

PSEUDO-HYDROGEN ATOM / ONE-ELECTRON  
SYSTEM CATION (HYDROGEN-LIKE ATOM)

**Problem-solving Example 18**

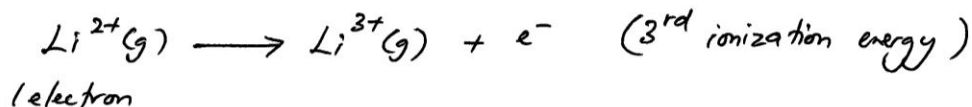
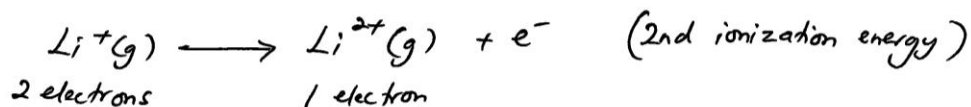
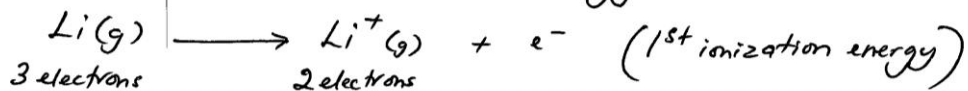
*For lithium atom ( $Z = 3$ ), which ionization energy can be determined using Bohr formula or Bohr Theory? Calculate the energy in  $\text{kJ mol}^{-1}$ .*

***Solution***



## Solution :

For Li atom, there are three ionization energy :



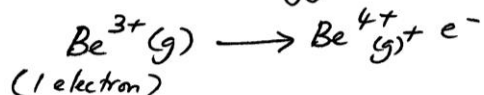
$\text{Li}^{2+}$  ion is hydrogen-like atom (pseudo-hydrogen atom) has a single electron. So the third ionization energy for Li atom can be calculated using Bohr formula.

$$\begin{aligned} \Delta E_{IE} &= (2.178 \times 10^{-18} \text{ J}) Z^2 \left[ \frac{1}{12} - \frac{1}{\infty^2} \right] \\ &= (2.178 \times 10^{-18} \text{ J}) (3^2) \\ \Delta E_{IE} &= 1.96 \times 10^{-17} \text{ J atom}^{-1} \\ &= (1.96 \times 10^{-17}) (6.022 \times 10^{23}) = 1.18 \times 10^7 \text{ J mol}^{-1} \\ &= 1.18 \times 10^4 \text{ kJ mol}^{-1} \end{aligned}$$

Note:

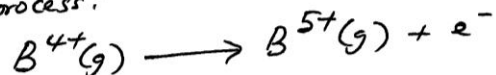
For any hydrogen-like atom which has a single electron, the following can be determined using Bohr formula:

a) Fourth ionization energy for Be atom ( $Z=4$ ) for the process:



b) Fifth ionization energy for B atom ( $Z=5$ )

for the process:



c) Sixth ionization energy for C atom ( $Z=6$ )

for the process:

