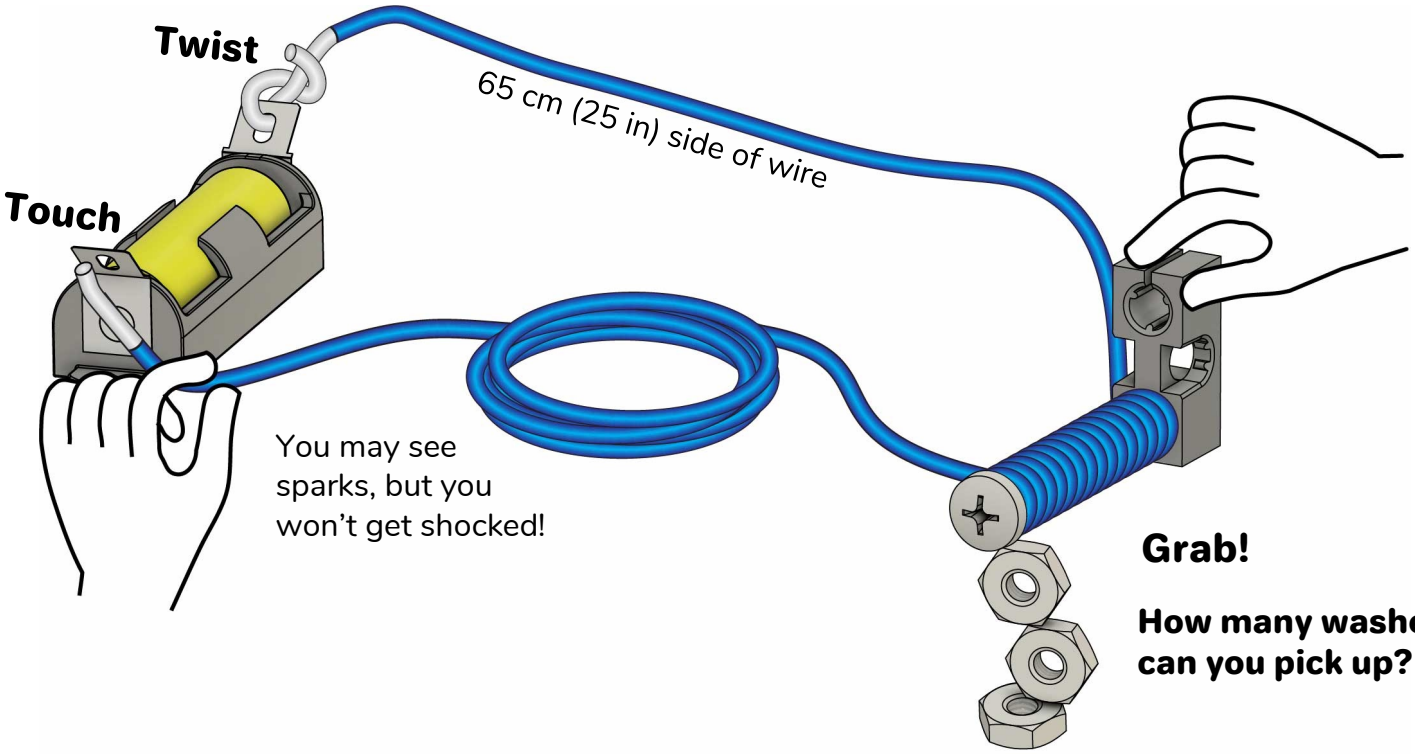
Test Your Magnet!

5 Put the **battery into** the **holder**.

Flat side of battery against the spring.



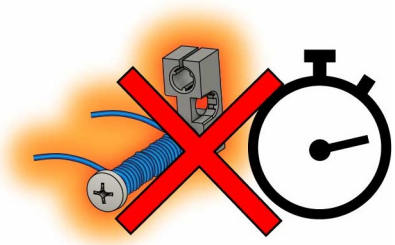
6 **Hook up your magnet and pick stuff up!**



Don't Overheat!

Don't cut the wire!

Don't leave your magnet on!

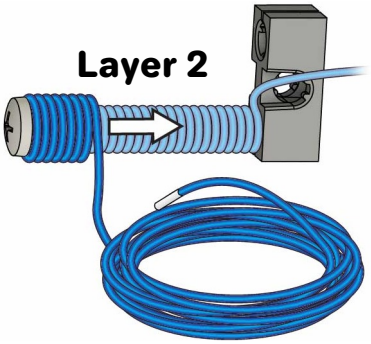


The wire, battery, and battery holder can get *very* hot.

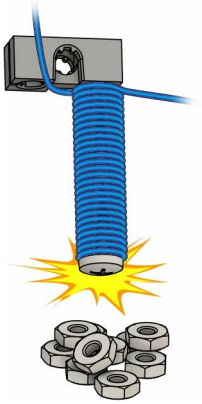
Do not permanently attach the magnet to the battery, run the magnet continuously, or cut the wire much shorter.

Wrap More Layers

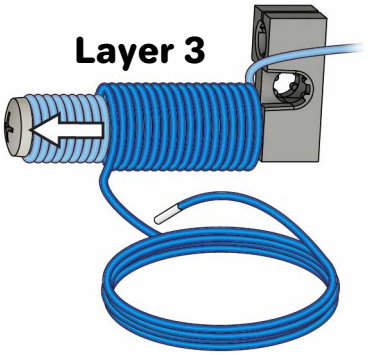
7 Wrap a **second layer**, then **test your magnet!**



How many nuts can you grab now?

