ELE432 Quiz 1

Question 1:

X-rays are produced by shooting high energy electrons into a fixed (atomic) target. Upon impact, the energy of the electron is released as EM radiation (German "Bremsstrahlung"). A small percentage of the accelerated electrons will produce x-rays.
Assume that the electrons are accelerated between 2 conductive parallel plates, which are spaced 0.5 m apart. If you want to generate x-rays with a wavelength of 0.02 nm, what voltage do you have to apply between the two plates.

Answer:
V = 62 kV

Physical Constants

Plank's constant	$h=6.63 \times 10^{-34}$ Js
Electron charge	$q=-1.60 \times 10^{-19}$ As
Electron rest mass	$m_0=9.11 \times 10^{-31}$ kg
Boltzmann's constant	$k=1.38 \times 10^{-23}$ J/°K
Permeability in vacuum	$\mu_0=4\pi \times 10^{-7}$ Vs/Am
Permittivity in vacuum	$\varepsilon_0=8.85 \times 10^{-12}$ As/Vm
Electron volt	$1\ eV=1.6 \times 10^{-19}$ J
Si Bandgap energy	$E_G=1.12$ eV
Si Lattice constant	a=0.543 nm
Si relative permittivity	$\varepsilon_{Si}=11.7$
SiO_2 relative permittivity	$\varepsilon_{SiO2}=3.9$

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Question 2:

Why is silicon the most preferred semiconductor material?
List 2 arguments.

Answer:
Abundant, inexpensive, simple processing, wide extrinsic range, comparatively balanced electron and hole mobility values

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Question 3:

Silicon crystallizes in a diamond lattice structure. Compute the distance between 2 nearest atomic neighbours if we know that the lattice constant of silicon is 0.543 nm.

Answer:
d = 0.235 nm

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Question 4:

How many silicon atoms fit into a cube of 1 mm side-length ?

Answer:
5.0×10^{19} Atoms

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Question 5:

What is the density of silicon atoms (atoms per m^2) in the (110) plane?

Answer:
$d_A(110) = 9.59 \times 10^{18}$ Atoms/m^2

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Question 6:

An electron is trapped in an infinitely deep potential well. What is the minimum possible energy E_1 of the electron if the walls are spaced 0.5 nm apart? (Express the energy in units of eV).

Answer:
$E_1 = 1.51$ eV