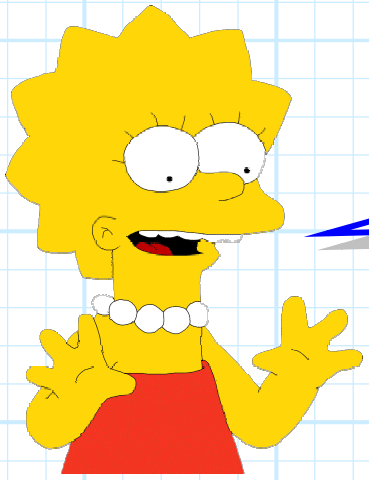
Drift Current

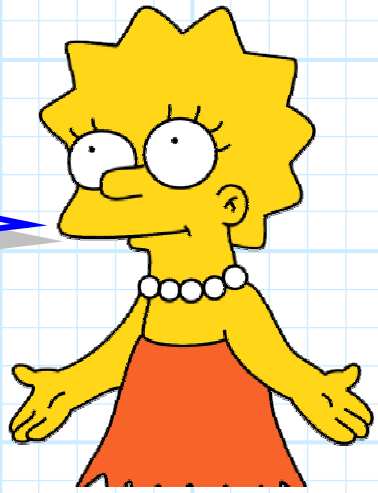
Say an **electric field** is applied to pure Silicon.



Q: *An electric field* $\mathbf{E}(\bar{r})$*! Tell me, what will happen?*

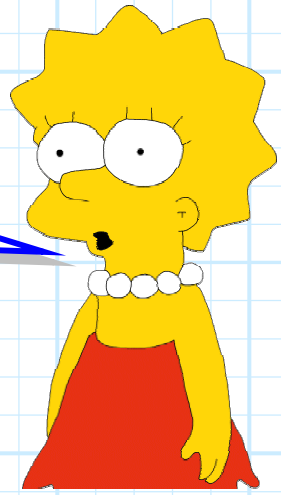
A: From EECS 220 we know what happens ! Since electrons and protons have electric **charge**, the electric field applies a **force** on them; a force that is proportional to the magnitude of the charge.

Q: *A force ! So, the electrons and protons* ***move****, right ???*



A: Not necessarily ! The protons, as well as (generally speaking) the **bound** electrons, are held **in place** by the lattice.

→ The electric field pulls at them, but atomic forces **hold** in place the charged particles **within** the lattice.



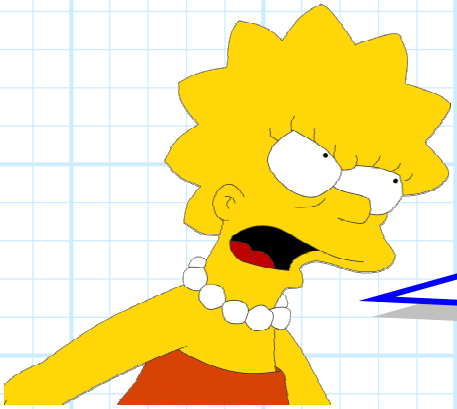
Q: *Within the lattice? The **free** electrons do not reside within the lattice. Do **they** move ??*

A: **YES !** Free electrons are free to **move**—they are not bound by atomic forces to the lattice.

Moving Charge ! → *Moving charge is **current** !*

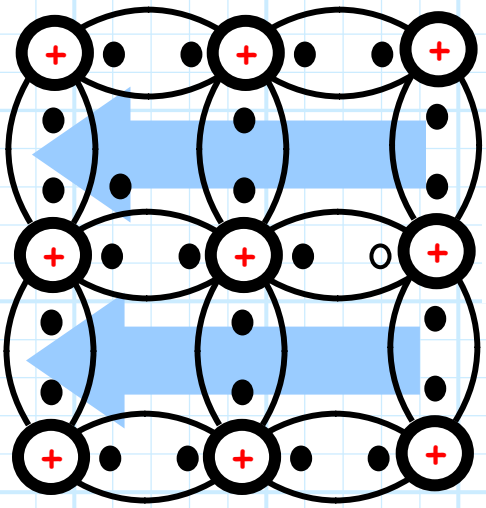
* Charge that moves in response to an applied electric field is known as **Drift Current**.

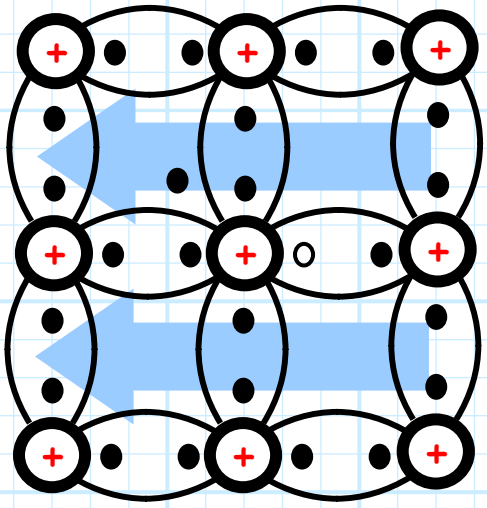
* Drift current in Silicon has **two** components—current due to moving free electrons, and current due to moving **holes**.

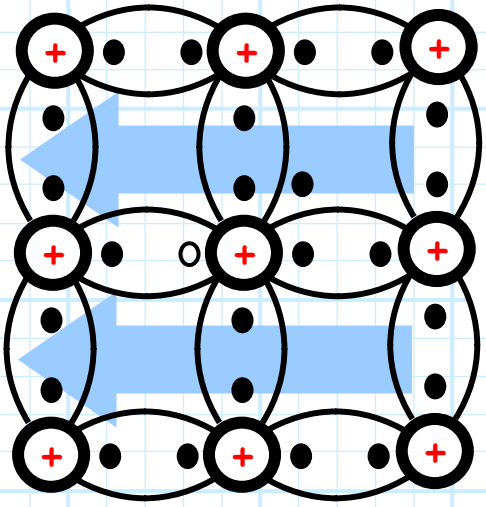


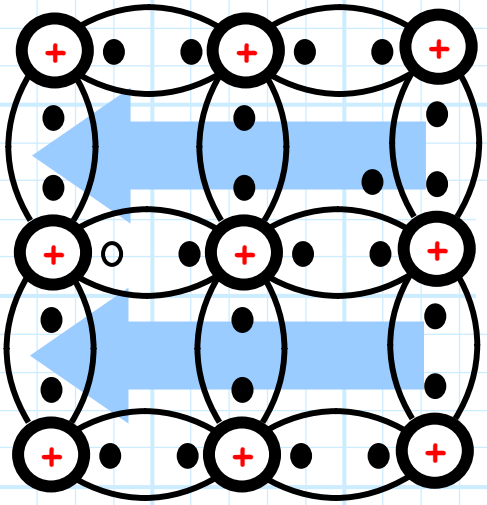
Q: *Moving **holes** !? How can moving holes create **current**? A hole is **nothing!***

A: Let's examine a Crystal Lattice as a function of **time**, while an electric field ⟵ is applied to it:









* Note over time, the **free electrons** move from **left to right**, in response to the electric field.

* But note also that some of the **bound** electrons **also** move from left to right, provided that there is a **hole** in the lattice for them to move into.

* As a result, the **hole** appears to moving from **right to left** !

* A **positive** charge would move right to left in the applied electric field—the **hole** appears to have **positive charge**!

* In fact, holes behave as if they are positively charged particles, with a charge equal to that of an **electron** (only positive !).

So, we have **negative** charge (free electrons) moving left to right, and **positive** charge (holes) moving right to left. **Both** result in (drift) current moving from **right to left**.