Grade 5 - Properties of and Changes in Matter

STATES OF MATTER SIMULATOR

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Review

- All things are made of matter
- Matter takes up space and has mass
- Matter exists in 3 main states
  - Solid
  - Liquid
  - Gas

Review

- **Solid**
  - Holds its shape and volume
- **Liquid**
  - Takes the shape of its container, volume stays constant
- **Gas**
  - Expands to fill the container it is in (doesn't hold shape or volume)

Changing Between States

- Temperature may cause matter to change states
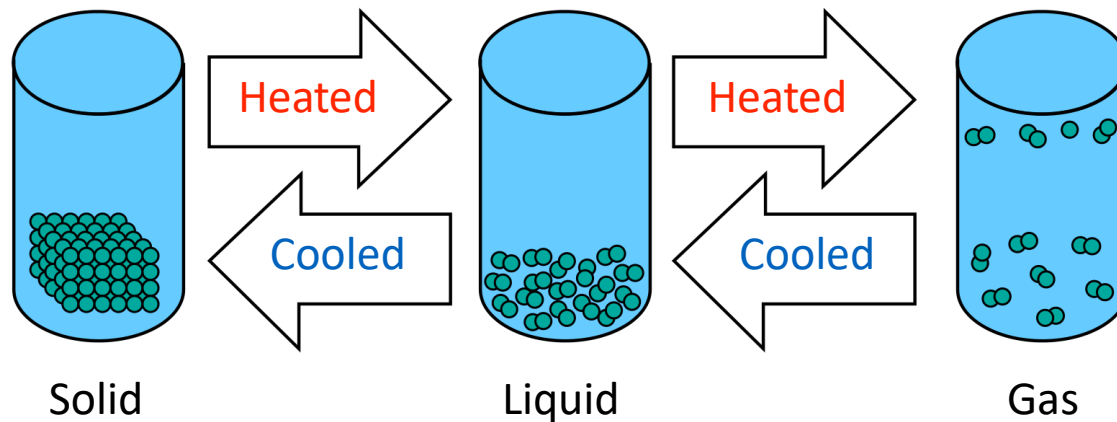

