Chemistry AR+ Activity - Teacher Answer Key

How Many Valence Electrons Does An Element Have and How Do These Elements Form Ions?

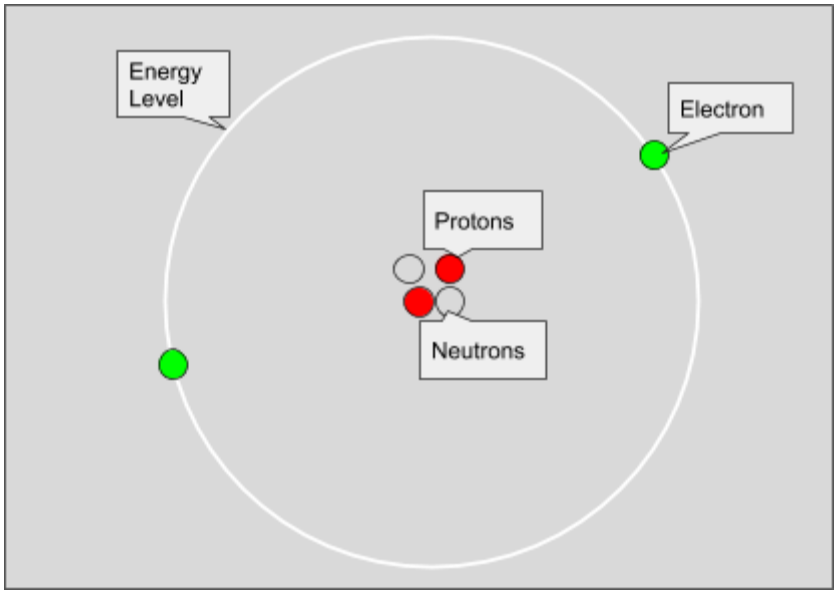
Is this activity you will use the iOS app Chemistry AR+ to learn about atomic structure and why certain elements form positively or negatively charged ions.. You can download the app from iOS App Store at the following link: click here. Or search for Chemistry AR+ if you are using the App Store app on your device. Please note you will need to purchase the $0.99 in-app purchase to access all of the models required for this activity.

Important things to know while using the app and viewing the models of the atom:

Once a model loads in the app, you have the option to walk around and look closer it if you do not touch the screen. If you do touch your device screen you can manipulate the model by moving your fingers and by pinching on unpinching your figures to zoom in or out. If you touch the screen and move the model around you can no longer walk around it.

Please be aware of your surroundings if you use the app in this manner. It is easy to lose track of where you are if you are not careful.

Information On Atomic Models In The App



Periodic Table of the Elements

1 H Hydrogen 1.008																1 H Hydrogen 1.008	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Berylium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.64	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Ytterbium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3	57 La Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)	113 Uut Ununtrium (284)	114 Fl Flerovium (289)	115 Uup Ununpentium (288)	116 Lv Livermorium (293)	117 Uus Ununseptium (294)	118 Uuo Ununoctium (294)

58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

Task

Use the atom view tab once you have started the app to view the atomic models.

- Locate the Hydrogen model in the menu and click on it to view the model, now read on.

Information

The electrons that are in the outermost energy level (green circles in the model) are known as valence electrons.

How many valence electrons does a Hydrogen atom have? Fill this number in the appropriate square that corresponds to the Hydrogen element on the blank periodic table provided. You can use the complete periodic table that is provided with this activity at the end of this document.

1 Valence Electron

Now go back to the main menu and select the Helium atom.

How many valence electrons does Helium have? Fill this number in the appropriate square that corresponds to the Helium element on the blank periodic table provided.

2 Valence Electrons

Now go back to the menu and select the Lithium atom.

How many energy levels does Lithium have?

Lithium Has Two Energy Levels

How many valence electrons does Lithium have? Fill this number in the appropriate square that corresponds to the Helium element on the blank periodic table provided.

1 Valence Electron

Repeat the following process for all of the elements in the second row of the periodic table. Count the number of valence electrons for each element (only the electrons on the outermost energy level) and fill in the count of valence electrons for each element in the correct box for the element based on its position on the periodic table.

Once you have accomplished this, answer the following questions on the following page.

What is the maximum number of electrons that can be held in the first energy level before another energy level must be used to hold more electrons?

The First Energy Level Can Hold A Maximum of 2 Valence Electrons

What is the maximum number of electrons that can be held in the second energy level before the third energy level must be used?

The Second Energy Level Can Hold A Maximum of 8 Valence Electrons

Repeat the following process for all of the elements in the third row of the periodic table. Count the number of valence electrons for each element (only the electrons on the outermost energy level) and fill in the count of valence electrons for each element in the correct box for the element based on its position on the periodic table.

Upon completion of the above task, you should have a table that contains the numbers of valence electrons for each of the first eighteen elements.

Do you notice any trends occuring down each column of the periodic table now that you have counted valence electrons for the first eighteen elements?

For Every Movement Down A Column An Energy Level Is Added

Question: What do you notice about your periodic table? Are there any trends that you can see? Are there any exceptions to these patterns? Explain in your own words what patterns and exceptions exist.

