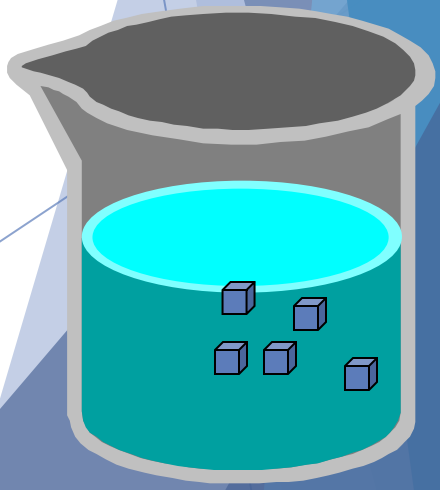
# Heat Calculations and Energy

April 21, 2015

Chemistry CP

# Some basic concepts

- **Phase**
  - A homogeneous region with distinct structure and physical properties
  - In principle, can be isolated
  - Can be solid, liquid or gas
- **Phase Diagram**
  - Representation of phases present under a set of conditions (Pressure, Temperature, Composition etc.)



# Concepts……

- **Phase transformation**
  - Change from one phase to another
  - Physical Change
  - E.g. L ⟶ S, S ⟶ G etc.
  - Occurs because energy change is either absorbed or released and particles are rearranged
- **Phase boundary**
  - Boundary between phases in a phase diagram

# Phase Changes Involving Solids and Liquids

## MELTING

- Phase change from a solid to a liquid
- Molecules speed up, move farther apart, and absorb heat energy

## FREEZING

- Phase Change from a liquid to a solid
- Molecules slow down, move closer together and release heat energy.

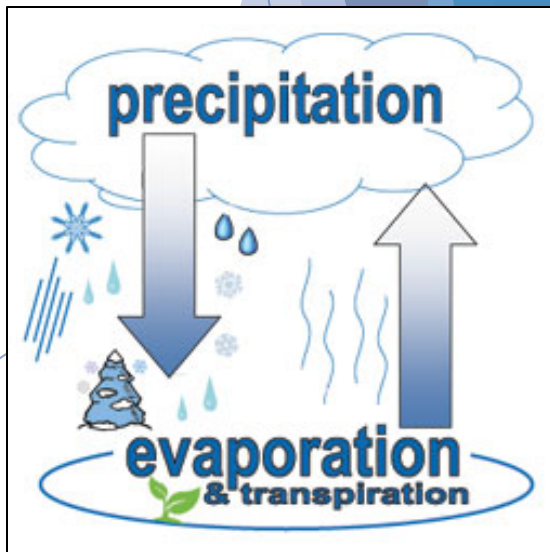
# Phase Changes Involving Liquids and Gases

## VAPORIZATION

- Phase change from a liquid to gas. It occurs at the boiling point of matter.
- Molecules speed up, move farther apart, and absorb heat energy.

## CONDENSATION

- Phase change from a gas to a liquid.
- Molecules slow down, move closer together and release heat energy.



# Phase Changes Involving Solids and Gases

## SUBLIMATION

- Phase change from a solid to a gas.
- Molecules speed up, move farther apart, and absorb heat energy.