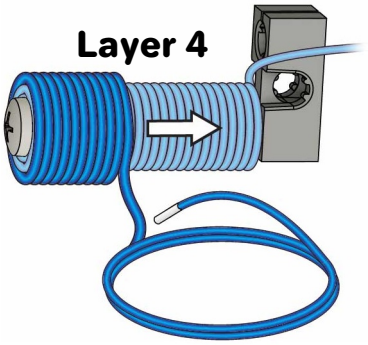


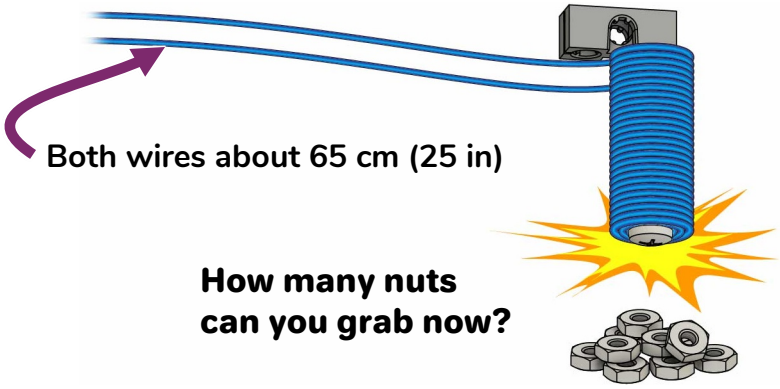
8 Wrap a **third layer**, then **test your magnet!**



How many nuts can you grab now?

9 **Wrap** until both **wires** are the **same length**, then **test it!**





How many nuts can you grab now?

☑ **You're ready to make a boom (arm) for your electromagnet!**

Want to learn more about magnets?

Download the Magnetic Materials Lab at teachergeek.com/electromagnetcrane

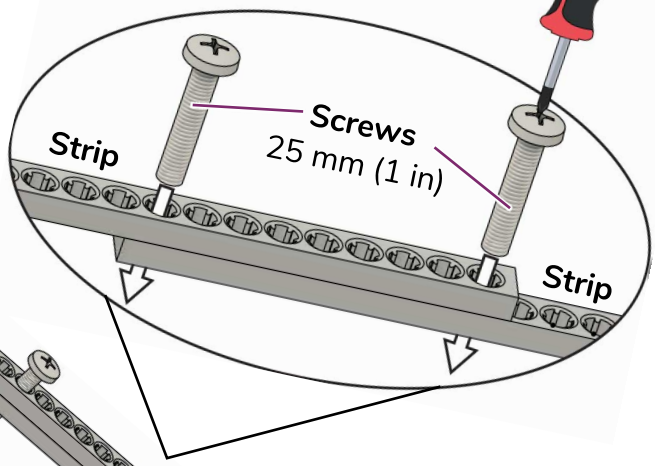
Ages 8+

Make the Boom

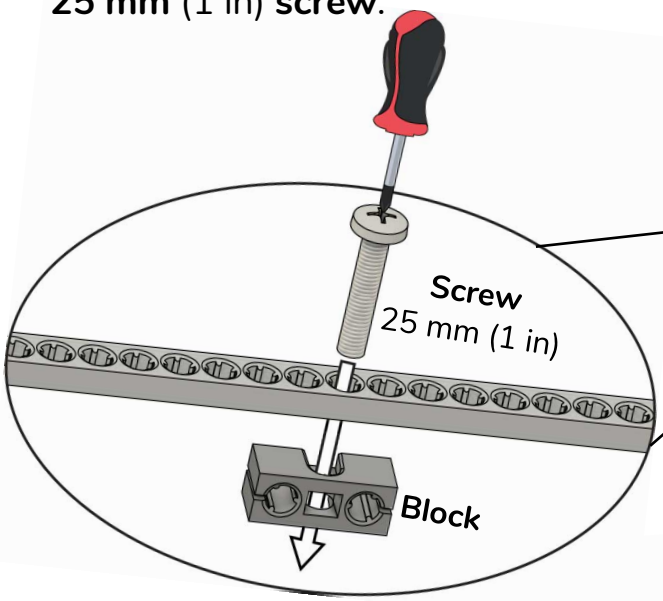
The boom is the arm of your crane.

Finished Boom

10 Attach **two strips** with **two 25 mm** (1 in) **screws**.



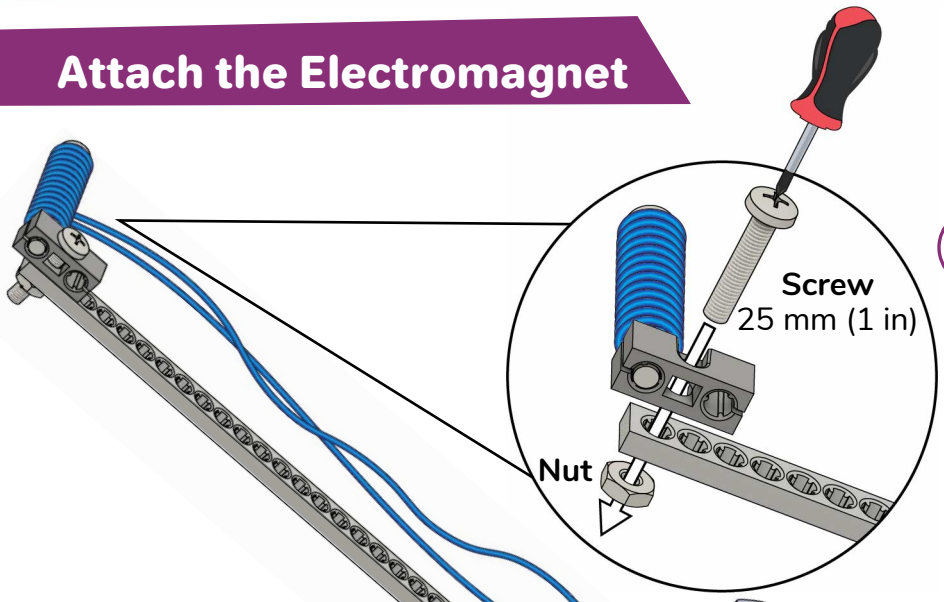
11 Attach a **block** using another **25 mm** (1 in) **screw**.



