Acids, Alkalis and Indicators Rainbow

Teacher		**Class**	Year 8
Subject	Science	**Topic**	Acids and alkalis
Date		**Room**	
Lesson length	60 minutes	**Country**	United Kingdom

Pupils learn how neutralisation, the pH scale and indicators link together. They test clear liquids with universal indicator to make a pH rainbow.

Curriculum links

- defining acids and alkalis in terms of neutralisation reactions
- the pH scale for measuring acidity/alkalinity

Learning objectives

- Students will describe neutralisation as acid plus alkali making salt and water.
- Students will use the pH scale to classify solutions as acidic, neutral or alkaline.
- Students will predict and test indicator colours in acids, alkalis and neutral solutions.

Success criteria

- I can name the products made when an acid and alkali neutralise.
- I can order solutions by pH as acid, neutral or alkali.
- I can state what litmus and universal indicator show in acids and alkalis.

What students already know

Ask: What does neutral mean in science? Listen for pH 7, like pure water, neither acid nor alkali. Correct quickly if pupils say neutral means nothing in it.

Key words

acid	a liquid or dissolved chemical with a pH below 7, such as vinegar [4]
alkali	a chemical that dissolves in water and can cancel out an acid, with pH above 7 [4]
neutralisation	mixing just the right amounts of acid and alkali to make a neutral liquid of salt and water [4][3]
pH scale	a number line from strongly acidic to strongly alkaline used to show how acidic a liquid is [4]
indicator	a dye that changes colour in acids or alkalis because a chemical reaction happens [3][4]

Materials

- Slide deck Slides 1-5, 7, 9, 11-12 and board
- pH colour chart showing universal indicator colours, large class copy and pair copies
- test tubes and rack, 5 per pair
- universal indicator solution or paper

Before the lesson

- Load Slides 1-5, 7, 9, 11-12 and check colours show clearly on the board
- Print pH colour charts, one large and one per pair, with green at pH 7 marked

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- labelled samples: dilute vinegar, lemon juice, tap water, liquid soap solution, shampoo solution
- dropping pipettes, safety goggles
- white paper for colour matching behind tubes
- Worksheet Task G copies - Spot the mistake
- mini-whiteboards and pens

- Make up and label five samples per class set: vinegar, lemon juice, tap water, liquid soap solution, shampoo solution
- Test universal indicator in each sample so red to dark purple range and green for water show well
- Print Worksheet Task G, one per pupil, and set out test tubes, racks, pipettes and goggles
- Decide bench layout for pairs and spill kit, sink access for washing hands

Lesson outline

0–5 min **Starter** 5 min · Pairs

Link home ideas about sour and soapy liquids to the rainbow question.

YOU DO

1. Show Slide 1 Acids, Alkalis and Indicators and read its question about making a rainbow using only clear liquids.
2. Show Slide 2 Think, pair, share and ask what sour or soapy liquids pupils know at home.
3. Give one minute of pair talk, then take two sour and two soapy ideas without confirming acid or alkali yet.
4. Link answers to the lesson: we will test and order them by pH and indicator colour.

STUDENTS DO

1. Discuss with a partner for one minute and list sour and soapy liquids.
2. Offer ideas to the class, for example lemon juice, vinegar, liquid soap and shampoo.
3. Look at Slide 1 question and keep the rainbow challenge in mind.

Say: Can we make a rainbow using only clear liquids? Talk to your partner for one minute. What sour or soapy liquids do you know at home? We will test them and put them in order from most acidic to most alkaline.

Ask: What sour liquids do you know at home? (Lemon juice and vinegar, which are weak acids [4].) · What soapy liquids do you know? (Liquid soap and shampoo, which are alkalis with pH higher than 7 [4].)

Check understanding: Hands up for one sour and one soapy example from most pairs. If ideas are thin, point to Slide 4 examples and move on.

Support: Give word bank on board: lemon juice, vinegar, soap, shampoo, water. **Stretch:** Ask: Do you think the sour ones and soapy ones would cancel each other out if mixed?

Use: Slides 1–2

5–17 min **Teaching** 12 min · Whole class

Explain acids, alkalis and neutralisation and model the word equation.

YOU DO

1. Show Slide 3 Big idea and explain that acid plus alkali cancel out to make salt and water.
2. Model the example sodium hydroxide + hydrochloric acid -> sodium chloride + water, then show the general pattern acid + alkali -> salt + water [3].
3. Show Slide 4 Acids and alkalis around you and link vinegar with ethanoic acid and soap and shampoo with alkalis with pH higher than 7 [4].
4. Define the pH rules: acids have pH lower than 7, pure water is neutral at pH 7, and alkalis have pH higher than 7 [4].

STUDENTS DO

1. Copy the general word equation and the sodium chloride example into books.
2. Repeat back the pH rules for acid, neutral and alkali with finger signals below 7, 7, above 7.
3. Sort Slide 4 examples with teacher into weak acids and alkalis.

