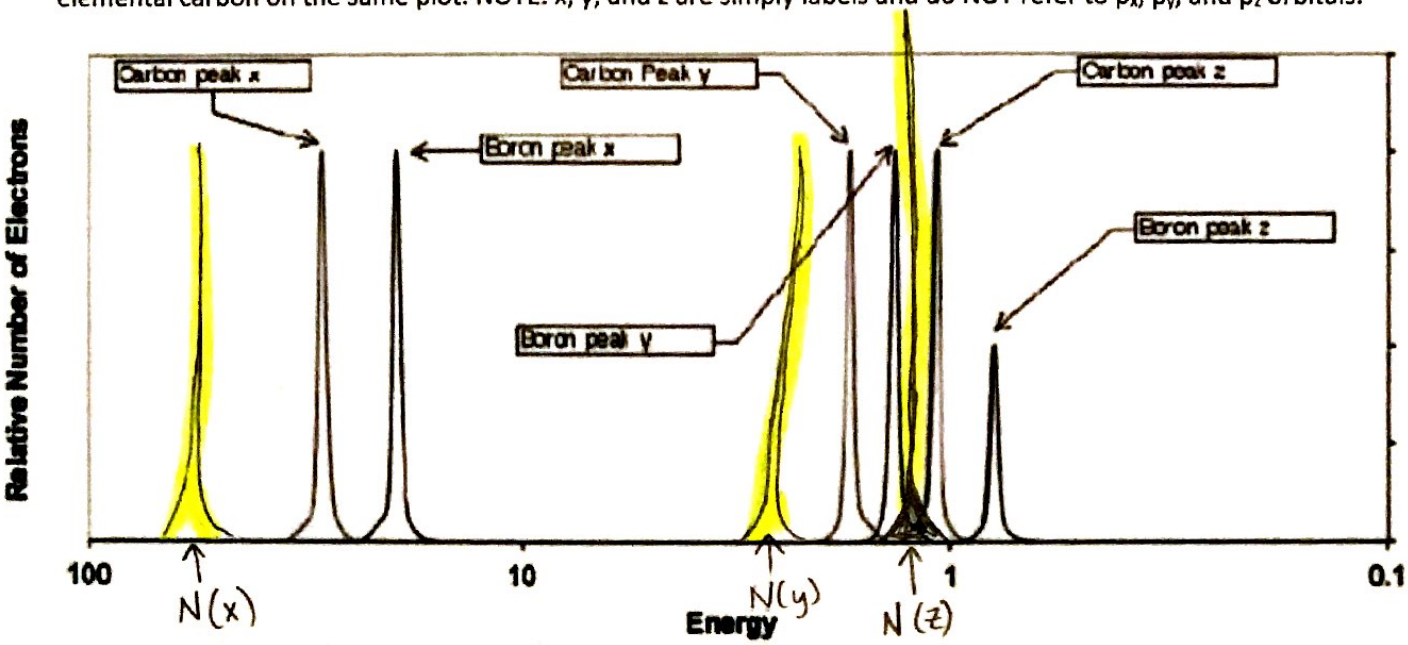
Free Response Practice #1 (10 points)

1. Consider the PES spectra shown below, that superimposes the simulated PES spectra for elemental boron and elemental carbon on the same plot. NOTE: x, y, and z are simply labels and do NOT refer to p_x, p_y, and p_z orbitals.



a. Suggest a reason why the boron and carbon peaks have been paired together in three groups labeled x, y, and z. (1 point)

b. Explain why the carbon 'x peak' is at a higher energy than the boron 'x peak'. (2 points)

c. Explain why the boron 'z peak' is half the height of the carbon 'z peak'. (1 point)

d. If one were to superimpose a third PES plat on the same axes for elemental nitrogen;

   i. Relative to carbon's 'x peak', where would nitrogen's 'x peak' appear on the x-axis. Explain AND draw and label the peak on the plot above. (2 points)

   ii. Relative to carbon's 'z peak', what would the height of nitrogen's 'z peak' be? Explain AND draw and label the peak on the plot above. (2 points)

e. Identify the electrons that are associated with each of the following peaks on the boron plot: (2 points)

   i. x peak ii. y peak iii. z peak

(a) The 3 groups represent the 3 occupied sublevels:
X = 1s, y = 2s, z = 2p

(b) C has more p^+ than B, so its nucleus exerts a greater attractive force on its e^-, thus it requires more energy to remove an e^- from C than B.

(c) C has 2 e^- at the 2p sublevel whereas B has only 1, hence B's 2_p peak ("z") is half the height (since peak height represents # of e^-)

(d)(i) N's x peak would appear at a higher energy than C's x peak, b/c N has 1 more p^+ than C, so its e^- are more attracted to its nucleus + would require more energy to remove.

(ii) Peak height represents # of e^-, + since N has 3 e^- in the 2p sublevel (compared to C's 2 e^-), the N z peak should be 150% of the height of C's z peak.

e.) i) x peak = 1s
ii) y peak = 2s
iii) z peak = 2_p