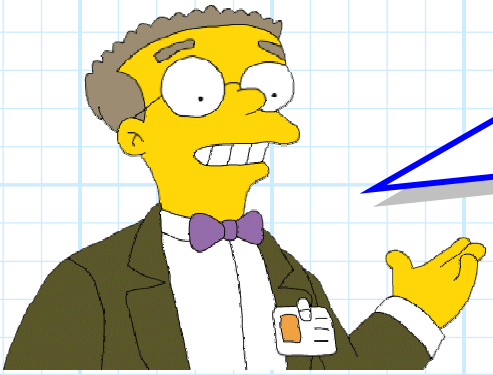
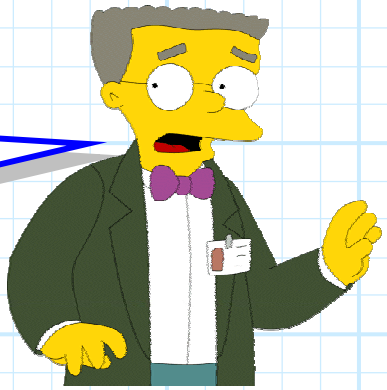
Diffusion Current



Q: *So, it seems to me that, **if** there is **no** electric field present, there can be **no** current flow in Silicon. Right ??*

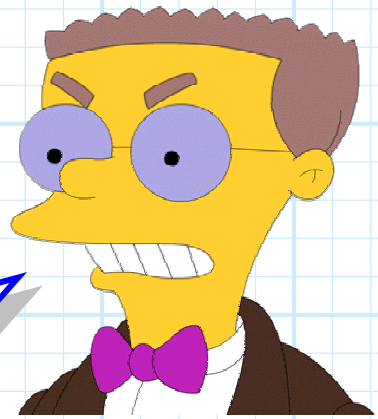
A: **NO !** There **can** still be current flow in a Silicon lattice, even if there is **no electric field** applied to it! This kind of current is **different** from drift current—we call this current **diffusion current**.

Q: *But, how can a charged particle **move** if there is no **force** applied to it ?!?*



A: Electrons, whether free or bound, have both a charge and a **mass**. There is a source of **energy** within the Silicon lattice that can move **particles**, independent of their charge. This energy is **heat** !

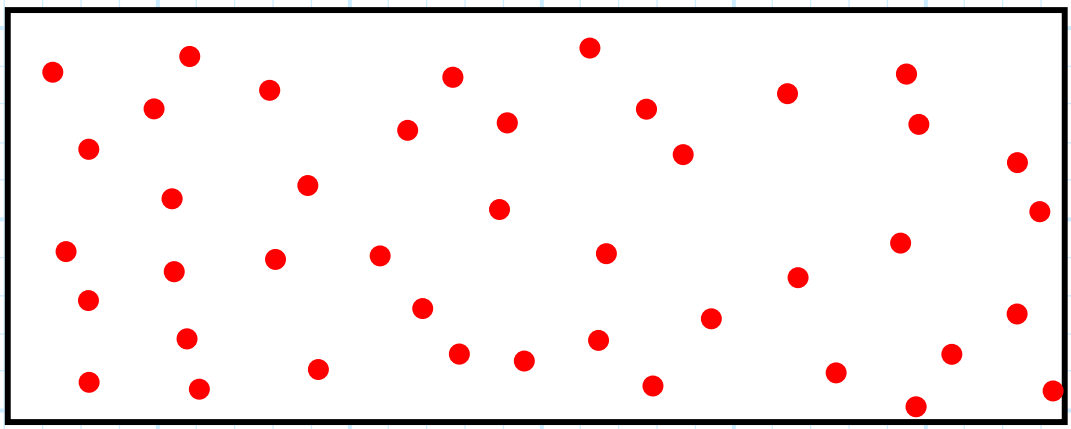
Q: ***HEAT! Seems like** heat would result in the particles moving **randomly** in the lattice, as opposed to moving in a **specific** direction. The **average** current would be **zero** right??*



