

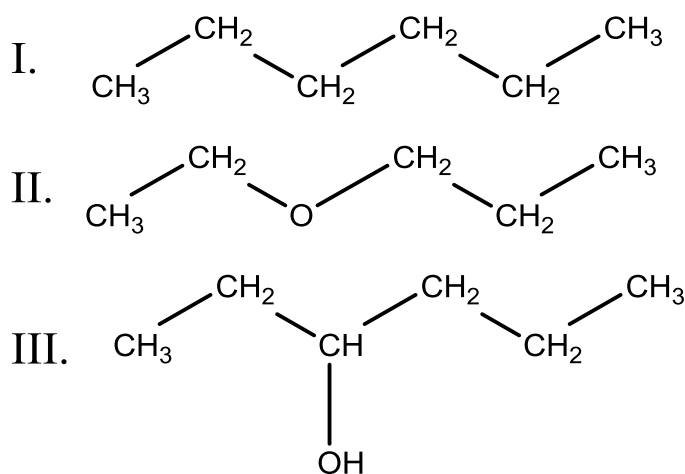
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1. Which of the following statements is **correct**?
- A. Gases have a higher density than solids and liquids.
 - B. Liquids are not easily compressible.
 - C. Solids have a definite shape but not a definite volume.
 - D. Molecules of solids can freely move around one another.
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2. Which statement best explains the trend in boiling points in the table below?

Substance	Molar mass, g/mol	Dipole moment, D	Boiling point, °C
CH ₄	16.04	0	-164
CH ₃ Cl	50.49	1.9	-24.2
CH ₃ Br	94.94	1.8	3.56
CH ₃ I	141.9	1.6	42.4

- A. Decreasing dipole moments lead to increased dipole-dipole forces and higher boiling points.
 - B. Increasing dipole-dipole forces lead to decreased dipole-dipole interactions and higher boiling points.
 - C. Decreasing molar masses lead to decreased dispersion forces and higher boiling points.
 - D. Increasing molar masses lead to increased dispersion forces and higher boiling points.
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3. Which molecule(s) experience(s) hydrogen bonding?



- A. only I
 - B. only III
 - C. II and III
 - D. I, II, and III
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4. Viscosity is
- A. the resistance of a liquid to compression, which *increases* with *increasing* strength of intermolecular forces.
 - B. the resistance of a liquid to flow, which *increases* with *increasing* strength of intermolecular forces.
 - C. the resistance of a liquid to flow, which *decreases* with *increasing* strength of intermolecular forces.
 - D. the resistance of a liquid to compression, which *decreases* with *increasing* strength of intermolecular forces.
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5. A liquid is placed in a sealed flask. Which of the following explains the process of establishing the equilibrium vapor pressure?
- A. The rate of vaporization starts at zero and increases until it equals the rate of condensation.
 - B. The rate of condensation starts at zero and increases until it matches the rate of vaporization.
 - C. The rate of vaporization and the rate of condensation both increase together until they no longer change.
 - D. The rate of vaporization begins high and decreases; the rate of condensation begins low and increases until it is the same as the rate of vaporization.
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6. Which of the following **increases** the rate of vaporization?
- | | |
|----------------------------|-------------------------------------|
| A. decreasing temperature | C. increasing atmospheric pressure |
| B. decreasing surface area | D. decreasing intermolecular forces |
-

7. Identify the **true** statement.
- A. Vapor pressure and temperature are inversely proportional to one another.
 - B. The vapor pressure of water is 1.00 atm at all temperatures.
 - C. The vapor pressure of all substances at their normal boiling point is 1.00 atm.
 - D. The vapor pressure of water is constant from 0 °C to 100 °C.
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8. A plot of $\ln P$ vs. $1/T$ yields a straight line of slope -2760 K for a substance. What is ΔH_{vap} of the substance?

A. 37.2 kJ/mol

C. 18.7 kJ/mol

B. 212 kJ/mol

D. 22.9 kJ/mol

9. The normal boiling point of diethyl ether is 34.6°C . What is the boiling point at 0.83 atm? $\Delta H_{\text{vap}} = 26.5$ kJ/mol.

A. 14.3°C

C. 29.2°C

B. 32.4°C

D. 46.1°C

10. What is the point in a phase diagram that represents the temperature and pressure above which a supercritical fluid exists?

