Phase Diagrams

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INFLUENCE OF IMF ON PHASES OF MATTER

Phases of matter: the stronger the intermolecular forces between molecules, the stronger the interactions between them.

STRONG IMFS	→	high melting point	high boiling point
WEAK IMFs	→	low melting point	low boiling point

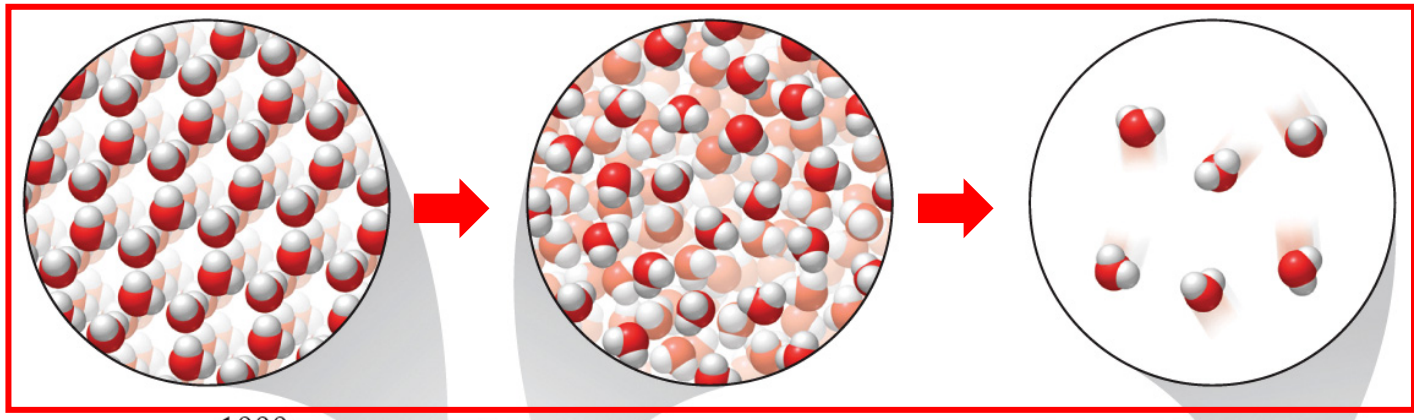
Solubility is determined by intermolecular forces between solute and solvent.

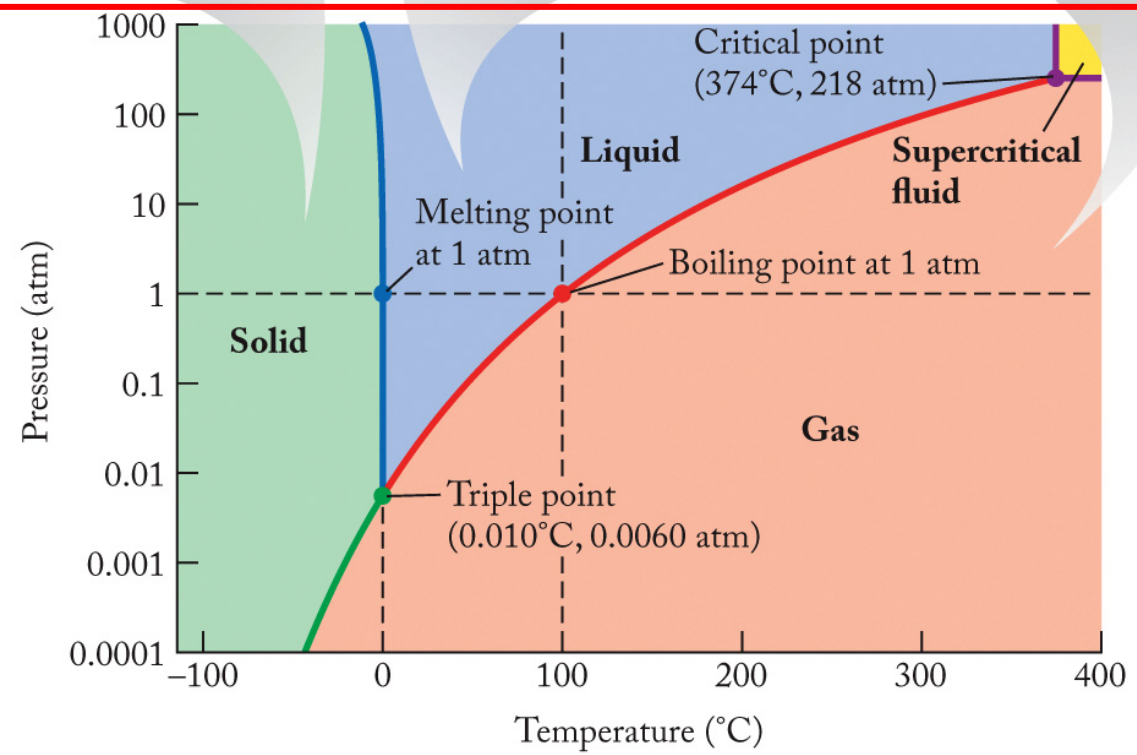
HAVE IMF	→	SOLUBLE
HAVE NO IMF	→	INSOLUBLE

PHASE DIAGRAM ANALYSIS

SOME KEY NOTES:

- From left to right: solid, liquid, gas (think about heating a substance).





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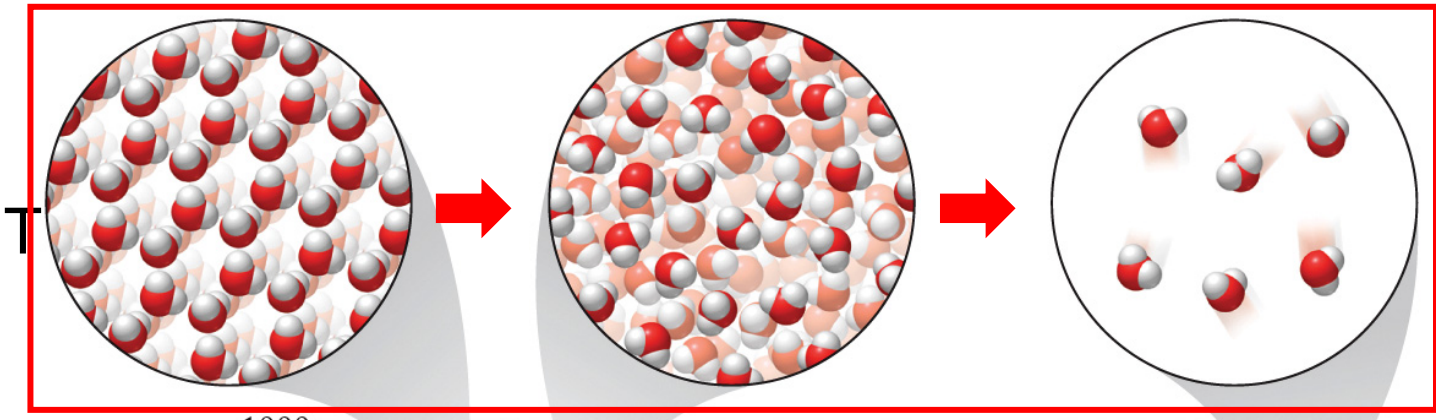