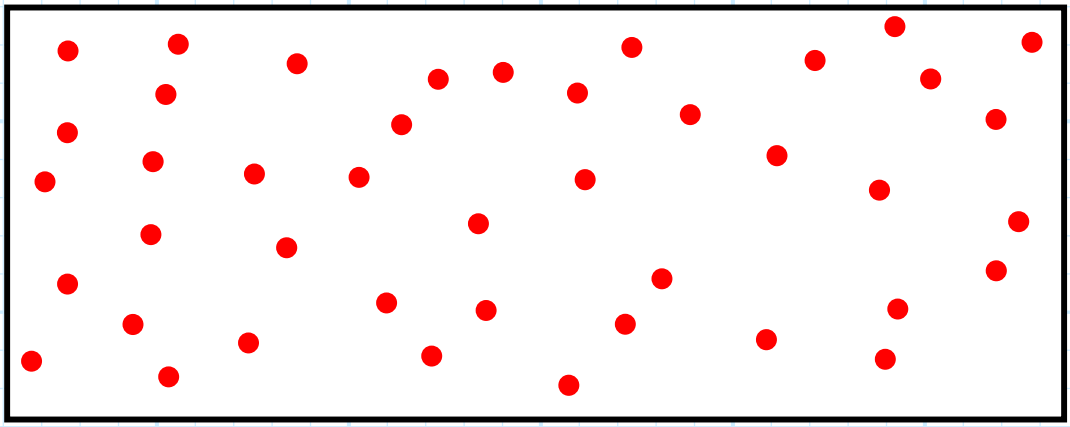
A: It **is** true that **if** the particles are **uniformly** distributed within the lattice, then the particles will remain **uniformly** distributed—the average current is **zero**.

However, if (for some reason) the particles are **concentrated** in one region of the lattice, **entropy** will ensure that they **move** from the region of **high** concentration into regions of **low** concentration. Moving **particles** mean moving **charge**—in other words **current**.

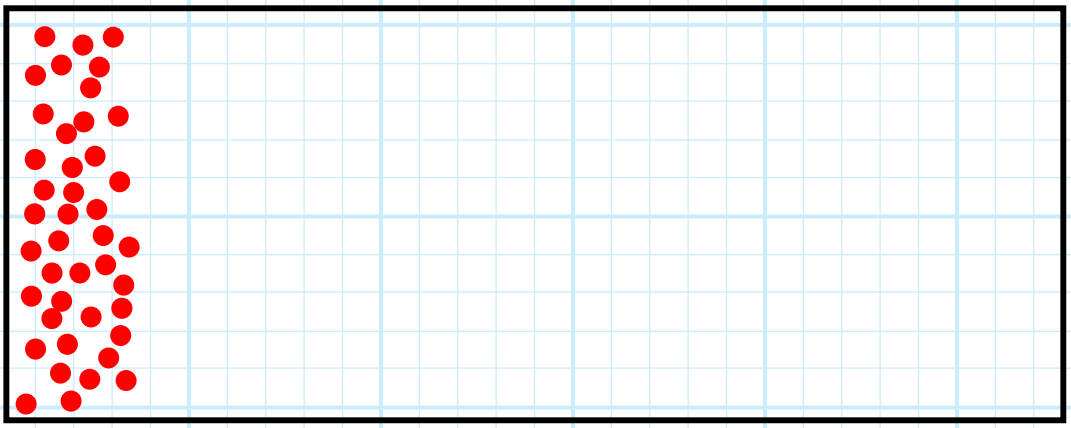
For example, consider the situation below, where a collection of particles (e.g., holes or free electrons), are **uniformly** distributed throughout the volume:



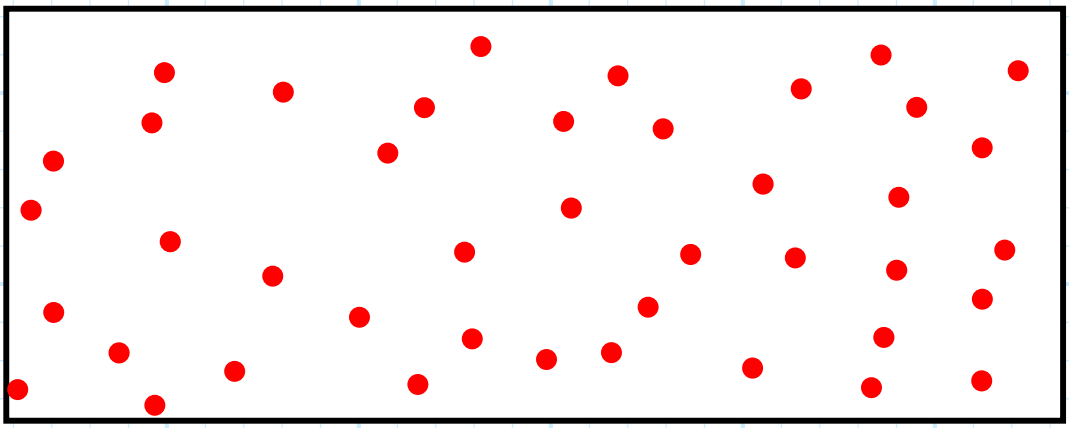
However, since these particles posses **thermal energy** (i.e., heat) they are moving randomly. As a result, at some **later time**, the particles have **all moved**, but are **still** uniformly distributed throughout the volume:



In contrast, consider the situation where the particles are **not** uniformly distributed, but instead are **concentrated** in one region of the volume:

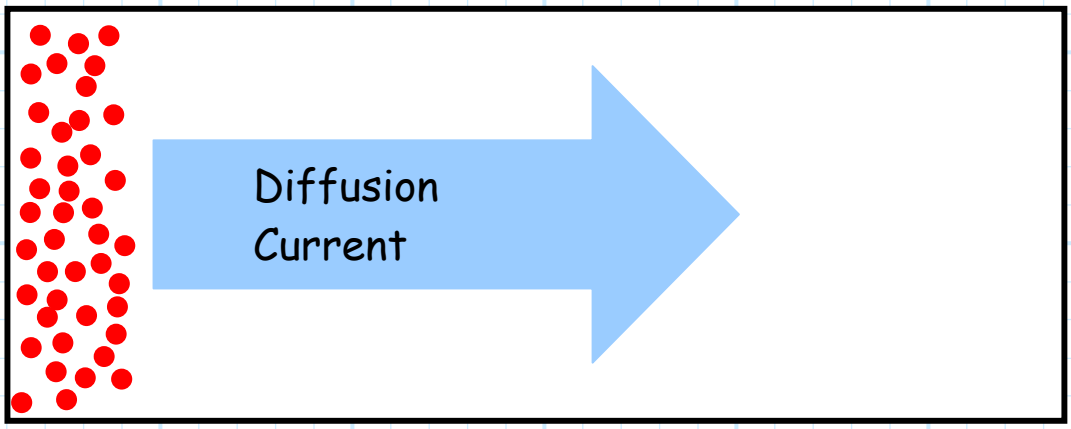


If there is no **other** force holding them in place, then thermal energy will cause these particles to **randomly redistribute** themselves over time, again **uniformly** across the volume:



Said another way, the thermal energy will maximize the **entropy** (i.e., randomness) of the volume !

But, notice what has happened. The charged particles have moved from one region of the volume into another. This movement, although having nothing to due with electromagnetics, is current!



Current generated by this mechanism is referred to as **Diffusion Current**.

Recapping:

1) **Drift current** is a result of electrons having **charge**. They move due to energy supplied by an **electric field**.

2) **Diffusion current** is a result of electrons having **mass**. They move due to energy supplied by **heat**.