Students should be able to see that in each column of the periodic table of the first three rows that the number of valence electrons is the same in the whole column. Additionally, they should be able to see that there is an exception to the trend in helium and the rest of the last column.

Ion Formation

Information

When an element forms an ion, it either loses and gains electrons. In order to reach stability an element must have either an **empty** valence energy level or a **full** energy level. This is known as the **Octet Rule**.

The number of protons remains the same regardless of how many electrons an atom loses or gains when an elemental atom forms an ion. A proton carries a +1 electrical charge and an electron carries a -1 electrical charge.

As a result, the ion is a positive ion (also known as a CATION) if electrons are lost because there are more protons than electrons. A negative ion (also known as an ANION) is formed when an atom gains electrons, because the resulting ion has more electrons than protons.

Use the models in the app if you need to in order to answer the following questions.

Count the number of protons in the nucleus of the Lithium atom? Write your answer in the space provided.

3 Protons

Count the total number of electrons in a Lithium atom. Write your answer in the space provided.

3 Electrons

How many valence electrons does Lithium have?

1 Valence Electron

Information: When an atom of an element forms and ion, it will either lose or gain electrons. In general, the process of losing or gaining electrons is governed by the process that causes the least gain or loss of electrons to form a full or empty valence energy level.

Question: Which of the following would you think would be more likely for Lithium to form an ion? (circle your answer)

- **A Lithium atom to lose its valence electron causing an empty valence energy level. (correct answer)**
- A Lithium atom to gain seven electrons to fill the second energy level causing a full valence energy level.

The formula for the Lithium ion is Li^+, because it has lost an electron (a valence electron) the atom is positively charged. This is why we write a + sign as a superscript above and to the right of the letter that symbolizes the element.

Question: Which of the following would you think would be more likely for Magnesium to form an ion? (circle your answer)

- **A Magnesium atom to lose its two valence electrons causing an empty valence energy level. (correct answer)**
- A Magnesium atom to gain six electrons to fill the second energy level causing a full valence energy level.

Write the formula for a Magnesium Ion given that it has lost both of its valence electrons and now has two more protons than electrons:

Mg^{2+}

Question: Which of the following would you think would be more likely for Aluminum to form an ion? (circle your answer)

- **An atom of Aluminum to lose three valence electrons causing an empty valence energy level. (correct answer)**
- An atom of Aluminum to gain five electrons to fill the second energy level causing a full valence energy level.

Write the formula for the Aluminum Ion given that it has lost its three valences electrons and now has three more protons than electrons:

Al^{3+}

Atoms with three or less valence electrons LOSE electrons to form CATIONS.

Question: Which of the following would you think would be more likely for Fluorine to form an ion? (circle your answer)

- A Fluorine atom to lose seven valence electrons causing an empty valence energy level.
- **A Fluorine atom to gain one electron to fill the second energy level causing a full valence energy level. (correct answer)**

Write the formula for the Fluorine Ion given that it has gained an electron and now has one more electron than protons:

F^{-}

Question: Which of the following would you think would be more likely for Oxygen to form an ion? (circle your answer)

- A Oxygen atom to lose six valence electrons causing an empty valence energy level.
- **A Oxygen atom to gain two electrons to fill the second energy level causing a full valence energy level. (correct answer)**

Write the formula for the Oxygen Ion given that it has gained two electrons and now has two more electrons than protons:

O^{2-}

Question: Which of the following would you think would be more likely for Nitrogen to form an ion? (circle your answer)

- A Nitrogen atom to lose five valence electrons causing an empty valence energy level.
- **A Nitrogen atom to gain three electrons to fill the second energy level causing a full valence energy level. (correct answer)**

Write the formula for the Nitrogen Ion given that it has gained three electrons and now has three more electrons than protons:

N^{3-}

Complete This General Statement

Atoms with five or more valence electrons **GAIN** electrons to form **ANIONS**.

Finally, given that elements with a full valence energy level are stable energetically speaking, they do not typically form ions.

Question: Where on the table are there elements with completely full energy levels? (Hint: these are elements with 2 electrons in the first energy level and 8 electrons in the second and third energy levels).

Elements will full valence energy levels are located on the farthest right column on the periodic table.

Activity Extension

- Use the blank periodic table provided to write out the formula for the ions for each of the elements in the first three rows of the table. Once complete, write a paragraph discussing any patterns or interesting things you observe.

  Students should become aware that the charges of the ions formed from elements on the periodic table are the same in the same column.

Answer Key Number Of Valence Electrons In Each Element in the App.

1																	2
1	2											3	4	5	6	7	8
1	2											3	5	5	6	7	8

Answer Key The Formulas Of All Ions For The First Eighteen Elements

H^+																	He
Li^+	Be^{2+}											B^{3+}	C^{4-}	N^{3-}	O^{2-}	F^-	Ne
Na^+	Mg^{2+}											Al^{3+}	Si^{4+}	P^{3-}	S^{2-}	Cl^-	Ar

Note: No discussion of any kind is included in the activity for the ions of Carbon and Silicon and why Carbon gains electrons and Silicon loses electrons.
