

## Activity 5: Ions and the Periodic Table

### Why?

- ★ Ions, like atoms, may also be identified by the numbers of protons, neutrons and electrons they contain.
- ★ Ions are particularly important in the formation of “ionic compounds”.
- ★ By understanding the types of ions formed by the elements, it is possible to predict the correct chemical formulas of ionic compounds.

### Learning Objectives

- ✓ Be able to identify an element as a metal, nonmetal, or semimetal based on its position in the periodic table
- ✓ Predict the type of ion an element will form
- ✓ Identify the numbers of protons, neutrons, and electrons in an ion

### Concepts and vocabulary

- Anion
- Cation
- Metal, nonmetal, semimetal

1 H 1.00	← IA																2 He 4.00																		
3 Li 6.94	4 Be 9.01	Alkali Metals										Alkaline Earth Metals					Transition Metals	Other Metals	Non-Metals	Halogens	Inert Gases	VIII A →													
11 Na 22.9	12 Mg 24.3	Columns = Groups I – VIII = Number of e- in Outer Shell																13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.4	18 Ar 39.9												
Rows = Periods 1-7 = Outer Shell Number																		19 K 39.1	20 Ca 40.1	21 Sc 44.9	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.6	29 Cu 63.5	30 Zn 65.3	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Ru 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 96.0	43 Tc 98	44 Ru 101	45 Rh 102	46 Pd 106	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	54 Xe 131																		
55 Cs 132	56 Ba 137	57 La 139	72 Hf 178	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 200	81 Tl 204	82 Pb 207	83 Bi 210	84 Po 209	85 At 210	86 Rn 222																		
87 Fr 223	88 Ra 226	89 Ac 227	104 Rf 267	105 Db 268	106 Sg 271	107 Bh 272	108 Hs 270	109 Mt 276	110 Ds 281	111 Rg 280																									
Lanthanide			58 Ce 140	59 Pr 141	60 Nd 144	61 Pm 145	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 162	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175																			
Actinide			90 Th 232	91 Pa 231	92 U 238	93 Np 237	94 Pu 244	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 258	102 No 259	103 Lr 262																			

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## Part 1. Introduction to the periodic table

Please use the periodic table on the first sheet, or in your chemistry book to answer these questions.

1. In some periodic tables, the atomic symbols are represented a little differently than in the exercise we have just completed. For example, your text represents sodium as:

11  
Na  
22.989770

Which number is the atomic number (Z)? The atomic mass?

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2. Using your periodic table, how can you be certain that you always pick the "right" number for the atomic number? Come up with a rule to help you distinguish which of the two numbers with the symbols of the elements is the atomic number.

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3. Neutrons don't exist as fractions, yet for sodium, the difference between the atomic mass and the atomic number is 11.989770. Why do you think the atomic mass is NOT a whole number in the periodic table, and how can you calculate the number of neutrons in an element from these decimal atomic weights? (We'll learn how these weights are determined shortly.)

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**KEEP GOING!**

4. What do the colors in the periodic table tell you about the elements?

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5. Which type of element is most abundant: metals, nonmetals, or semimetals (metalloids)?

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6. What are characteristics that you associate with metals? (Just write down what you know from life experience.)

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7. As well as colors, there are other classifications for the elements in the periodic table. What are they?

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**YOU'RE NOT DONE YET... THERE IS MORE CHEMISTRY FUN TO COME...**

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## Part 2. Ions

Model: Ions of several elements, P = protons, N = neutrons,  $e^-$  = electrons

The diagrams below show atoms and ions formed by several elements.

Cations

Atom	Configuration	Corresponding Ion	Configuration
Na	11P, 12N, 11 $e^-$	Na <sup>+</sup>	11P, 12N, 10 $e^-$
K	19P, 20N, 19 $e^-$	K <sup>+</sup>	19P, 20N, 18 $e^-$
Ca	20P, 20N, 20 $e^-$	Ca <sup>+2</sup>	20P, 20N, 18 $e^-$
Mg	12P, 12N, 12 $e^-$	Mg <sup>+2</sup>	12P, 12N, 10 $e^-$
Al	13P, 14N, 13 $e^-$	Al <sup>+3</sup>	13P, 14N, 10 $e^-$
Fe	26P, 30N, 26 $e^-$	Fe <sup>+2</sup>	26P, 30N, 24 $e^-$
		Fe <sup>+3</sup>	26P, 30N, 23 $e^-$
Cr	24P, 28N, 24 $e^-$	Cr <sup>+3</sup>	24P, 28N, 21 $e^-$
		Cr <sup>+6</sup>	24P, 28N, 18 $e^-$
Mn	25P, 30N, 25 $e^-$	Mn <sup>+2</sup>	25P, 30N, 23 $e^-$
		Mn <sup>+4</sup>	25P, 30N, 21 $e^-$
		Mn <sup>+7</sup>	25P, 30N, 18 $e^-$

Anions

Atom	Configuration	Corresponding Ion	Configuration
F	9P, 10N, 9 $e^-$	F <sup>-</sup>	9P, 10N, 10 $e^-$
O	8P, 8N, 8 $e^-$	O <sup>-2</sup>	8P, 8N, 10 $e^-$
N	7P, 7N, 7 $e^-$	N <sup>-3</sup>	7P, 7N, 10 $e^-$
Cl	17P, 18N, 17 $e^-$	Cl <sup>-</sup>	17P, 18N, 18 $e^-$
S	16P, 16N, 16 $e^-$	S <sup>-2</sup>	16P, 16N, 18 $e^-$
P	15P, 16N, 15 $e^-$	P <sup>-3</sup>	15P, 16N, 18 $e^-$

**DON'T GIVE UP YET...**

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Key questions:

1. What is the difference between the sodium atom and the sodium ion? The magnesium atom and the magnesium ion? The oxygen atom and the oxygen ion?

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2. How is the charge on the ion determined? Where is the charge written with the elemental symbols?

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3. What type of charge do metal atoms have in their ionic form? What are these ions called?

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4. What type of charge do nonmetals have in their ionic form? What are these ions called?

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**YOU'RE ALMOST THERE...**

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5. What would you predict the charge of Cs will be in its ionic form? What would you predict for the charge on Ba as an ion? What about In? Devise a rule summarizing your predictions.

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6. What would you predict the charge of I will be in its ionic form? What would you predict for the charge on Se as an ion? Devise a rule summarizing your predictions (this is harder than for the metals).

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7. What do you notice about the ions formed by Fe? Cr? Mn? Where are they located in the periodic table? How can you predict what charges ion in this section will form?

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**ONE MORE PAGE TO GO!!**

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8. Complete the following table:

Symbol	Protons	Neutrons	Electrons
${}_{37}^{86}\text{Rb}^{+1}$			
${}_{56}^{137}\text{Ba}^{+2}$			
${}_{34}^{79}\text{Se}^{-2}$			
	53		54
	15		18
	15		15
${}_{27}^{59}\text{Co}^{+2}$			
${}_{47}^{108}\text{Ag}^{+1}$			
	38		36

**THE END!**

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