

Welcome to The Cat-in-a-Box  
Material Science Certification Program!  
Take a passport and **ONE** cat. Do an experiment at every station to receive your token. Finish by collecting the final token here and completing your passport! You can do the stations as many times as you want in any order.





# ***Avalanche!***

Use the materials to create a small box or barrier.

Iterate!

Place in the cat in the box in a tub at the end of the ramp.

Change your box design and try the experiment again!

Roll the balls and snow down the ramp on to the box.

What happens to the box?

What happens to the cat?

Does anything change?

What have you learned?

Don't forget your stamp!

# The Science

With the avalanche, you are experimenting with **Impact Testing**. Impact testing is a way of measuring how much energy a material can absorb before it breaks when hit by a sudden force. Although in a real test the environment is more controlled, you can still learn a lot about how different materials will hold up to an impact, or under pressure.

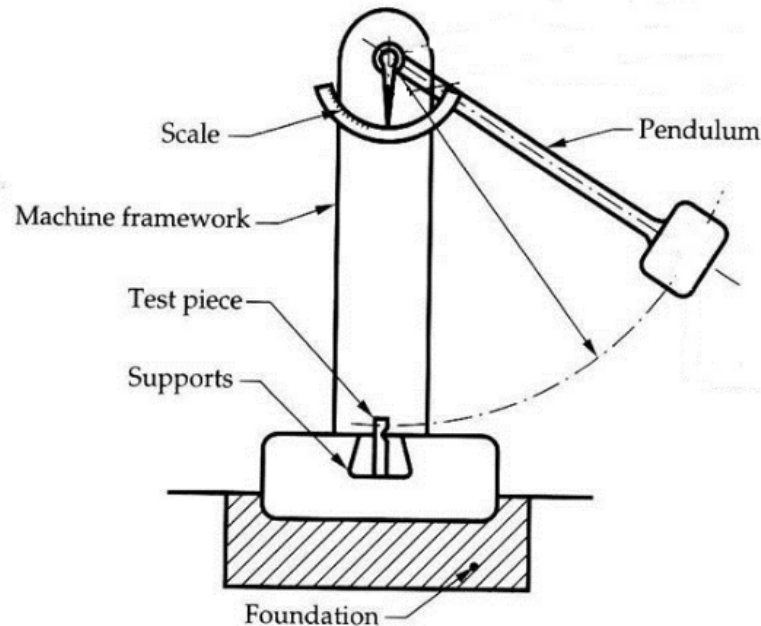
Which pieces are stronger? Where does your box break or bend, if it breaks at all?

## Charpy Impact Test:

A thin sliver of test material is held secure in a block while a hammer swings along a pendulum.

The amount of energy it takes to break the material can be recorded by how far the hammer travels **after** it breaks the test object. Having a controlled, measurable environment makes for good material science!

What are some of the **variables** (things that might change per test) in your avalanche?



## Cat Avalanche Station Instructions

### Material list:

Cardboard squares	Large bins (3+)
Foam sheets	paper towels
paper	two ramps
Straws	Plastic sheets
Felt	Fake snow
Craft Sticks	Wiffle balls
Tape	2+ pitchers
scissors	
rubberbands	Ice (optional)
	cups (optional)

Set out construction materials on two tables with instructions to build a simple box for the cat. Have a third table ready if these crowd. Station instructions go on these tables.

Lay down plastic sheets beneath the two large tubs. Make the fake snow according to directions in another tub.

Set up the ramps so that the low end is in a bin and the high end is resting on a chair, both over plastic. Place wiffle balls, fake snow, ice and paper towels (for cleaning hands).

Students will make structures or barriers for their cat at the tables, then test it in the tub by rolling balls down the ramp and using pitchers/cups to dump on snow and ice. Ask them what happens to their structures? What test was it more prepared for? What could you change?

Students are welcome to fix or change their structure, but facilitate a line so everyone gets a turn testing and encourage patrons to clean up any big messes. Award the badge!

If the instant snow runs out or becomes too unmanageable, sand, gravel or beads can be substituted-or rely on only the wiffle ball experiment.



