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Electron Shells with the Valence card game

A 50-minute lesson on electron shells, electron arrangement and ions for Years 9–10 (Grades 9–10)

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Free · iPhone and Android
valence-2b95b.web.app/get

Valence is a free chemistry card game: every card is an element, and students combine cards into real compounds to fight. In **Act 4**, the Lightning Power Plant, each atom enemy shows its **outer-shell electrons** as a gauge that students empty (metals) or fill to eight (non-metals).

Learning goals

1. Draw shell diagrams and write electron arrangements (such as 2,8,1) for the first 20 elements.
2. Link the number of outer-shell electrons to an element's group, and the number of shells to its period.
3. Explain why metals lose electrons (positive ions) and non-metals gain them (negative ions), and predict the charge.
4. Explain two ways the game is simpler than real chemistry.

HOW THE ELECTRON GAUGE WORKS IN ACT 4

- **Metal atoms** (Li, Mg, Al, Ca) lose one outer electron each time they are hit with an **oxidising agent** such as F_2, O_2, Cl_2 or H_2O_2, or a thrown F or Cl card. At 0 the atom becomes a positive ion.
- **Non-metal atoms** (F, O, N) gain one electron each time they are hit with a **reducing agent** such as H_2, LiH, NaH or CH_4, or a thrown metal card such as Li, Na or K. At 8 the atom becomes a negative ion.
- As an ion, the enemy skips a turn, loses its armour, takes 25% more damage and deals 30% less.
- The F, O and N atoms take half damage from oxidising agents. The boss has no resistance.
- The boss, the Lightning Atom Giant, starts as an Al atom. At half health lightning turns it into an N atom with a new gauge, more armour and strength.



Five Act 4 enemies and, on the right, the boss, as drawn in the game.

Curriculum links

- **Australia**: Year 10 atomic structure and the organisation of the periodic table, AC9S10U06
- **New Zealand**: Year 10 Science (Phase 4), electrons in shells; leads to NCEA Level 2 Chemistry 91164 (bonding)
- **Ontario**: Grade 9 Science SNC1W, C2.3 and C2.4 (Bohr–Rutherford diagrams; the periodic table)
- **British Columbia**: Science 9, "the electron arrangement of atoms impacts their chemical nature"; the periodic table

Enemy names and Canada use "aluminum"; Australia and New Zealand, "aluminium". Ontario says Bohr–Rutherford diagrams. Not endorsed by any education authority.

Before class

- Install Valence: free, no ads, no account, works offline.
- **Act 4 comes after Acts 1 to 3**, so few students reach it in one lesson. Parts A, B and D need no game; Part C uses the enemies on page 3.
- The worksheet uses the 2,8,8 shell model for the first 20 elements. Subshells (s, p, d) are not needed.
- Optional demo: flame tests with lithium, sodium and calcium salts (for D3).
- If asked: in the game H_2 and CH_4 "give electrons" to F, O and N. Really they share electrons (HF, H_2O). F^- and O^{2-} form mainly with metals (LiF, MgO).
- Print pages 2 and 3 for each student. Page 4 is the answer key.

Lesson plan

5 min	Hook. "Sodium fizzes and races across water. Neon does nothing at all. What is different inside the atoms?"
12 min	Part A: the shell rules (2, then 8, then 8). Draw four shell diagrams and write arrangements.
13 min	Part B: outer electrons, groups and periods; predict which atoms lose or gain electrons and the ion charge.
10 min	Part C: match each Act 4 enemy to its arrangement, ion and a card that works.
10 min	Discuss D1 and D2 (D3 is an extension), then the exit ticket at the bottom of page 3.

STUDENT WORKSHEET

Electron Shells

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Name _____ Class _____ Date _____

Shell
A layer around the nucleus that holds electrons. Inner shells fill first.

Electron arrangement
How many electrons are in each shell, inside first. Sodium: 2,8,1.

Outer-shell electrons
The electrons in the outermost shell (also called valence electrons).

Ion
An atom that has lost electrons (+ charge) or gained electrons (− charge).

