

# Chem!stry

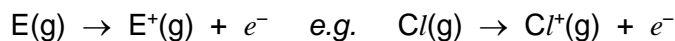
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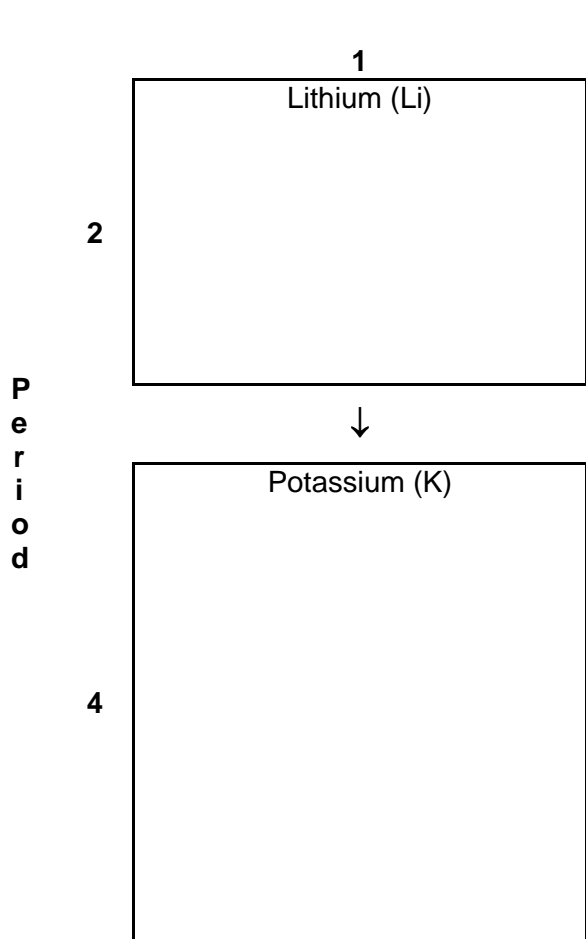
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## First Ionization Energy

First ionization energy is defined as *the energy required to convert 1 mole ( $6 \times 10^{23}$ ) of gaseous atoms into one mole of unipositive gaseous ions*. It can be represented by the following general equation where E represents the symbol of any chemical element and  $e^-$  is the symbol used to represent an electron:



In more simplistic terms, first ionization energy is a measure of how easily a single valence electron can be removed from an atom of a particular element.



### Question 1:

- a) In the spaces provided, give the electron configurations and nuclear charges for lithium, potassium and fluorine.
- b) Identify factors that will affect the electrostatic force of attraction between an electron in the valence shell and the protons in the nucleus of the atom.
- c) By comparing the atomic structures of lithium and fluorine, state how you would expect the value of 1<sup>st</sup> ionization energy to change *across a Period*. Support your answer using sound scientific reasoning.
- d) By comparing the atomic structures of lithium and potassium, state how you would expect the value of 1<sup>st</sup> ionization energy to change *down a Group*. Support your answer using sound scientific reasoning.

Space to answer **Question 1 b)**:

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Space to answer **Question 1 c)**:

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Space to answer **Question 1 d)**:

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**Question 2:**

**a)** Explain how the radius of an atom (*atomic radius*) changes *across a Period*:

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**b)** Explain how the radius of an atom (*atomic radius*) changes *down a Group*:

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**Question 3:**

Compare the radius of a potassium *atom* with the radius of a potassium *ion*. Which one is larger?

Explain your answer:

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**Question 4:**

What do you think is meant by the term *first electron affinity*? Write a general balanced chemical equation to describe *first electron affinity*.

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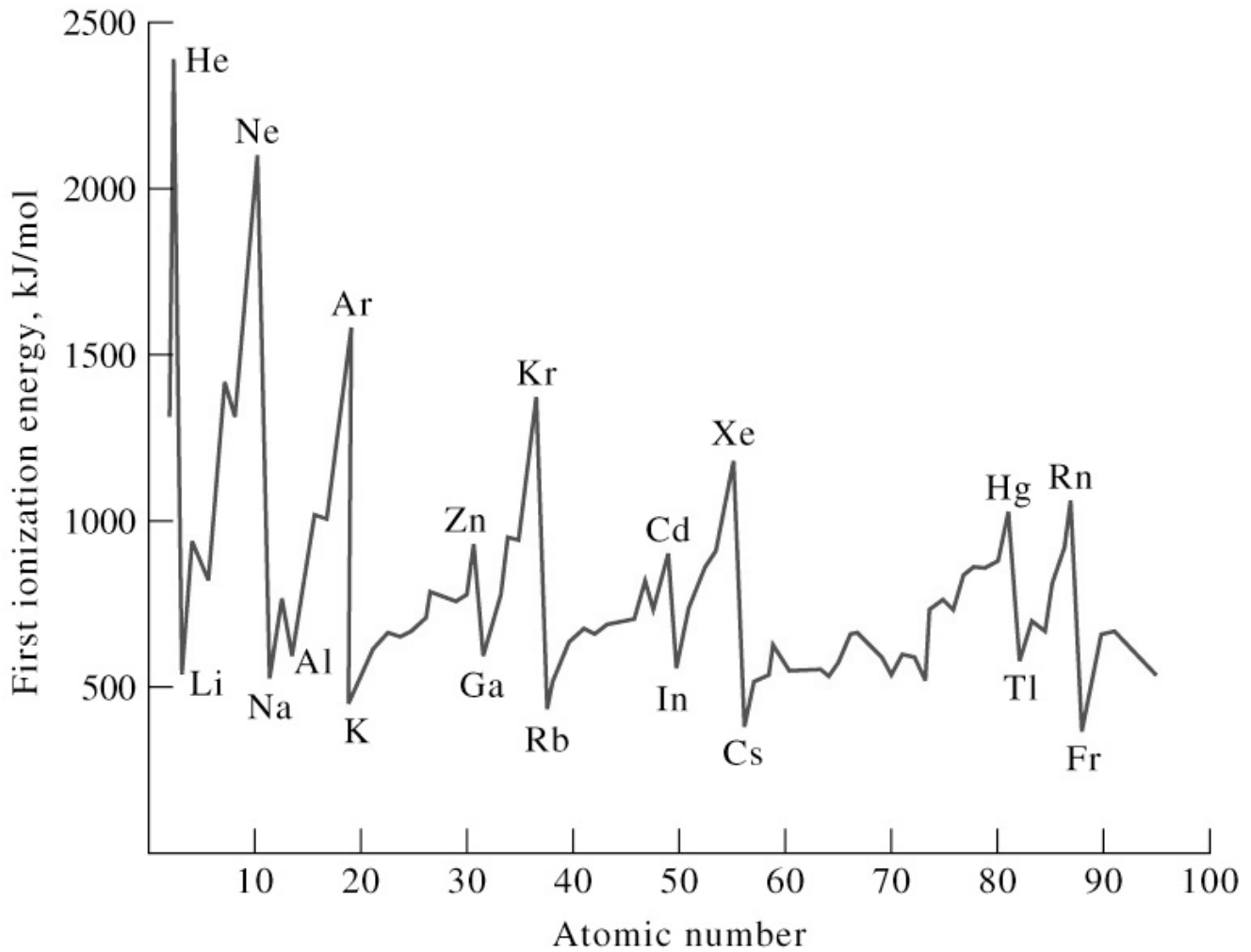
**Question 5:**