13 holes (between screws)

☑ **You're ready to add the electromagnet to your boom!**

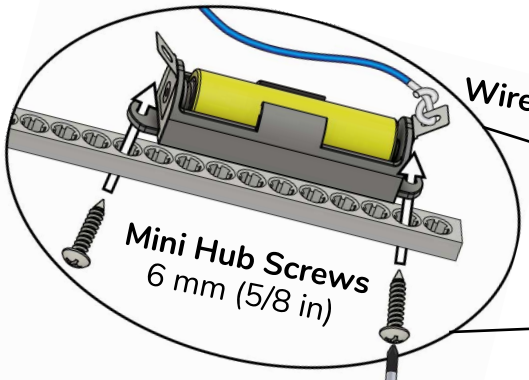
Attach the Electromagnet



12 Attach the **electromagnet** using a **nut** and a **25 mm** (1 in) **screw**.

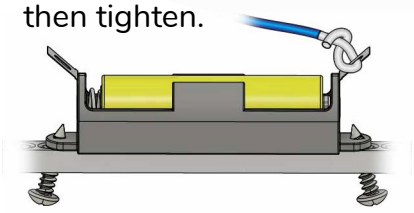
Optional: to tighten nut

13 Attach the **battery holder** using **two Mini Hub Screws**.

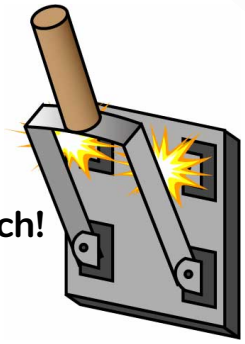


Tip:

Start both screws first, then tighten.



☑ **You're ready to add a switch!**



Make Your Switch

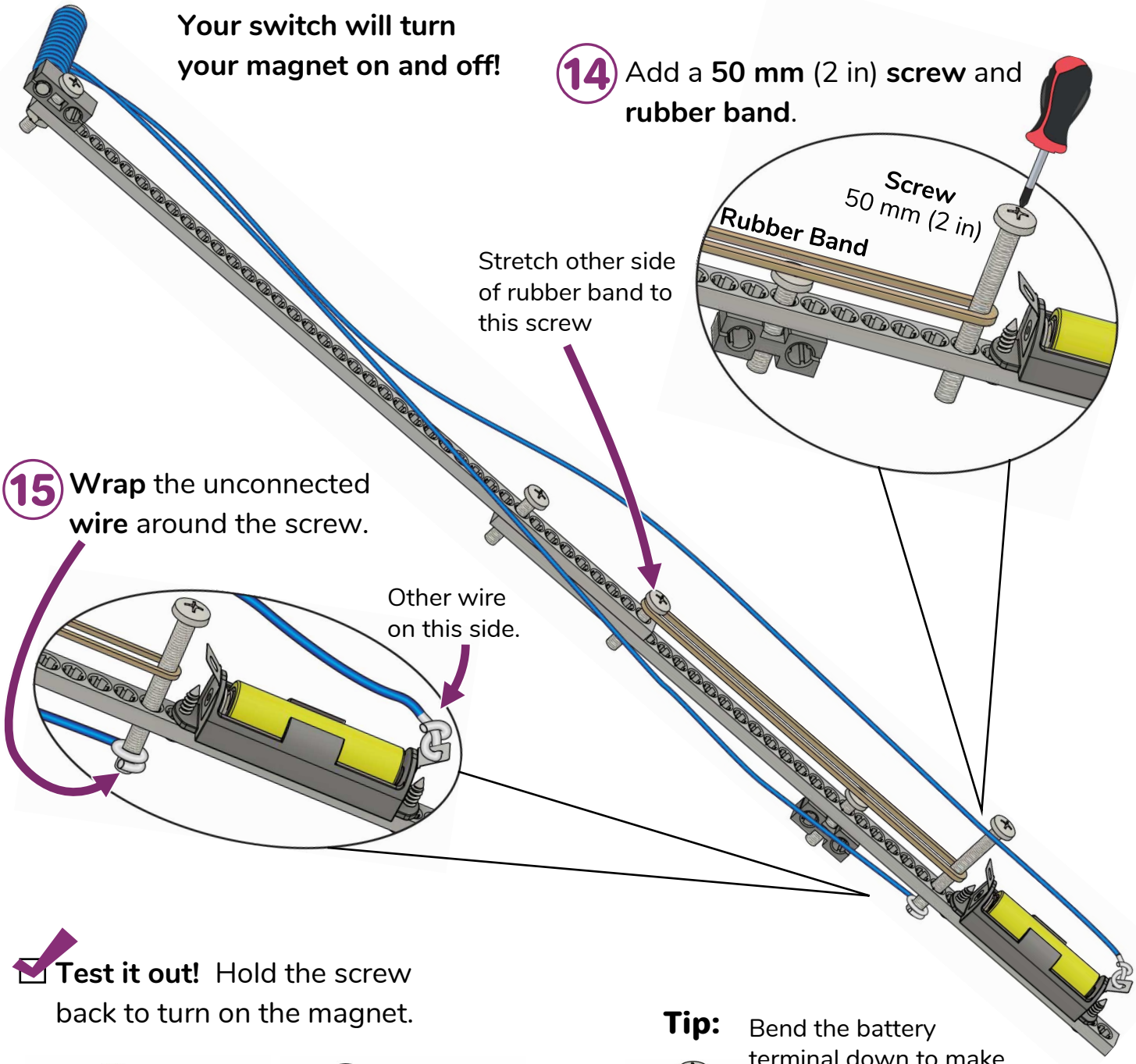
Your switch will turn your magnet on and off!