Water as a Solid
0°C or colder
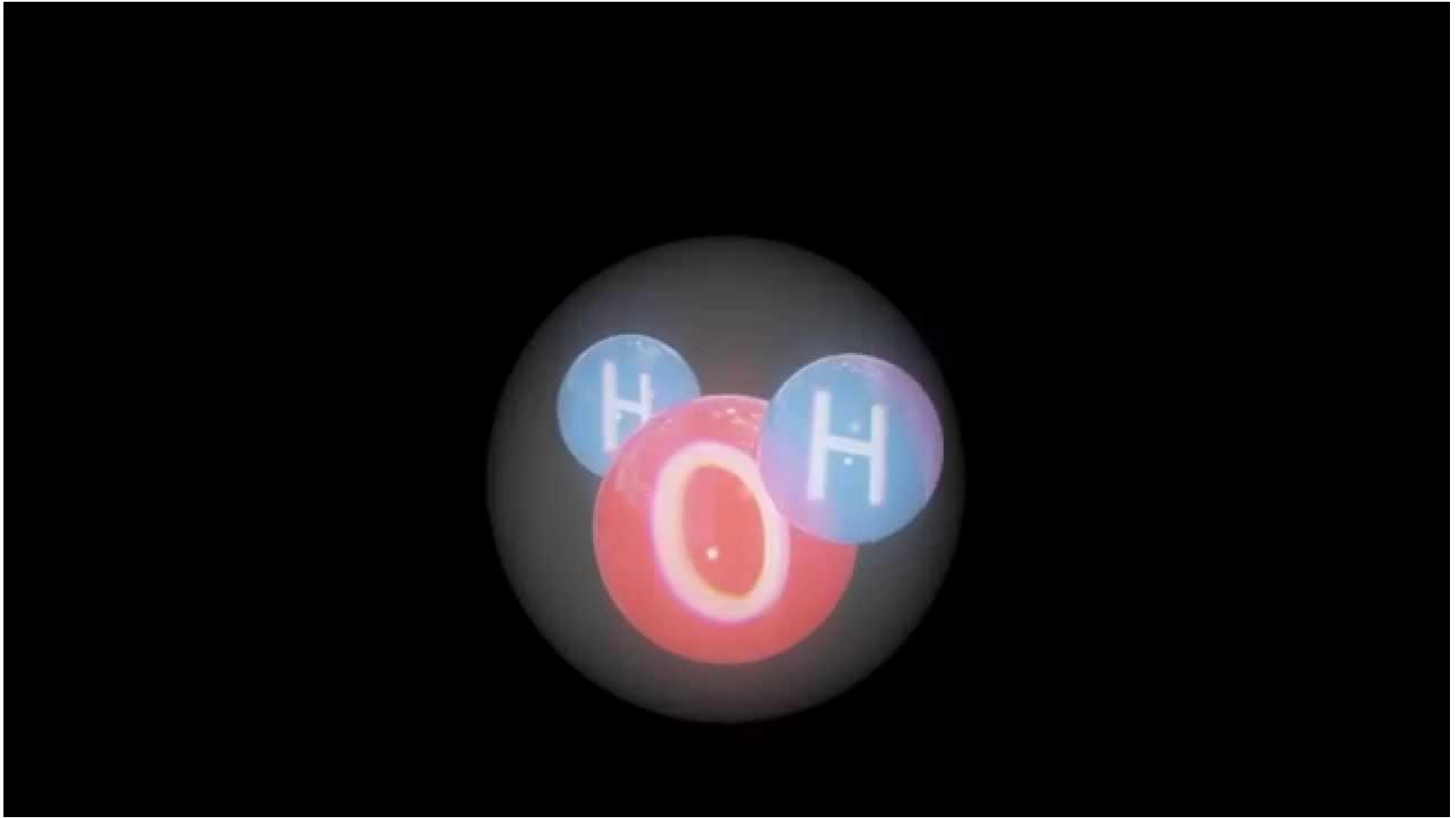

Water as a Liquid
between 0°C and 100°C

Water as a Gas
100°C or hotter

At the Molecular Level

- **Solid:** molecules are tightly packed together and barely move
- **Liquid:** molecules are close together and move around each other
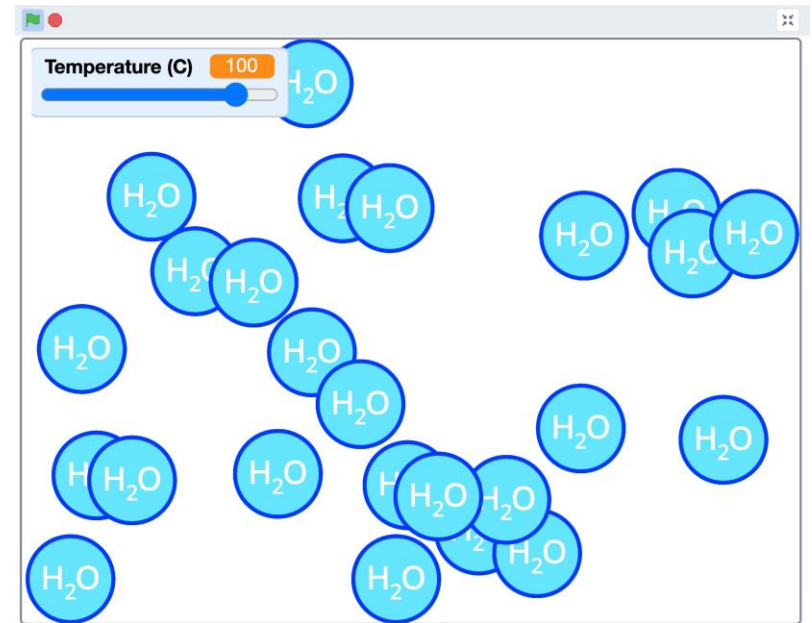- **Gas:** molecules move freely and quickly

Solid   Heated →   ← Cooled   Liquid   Heated →   ← Cooled   Gas

Water States of Matter Animation

Coding Task!

- Using Scratch, you will code an interactive animation that shows how water molecules respond to changes in temperature

Starting from a Template

- For this project, you will start from a template

- This means a little bit of the work has been done for you, so we can jump right into the important stuff

- You still have the freedom to customize it!

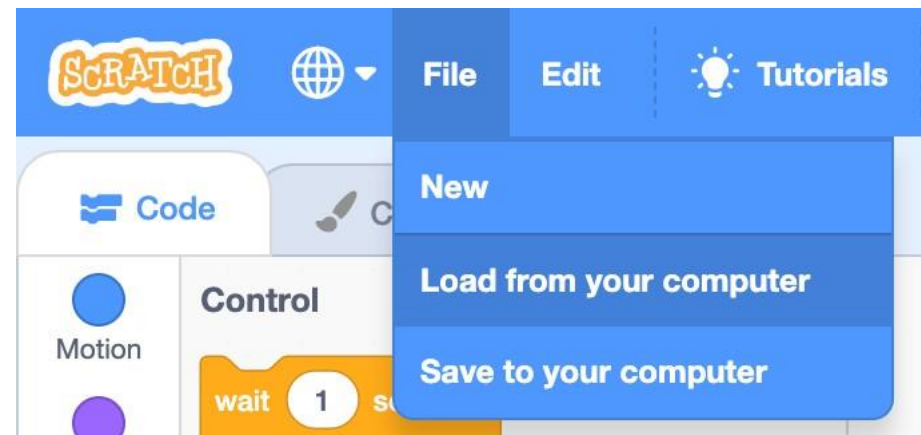# Finding the Template

1. Use the following link:

   https://scratch.mit.edu/projects/888301602/

2. Teachers can "look inside" the file ahead of time and save it onto computers. Name it: Water Molecule Simulation - Starter