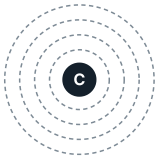
A Filling the shells



The rules (first 20 elements). Electrons = atomic number. Fill from the inside out: **1st shell up to 2**, **2nd up to 8**, **3rd up to 8**, then the 4th.

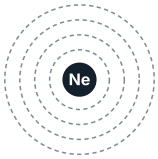
Example. Sodium, 11 electrons: 2 + 8 + 1, so **2,8,1** with **1** outer-shell electron.

A1. Draw the electrons as dots on the rings. Use only as many rings as you need. Then write the arrangement.



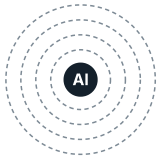
Carbon · 6 electrons

Arrangement: _____



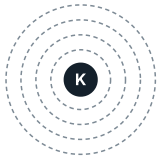
Neon · 10 electrons

Arrangement: _____



Aluminium · 13 electrons

Arrangement: _____



Potassium · 19 electrons

Arrangement: _____

A2. Write the electron arrangement of each atom.

ATOM	Be (4)	O (8)	P (15)	Ar (18)	Ca (20)
Arrangement					

A3. An atom has the arrangement **2,8,6**. What is its atomic number, and which element is it?

B Outer electrons, groups and ions

GROUP	1	2	13	14	15	16	17	18
Period 1	H 1							He 2
2	Li 3	Be 4	B 5	C 6	N 7	O 8	F 9	Ne 10
3	Na 11	Mg 12	Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
4	K 19	Ca 20						

B1. Use your answers to Part A. Elements in the same **group** (column) have the same number of _____. Elements in the same **period** (row) have the same number of _____.

A full outer shell (like group 18) is stable. Metals **lose** outer electrons; non-metals **gain** them until the outer shell has 8.

B2. Complete the table. The first row is done for you.

ATOM	ARRANGEMENT	OUTER ELECTRONS	LOSE OR GAIN?	HOW MANY?	ION FORMED	ION ARRANGEMENT
Na	2,8,1	1	lose	1	Na^+	2,8
Mg						
Cl						
S						
Ar						

B3. Look at the last column. Na^+ has the same arrangement as which noble gas? Why does argon not form an ion?

Electron Shells

C The Lightning Power Plant (Act 4)

Each atom enemy has a gauge of its **outer-shell electrons**. Oxidising agents **take** electrons; reducing agents **give** them.

C1. Fill in the table. Take, e.g.: F_2 O_2 Cl_2 H_2O_2 Give, e.g.: H_2 LiH NaH CH_4

ENEMY	ARRANGEMENT	LOSE OR GAIN? HOW MANY?	ION FORMED	TAKE OR GIVE?	ONE CARD THAT WORKS
 Lithium Ember `Li`					
 Magnesium Flash `Mg`					
 Aluminum Wire Snake `Al`					
 Fluorine Atom Wraith `F`					
 Oxygen Atom Radical `O`					
 Nitrogen Atom Storm `N`					

C2. The boss starts as an aluminium atom and turns into a nitrogen atom at half health. What changes about the electrons, and which cards should you switch to?

C3. F_2 does only half damage to the Fluorine Atom Wraith. Use the word "electron" to explain why.

D Where the game simplifies



D1. In the game, each hit takes **one** electron from Mg.
When magnesium burns ($2Mg + O_2 \rightarrow 2MgO$), what happens to both outer electrons, and where do they go?



D2. The game says 8 outer electrons (or 0) is stable.
Li^+ has only 2 electrons. Which noble gas has the same arrangement, and why is 2 a full shell?



D3. *Extension.* Flames: Li red, Na yellow, Ca orange-red.
The game says heated electrons "jump up to an outer shell" and fall back. Where does the light come from, and why does each element have its own colour?



EXIT TICKET

Calcium is 2,8,8,2. Will a calcium atom lose or gain electrons, how many, and what is the charge on its ion? Explain using the words "outer shell".