14 Add a **50 mm** (2 in) **screw** and **rubber band**.

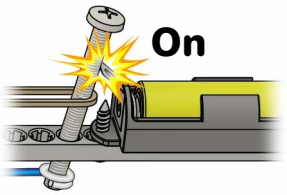
Stretch other side of rubber band to this screw

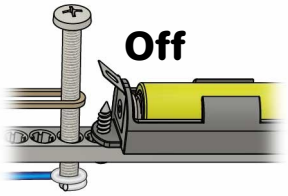
15 **Wrap** the unconnected **wire** around the screw.

Other wire on this side.

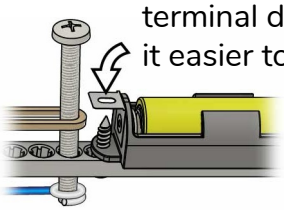


☑ **Test it out!** Hold the screw back to turn on the magnet.

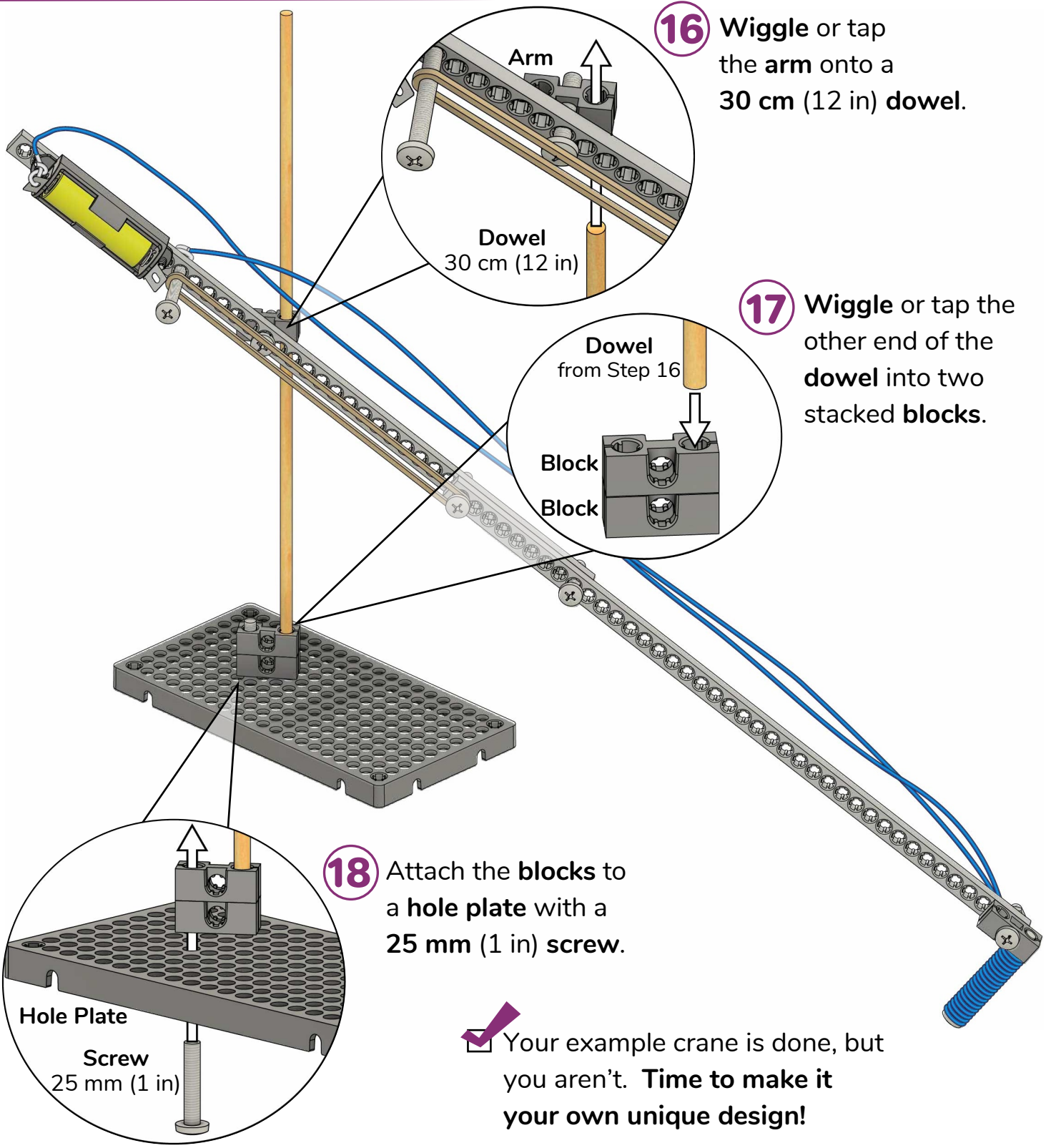




Tip: Bend the battery terminal down to make it easier to turn on.



Add the Base & Mast



16 **Wiggle** or tap the **arm** onto a **30 cm** (12 in) **dowel**.