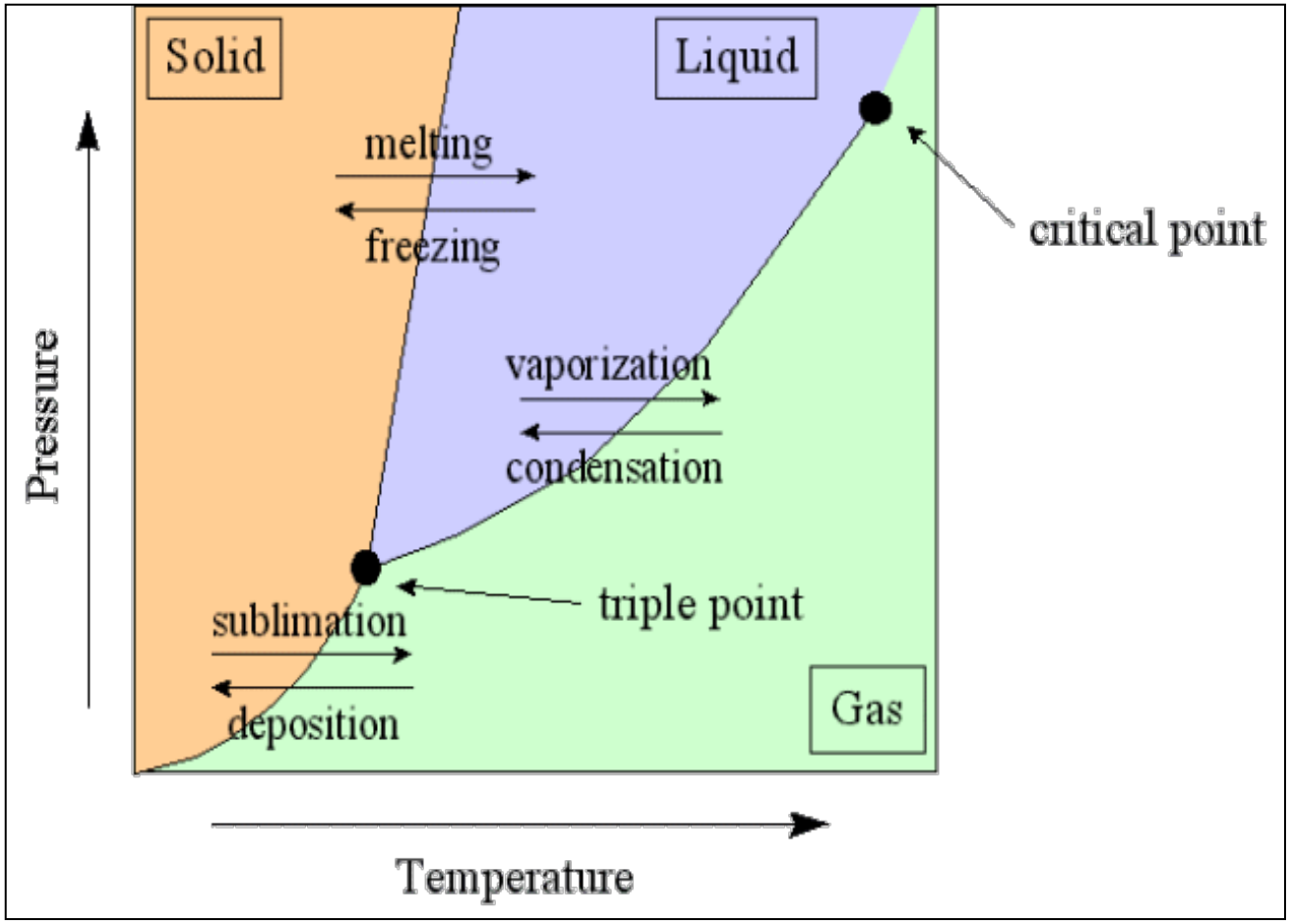
## DEPOSITION

- Phase change from a gas to a solid.
- Molecules slow down, move closer together and release heat energy.

# Melting, Freezing & Boiling Points

- **Melting Point**: The temperature at which a solid changes into a liquid
- **Freezing Point**: The temperature at which a liquid changes into a solid
  - For water 0°C
- **Boiling Point:** The temperature at which a liquid changes into a gas.
  - For water 100°C

