

Test

Digital States of Matter

Final Report - Answer Guide

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Session	Test
Course	Test
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Test Your Knowledge

Match the terms to the transitions.

Left column (Terms):

- ⌘ Condensation
- ⌘ Deposition
- ⌘ Freezing
- ⌘ Melting
- ⌘ Sublimation
- ⌘ Vaporization

Right column (Transitions):

- Gas to solid 1
- Gas to liquid 2
- Liquid to gas 3
- Liquid to solid 4
- Solid to gas 5
- Solid to liquid 6

Correct answers:

- 1 Deposition 2 Condensation 3 Vaporization 4 Freezing
5 Sublimation 6 Melting

Classify each statement as describing a gas, liquid, or solid phase.

Gas	Liquid	Solid
1	2	3

⌘ Can be crystalline or amorphous

⌘ Exhibits surface tension

⌘ Fills the volume of a container, regardless of size of container

⌘ Has molecules in a constant state of random motion

⌘ Has molecules in a fixed volume and a fluid shape

⌘ Has molecules in a fixed arrangement, closely packed

⌘ Has rapidly moving molecules with no definite shape or volume

Correct answers:

1 Fills the volume of a container, regardless of size of container
Has molecules in a constant state of random motion
Has rapidly moving molecules with no definite shape or volume

2 Exhibits surface tension
Has molecules in a fixed volume and a fluid shape

3 Can be crystalline or amorphous
Has molecules in a fixed arrangement, closely packed

Determine whether each molecule exhibits hydrogen bonding or does not exhibit hydrogen bonding.

	Exhibits Hydrogen Bonding	Does Not Exhibit Hydrogen Bonding
⚡ Ammonia	1	2
⚡ Hydrogen chloride		
⚡ Hydrogen fluoride		
⚡ Sodium chloride		
⚡ Water		

Correct answers:

1 Ammonia Hydrogen fluoride Water

2 Hydrogen chloride Sodium chloride

Exploration

The liquid phase of matter has a fixed volume and shape.

☐ True

☒ False



Hydrogen bonding is exhibited between water molecules (H_2O) in the liquid and solid phases.

☒ True

☐ False



Solids are most stable when they are ____.

- ☐ oxidizers
- ☒ crystalline ✓
- ☐ amorphous
- ☐ melting

Phase changes that release energy include deposition, freezing, and vaporization.

- ☐ True
- ☒ False ✓

A(n) ____ describes temperature changes for a sample passing through different states of matter, and can be used to determine the melting point and boiling point of substances.

- ☒ heating curve ✓
- ☐ intermolecular force
- ☐ van der Waals force

Exercise 1

As shown in the simulation, what are particles that are in the solid state doing? What differentiates them from liquid particles?

Solid particles vibrate more or less in place. Liquid particles move past each other.

As shown in the simulation, what are particles in the liquid state doing? How is this different from what they are doing in the gas state?

Liquid particles move past each other, flowing to fit the shape of the container as bounded by gravity. Gases on the other hand, expand to fit their container, filling the whole chamber and moving more energetically than liquid particles.

In contrast to solids, liquids and gases are both categorized as “fluids.” Describe how this concept is illustrated in particle form in this simulation.

"Fluid" describes the idea of moving past each other. Both liquid and gas particles are free to roam through space as bounded by their containers; solids do not do this, staying fixed to their surrounding molecules.

Water, and to an extent oxygen, appear significantly more riotous in their movements in liquid and gas form than neon and argon do. Why does this occur, and is there something significantly different happening?

Water (and oxygen) are multi-atom molecules. As such, we can observe their spinning movements as well, which we cannot observe in the basic spherical representations of argon and neon. This does not mean that argon and neon aren't also spinning with the same energy that the multi-atom particles are, and if we could see it that might make them look the same.

When heating the chamber, what key feature(s) are seen that indicate the transition from solid to liquid has occurred?

The vibrating, fixed particles are suddenly moving across each other, changing shape.

Water's transition from solid to liquid is unique amongst these four species. What noticeable feature occurs during its solid to liquid transition?

Water appears to "collapse" down from its solid crystalline form into a more dense fluid when it transitions to liquid.

Oxygen's liquid form behaves differently from the other three species shown in this simulation. What is unique about it and what does this indicate about actual liquid oxygen?

Liquid oxygen, rather than spreading out and filling the bottom of the container, tends to float around, adhering to itself even as the particles move past each other. This likely signifies that liquid oxygen is particularly coherent to itself.

Solid water, upon compression, turned to liquid. Would you expect this behavior from other compounds that do not expand when solidified?