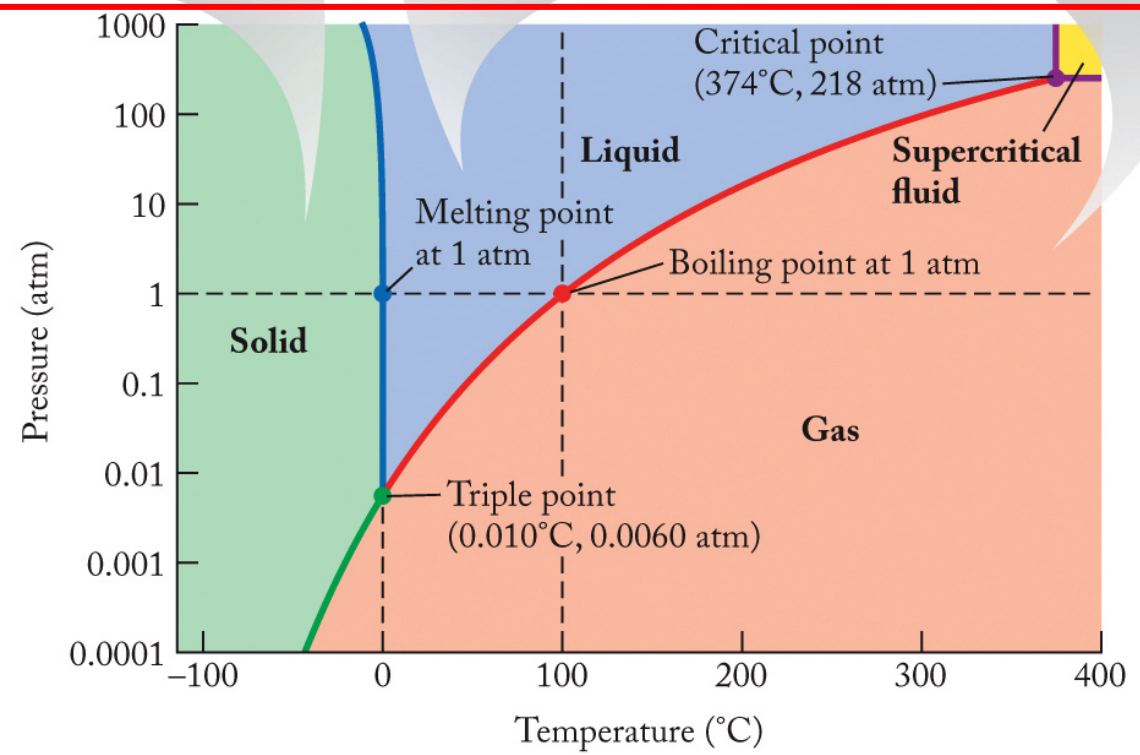

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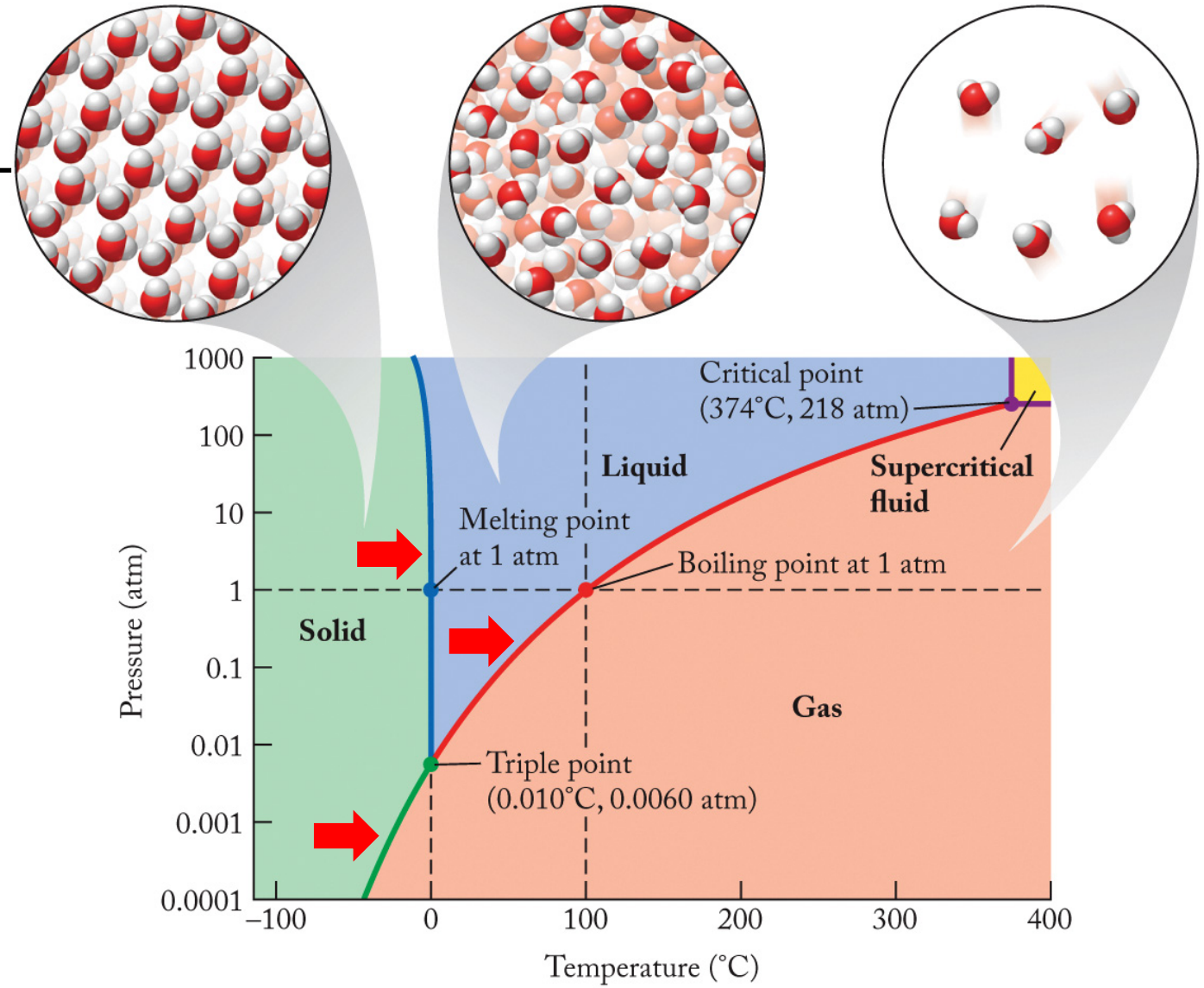

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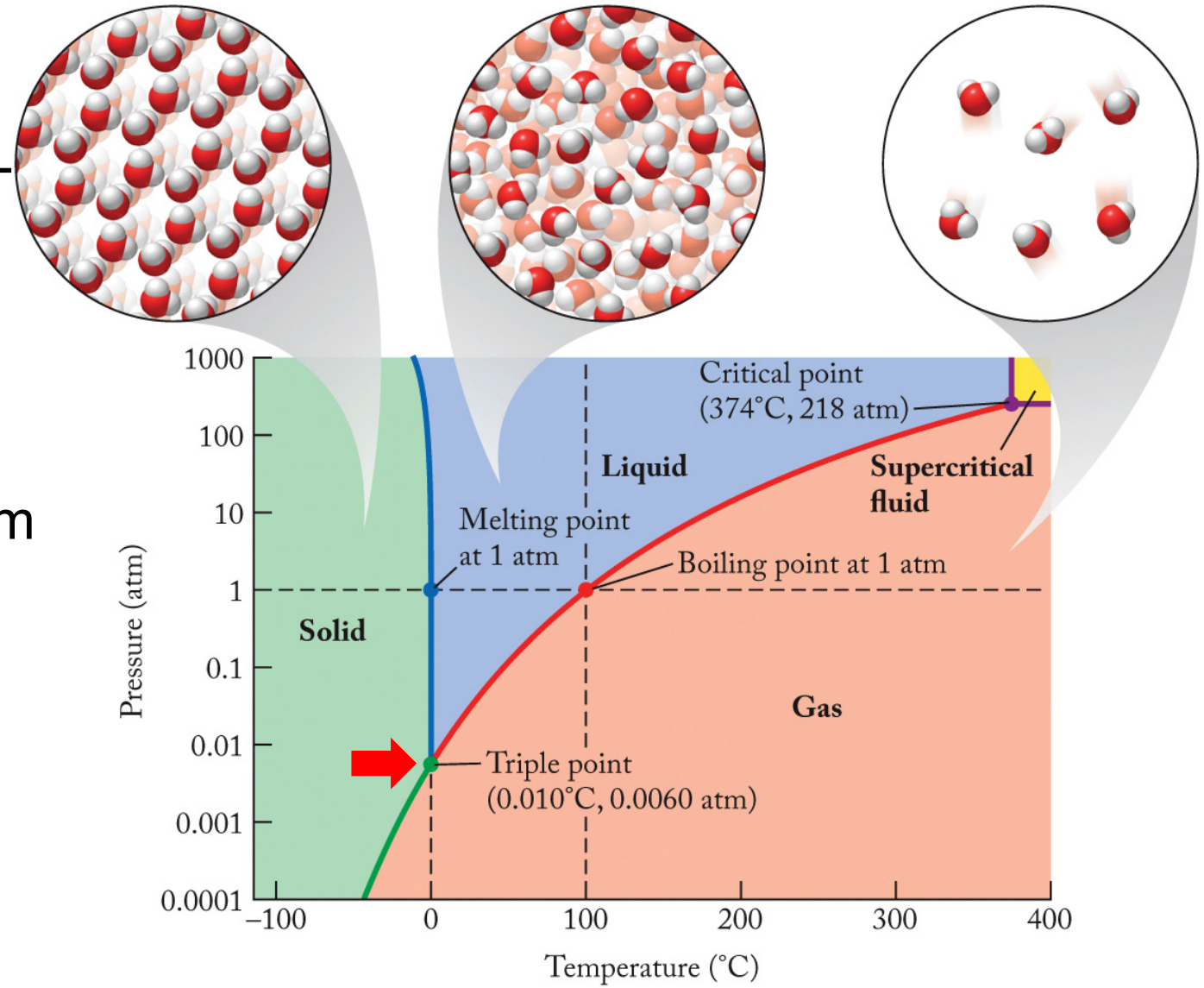