Say: An acid has a pH lower than 7 and an alkali has a pH higher than 7, while pure water is neutral at pH 7 [4]. A base is a substance that neutralises an acid, and bases that dissolve in water are called alkalis [4]. If you mix just the right amounts, you get a neutral solution of salt and water [4][3].

Worked example: Hydrochloric acid + sodium hydroxide: Step 1 name the acid and alkali. Step 2 remember acid + alkali -> salt + water [3]. Step 3 fill in: hydrochloric acid + sodium hydroxide -> sodium chloride + water [3]. Step 4 label: sodium chloride is the salt, water is the other product every time.

Ask: What is made every time an acid and an alkali neutralise? (A salt and water [3].) · A solution has pH 3. Is it acidic, neutral or alkaline? (Acidic, because an acid has pH lower than 7 and strong acids can be pH 1-3 [4].) · What is an alkali in terms of neutralisation? (A soluble base that neutralises an acid, with pH higher than 7 [4].)

Check understanding: Mini-whiteboards: write salt + water for products and hold up pH 7 for pure water. Re-teach with Slide 3 if many miss it.

Support: Give half-written equation with word bank: acid, alkali, salt, water. **Stretch:** Ask pupils to predict the salt name if potassium hydroxide neutralises hydrochloric acid, using the example pattern.

Use: Slides 3–4

17–27 min **Teaching** 10 min · Whole class

Teach litmus, universal and natural indicator colours for the practical.

YOU DO

1. Show Slide 5 mystery liquid that turned bright green with universal indicator and confirm neutral pH 7 like pure water.
2. Show Slide 7 Three ways to test and teach litmus, universal and natural indicators side by side.
3. Model litmus table: red litmus stays red in acid and turns blue in alkali, blue litmus turns red in acid and stays blue in alkali, with purple for neutral solution [4].
4. Model universal range from red for strongly acidic to dark purple for strongly alkaline, with green for neutral pH 7, and note red cabbage, tea and rose petals also change colour [4].

STUDENTS DO

1. Answer Slide 5 vote: acid, alkali or neutral, then chant the litmus rules with red and blue pens up.
2. Copy a three-row table for litmus in acidic, neutral and alkaline solutions.
3. Practise reading the universal chart: red acid, green neutral pH 7, purple alkali.

Say: Litmus solution turns red in acidic solutions and blue in alkaline solutions, and purple in neutral solutions [4]. Universal indicator has many colours, from red for strongly acidic to dark purple for strongly alkaline, with green at neutral pH 7 [4]. Indicators change colour because a chemical reaction takes place with the acid or alkali [3].

Worked example: Test lemon juice: Step 1 predict acid with pH lower than 7 [4]. Step 2 red litmus stays red, blue litmus turns red [4]. Step 3 universal indicator turns red-orange for acid, not green and not dark purple [4]. Step 4 conclude acidic.

Ask: Universal indicator turns bright green. What does that mean? (Neutral, pH 7 like pure water [4].) · What do red and blue litmus do in an alkali? (Red litmus turns blue and blue litmus stays blue; litmus turns blue in alkaline solutions [4].)

Check understanding: Cold-call with colour cards: show red, green, dark purple and ask acid, neutral or alkali. Re-show chart if green is missed.

Support: Leave a reminder card on desks showing litmus in acidic, neutral and alkaline solutions [4]. **Stretch:** Ask why universal indicator is more useful than litmus when you need a pH number, not just acid or alkali.

Use: Slides 5, 7

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27–50 min **Main Activity** 23 min · Pairs

Use universal indicator to order everyday solutions from acidic to alkaline.

YOU DO

1. Show Slide 9 Your task and read the steps: predict acid or alkali, add a few drops of universal indicator, record colour, match pH chart, decide acid, alkali or neutral.
2. Demonstrate safety and method with water: goggles on, few drops only, do not taste, wash hands after soap and shampoo solutions.
3. Circulate as pairs test dilute vinegar, lemon juice, tap water, liquid soap solution and shampoo solution.
4. Stop class at 18 minutes to line tubes up red-orange to green to blue-purple and check order from most acidic to most alkaline.

STUDENTS DO

1. In pairs, predict acid or alkali for each of the five samples, then add indicator and record colour and pH.
2. Identify vinegar as ethanoic acid with pH lower than 7 and soap and shampoo as alkalis with pH higher than 7 [4].
3. Place test tubes in order from most acidic to most alkaline and tidy spills at once.

Say: Predict acid or alkali first, then add a few drops of universal indicator. Record the colour, match it to the pH chart, and decide acid, alkali or neutral. Put your tubes in order from most acidic to most alkaline. Wear goggles, do not taste any sample, and wash your hands afterwards.

