

Intermolecular Forces And Physical Properties Of Substances

1 Which term identifies a type of intermolecular force?

- (1) covalent bonding (3) ionic bonding
(2) hydrogen bonding (4) metallic bonding

2 Compared to H_2S , the higher boiling point of H_2O is due to the

- (1) greater molecular size of water
(2) stronger hydrogen bonding in water
(3) higher molarity of water
(4) larger gram-formula mass of water

3 What is the vapor pressure of propanone at $50.^\circ\text{C}$?

- (1) 37 kPa (3) 83 kPa
(2) 50. kPa (4) 101 kPa

4 Based on Table H, what is the vapor pressure of CH_3COOH at $90.^\circ\text{C}$?

- (1) 40. kPa (3) 114 kPa
(2) 48 kPa (4) 150. kPa

5 Which term represents an intermolecular force in a sample of water?

- (1) hydrogen bonding (3) metallic bonding
(2) covalent bonding (4) ionic bonding

6 Which compound has the strongest hydrogen bonding at STP?

- (1) H_2O (3) H_2Se
(2) H_2S (4) H_2Te

7 Which substance in the table below has the strongest intermolecular forces?

Substance	Molar Mass (g/mol)	Boiling Point (kelvins)
HF	20.01	293
HCl	36.46	188
HBr	80.91	207
HI	127.91	237

- (1) HF (3) HBr
(2) HCl (4) HI

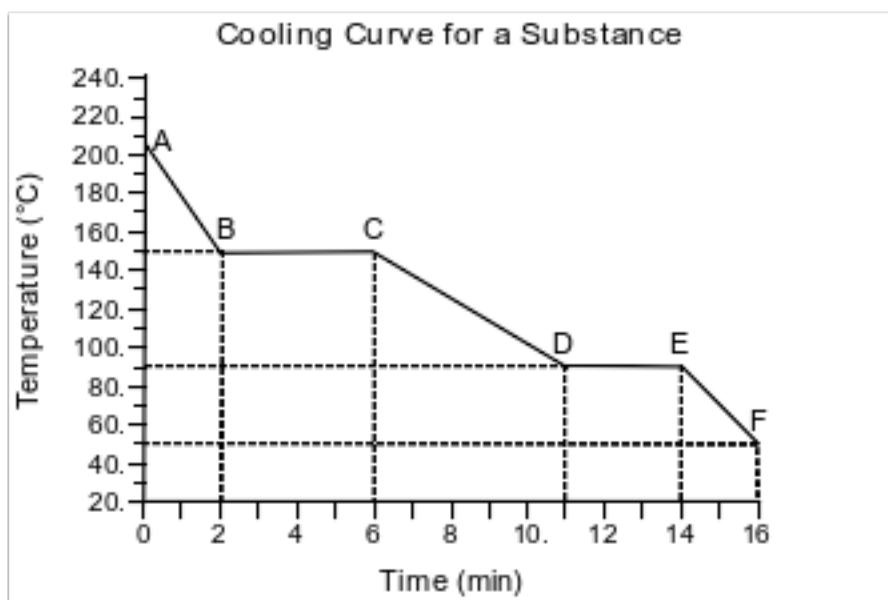
Base your answers to questions 8 on the information below and on your knowledge of chemistry.

A 100.-gram sample of liquid water is heated from 20.0°C to 50.0°C . Enough $\text{KClO}_3(\text{s})$ is dissolved in the sample of water at 50.0°C to form a saturated solution.

8 Based on Table H, determine the vapor pressure of the water sample at its final temperature.

Base your answers to questions 9 on the information below and on your knowledge of chemistry.

A sample of a molecular substance starting as a gas at 206°C and 1 atm is allowed to cool for 16 minutes. This process is represented by the cooling curve below.



- 9 Compare the strength of the intermolecular forces within this substance at 180.°C to the strength of the intermolecular forces within this substance at 120.°C.

Base your answers to questions 10 on the information below and on your knowledge of chemistry.

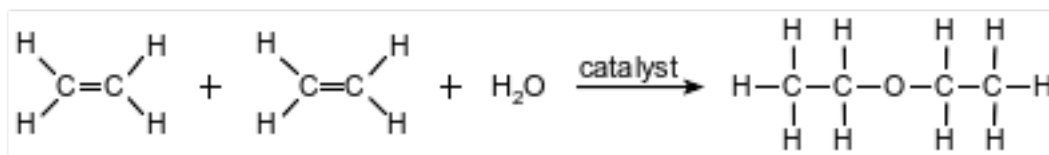
Nitrogen dioxide, NO₂, is a dark brown gas that is used to make nitric acid and to bleach flour. Nitrogen dioxide has a boiling point of 294 K at 101.3 kPa. In a rigid cylinder with a movable piston, nitrogen dioxide can be in equilibrium with colorless dinitrogen tetroxide, N₂O₄. This equilibrium is represented by the equation below.