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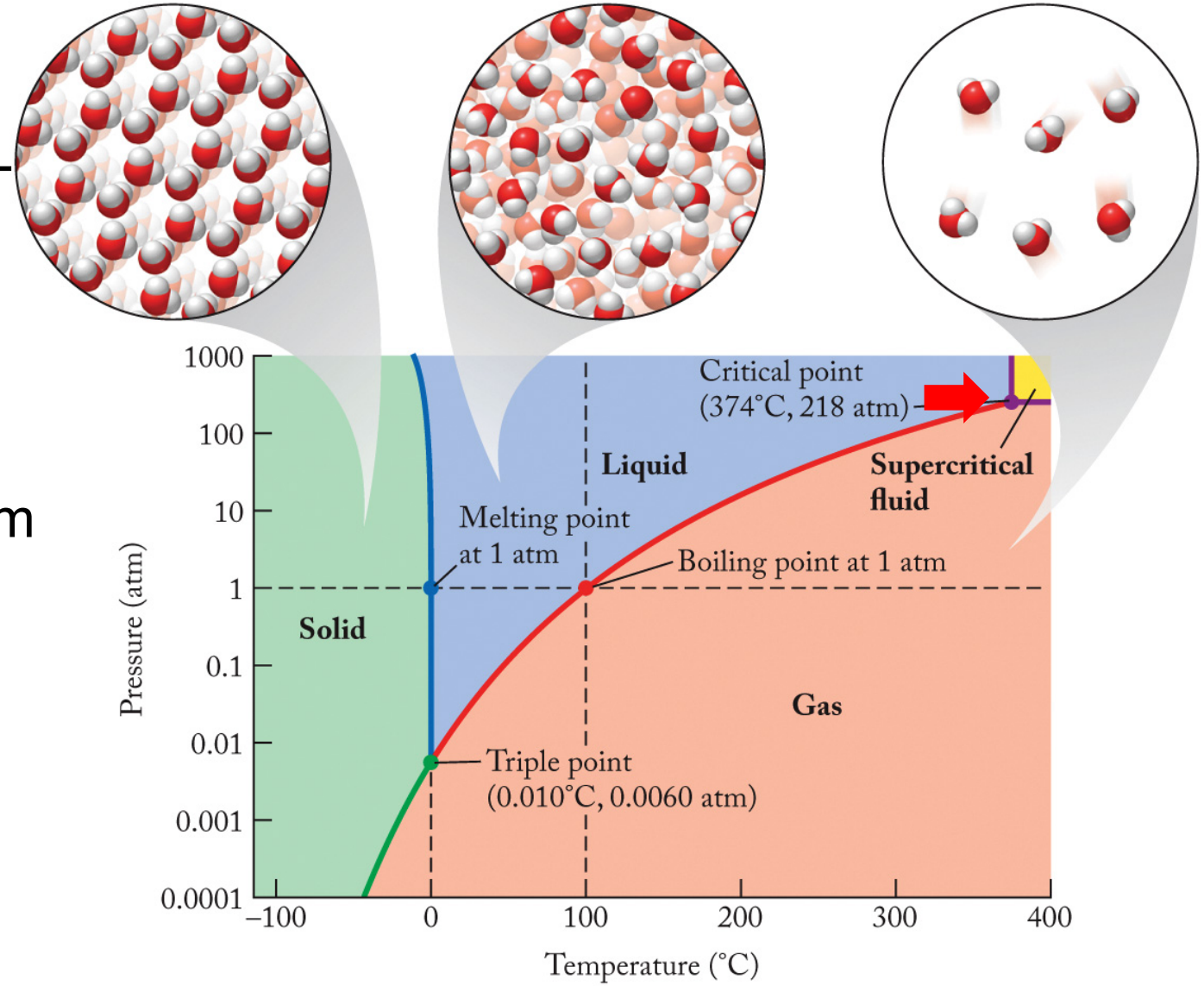
- **Critical point**: liquid & gas phases indistinguishable; above this point matter is a supercritical fluid.



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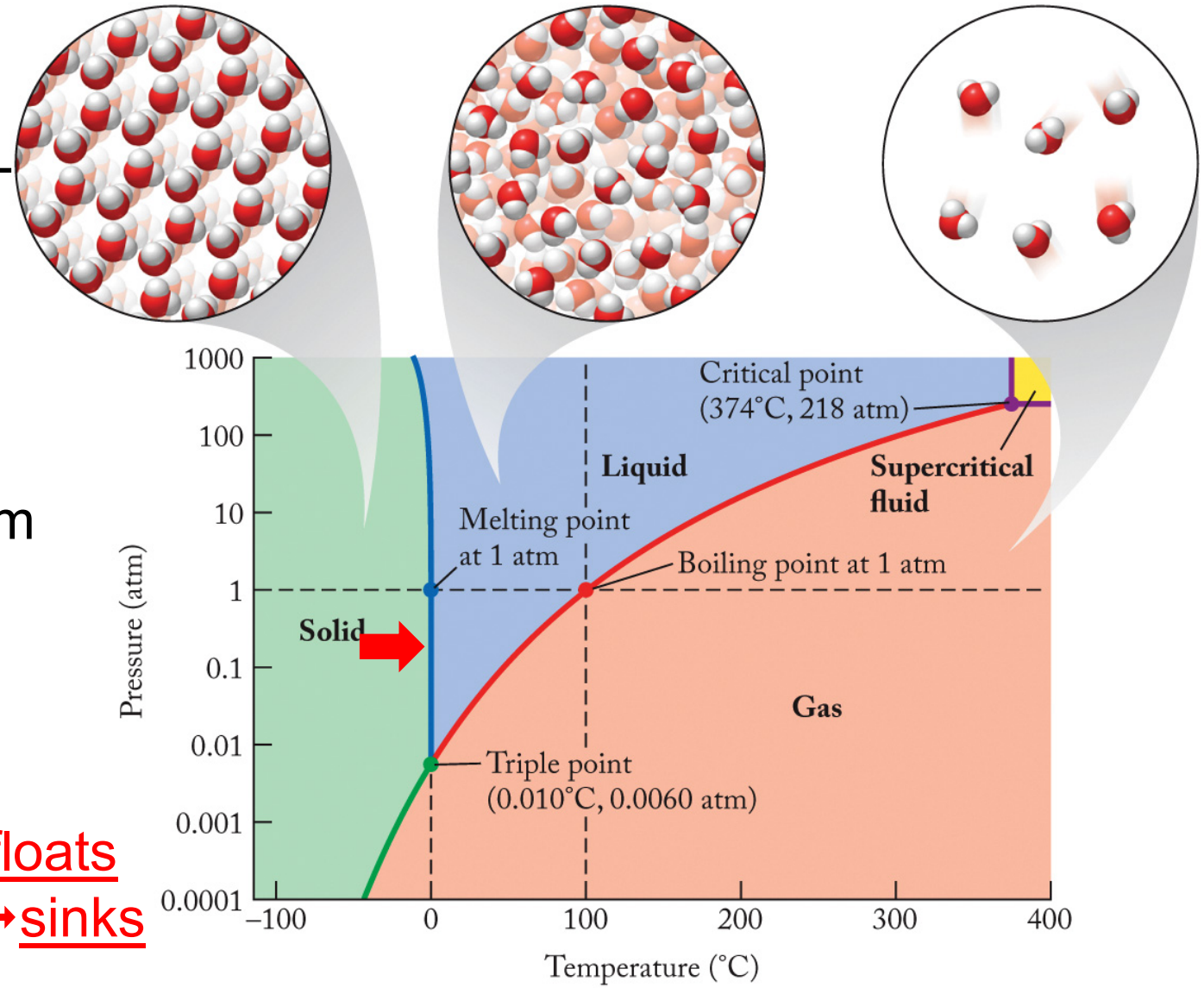
- Slope of solid/liquid line:
  Left: solid less dense than liquid → floats
  Right: solid more dense than liquid→sinks



Shown to the right is the phase diagram for helium (He).

