Answer on Question #77360 – Chemistry – Other

a) List four characteristics of allotropy.
b) If the solubility in water is high for NaCl and low for $Ca_3(PO_4)_2$:
i) derive expressions for the solubility products for NaCl and $Ca_3(PO_4)_2$
ii) draw a Hess's law cycle for the dissolution of NaCl.
Discuss the structure, properties and applications of steel.

Solution:

a) Allotropes generally differ in physical properties such as colour and hardness; they may also differ in molecular structure or chemical activity, but are usually alike in most chemical properties.

b) i) $Ca_3(PO_4)_2(s) \leftrightarrow 3Ca^{2+}(aq) + 2PO_4^{3-}(aq)$

$K_{sp} = [Ca^{2+}]^3 \times [PO_4^{3-}]^2$

$NaCl(s) \leftrightarrow Na^+(aq) + Cl^-(aq)$

ii)

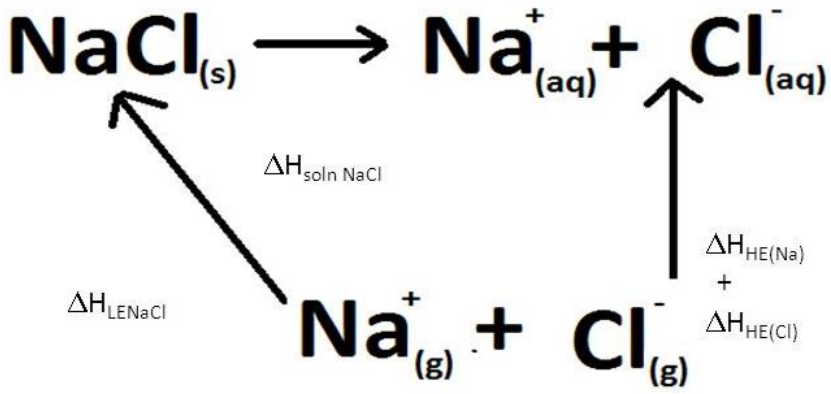
$NaCl_{(s)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$

Then the following has to happen

a. $NaCl_{(s)} \rightarrow Na^+_{(g)} + Cl^-_{(g)}$ The lattice has to be broken up (supply the LE)

b. $Na^+_{(g)} + Cl^-_{(g)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$ The ions are hydrated (Hydration energy is given out)

Hence we can set up a Hess Cycle



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$\Delta H_{LENaCl} + \Delta H_{soln\ NaCl} = \Delta H_{HE(Na)} + \Delta H_{HE(Cl)}$

Iron, in its solid form, assumes a crystalline structure, meaning simply that the iron atoms are arranged in a regular, repeating pattern called a lattice. Many lattices exist in nature, but iron comes in one of two forms -- the body-centered cube, which exists at higher temperatures, and the face-centered cube, its room-temperature form. Adding carbon to liquid iron -- typically in amounts ranging from .035% to 3.5% by mass -- changes what happens when the mixture cools to its freezing point (roughly 1,500°C). Instead of going from being a body-centered lattice to becoming a face-centered lattice, the iron atoms settle directly into the latter. At the same time, the carbon atoms lodge in the center of these cubes. This ultimately accounts for the greater durability of steel compared to pure iron.

The addition of carbon makes the steel tougher and more durable until a certain concentration is reached, at which point it becomes brittle. That said, steel can have many different properties depending on the other elements that compose it. For example, stainless steel –

which is rust resistant, relatively weak, and finds use in cutlery and knives – contains a minimum 10.5 percent chromium. Steels used in construction fall into three types: carbon-manganese steel; high-strength, low-alloy (HSLA) steel; and high-strength quenched and tempered alloy steel. Tough, versatile and resilient, steel can be found in most construction projects. Though steel can rust, and rust-resistant steels tend to be weak, it is fairly easily recycled.

After its invention, steel steadily spread across the world, reaching most cultures and finding a variety of uses. Early uses of steel included weaponry, as steel held its shape and edge better than pure iron. Since then, it has found use across industries. Tools like hammers and screwdrivers contain steel, as do many of the things these tools make. The construction industry uses about a quarter of the world's steel, which can be found in almost every building made by humans. Stainless steel finds use as cutlery material; chef knives are made of different grades of knife steel; and cast iron pans remain a popular kitchen accoutrement. Steel can also be found in piano wires, sewing needles and electronics.