3. Follow the steps on the next slide to learn how to open a downloaded file.
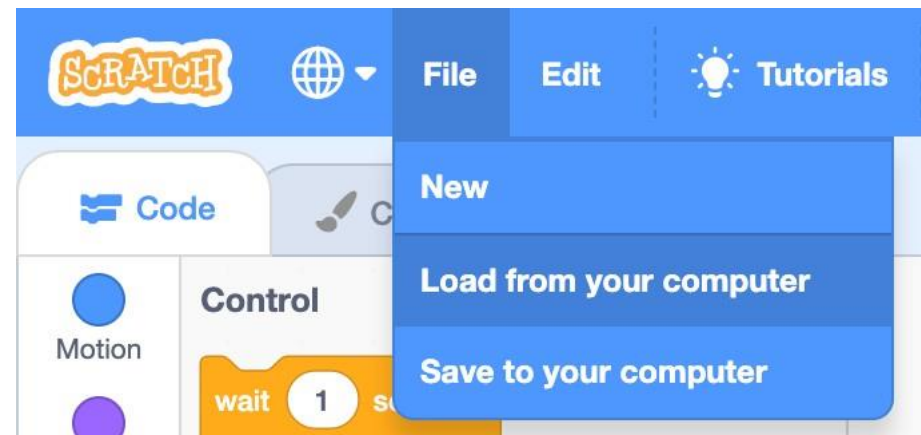
Loading the Template

If the template has been downloaded onto computers:

1. In Scratch, create a new project then select File > Load from your computer

2. Find the template file - "Water Molecule Simulation - Starter.sb3"

3. Open it

What does the template provide?

Part 1

CONDITIONAL STATEMENTS

Determining Temp. Ranges

- Our first step will be to determine whether our water molecule should be acting like a solid, liquid, or gas based on the temperature reading

- **Recall:** At what temperature range is water…

  - a solid?

  - a liquid?

  - a gas?

Temperature Ranges

- If the temperature is <u>less than or equal to 0°C</u>, the water will be a <u>solid</u>

- If the temperature is <u>greater than 0°C and less than 100°C</u>, the water will be a <u>liquid</u>

- If the temperature is <u>greater than or equal to 100°C</u>, the water will be a <u>gas</u>

Temperature Variable

- In this project we have a variable that represents temperature in degrees Celsius
- The template has been set up so that there is a slider the user can use to change the temperature from -20°C to 120°C

Temperature (C)   100
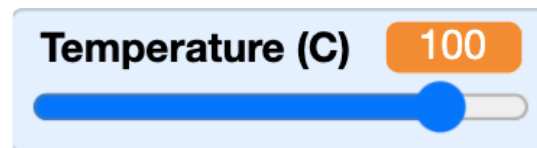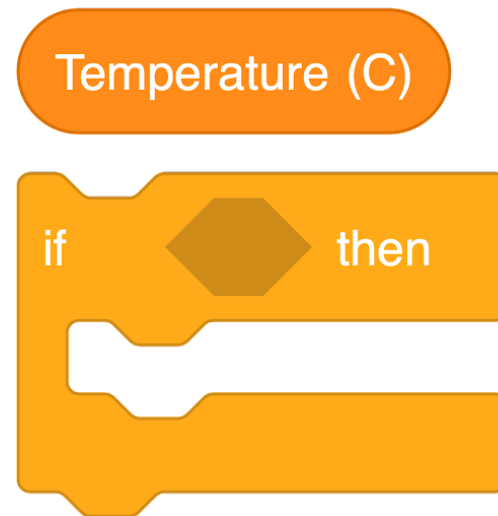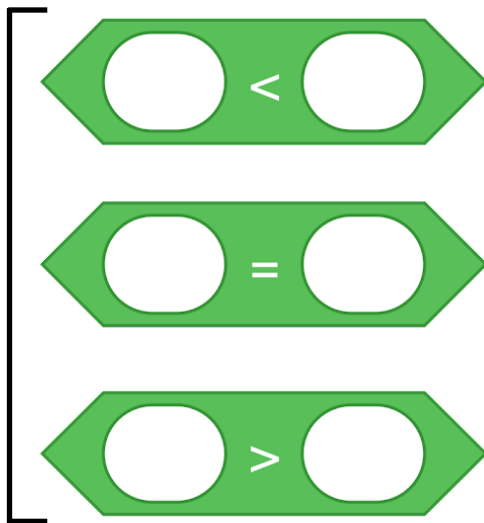
Conditionals

- In coding we use <u>conditional statements</u> to check if something is true

- If it is true, we can then take a certain action

- Examples from everyday life:

  - If it is raining, then grab my umbrella

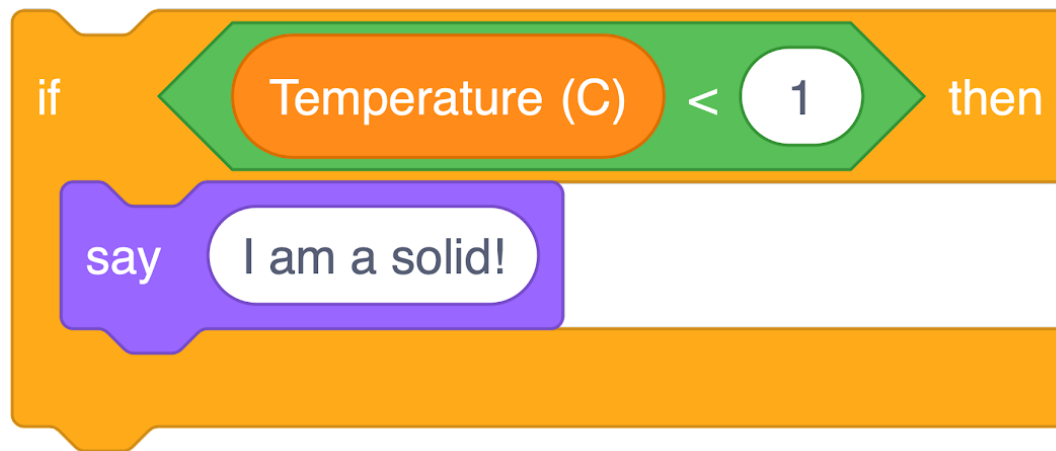 - If time = 6 pm, then go to kitchen for dinner

Conditionals - Solid

- Using the blocks below, how can we check if the water molecules should behave like a solid?

- **Hint:** it can be helpful to think of it as "less than 1" rather than "less than or equal to 0"

We only need one of these, but which one?

Conditionals - Solid

- If the temperature is <u>less than or equal to 0°C</u>, the water will be a <u>solid</u>
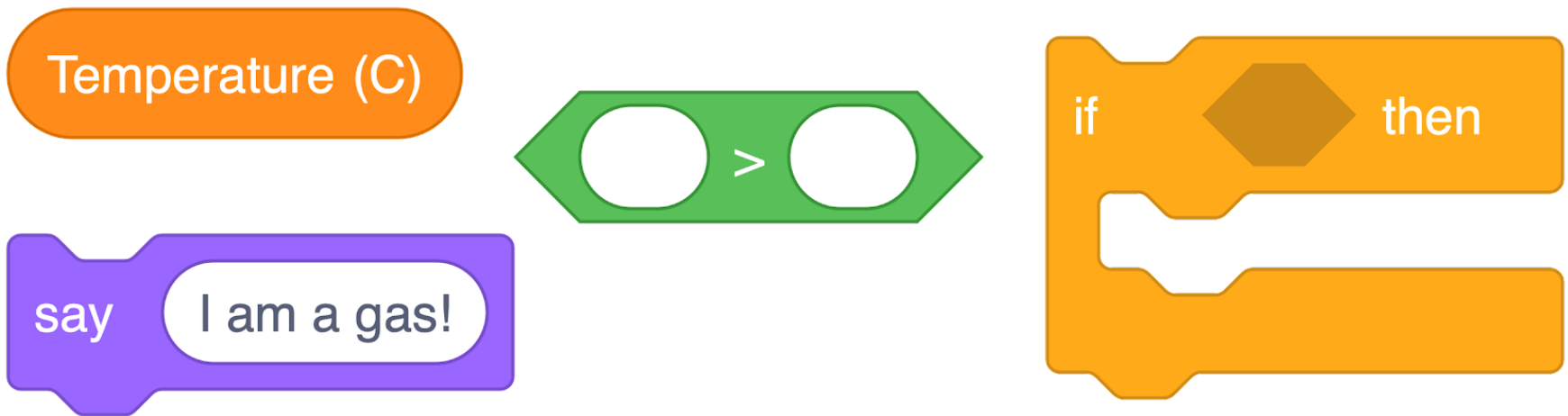- **In code:**

Conditionals - Solid

- Add this code to your project inside the forever loop

Conditionals - Gas

- If the temperature is <u>greater than or equal to 100°C</u>, the water will be a <u>gas</u>

- Use the blocks below to check if the water molecules should behave like a gas!
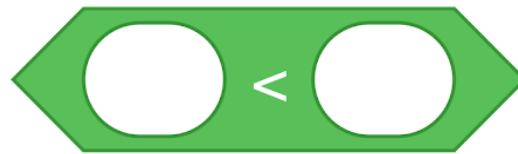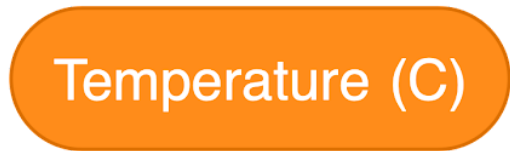
Conditionals - Gas

Conditionals - Liquid

- Checking for liquid state is a little different because there are two conditions we have to check

- If the temperature is <u>greater than 0°C **and** less than 100°C</u>, the water will be a <u>liquid</u>

Conditionals - Liquid

- If the temperature is <u>greater than 0°C **and**</u> <u>less than 100°C</u>, the water will be a <u>liquid</u>

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Conditionals Complete!

