

Pre-AP Chemistry

September 4, 2011

17. Metallic Bonding



Review

Draw the Lewis structure for



Outline

- Metallic Bonding
- Properties of Metals

- Metallic Bonding
- Properties of Metals
 - Malleability and Ductility
 - Melting and Boiling Points
 - Thermal and Electrical Conductivity

Outline

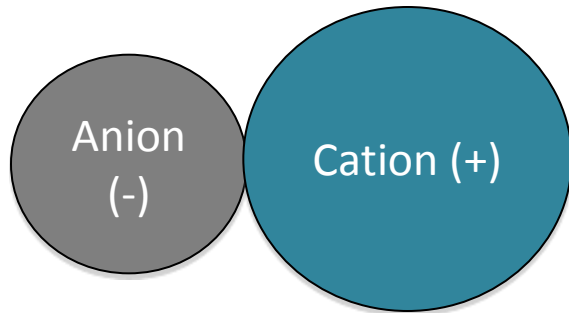
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Metallic Bonding

- In **ionic bonds**, electrons are transferred
- In **covalent bonds**, electrons are shared between **two or a few atoms**

Ionic Bond



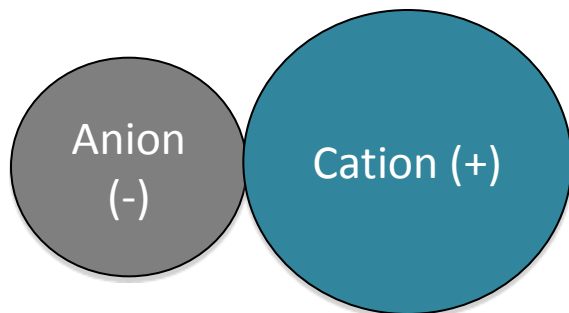
Covalent Bond



Metallic Bonding

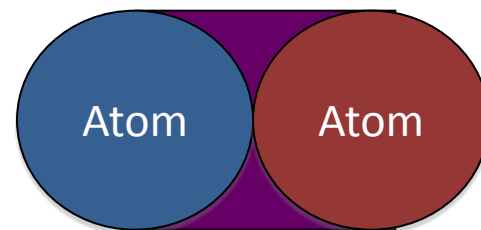
- **Electrons in ionic bonds are highly localized**
- **Electrons in covalent bonds are also localized** and somewhat delocalized in resonance hybrids

Ionic Bond



Almost all e- around individual atoms (highly localized)

Covalent Bond

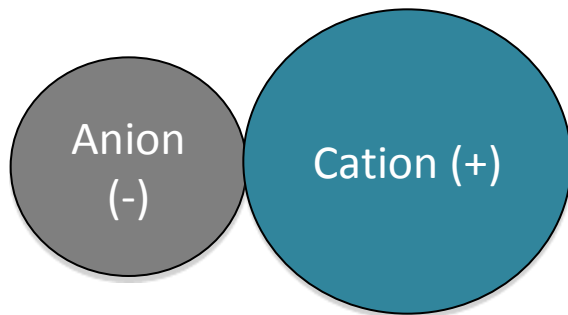


Some e- between atoms (localized)

Metallic Bonding

- In pure substances of a single metal, **metallic bonds** hold nuclei together in a **delocalized 'electron sea'**

