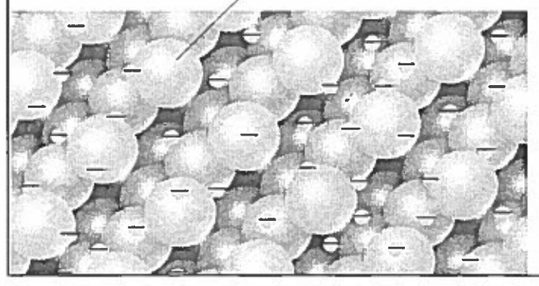
Metallic Bonding: Electron-Sea Model

- This explains properties of metals —
  - Conductivity of heat and electricity
  - Deformation



- Metals can be thought of as cations suspended in "sea" of valence electrons.
- Attractions hold electrons near cations, but not so tightly as to impede their flow.

Intermolecular Forces

Practice Problems

(a) At a pressure of 1 atm, the boiling point of $NH_3(l)$ is 240 K, whereas the boiling point of $NF_3(l)$ is 144 K. (i) Identify the intermolecular forces(s) in each substance.

NH_3 → LDF, dipole-dipole, H-bonding

NF_3 → LDF, dipole-dipole

(ii) Account for the difference in the boiling points of the substances.

NH_3 has a ↑ b.p than NF_3 due to the H-bonding that's present

(b) The melting point of KCl(s) is 776°C, whereas the melting point of NaCl(s) is 801°C.

(i) Identify the type of bonding in each substance. Both have ionic bonds

(ii) Account for the difference in the melting points of the substances.

Both have ionic bonds and the same charge. The diff. in m.p. is due to size diff. NaCl has a smaller atomic radius ∴ it's mp. should be higher due to Coulomb's Law.

Intermolecular Forces

(d) MgO melts at a much higher temperature (2,852°C) than NaF (993°C).

Intermolecular Forces

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

2004 A

(a) At 25°C and 1 atm, F_2 is a gas, whereas I_2 is a solid.

Both have LDF, however, F_2 is smaller. Since F_2 is smaller than I_2, it is less polarizable. Since I_2 is more polarizable, it can have some induced-dipole forces making it stronger

(b) The melting point of NaF is 993°C, whereas the melting point of CsCl is 645°C

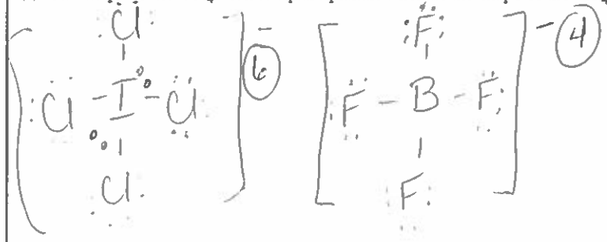
bigger

Due to coulomb's law ↑ dist. between means weaker lattice energy ∴ ↓ m.p.

Intermolecular Forces

36 - 8 = 28 - 28 = 0 　　32 - 8 = 24

(c) The shape of the ICl_4^- ion is square planar, whereas the shape of the BF_4^- ion is tetrahedral.



Intermolecular Forces

2005 A

(c) As shown in the table below, the first ionization energies of Si , P, and Cl show a trend.

Element	First Ionization Energy ($kJ\ mol^{-1}$)
Si	786
P	1,012
Cl	1,251

(i) For each of the three elements, identify the quantum level (e.g., $n = 1$, $n = 2$, etc.) of the valence electrons in the atom.

n = 3 for the the valence e⁻ in all 3 atoms

(ii) Explain the reasons for the trend in first ionization energies.

Intermolecular Forces

A certain element has two stable isotopes. The mass of one of the isotopes is 62.93 amu and the mass of the other isotope is 64.93 amu.

(i) Identify the element. Justify your answer.

It must be Cu as the atomic mass is btw that of the 2 isotopes.

(ii) Which isotope is more abundant? Justify your answer.

Since the atomic mass (63.55amu) is closer to the lighter isotope, the isotope w/ a mass of 62.93amu must be more abundant.

Intermolecular Forces

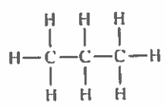
16e⁻ − 4 = 12

2005 B

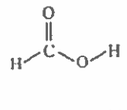
a) Draw a complete Lewis electron-dot structure for the CS_2 molecule. Include all valence electrons in you structure.

b) The carbon-to-sulfur bond length in CS_2 is 160 picometers. Is the carbon-to-selenium bond length in CS expected to be greater than, less than, or equal to this value? Justify your answer.

(c) The bond energy of the carbon-to-sulfur bond in CS_2 is 577 kJ mol^{-1}. Is the bond energy of the carbon selenium bond in CSe_2 expected to be greater than, less than, or equal to this value? Justify your answe



Propane



Methanoic Acid

(d) The complete structural formulas of propane, C_3H_8, and methanoic acid, HCOOH, are shown above. In t table below, write the type(s) of intermolecular attractive forces(s) that occur in each substance.

Substance	Boiling Point	Intermolecular Attractive Force(s)
Propane	229 K	LDF
Methanoic acid	374 K	LDF, D-D, H-bonding

(e) Use principles of intermolecular attractive forces to explain why methanoic acid has a higher boiling po than propane.

Forces

a) S = C = S

b) and e) answered on next slide

2005B Answer Box

CS_2 160pm

CSe_2

b) the C-Se bond length in CSe_2 is > than C-S bond length in CS_2. Because Se_2 is a larger atom and it's valence e⁻ are in a larger orbital (n=3) ∴ C-Se bond length is > than C-S

e) H-bonding IMF among methanoic acid molec. are much stronger than LDF among propane molec. The stronger IMF's, the ↑ the b.p.

Intermolecular Forces

8. Use chemical and physical principles to account for each of the following. 2006 (B)

(a) An aluminum container filled with an aqueous solution of $CuSO_4$ eventually developed a leak. Include a chemical equation with your answer.

$2Al(s) + 3CuSO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3Cu(s)$

$2Al(s) + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu(s)$

- Cu^{2+} has a higher reduction potential than Al^{3+}, which results in the oxidation + eventual disappearance of Al metal
- Al is higher in reactivity than Cu so it has the potential to replace Cu^{2+} in an oxidation-reduction reaction is which copper is reduced + aluminum oxidized

Intermolecular Forces

2006 (B)
cont.

(c) Skin feels cooler after rubbing alcohol has been applied to it.

Rubbing alcohol evaporates quickly which is an endothermic process. Heat leaves your arm during the evaporation process.

(d) The redness and itching of the skin caused by ant bites (injections of methanoic acid, HCO_2H) can be relieved by applying a paste made from water and baking soda (solid sodium hydrogen carbonate). Include a chemical equation with your answer.

$HCO_2H + NaHCO_3 \rightarrow NaHCO_2 + H_2O(l) + CO_2(g)$

Methanoic acid is neutralized, & w/ the neutralization of the acid the redness + itching of the ant bites subside

Intermolecular Forces

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

2003 A

(d) Water droplets form on the outside of a beaker containing an ice bath.

H_2O vapor in the air in contact w/ the lower temp on the surface of the glass condenses bc the eqm vapor pressure for H_2O @ the lower temp is ↓ than the pressure exerted by the H_2O in the vapor phase in the room

Intermolecular Forces