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The Periodic Table with the Valence card game

A 50-minute lesson on groups, periods and element families for Years 9–10 (Grade 9)

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Valence is a free chemistry card game: every card is an element, and students combine cards into real compounds to fight. In **Act 6**, the Neon Electronics Market, students win by making **group chains**: the same compound again, with one element swapped for another from the same group of the periodic table.

Learning goals

1. Find an element's group and period, and say what each tells you about its electrons.
2. Describe a pattern in the alkali metals, the halogens and the noble gases, and use it to make a prediction.
3. Use a group to predict the formula of an unfamiliar compound.
4. Explain how Mendeleev predicted an undiscovered element, and one way the game is simpler than real chemistry.

Curriculum links

- **Australia**: Year 10, atomic structure and the organisation of the periodic table, AC9S10U06
- **New Zealand**: Year 9 Science (Phase 4 of the refreshed curriculum), patterns in properties within each group of the periodic table
- **Ontario**: Grade 9 Science SNC1W, C2.4 and C2.5 (an element's position and the structure of its atoms; patterns in the periodic table)
- **British Columbia**: Science 9, "element properties as organized in the periodic table"

Descriptions are our paraphrases unless quoted. Not endorsed by any education authority.

HOW THE GROUP CHAIN WORKS IN ACT 6

- The game remembers the last compound made this turn. If the next compound is the same except that an element (or more than one) is **swapped for a different element from the same group**, atom for atom, it is a chain step: HCl → HBr, NaCl → KCl, He → Ne.
- **Hydrogen never counts as a swap**, so HCl → NaCl is not a chain.
- Each chain step in a row adds 25% to the compound's damage and block, up to 3 steps (+75%). A compound that does not fit sets the chain back to zero, and so does a new turn.
- Act 6 enemies have a **chain gauge**: 2 slots (stronger enemies 3, the boss 4). Each chain step fills one slot, and filled slots stay between turns. When it is full the enemy skips a turn, loses its armour, takes 25% more damage and deals 30% less.
- At half health the boss, the Blank Element Ghost, gains armour and attack, and loses 2 filled slots unless its gauge is already full.



Act 6 enemies and, on the right, the boss.

Before class

- Install Valence: free, no ads, no account, works offline.
- **Act 6 comes after Acts 1 to 5**, so few students reach it in one lesson. Parts A, B and D need no game; Part C prints the rule on page 3.
- Students need a full periodic table for D1 (a wall chart is enough).
- Group numbers here are 1 to 18. Older tables call groups 13 to 18 "3 to 8" or "IIIA to VIIIA".
- For B1, show a video of lithium, sodium and potassium in water. Demonstrate alkali metals live only if you are trained and follow your school's risk assessment (rice-grain pieces, safety screen, eye protection).
- Print pages 2 and 3 for each student. Page 4 is the answer key.

Lesson plan

5 min	Hook. "In 1871 Mendeleev described an element nobody had ever seen, and got its mass right. How?"
12 min	Part A: electron arrangements, then what the group and period numbers mean.
10 min	Part B: patterns in three families (video for B1).
13 min	Part C: group chains, on paper or in Act 6 for pairs who have reached it, then predicting formulas.
10 min	Part D: Mendeleev's blank square (D1); discuss D2 aloud. Then the exit ticket on page 3.

STUDENT WORKSHEET

The Periodic Table

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Name _____ Class _____ Date _____

	1	2		13	14	15	16	17	18
Period 1	1 H								2 He
Period 2	3 Li	4 Be		5 B	6 C	7 N	8 O	9 F	10 Ne
Period 3	11 Na	12 Mg		13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
Period 4	19 K	20 Ca	3–12	31 Ga	32	33 As	34 Se	35 Br	36 Kr

Part of the periodic table. The small number is the **atomic number**.

A **group** is a column (numbered at the top). A **period** is a row.

Groups 3 to 12, the transition metals, are left out here. One square is blank: you will fill it in Part D.

A Groups and periods

A1. Write the electron arrangement of each atom, then finish the row. Use the table above for the group and period.

