

1991

Experimental data provide the basis for interpreting differences in properties of substances.

TABLE 1

Compound	Melting Point ( $^{\circ}\text{C}$ )	Electrical Conductivity of Molten State ( $\text{ohm}^{-1}$ )
$\text{BeCl}_2$	405	0.086
$\text{MgCl}_2$	714	> 20
$\text{SiCl}_4$	-70	0
$\text{MgF}_2$	1261	> 20

TABLE 2

Substance	Bond Length (angstroms)
$\text{F}_2$	1.42
$\text{Br}_2$	2.28
$\text{N}_2$	1.09

Account for the differences in properties given in Tables 1 and 2 above in terms of the differences in structure and bonding in each of the following pairs.

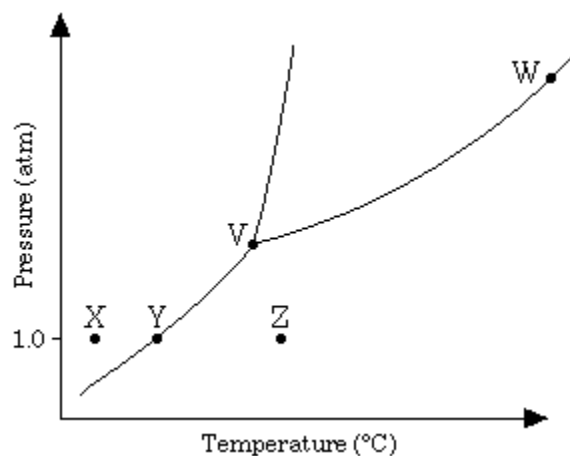
- $\text{MgCl}_2$  and  $\text{SiCl}_4$
- $\text{MgCl}_2$  and  $\text{MgF}_2$
- $\text{F}_2$  and  $\text{Br}_2$
- $\text{F}_2$  and  $\text{N}_2$

1992

Explain each of the following in terms of atomic and molecular structures and/or intermolecular forces.

- Solid K conducts an electric current, whereas solid  $\text{KNO}_3$  does not.
- $\text{SbCl}_3$  has measurable dipole moment, whereas  $\text{SbCl}_5$  does not.
- The normal boiling point of  $\text{CCl}_4$  is  $77^{\circ}\text{C}$ , whereas that of  $\text{CBr}_4$  is  $190^{\circ}\text{C}$ .
- Iodine has a greater boiling point than bromine even though the bond energy in bromine is greater than the bond energy in iodine.

1995



The phase diagram for a pure substance is shown above. Use this diagram and your knowledge about changes of phase to answer the following questions.

- What does point V represent? What characteristics are specific to the system only at point V?
- What does each point on the curve between V and W represent?
- Describe the changes that the system undergoes as the temperature slowly increases from X to Y to Z at 1.0 atmosphere.
- In a solid-liquid mixture of this substance, will the solid float or sink? Explain.

2003

For each of the following, use appropriate chemical principles to explain the observation. Include chemical equations as appropriate.

- In areas affected by acid rain, statues and structures made of limestone (calcium carbonate) often show signs of considerable deterioration.
- When table salt ( $\text{NaCl}$ ) and sugar ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ) are dissolved in water, it is observed that
  - both solutions have higher boiling points than pure water, and
  - the boiling point of 0.10 M  $\text{NaCl}(\text{aq})$  is higher than that of 0.10 M  $\text{C}_{12}\text{H}_{22}\text{O}_{11}(\text{aq})$ .
- Methane gas does not behave as an ideal gas at low temperatures and high pressures.
- Water droplets form on the outside of a beaker containing an ice bath.

2004

Use appropriate chemical principles to account for each of the following observations. In each part, your response must include specific information about both substances.

- (a) At 25°C and 1 atm,  $F_2$  is a gas, whereas  $I_2$  is a solid.
- (b) The melting point of NaF is 993°C, whereas the melting point of CsCl is 645°C.
- (c) The shape of the  $ICl_4^-$  ion is square planar, whereas the shape of the  $BF_4^-$  ion is tetrahedral
- (d) Ammonia,  $NH_3$ , is very soluble in water, whereas phosphine,  $PH_3$ , is only moderately soluble in water.