17 **Wiggle** or tap the other end of the **dowel** into two stacked **blocks**.

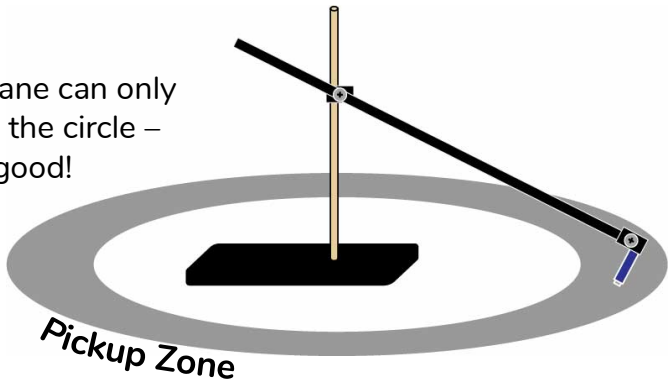
18 Attach the **blocks** to a **hole plate** with a **25 mm** (1 in) **screw**.

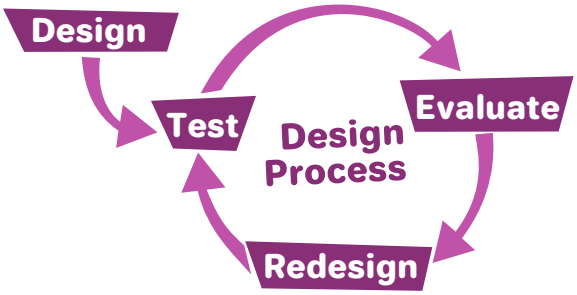
☑ Your example crane is done, but you aren't. **Time to make it your own unique design!**

Evolve Your Design

The example crane to just gets you started – now it's time to evolve the design into a much better crane!

The example crane can only grab objects on the circle – that's not very good!



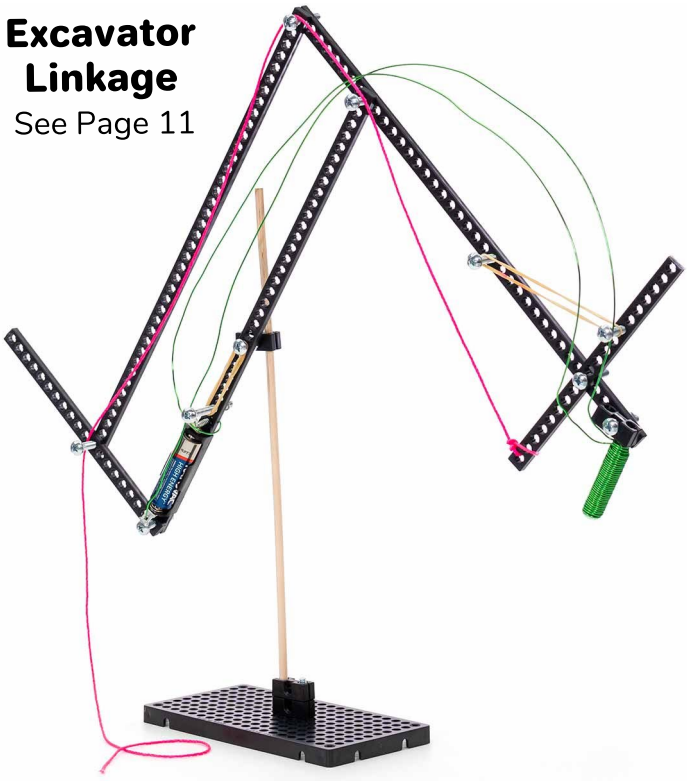


The Design Process never ends! There is no perfect design.

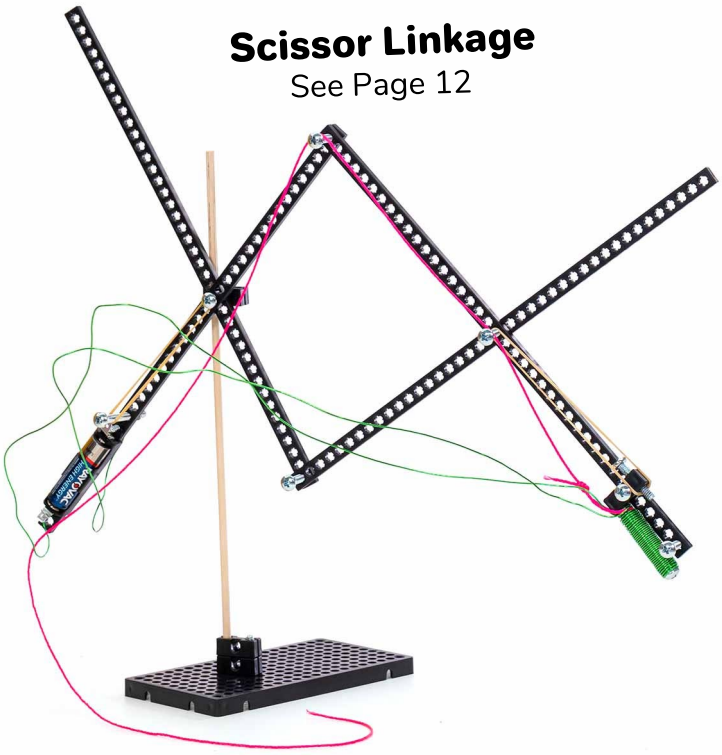
Experiment with these designs!

These can reach much more area than the example crane. But don't stop there – keep testing and evolving the design to make it even better.

