TEACHER NOTES · FREE TO COPY FOR CLASSROOM USE

Neutralisation with Valence

A 50-minute lesson on acids, bases and pH for Years 9–10 (Grades 9–10)

Scan to get Valence
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 2**, set in an abandoned mine, six of the enemies are acidic or basic and carry a **pH gauge**. Students bring each enemy to pH 7 with the right kind of compound: neutralisation.

The game is the hook and the evidence. The worksheet does the chemistry: classifying acids and bases, predicting pH change, writing equations, and spotting where the game simplifies real chemistry.

Learning goals

1. Classify common compounds as acids or bases from their formulas.
2. Predict which way pH moves when an acid or base is added.
3. Write word and balanced equations for acid + base → salt + water (+ CO_2 for carbonates).
4. Explain two ways the game's pH model is simpler than real chemistry.

HOW THE pH GAUGE WORKS IN THE GAME

- Acidic enemies start below pH 7, basic enemies above 7.
- Each **base** attack raises an acidic enemy's pH by **2**. Each **acid** attack lowers a basic enemy's pH by **2**. Water moves pH **1** step toward 7.
- At 7 (or past it) the enemy is **neutralised**: it stops for a turn, loses its armour, takes 25% more damage and deals 30% less.
- The same kind of attack (acid on an acid) makes it **more concentrated**: pH moves away from 7 and the enemy grows stronger.



The six Act 2 enemies with a pH gauge, as drawn in the game. Two others (a pyrite beetle and a coal dust goblin) have none.

Curriculum links

- **Australia**: Year 10 chemical reactions, AC9S10U07
- **New Zealand**: Years 9–10 acids, bases and pH; NCEA Level 1 Chemistry and Biology 92021
- **Ontario**: Grade 10 Science SNC2D, C2.6, C3.6, C3.7 (Ontario and BC spell it "neutralization")
- **British Columbia**: Science 10, acid–base chemistry

Full notes: valence-2b95b.web.app/curriculum-australia, /curriculum-new-zealand, /curriculum-canada. 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 2 opens after Act 1.** Set Act 1 as homework the night before, or run the lesson over two periods. Parts A and C work without the game.
- Print pages 2 and 3 for each student. Page 4 is the answer key.

Lesson plan

`5 min`	Hook. "Acid rain is falling on a lake. What could you add to fix it?" Collect answers on the board.
`15 min`	Play Act 2 in pairs. Students fill in Part B as they meet each enemy. Pairs still in Act 1 start with Part A.
`15 min`	Parts C and D. Link each enemy to a real neutralisation, such as liming acid mine water.
`10 min`	Discuss Part D: why does the game stop at exactly 7, and why is "2 steps" not how real pH works?
`5 min`	Exit ticket at the bottom of page 3.

STUDENT WORKSHEET

Neutralisation with Valence

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

Name _____ Class _____ Date _____

The pH scale (typical colours of universal indicator). pH 7 is neutral.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

← more acidic — neutral — more basic →

A Acid or base?

All of these can be made in Valence. Write **acid** or **base**, and the clue in the formula that told you.

FORMULA	NAME	ACID OR BASE?	CLUE IN THE FORMULA
HCl	hydrochloric acid		
$NaOH$	sodium hydroxide		
H_2SO_4	sulfuric acid		
$Ca(OH)_2$	calcium hydroxide (slaked lime)		
HNO_3	nitric acid		
$Mg(OH)_2$	magnesium hydroxide		
$NaHCO_3$	sodium hydrogen carbonate (bicarbonate, baking soda)		
NH_3	ammonia		

A2. Two of these are bases even though their formula does not end in OH (and one even contains H). Which two, and how can they act as bases?

B The Act 2 enemies

Fill this in as you meet each enemy. One acid or base attack moves pH 2 steps toward 7. If that would take it past 7, pH stops at exactly 7.

ENEMY	START pH	ACIDIC OR BASIC?	ATTACK WITH	ATTACKS TO REACH 7
 Acid Mine Water $H_2SO_4 + Fe^{3+}$	3			
 Cement Paste Golem $Ca(OH)_2$	12			
 Lye Puddle $NaOH(aq)$	13			
 Limestone Cave Giant $CaCO_3$	10			
 Sulfuric Mist Serpent H_2SO_4	1			
 Queen of the Red River (boss) $H_2SO_4 + Fe^{3+}$	2			

B2. The Cement Paste Golem is at pH 12. Your hand makes HCl, HCl, H_2O and NaOH. Which cards would you play, in what order, to neutralise it in the fewest moves? Write the pH after each move. Which card should you not play, and why?

Neutralisation with Valence

B3. What happened (or what would happen) when you attacked an acidic enemy with an acid? Explain it in terms of concentration.

C From the game to the real world

Acid + base → salt + water. Write the word equation, then the balanced symbol equation.