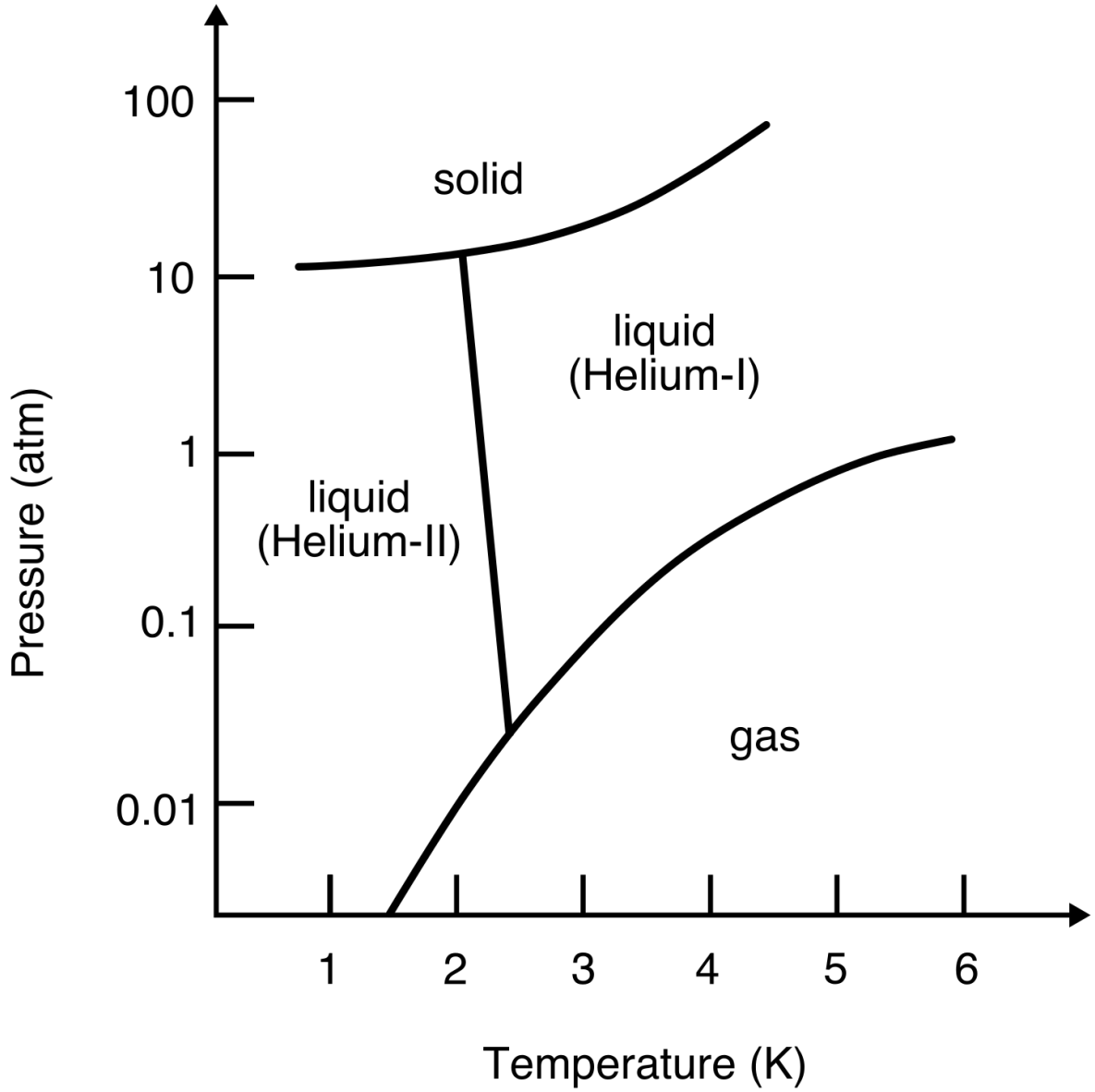
A. What is the maximum temperature for which "superfluid" helium-II exists?

B. What is the minimum pressure at which solid helium can exist?

C. What is the normal boiling point of helium-I?

D. Can He sublime?

E. Which liquid phase of helium is more dense?



Shown to the right is the phase diagram for helium (He).

A. What is the maximum temperature for which "superfluid" helium-II exists?
   ~2.4 K
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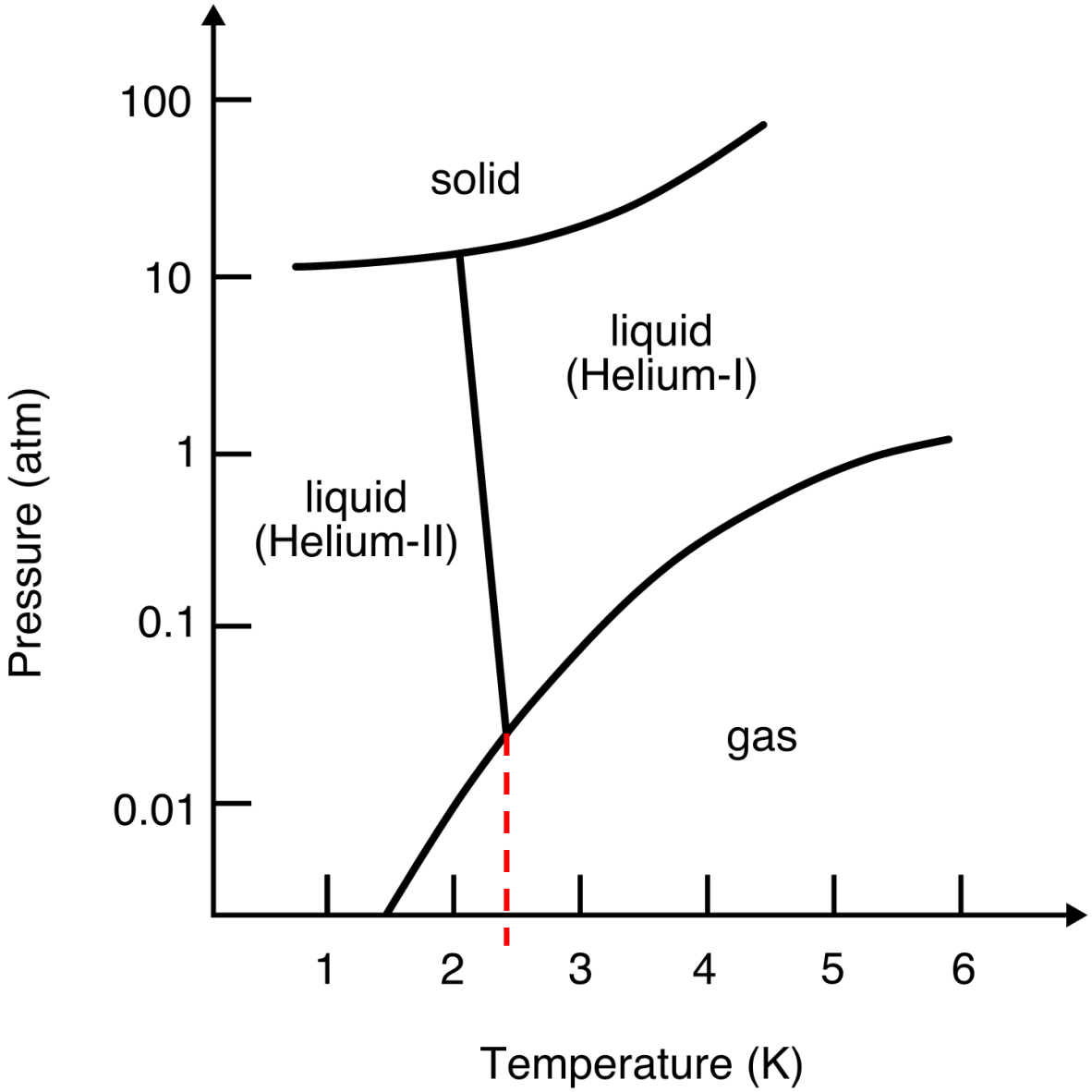

