

STEM PATHWAYS

Please Just Contain It **STEM** Challenge!

The Problem

The County's Emergency Management Board is developing a plan to improve containment and clean up of chemical spills. They have contacted your team of scientists to investigate the use of the super absorbent material found in diapers (Hydrogel). You have been given the product to test and establish recommendations for use by the EMA board.

The Challenge

To develop and test an hypothesis to determine hydrogel's absorption capacity for different liquid wastes.

Find a Measurable Solution

ASK: What is your hypothesis?

HYPOTHESIZE: Identify independent & dependent variables.

TEST: Conduct an experiment.

ANALYZE: Results, draw conclusions, try again!

COMMUNICATE: Findings and make recommendations.

Things to Consider

1. What are the chemical and physical differences between water and oil ?
2. Which type of spill do you predict the product will best contain or least contain? What is the basis for your prediction?
3. How will you determine the product's effectiveness in containing a spill?

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What is Your Hypothesis?

Identify Independent and Dependent Variables

- Color
- Odor or Smell
- Water Base
- Oil Base
- Hydrogel Amount



SAFETY ALERT:

You can touch this "hydrogel", but PLEASE don't put any chemical, even a safe, non-toxic one like this, into your eyes, nose or mouth!



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Materials & Supplies

- Polymer Compounds
 - Baby Diapers (mine the hydrogel) OR
 - Hydrogel (purchase from science source)
 - Corn Based Polymer (contact Ohio Corn Growers Association)
- Water Base Items (vinegar, ketchup, water, tempera paint, juice, milk, syrup, salt water, etc.)
- Oil Base Items (vegetable oil, baby oil with coloring, mineral oil, soy ink, oil based paint, etc.)
- 1 Gallon Plastic Zipper Type Bag, Scissors (if mining the polymer from diapers)
- Single serve plastic cup, ½ teaspoon for each polymer type, 1 tablespoon for each water and oil base sample, plastic spoons

TIME: 30 - 45 MINUTES

Design Space

- Table space sufficient for each group to work.
- Cover tables for easy clean-up.
- Supplies to diaper mine for each group or hydrogel.



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- Did you accept or reject your hypothesis?
- What changes will you make?
- What questions do you still want to explore?

Engage the Learner

- What do you already know about the test compound? What might you need to research?
- What other variables could be tested?
- How should product application be factored into your recommendations?
- How will you report your findings to consumers, emergency management board and other scientists?

Observations & Conclusions

- Observe the rate of absorption and the amount absorbed... successful, somewhat, not at all?
- How does the volume change in each sample tested?
- How does the product standup to masking an odor or soaking up color?
- What might be some other uses for this product by consumers, industries, agriculture producers, etc.?

What other variables would you like to test? Post your findings and challenge others to find hydrogel’s contain it limits!

STEM Career Path...

Materials Scientist

- Who else might be involved? *Chemists, engineers, health specialists, hydrologists, soil scientists, physicians, marketers*
- Who benefits? *Environmental and human health benefits are extensive – protection of drinking, surface and ground water sources, soil, wildlife, animal and plant life*
- What other industries might benefit from this work? *Manufacturers of any chemical, health care, homeland security, oil and gas, transportation, government, etc.*

Refer to Career Focus Card for more details.



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Working in Groups of 4 to 6...

FIRST! Mine Your Polymer

Step 1: Carefully use the scissors to cut through the inside lining of the diaper and remove the cotton-like material.

Step 2: Put the stuffing and the plastic lining into a clean, 1 gallon zipper-type bag.

Step 3: Scoop up any powdery material from the table; place it in the bag and seal the bag.

Step 4: Shake the bag to remove the powdery polymer from the stuffing.

Step 5: Remove the stuffing and plastic lining from the bag; **THROW IT AWAY.** You should have the mined polymer remaining in the bag.

SECOND! Test the Polymer for Spill Containment

Step 6: Use water as your control test. Place 1 T. of water in a plastic cup and add ½ teaspoon of the hydrogel polymer. Wait a few seconds and stir with a spoon.

Step 7: Now choose two water-base products and two oil-base products to test.

Step 8: Repeat step 6 by placing 1 T of each water base and oil base product chosen in a separate plastic cup and adding ½ teaspoon of the hydrogel to each cup. Wait a few seconds and stir with a spoon.

How effective was the hydrogel polymer?