# HEATWAVE

Can you keep your cat cool?



Make a structure or surface to protect your cat from the heat! Try using different materials to make a blanket, pouch or other protective gear and use the tools to watch the temperature. Can you measure how cool your cat is?

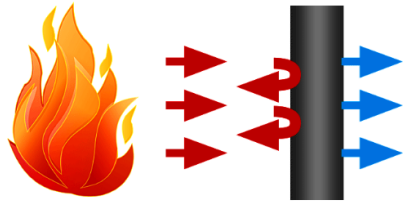
Use the heat lamp, blow dryer and hand warmers to turn up the heat!

Explore the mirrors— does reflecting light also reflect heat?

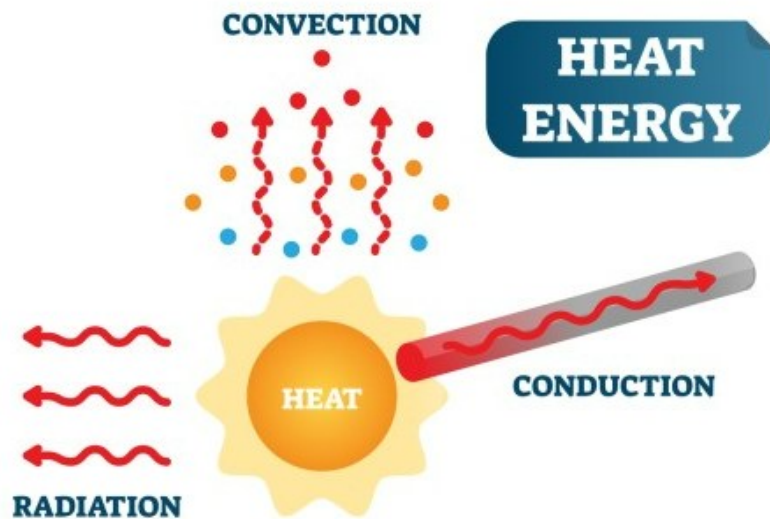
Try the dark colored paper vs the light colored paper— what difference does it make?

# The Science

a material that does not  
conduct heat well



thermal insulator



To protect the cat from heat, you are determining which materials make good insulators. Insulating materials do not heat up easily—they do not conduct heat. All the materials will be different but using the measuring tools you should be able to get an idea of what materials conduct heat better or worse. The shape and amount of material also matters as well as the heat source.

Heat energy transfers in a few ways. The primary methods are radiation (can you feel the heat through the air coming off something that is hot?) and conduction (can you heat up a material and feel that it is warmer?).

Which sources of heat shed more radiation? Which use more conduction?

For an added experiment, you can add the wax with a low melting point—can you increase the heat enough to melt the wax on a piece of cardboard?

## Heatwave station Instructions

### Materials:

Cardboard squares paper bags foam sheets Light construction paper Dark construction paper Mesh/ Screen material Foil Craft sticks Coffee filters Mirror tiles mirror plates	Heat lamp hand warmers thermometers thermal leak detector tape scissors 2+ tubs wax pieces/broken crayons
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Arrange two tables with the building supplies and instructions. Set up the heat lamp over a tub with the blow dryer and hand-warmers nearby. Arrange the testing tools on another table- thermometers, leak detector and crayon pieces. Test the heat lamp.

Students will make a structure or surface for their cat- this can be as simple as putting the cat under a piece of paper or as complex as a little house.

Test how insulating the structures and materials are through different methods: placing under the heat lamp, using the hand warmers (they can go inside, sit on top, bottom, etc.) blowing with the dryer. Allow students to be creative and run their tests but keep a close eye on the heat lamp for safety! The lamp should be left in place and students will have to take turns measuring underneath it.

Encourage the students to use the thermometers and leak detector to observe temperature changes, and try again using different materials or a different shape. Be patient and share supplies!

# *Downpour!*

*Put your cat on a sponge “bed” and test each of these materials by placing it over your cat. Use the pipette to drip a few drops of water over the material and observe what happens.*

*Check on your cat!*

*Try again with another material and observe how the results are different. Finally, try one of the chemically treated materials to see how its properties can be changed.*

*Clean up and dry off!*



## **Gather:**

Your cat  
A pipette  
an empty bowl or plate  
a cup of water

## Several materials:

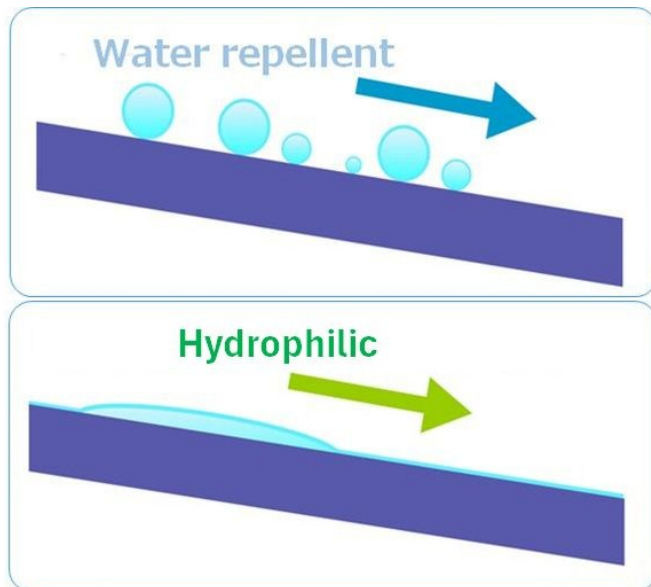
plastic  
foil  
paper  
foam  
felt  
Chemically treated paper

**Remember to share!**

# The Science

What materials repel water (hydrophobic)?  
What materials absorb water (hydrophilic)?

Which of these could be used as a jacket or  
clothing? Which would not?



**Hydrophobic materials** repel water. It may bubble, slide off or pass through but water does not **absorb** into the material. This doesn't mean it will keep the cat dry! If a hydrophobic material has holes or gaps, the water will still fall through!

**Hydrophilic materials** absorb water. When you drip water on them, they bond into the material until they reach a **saturation point**: the material is full and water may drip off or overflow!

## Station set-up and volunteer instructions:

### **Downpour**

#### **Material checklist:**

Pipettes  
sponges  
plastic  
foil  
paper  
foam  
felt  
Chemically treated paper cats  
towels  
2 Pitchers of water  
plastic covering  
Cups  
Bowls  
Bucket for water dumping

Use one table for the testing materials: plastic, foil, etc.

Cover two other tables with plastic and supply bowls, cups and pipettes. Prep the cups with a small amount of water. Keep the pitchers safe for you to refill as needed. Students will put a sponge in a bowl and then their cat. They'll place a material over the cat, drip water with the pipette and see if the cat gets wet. Encourage them to explore absorption, repelling, etc. and ask them about their cat. Place wet supplies in a foil tray. These can be used if they want!

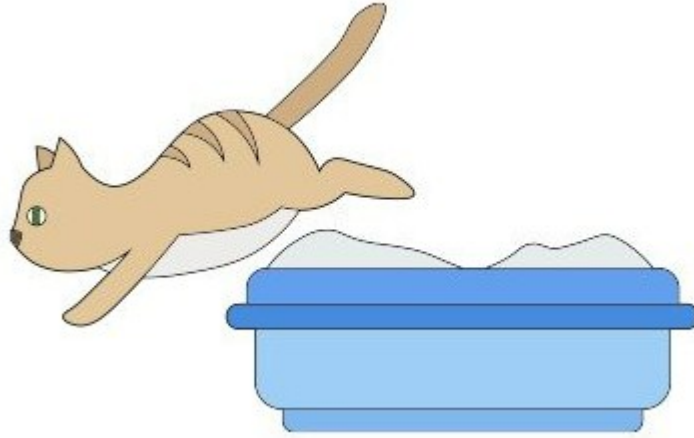
Place bucket to the side of the tables and dump test water there. Clean/dry the workspace, organize materials and refill supplies as needed.

