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**Question #: 1**

Which phases of matter are described below?

  1   = Relatively high density, indefinite shape, definite volume, and moderate intermolecular forces.

  2   = Relatively low density, indefinite shape, indefinite volume, and weak intermolecular forces.

  3   = Relatively high density, definite shape, definite volume, and strong intermolecular forces.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

---

**Question #: 2**

Rank the following in order from **lowest** to **highest** boiling point. The numbers do not have to be subscripts in your formulas.

CH<sub>4</sub>, CH<sub>3</sub>OH, CH<sub>3</sub>Cl, CH<sub>3</sub>Br

Lowest   1   <   2   <   3   <   4   Highest

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

---

**Question #: 3**

The energy required to increase the surface area of a liquid by a unit amount is \_\_\_\_\_, which \_\_\_\_\_ increasing strength of intermolecular forces.

- A. viscosity; increases with
- B. viscosity; decreases with
- C. surface tension; increases with

D. surface tension; is independent of

---

**Question #: 4**

The equilibrium vapor pressure of a liquid in a sealed flask at constant temperature is established when the \_\_\_\_\_ rate of condensation equals the \_\_\_\_\_ rate of vaporization.

- A. increasing; constant
  - B. decreasing; constant
  - C. increasing; decreasing
  - D. decreasing; increasing
- 

**Question #: 5**

Levomenthol,  $C_{10}H_{20}O$ , has a normal boiling point of  $212\text{ }^{\circ}\text{C}$  and a heat of vaporization ( $\Delta H_{\text{vap}}$ ) of  $56.9\text{ kJ/mol}$ . What is the vapor pressure of levomenthol at  $247\text{ }^{\circ}\text{C}$ ?

- A. 2.59 atm
  - B. 0.781 atm
  - C. 4.62 atm
  - D. 1.10 atm
- 

**Question #: 6**

Which statement is **false** about supercritical fluids?

- A. The liquid phase cannot exist above a substance's critical temperature.
  - B. At the critical point of a substance, the densities of its gas and liquid phases become equal.
  - C. Supercritical fluids can act as good, selective solvents.
  - D. The gas phase cannot exist below a substance's critical pressure.
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**Question #: 7**

Direct conversion of a solid to a gas is called 1 ; direct conversion of a gas to a solid is called 2 .

1. \_\_\_\_\_
2. \_\_\_\_\_

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**Question #: 8**

Which one of these phase changes generally has the most positive  $\Delta H$  value?

- A. fusion
- B. condensation
- C. vaporization
- D. freezing

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**Question #: 9**

How much energy is required to warm 90.1 g (5.00 mol) of  $\text{H}_2\text{O}(s)$ , initially at  $-19.4\text{ }^\circ\text{C}$ , to  $\text{H}_2\text{O}(l)$  at  $100.0\text{ }^\circ\text{C}$ ?

