

3.091 OCW Scholar

Self-Assessment
Structure of the Atom

Supplemental Exam Problems for Study

Problem #1

Tantalum metal is produced by the reaction of potassium heptafluorotantalate (K_2TaF_7) with elemental sodium (Na) in a reactor heated to $850^\circ C$. The by-products are potassium fluoride (KF) and sodium fluoride (NaF).

(a) Write the balanced equation for the reaction.

(b) A reactor is charged with 222 kg of K_2TaF_7 and 6.66 kg of Na, and the reaction is allowed to go to completion. Calculate how much tantalum is produced. Express your answer in kg.

Problem #2

(a) Name the element with these ground-state electron configurations:

(i) a neutral atom with $[\text{Kr}]4d^{10}5s^25p^1$

(ii) an atom with *net charge* $2-$ and $[\text{Ne}]3s^23p^6$

(b) Write the quantum numbers (n, l, m, s) of each of the 5d and 6s electrons in rhenium (Re).

(c) For each of the following pairs, (1) Identify the larger atom or ion and (2) state one reason for your choice

(i) Rb and Rb^+

(ii) Rb^+ and Kr

(d) Making the reference to the underlying physical principle, describe how a beam of mercury atoms (Hg) would behave in the Stern-Gerlach experiment (passage of a beam of atoms through a divergent magnetic field).

Problem #3

Determine whether a beam of α -particles with a de Broglie wavelength of 3.091×10^{-12} m is capable of ionizing argon (Ar) gas. α -particles are doubly ionized helium atoms (He^{2+}).

Problem #4

- In box notation (arrows for electrons and boxes for orbitals), give the ground-state electron configuration of thallium (Tl).
- Specify the values of the 4 quantum numbers for the outermost electron in thallium.
- Are thallium atoms paramagnetic? If so, why? If not, why not?
- The ionic forms of thallium are Tl^+ and Tl^{3+} . Explain with reference to the relevant electron configurations.

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