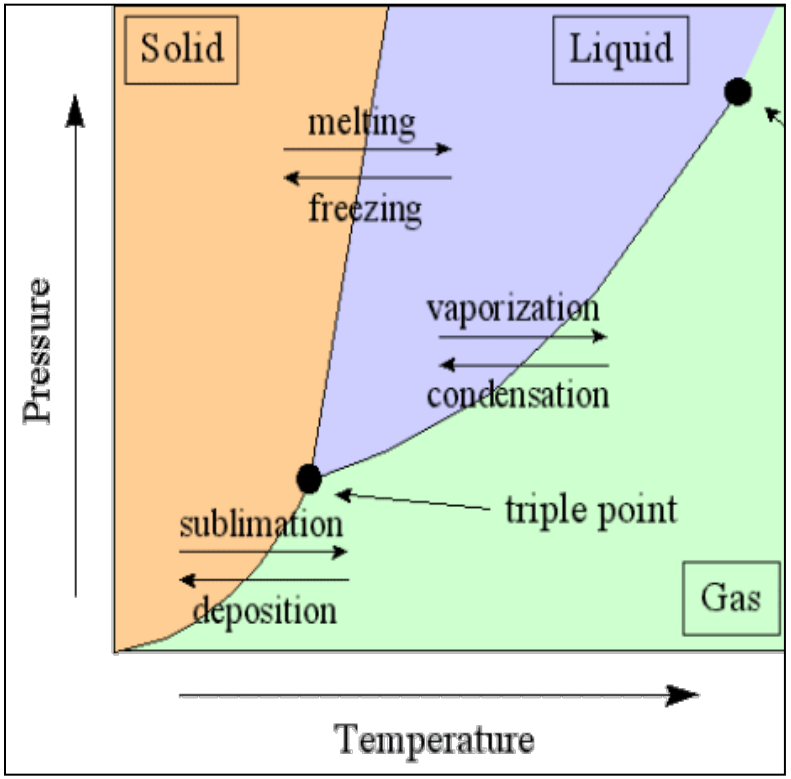
# Phase Diagrams




- **Melting/Freezing**: Any point on this line (pressure & temperature) the substance is both **solid** and **liquid**
- **Sublimation/ Deposition**: Any point on this line (pressure & temperature) the substance is both **solid** and **gas**
- **Vaporization/ Condensation**: Any point on this line (pressure & temperature) the substance is both **liquid** and **gas**

# KEY POINTS ON PHASE DIAGRAMS

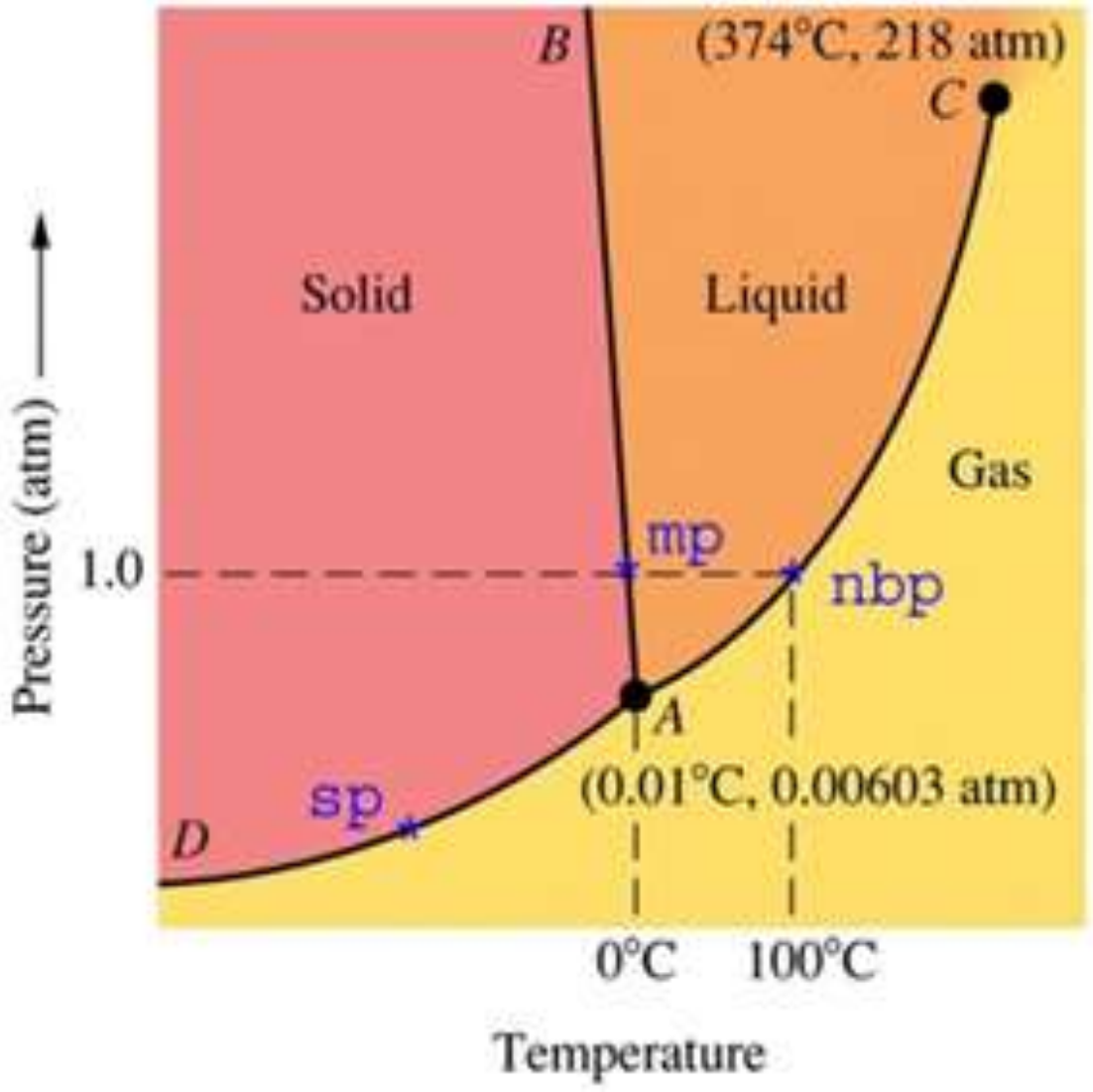
- **Triple Point:**
  - Temperature and pressure when all three phases of matter exist
- **Critical Point**:
  - Above this point the separate liquid/gas phases don't exist, resulting in one "phase" called a "supercritical fluid"