A. triple point

C. critical point

B. vaporization point

D. sublimation point

11. Sublimation is the phase change from _____ while fusion is the phase change from _____.

A. liquid to solid; gas to solid

C. solid to liquid; solid to gas

B. solid to gas; solid to liquid

D. liquid to gas; liquid to solid

12. How much heat is required to melt 8.50 g of acetone?

For acetone: $\Delta H_{\text{fus}} = 5.69$ kJ/mol, molar mass = 58.08 g/mol, melting point = -94.8°C

A. 0.833 kJ

C. 63.5 kJ

B. 48.4 kJ

D. 1.45 kJ

13. Which list ranks the enthalpies in **increasing** order (smallest to largest)?

- A. $\Delta H_{\text{vaporization}} < \Delta H_{\text{sublimation}} < \Delta H_{\text{fusion}}$ C. $\Delta H_{\text{fusion}} < \Delta H_{\text{vaporization}} < \Delta H_{\text{sublimation}}$
B. $\Delta H_{\text{sublimation}} < \Delta H_{\text{vaporization}} < \Delta H_{\text{fusion}}$ D. $\Delta H_{\text{fusion}} < \Delta H_{\text{sublimation}} < \Delta H_{\text{vaporization}}$
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14. Glycerol, $\text{C}_3\text{H}_8\text{O}_3$, has the following properties:

molar mass = 92.09 g/mol

melting point = 17.0 °C

boiling point = 287 °C

$\Delta H_{\text{fus}} = 18.3 \text{ kJ/mol}$

$\Delta H_{\text{vap}} = 91.7 \text{ kJ/mol}$

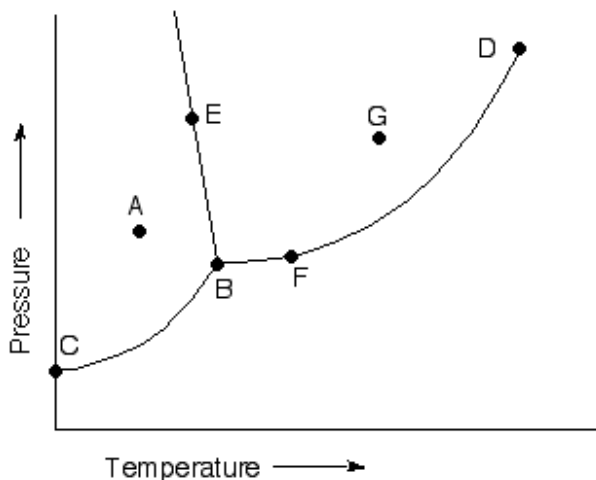
C_s of $\text{C}_3\text{H}_8\text{O}_3(s) = 1.63 \text{ J/g } ^\circ\text{C}$

C_s of $\text{C}_3\text{H}_8\text{O}_3(l) = 2.41 \text{ J/g } ^\circ\text{C}$

How much energy is required to warm 25.2 g of $\text{C}_3\text{H}_8\text{O}_3(s)$, initially at $-10.0 \text{ } ^\circ\text{C}$, to $\text{C}_3\text{H}_8\text{O}_3(l)$ at $99.0 \text{ } ^\circ\text{C}$?

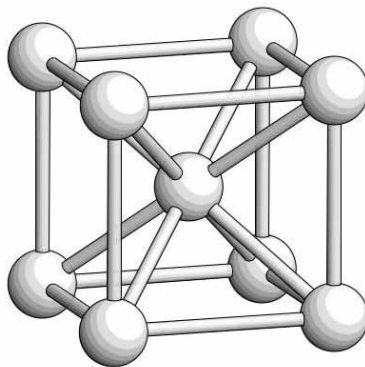
- A. 16.2 kJ C. 7.28 kJ
B. 11.1 kJ D. 2.93 kJ
-

15. What phase change occurs when going from point A to point G?



- A. liquid to gas C. solid to gas
B. solid to liquid D. gas to liquid
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16. Which type of unit cell is depicted in the image below?