ELEMENT	ELECTRON ARRANGEMENT	OUTER ELECTRONS	SHELLS IN USE	GROUP	PERIOD
Li (3)	*2, 1*	*1*	*2*	*1*	*2*
Na (11)					
K (19)					
Mg (12)					
F (9)					
Cl (17)					
Ne (10)					

A2. Look down your columns. What does an element's **group** tell you about its electrons? What does its **period** tell you?

A3. Bromine (Br) is in group 17 and period 4. Without writing its arrangement: how many outer electrons does it have, and how many shells does it use?

B Three families



B1. Group 1, the **alkali metals**, in water.
Lithium fizzes steadily. Sodium melts into a ball and fizzes fast. Potassium catches fire with a lilac flame. Describe the pattern down the group, and predict what rubidium (below K) does.



B2. Group 17, the **halogens**, at room temperature.
F_2 is a pale yellow gas, Cl_2 a yellow-green gas, Br_2 a red-brown liquid, I_2 a grey-black solid. Describe the pattern, and predict the state and colour of astatine (below I).



B3. Group 18, the **noble gases**.
In the game the Neon Ghost "hardly reacts". Use neon's electron arrangement to explain why noble gases form almost no compounds.

C Group chains (Act 6)



The rule. Make a compound, then make the same compound with an element (or more than one) **swapped for a different element from the same group**, atom for atom. That is one chain step: **HCl → HBr**. Hydrogen never counts as a swap. Each step in a row adds 25% to damage and block (up to +75%) and fills one slot of the enemy's chain gauge. A play that does not fit resets the chain.

C1. Circle the play that makes a chain step. Write which element was swapped for which, and their group.

YOU JUST MADE	CIRCLE THE NEXT PLAY	SWAP	GROUP
HCl	HBr NaCl H_2O	*Cl → Br*	*17*
NaCl	NaOH $MgCl_2$ KCl		
He	H_2 Ne O_2		
MgO	CaO $MgCl_2$ Na_2O		
H_2O	H_2O_2 HF H_2S		
LiF	LiH NaCl HF		

C2. The Neon Ghost has a chain gauge of 2 slots, and you have three plays this turn. Which line fills the gauge, and why? **X: LiCl → NaCl → KCl** or **Y: HCl → NaCl → KCl**

C3. Same group, same pattern. Swap in the new elements and write the formula.

NaCl	$MgCl_2$	H_2O	CH_4	Na_2O
K for Na, Br for Cl	Ca for Mg, Br for Cl	S for O	Si for C	K for Na, S for O

D The blank square, and where the game simplifies

D1. In 1871 Dmitri Mendeleev left a blank below silicon and predicted the missing element from its neighbours in group 14. Do the same: estimate each value as roughly halfway between the element above and the element below.

GROUP 14	ATOMIC MASS	DENSITY (G/CM³)	FORMULA OF OXIDE	FORMULA OF CHLORIDE
Silicon, Si (period 3)	28.1	2.3	SiO_2	$SiCl_4$
? (period 4)				
Tin, Sn (period 5)	118.7	7.3	SnO_2	$SnCl_4$

Found in 1886. Its name (use a full periodic table): _____ Write its symbol in the blank on page 2.

D2. In the game every swap within a group earns the same bonus, as if the elements were the same. Use B1 or B2 to show that elements in a group are similar but **not** identical.



EXIT TICKET

Strontium (Sr) is in group 2, period 5, below calcium. How many outer electrons does it have? Predict the formula of strontium chloride, and say whether strontium is more or less reactive than calcium.

The Periodic Table

A Groups and periods

ELEMENT	ELECTRON ARRANGEMENT	OUTER ELECTRONS	SHELLS IN USE	GROUP	PERIOD
Na	2, 8, 1	1	3	1	3
K	2, 8, 8, 1	1	4	1	4
Mg	2, 8, 2	2	3	2	3
F	2, 7	7	2	17	2
Cl	2, 8, 7	7	3	17	3
Ne	2, 8	8	2	18	2

A2. Group: the number of outer-shell electrons (groups 1 and 2: the group number; groups 13 to 18: the last digit, so group 17 has 7). Period: the number of shells in use. Accept "elements in a group have the same number of outer electrons". Helium is the exception: group 18, but only 2 electrons, because the first shell is full at 2.