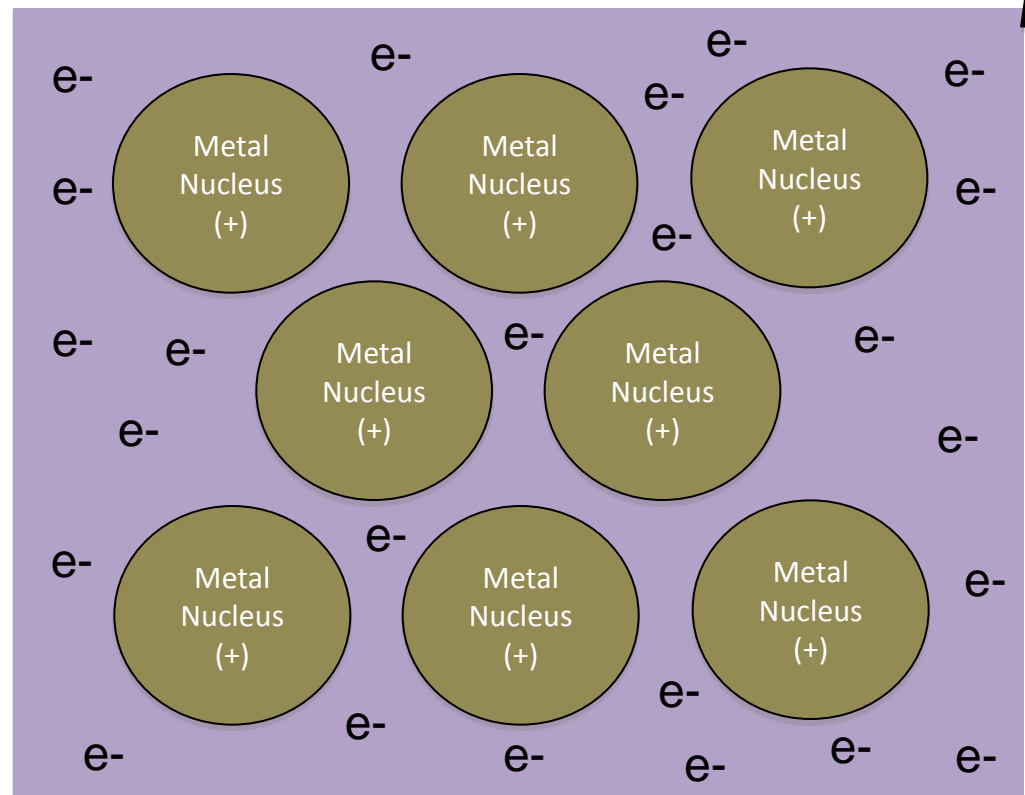
Ionic Bond



Covalent Bond



Metallic Bond



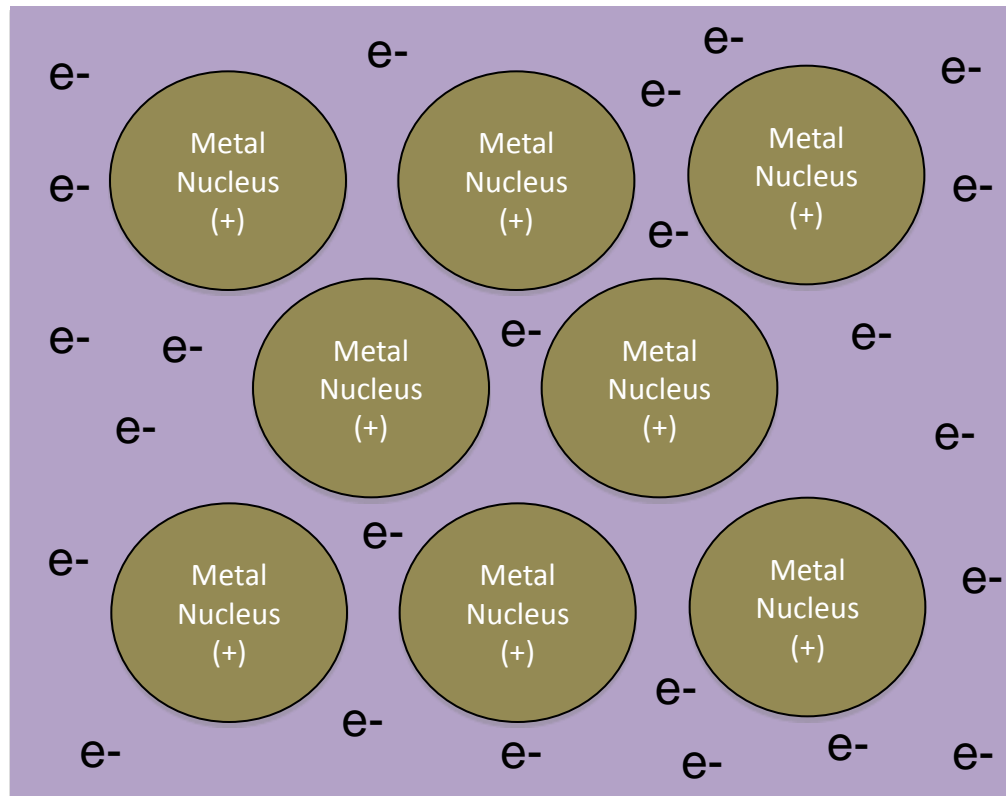
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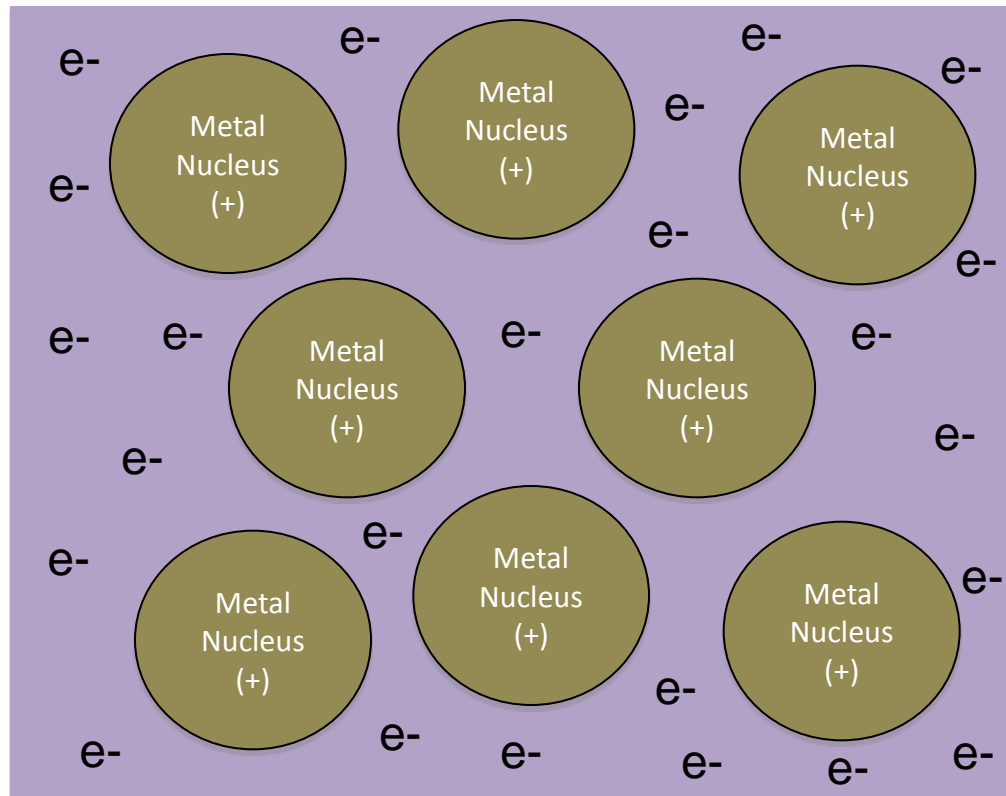
Metallic Properties

- Many properties of metals come from the freedom of nuclei to 'swim' relatively freely in the 'electron sea'