Excavator Linkage
See Page 11



Scissor Linkage
See Page 12

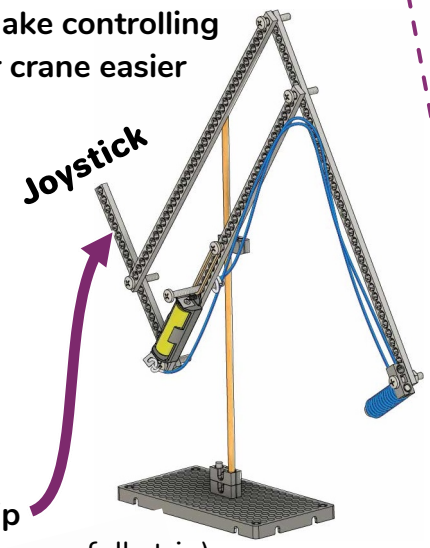


Excavator Linkage

Move the two strips to make your crane move like an excavator!

Add a **Joystick**

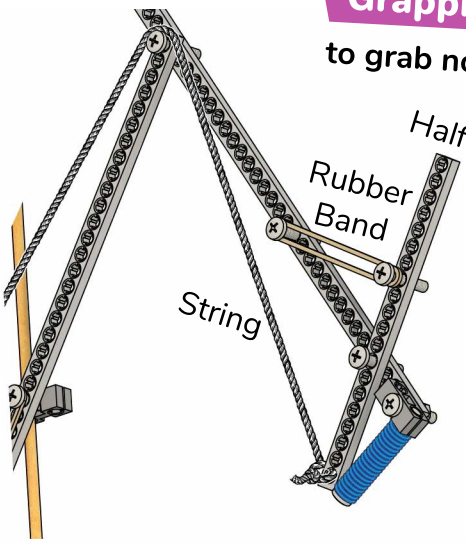
to make controlling your crane easier



Half strip
(cut or snap a full strip)

