This print-out should have 16 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 10.0 points

Which one of the following substances is INCORRECTLY matched with the kind of solid that it forms?

1. methane : molecular

2. sulfur dioxide : molecular

3. graphite : covalent

4. calcium bromide : ionic

5. lithium : covalent **correct**

Explanation:

Molecular solids consist of molecules held together by weak intermolecular forces.

Ionic solids are held together by electrostatic attraction between metal cations and non-metal anions.

Metallic solids consist only of metals held together by metallic bonds.

Covalent (or network) solids are like huge molecules held together by covalent bonds. Carbon in diamond is the most well-known example. Group IV B elements can form tetrahedral electronic geometries.

Lithium will form a metallic solid.

002 10.0 points

Why does it take longer to cook foods in boiling water at higher altitude than at or below sea level?

1. The ambient temperature is lower at higher altitudes.

2. There is a reduction in atmospheric pressure. **correct**

3. It does not take longer.

4. There is an increase in atmospheric pressure.

Explanation:

The reduced atmospheric pressure results in a lower boiling temperature.

003 10.0 points

Arrange the compounds

CsCl, $BaCl_2$, diamond (C), H_2, HF

in order of increasing expected melting points.

1. H_2, HF, diamond, CsCl, $BaCl_2$

2. HF, H_2, CsCl, $BaCl_2$, diamond

3. H_2, HF, CsCl, $BaCl_2$, diamond **correct**

4. HF, H_2, diamond, CsCl, $BaCl_2$

5. H_2, HF, $BaCl_2$, CsCl, diamond

Explanation:

004 10.0 points

Which of the following statements regarding intermolecular forces (IMF) is/are true?

I) Intermolecular forces result from attractive forces between regions of positive and negative charge density in neighboring molecules.

II) The stronger the bonds within a molecule are, the stronger the intermolecular forces will be.

III) Only non-polar molecules have instantaneous dipoles.

1. II and III

2. I only **correct**

3. II only

4. III only

5. I and III

6. I and II

7. I, II, and III

Explanation:

Statement I is true - all IMF result from Coulombic attraction. Statements II and III are both false; the strength of the bonds within a molecule have no bearing on the strength of the bonds between molecules; all molecules have London forces.

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005 10.0 points

Which of the following is not correctly paired with its dominant type of intermolecular forces?

1. NH_3, hydrogen bonding

2. HBr, hydrogen bonding **correct**

3. C_6H_6 (benzene), instantaneous dipoles

4. CaO, ionic forces

5. SiH_4, instantaneous dipoles

Explanation:

London forces, dispersion forces, van der Waals' forces, instantaneous or induced dipoles all describe the same intermolecular force. London forces are induced, short-lived, and very weak. Molecules and atoms can experience London forces because they have electron clouds. London forces result from the distortion of the electron cloud of an atom or molecule by the presence of nearby atoms or molecules.

Permanent dipole-dipole interactions are stronger than London forces and occur between polar covalent molecules due to charge separation.

H-bonds are a special case of very strong dipole-dipole interactions. They only occur when H is bonded to small, highly electronegative atoms – F, O or N only.

Ion-ion interactions are the strongest due to extreme charge separation and occur between ions (including polyatomic ions). They can be thought of as both inter- and intramolecular bonding.

HBr is a polar molecule that does not contain H bonds; therefore, dipole-dipole forces will be the most significant type of intermolecular forces present.

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006 10.0 points

Identify the dominant intermolecular force in the following species, respectively: RbCl, C_6H_6 (benzene), HI, Fe_2O_3, CH_2NH.

a) ionic forces
b) hydrogen bonding
c) dipole-dipole
d) instantaneous dipoles

1. b, d, c, d, d

2. a, c, c, d, b

3. c, d, a, a, b

4. a, b, d, a, c

5. a, b, c, b, a

6. a, d, c, a, b **correct**

7. c, b, d, c, c

Explanation:

Rubidium Chloride and Iron(III) oxide are both ion-ion. Benzene is non-polar and thus has only van der Waal's forces. Hydroiodic acid is polar and has dipole-dipole interactions. Methylimine has H-bonding.

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007 10.0 points

Which of the following statements about boiling is false?

1. For a given pressure, the boiling point is always at a higher temperature than melting point.

2. Boiling occurs when vapor pressure exceeds atmospheric pressure.

3. As intermolecular forces increase, boiling point increases as well.

4. The boiling point of a liquid is independent of atmospheric pressure. **correct**

Explanation:

Boiling point is directly proportional to atmospheric pressure.

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008 10.0 points

Dispersion (London) forces result from

1. attractive forces between a molecule at the surface of a liquid and those beneath it which are not balanced by corresponding forces from above.

2. the formation of a loose covalent linkage between a hydrogen atom connected to a very electronegative atom in one molecule and another very electronegative atom in a neighboring molecule.

3. attraction between molecules in a liquid and molecules or atoms in a solid surface with which the liquid is in contact.