Not necessarily. If the compression increases the temperature, possibly, but solid water shows a fairly unique property in that under compression, it liquifies.

Data Table 1: Temperature of Different States of Matter
(SAMPLE ANSWER BELOW)

Substance	Solid Temp	Liquid Temp	Gas Temp
Neon	No sample answer	No sample answer	No sample answer
Argon	No sample answer	No sample answer	No sample answer
Oxygen	No sample answer	No sample answer	No sample answer
Water	No sample answer	No sample answer	No sample answer

Data Table 2: Temperature of Phase Changes
(SAMPLE ANSWER BELOW)

Substance	S→L Transition Temp	L→G Transition Temp
Neon	No sample answer	No sample answer
Argon	No sample answer	No sample answer
Oxygen	No sample answer	No sample answer
Water	No sample answer	No sample answer

Data Table 3: Phase Changes Simulation
(SAMPLE ANSWER BELOW)

Manipulation	Temperature Change	Pressure Change	Describe Phase or Phase Change
Adding Neon Particles	No sample answer	No sample answer	No sample answer
Adding Oxygen Particles	No sample answer	No sample answer	No sample answer
Decreasing Chamber Volume Over Solid Water	No sample answer	No sample answer	No sample answer
Compressing Solid Water	No sample answer	No sample answer	No sample answer

Competency Review

A ____ phase of matter has no fixed volume or shape.

- ☐ solid
- ☐ liquid
- ☒ gas ✓

Intermolecular forces are generally weaker than ionic or covalent bonds.

- ☒ True ✓
- ☐ False

When water molecules interact, the ____ charged hydrogen end of one molecule is attracted to the ____ charged oxygen end of another molecule.

- ☒ positively, negatively ✓
- ☐ negatively, positively

Liquids have distinct properties including ____.

- ☐ surface tension
- ☐ viscosity
- ☐ vapor pressure
- ☒ all of the above

✓

Crystalline solids have a disorderly configuration of particles.

- ☐ True
- ☒ False

✓

A phase change from a gas to a solid is known as ____.

- ☒ deposition
- ☐ condensation
- ☐ sublimation
- ☐ vaporization

✓

When pressure is decreased, a substance is more likely to undergo ____ or ____.