melting point =  $0.00\text{ }^\circ\text{C}$

boiling point =  $100.0\text{ }^\circ\text{C}$

$\Delta H_{\text{fus}} = 6.02\text{ kJ/mol}$

$\Delta H_{\text{vap}} = 40.7\text{ kJ/mol}$

$C_s$  of  $\text{H}_2\text{O}(s) = 2.09\text{ J/g }^\circ\text{C}$

$C_s$  of  $\text{H}_2\text{O}(l) = 4.18\text{ J/g }^\circ\text{C}$

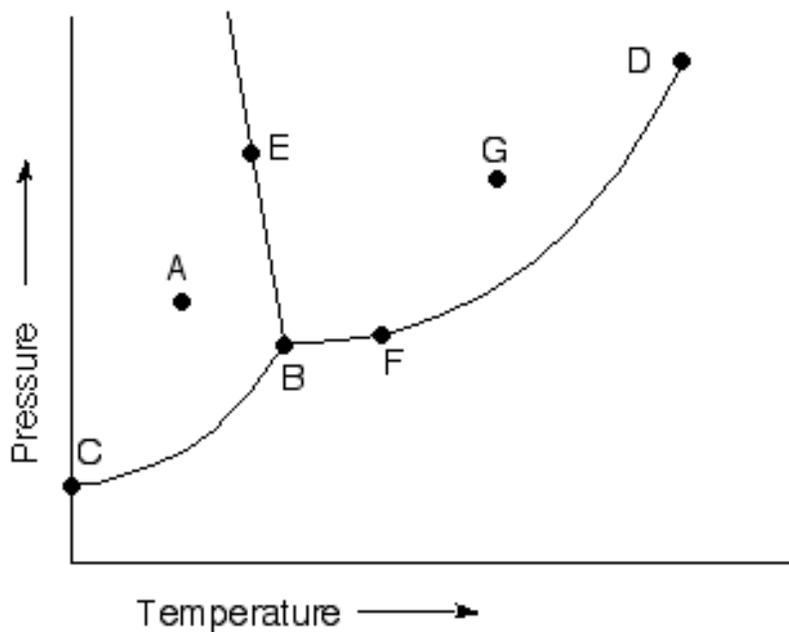
$C_s$  of  $\text{H}_2\text{O}(g) = 2.01\text{ J/g }^\circ\text{C}$

- A. 40.2 kJ
- B. 3.02 kJ
- C. 71.4 kJ
- D. 98.4 kJ

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**Question #: 10**

Name the indicated points on the phase diagram.



Point B is the   1   [critical, triple] point.

Point G is located in the   2   [solid, liquid, gas] region.

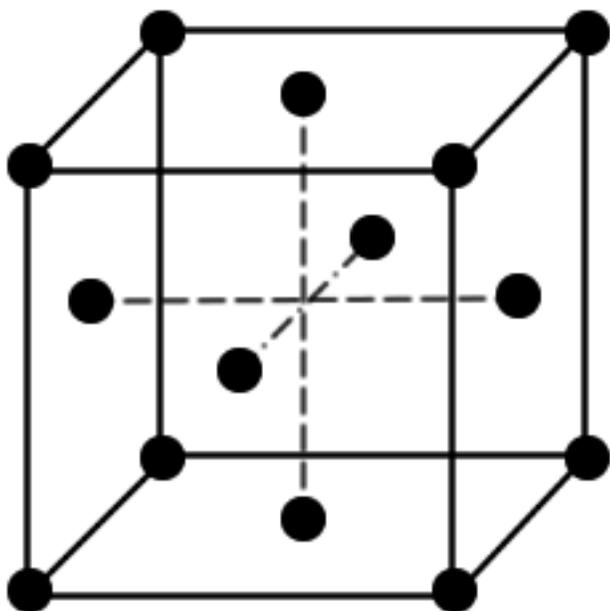
Point F is located on the   3   [fusion, vaporization, sublimation] curve.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

**Question #: 11**

Iridium (192 g/mol) crystallizes in a face-centered cubic structure as shown below. The volume of the unit cell is

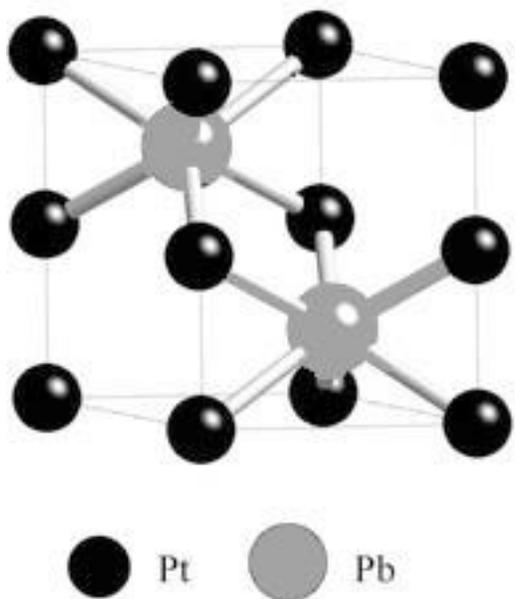
$5.62 \times 10^{-23} \text{ cm}^3$ . What is the **density** of crystalline iridium?



- A.  $5.06 \text{ g/cm}^3$
- B.  $0.264 \text{ g/cm}^3$
- C.  $22.7 \text{ g/cm}^3$
- D.  $15.2 \text{ g/cm}^3$

**Question #:** 12

Determine the formula for the platinum-lead alloy shown below. Lead atoms (gray circles) are located inside the unit cell while platinum atoms (black circles) are located on each of the eight corners and on four of the edges.