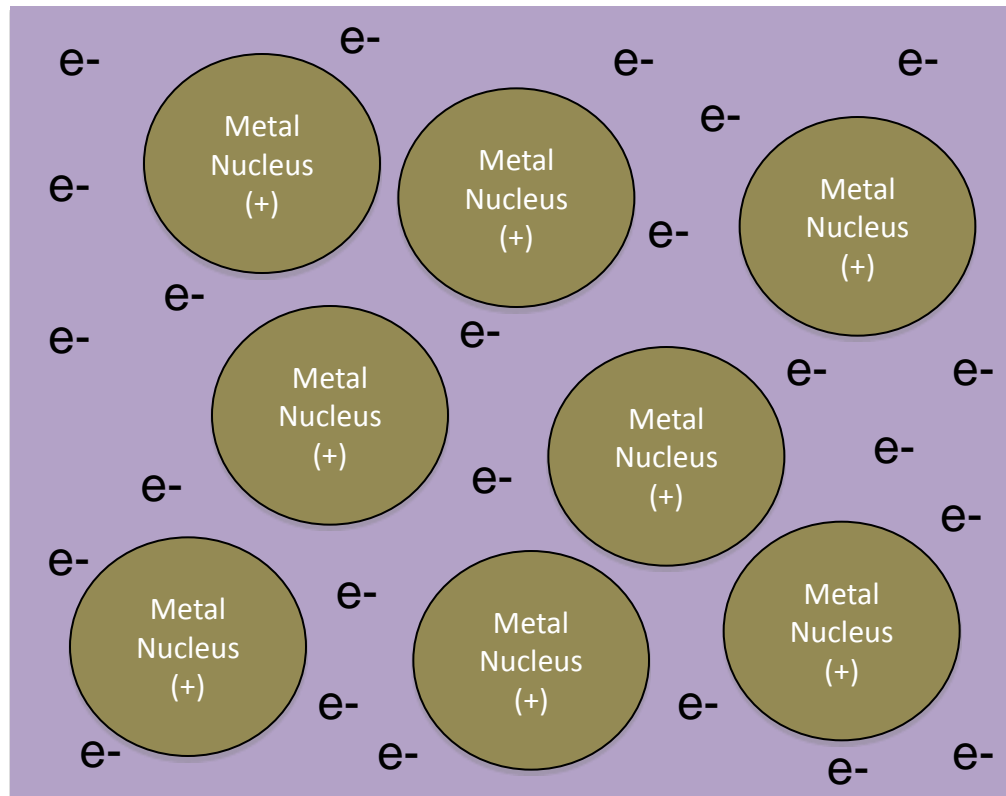
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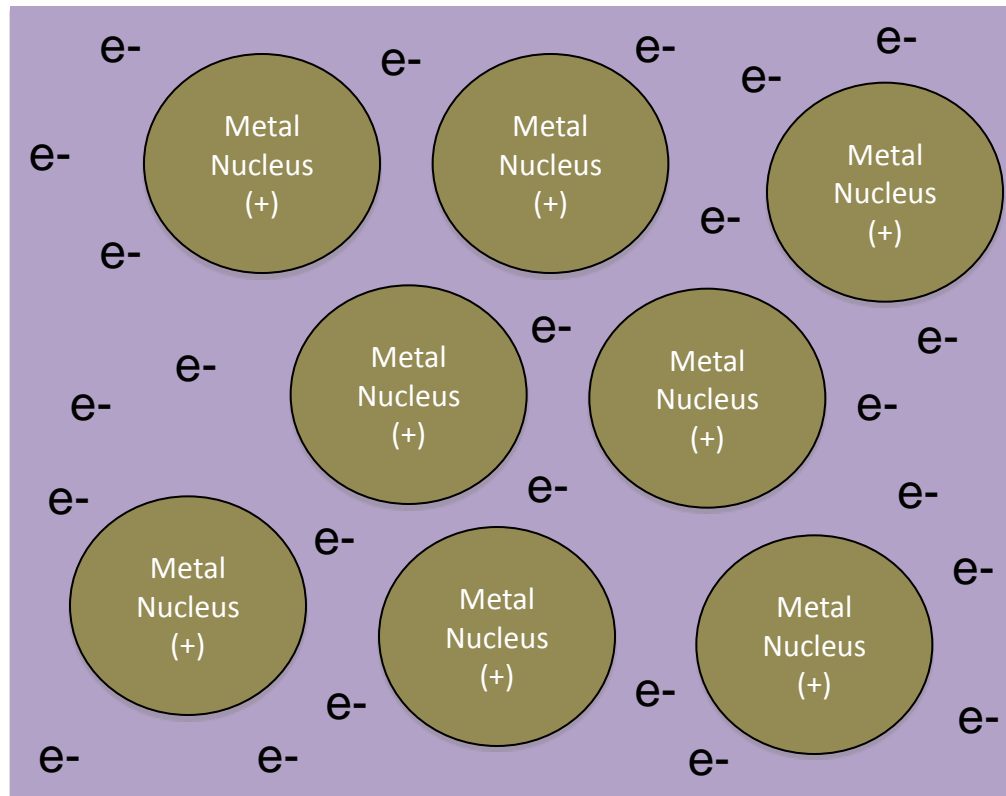
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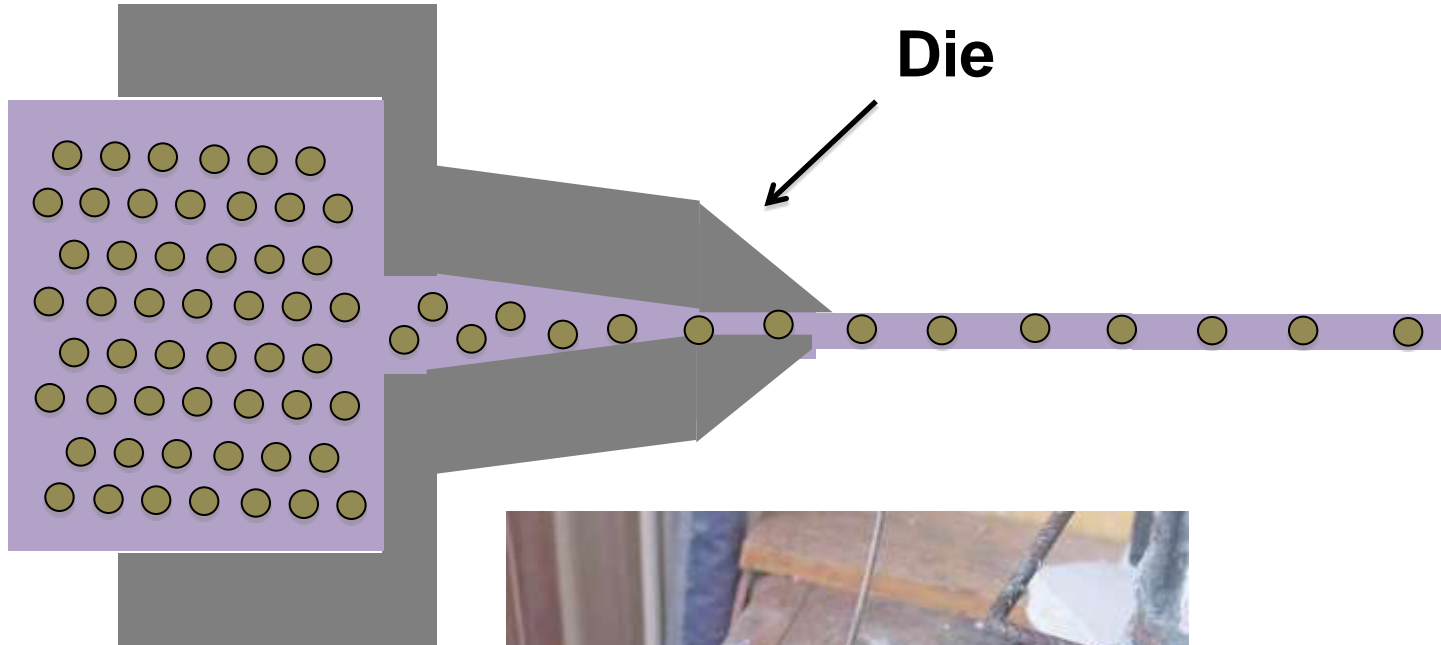
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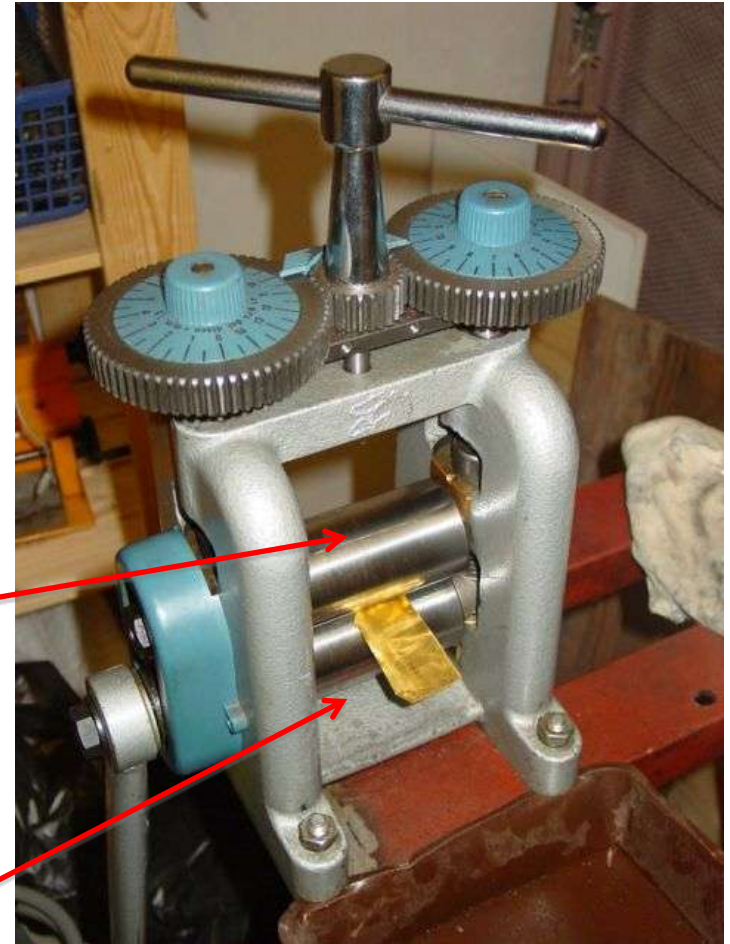
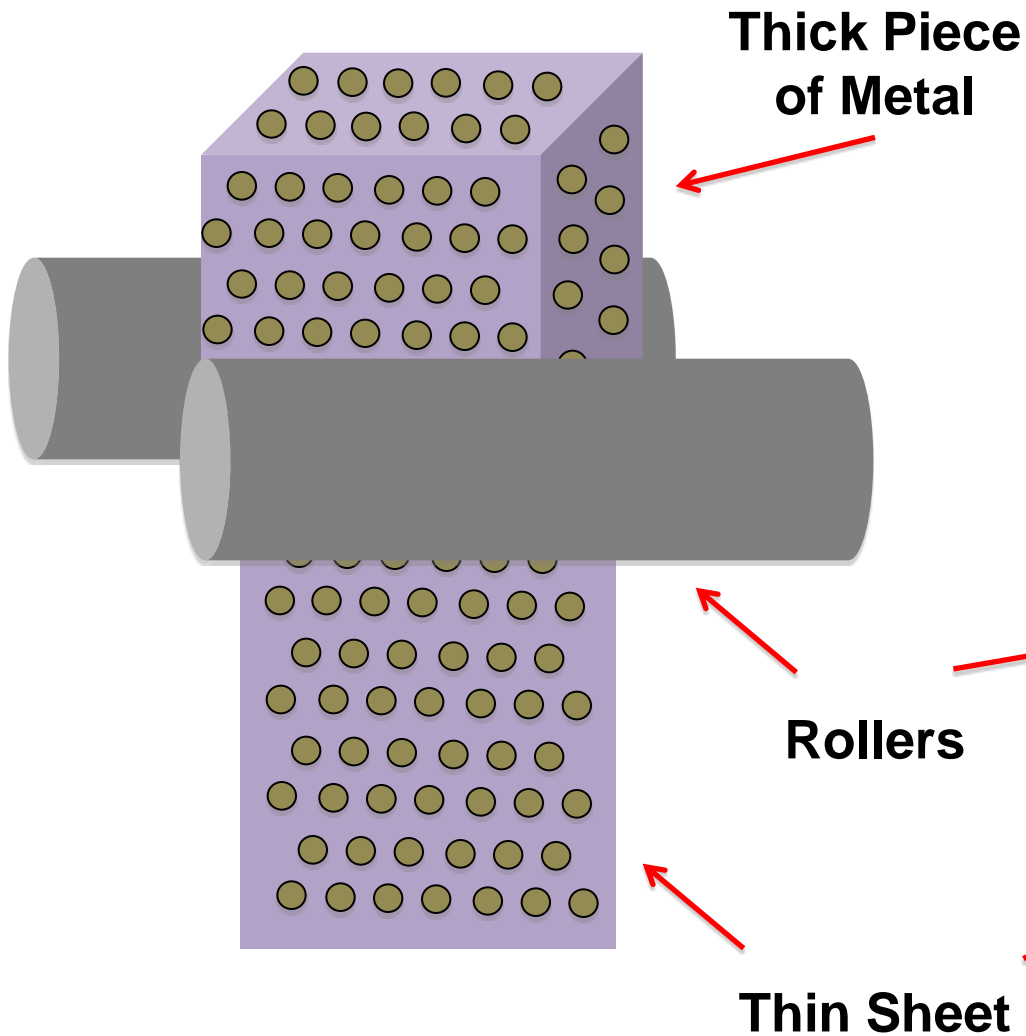
Ductility