# Phase Diagrams Practice

PRACTICE

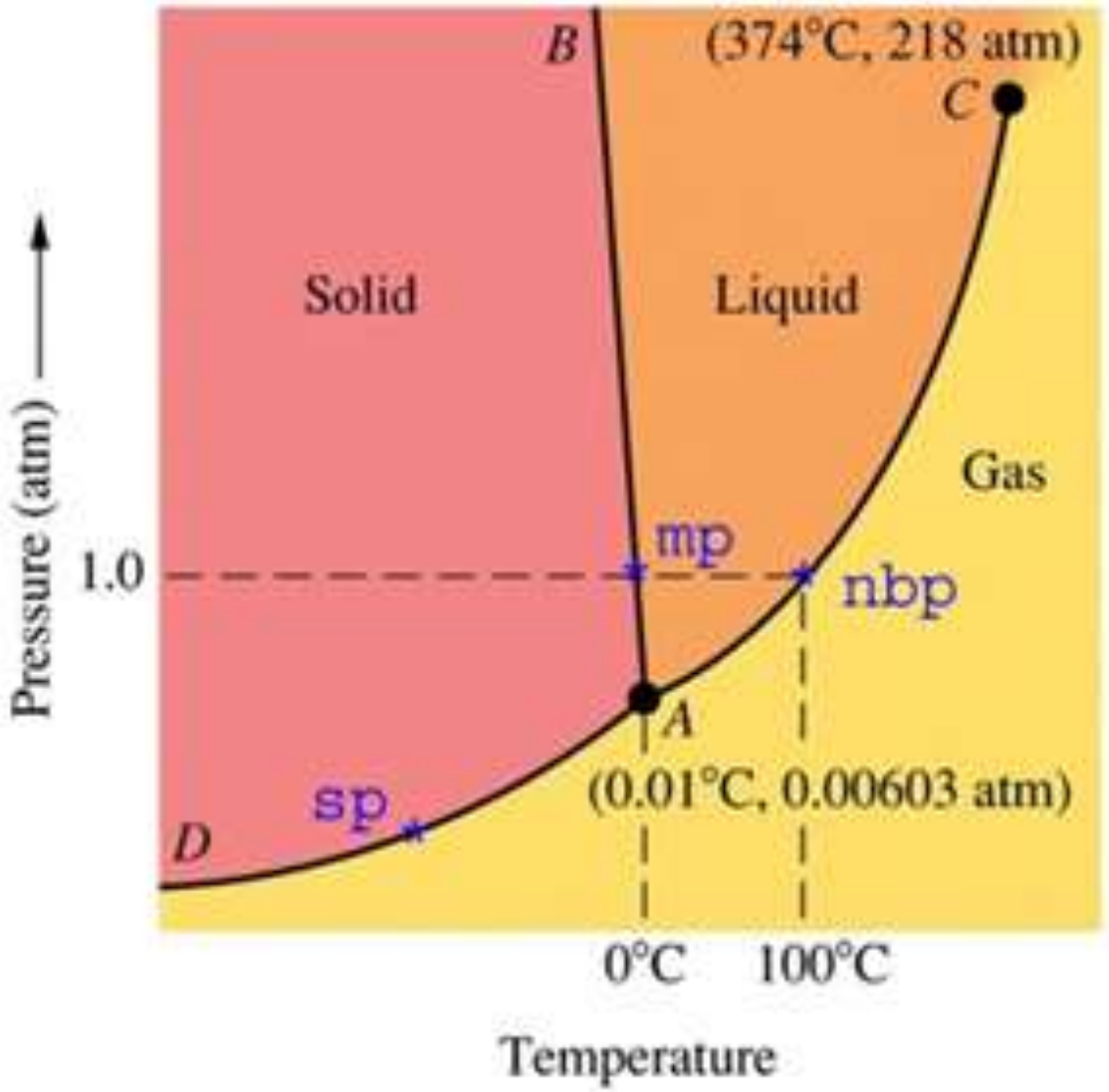
1. At what temperature and pressure does $H_2O$ exist as a solid, liquid and a gas?



