

NANO 705
Homework 5
Due: M-4/10, 10:00 AM

Show all work. Discuss results.

1) Various carbon nanotubes with roll-up vectors specified by indices (m, n) are listed below. For each find:

- i) the circumference c ;
- ii) the diameter d ;
- iii) whether the nanotube is zig-zag (Z), armchair (A), or other (X).
- iv) whether the nanotube is semiconducting (S) or metallic (M);
- v) the bandgap E_g , in eV (zero if metallic)
- vi) the subband index ℓ for the band most closely approaching the Fermi point.

- a) (12,0) b) (6,-6) c) (6,6) d) (24,3) e) (18,12)
f) (25,-25) g) (18,18) h) (18,-18) i) (9,-5) j) (9,-15)

Note that $a_0 = 0.142$ nm

2) Consider a box of size $30 \times 40 \times 50$ nm³, with dispersion relation:

$$E(k) = E_c + \frac{\hbar^2 k^2}{2m_c}$$

Assume the electron effective mass is $m_c = (0.1)m$ where $mc^2 = 5.11 \times 10^5$ eV.

Assume the band edge has energy $E_c = 0.70$ eV.

- a) How many states does the box contain with wave vector $k \leq k_F$, where $k_F = 2.0$ nm⁻¹?
- b) What is the Fermi energy $E_F = E(k_F)$?
- c) What is the density of states at the Fermi energy $D(E_F)$? Use appropriate units.