- Metals are **ductile** – they can be pulled into thin wires



Malleability

- Metals are **malleable** – they can be pressed into thin sheets



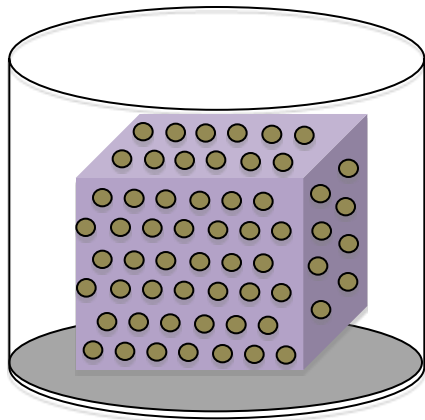
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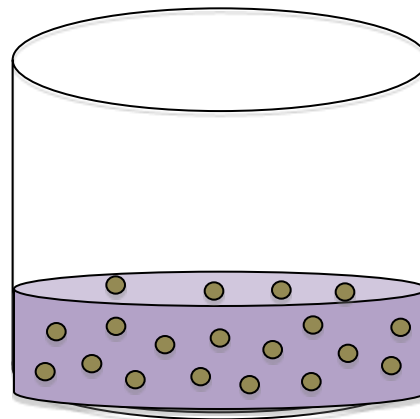
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Melting Points

- The melting points of metals are only moderately high because positively charged nuclei can move easily in negatively charged electron sea



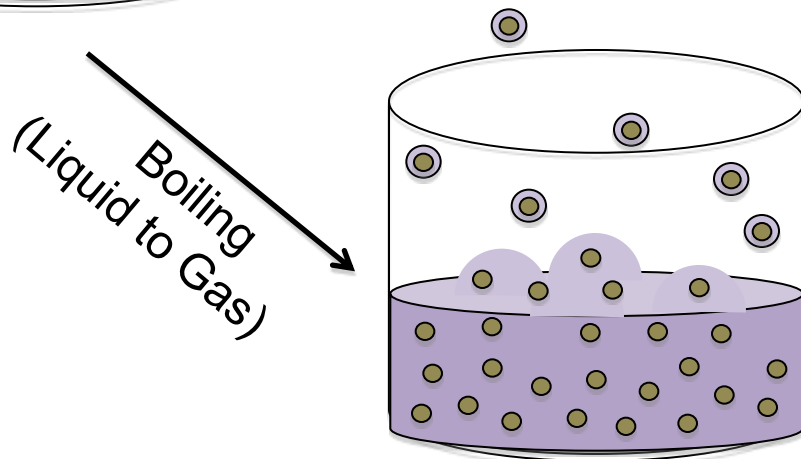
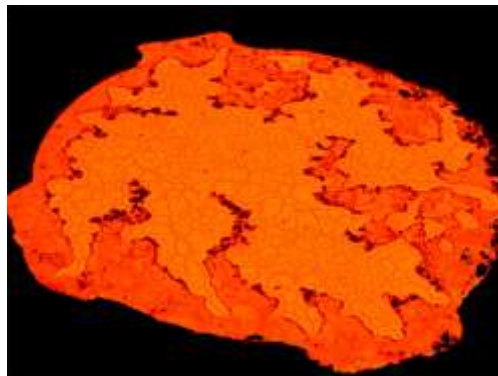
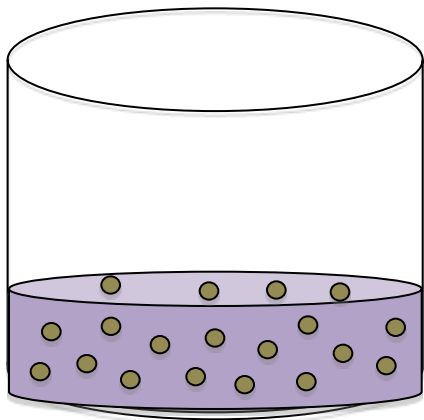
Melting
(Solid to Liquid)



Element	mp (°C)
Lithium (Li)	180
Tin (Sn)	232
Aluminum (Al)	660
Barium (Ba)	727
Silver (Ag)	961
Copper (Cu)	1083
Uranium (U)	1130
Gallium (Ga)	30

Boiling Points

- The boiling points of metals are quite high because it is difficult to separate a positive nucleus with all its electrons from the electron sea



Element	mp (°C)	bp (°C)
Lithium (Li)	180	1347
Tin (Sn)	232	2623
Aluminum (Al)	660	2467
Barium (Ba)	727	1850
Silver (Ag)	961	2155
Copper (Cu)	1083	2570
Uranium (U)	1130	3930
Gallium (Ga)	30	2204
Tungsten (W)	3422	5555



Mini Quiz

- NaCl (table salt) is an ionic compound.
- Do you expect its melting point to be higher than most metals? What about its boiling point?

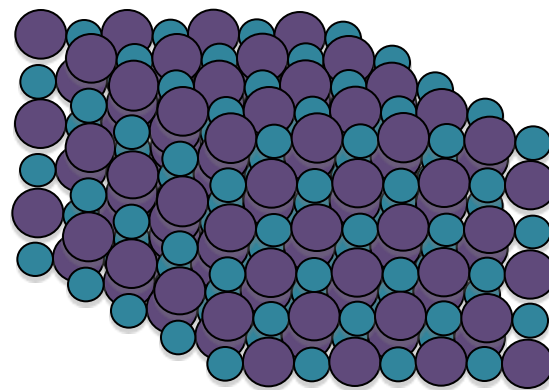
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Boiling Point (NaCl) = 1413°C
Melting Point (NaCl) = 801°C

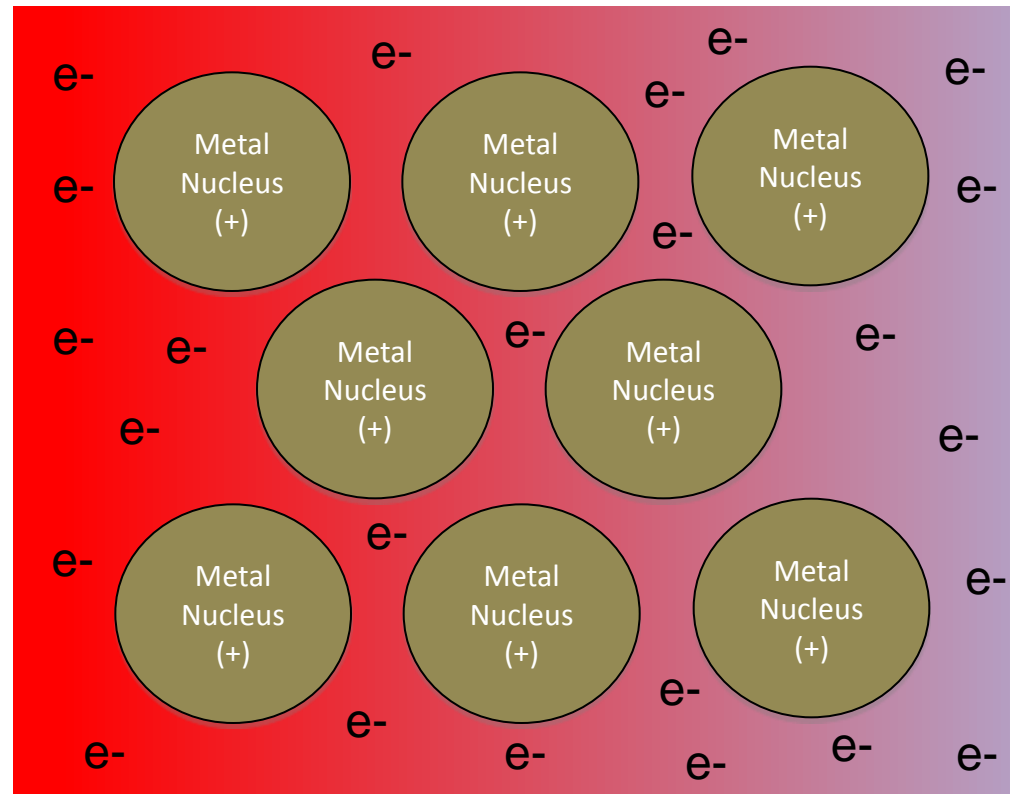
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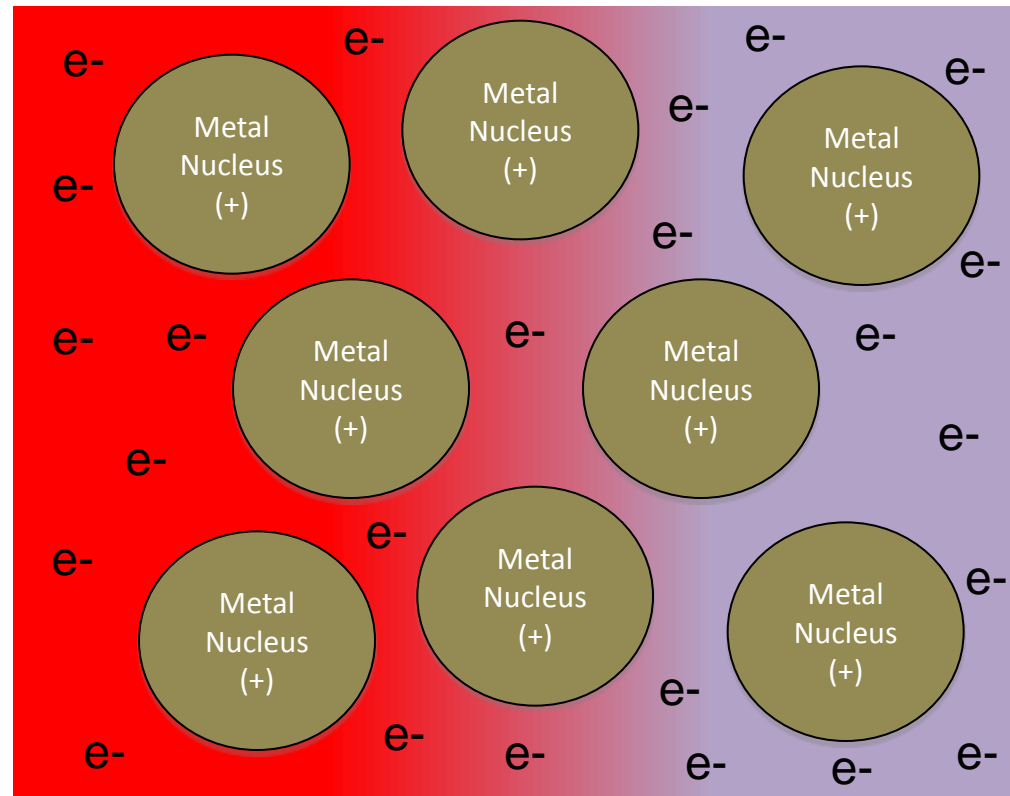
Thermal Conductivity