- A.  $\text{Pt}_2\text{Pb}_{12}$
- B.  $\text{PtPb}_6$
- C.  $\text{Pt}_2\text{Pb}_4$
- D.  $\text{PtPb}$

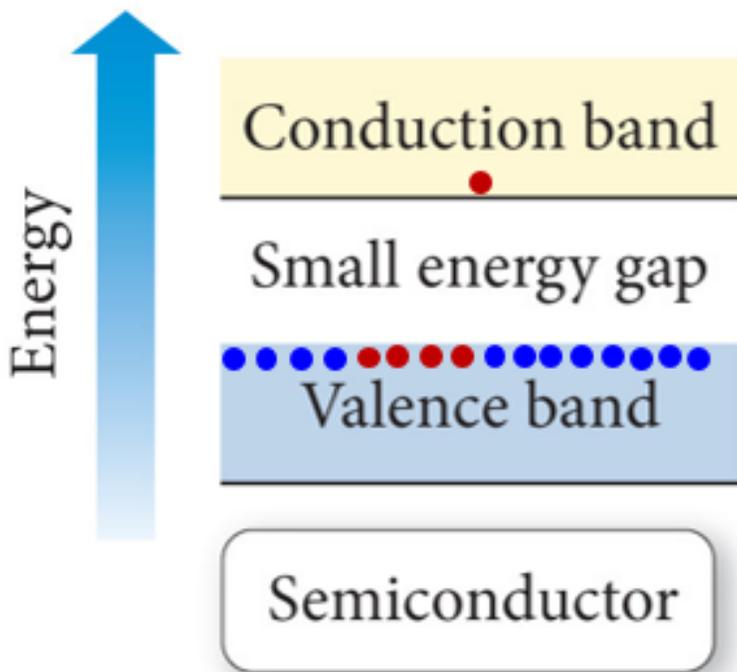
**Question #:** 13

Zincite,  $\text{ZnO}(s)$ , is a(n)   1   [molecular, ionic, nonbonding atomic, metallic, network covalent] crystalline solid.

1. \_\_\_\_\_

**Question #:** 14

Silicon is doped, resulting in the material with the band diagram below.



If the blue dots represent electrons from silicon and red dots represent electrons from the dopant, what is the identity of the dopant and the type of semiconductor formed?

- A. arsenic; n-type
- B. gallium; n-type
- C. germanium; p-type
- D. indium; p-type

Question #: 15

Select the false statement.

- A. Solutions form when both solvent and solute have similar intermolecular forces.
- B. Air is an example of a gaseous solution.
- C. A liquid solution can only be formed between two or more liquids.
- D. A solid solution can only be formed between two or more solids.

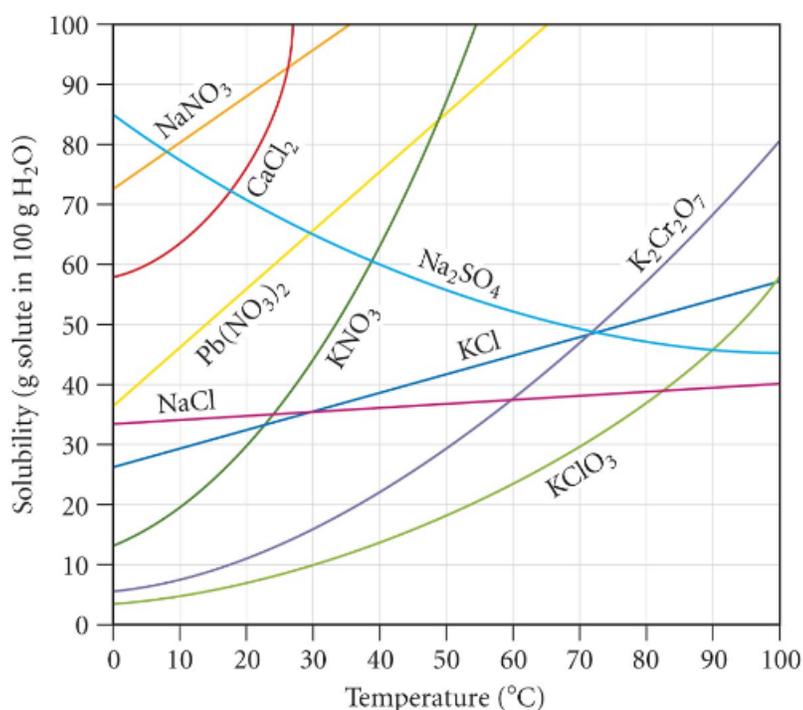
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In a saturated solution of  $\text{NaNO}_3$ ,