# Phase Diagrams Practice

PRACTICE

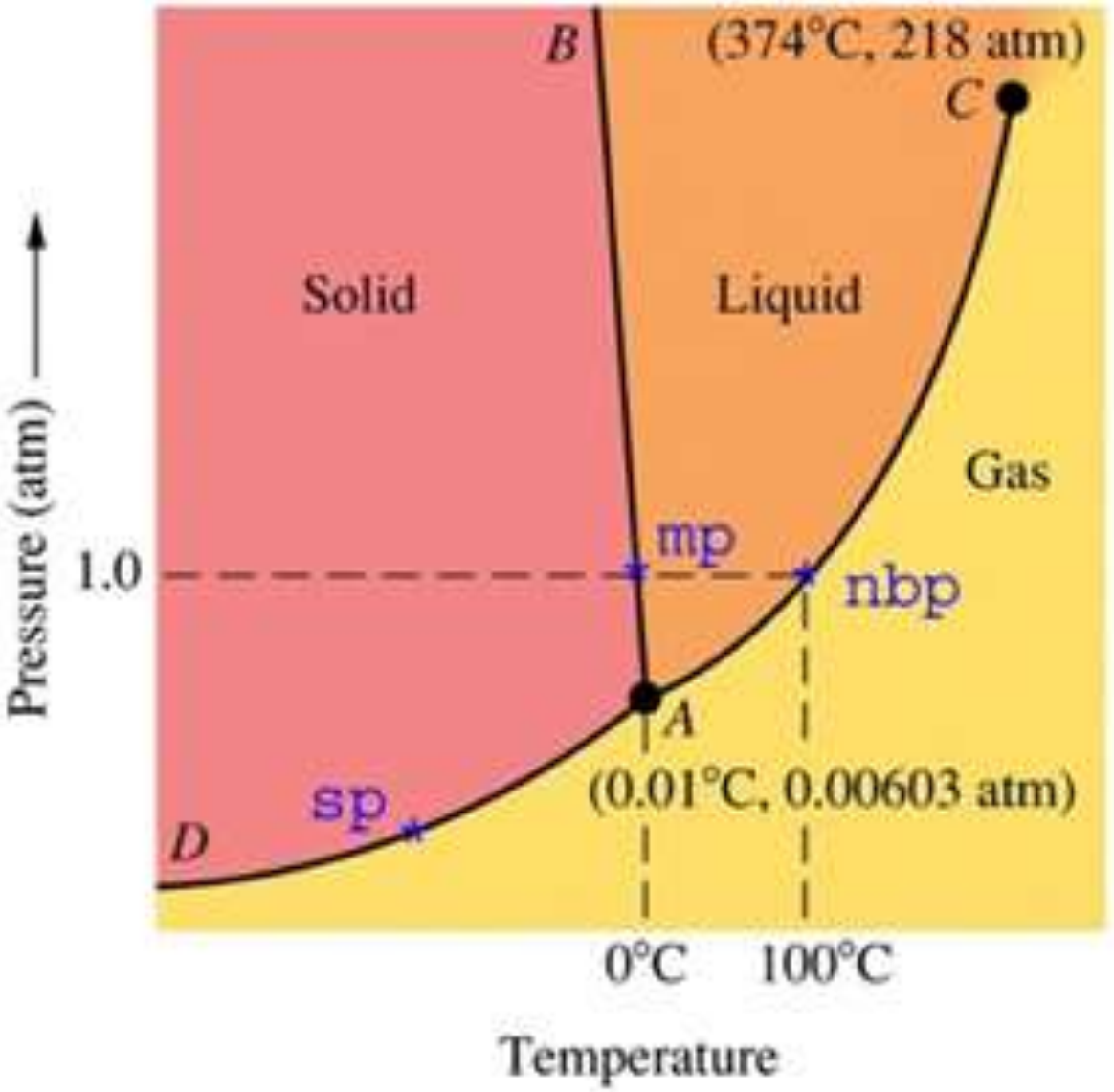
2. At 100˚C and a pressure above 1.0 atm, $H_2O$ exists in which phase of matter?