- Heat is transferred when atoms move around
- Materials that transfer heat well have high thermal conductivity
- Metals have high thermal conductivity because their atoms are free to move around



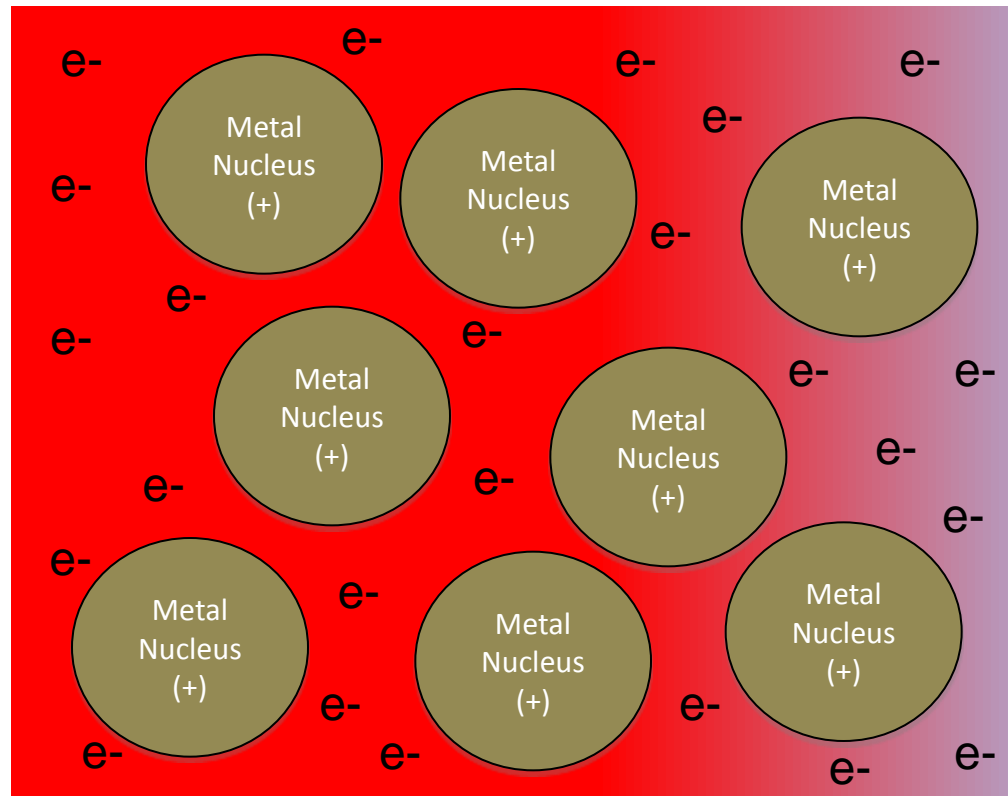
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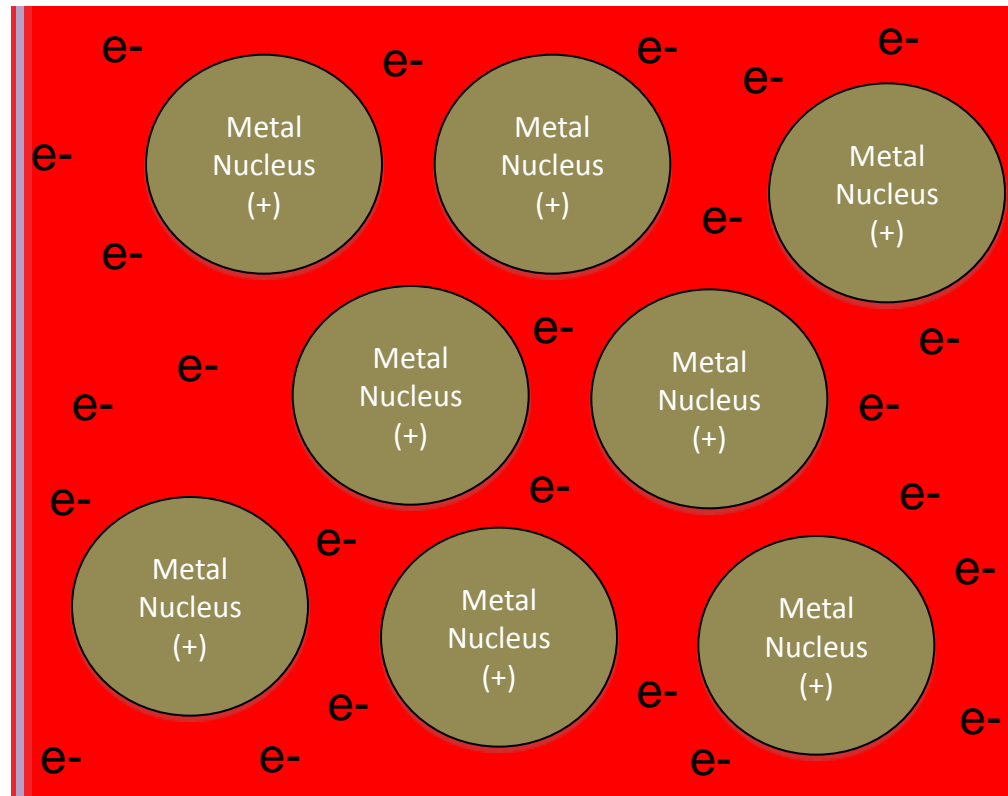
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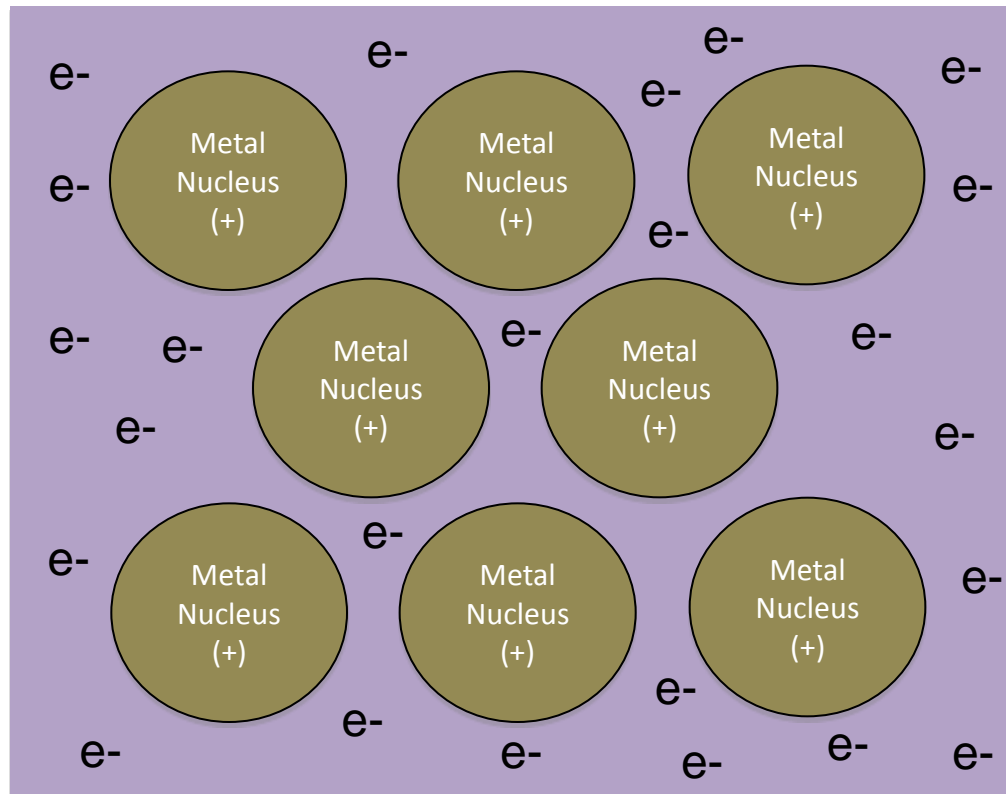
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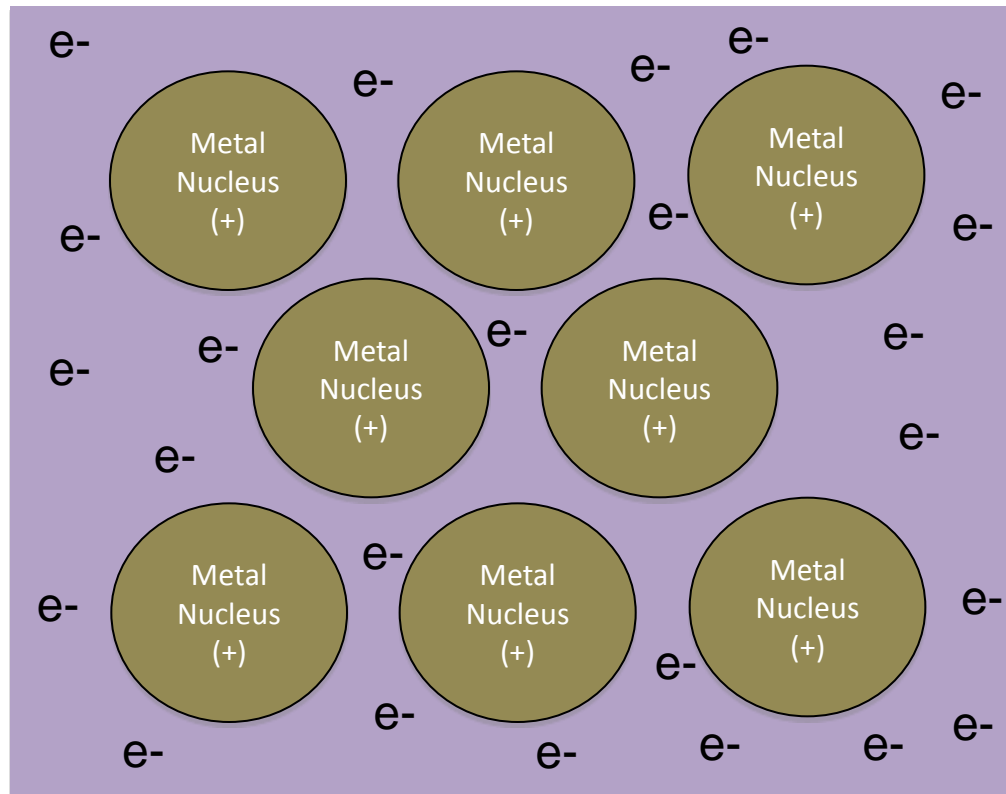
Metallic Properties