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A. What is the maximum temperature for which "superfluid" helium-II exists?
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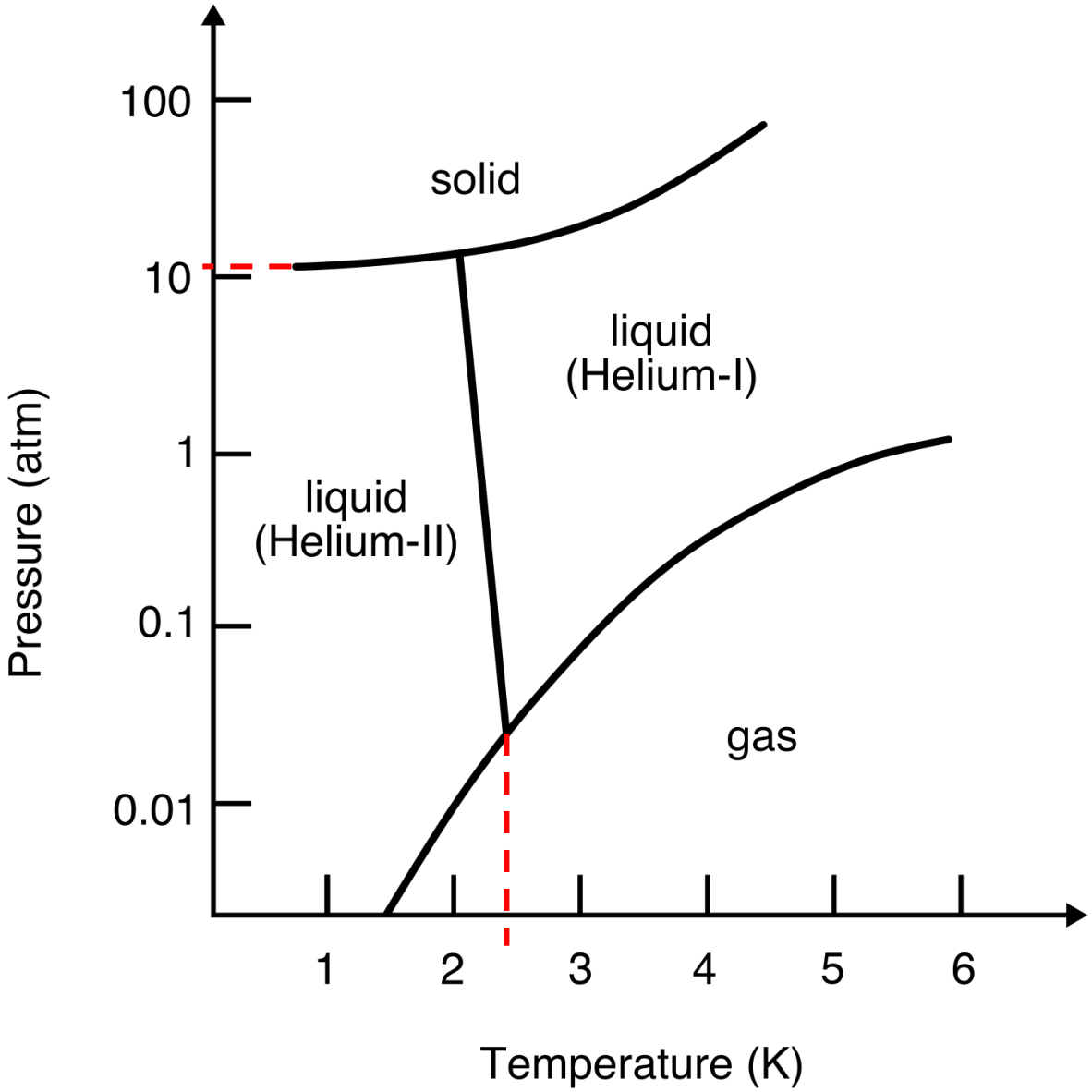

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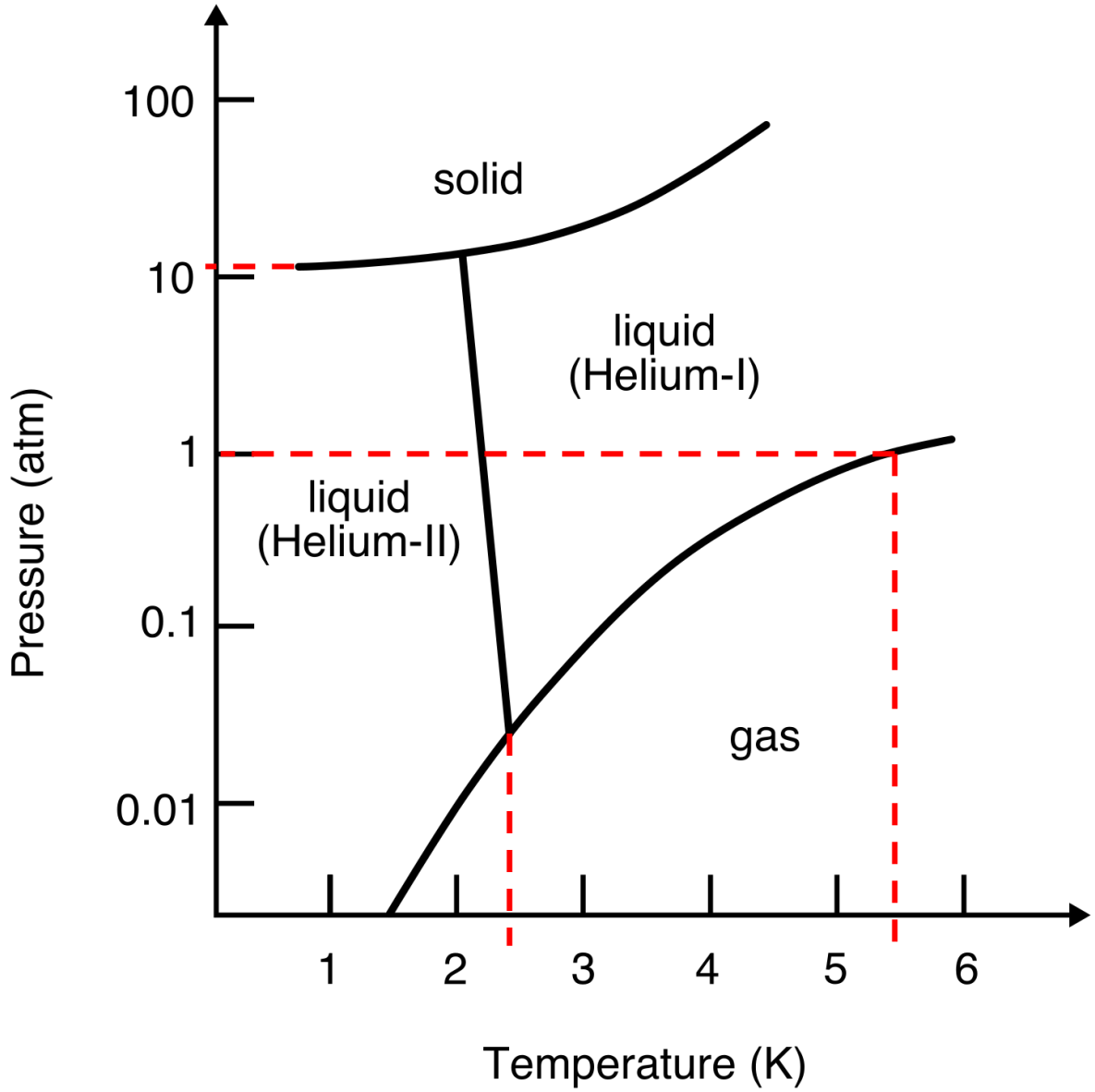

