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Elements, Compounds and Formulas with Valence

A 50-minute lesson on reading chemical formulas for Years 7–8 (Grades 7–8)

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

Valence is a free chemistry card game. Every card is one atom of an element. In **Act 1**, the Polluted City, students fight pollution monsters by building real compounds: to make water they must pick exactly two hydrogen cards and one oxygen card. Apart from a single-card atom throw, the game only accepts a combination when the atoms match a compound in its list.

The game is the hook and the practice; the worksheet does the chemistry.

Learning goals

1. Tell elements, compounds and mixtures apart from formulas and particle diagrams.
2. Read a formula: name the elements and count the atoms of each.
3. Write the formula of a simple compound from the atoms in it.
4. Explain two ways the game is simpler than real chemistry.

HOW COMPOUNDS ARE BUILT IN THE GAME

- Each card is one atom, shown with its symbol. Starting decks are about half **H** and **O** cards. The rest depend on the researcher chosen: C, N, Na and Cl, and for some researchers S, K, Mg, Fe or Al.
- Select cards whose atoms match a formula **exactly**: H + H + O makes H_2O. The order does not matter.
- One atom too many or too few, and the game says "No compound can be made from this combination."
- A single card on its own is an "atom throw": a weak 2-damage attack.
- Each Act 1 enemy shows its own formula, such as C (soot) or $(C_2H_4)_n$.



Six of the nine Act 1 enemies, as drawn in the game. The boss is the Smog Giant.

Curriculum links

- **Australia**: Year 8 AC9S8U06; Year 7 AC9S7U06 (mixtures)
- **New Zealand**: Science Phase 4 (Year 9): elements, compounds, mixtures and reading formulas. An early start for Years 7–8 or revision.
- **Ontario**: Grade 7 C2.8 (and C2.1, particle theory); formulas come in Grade 9 SNC1W C2.7
- **British Columbia**: Science 7, elements and compounds; names and formulas in Science 9

Full tables: valence-2b95b.web.app/teachers. Not endorsed by any education authority.

Before class

- Install Valence: free, no ads, no purchases, no account. Students under 14 play as guests and no data leaves the device. Works offline.
- **Act 1 is where every game starts**, with a short tutorial in the first battle. No homework needed. Parts A, B and D work without the game.
- Print pages 2 and 3 for each student. Page 4 is the answer key.

Lesson plan

`5 min`	Hook. "Water, oxygen, salt, diamond, air: which are made of only one kind of atom?" Keep the answers.
`10 min`	Key words and Part A: element, compound, molecule, mixture. Particle diagrams.
`15 min`	Play Act 1 in pairs; note one compound you made. Then do Part C on paper.
`10 min`	Part B: counting atoms and writing formulas. Revisit the hook answers.
`10 min`	Discuss D1 and D3 (D2 is an extension), then the exit ticket at the bottom of page 3.

STUDENT WORKSHEET

Elements, Compounds and Formulas

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Name _____ Class _____ Date _____

Element
Made of only one kind of atom. Each has a symbol: H, O, Na.

Compound
Two or more different elements chemically joined in a fixed ratio.

Molecule
Two or more atoms joined together. Can be an element (O_2) or a compound (H_2O).

Mixture
Two or more substances mixed but not chemically joined.

A Element or compound?

All of these can be made in Valence. Fill in the table.

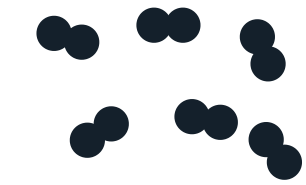
FORMULA	NAME	SYMBOLS OF THE ELEMENTS IN IT	HOW MANY ELEMENTS?	ELEMENT OR COMPOUND?
H_2	hydrogen			
H_2O	water			
NaCl	sodium chloride (salt)			
He	helium			
CO_2	carbon dioxide			
O_2	oxygen			
CH_4	methane			

A2. A hydrogen molecule, H_2, has two atoms. Why is it still an element and not a compound?

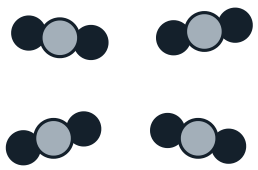
A3. Each box shows particles. Write **element**, **compound** or **mixture**, and the formula of each kind of particle.

● oxygen atom ○ hydrogen atom ◉ carbon atom

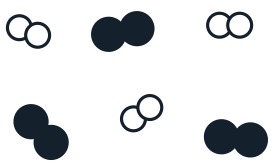
(a)



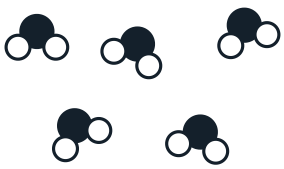
(b)



(c)



(d)



B Counting atoms

A small number written after a symbol tells you how many atoms of that element there are. No number means one atom. In the game, each atom is one card.

FORMULA	ATOMS OF EACH ELEMENT	TOTAL ATOMS (CARDS NEEDED)
H_2O	H 2, O 1	3
CO_2		
NH_3		
NaOH		
H_2SO_4		
Fe_2O_3		

B3. What is the difference between 2H and H_2?

Elements, Compounds and Formulas

B2. Write the formula. Put the element named first, first.