- Other properties of metals come from the freedom of electrons to move relatively freely in the nuclear crystal



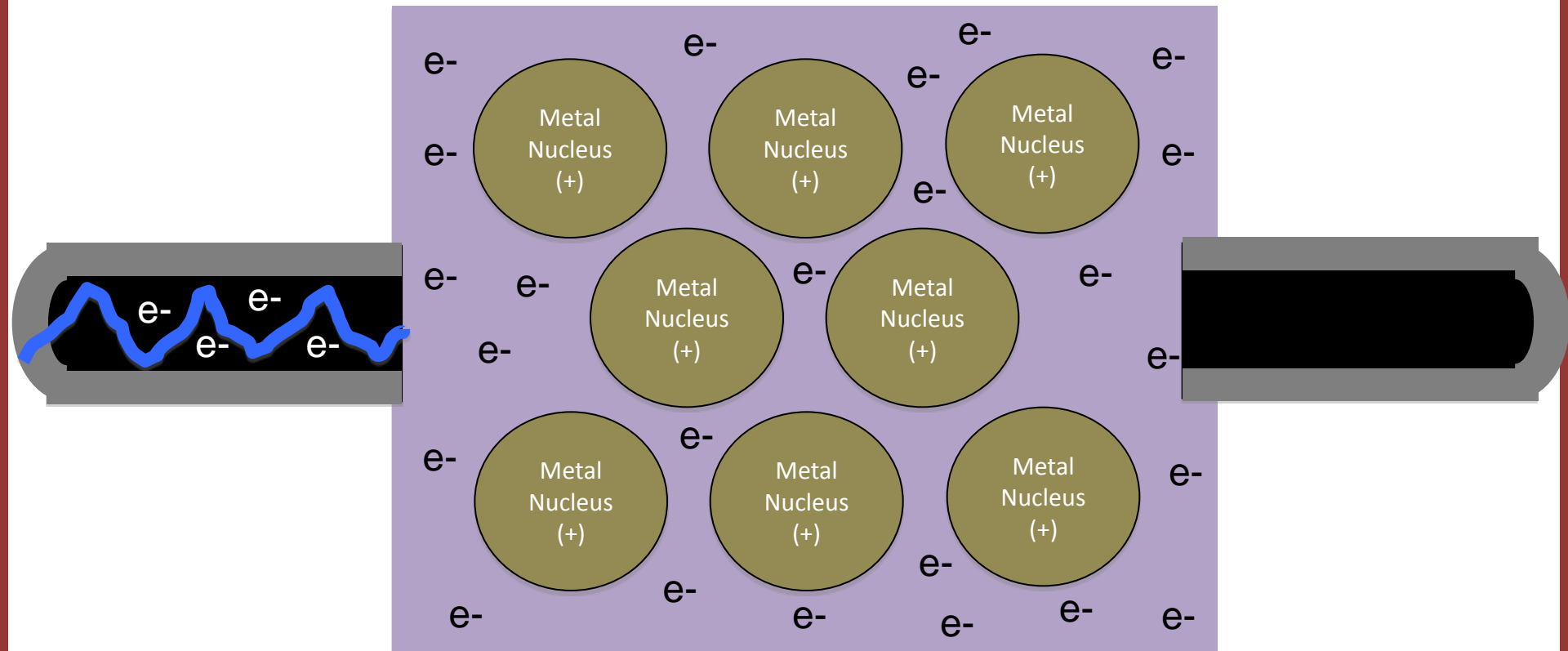
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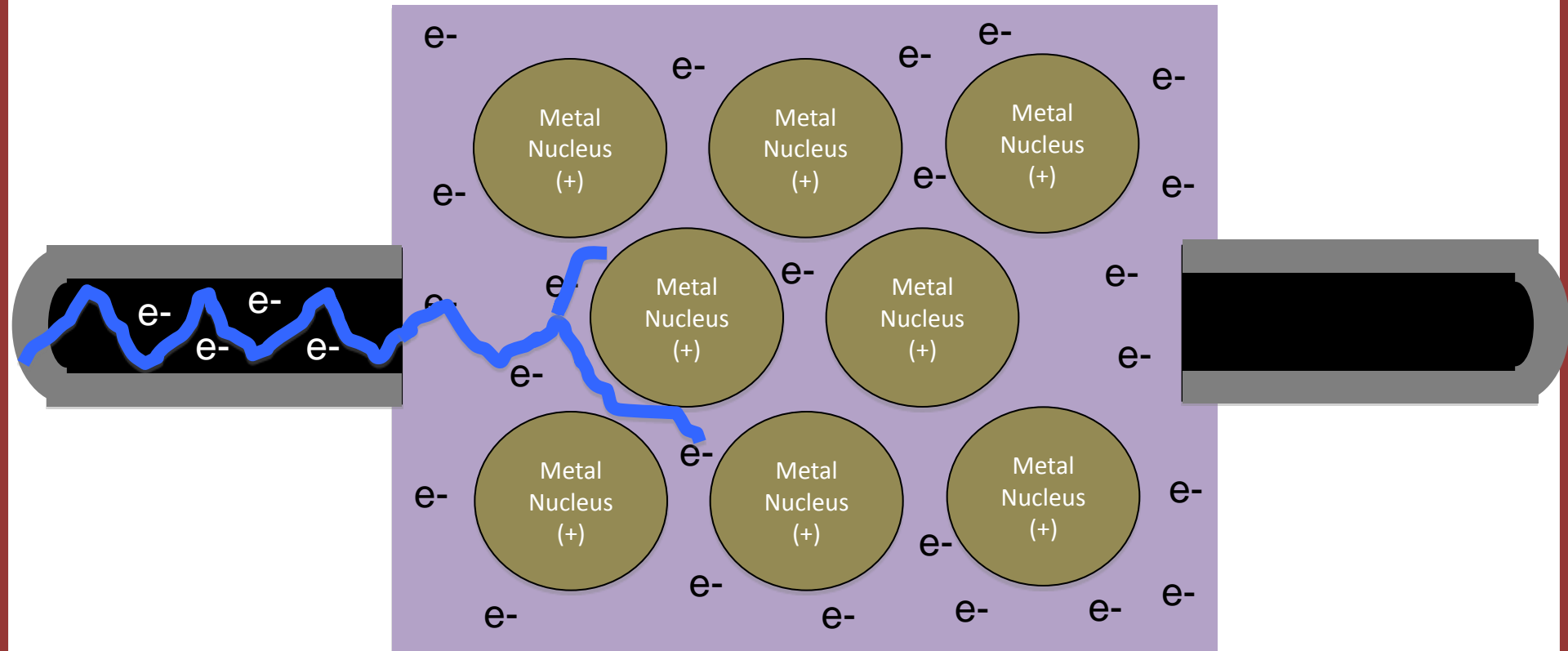
Electrical Conductivity