- ☐ deposition; condensation
- ☐ melting; freezing
- ☒ vaporization; sublimation

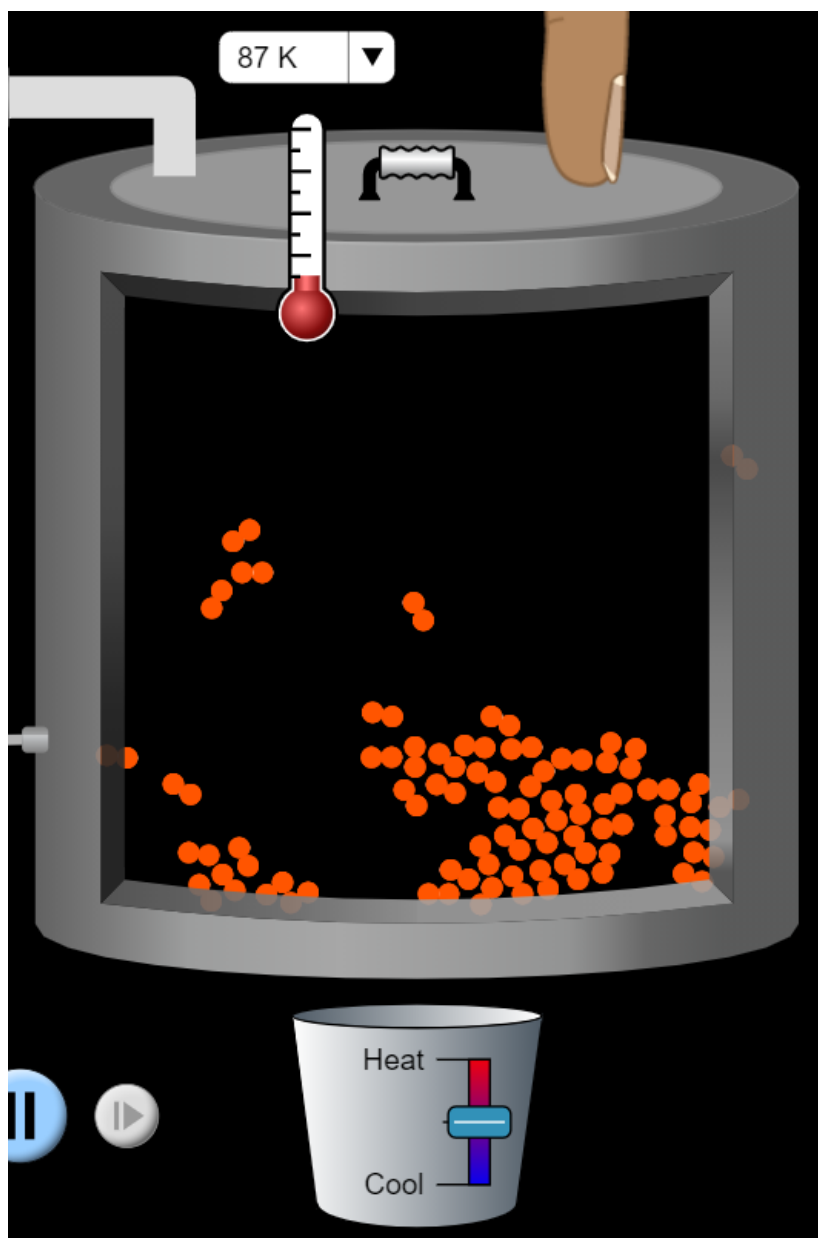
✓

There is ____ in the temperature of a substance at the melting and boiling points during the melting or boiling process.

- ☒ no change
- ☐ an increase
- ☐ a decrease

✓

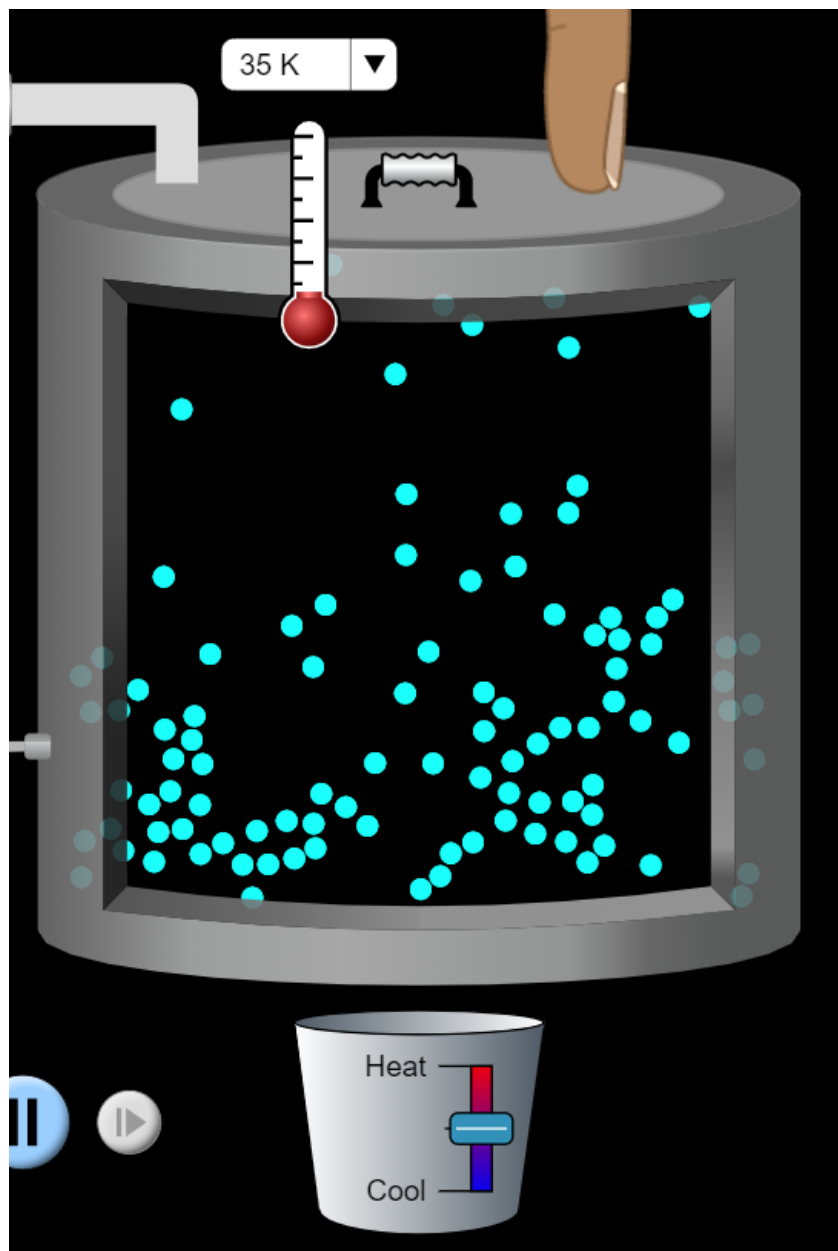
If more heat energy is added to the system, _____.