Testing your Code

- Press the green flag button and see if your molecules respond to different temperatures by adjusting the temperature slider.

- If they don't respond the way you expect, take some time to "debug" your code
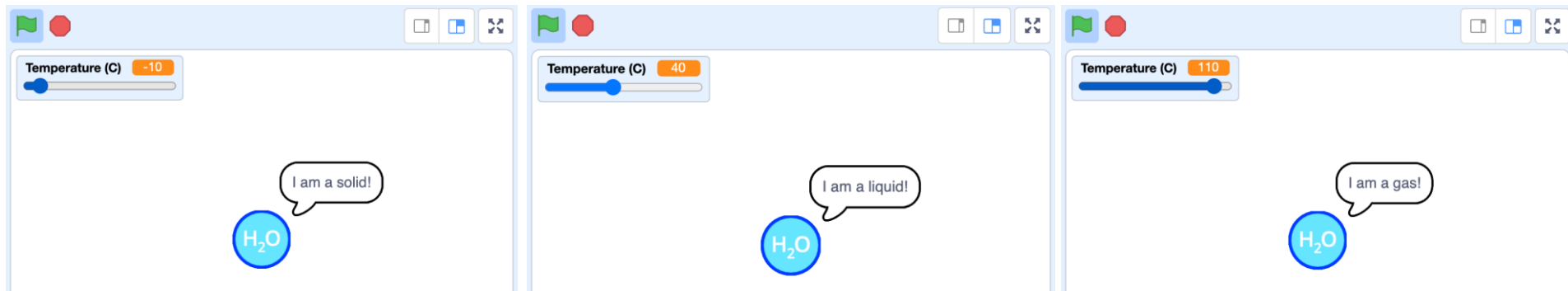
Save your Code!

Part 2

MOLECULE MOVEMENT

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How should they move?

- Now that our sprite knows when it should be a solid, liquid, or gas, we have to make it move like it.

- **Recall:** What should molecule movement look like as…

  - a solid?

  - a liquid?

  - a gas?

At the Molecular Level (Recall)

- **Solid:** molecules are tightly packed together and barely move
- **Liquid:** molecules are close together and move around each other
- **Gas:** molecules move freely and quickly

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Movement - Solid

- Using the blocks below, how can we make the water molecules move like a solid?
- Molecules are tightly packed together and barely move
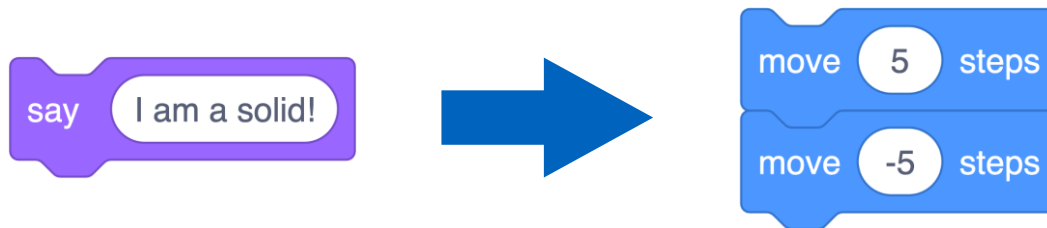- **Hint:** using a negative number for steps will make the sprite move *backwards*
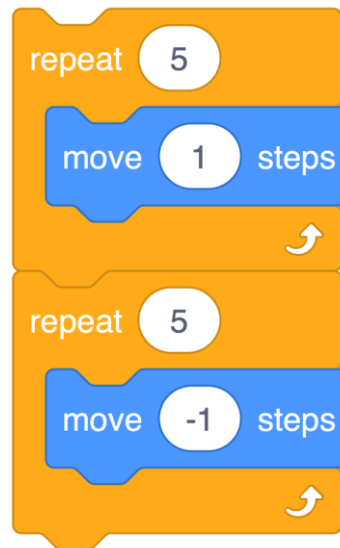
Movement - Solid

- Your first question might be - why do we need repeat blocks? Why can't we just use the move blocks alone?

- Replace your "say 'I am a solid!'" block with the movement code below!

  - What do you observe?

  - Does it give the visual effect we want?