Worked example: Vinegar: Step 1 predict acid because vinegar contains ethanoic acid with pH lower than 7 [4]. Step 2 add indicator, see orange-yellow. Step 3 match chart around pH 3, which is in the strong acid 1-3 end for acids [4]. Step 4 record acid, place left of green neutral water [4].

Ask: Your tube is green at pH 7. What is it? (Neutral, like pure water [4].) · Your tube is red-orange with low pH. What does that tell you? (Strongly acidic; strong acids have lower pH values such as pH 1-3 and universal is red for strongly acidic [4].) · Your tube is blue-purple with high pH. What does that tell you? (Alkaline; universal goes to dark purple for strongly alkaline and alkalis have pH higher than 7 [4].)

Check understanding: Check each pair has tubes ordered and table filled with colour, pH and acid, alkali or neutral. If colours are off, compare to large chart and retest water as green control.

Support: Provide a large colour chart that shows green means neutral pH 7 and red means strongly acidic [4].
Stretch: Ask pupils to predict what would happen to the pH and colour if an acidic sample was diluted with pure water.

Use: Slide 9

50–60 min **Plenary** 10 min · Whole class

Check which indicator to use and correct ideas about acid danger and pH.

YOU DO

1. Show Slide 11 Which indicator for pond water and run a vote: universal indicator paper, litmus paper or red cabbage juice.
2. Confirm universal paper is best for a pH number outside, litmus only tells acid or alkali, cabbage juice is a real indicator but messy to carry [4].
3. Show Slide 12 True or false and use Worksheet Task G Spot the mistake for pupils to fix the same ideas in writing.
4. Collect exit answers on whiteboards before pack-away.

STUDENTS DO

1. Vote with boards for best pond-water indicator and justify with colour and pH reasons.
2. Complete Worksheet Task G by spotting that not all acids are dangerous and corrosive because weak acids like vinegar are safe to handle [4].
3. Answer true or false that universal indicator is green at pH 7, which is true like pure water [4].

Say: You are testing pond water outside. Which indicator would you take? Choose and justify your choice. Then decide true or false and fix any false statement so it becomes true. Red cabbage juice is a real indicator, it changes colour in acids and alkalis like tea and rose petals [4].

Ask: Which indicator for pond water outside and why? (Universal indicator paper, because it gives a pH number and colour from red acid to purple alkali with green neutral [4].) · All acids are dangerous and corrosive. True or false? (False; if acids are weak they are safe to handle and will not have hazard labels, for example vinegar [4].)

Check understanding: Whiteboard vote and Task G answers: most should pick universal paper and mark green at pH 7 as true. Re-teach litmus versus universal if mixed.

Support: Let pupils keep the colour chart in view that shows green is neutral pH 7 and red is strongly acidic [4].
Stretch: Ask pupils to improve the false statement so it becomes true by adding weak and strong acid detail.

Use: Slides 11–12, Worksheet Task G

Common mistakes

Mistake	How to spot it	How to fix it
All acids are dangerous and corrosive.	Pupils mark true on Slide 12 or Task G and avoid testing vinegar.	Show that weak acids like vinegar are safe to handle, while only strong concentrated acids are corrosive and labelled [4].
Green with universal indicator means acidic.	Pupils label tap water tube as acid despite green colour.	Point to chart: universal is green at neutral pH 7 like pure water, red is strongly acidic and dark purple is strongly alkaline [4].
Litmus gives a pH number.	Pupils say red litmus shows pH 1 or blue litmus shows pH 13.	Recall litmus only turns red in acid and blue in alkali, with purple neutral; use universal indicator for pH numbers and range of colours [4].

Support

- Provide a large colour chart that shows green means neutral pH 7 and red means strongly acidic [4]
- Give worked first row, pre-labelled tiles and half-written word equation with word bank

Stretch

- Ask pupils to predict what would happen to the pH and colour if an acidic sample was diluted with pure water

- Challenge pupils to predict the salt name for a different acid and alkali pair and justify choice of indicator for pond water

For the LSE or teaching assistant

Stay with pairs needing help to match colours to the chart and record acid, alkali or neutral. Prompt green means pH 7, red means acid, purple means alkali.

Safety

- Wear safety goggles for all indicator testing
- Teacher handles stock bottles, pupils use only dilute solutions and few drops
- Do not taste or drink samples, wash hands after handling soap and shampoo solutions, wash splashes off skin and wipe spills at once

Check for understanding

Question	Answer
Acid plus alkali are mixed in just the right amounts. What is made?	A salt and water, leaving a neutral solution [3][4].
Solution A is pH 2 and solution B is pH 7. Which is acidic and which is neutral?	A is acidic with pH lower than 7 and B is neutral like pure water [4].
How do litmus and universal indicator differ in what they tell you?	Litmus turns red in acid and blue in alkali, while universal gives many colours and a pH number with green at pH 7 [4].

Homework

Complete Worksheet Task G corrections: rewrite each false statement about acids and indicators to make it true.

Sources

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