

Grade 5 - Properties of and Changes in Matter

STATES OF MATTER SIMULATOR

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



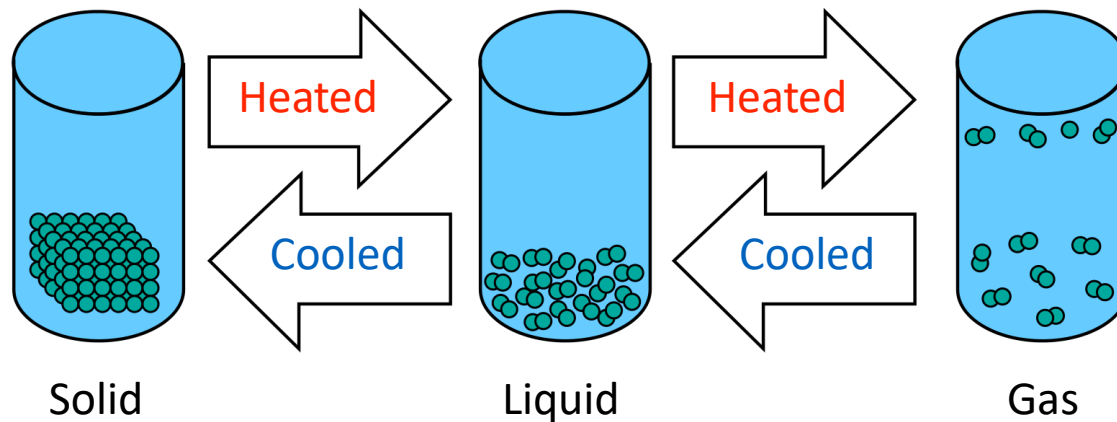
Water as a Liquid
between 0°C and 100°C



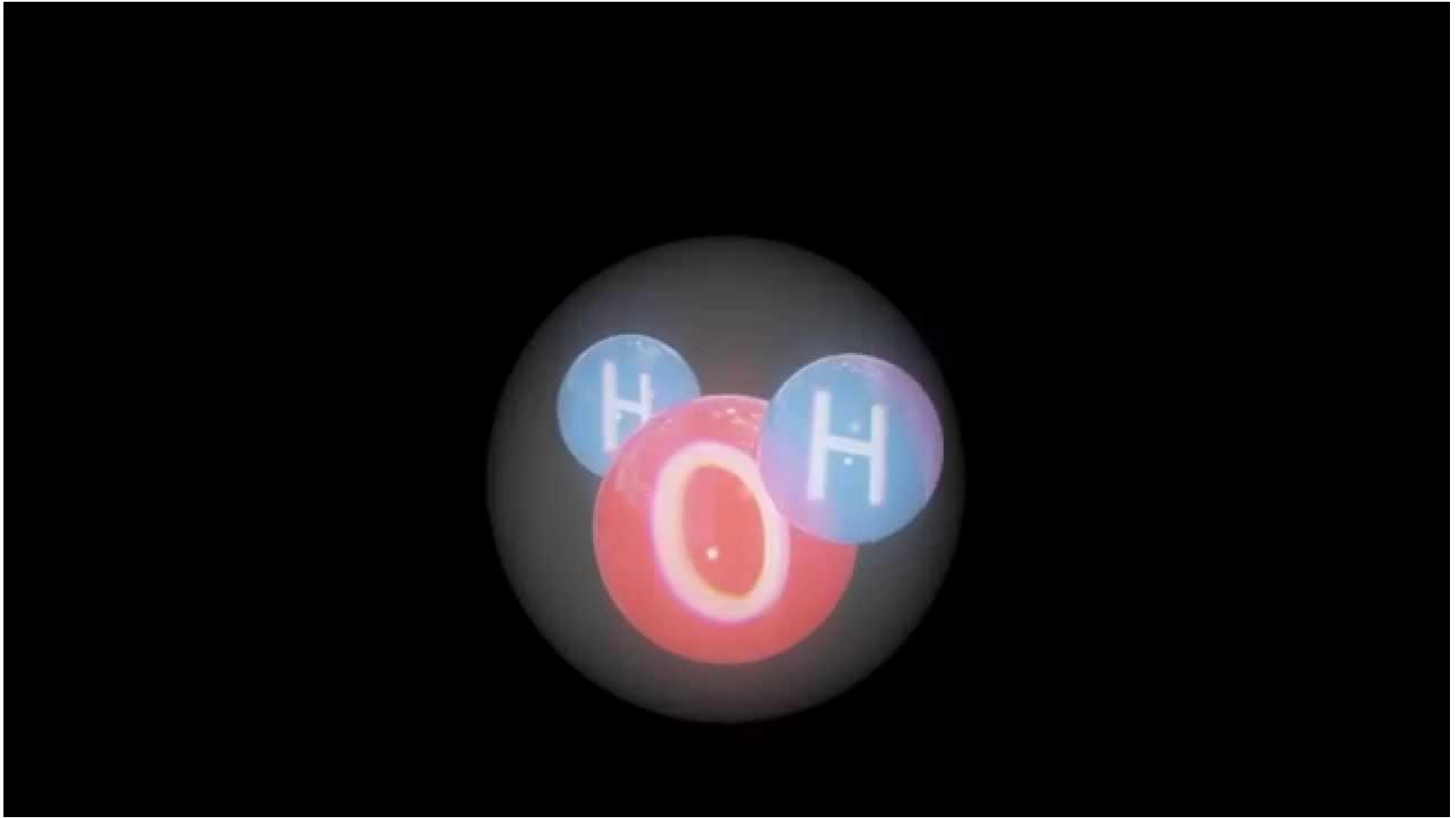
Water as a Gas
100°C or hotter

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

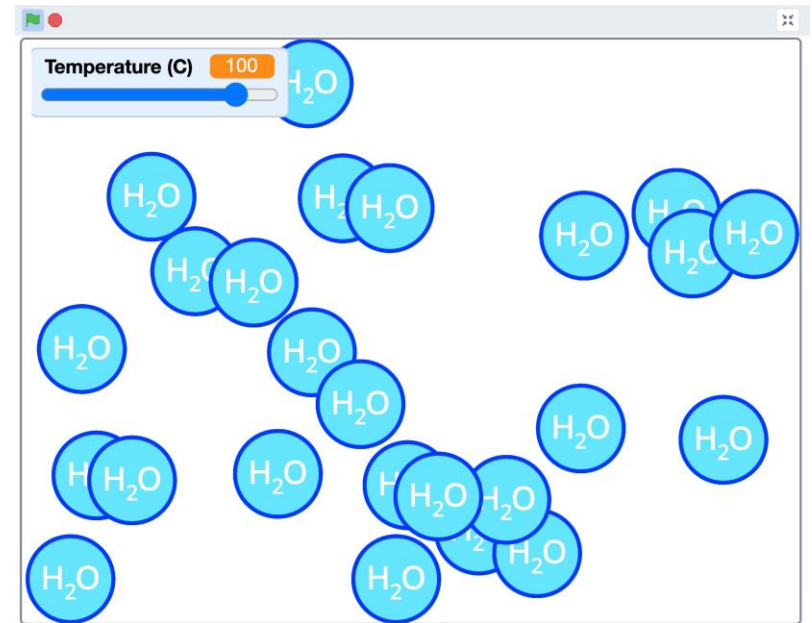


Water States of Matter Animation



Coding Task!

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



Starting from a Template

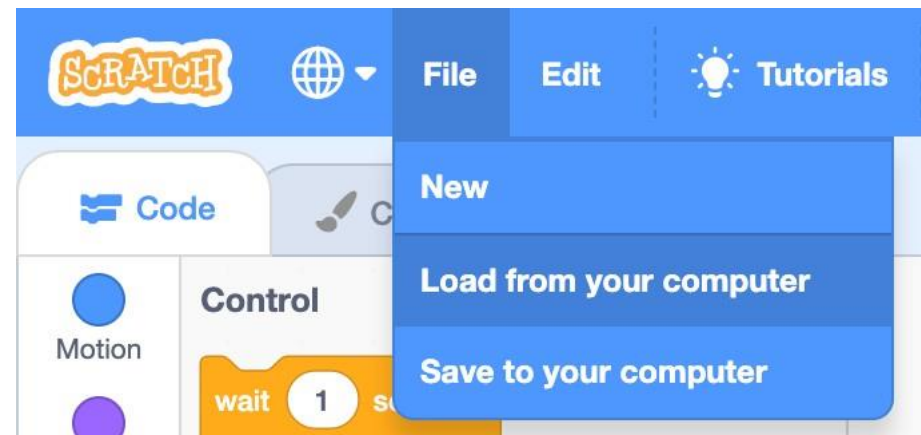