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- C.  $\text{NaNO}_3$  is precipitating at the same rate that solid  $\text{NaNO}_3$  is dissolving.
- D. solid  $\text{NaNO}_3$  is dissolving more rapidly than  $\text{NaNO}_3$  is precipitating.

**Question #: 17**

A 100.0 g portion of water is heated to 65 °C and 99.5 g of solid  $\text{Pb}(\text{NO}_3)_2$  is added, with stirring, until all of the solid dissolves. The resulting solution is removed from the heat source and allowed to cool to room temperature (25 °C). What happens to the solution?

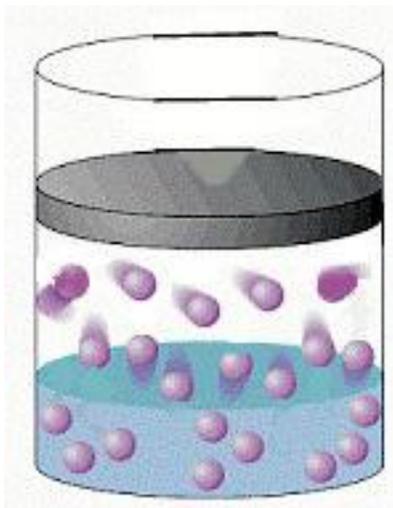


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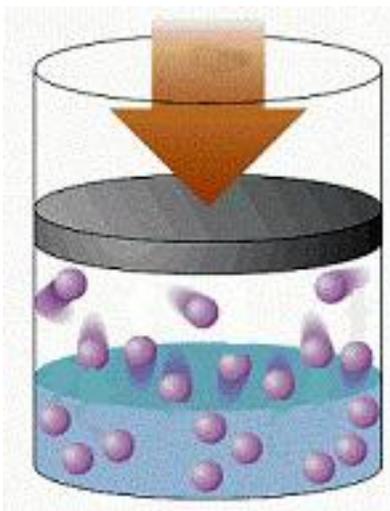
- A. All of the  $\text{Pb}(\text{NO}_3)_2(aq)$  remains in solution at 25 °C and the solution becomes unsaturated.
- B. All of the  $\text{Pb}(\text{NO}_3)_2(aq)$  remains in solution at 25 °C and the solution remains saturated.
- C. All of the  $\text{Pb}(\text{NO}_3)_2(aq)$  remains in solution at 25 °C and the solution becomes supersaturated.
- D. The  $\text{Pb}(\text{NO}_3)_2(aq)$  exceeds the equilibrium solubility at 25 °C and begins to precipitate, leaving behind an unsaturated solution.

Question #: 18

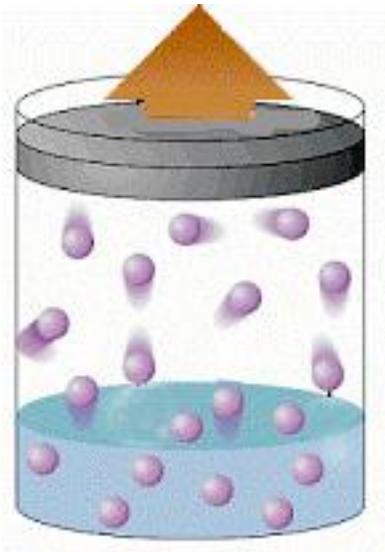
Which change(s) in conditions increase(s) the solubility of a gas in a solvent?  
Select all that apply.



