PHY2005 – Atomic Physics – Assignment 2

Solutions to be uploaded to Canvas by **10pm** on **FRIDAY Feb 25th 2022.**

Attempt all questions. Please upload a single pdf file, and make sure the scan is readable. The assignment will be marked out of 20.

Q1 In this question, we consider states of neutral silicon (Z=14) with configuration $1s^2 2s^2 2p^6 3s^2 3p4p$. Make use of the fact that filled sub-shells make no net contribution to any of the angular momentum quantum numbers *L*, *S* or *J.*

(a) Apply the rules for addition of angular momentum to find all the terms for this configuration. List all the terms using spectroscopic notation.

(b) How many distinct quantum states does this configuration have in which $J = 0$?

(c) How many distinct quantum states does this configuration have in which $M_J = -1$?

(d) The ground configuration of the silicon atom, $1s^2 2s^2 2p^6 3s^2 3p^2$, is observed to have only three *L*-*S* terms. Without detailed calculation, explain qualitatively why this is different from the number of *L*-*S* combinations you found in part **(a)**.

[10 marks]

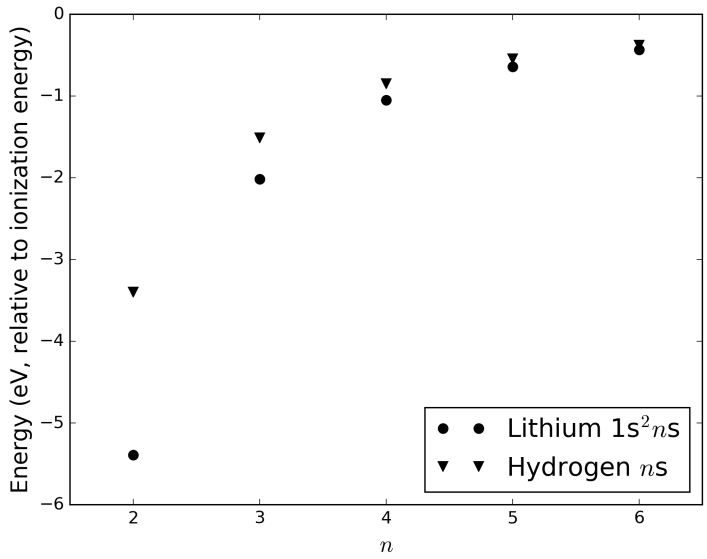
Q2 Potassium has atomic number Z = 19.

(a) Give the *electron configuration* and *spectroscopic term* for the ground state of neutral potassium.

(b) The potassium ground state lies at energy −4.34 eV relative to first ionization. Estimate the effective nuclear charge, Z_{n}, for the 4s electron.

[6 marks]

Q3 The figure below shows the energies, measured relative to first ionization, of $1s^2\,n$s states of lithium and ns states of hydrogen for $n = 2$ to 6. Without detailed calculation, *approximately* indicate on a copy of the figure where the energies for $1s^2\,n$d states of lithium would lie for this range of n.



[4 marks]

[**Important Note**: In Q2 and Q3 we use the common convention of measuring energies "relative to first ionization". I.e. the energy values indicate how much energy is needed to remove the outermost electron.]