- For this project, you will start from a template
- This means a little bit of the work has been done for you, so we can jump right into the important stuff
- You still have the freedom to customize it!

Finding the Template

1. Use the following link:

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

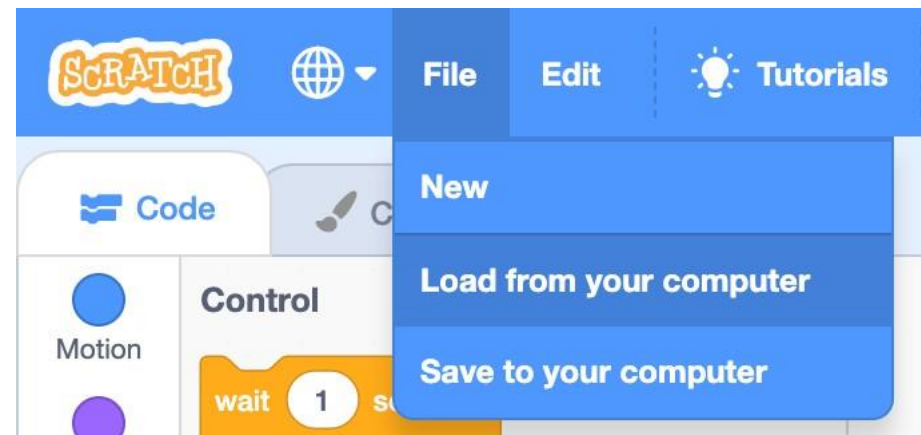
2. Teachers can “look inside” the file ahead of time and save it onto computers. Name it: Water Molecule Simulation - Starter
3. Follow the steps on the next slide to learn how to open a downloaded file.