(a) 1 sulfur + 2 oxygen atoms

(b) 2 aluminium + 3 oxygen atoms

C Building compounds in Act 1

Imagine your hand holds these eight cards. Each card can be used only once.

H	H	H	O	C	N	Na	Cl

COMPOUND	CARDS YOU WOULD SELECT	CAN IT BE MADE? IF NOT, WHY?
H_2O		
NH_3		
CH_4		
CO_2		

C2. *Extension.* Find three compounds that together use all eight cards, each card once. (Hint: one of them is CO.)

C3. You select C, O, O, O and the game says "No compound can be made from this combination." Which card or cards could you take away to make a real compound? Name it.

C4. Each enemy shows its formula. Element, compound or mixture?

ENEMY	ELEMENT, COMPOUND OR MIXTURE?	ELEMENTS IN IT (SYMBOLS)
 Soot Bat — C (soot)		
 Plastic Golem — $(C_2H_4)_n$		
 Smog Giant (boss) — O_3 + NO_x		

D Where the game simplifies



D1. In the game, a Na card and a Cl card simply become salt.
Real sodium is a soft metal that fizzes violently in water. Chlorine is a poisonous yellow-green gas. Salt is safe to eat. What does this tell you about a compound and its elements?



D2. *Extension.* Three C cards make diamond, C_n.
Is diamond an element or a compound? What does the *n* mean, and why is "three atoms" a simplification?



D3. H, H and O cards become water at once.
A balloon of hydrogen and oxygen gas can sit for years without making water, until a spark sets it off. Is the gas in the balloon a compound or a mixture? Explain.

EXIT TICKET



Write the formula of one element and one compound from today. How can you tell from a formula which one is the compound?

Elements, Compounds and Formulas

A Element or compound?

FORMULA	ELEMENTS	HOW MANY	ANSWER
H_2, O_2	H; O	1	element (a molecule of an element)
He	He	1	element (single atoms)
H_2O, CO_2, CH_4	H, O; C, O; C, H	2	compound
NaCl	Na, Cl	2	compound (ionic: not made of molecules)

A2. Both atoms are hydrogen. A compound needs atoms of two or more **different** elements. Accept "it has only one kind of atom" or "one symbol in the formula".

A3. (a) element, O_2 molecules. (b) compound, CO_2. (c) mixture of two elements, H_2 and O_2. (d) compound, H_2O. Point out that (c) and (d) contain the same kinds of atom: what matters is whether different atoms are joined.

B Counting atoms

FORMULA	ATOMS OF EACH ELEMENT	TOTAL
CO_2	C 1, O 2	3
NH_3	N 1, H 3	4
NaOH	Na 1, O 1, H 1	3
H_2SO_4	H 2, S 1, O 4	7
Fe_2O_3	Fe 2, O 3	5

B2. (a) SO_2 (sulfur dioxide). (b) Al_2O_3 (aluminium oxide). Accept normal-sized numbers (SO2) for Year 7. Do not accept O_2S: the order is a convention worth fixing now.

B3. 2H is two separate hydrogen atoms. H_2 is one molecule of two hydrogen atoms joined together. Accept a drawing that shows the difference.

C Building compounds in Act 1

C1. H_2O: H, H, O **yes**. NH_3: N, H, H, H **yes**. CH_4: C, H, H, H, H **no**, needs four H and the hand has three. CO_2: C, O, O **no**, needs two O and the hand has one. Card order does not matter.

C2. $CO + NH_3 + NaCl$. This is the only way to use all eight cards with Act 1 compounds.

C3. Take away one O to make CO_2, carbon dioxide, or two O to make CO, carbon monoxide. Taking away C leaves O_3 (ozone): a real substance, but an element, and the game does not accept it. If a student takes away C and one O to get O_2, accept it but note O_2 is an element, not a compound.

C4. Soot Bat: element, C. (The game shows soot as pure carbon. Accept "mixture" if the student explains that real soot is carbon mixed with other substances.) Plastic Golem: compound, C and H (*n* means the C_2H_4 unit repeats many times in a long chain). Smog Giant: mixture; symbols O and N. Ozone, O_3, is an element (oxygen only). Nitrogen oxides (NO, NO_2) are compounds of N and O.

D Where the game simplifies

D1. A compound has different properties from the elements it is made of. When elements join chemically they make a new substance. Accept "it is a new substance" or "it does not act like sodium or chlorine". Extension: real chlorine gas is Cl_2, so one Cl_2 molecule reacts with two sodium atoms to make two NaCl.

D2. An element: only carbon atoms. The *n* stands for a very large number: a real diamond has billions of billions of carbon atoms joined in one giant structure, not three. Accept "it is pure carbon, so element".

D3. A mixture. The H_2 and O_2 molecules are mixed but not joined. A chemical reaction (started here by the spark) is needed to join the atoms into H_2O, a compound. In the game, selecting cards stands in for the reaction.

Exit ticket. Any element (H_2, O_2, N_2, Cl_2, He, C, Hg) and any compound (H_2O, CO_2, NaCl ...). A compound's formula has two or more **different** symbols; an element's has only one, even with a small number. Watch for students who say "more than one atom means compound".