IN THE GAME, AND IN REAL LIFE	WORD EQUATION AND BALANCED EQUATION
 **C1.** NaOH on HCl A titration in the school lab. Phenolphthalein indicator turns pale pink at the end point.	
 **C2.** $Ca(OH)_2$ (lime) on the Acid Mine Water, H_2SO_4 How real mine water is treated before it reaches rivers.	
 **C3.** HCl on the Limestone Cave Giant, $CaCO_3$ A carbonate also gives off a gas.	
 **C4.** $Mg(OH)_2$ on stomach acid, HCl How an antacid works.	

D Where the game simplifies

D1. In the game every acid attack moves pH by exactly 2. In real chemistry, a solution at pH 3 has **10 000 times** the concentration of hydrogen ions of a solution at pH 7. What does that tell you about the real pH scale?

D2. In the game, if you overshoot (pH 6 plus one base attack), pH stops at exactly 7. What would really happen if you added too much base to an acid?

D3. In the game, water moves pH 1 step toward 7. Can adding water to an acid ever make it reach exactly 7, or go past it? Explain.



EXIT TICKET

A farmer's soil is at pH 5. Name one compound from this worksheet the farmer could add, and the type of reaction that happens.

Neutralisation with Valence

A Acid or base?

FORMULA	ANSWER	CLUE
HCl, H_2SO_4, HNO_3	acid	Release H^+ ions in water (H first, bonded to a non-metal or polyatomic ion)
$NaOH$, $Ca(OH)_2$, $Mg(OH)_2$	base	Metal hydroxides: release OH^- ions
$NaHCO_3$	base	Contains H but is a (weak) base: the hydrogen carbonate ion accepts H^+
NH_3	base	No OH in the formula, but it accepts H^+ from water to form NH_4^+ and OH^-

A2. **$NaHCO_3$** (contains H, but is a weak base) and **NH_3** (no OH, but is a base). Accept "they react with / neutralise acids". Best answers say they accept H^+ ($NH_3 + H_2O \rightarrow NH_4^+ + OH^-$).

B The Act 2 enemies

ENEMY	START pH	TYPE	ATTACK WITH	ATTACKS
Acid Mine Water	3	acidic	base	2 (3 → 5 → 7)
Cement Paste Golem	12	basic	acid	3 (12 → 10 → 8 → 7)
Lye Puddle	13	basic	acid	3 (13 → 11 → 9 → 7)
Limestone Cave Giant	10	basic	acid	2 (10 → 8 → 7)
Sulfuric Mist Serpent	1	acidic	base	3 (1 → 3 → 5 → 7)
Queen of the Red River	2	acidic	base	3 (2 → 4 → 6 → 7)

B2. 3 moves: HCl, HCl and H_2O in any order, e.g. 12 → 10 → 8 → 7 or H_2O first: 12 → 11 → 9 → 7. Two HCl alone only reach pH 8. Do not play NaOH: it is a base, so it pushes pH away from 7 (to 14) and makes the Golem stronger.

B3. More acid adds more H^+ ions, so the solution becomes more concentrated and more acidic (pH goes down, further from 7). In the game the enemy also gets stronger. Strictly, mixing in more acid only lowers pH if the added acid is more concentrated; the game simplifies this.

Part B "Attack with": accept a named compound of the right kind, e.g. NaOH or $Ca(OH)_2$ for base, HCl or H_2SO_4 for acid.

C Equations

Accept reactants in either order. State symbols are not required.

C1. sodium hydroxide + hydrochloric acid → sodium chloride + water

$NaOH + HCl \rightarrow NaCl + H_2O$

C2. calcium hydroxide + sulfuric acid → calcium sulfate + water

$Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$

C3. calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

C4. magnesium hydroxide + hydrochloric acid → magnesium chloride + water

$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

D Where the game simplifies

D1. The scale is logarithmic: each step of 1 pH is a tenfold change in H^+ concentration, so equal "steps" in the game are not equal amounts of acid or base in real life. Going from pH 3 to 5 removes 99% of the H^+; going from 5 to 7 removes only a tiny amount more.

D2. It would go past 7 and become basic. Near the end point one extra drop can change pH a lot, so real neutralisation needs the right amounts, as in a titration, with an indicator or pH meter to show the end point.

D3. No. Water is neutral, so diluting an acid moves its pH closer to 7. With a huge amount of water it can get very close, but it never reaches or passes 7, because the acid's H^+ is still there and water adds no OH^- to cancel it. Only a base can neutralise it.

Exit ticket. $CaCO_3$ (limestone, "agricultural lime") or $Ca(OH)_2$ (slaked lime); also accept $Mg(OH)_2$. The reaction is neutralisation. If a student names NaOH or NH_3, discuss why a farmer would not use them: NaOH is corrosive and its sodium harms soil, and ammonia fertiliser makes soil more acidic over time.