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?

The screenshot displays the Scratch IDE interface for a project titled "Water Molecule Simulation". The left sidebar shows the "Control" category selected, with various code blocks available. The main workspace contains the following code:

- when clicked** event block.
- hide** block.
- repeat 25** loop containing a **create clone of myself** block. A tooltip indicates: "Creates 25 individual water molecules".
- when I start as a clone** loop containing a **show** block and a **forever** loop. A tooltip for the **show** block states: "Because the original sprite was hidden, we have to use the 'show' block to make the clones visible". A tooltip for the **forever** loop says: "New code goes in here!".

The stage area on the right features a "Temperature (C)" slider set to 50 and a "Water Molecule" sprite on the stage. The sprite's properties are: x: 0, y: 0, size: 100, direction: 90. The stage has one backdrop.

Part 1

CONDITIONAL STATEMENTS

Determining Temp. Ranges

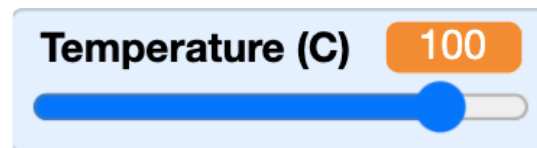
- Our first step will be to determine whether our water molecule should be acting like a solid, liquid, or gas based on the temperature reading
- **Recall:** At what temperature range is water...
 - a solid?
 - a liquid?
 - a gas?

Temperature Ranges

- If the temperature is less than or equal to 0°C , the water will be a solid
- If the temperature is greater than 0°C and less than 100°C , the water will be a liquid
- If the temperature is greater than or equal to 100°C , the water will be a gas

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



Conditionals

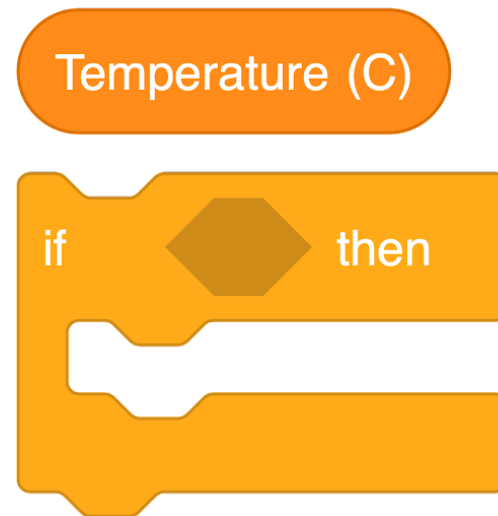
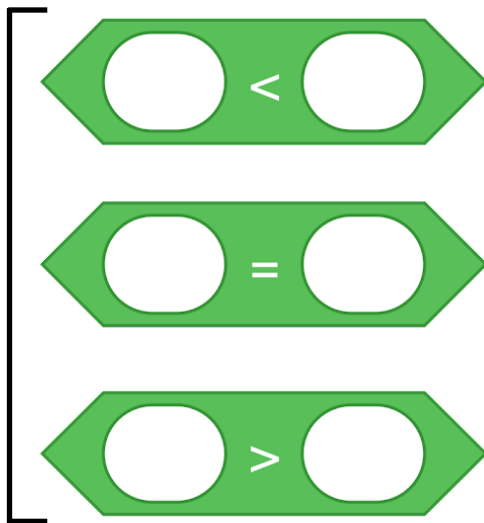
- In coding we use conditional statements to check if something is true
- If it is true, we can then take a certain action
- Examples from everyday life:
 - If it is raining, then grab my umbrella
 - If time = 6 pm, then go to kitchen for dinner