Compare the radius of a fluorine *atom* with the radius of a fluoride *ion*. Which one is larger? Explain your answer:

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### Reference Materials

- Graph showing trends and patterns in first ionization energy for the chemical elements, hydrogen to thorium:



- Coulomb's Law* states that the force of attraction (**F**) between two particles of charge **Q<sub>1</sub>** and **Q<sub>2</sub>** separated by a distance **r** is given by the equation:

$$F = \frac{1}{4 \times \pi \times \epsilon_0} \times \frac{Q_1 \times Q_2}{r^2}$$

where  $\epsilon_0$  = the relative permittivity of free space =  $8.854 \times 10^{-12} \text{ F m}^{-1}$ .

Periodic Table showing trends and patterns in atomic and ionic radii. Measurements are given in picometres, pm, where  $1 \text{ pm} = 1 \times 10^{-12} \text{ m}$ .

<b>Li</b> 152	<b>Be</b> 111	<b>B</b> 88	<b>C</b> 77	<b>N</b> 75	<b>O</b> 73	<b>F</b> 71
<b>Li<sup>+</sup></b> 59	<b>Be<sup>2+</sup></b> 27	<b>Al</b> 143	<b>Si</b> 117	<b>P</b> 110	<b>S</b> 104	<b>Cl</b> 99
<b>Na</b> 186	<b>Mg</b> 160	<b>Al<sup>3+</sup></b> 53		<b>P<sup>3-</sup></b> 212	<b>S<sup>2-</sup></b> 184	<b>Cl<sup>-</sup></b> 181
<b>Na<sup>+</sup></b> 99	<b>Mg<sup>2+</sup></b> 72		<b>Ge</b> 122	<b>As</b> 121	<b>Se</b> 117	<b>Br</b> 114
<b>K</b> 227	<b>Ca</b> 197	<b>Ga</b> 122	<b>Ga<sup>3+</sup></b> 62		<b>Se<sup>2-</sup></b> 198	<b>Br<sup>-</sup></b> 196
<b>K<sup>+</sup></b> 138	<b>Ca<sup>2+</sup></b> 100	<b>Zn</b> 133	<b>Zn<sup>2+</sup></b> 75	<b>Cu</b> 128	<b>Cu<sup>+</sup></b> 96	<b>I</b> 133
		<b>Co</b> 125	<b>Co<sup>2+</sup></b> 75	<b>Ni</b> 125	<b>Ni<sup>2+</sup></b> 70	<b>Te</b> 137
		<b>Fe</b> 124	<b>Fe<sup>2+</sup></b> 77	<b>Co<sup>3+</sup></b> 61	<b>Co<sup>2+</sup></b> 73	<b>Te<sup>2-</sup></b> 221
		<b>Mn</b> 124	<b>Mn<sup>2+</sup></b> 83	<b>Ag</b> 144	<b>Ag<sup>+</sup></b> 115	<b>I<sup>-</sup></b> 220
		<b>Cr</b> 125	<b>Cr<sup>2+</sup></b> 82	<b>Cd</b> 149	<b>Cd<sup>2+</sup></b> 95	
		<b>V</b> 132	<b>V<sup>2+</sup></b> 79	<b>In</b> 163	<b>In<sup>3+</sup></b> 79	
		<b>Ti</b> 145	<b>Ti<sup>2+</sup></b> 86	<b>Sn</b> 141	<b>Sn<sup>2+</sup></b> 93	
		<b>Sc</b> 161	<b>Sc<sup>3+</sup></b> 75	<b>Sb</b> 140	<b>Sb<sup>3+</sup></b> 76	
		<b>Rb</b> 248	<b>Rb<sup>+</sup></b> 149			

- Scan the QR code given below to view the answers to this assignment.



[http://www.chemist.sg/chemical\\_bonding/notes\\_atomic\\_structure/first\\_ionisation\\_energy\\_ans.pdf](http://www.chemist.sg/chemical_bonding/notes_atomic_structure/first_ionisation_energy_ans.pdf)