**Cleanup:** Dump all extra water, clean water off plastic tablecloths into the bucket. dump the bucket in the multipurpose room sink. Return all dry supplies to a blue bin. Collect wet supplies and place in a tray. Wet paper can be recycled. Wet plastic cover can be re-used. Gather bowls cups and pipettes for a quick rinse.

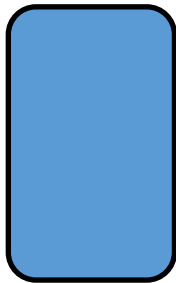
# Litterbox Escape!

For this experiment, your cat will need a leash!

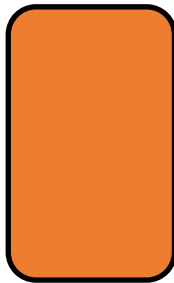
Can you tie a string around your cat?



A



B



C



Test how your cat moves through different materials. Put your cat in one end of a material “litterbox” and drag it through.

What happens to the material? To the cat?

Try dragging the cat through at different speeds– does it make a difference if the cat moves fast or slow?

How do the different materials change what happens?

Which is more messy?

Now try the wet test!

# The Wet Test

Put your cat in a cup of water and bring it to a bowl of material.

Pull out the cat, and dunk it in the bowl– pull it back out.

Is anything different from when the cat was dry?

Try again with different materials! What material would make the cleanest litter?

What material might absorb the most liquid?

Clean off your cat and clean up any spilled litter!



# The Science

Cat litter is intended to contain a cat's waste by being absorbent and bonding with the liquids, but sometimes it can be messy and stick to the cat.

Moving through the materials shows a few things– how **dense** is the material? The cat will sink into low-density materials, but stand on top of higher densities.

It also shows **friction**. When objects rub against each other, they create friction. Overcoming friction takes energy– so the harder it is to pull your cat across or out of the litter, the more friction you have to overcome.

Which material slows down the cat the most?

Friction will also cause some materials to stick to your cat. Is anything stuck to it when you pull it out? When you add water, it begins bonding with some of the materials and being absorbed. This increases friction and makes it more likely material will stick to your cat. **Adhesion** is when the water causes something to stick.

Which materials stick the most? Would they make good litter or bad litter?

Station set-up and volunteer instructions:

## **Litter Box Escape**

### Materials:

6 tubs  
cat litter  
sand  
shredded paper  
yarn or string  
scissors  
Tarp  
Small bowls  
2 large bowls  
paper towels  
broom

Move or remove all but two tables in the multipurpose room.

Spread the tarp out of the floor

Half-fill two tubs of each: Litter, sand, shredded paper and place on the tarp.

cover a table with plastic and place the extra materials on it, pushed off to the side.

Arrange string, scissors and station instructions on the other table and place near the entrance to make cat leashes. Students may need help with the knots.

Students will place the leashed cat in a tub of material and pull it out-fast or slow, however they want. Ask them to observe what happens to the material and how the materials are different. Encourage them to take turns. Paper can be just put back in the tub. Sand and litter will have to be occasionally swept up.

Prep some bowls with small amounts of paper, litter or sand at the covered table. Bring the large bowls of water around for the students to dip their cat in before the wet test- try not to leave the large bowls in the floor! They can then dip and pull their wet cat from the small bowls. These bowls can be on the table, or on the tarp depending on how busy the station is. Kids are welcome to repeat these tests as much as they like but make sure everyone is getting a turn!

This will be a messy activity! Patrons are welcome to use the sink. Do your best to keep it safe- have a walkable path into and out of the room as well as to the sink and around the tests.

Clean-up:

Recycle shredded paper (even wet).

Dump the water in the sink.

Debris on tarp can be slid into the trash

Fold up tarp to be cleaned outside

Return any dry materials, trash any wet materials in bowls.

Clean bowls in sink

Sweep up any remaining debris.

# Dress to Impress!

Make an outfit to protect your cat from the elements. Think about what materials can keep it warm and safe in any weather.



Sketch your design here

What materials are you using?

How will your design protect the cat?

Take a picture or show off your cat to receive your badge!