Conditionals - Solid

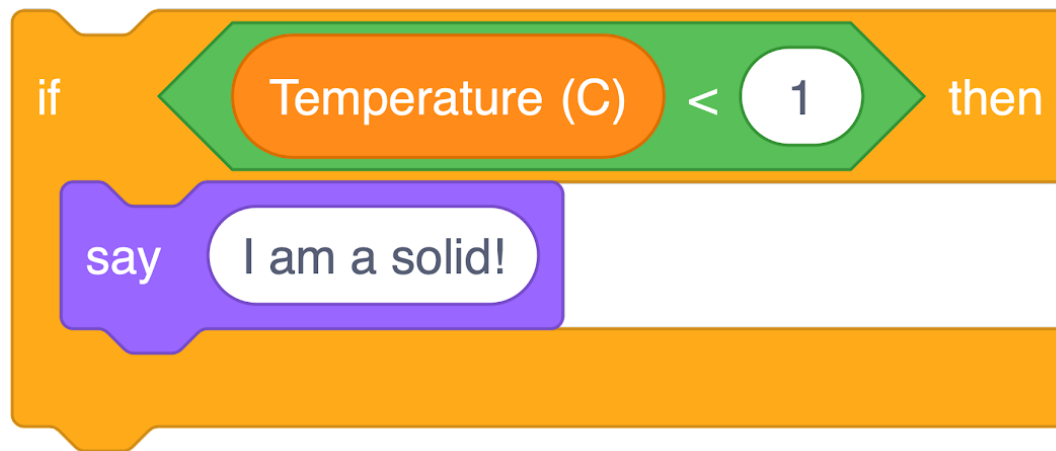
- Using the blocks below, how can we check if the water molecules should behave like a solid?
- **Hint:** it can be helpful to think of it as “less than 1” rather than “less than or equal to 0”

We only need one of these, but which one?



Conditionals - Solid

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



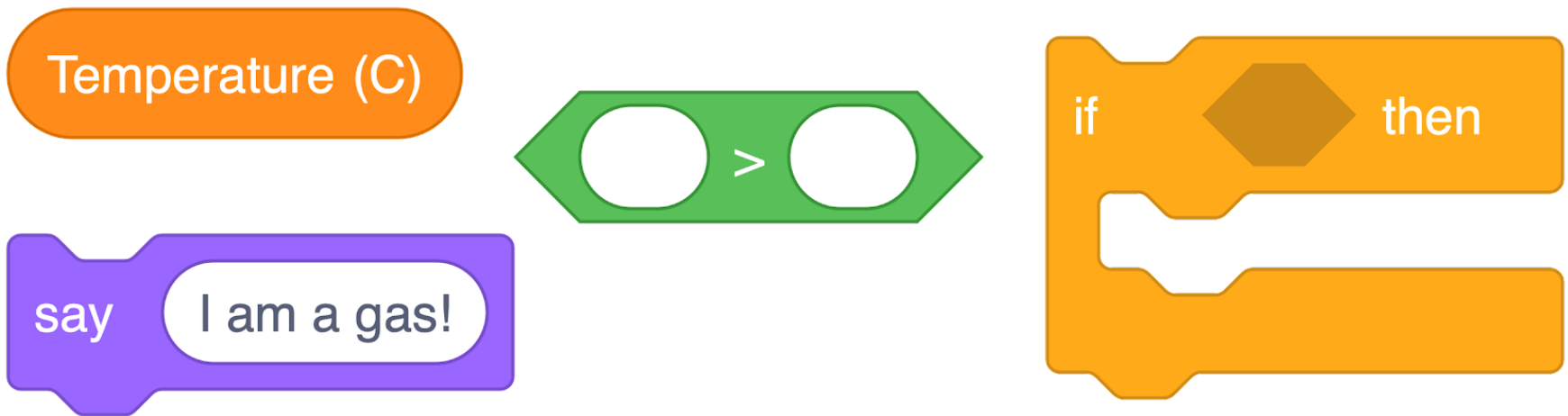
Conditionals - Solid

- Add this code to your project inside the forever loop

The image shows a Scratch script on a grid background. The script starts with an orange 'when I start as a clone' block, followed by a purple 'show' block. Below these is an orange 'forever' loop block. Inside the loop is an orange 'if' block with a green arrow-shaped condition 'Temperature (C) < 1'. The 'if' block contains a purple 'say' block with the text 'I am a solid!' and a long orange block that is partially obscured. Two yellow callout boxes are present: one pointing to the 'show' block with the text 'Because the original sprite was hidden, we have to use the "show" block to make the clones visible', and another pointing to the space below the 'if' block with the text 'New code goes in here!'.

Conditionals - Gas

- If the temperature is greater than or equal to 100°C, the water will be a gas
- Use the blocks below to check if the water molecules should behave like a gas!



Conditionals - Gas

```
when I start as a clone
  show
  forever
    if Temperature (C) < 1 then
      say I am a solid!
    if Temperature (C) > 99 then
      say I am a gas!
```

Because the original sprite was hidden, we have to use the "show" block to make the clones visible

New code goes in here!

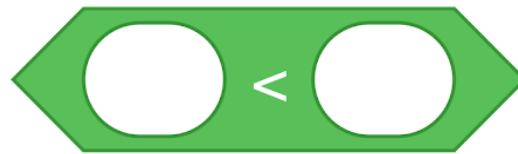
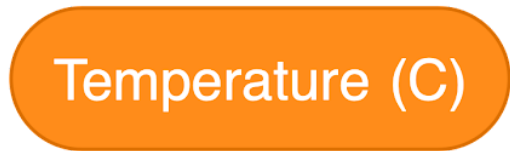
Conditionals - Liquid

- Checking for liquid state is a little different because there are two conditions we have to check
- If the temperature is greater than 0°C and less than 100°C , the water will be a liquid



Conditionals - Liquid

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



Conditionals Complete!