A3. 7 outer electrons and 4 shells. (Full arrangement 2, 8, 18, 7 is not expected at this level.)

B Three families

B1. Reactivity increases down group 1. Rubidium reacts more violently than potassium: it catches fire at once or explodes. Accept "faster", "more violent". Best answers add why: the outer electron is further from the nucleus, so it is lost more easily. The game shows the same pattern: K + H_2O hits harder than Na + H_2O (base damage 22 against 15, before the game's bonuses).

B2. Going down, the state changes from gas to liquid to solid (melting and boiling points rise) and the colour gets darker. Astatine: a dark (black) solid. Accept "dark grey". It is so radioactive that no visible sample has ever been made, so this is still a prediction.

B3. Neon is 2, 8: its outer shell is full, so it does not readily gain, lose or share electrons. Accept "stable arrangement". Note for strong students: xenon and krypton do form a few compounds (neon forms none), so "almost no" is the right wording.

C Group chains (Act 6)

C1. NaCl → **KCl** (Na → K, group 1). He → **Ne** (group 18). MgO → **CaO** (Mg → Ca, group 2). H_2O → **H_2S** (O → S, group 16). LiF → **NaCl** (two swaps at once: Li → Na in group 1 and F → Cl in group 17; give credit for either). Why the others fail: NaOH has three elements, not two; $MgCl_2$ after NaCl swaps Na for Mg (group 2) and has 2 Cl; H_2 and O_2 are not in group 18; after MgO, $MgCl_2$ swaps O for Cl and Na_2O swaps Mg for Na, both a different group; H_2O_2 and HF do not keep the same numbers of atoms as H_2O; LiH and HF after LiF would swap an element for hydrogen, which never counts.

C2. Line X, LiCl → NaCl → KCl. Li, Na and K are all in group 1, so both the second and third plays are chain steps (+25%, then +50%): 2 slots, and the gauge is full. In line Y, HCl → NaCl, the swap is hydrogen for sodium, which does not count, so only NaCl → KCl is a step: 1 slot. The first play of a turn can never be a chain step.

C3. **KBr, $CaBr_2$, H_2S, SiH_4, K_2S**. Accept H_4Si for silane and SH_2. Why it works: elements in the same group have the same number of outer electrons, so they form ions with the same charge (or make the same number of bonds), and combine in the same ratio.

D The blank square, and where the game simplifies

D1. Halfway between silicon and tin: atomic mass about 73, density about 4.8; oxide XO_2, chloride XCl_4 (accept ?O_2 or GeO_2, ?Cl_4 or $GeCl_4$). Accept mass 70 to 76 and density 4.5 to 6. The element is **germanium, Ge**: atomic mass 72.6, density 5.3 g/cm³, GeO_2 and $GeCl_4$. Mendeleev called it "eka-silicon" and predicted mass 72 and density 5.5 (he also used the neighbours to its left and right). Clemens Winkler found it in 1886. The boss of Act 6, the Blank Element Ghost, is this empty square.

D2. Any one: potassium reacts with water much more violently than lithium; the halogens change from gas to liquid to solid and get darker; fluorine is far more reactive than iodine. Properties change step by step down a group, so a real chemist cannot simply replace one group member with another. Other examples to share: HF is a weak acid but HCl and HBr are strong; AgF dissolves in water but AgCl and AgBr do not; CO_2 is a gas but SiO_2 is sand.

Also worth discussing. The game never lets hydrogen count as a group 1 swap. Hydrogen has 1 outer electron like the alkali metals, but it is a non-metal gas that usually shares electrons, which is why many tables draw it apart from group 1.

Exit ticket. 2 outer electrons. $SrCl_2$ (like $CaCl_2$ and $MgCl_2$). More reactive than calcium: metals in groups 1 and 2 get more reactive down the group. Accept Sr^{2+} as evidence for the formula.