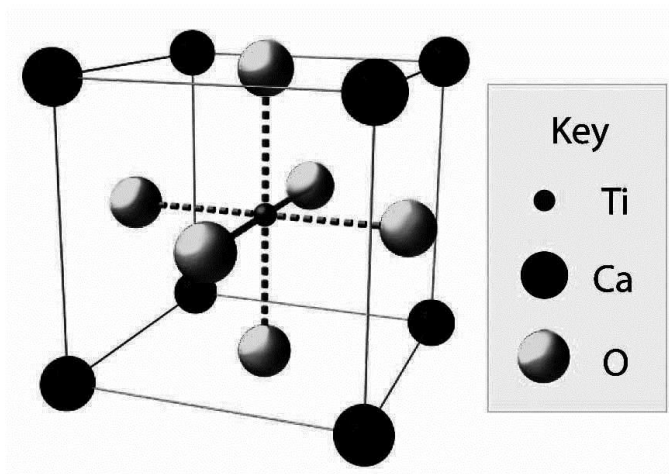
A. body-centered cubic

C. simple cubic

B. face-centered cubic

D. quarter cubic

17. The crystalline unit cell shown below contains an oxide ion on each cell face, a calcium ion on each cell corner and a titanium ion at the cell center. Determine the formula of the compound.



A. CaTiO_6

C. CaTiO

B. Ca_2TiO_6

D. CaTiO_3

18. Sodium has a body-centered cubic unit cell with a density of 0.971 g/cm^3 . What is the edge length of a single unit cell?

A. $3.40 \times 10^{-8} \text{ cm}$

C. $4.19 \times 10^{-8} \text{ cm}$

B. $3.71 \times 10^{-8} \text{ cm}$

D. $4.28 \times 10^{-8} \text{ cm}$

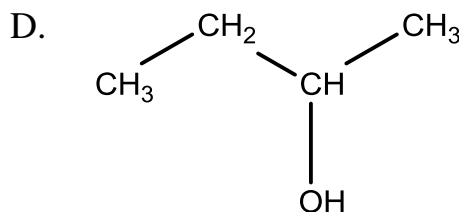
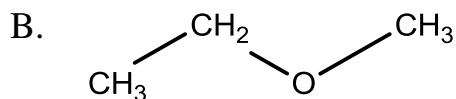
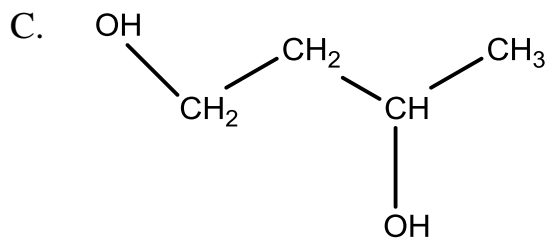
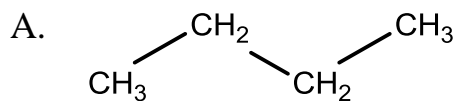
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19. Which of the following **incorrectly** matches the description with the type of crystalline solid?
- A. Metallic solids display a narrow range of melting points.
 - B. Network covalent solids have atoms at the lattice points held together by covalent bonds.
 - C. Most molecular solids have low melting points.
 - D. Ionic solids have cations or anions at the lattice points of the unit cell.

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20. In the figure below, the smaller circles represent sucrose molecules and the larger ovals represent water molecules. Which statement best describes the illustrated process?



- A. Sucrose is the solute, water is the solvent, and mixing is driven by entropy.
 - B. Sucrose is the solvent, water is the solute, and mixing is driven by enthalpy.
 - C. Sucrose is the solute, water is the solvent, and mixing is driven by enthalpy.
 - D. Sucrose is the solvent, water is the solute, and mixing is driven by entropy.
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21. Which solute is **most** soluble in water?