The image shows a Scratch script on a grid background. The script starts with an orange 'when I start as a clone' block, followed by a purple 'show' block. Below these is an orange 'forever' loop block. Inside the loop, there are three conditional blocks: 1) an 'if' block with a green arrow-shaped condition 'Temperature (C) < 1' and a purple 'say I am a solid!' block; 2) an 'if' block with a green arrow-shaped condition 'Temperature (C) > 99' and a purple 'say I am a gas!' block; 3) an 'if' block with a green arrow-shaped condition 'Temperature (C) > 1 and Temperature (C) < 99' and a purple 'say I am a liquid!' block. The loop ends with a curved arrow icon. Two yellow callout boxes are present: one pointing to the 'show' block with the text 'Because the original sprite was hidden, we have to use the "show" block to make the clones visible', and another pointing to the 'forever' loop with the text 'New code goes in here!'.

when I start as a clone

show

forever

if Temperature (C) < 1 then

say I am a solid!

if Temperature (C) > 99 then

say I am a gas!

if Temperature (C) > 1 and Temperature (C) < 99 then

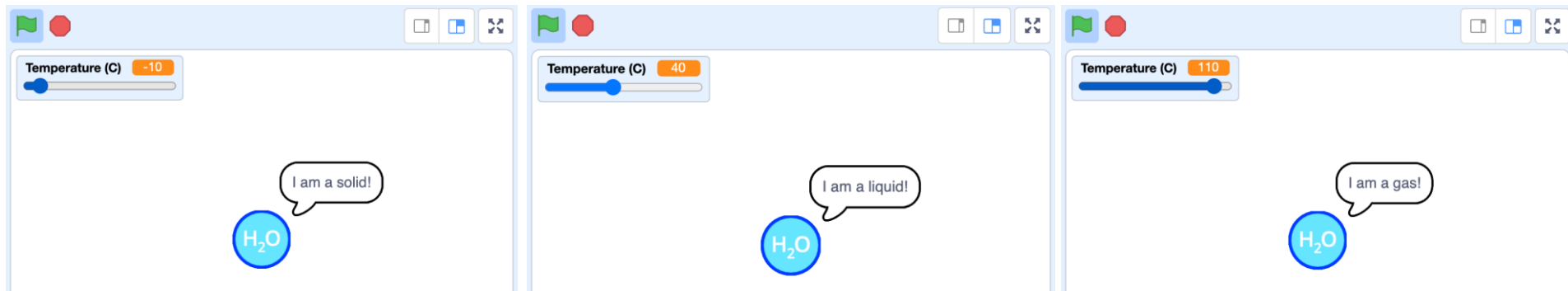
say I am a liquid!

Because the original sprite was hidden, we have to use the "show" block to make the clones visible

New code goes in here!

