

HW6 PH312

1. What element has a $K\alpha$ x-ray line of wavelength 0.144 nm?

$$(Z - 1)^2 = \frac{4}{3R\lambda}, \quad Z = 1 + \sqrt{\frac{4}{3R\lambda}}$$

Using the given value for the wavelength,

$$Z = 1 + \sqrt{\frac{4}{3 (1.097 \times 10^7 \text{ m}^{-1}) (0.144 \times 10^{-9} \text{ m})}} = 30$$

to the nearest integer, which is the atomic number of zinc.

2. The effective nuclear charge that acts on the outer electron in the sodium atom is $1.84e$. Use this figure to calculate the ionization energy of sodium.

The ionization energy will be $E = \frac{Z^2}{n^2} E_1$, where E_1 is the ionization energy of hydrogen, 13.6 eV. For the outer electron in the sodium atom, $n = 3$ (a 3s electron)

$$E = \frac{(1.84)^2}{(3)^2} (13.6 \text{ eV}) = 5.12 \text{ eV}.$$

3. Why is the ground state of the hydrogen atom not split into two sublevels by spin orbit coupling?

ANSWER: In the ground state, a hydrogen atom has no orbital angular momentum, and there can be no spin-orbit coupling.