Add a **Grapple**

to grab non-magnetic objects

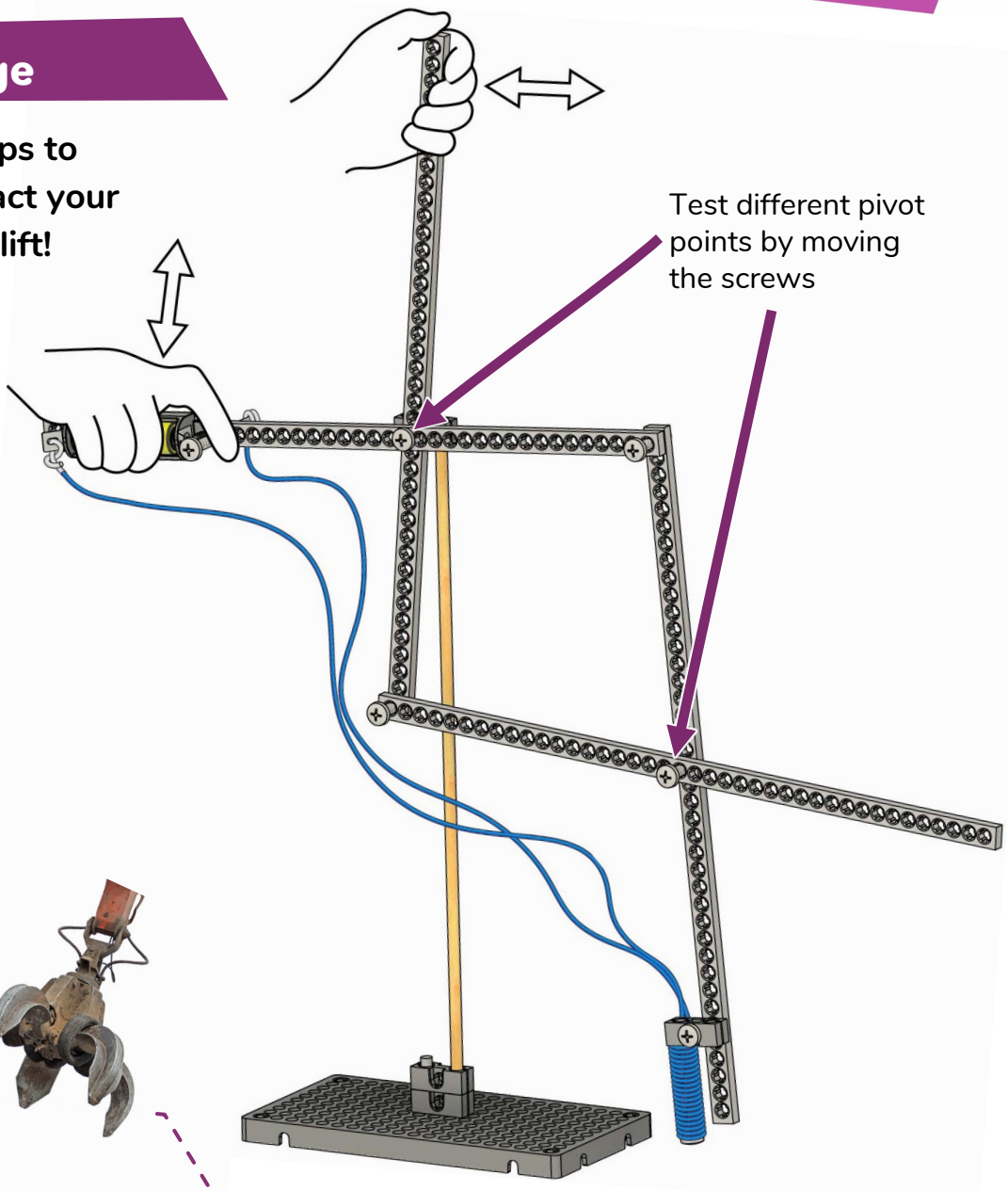


Grapple

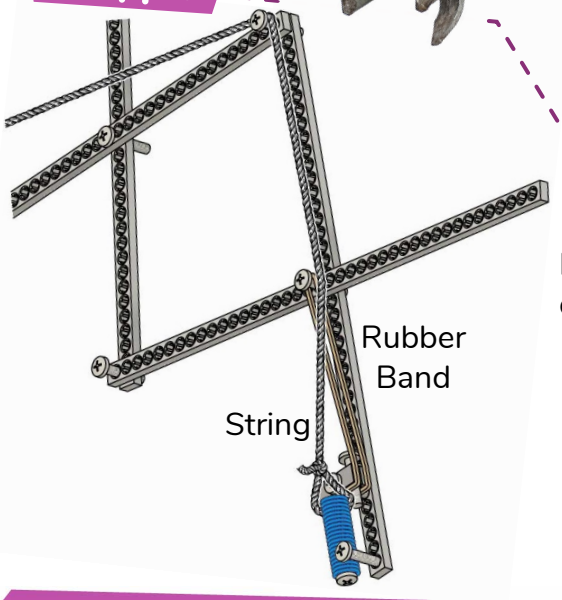
Pull string to open grapple

Scissor Linkage

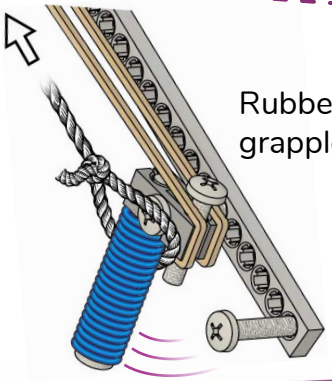
Move the two strips to extend and contract your arm like a scissor lift!



Add a **Grapple**



Pull string to open grapple



Rubber band pulls grapple closed

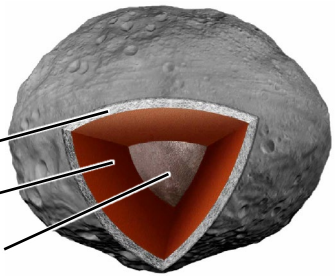
Space Mining Challenge

Want more challenges?
Download them at
teachergeek.com/electromagnetcrane

Redesign your crane to mine minerals from asteroids! Load the most minerals in the spacecraft to win!

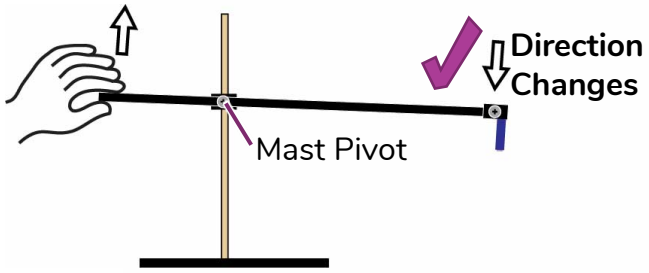
Smash through the crust (optional), gather minerals, and place them in the spacecraft to ship back to Earth!

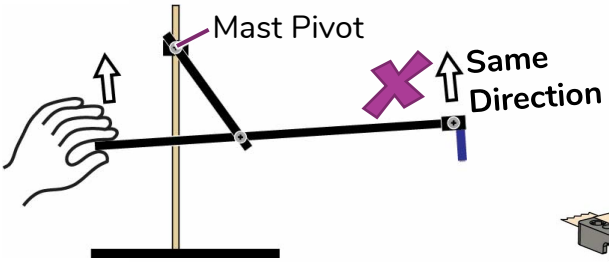
Layers of 4-Vesta, a large asteroid in our solar system.



Constraints
(rules and limits for your design)

1. **Crane's Mast Pivot** must **change direction** of motion

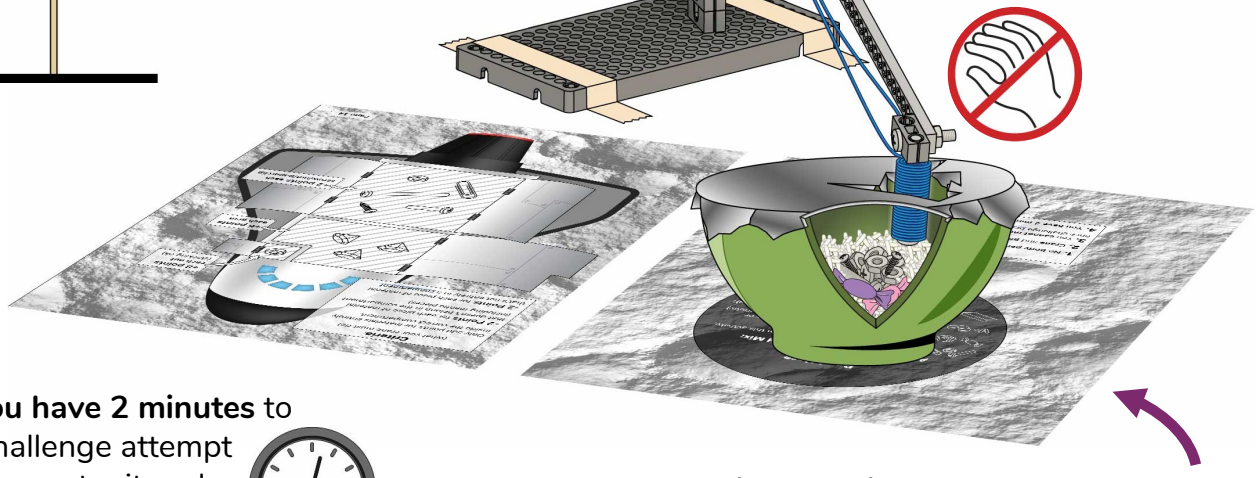




2. Crane base, bowl, and game boards **cannot be moved** once the challenge begins

Tip: Anchor your crane base with tape or a book/weight.