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

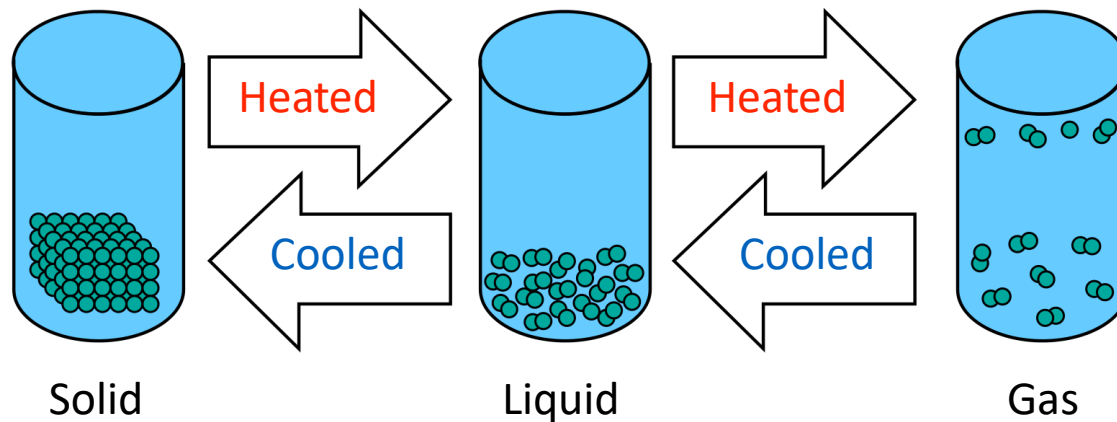
MOLECULE MOVEMENT

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



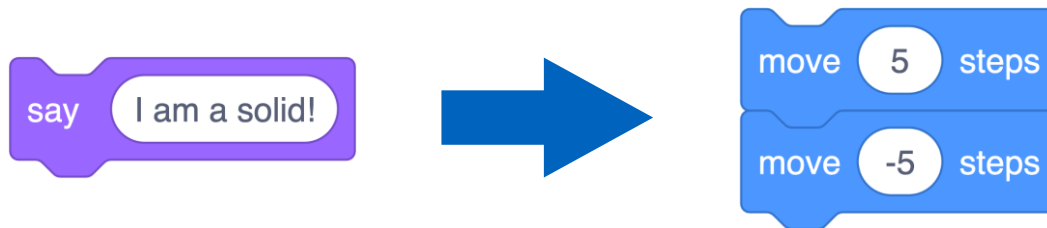
Movement - Solid

- 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*



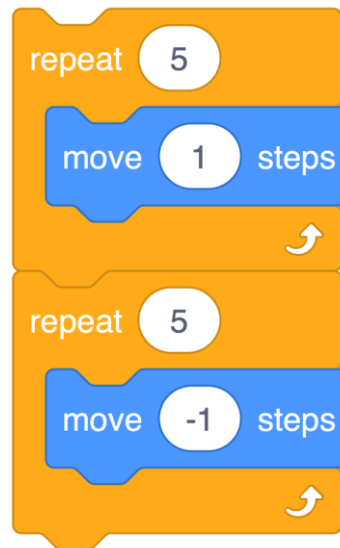
Movement - Solid

- 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?