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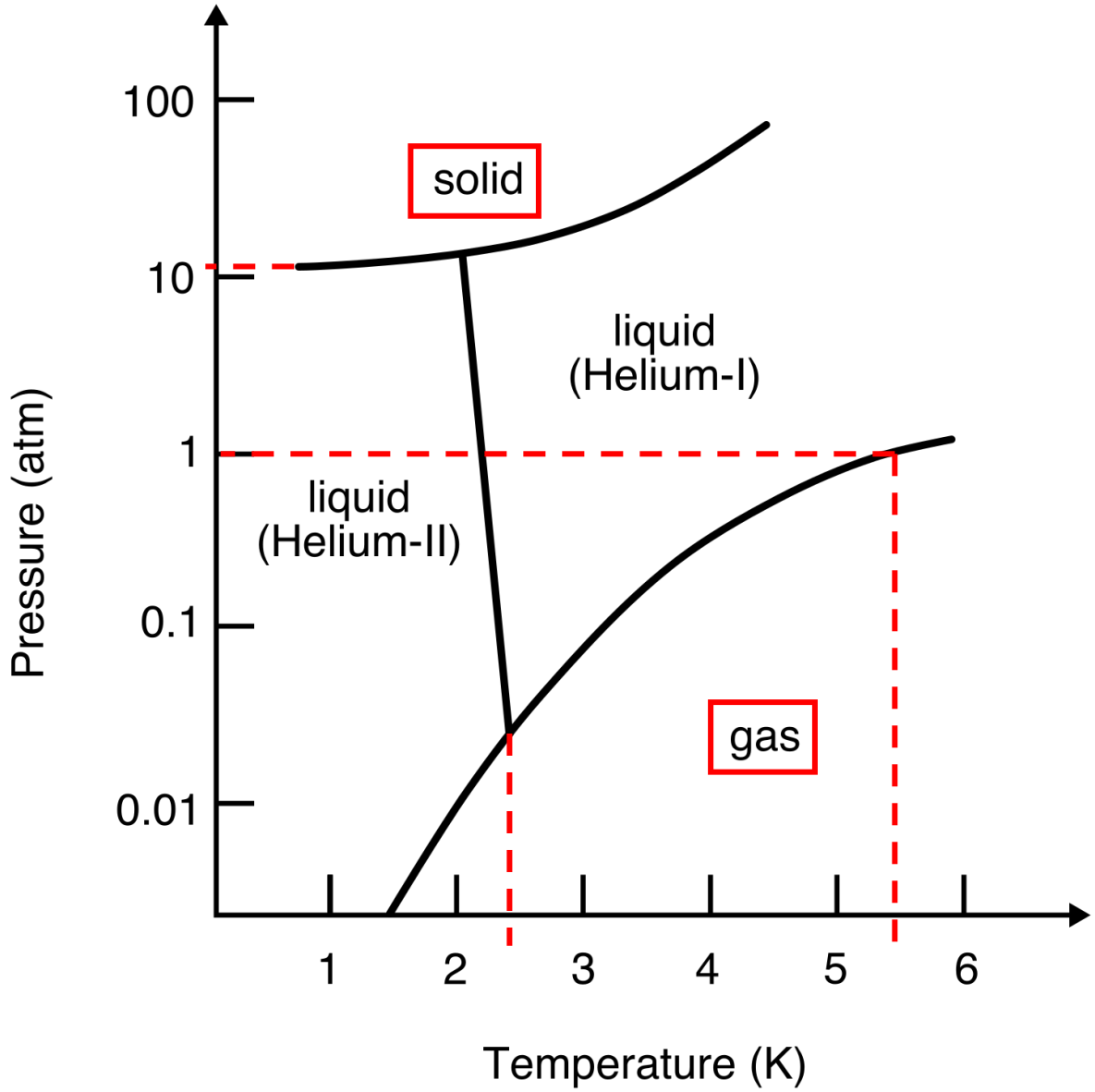

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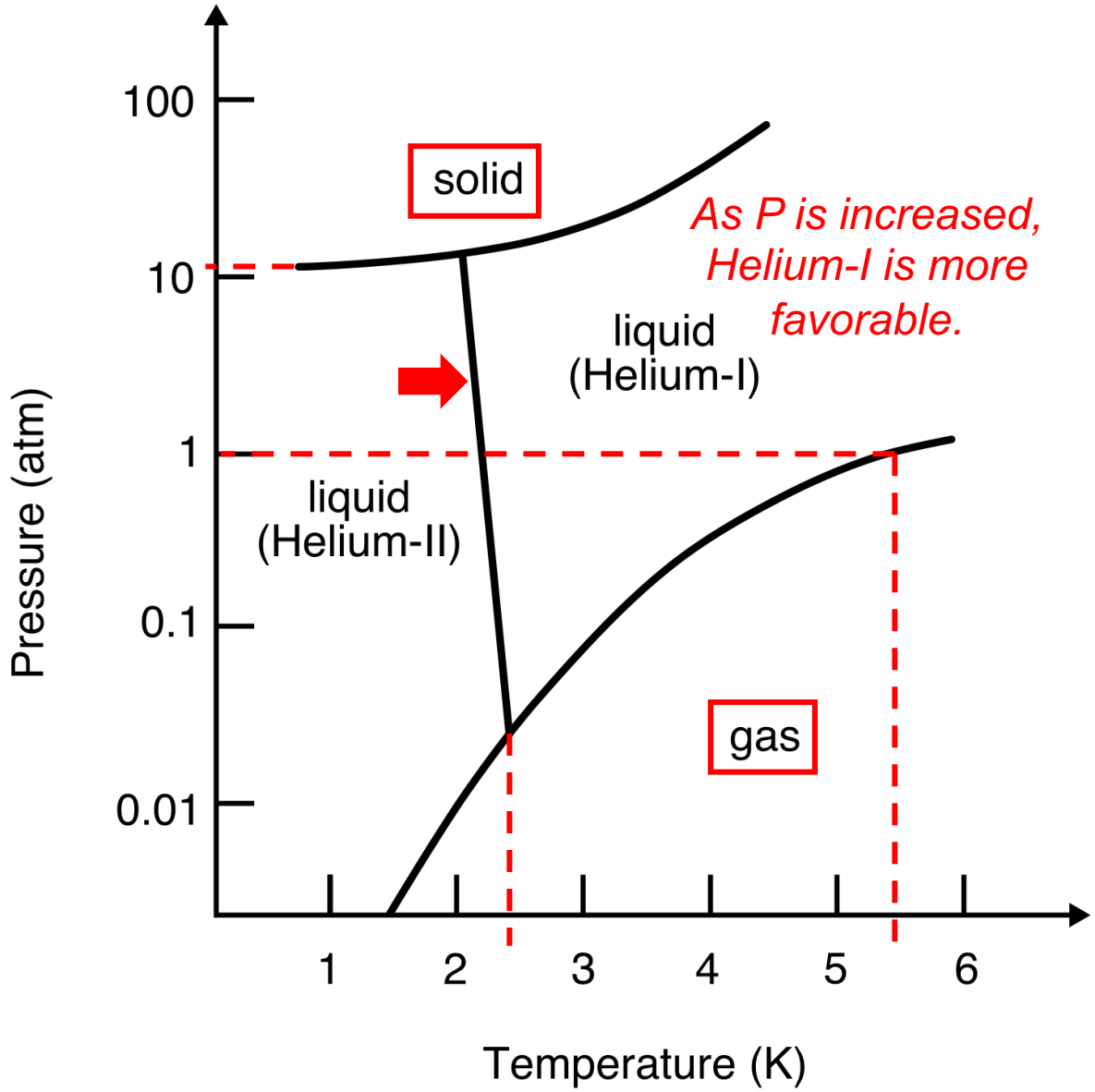
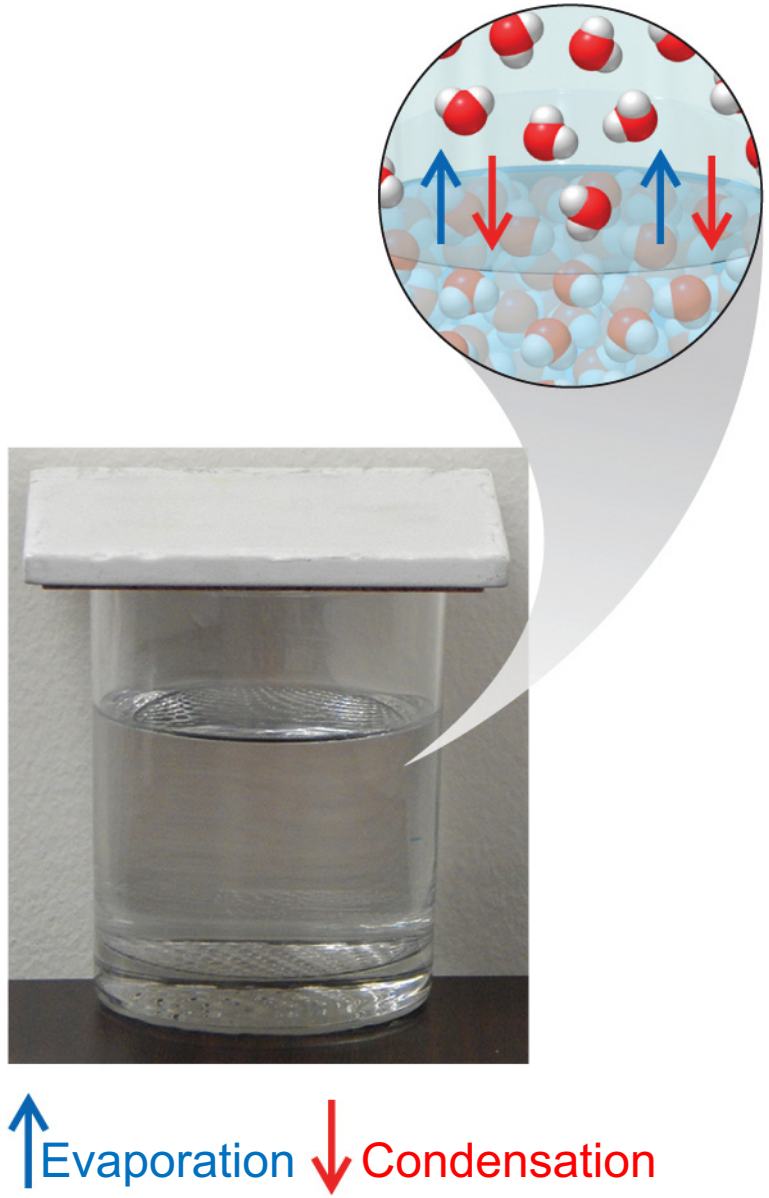
   No, it will pass through liquid(s) first.
E. Which liquid phase of helium is more dense?
   Helium-I, since the Helium-1/Helium-II equilibrium line slopes to the left.



