# SALTY STATES

## TEACHER GUIDE

LAUNCH

# PLANNING

Here's a suggested schedule for this kit! The activities are designed to be completed in order, but you can decide when to do them over time. Required times are estimated.

| ACTIVITY INFORMATION | SECTION (S) | TIME REQUIRED | DAY/ LESSON |
|---|---|---|---|
| **ACTIVITY 1: EXCITING PHASES**<br>Conduct an evaporation race to begin learning about phase changes.<br>**Time required: 2 h** | ☐ Vapor Race | 60 minutes | Day 1 |
| | ☐ State and Temperature | 60 minutes | Day 2 |
| **ACTIVITY 2: ELEVATE THE POINT**<br>Mix up some solutions and investigate the effect of salt on the boiling point of water.<br>**Time required: 3 h** | ☐ Salt Solutions | 60 minutes | Day 3 |
| | ☐ Waiting on Wat | | Day 4 |
| **ACTIVITY 3: LOWER THE POINT**<br>Make salt | | | |

activity 1

# EXCITING PHASES

If a liquid is left out in the open for a few days, it might seem to disappear. This type of change depends not just on the liquid's surroundings, but on the liquid itself. In this activity, your student will conduct a "vapor race" to find out how easily different liquids evaporate.

***LEARNING GOALS:***

I can use visual, graphical, and mathematical representations to explain the relationship between state of matter and temperature for various substances.

## I VAPOR RACE

**WARNING! Contains hazardous chemicals.**
Do not eat or drink. Wash your hands after use.

**WARNING! Contains flammable chemicals that can easily catch fire. DO NOT BRING NEAR HEAT OR FLAMES.**

## PREPARATION AND SUPERVISION

- In this activity, your student will be determining how quickly several different liquids evaporate by streaking them across a piece of paper with cotton swabs.
- Throughout the kit, they will learn more about why the evaporation rates are different (it is based on volatility or vapor pressure resulting from differences in intermolecular forces such as hydrogen bonding).
- They should observe that the acetone evaporates the fastest, followed by isopropyl alcohol, then the isopropyl alcohol-water mixture, then water.
- The vocabulary term evaporation is defined.
- Chemical structures of the three compounds are included, but your student will likely not yet be equipped to use them to explain the vapor races.
- Encourage your student to keep the caps on the alcohol and acetone when not in use so they do not evaporate too much during wait time.
- All the supplies will need to be reused later in the kit, so be sure your student is mindful of that.

## THINK ABOUT IT!

**Question 1: Summarize the results of the vapor races. What were the fastest and slowest liquids to evaporate? Were your predictions correct? Explain.**
**Answer:** From fastest to slowest: acetone, alcohol, alcohol/water, water.
**How to Help:** *Encourage your student to think about the reasons for their predictions and whether they were surprised by the result and why.*

**Question 2: Use the diagrams from Question 1 to predict how their boiling points will be different.**
**Answer:** The aluminum chloride will increase the boiling point more than the potassium chloride will because it dissociates into four ions rather than two.

**Question 3: Determine the boiling point elevation for a 2.0 molality solution of each solution from Question 1.**
**Answer:**
- Using the equation provided in the Student Workbook,
  - For aluminum chloride: $\Delta T_b = 0.512 \times 2.0 \times 4 = 4.10$ °C increase
  - For potassium chloride: $\Delta T_b = 0.512 \times 2.0 \times 2 = 2.05$ °C increase

activity 3

# LOWER THE POINT

In the previous activity, your student saw that adding different salts to water changes the solution's boiling point. Can salts also change the freezing point of solutions?

***LEARNING GOALS:***

I can describe the formation, properties, and behaviors of solutions at the bulk scale and explain them at a particle level.

## STOP THE FREEZE

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### PREPARATION AND SUPERVISION

- In this section, your student will make more salty solutions and find out how long each solution takes to freeze.
- The time required to freeze is directly correlated with the melting point (and freezing point) of each solution.
  - The longer a solution is in the freezer, the more thermal energy that is transferred from the solution to the surroundings in the freezer.
  - This means the solution's temperature decreases more when it is in the freezer for a longer time until the temperatures of the solutions and the inside of the freezer are equal.
- The student is asked to make particle diagrams for each solution while the ice cubes are in the freezer. Use the previous guidelines for particle diagrams to check their work.

### THINK ABOUT IT!

**Question 1: Summarize your results. What solutions froze at the highest and lowest temperatures? How did your results compare to your predictions?**
**Answer:** The solution that should have taken the longest to freeze (had the lowest freezing point or the greatest decrease) is aluminum sulfate, and the solution that should have taken the least time to freeze (had the highest freezing point or the least decrease) is the dilute sodium chloride (C).
**How to Help:** *Encourage your student to think critically about their predictions and analyze the reasons for them.*

LAUNCH

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|---|---|
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| Instructions | IN-SALTSTT |
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