- ☛ In absorbing the spill
- ☛ In neutralizing the odor
- ☛ In soaking up the color

Note: Compare each test to the water control. What are the similarities and differences to volume change indicating the spill is binding with the polymer?

THIRD! OPTIONAL
Compare Petroleum-Based
to Corn-Based Polymer

Step 9: Place 1 T of water in a cup and add ½ teaspoon of the corn-based polymer to the water. Wait a few seconds and stir.

Step 10: Place 1 T of the same water and oil base samples that you used in Step 8 in separate cups and add ½ teaspoon of the corn-based polymer to each cup.

What differences did you observe between the effectiveness of the hydrogel petroleum-based polymer and the corn-based polymer in containing or cleaning up the spill, neutralizing odor or absorbing color?

What is your hypothesis?
Will results find you accepting or rejecting your hypothesis?

What are your independent and dependent variables?



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STEM PATHWAYS Please Just Contain It Analysis Data Sheet

Hypothesis: _____

_____ Accept Reject

Independent Variable: _____ Dependent Variable: _____

Sample Tested	Describe Rate of Absorption	Describe Change in Volume	Describe Ability to Mask Odor	Describe Ability to Soak up Color
Control Solution				
Water Based Sample 1				
Water Based Sample 2				
Oil Based Sample 1				
Oil Based Sample 2				

Your Recommendation to the EMA Board:



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career

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Did You Know? Some polymers can absorb 500 times their weight in water increasing in volume by 30 to 60 times.

SCIENCE

Materials Scientist

What other product benefits could result from incorporation of hydrogels?

- Hydrogels are polymers, long chain molecules that are superabsorbent used to make millions of disposable diapers and to improve water holding capacity in container gardens.
- New hydrogels are being used in drug delivery systems, soft contact lenses, wound dressing, replacement cartilage and scaffold for tissue engineering – medical advances improving the health care of all ages.
- Some hydrogels are environmentally sensitive having the ability to sense changes in pH, temperature or the concentration of a metabolite.

TECHNOLOGY

IT Specialist

Why is computer modeling important in the design process of new materials and products?

- 3-D computer modeling software is used to study the structure and properties of complex molecules.
- Sophisticated testing equipment supports modeling, simulation and analysis of experimentation.

ENGINEERING

Chemical Engineer

Why would comparing natural versus synthetic polymers be important in designing new products?

- Green products are growing in demand as consumers are looking to do their part to reduce global impact and the carbon footprint.
- Savings in production costs, worker safety, shrinking natural resources are strong reasons for using one polymer source over another or seeking alternative polymer sources.

MATH

Marketing Specialist

Why is it important for your team to understand what the consumer wants from your product?

- Trends in the market place are important to creating new products.
- Challenges or problems manufacturers or consumers have had with a product enables tests to be run to fine-tune materials or focus on new product development.
- Every product requires a marketing plan highlighting the products safety and consumer benefits.



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Materials Scientist

Finding
Solutions
For...

- New products, processes and testing methods through applied research.
- Safer products and higher quality with a focus on more environmentally friendly alternatives.
- Make materials that make life better from sun lotions to prosthetic limbs, race cars to snowboards.

Job
Forecast
Looks
Like...

- **Median Income:** \$88,990 per year
- **Job Outlook:** 5% growth from 2012-2022
- **Job Environment:** Laboratories and offices where they conduct experiments and analyze data.
- **Expected Growth Areas:** Electronics, energy and transportation, environmental research to reduce pollution and improve efficiency.

Skill Set
Needed...

- **High School Courses:**
 - Math: geometry, algebra, calculus, statistics
 - Science: biology, chemistry, and physics
 - Specialized: computer science
- **Initiative:** curiosity, perseverance, great focus for hands-on experimenting.
- **Critical-thinking:** analytical and problem-solving skills to conduct precise and accurate scientific experiments to develop new and improved products, processes and materials
- **Communication:** writing and speaking skills to share experiments and results
- **Teamwork:** to motivate and work well with others on a research group

Education
and Training
Required...

- **Entry Level Jobs:** Require Bachelor's degree in chemistry, biology, engineering or other related field
- **Additional Training and Certifications:** master's or doctorate degrees preferred, HAZMAT training



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COLLEGE OF FOOD, AGRICULTURAL,
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U.S. Department of Labor, Occupational Outlook
Handbook, 2014-2015 Edition,
bls.gov/ooh