- 10 At standard pressure, compare the strength of intermolecular forces in NO₂(g) to the strength of intermolecular forces in N₂(g).

Base your answers to questions 11 on the information below and on your knowledge of chemistry.

Diethyl ether is used as a laboratory and industrial solvent. The boiling point of diethyl ether at standard pressure is 34.6°C. The equation below represents a reaction that produces diethyl ether.



- 11 Explain, in terms of the strength of intermolecular forces, why the boiling point of diethyl ether at standard pressure is lower than the boiling point of water at standard pressure.

12 Based on Table H, state the vapor pressure of ethanol at 75°C.

13 Determine the vapor pressure of ethanol at 90.°C.


Base your answers to questions 14 on the information below and on your knowledge of chemistry.

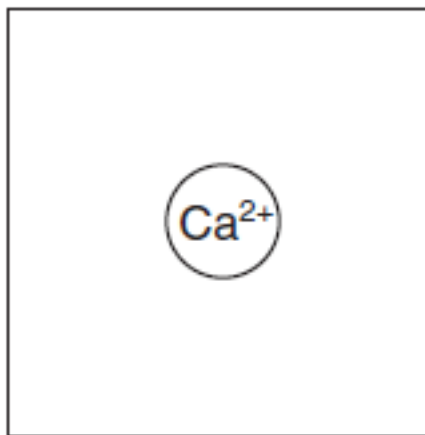
A sample of seawater is analyzed. The table below gives the concentration of some ions in the sample.

**Concentration of Some Ions
in a Seawater Sample**

Ion	Concentration (M)
Cl ⁻	0.545
Na ⁺	0.468
Mg ²⁺	0.054
SO ₄ ²⁻	0.028
Ca ²⁺	0.010
K ⁺	0.010

14 Using the key below, draw two water molecules in the box, showing the orientation of each water molecule toward the calcium ion.

Key	
●	= hydrogen atom
○	= oxygen atom
	= water molecule



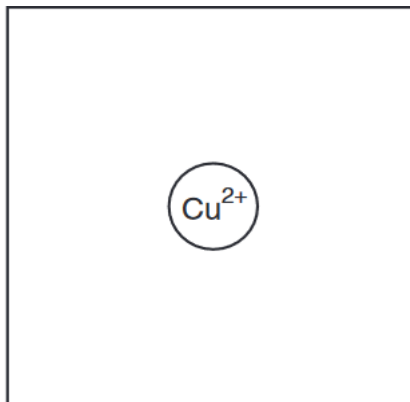
Base your answers to questions 15 on the information below and on your knowledge of chemistry.

Copper can be used for water pipes in homes. When the pipes corrode, copper atoms oxidize to form Cu²⁺ ions in the water.

A homeowner has a water quality report prepared for a sample of water taken from pipes in the home. According to the report, the 550.-gram sample contains 6.75×10^{-4} gram of dissolved Cu²⁺ ions.

15 Using the key below, draw two water molecules in the box, showing the orientation of each water molecule toward the Cu^{2+} ion.

Key	
●	= Hydrogen atom
○	= Oxygen atom
○ ● ●	= Water molecule



Answer Keys

1 2

2 2

3 3

4 1

5 1

6 1

7 1

8 Allow 1 credit for any value from 11 kPa to 13 kPa, inclusive.

9 Allow 1 credit. Acceptable responses include, but are not limited to:

- The intermolecular forces are weaker at 180.°C than at 120.°C.
- The forces are stronger at 120°C.
- The IMF is stronger at the lower temperature.
- The liquid has stronger IMF than the gas.

10 Allow 1 credit. Acceptable responses include, but are not limited to:

- The NO_2 has stronger intermolecular forces of attraction than N_2 .
- The attractions in $\text{N}_2(\text{g})$ are weaker.

11 Allow 1 credit. Acceptable responses include, but are not limited to:

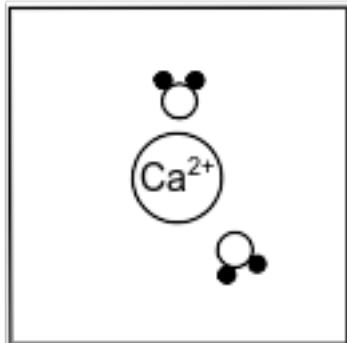
- Diethyl ether has weaker intermolecular forces than water.
- Water has stronger intermolecular forces.
- Water has stronger IMFs due to its hydrogen bonding.

12 Allow 1 credit for any value from 84 kPa to 87 kPa, inclusive.

13 Allow 1 credit for any value from 148 kPa to 152 kPa, inclusive.

14 Allow 1 credit. Acceptable responses must show at least two water molecules with the oxygen atom

- of each water molecule oriented toward the calcium ion.
- Example of a 1-credit response:



15 Allow 1 credit. Acceptable responses must show at least two water molecules. The oxygen atom of

- each water molecule must face toward the copper ion.

- Examples of 1-credit responses:

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