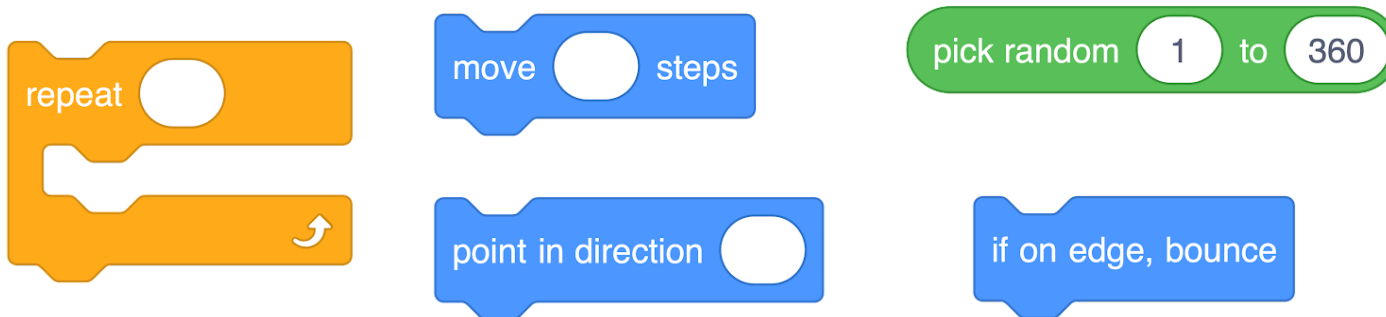
Movement - Solid

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



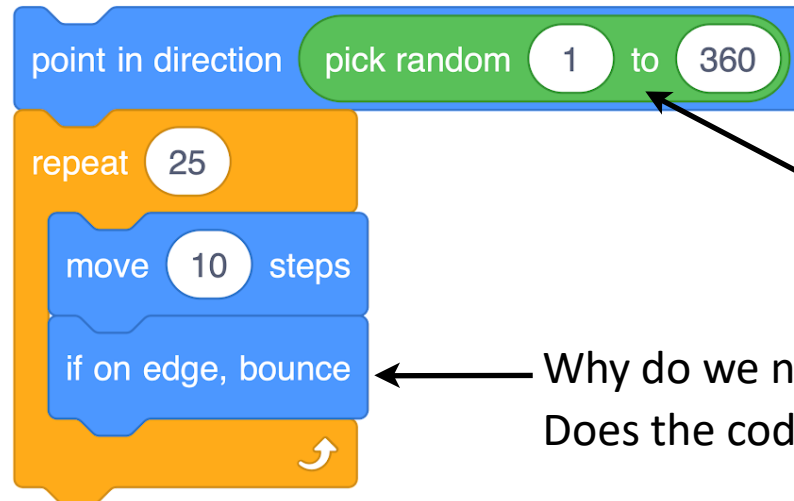
Movement - Gas

- 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



Movement - Gas

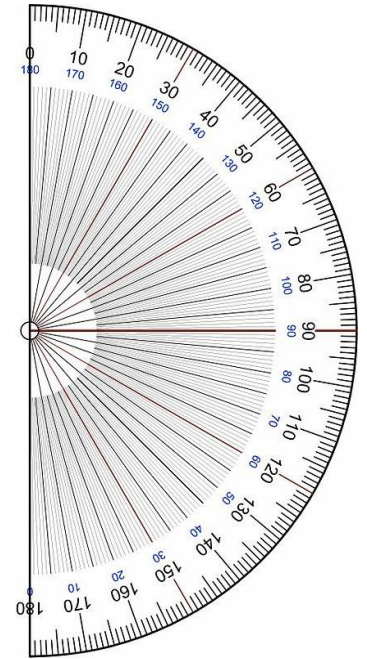
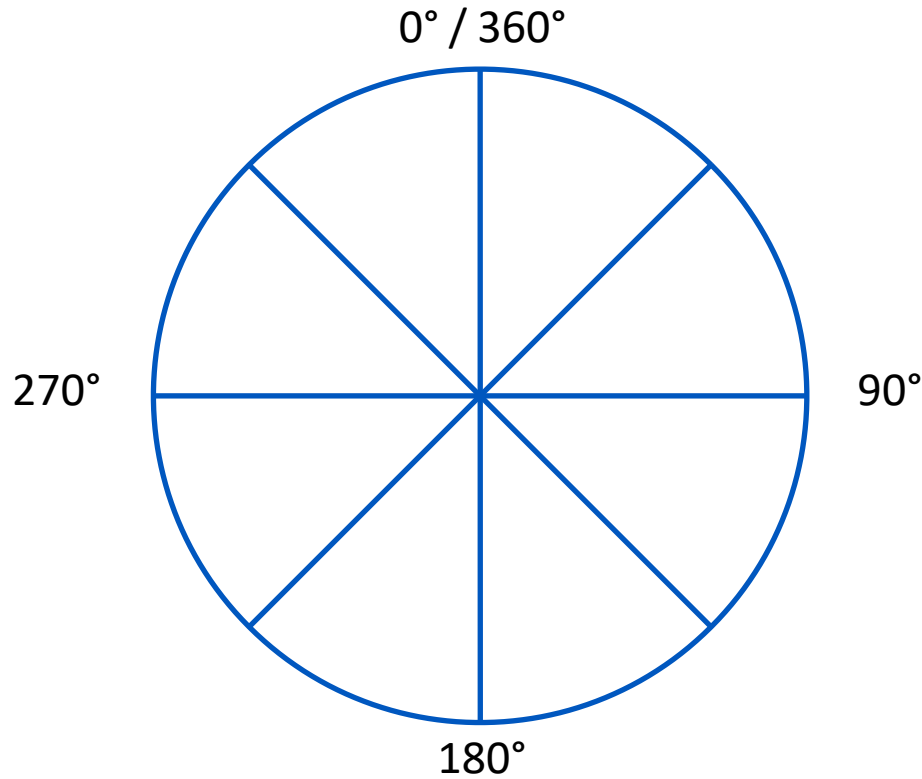
- Gas molecules move freely and quickly
- **In code:**



Why 1 to 360?

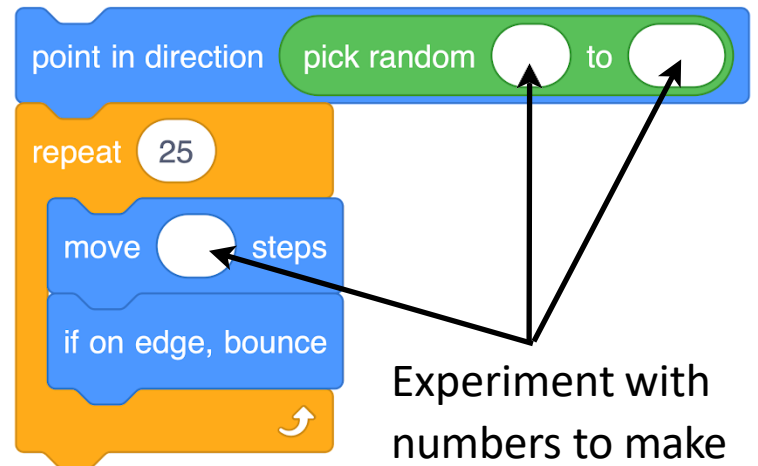
Why do we need this block?
Does the code work without it?

Degrees of a Circle



Movement - Liquid

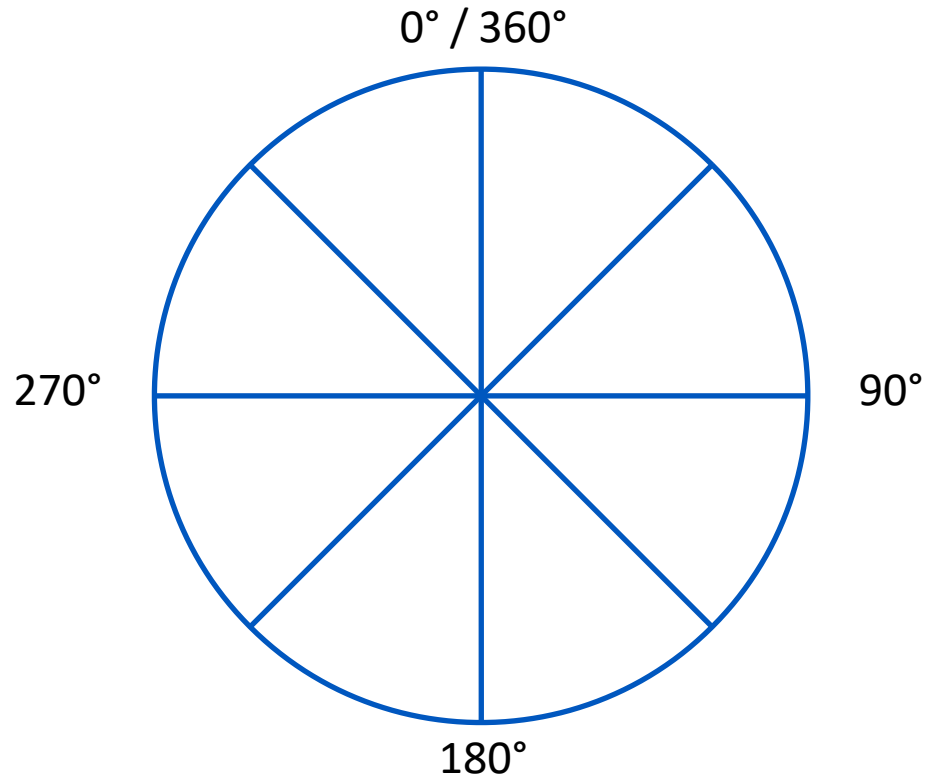
- Liquid molecules are close together and move around each other
- Liquid will be almost the exact same as gas, with two main differences:
 1. It should move slower
 2. It should "pool" at the bottom of the screen instead of moving in any direction