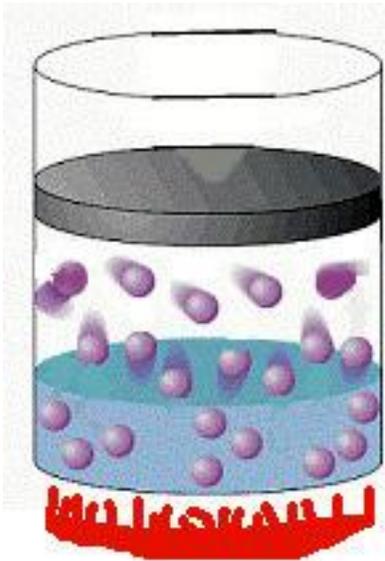
A. increasing pressure



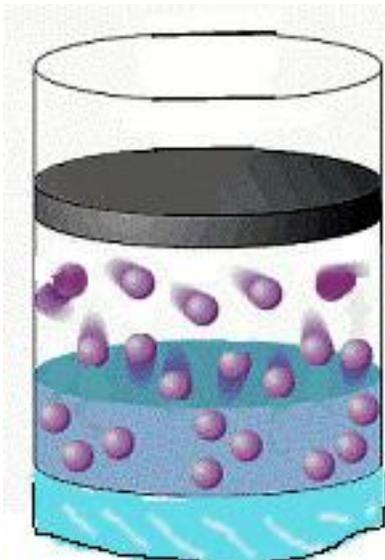
B. decreasing pressure



C. increasing temperature



D. decreasing temperature



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Question #: 19

What is the molality of a solution prepared by dissolving 15.0 g  $\text{H}_2\text{SO}_4$  (98.08 g/mol) in 500. g of water?

- A. 28.0 *m*
- B. 0.270 *m*
- C. 0.306 *m*
- D. 1.56 *m*

---

Question #: 20

How many Hg atoms (200.6 g/mol) are found in a 9.00 g water sample that is 25.0 ppb by mass mercury?

- A.  $6.75 \times 10^{14}$  atoms
- B.  $4.05 \times 10^{23}$  atoms
- C.  $1.28 \times 10^{12}$  atoms
- D.  $8.35 \times 10^{24}$  atoms

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Question #: 21

What is the molarity of a 1.25 *m* HCl (36.46 g/mol) solution with a density of 1.017 g/mL?

- A. 1.34 M
- B. 1.18 M
- C. 1.29 M
- D. 1.22 M

---

Question #: 22

Which substance has the correct van't Hoff factor indicated?

- A.  $\text{K}_2\text{SO}_4$ ,  $i = 2$

- B.  $(\text{NH}_4)_3\text{PO}_4$ ,  $i = 7$   
C. glucose (non-electrolyte),  $i = 1.5$   
D.  $\text{MgCl}_2$ ,  $i = 3$
- 

**Question #: 23**

Determine the vapor pressure of a solution at 90 °C that contains 15.0 g (0.250 mol) of urea, a nonvolatile nonelectrolyte, dissolved in 240. g (13.32 mol) of water. The vapor pressure of pure water at 90 °C is 526 torr.

- A. 516 torr  
B. 504 torr  
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**Question #: 24**

Calculate the boiling point of a solution prepared by dissolving 0.600 g of nonvolatile naphthalene ( $\text{C}_{10}\text{H}_8$ ) in 15.00 g  $\text{CCl}_4$ .

molar mass ( $\text{C}_{10}\text{H}_8$ ) = 128.1 g/mol

molar mass ( $\text{CCl}_4$ ) = 153.8 g/mol

normal boiling point  $\text{CCl}_4 = 76.72$  °C

$K_b(\text{CCl}_4) = 5.020$  °C/m

boiling point of solution (report with two decimal places) =   1   °C

1. \_\_\_\_\_

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**Question #: 25**

Which solution has the **highest** vapor pressure?

- A. 1.0 m  $\text{AlCl}_3$   
B. 1.0 m  $\text{K}_3\text{PO}_4$   
C. 1.0 m  $\text{C}_6\text{H}_{12}\text{O}_6$   
D. 1.0 m  $\text{Na}_2\text{SO}_4$



---

**Question #: 1**

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1. liquid
2. gas
3. solid

---

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Rank the following in order from **lowest** to **highest** boiling point. The numbers do not have to be subscripts in your formulas.