Movement - Solid
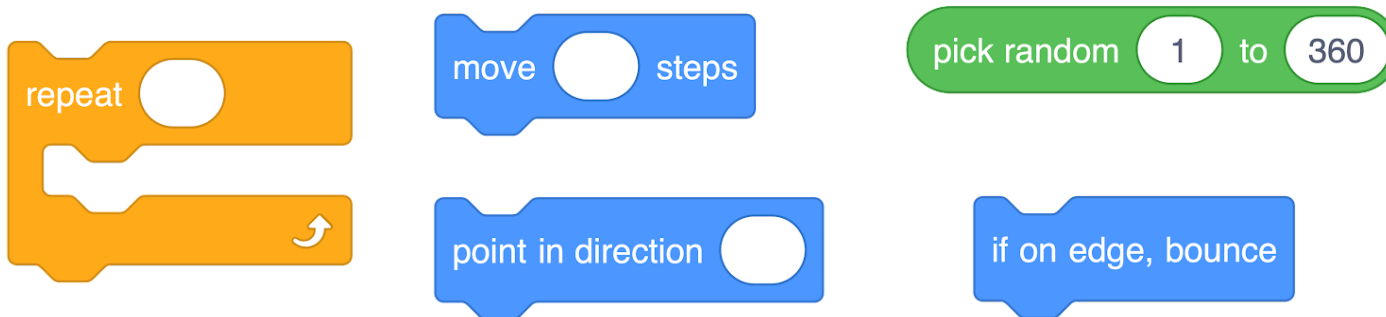
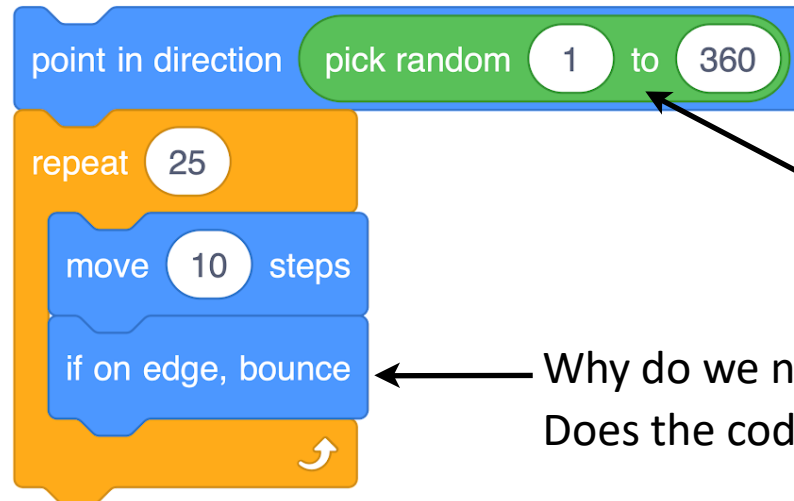- Molecules are tightly packed together and barely move
- **In code:**

Movement - Gas

- Gas and liquid will be a little different than the solid!

- Using the blocks below, how can we make the water molecules move like a gas?

- Gas molecules move freely and quickly

repeat

move [ ] steps

pick random (1) to (360)

point in direction [ ]

if on edge, bounce

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Movement - Gas

- Gas molecules move freely and quickly
- **In code:**

point in direction (pick random 1 to 360)

repeat 25
    move 10 steps
    if on edge, bounce

Why 1 to 360?

Why do we need this block?
Does the code work without it?

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Degrees of a Circle
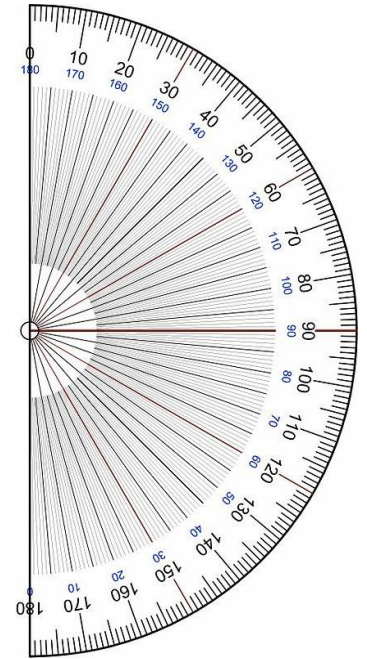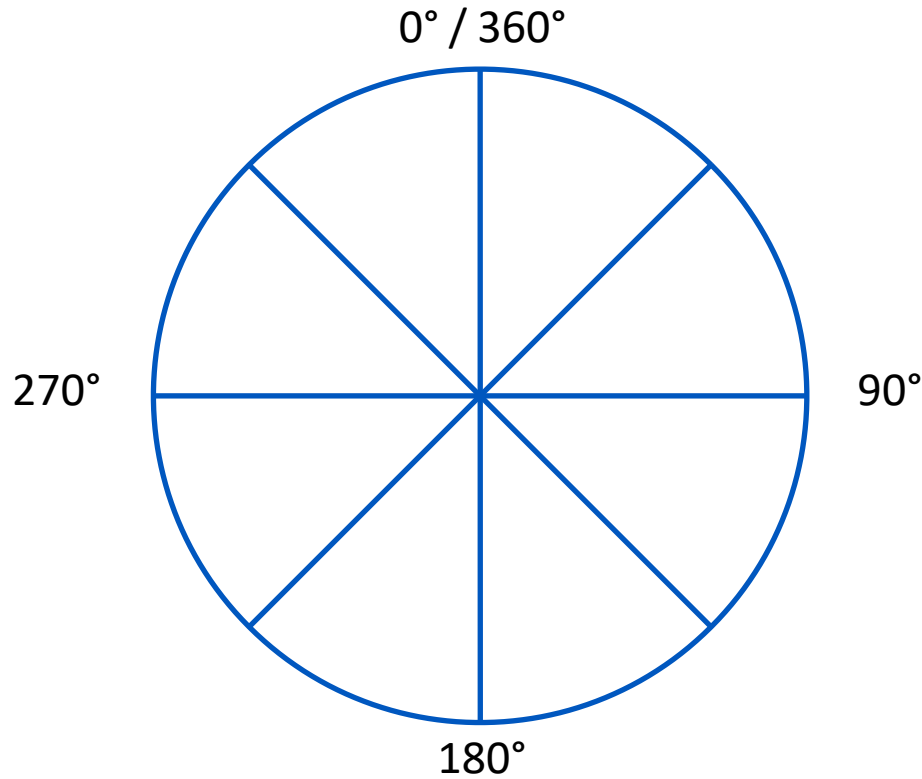
Movement - Liquid