Experiment with numbers to make the molecules behave like a liquid

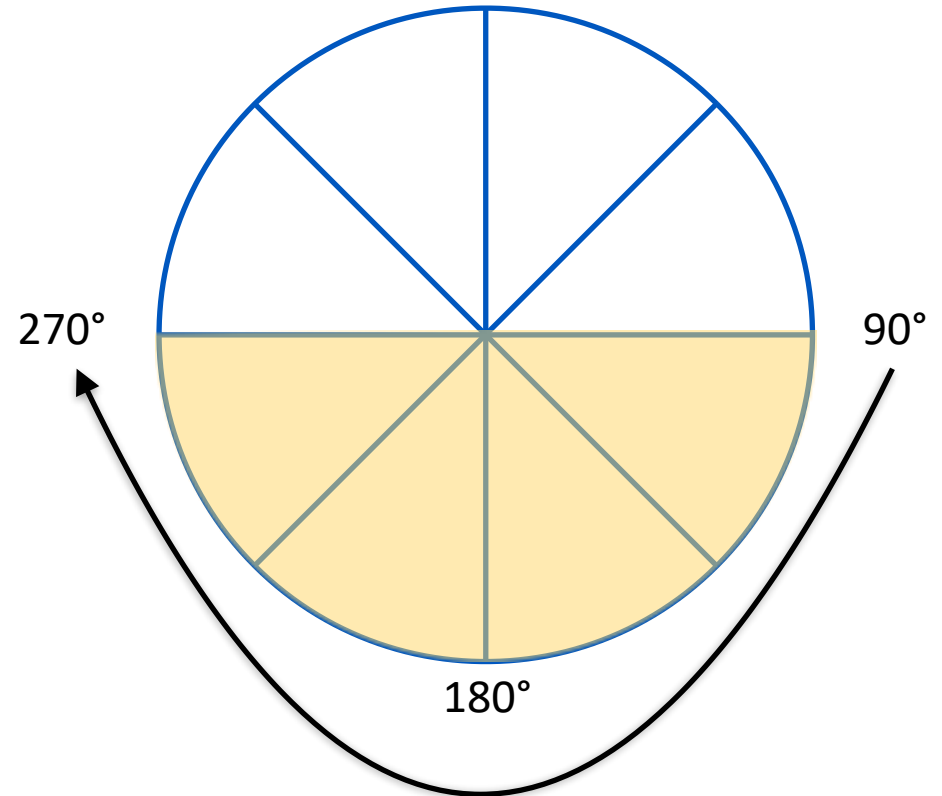
Degrees of a Circle

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



Degrees of a Circle

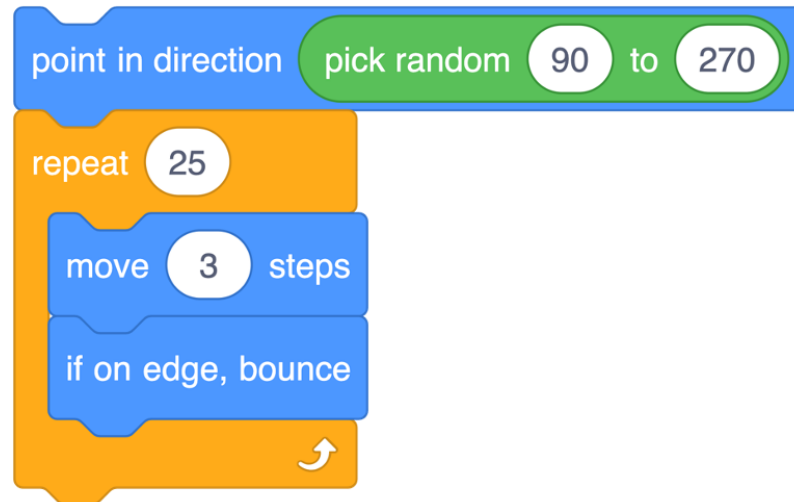
$0^\circ / 360^\circ$



pick random to

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?