

(e) IONIZATION ENERGY

Key

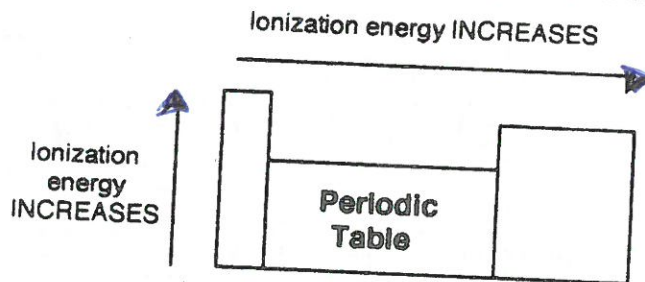
In order to form a positive ion, an electron must be removed from a neutral atom.



Definition: IONIZATION ENERGY is the energy required to remove an electron from a neutral atom. (The electron removed is the outermost and therefore most easily removed electron and is always a valence electron unless the atom has a closed shell.)

EXERCISES:

48. (a) What happens to the distance between the nucleus and outermost electrons going down a chemical family? *DISTANCE INCREASES.*
(b) What happens to the electrostatic attraction of the nucleus to an electron in the outermost shell going down a family? *ATTRACTION DECREASES.*
(c) What happens to the ionization energy going down a family? *IT DECREASES.*
49. (a) What happens to the distance between the nucleus and the outermost electrons going left to right across a period? *(hint: see exercise 44) DISTANCE DECREASES*
(b) What happens to the nuclear charge going across the period? *IT INCREASES*
(c) What happens to the electrostatic attraction of the nucleus to an electron in the outermost shell going across a period? *IT INCREASES.*
(d) What happens to the ionization energy going across the period? *IT INCREASES.*
50. Place arrowheads in the correct direction on the horizontal and vertical lines below.



51. Which member of each of the following pairs should have a greater ionization energy?

- (a) Br or Cl (b) Al or Cl (c) Ne or Xe (d) Mg or Ba (e) F or Ne (f) Rb or I

53. Consider two atoms: O and Te.

- (a) Which atom has a larger atomic radius? *Te*
(b) Which atom has the larger ionization energy? *O*
(c) Which atom has more shells? *(orbitals) Te*
(d) How many valence electrons does Te have? *6*
(e) What is the valence of Te? *omit*
(f) Which atom has a greater electrostatic attraction between its nucleus and outermost electrons: O or Te? *O*

55. Consider two atoms: Ga and Br.

- (a) Which atom has a larger atomic radius? *Ga*
(b) Which atom has the larger ionization energy? *Br*
(c) Which atom has more shells? *same*
(d) How many valence electrons does each atom have? *Ga = 3, Br = 7*
(e) What is the valence of each atom? *omit*
(f) Which atom has a greater electrostatic attraction between its nucleus and outermost electrons? *Br*

Summary
Quiz 2

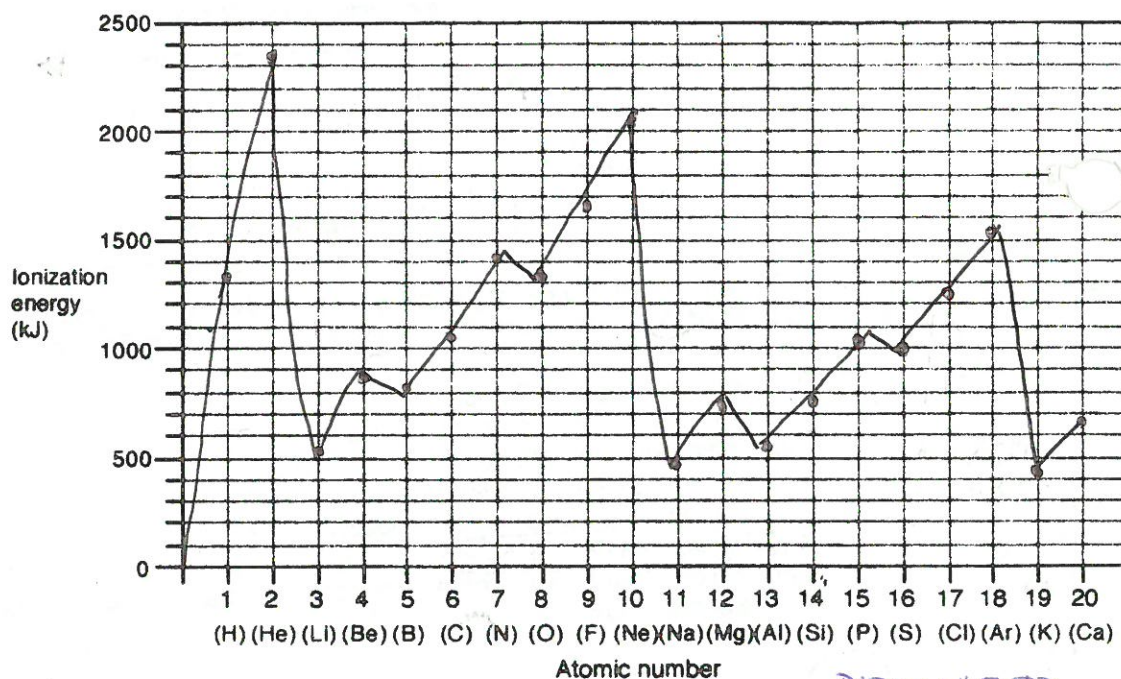
AN EXTENSION TO "IONIZATION ENERGY"

The ionization energies (IE) of the first 20 elements are given in the table below.

Atom	Atomic #	IE (kJ)	Atom	Atomic #	IE (kJ)	Atom	Atomic #	IE (kJ)
H	1	1312	O	8	1314	P	15	1012
He	2	2372	F	9	1681	S	16	1000
Li	3	520	Ne	10	2081	Cl	17	1251
Be	4	899	Na	11	496	Ar	18	1521
B	5	801	Mg	12	738	K	19	419
C	6	1086	Al	13	578	Ca	20	590
N	7	1402	Si	14	787			

EXERCISE:

52. Plot the ionization energy versus atomic number on the following graph and connect each point to the next with a straight line. Then answer the following questions.



- Why are the ionization energies for He, Ne and Ar so high?
- Why do the ionization energies decrease going from He to Ne to Ar?
- Why is there a general increase in ionization energy going from Li to Ne?
- "Filled subshells and half-filled subshells have a special stability which requires extra energy to be applied before electron removal can occur". This general statement is supported by the existence of the electron configuration exceptions found for Cu and Cr. What experimental evidence exists in the graph "ionization energy versus atomic number" to support this general statement?

DIFFICULT TO REMOVE FROM FULL (P6)

E are further from nucleus
∴ easier to REMOVE!

Omit

Be + Mg have ~~high~~ filled s-subshells
∴ they have HIGHER energies than Na + Li (respectively)

↑ FORCE OF ATTRACTION