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Lowest   1   <   2   <   3   <   4   Highest

1. CH4
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1. sublimation
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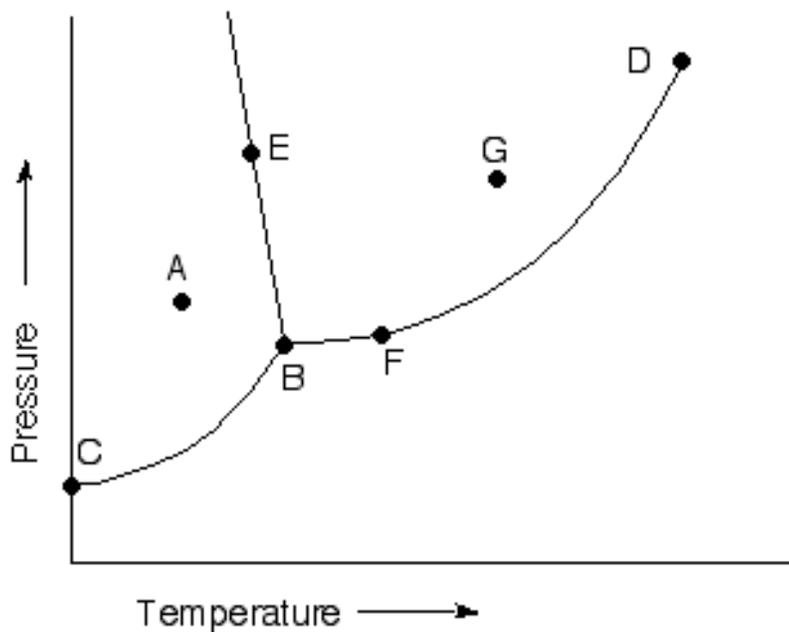
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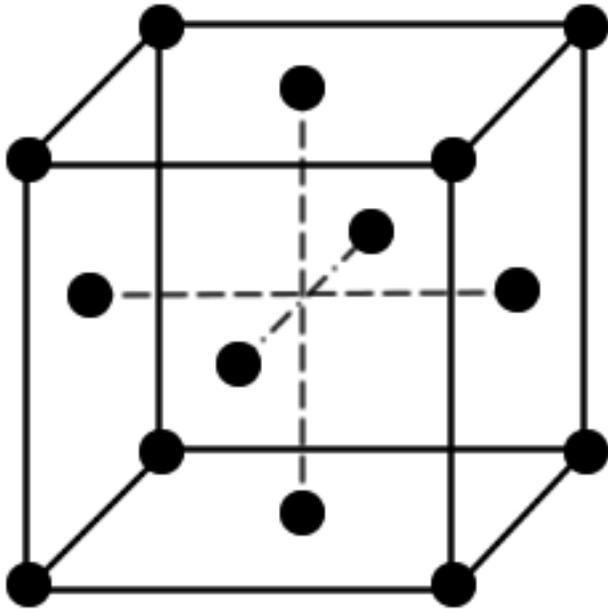
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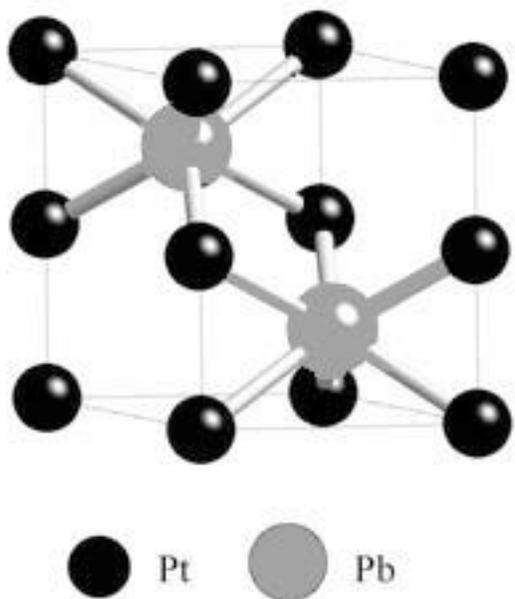
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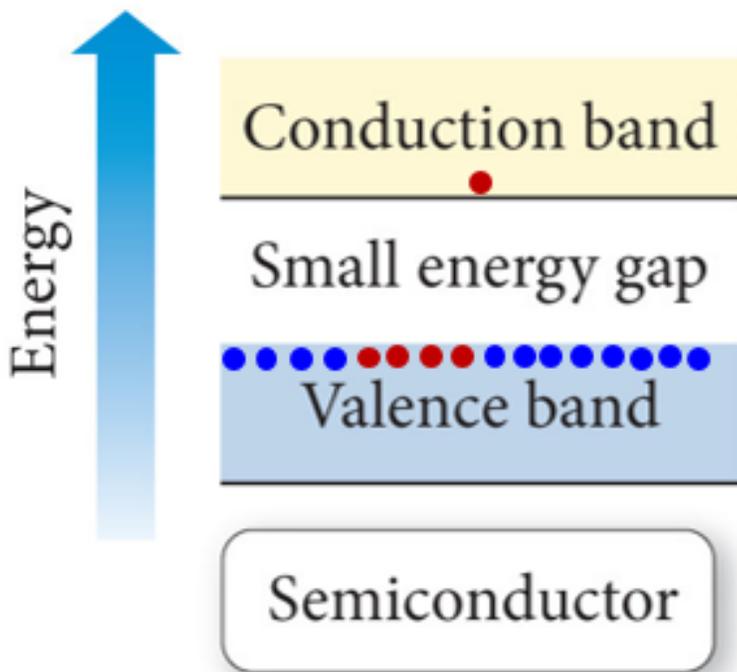
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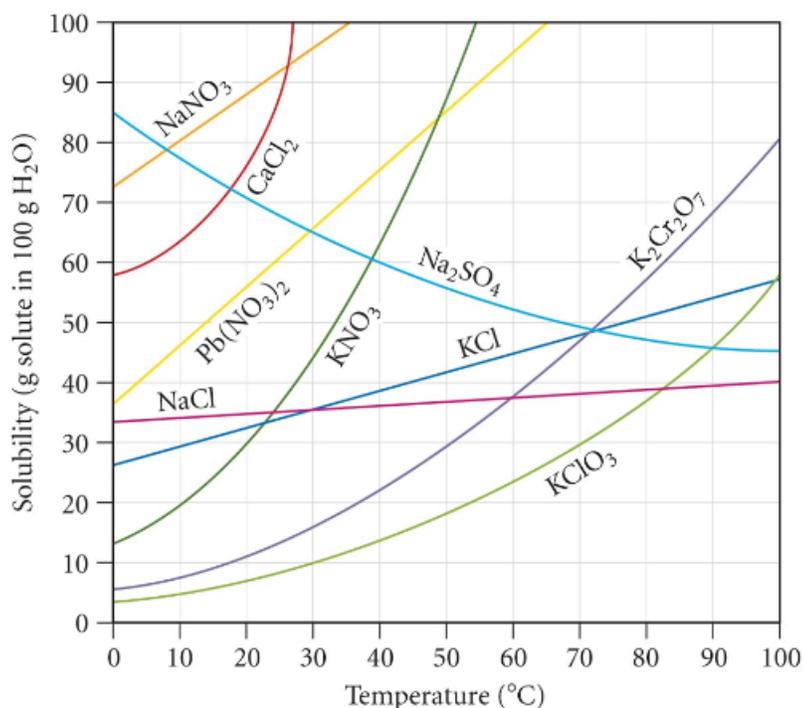
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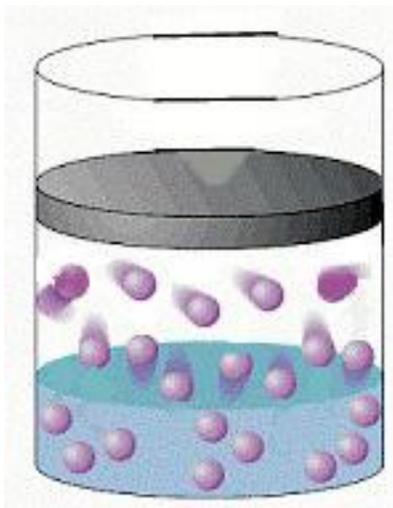