VAPOR PRESSURE

Pressure exerted by the vapor (gaseous state) of a liquid when the two states are in equilibrium.



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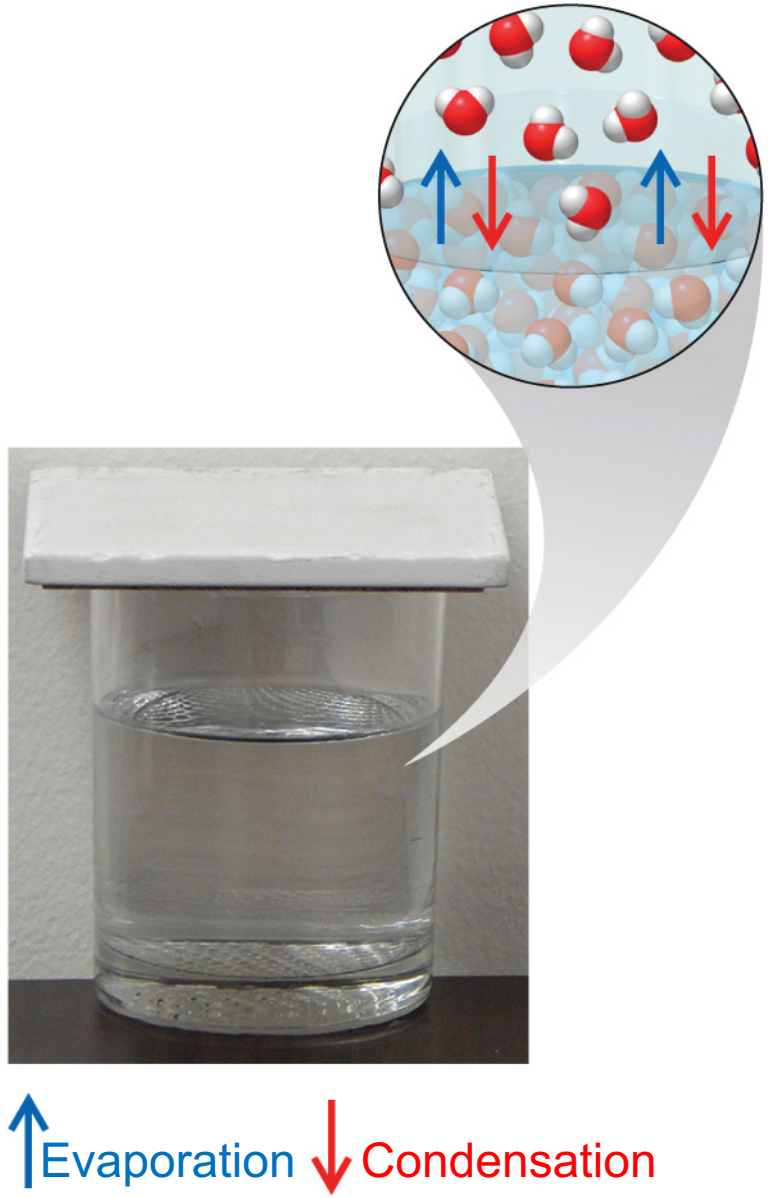
Vapor pressure is affected by three things:

1. Temperature: as temperature increases, more liquid molecules have sufficient kinetic energy to escape into the gas phase. T ⇧, P_{vap} ⇧



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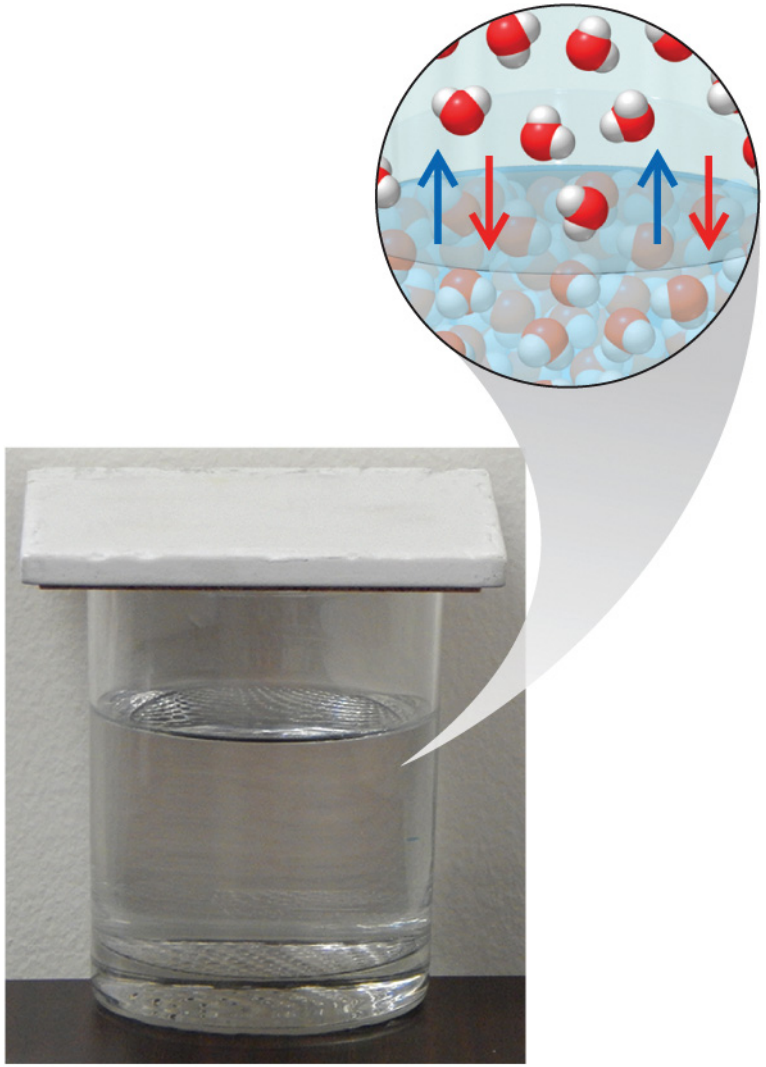
2. Surface area: as surface area increases, more liquid molecules are exposed to the surface. Area ⇧, P_{vap} ⇧



