

Teacher's Tools[®] Chemistry

Intermolecular Forces: Worksheet 5: Answer Key

1. The correct choice was B.

Quartz, or SiO_2 is a network covalent solid. Melting it breaks the covalent bonds that form the solid structure.

2. The correct choice was B.

Remember that "like dissolves like." Water is a very polar molecule and therefore molecules with a dipole moment or salts that can break into cation and anion will dissolve in water. Here, that's all the choices except carbon dioxide. Carbon dioxide is a non-polar molecule and therefore is insoluble in water.

3. The correct choice was A.

In order for something to conduct electricity, there needs to be mobile charge carriers. These can be electrons in the case of a metal or ions in the case of an electrolyte solution. Tungsten is a metal and it will be the best conductor of electricity. None of the other choices has mobile charge carriers.

4. The correct choice was D.

Highest melting point means strongest intermolecular forces. The first two choices are hydrocarbons and they are essentially non-polar. They'll interact via dispersion forces. Mercury is a metal and the atoms interact through metallic bonds. Ethanol can hydrogen bond and therefore the molecules interact through a strong dipole attraction. Silicon dioxide is a network covalent solid. Covalent bonds are the strongest intermolecular forces and therefore it would have the highest melting point.

5. The correct choice was C.

Low melting point means weak intermolecular forces. Sodium is a metal, held together by metallic bonds, graphite is a network covalent solid held together by covalent bonds, neon is a nonpolar atom that experiences dispersion forces between like-molecules, calcium chloride is an ionic solid held together by ionic bonds and water is a molecular solid held together by hydrogen bonding. In terms of the relative strengths of the intermolecular forces: dispersion forces < hydrogen bonding < metallic bonds < ionic bonds < covalent bonds

Neon will therefore melt well below the other species.

6. The correct choice was C.

Remember that "like dissolves like." Water is a very polar molecule. It will dissolve other polar molecules or ions. C_8H_{10} is a nonpolar hydrocarbon. Br_2 is also a nonpolar molecule. NaI is an ionic solid and will dissolve in water. SiC is a network covalent solid and Cr is a metal.

7. The correct choice was B.

You should commit SiO_2 , SiC , germanium and graphite to memory as network covalent solids.

8. The correct choice was B.

Highest melting point means the strongest intermolecular forces. Iron is a metal, held together by metallic bonds, barium chloride is an ionic solid held together by ionic bonds, diatomic chlorine is a nonpolar

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molecule that interacts with like-molecules through dispersion forces, water is a polar molecule with hydrogen bonding as its intermolecular force and diatomic iodine is a nonpolar molecule that interacts with like-molecules through dispersion forces.

dispersion forces < hydrogen bonding < metallic bonds < ionic bonds < covalent bonds

The strongest intermolecular force of the choices is ionic bonding and therefore barium chloride would have the highest melting point.

9. The correct choice was E.

In general, when hydrogen is bonded to oxygen, fluorine or nitrogen, hydrogen bonding is possible. The typical examples are H₂O, HF and NH₃. For a molecule to hydrogen bond, it needs a strong dipole and the ability for opposite poles of the dipole to interact. The positive-negative polar character of ammonia is lost when you add another hydrogen cation to make ammonium. Ammonium will therefore not hydrogen bond.

10. The correct was D.

Sodium chloride is an ionic solid. It will dissolve in a polar solvent. Of the choices, hydrogen sulfide is the only polar molecule.

11. The correct was D.

Sodium chloride is an ionic solid. It will dissolve in a polar solvent. Diamond, is a network covalent solid. It will not dissolve in a polar solvent. Determining which dissolves in water will do the trick.

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Intermolecular Forces: Worksheet 6: Answer Key

1. Select the highest boiling member of each pair and indicate which intermolecular forces are involved.

(A) NaCl or H₂O

NaCl is an ionic solid and the intermolecular forces are ionic bonds. The intermolecular forces for H₂O are hydrogen bonds. Ionic bonds are stronger than hydrogen bonds and therefore NaCl will have a higher boiling point than H₂O.

(B) NH₃ or CH₄

The intermolecular forces for NH₃ are hydrogen bonds. CH₄ is a nonpolar molecule that interacts with like-molecules through dispersion forces. Hydrogen bonding is stronger than dispersion force interactions. NH₃ will have a higher boiling point than CH₄.

(C) H₂O₂ or SiO₂

In the solid phase, H₂O₂ consists of discrete molecules with hydrogen-bonding and London (dispersion) forces among the molecules. These intermolecular forces are relatively weak and are easily overcome at a relatively low temperature.

SiO₂ is a network of Si and O atoms linked by strong covalent bonds. These covalent bonds are much stronger than typical intermolecular interactions, so very high temperatures are needed to overcome the covalent bonds in SiO₂.

(D) Ne or Xe

Both atoms are noble gases and interact with like-molecules through dispersion forces. Dispersion forces increase with atomic size and therefore the dispersion forces for Xe will be greater than for Ne. Xe will have a higher boiling point than Ne.

2. Indicate the strongest attractive forces that must be overcome to

(A) Vaporize Hg

Hg is a metal although it is in the liquid phase at room temperature. The interactions are still metallic bonds and these must be overcome to vaporize the metal.

(B) Melt NaNO₃

Sodium nitrate is an ionic solid. In order to melt it, the ionic attractions in the solid lattice structure must be overcome.

(C) Boil C₃H₇OH

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Propanol will interact with like-molecules through hydrogen bonding. The strong dipole-dipole interactions associated with hydrogen bonding must be overcome to boil (the state at which the vapor pressure of propanol is equal to atmospheric pressure) propanol.

(D) Dissolve CaCl_2 in H_2O

CaCl_2 is an ionic solid. The cations and anions interact in the solid lattice structure through ionic bonds. When placed in water, the very polar H_2O molecule can "pick off" cations and anions from the edge of the lattice and hydrate them. The strong polar attraction of water overcomes the ionic attraction at the lattice edge and the salt dissolves.

3. State TRUE or FALSE accordingly and provide an explanation if false.

(A) KBr is higher melting than SF_6 .

True (ionic solid versus non-polar molecule)

(B) $\text{C}_2\text{H}_5\text{OH}$ is higher boiling than $\text{C}_2\text{H}_5\text{Cl}$.

True (H-bonding)

(C) Dry Ice (solid CO_2) melts readily at room temperature.

False: Dry ice sublimates at room temperature.

(D) Iodine is more volatile than bromine.

False: both are non-polar diatomic molecules that interact through dispersion forces. Since iodine is larger than bromine, the dispersion forces are greater and it will therefore be less volatile than bromine.

4. Classify each of the following as ionic, molecular (polar or nonpolar), network covalent, or metallic.

(A) sodium

metallic

(B) SiO_2

network covalent

(C) C_{10}H_8

nonpolar molecular

(D) CaCO_3

ionic

(E) titanium

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metallic

(F) water

polar molecular

5. Of the four general types of solids, which one(s)

(A) melt below 100°C to give a nonconducting liquid?

Molecular solids

(B) melt at moderate (100°C - 600°C) temperatures to give a conducting liquid?

Metallic solids

(C) melt at very high temperatures to give a conducting liquid?

Ionic solids

(D) conduct electricity as a solid?

Metals

(E) are very hard solids but dissolve readily in H₂O?

Ionic solids

(F) are very hard solids that do not dissolve in common solvents?

Network covalent solids

(G) dissolve in nonpolar solvents?

Nonpolar molecular solids