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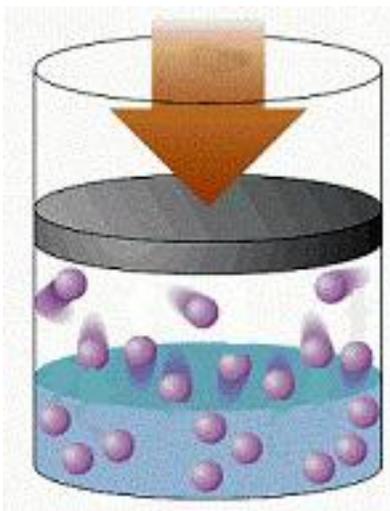
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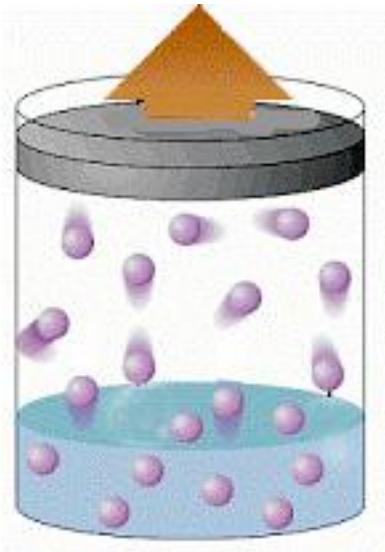
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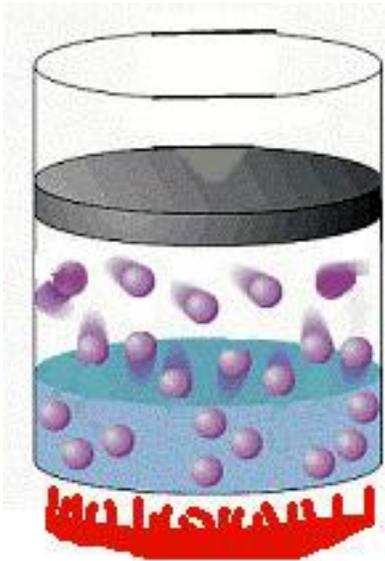
✓A. increasing pressure



