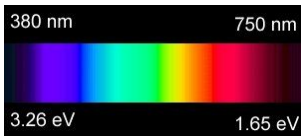
Solution to

All Quick Questions / Class Exercises to

2.3 III-V Semiconductors

- What band gaps of which type would we like to have for **III-V** properties?
  - We want to cover regular optics, meaning whatever one can do with **visible light**. The human eye can perceive wavelengths from **750 nm** or **1.65 eV** (= red) to **380 nm** or **3.26 eV** (= violet)



Visible spectrum as far as it can be reproduced on a screen.

  - So we like to have semiconductors with a *direct* band gap and with every conceivable band gap energy between **1.65 eV** and **3.26 eV**
  - We also *know* that **infra red** (**IR**) optics is important - at the very least for communication via **optical fibres**. This happens at a wavelength of about **1 500 nm** or an energy of about **0.83 eV**. This means that we would also like to commandeer *direct* semiconductors with band gaps ranging from **1.65 eV** down to at least **0.8 eV**.
  - Moreover, we know that there is not only a lot of demand for **white light** but that there are already "white" **LED's** in, e.g., flashlights and car headlights. The easiest way to make white light out of monochromatic light (that we will always get from a **LED**) is to produce **ultraviolet light** (**UV**) that is converted to white light via some intermediate fluorescent material like in any "fluorescent" lighting fixture. This means that we also want to have *direct* semiconductors with band gaps ranging from **3.26 eV** up to **???** - well. at least **4 eV**.
  - *Summing up*: We need to have *direct* semiconductors with band gaps ranging from **4eV** - **0.8 eV**
- What are the requirements for substituting light bulbs by **LED's**? What is the state of the art?
  - First we remember: "Light "bulbs", i.e. lighting fixtures already do exist in many variants. If we want to replace what has been around for more than a century, we must be *cheaper* or *better*. We can be if we look at the weak points of existing "standard" lighting with some kind of "bulbs" where light is produced because something is very hot.
    - **LED's** can have much better efficiencies, i.e. you get more light per Watt.
    - **LED's** can have a much larger lifetime, i.e. you change them after **10** years instead of after just a (felt) few months.
  - The problem is to have high power (not the same as high efficiency) and all colors.
  - State of the art: Look in the Internet and you see: **LED** lighting is just now starting to replace conventional lighting in special applications. It is expected to go far in replacing general lighting in the next **10** years or so.
- Amend and discuss - the list of optoelectronic products
  - The most important *optoelectronic* products besides **LED's** are:
    - **Semiconductor Lasers**. No bar-code reader, ***CD*** or ***DVD*** or whatever comes next without them.
    - **Optical sensors**. The output of the fibre optic cable spanning the Pacific or Atlantic is modulated light. Something must convert it back into modulated voltage.
    - **Displays**. Large display boards, e.g. on Times Square in Mamhatan, consistof hundred thousands of individual **LED's**. Small display in your cell phone or (soon) **TV** screens consist of millions of *integrated* **organic LED's** in an ***OLED*** display.