

# IMF – Intermolecular Forces Worksheet

Indicate the **strongest** IMF holding together **thousands of molecules** of the following. Then indicate what type of bonding is holding the atoms together in **one molecule** of the following. NOTE – if the molecule is an ionic compound, then there is no IMF, the ions are all held together by ionic bonds.

		IMF			Bonding		
		London forces	Dipole-dipole forces	Hydrogen Bonding Forces	Ionic Bonds	Polar Covalent Bonds	Nonpolar Covalent Bonds
1.	NH <sub>3</sub>						
2.	K <sub>2</sub> S						
3.	HCl						
4.	F <sub>2</sub>						
5.	PCl <sub>3</sub>						
6.	NaCl						
7.	SO <sub>2</sub>						
8.	CO <sub>2</sub>						
9.	I <sub>2</sub>						
10.	CH <sub>4</sub>						
11.	CH <sub>3</sub> Cl						
12.	HF						
13.	H <sub>2</sub> O						
14.	NO						
15.	H <sub>2</sub>						
16.	CaO						
17.	O <sub>2</sub>						
18.	CH <sub>3</sub> OH						
19.	CO						
20.	N <sub>2</sub>						

Answer the following questions with dipole dipole forces, H bonding forces, London forces, ion dipole forces, ionic bond, polar covalent bond, or nonpolar covalent bond.

1. What holds molecules of water together?
2. What hold the O and H atoms together in a molecule of water?
3. What holds Na<sup>+</sup> and Cl<sup>-</sup> ions together in salt?
4. What holds NaCl(aq) together in salt water?
5. What holds the two F atoms together in diatomic fluorine?
6. What holds molecules of fluorine together?
7. What holds KBr(aq) together?
8. What holds the C and H atoms together in methane, CH<sub>4</sub>?
9. What hold methane molecules with each other?
10. What holds the C and O atoms together in carbon monoxide?
11. What holds five molecules of carbon monoxide together?

Now let us compare two liquids and their properties. Consider benzene, C<sub>6</sub>H<sub>6</sub>, and phenol, C<sub>6</sub>H<sub>5</sub>OH:

1. Which has the stronger IMF?
2. Which has the lower vapor pressure?
3. Which has the higher boiling point?
4. Which has the lower viscosity?
5. Which has the higher surface tension?
6. Which one can H bond?
7. Which one has only London dispersion forces?

## IMF – Intermolecular Forces **Key**

Indicate the **strongest** IMF holding together **several molecules** of the following. Then indicate what type of bonding is holding the atoms together in **one molecule** of the following. NOTE – if the molecule is an ionic compound, then there is no IMF, the ions are all held together by ionic bonds.

		IMF			Bonding		
		London forces	Dipole-dipole forces	Hydrogen Bonding Forces	Ionic Bonds	Polar Covalent Bonds	Nonpolar Covalent Bonds
1.	NH <sub>3</sub>			X		X	
2.	K <sub>2</sub> S				X		
3.	HCl		X			X	
4.	F <sub>2</sub>	X					X
5.	PCl <sub>3</sub>		X			X	
6.	NaCl				X		
7.	SO <sub>2</sub>		X			X	
8.	CO <sub>2</sub>	X				X	
9.	I <sub>2</sub>	X					X
10.	CH <sub>4</sub>	X					X
11.	CH <sub>3</sub> Cl		X			X (C-Cl)	X (C-H)
12.	HF			X		X	
13.	H <sub>2</sub> O			X		X	
14.	NO		X			X	
15.	H <sub>2</sub>	X					X
16.	CaO				X		
17.	O <sub>2</sub>	X					X
18.	CH <sub>3</sub> OH			X		X (O-H)	X (C-H)
19.	CO		X			X	
20.	N <sub>2</sub>	X					X

Answer the following questions with dipole dipole forces, H bonding forces, London forces, ion dipole forces, ionic bond, polar covalent bond, or nonpolar covalent bond.

1. What holds molecules of water together? **H bonding force**
2. What hold the O and H atoms together in a molecule of water? **Polar cov bonds**
3. What holds  $\text{Na}^+$  and  $\text{Cl}^-$  ions together in salt? **ionic bonds**
4. What holds  $\text{NaCl}(\text{aq})$  together in salt water? **Ion dipole force**
5. What holds the two F atoms together in diatomic fluorine? **Nonpolar cov bond**
6. What holds molecules of fluorine together? **London force**
7. What holds  $\text{KBr}(\text{aq})$  together? **Ion dipole force**
8. What holds the C and H atoms together in methane,  $\text{CH}_4$ ? **Nonpolar cov bond**
9. What hold methane molecules with each other? **London force**
10. What holds the C and O atoms together in carbon monoxide? **Polar cov bond**
11. What holds five molecules of carbon monoxide together? **Dipole dipole force**

Now let us compare two liquids and their properties. Consider benzene,  $\text{C}_6\text{H}_6$ , and phenol,  $\text{C}_6\text{H}_5\text{OH}$ :

1. Which has the stronger IMF? **phenol**
2. Which has the lower vapor pressure? **phenol**
3. Which has the higher boiling point? **phenol**
4. Which has the lower viscosity? **benzene**
5. Which has the higher surface tension? **phenol**
6. Which one can H bond? **phenol**
7. Which one has only London dispersion forces? **benzene**