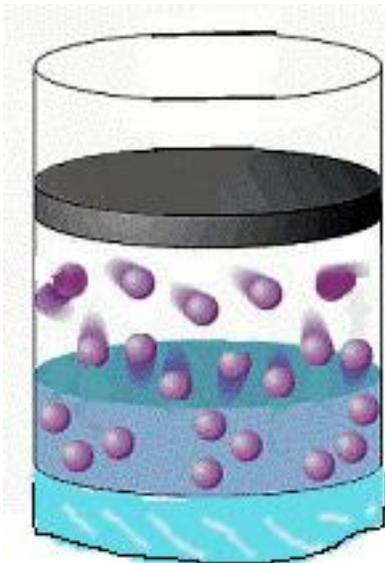
B. decreasing pressure



C. increasing temperature



✓D. decreasing temperature



---

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What is the molality of a solution prepared by dissolving 15.0 g  $\text{H}_2\text{SO}_4$  (98.08 g/mol) in 500. g of water?

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Which substance has the correct van't Hoff factor indicated?

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- B.  $(\text{NH}_4)_3\text{PO}_4$ ,  $i = 7$   
C. glucose (non-electrolyte),  $i = 1.5$   
✓D.  $\text{MgCl}_2$ ,  $i = 3$
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Calculate the boiling point of a solution prepared by dissolving 0.600 g of nonvolatile naphthalene ( $\text{C}_{10}\text{H}_8$ ) in 15.00 g  $\text{CCl}_4$ .

molar mass ( $\text{C}_{10}\text{H}_8$ ) = 128.1 g/mol

molar mass ( $\text{CCl}_4$ ) = 153.8 g/mol

normal boiling point  $\text{CCl}_4$  = 76.72 °C

$K_b(\text{CCl}_4) = 5.020 \text{ }^\circ\text{C}/m$

boiling point of solution (report with two decimal places) = 1 °C

1. 78.29

---

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Which solution has the highest vapor pressure?

- A. 1.0 m  $\text{AlCl}_3$   
B. 1.0 m  $\text{K}_3\text{PO}_4$   
✓C. 1.0 m  $\text{C}_6\text{H}_{12}\text{O}_6$   
D. 1.0 m  $\text{Na}_2\text{SO}_4$