4. distortion of the electron cloud of an atom or molecule by the presence of nearby atoms or molecules. **correct**

5. the balance of attractive and repulsive forces between two polar molecules.

Explanation:

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009 10.0 points

Consider four molecules

I) $CHCl_3$
II) CH_4
III) CH_3Cl
IV) CCl_4

Which of these exhibit permanent dipole-dipole interactions?

1. I, III, and IV only

2. None of these

3. I and III only **correct**

4. I only

5. III only

Explanation:

Dipole-dipole interactions occur in polar molecules. $CHCl_3$ and CH_3Cl are polar because their dipole moments do not cancel.

CH_4 and CCl_4 are symmetric; their dipole moments cancel and the overall molecule is non-polar.

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010 10.0 points

Classify the solid dry ice (CO_2).

1. ionic

2. molecular **correct**

3. network

4. None of these

Explanation:

Molecular solids consist of molecules held together by weak intermolecular forces.

Ionic solids are held together by electrostatic attraction between metal cations and non-metal anions.

Covalent (or network) solids are like huge molecules held together by covalent bonds. Carbon in diamond is the most well-known example. Group IV B elements can form tetrahedral electronic geometries.

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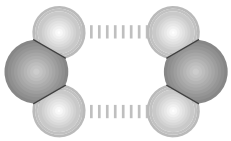
011 10.0 points

Which best describes the hydrogen bonding between two water molecules?

1.



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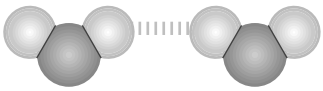

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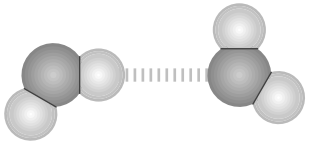
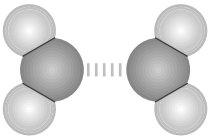


correct

4. 

Explanation:
Note the water molecules line up so the δ^- on the O of one molecule is aligned with a δ^+ on a H of another molecule.

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012 10.0 points

In which of these compounds would you find ONLY dispersion forces existing between the molecules?

I. CO_2;
II. CCl_4;
III. CH_2Cl_2;
IV. NH_3.

1. II and IV only

2. III and IV only

3. II only

4. I and IV only

5. I only

6. III only

7. I and III only

8. II and III only

9. IV only

10. I and II only **correct**

Explanation:
A nonpolar covalent molecule would have only dispersion forces with another nonpolar covalent molecule.

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013 10.0 points

Rank the following compounds by boiling point, from lowest to highest: HF, sugar ($C_6H_{12}O_6$), H_2O, NH_3.

1. HF < H_2O < sugar < NH_3

2. H_2O < NH_3 < sugar < HF

3. NH_3 < HF < H_2O < sugar **correct**

4. H_2O < sugar < NH_3 < HF

Explanation:
Knowing the ranking of hydrofluoric acid, ammonia and water is a matter of memorization and sugar obviously comes last because it is the only species that is solid at room temperature.

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014 10.0 points

Rank the following liquids by viscosity, from most viscous to least: C_5H_{12}, CH_4, C_3H_8, C_2H_6, C_4H_{10}.

1. $CH_4 > C_2H_6 > C_4H_{10} > C_3H_8 > C_5H_{12}$

2. $CH_4 > C_2H_6 > C_3H_8 > C_5H_{12} > C_4H_{10}$

3. $C_5H_{12} > C_4H_{10} > C_3H_8 > C_2H_6 > CH_4$ **correct**

4. $C_5H_{12} > C_3H_8 > C_4H_{10} > C_2H_6 > CH_4$

5. $CH_4 > C_2H_6 > SC_3H_8 > C_4H_{10} > C_5H_{12}$

Explanation:
All of these molecules are non-polar, and viscosity is directly proportional to IMF, so one simply has to rank them from largest to smallest.

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015 10.0 points

Rank the following species by vapor pressure, from lowest to highest: $K_2S, CHCl_3, Kr, CH_3NH_2, CHF_3$.

1. K_2S < CH_3NH_2 < CHF_3 < $CHCl_3$ < Kr **correct**

2. CH_3NH_2 < $CHCl_3$ < CHF_3 < Kr < K_2S

3. CH_3NH_2 < CHF_3 < K_2S < $CHCl_3$ < Kr

4. $Kr < CH_3NH_2 < CHF_3 < CHCl_3 < K_2S$

Explanation:
Vapor pressure is inversely proportional to intermolecular forces, so ranking by increasing vapor pressure requires ranking by decreasing IMF. Krypton is non-polar and thus only has dispersion forces. Methylamine has hydrogen bonding. Potassium sulfide has ion-ion interactions. Chloroform and fluoroform both have dipole-dipole interactions and the latter has a stronger total dipole.

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016 10.0 points

Which of the following is not a covalent network solid?

1. glass

2. diamond

3. cellulose

4. table sugar **correct**

5. starch

6. graphite

Explanation:
Table sugar is a molecular covalent solid. The other choices are all covalent network solids.