Electron Shells

A Filling the shells

A1. Carbon `2,4` (2 rings). Neon `2,8` (2 rings, both full). Aluminium `2,8,3` (3 rings). Potassium `2,8,8,1` (all 4 rings). Accept electrons drawn in pairs or spread evenly; the count on each ring is what matters. Watch for `2,8,9` for potassium: in this model the 3rd shell takes 8 before the 4th starts.

ATOM	Be (4)	O (8)	P (15)	Ar (18)	Ca (20)
A2. Arrangement	`2,2`	`2,6`	`2,8,5`	`2,8,8`	`2,8,8,2`

A3. 2 + 8 + 6 = 16 electrons, so atomic number 16: sulfur (S). Also accept "sulphur" with the correct number.

B Outer electrons, groups and ions

B1. Same group: the same number of **outer-shell electrons** (group 1 has 1, group 2 has 2, groups 13 to 17 have 3 to 7, group 18 has a full shell). Same period: the same number of **shells** (period 3 atoms use 3 shells). Accept "valence electrons" and "energy levels".

ATOM	ARRANGEMENT	OUTER e^-	LOSE OR GAIN?	HOW MANY?	ION	ION ARRANGEMENT
`Mg`	`2,8,2`	`2`	lose	`2`	`Mg²⁺`	`2,8`
`Cl`	`2,8,7`	`7`	gain	`1`	`Cl⁻`	`2,8,8`
`S`	`2,8,6`	`6`	gain	`2`	`S²⁻`	`2,8,8`
`Ar`	`2,8,8`	`8`	neither	`0`	none	`— (stays 2,8,8)`

Watch for "Cl^- has a + charge because it gained": gaining negative electrons makes the charge negative.

B3. Na^+ (2,8) matches neon. Argon already has a full outer shell of 8, so it has no reason to lose or gain electrons and does not form an ion. Accept "it is a noble gas" only with the full-shell reason.

C The Lightning Power Plant (Act 4)

C1. Lithium Ember: `2,1`, lose 1, Li^+, take. Magnesium Flash: `2,8,2`, lose 2, Mg^{2+}, take. Aluminum Wire Snake: `2,8,3`, lose 3, Al^{3+}, take. Fluorine Atom Wraith: `2,7`, gain 1, F^-, give. Oxygen Atom Radical: `2,6`, gain 2, O^{2-}, give. Nitrogen Atom Storm: `2,5`, gain 3, N^{3-}, give. Cards: F_2, O_2, Cl_2 or H_2O_2 (or a thrown F or Cl) to take electrons; H_2, LiH, NaH or CH_4 (or a thrown Li, Na or K) to give them. Accept any other card the game marks as an oxidising or reducing agent. The number of attacks the game asks for equals "how many" in each row.

C2. Aluminium (2,8,3) must **lose** 3 electrons to become Al^{3+}; nitrogen (2,5) must **gain** 3 to become N^{3-}. The direction flips, so switch from oxidising agents (F_2, O_2, Cl_2, H_2O_2) to reducing agents (H_2, LiH, NaH, CH_4).

C3. Fluorine has 7 outer electrons and needs to **gain** one to reach 8. An oxidising agent takes electrons away, the opposite of what it needs. Fluorine is itself the strongest oxidising agent: it pulls electrons harder than anything else.

D Where the game simplifies

D1. Both outer electrons leave in the same reaction, not one per step. They move to oxygen atoms: each Mg becomes Mg^{2+} (2,8) and each O becomes O^{2-} (2,8), held together as magnesium oxide. Accept "they are transferred to oxygen" or "magnesium oxide forms from ions".

D2. Helium (2). The 1st shell can hold only 2 electrons, so 2 is full. When lithium loses its 1 outer electron, the full 1st shell becomes the outer shell. "0 outer electrons" in the game means the old outer shell is empty.

D3. Heat gives electrons energy so they jump to a higher shell. When they fall back they give that energy out as light. The gaps between shells are different in each element, so each gives out its own colour. This is how fireworks get their colours.

Exit ticket. Lose 2 electrons (its 2 outer-shell electrons), leaving a full outer shell of 8 (2,8,8). It becomes Ca^{2+}, charge 2+, because it now has 2 more protons than electrons. Watch for "gains 6": far harder than losing 2.