3. **No body parts above gameboards**



4. **You have 2 minutes** to per challenge attempt (you can retry it and change your design)

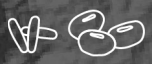
Setup instructions on the gameboards.
(Pages 14 & 16)

Bowl Here

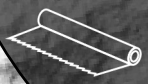
Add These to the Bowl and Mix:

Iron (15 pieces): spare parts from this activity, or paperclips, etc.

Space Gems (optional; 5 pieces): small candies or crumpled colored paper, etc. (can't be magnetic)



Mantle Material (enough to bury iron/gems): rice, beans, or pieces of crumpled paper, etc.



Crust (optional): stretch aluminum foil across top (add layers for greater challenge)

Challenge Rules

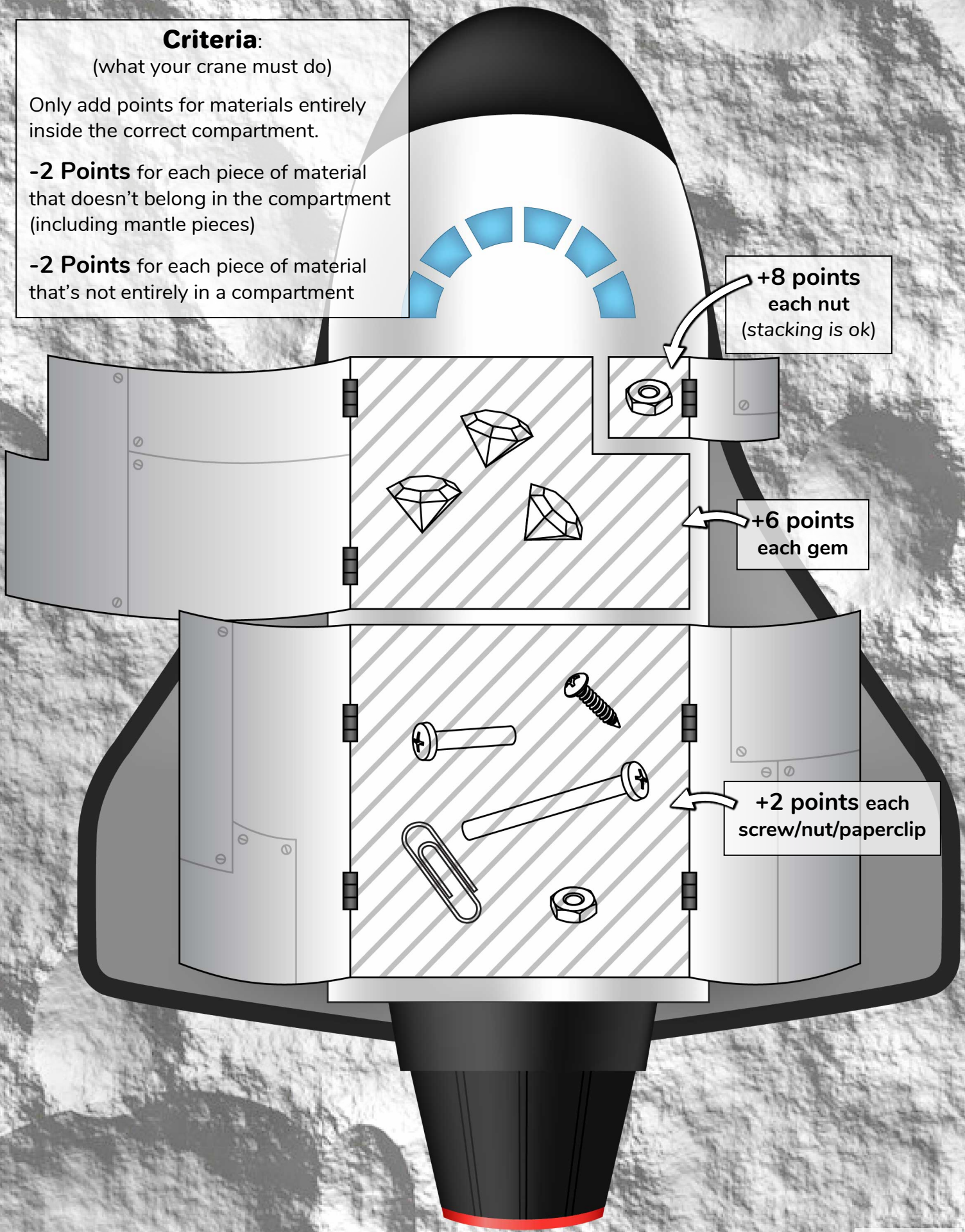
1. **Crane's Mast Pivot** on crane mast must **change direction** of motion

2. You **cannot move** crane **base**, **bowl**, or **game boards** once challenge begins

3. **No body parts above gameboards**

4. **You have 2 minutes** to complete challenge

[back of game board]


Criteria:
(what your crane must do)
Only add points for materials entirely inside the correct compartment.
-2 Points for each piece of material that doesn't belong in the compartment (including mantle pieces)
-2 Points for each piece of material that's not entirely in a compartment
+8 points each nut (*stacking is ok*)
+6 points each gem
+2 points each screw/nut/paperclip

[back of game board]