# Phase Diagrams

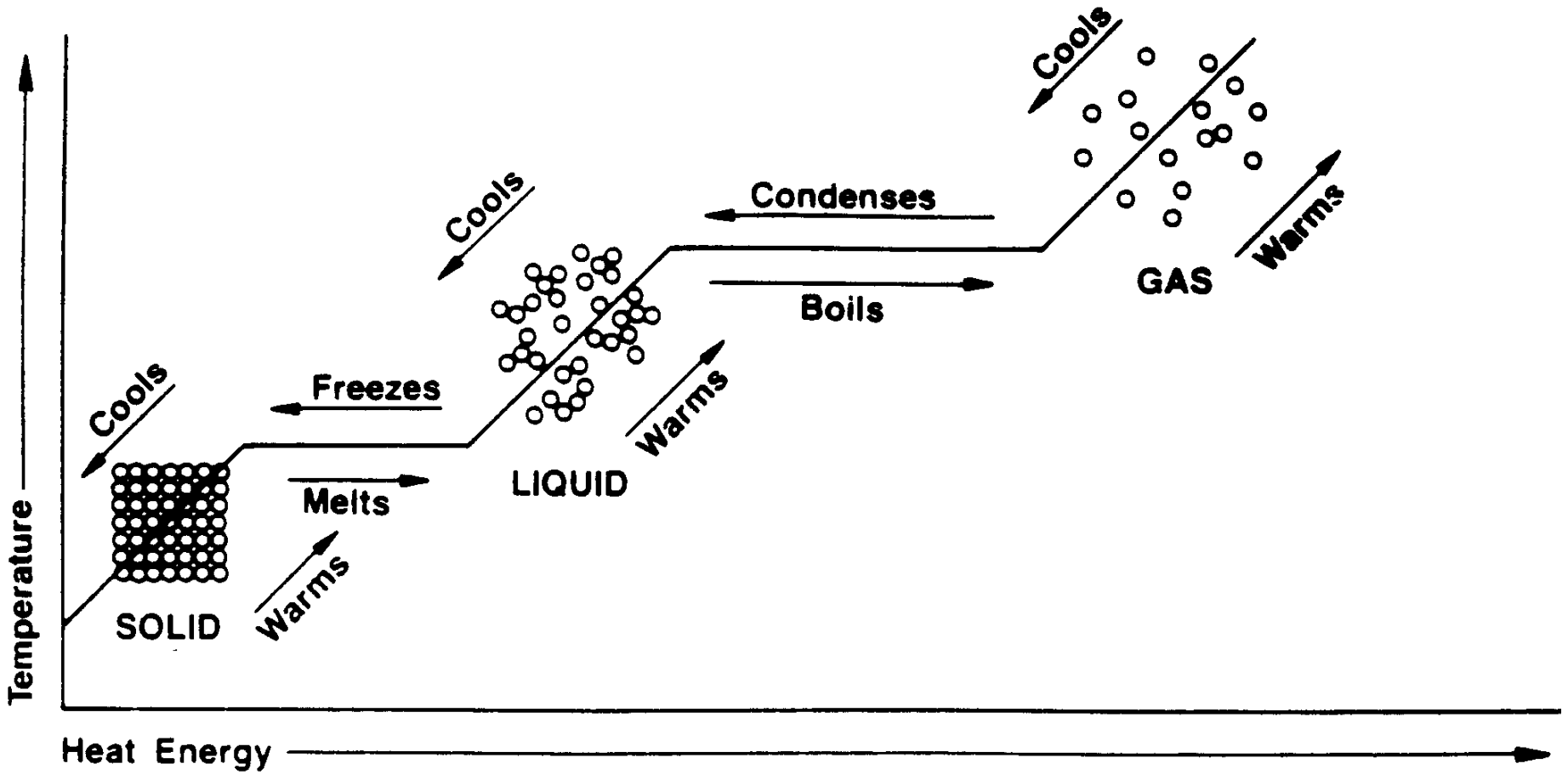
PRACTICE

3. At 100°C and a pressure below 1.0 atmosphere, $H_2O$ exists in which phase of matter?



# Heating/Cooling Curve

- A heating curve shows how the temperature of a substance changes as heat is added at a constant rate.
- NO TEMPERATURE CHANGES DURING PHASE CHANGES



# Heating/Cooling Curve

1. In the heating curve for iron, describe the phase change that occurred between points D and E on the graph.

2. Explain why the temperature stayed constant between points D and E.