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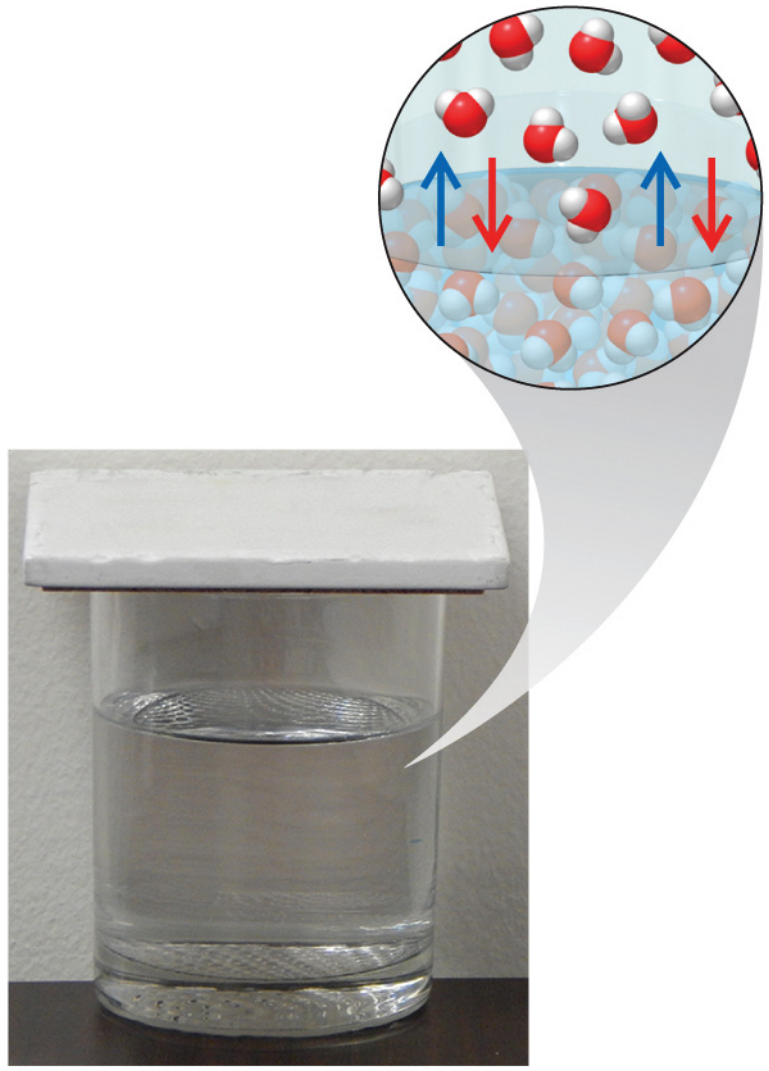
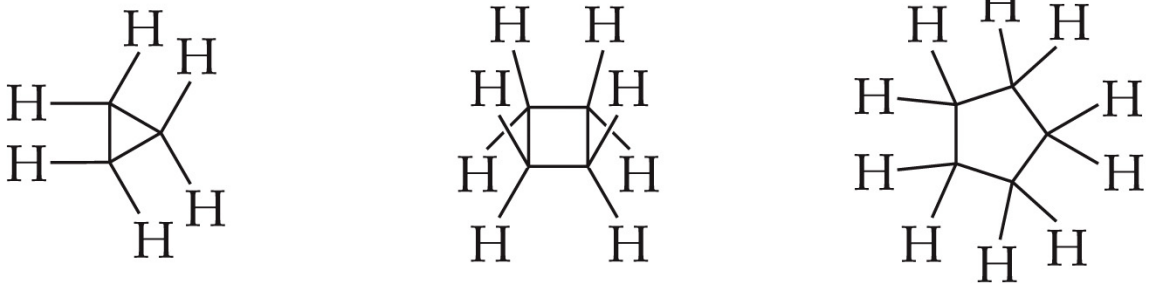
2. Surface area: as surface area increases, more liquid molecules are exposed to the surface. Area ⇧, P_{vap} ⇧
3. Intermolecular forces: as the intermolecular forces between liquid molecules strengthens, vapor pressure decreases because it requires more energy to escape the liquid phase. IMF ⇧, P_{vap} ⇩



Which has the higher vapor pressure:

A. $C_2H_5OC_2H_5$ or H_2O

B.



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IMF ⇧, P_{vap} ⇩

Which has the higher vapor pressure:

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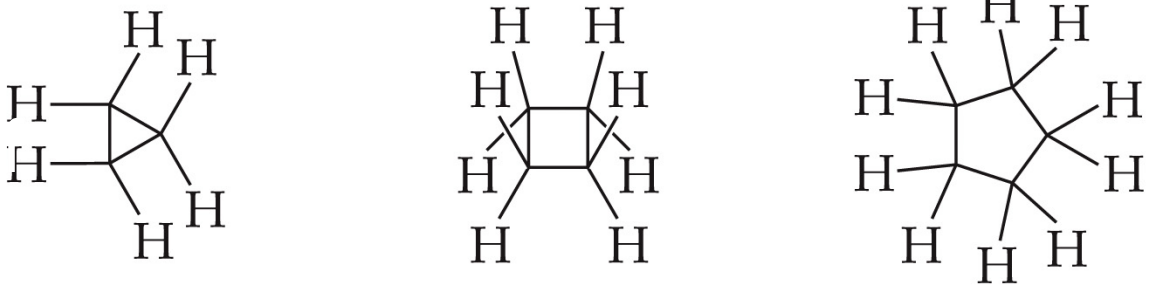
H_2O has stronger IMFs: hydrogen bonding, dipole-dipole, and dispersion. $C_2H_5OC_2H_5$ only has dipole-dipole and dispersion.

B.



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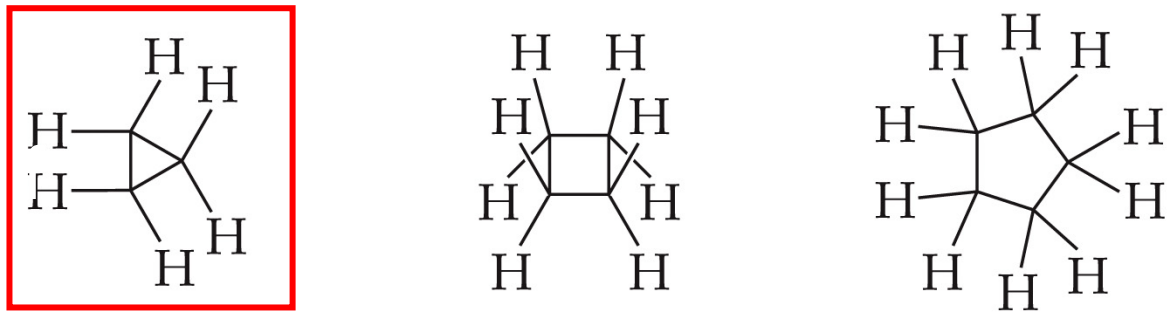

All three only have dispersion forces, and the heaviest compound has the strongest.

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