- Electricity is conducted when electrons move around
- Materials that transfer electricity well have high electrical conductivity
- Metals have high electrical conductivity because their electrons freely move around



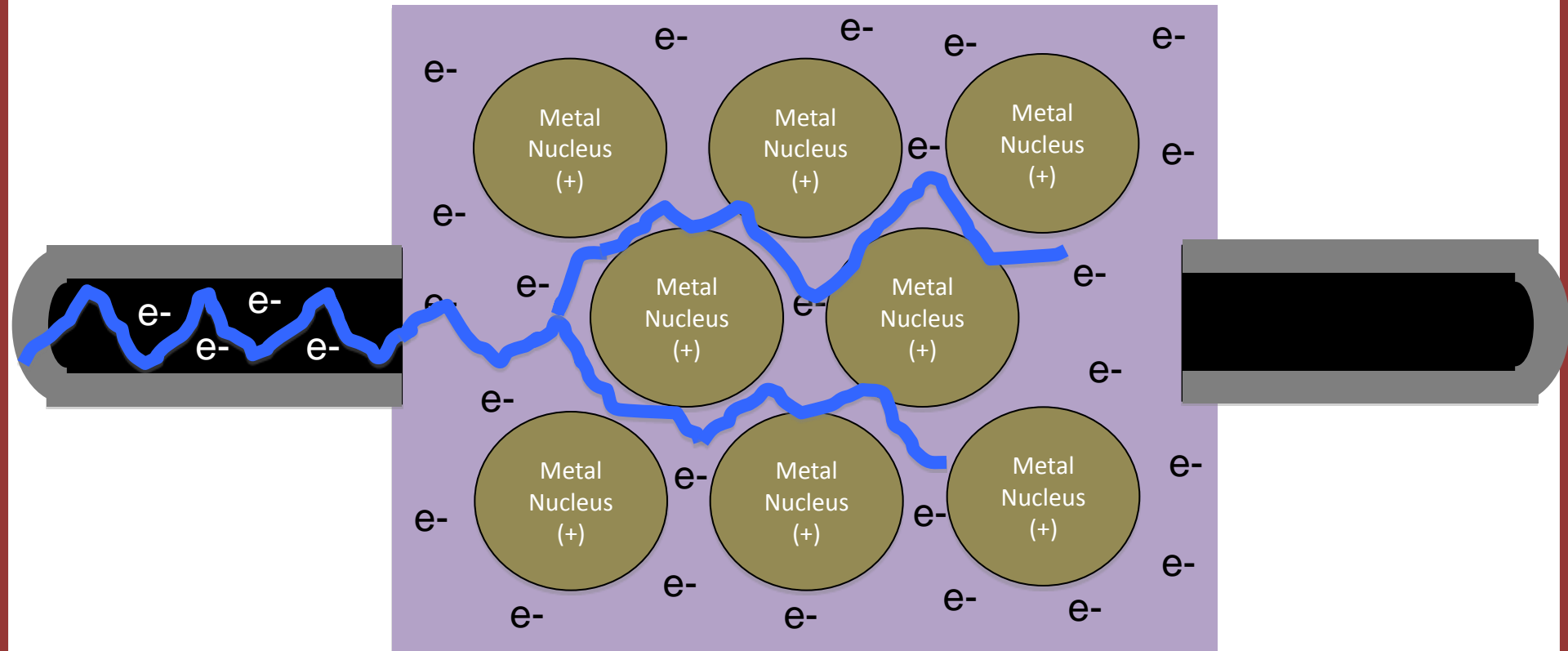
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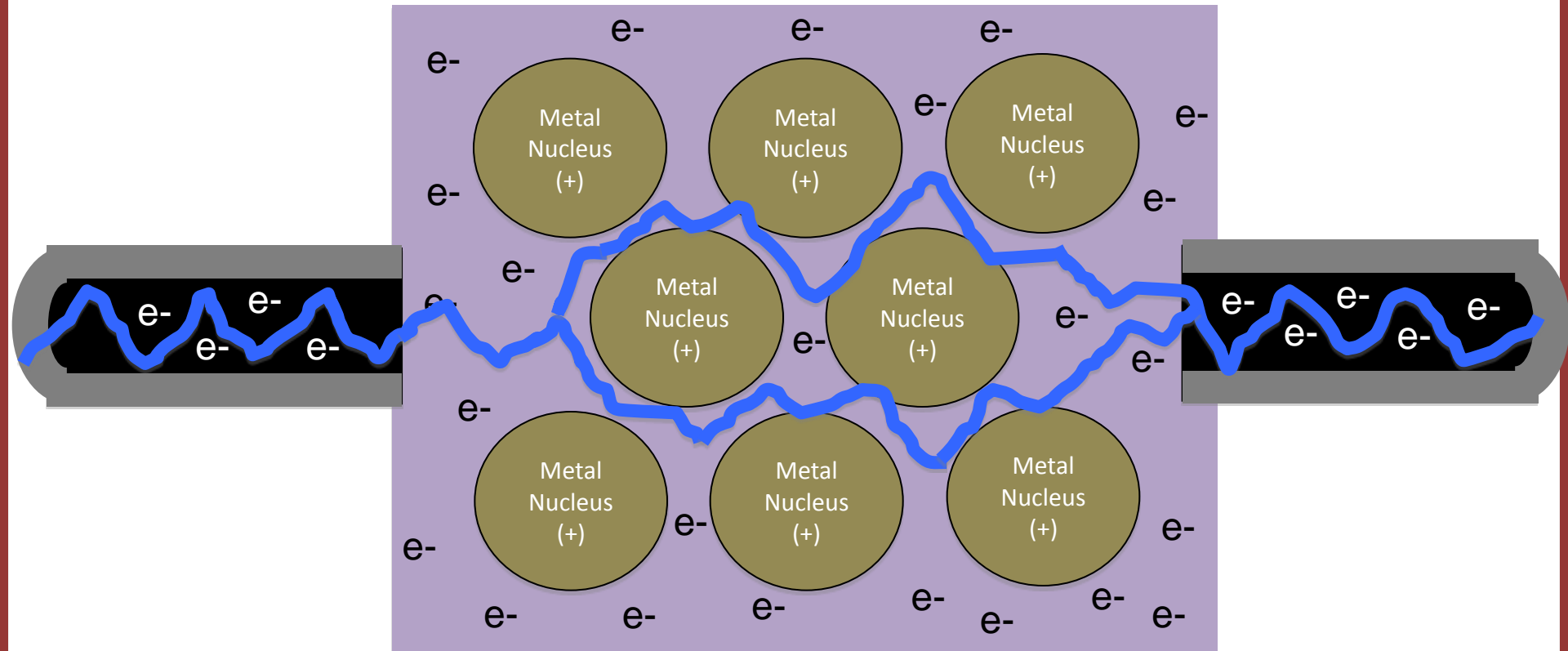
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Mini Quiz

- Which of the following substances or solutions will conduct electricity?