- Liquid molecules are close together and move around each other

- Liquid will be almost the exact same as gas, with two main differences:

    1. It should move slower
    2. It should "pool" at the bottom of the screen instead of moving in any direction

point in direction (pick random ( ) to ( ))

repeat 25

move ( ) steps

if on edge, bounce
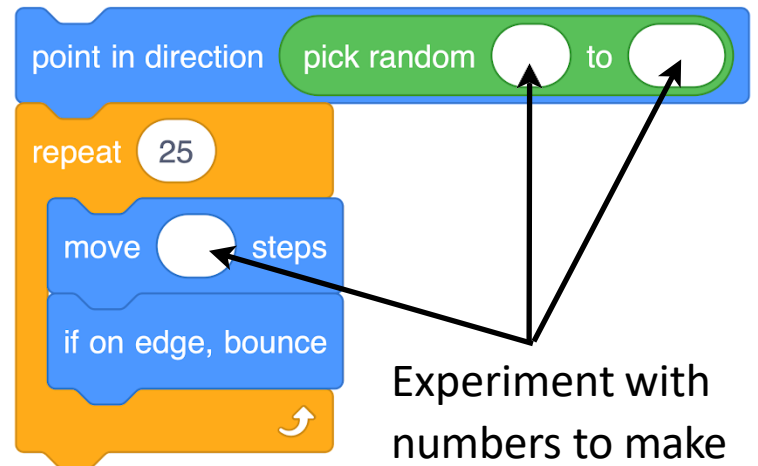
Experiment with numbers to make the molecules behave like a liquid