- ☐ more molecules would condense.
- ☒ more molecules would vaporize.
- ☐ there would be no change.
- ☐ all the molecules would rotate faster.

✓

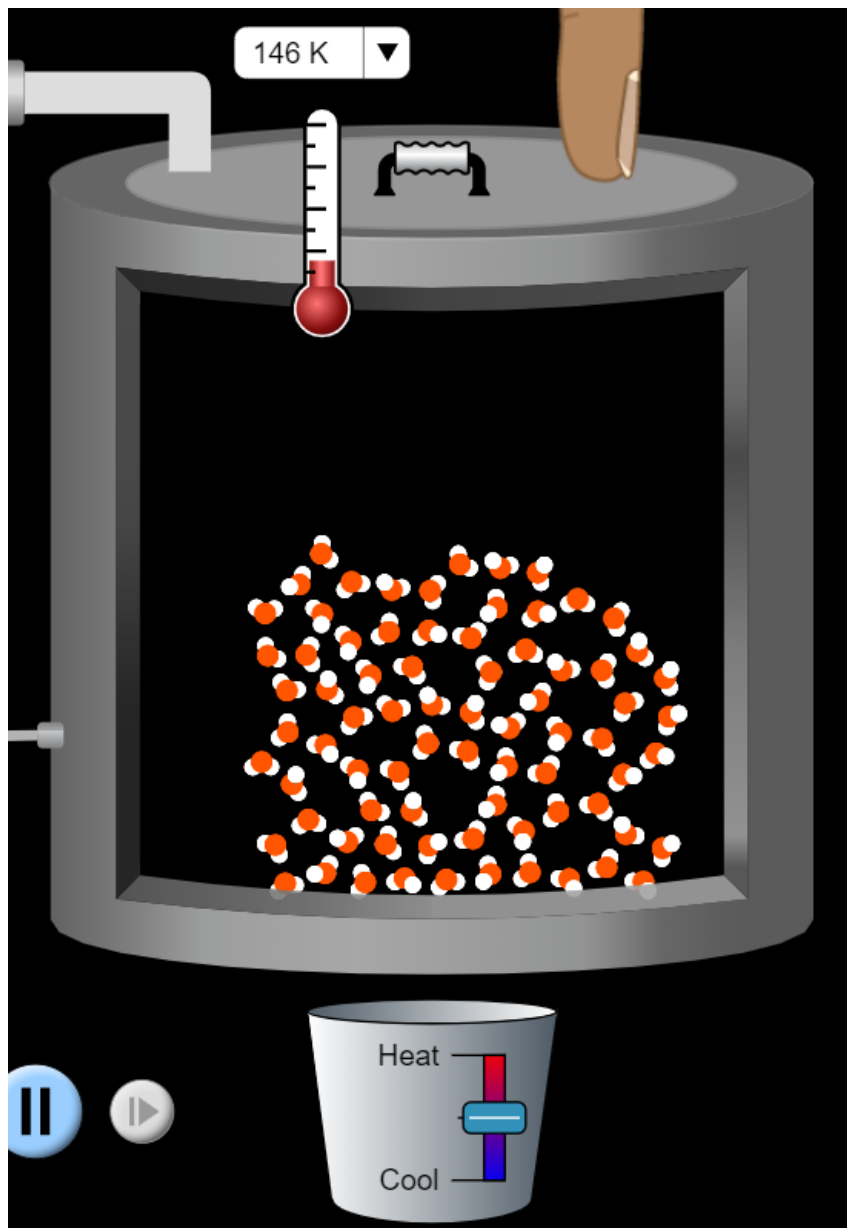
To get more atoms to condense within this chamber, you can_____.



- ☐ increase the temperature.
- ☐ decrease the temperature.
- ☐ increase the pressure.
- ☐ decrease the pressure
- ☐ both increase the temperature and decrease the pressure.
- ☒ both increase the pressure and decrease the temperature.



If you reduce the volume of this chamber just a little, _____.



- ☐ more molecules would condense.
- ☐ more molecules would evaporate.
- ☐ fewer molecules would exist.
- ☐ there would be no change.



Extension Questions

If Sara was planning a wedding and wanted to have a sculpture of a heart made of butter at the reception, describe how Sara could test the temperature range at which the heart would remain a solid. (SAMPLE ANSWER BELOW)

Sara would prepare a heating curve for butter, to determine the temperature range that the butter would remain in a solid form, and identify the specific melting point temperature that the butter sculpture would begin to melt.