22. A sugar solution is prepared by warming water to 90 °C, saturating the water with sugar and then allowing the water to slowly cool to 25 °C. No sugar precipitated. The resulting solution is

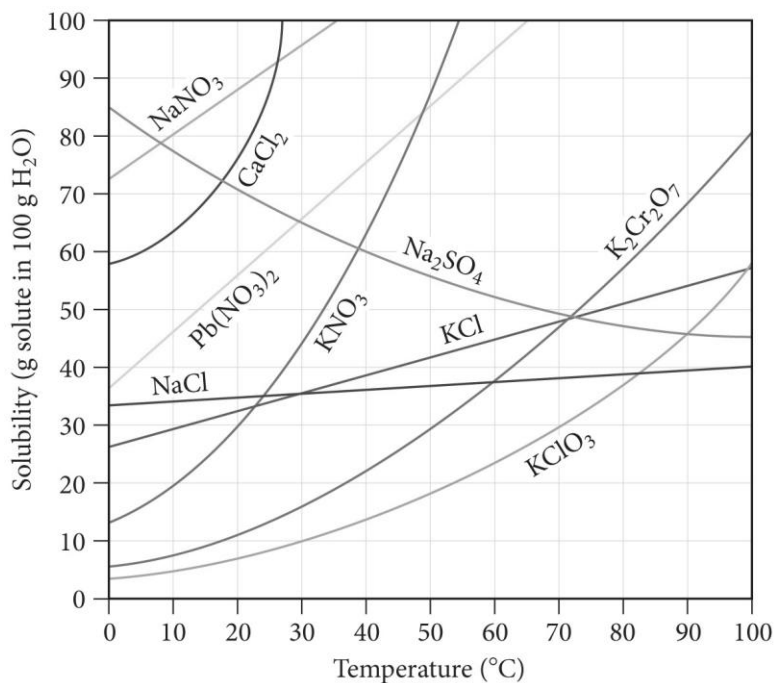
A. supersaturated.

C. unsaturated.

B. saturated.

D. at equilibrium.

23. Which type of solution results when 70.0 g of CaCl_2 are added to 200.0 g of H_2O at 5.0 °C?



A. an unsaturated solution

C. a supersaturated solution

B. a saturated solution

D. a supercritical solution

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24. Which conditions result in the **greatest** concentration of dissolved oxygen?
- A. A glass of water at 25 °C open to the atmosphere with the atmospheric pressure at 1.0 atm and the partial pressure of O₂ at 0.20 atm
 - B. A glass of water at 10 °C open to the atmosphere with the atmospheric pressure at 1.0 atm and the partial pressure of O₂ at 0.20 atm
 - C. Water at 25 °C in a sealed container in which the partial pressure of O₂ is 1.0 atm
 - D. Water at 10 °C in a sealed container in which the partial pressure of O₂ is 1.0 atm
-

25. At 25 °C and a pressure of 0.254 atm, the concentration of CO₂ in water is 8.6×10^{-3} M. What is the concentration when the pressure is raised to 0.419 atm?
- A. 0.19 M
 - B. 0.36 M
 - C. 1.4×10^{-2} M
 - D. 5.3×10^{-3} M

-
26. Calculate the **molality** of a solution prepared by dissolving 15.0 g of lead nitrate in 100 g of water. The molar mass of lead nitrate is 124.0 g/mol.
- A. 0.150 *m*
 - B. 1.20 *m*
 - C. 2.36 *m*
 - D. 1.49 *m*
-

27. What **volume** of solution that is 10.5% NaCl by mass contains 52.4 g of NaCl? The density of the solution is 1.075 g/mL.

A. 293 mL solution

C. 464 mL solution

B. 385 mL solution

D. 554 mL solution

28. What is the **mole fraction** of butanol in a solution of 25.0 g of butanol (molar mass = 74.1 g/mol) in 100.0 g of hexane (molar mass = 86.2 g/mol)?

A. 0.225

C. 0.290

B. 0.250

D. 0.200

29. What is the **molality** of a 2.50-M NaCl solution whose density is 1.01 g/mL?

A. 2.89 *m*

C. 2.50 *m*

B. 2.63 *m*

D. 2.45 *m*

30. Calculate the **percent by mass** of a 0.300-M glucose (C₆H₁₂O₆) solution. The density of the solution is 1.02 g/mL and the molar mass of glucose is 180.156 g/mol.

A. 5.22 %

C. 5.41 %

B. 3.01 %

D. 5.30 %

Answer Key:

1. B
2. D
3. B
4. B
5. B
6. D
7. C
8. D
9. C
10. C
11. B
12. A
13. C
14. B
15. B
16. A
17. D
18. D
19. A
20. A
21. C
22. A
23. A
24. D
25. C
26. B
27. C
28. A
29. A
30. D