Wood



Copper Block



Pure H₂O



MgBr dissolved in H₂O

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- Alloys

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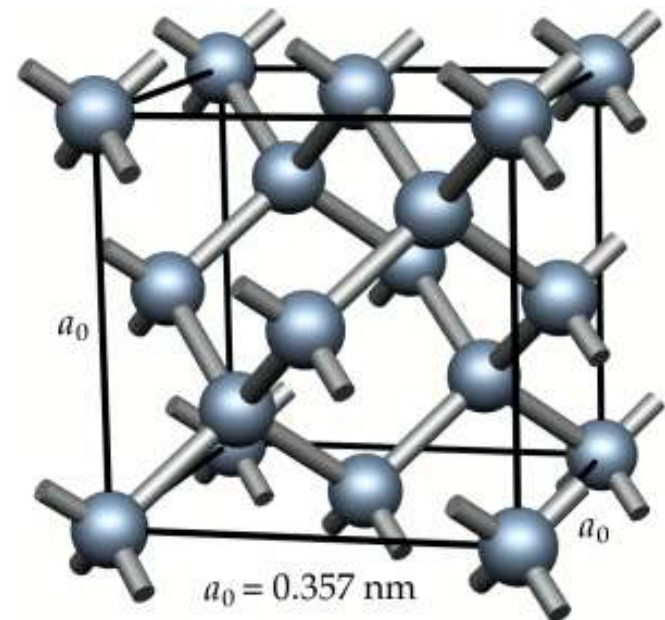
- Diamonds are made entirely of carbon
 - Are diamonds ductile? Malleable?
-
- What do these properties tell you about C-C bonds in diamonds?



Mini Quiz

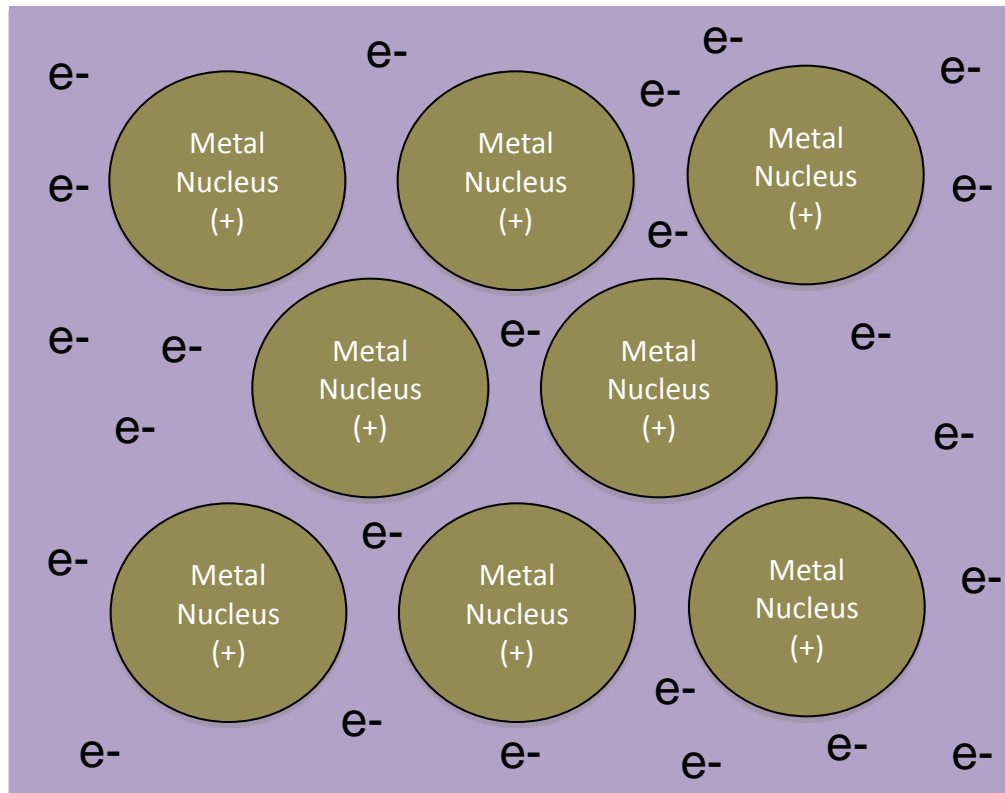
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- What do these properties tell you about C-C bonds in diamonds? ...
→ **They are covalent!**



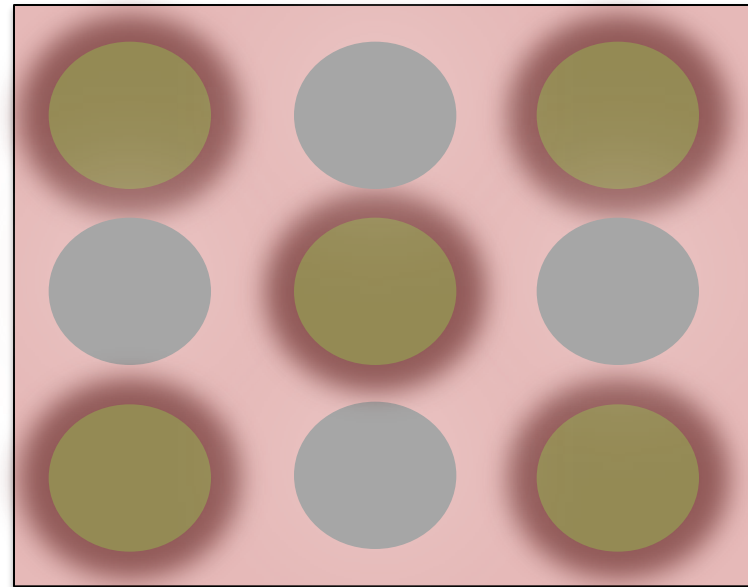
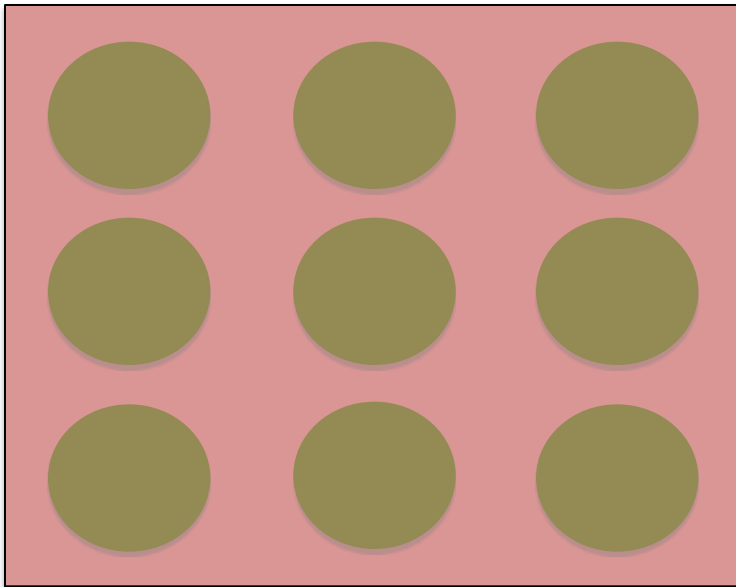
Alloys

- Since all electrons in a pure metal see atoms of the same element, the 'electron sea' is uniform – the same throughout
- Metallic properties come from the uniformity of the electron sea



Alloys

- Alloys are solutions of different elements that have metallic properties
- The electron sea is not uniform in alloys, because different elements have different electronegativities



Alloys

- Alloys are useful because they combine the properties of different metals
 - Brass = Copper + Zinc
 - Lower melting point, more resistant to corrosion
 - Steel = Iron + Carbon
 - Harder, stronger, less ductile, more corrosion resistant



Summary

- Atoms in pure metals are held together by metallic bonds
- Delocalized electrons in metallic bonds move freely in an 'electron sea'
- Many metallic properties come from the relative freedom of nuclei and electrons to move in metals

Homework

- TBD