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Degrees of a Circle

- If we want our molecules to only <u>point towards the bottom of the screen</u>, what degree range would that be?
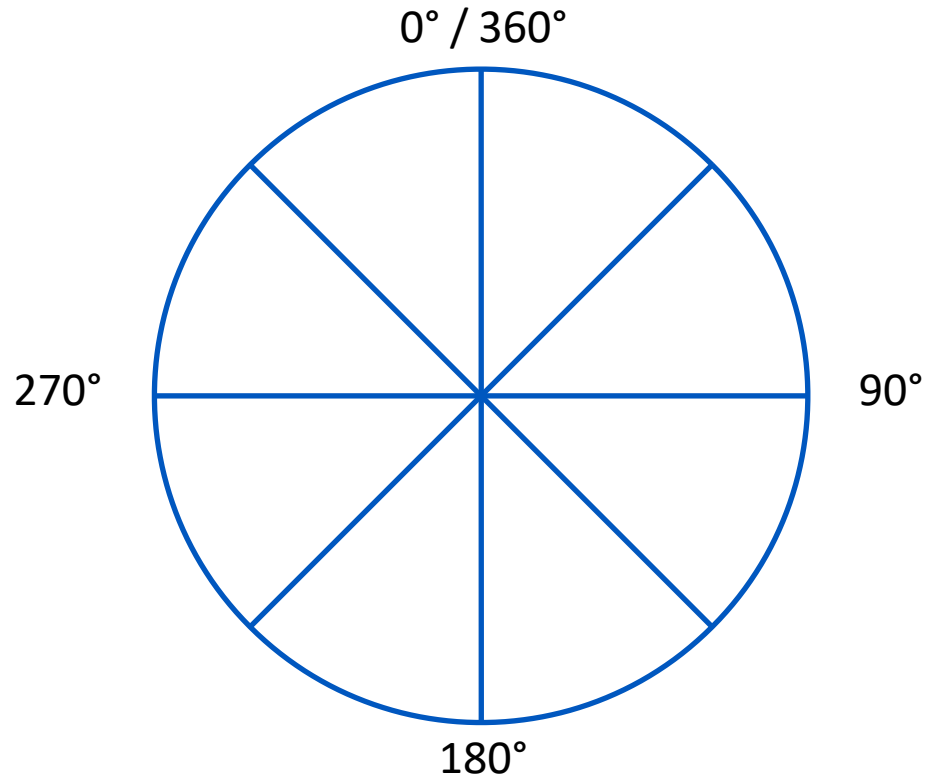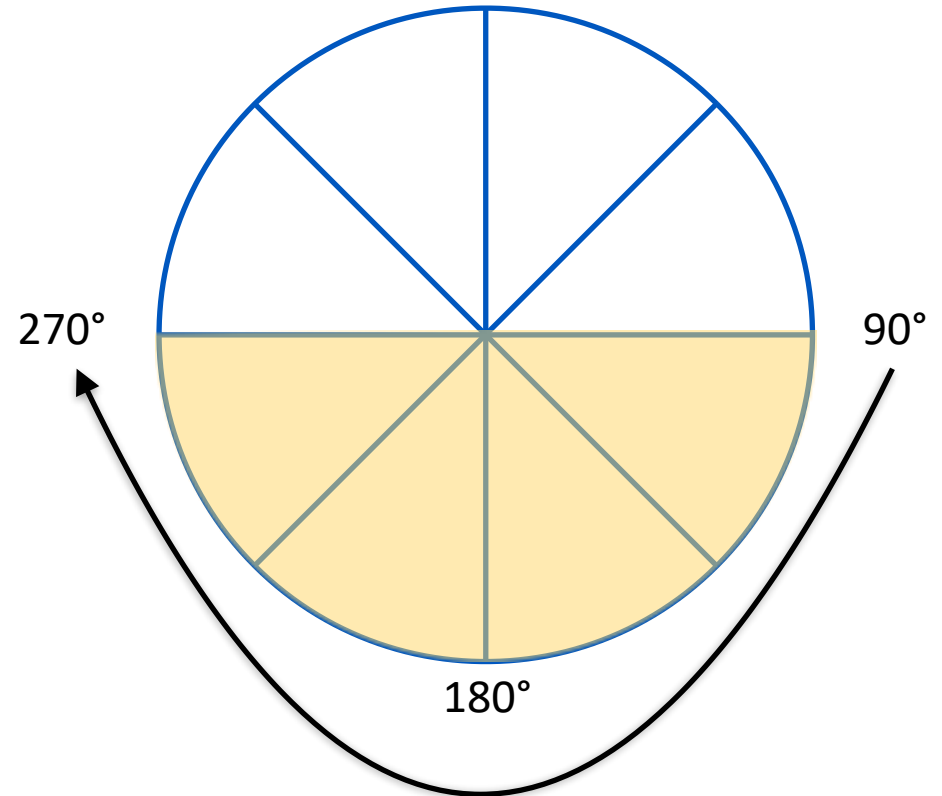

0° / 360°
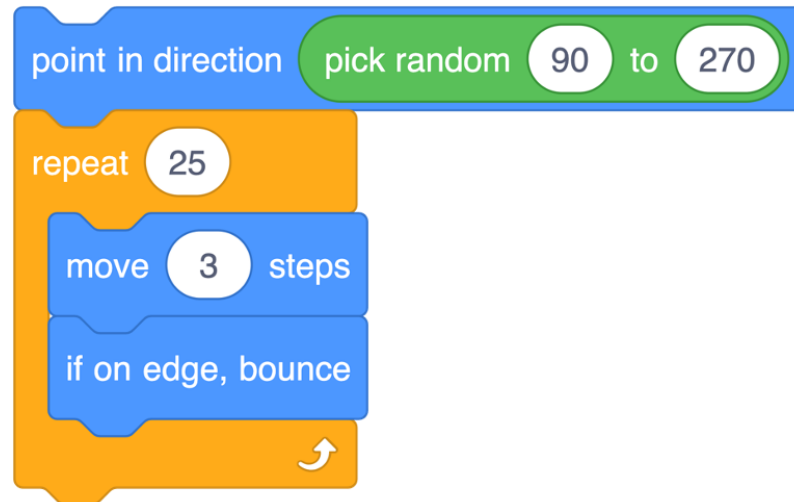
270°

90°

180°

Degrees of a Circle

Movement - Liquid

- Liquid molecules are close together and move around each other
- **In code:**

Save your Code!

Optional

CUSTOMIZATION!

Customize your Simulation!

- Get creative and customize your simulation, but be sure that the simulation still demonstrates the states of matter accurately

- Some ideas:
  - Add a background
  - Sound effects
  - What else?

Customize your Simulation!

- Remember the code might have bugs in it.
- Look at the solution code: https://scratch.mit.edu/projects/888308269/
  - Does it do some strange things?
  - What happens if you start the code at different temperatures?
  - What happens if you lower the temperature quickly?
  - Can you change this behaviour of the sprites?