EXAM I – Sept. 12, 2019

Answers to Calculation-Based Problems

10. (14 pts) You may have heard about the lead-contaminated drinking water in Flint, Michigan. In 2015, researchers from Virginia Tech measured lead-contaminated water in over 200 Flint homes. In the worst case they found, the lead concentration was as high as 13.2 g/m^3 (which is more than 2500 times the threshold level deemed unsafe for drinking). Suppose that the homeowner drank 64 ounces (oz) of this highly contaminated water per day. How many grams of lead would she ingest in a year (assuming she lived that long)?

Note: 1 L = 33.814 oz = 1000 cm^3

Answer: 9.1 g

11. (14 pts) As I've mentioned in class, a technique called photoelectron spectroscopy uses the photoelectric effect to experimentally determine orbital energies and, from them, electron configurations. This is done by bombarding atoms with high-energy photons and measuring the speeds at which electrons are ejected: from the measured speeds one can calculate the binding energies with which the electrons had been held in their atoms (allowing for determination of which subshells the electrons had occupied).

Suppose that you bombard an aluminum surface with X-rays 850.0 pm in wavelength and measure the speed of some ejected (2*p)* electrons to be 2.17×10^7 m/s.

a. What is the **energy of each X-ray photon**?

Answer: 2.337×10^{-16} J

b. Given the measured speed of the ejected electrons (2.17×10^7 m/s), **with what binding energy** were these 2*p* electrons bound to the Al nuclei (until the instant of ejection)? The mass of an electron is 9.10938×10^{-31} kg.

[**Hint:** Which quantity in your equation for the photoelectric effect corresponds to the binding energy – the amount of energy holding the electron in the atom?]

Answer: 1.92×10^{-17} J