Grade 8, all subjects

Every written unit for this grade, subject by subject (unreviewed AI drafts)

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Grade 8 Science — Acids, alkalis and indicators: reading the colour of a liquid

> **Unreviewed AI draft.** Written by Claude Opus 5.5 (an AI agent) on 2026-11-04. No teacher has checked it yet. Read it fully, adapt it to your class and local rules, and test any practical work yourself before using it with students.

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Big idea

Many liquids are acidic, alkaline or neutral, and we cannot tell which by looking. An indicator is a dye that changes colour depending on how acidic or alkaline a liquid is, so it lets us "read" a liquid safely without tasting or touching it. The pH scale (usually 0 to 14) puts this on a number line: below 7 is acidic, 7 is neutral, above 7 is alkaline. When an acid and an alkali are mixed in the right amounts they cancel each other out (neutralisation), making a salt and water. People use this every day, from indigestion tablets to farmers adding lime to sour soil.

Outcomes

By the end of the unit, students can:

1. Make a red cabbage indicator and use it to sort everyday liquids into acidic, neutral and alkaline, recording colours in a table.
2. Place liquids on the pH scale using universal indicator, and explain that below 7 is acidic, 7 is neutral and above 7 is alkaline.
3. Write the word equation acid + alkali → salt + water, and explain that adding a carbonate or hydrogencarbonate (such as baking soda) to an acid also gives off carbon dioxide.
4. Carry out a repeated, fair comparison of how much alkali is needed to neutralise two acids, and use the median of repeats.
5. Explain two real uses of neutralisation (antacids for indigestion; lime for acidic soil) and what "ocean acidification" does and does not mean.
6. Correct the common ideas that "all acids burn", "alkalis are safe", "neutral means no chemicals" and "an indicator turns a liquid into an acid".

Prior knowledge

- Some substances dissolve to make solutions; mixtures can be separated; some changes make new materials, and a gas given off is a sign of this (grade 5).
- Bromothymol blue changes colour when carbon dioxide dissolves in water (grade 7).
- Fair tests: change one thing, keep the rest the same, repeat, use the median (grades 3–7).

Lessons (about 50 minutes each)

#	Lesson	Practical?
1	Can you tell by looking? Making a red cabbage indicator	Make indicator; test 8 liquids
2	The pH scale and universal indicator	Universal indicator paper; rank liquids

#	Lesson	Practical?
3	Cancelling out: neutralisation by drops	Count drops of baking soda solution to neutralise vinegar and lemon juice
4	Neutralisation at work: stomachs, soils and seas	Test soil samples; antacid demonstration; ocean pH data
5	Acids and alkalis in the world + unit check	Discussion and written assessment

Materials (whole unit)

- Eye protection for everyone in every practical lesson.
- Lesson 1: red cabbage (about a quarter of a head per class); a kettle (teacher only); a heatproof jug; a sieve; clear plastic cups or spotting tiles; droppers; labelled test liquids (see lesson 1): lemon juice, white vinegar, fizzy (carbonated) water, tap water, salt solution, baking soda (sodium hydrogencarbonate) solution, milk of magnesia, and washing soda (sodium carbonate) solution made up dilute by the teacher.
- Lesson 2: universal indicator paper and its colour chart (or universal indicator solution); the same liquids; tweezers or glass rods.
- Lesson 3: cabbage indicator; white vinegar; lemon juice; baking soda solution (1 level teaspoon in 100 ml water, made up fresh); 10 ml plastic syringes or measuring cylinders; droppers; white tiles.
- Lesson 4: three soil samples (for example garden soil, a peat-free compost and soil from under conifers, or whatever is available); distilled or deionised water; filter paper and funnels; universal indicator paper; one antacid tablet or milk of magnesia (teacher demonstration only).
- Student record sheets (tables are given in each lesson).

Assessment

- Ongoing: closing check questions at the end of each lesson (answers included).
- Lesson 3: the results table, medians and conclusion are a practical skills task.
- Lesson 5: a 10-question unit check (20 marks) with an answer guide and marking notes.

Sources

These are general references that a teacher can use to check facts. Links were checked to load on 2026-11-04.

- Wikipedia, "PH": https://en.wikipedia.org/wiki/PH
- Wikipedia, "Acid": https://en.wikipedia.org/wiki/Acid
- Wikipedia, "Base (chemistry)": https://en.wikipedia.org/wiki/Base_(chemistry)
- Wikipedia, "Alkali": https://en.wikipedia.org/wiki/Alkali
- Wikipedia, "PH indicator": https://en.wikipedia.org/wiki/PH_indicator
- Wikipedia, "Universal indicator": https://en.wikipedia.org/wiki/Universal_indicator
- Wikipedia, "Litmus": https://en.wikipedia.org/wiki/Litmus
- Wikipedia, "Phenolphthalein": https://en.wikipedia.org/wiki/Phenolphthalein
- Wikipedia, "Red cabbage" (pH indicator section): https://en.wikipedia.org/wiki/Red_cabbage
- Wikipedia, "Anthocyanin": https://en.wikipedia.org/wiki/Anthocyanin
- Wikipedia, "Neutralization (chemistry)": https://en.wikipedia.org/wiki/Neutralization_(chemistry)
- Wikipedia, "Sodium bicarbonate": https://en.wikipedia.org/wiki/Sodium_bicarbonate

- Wikipedia, "Sodium hydroxide": https://en.wikipedia.org/wiki/Sodium_hydroxide
- Wikipedia, "Magnesium hydroxide": https://en.wikipedia.org/wiki/Magnesium_hydroxide
- Wikipedia, "Antacid": https://en.wikipedia.org/wiki/Antacid
- Wikipedia, "Citric acid": https://en.wikipedia.org/wiki/Citric_acid
- Wikipedia, "Acetic acid": https://en.wikipedia.org/wiki/Acetic_acid
- Wikipedia, "Vinegar": https://en.wikipedia.org/wiki/Vinegar
- Wikipedia, "Soil pH": https://en.wikipedia.org/wiki/Soil_pH
- Wikipedia, "Ocean acidification": https://en.wikipedia.org/wiki/Ocean_acidification
- Wikipedia, "Acid rain": https://en.wikipedia.org/wiki/Acid_rain

Known gaps and cautions

- **Not reviewed** by a teacher or a science technician. Check every practical against your school's or region's chemical safety guidance before use.
- **Only household-strength chemicals** are used by students. Laboratory acids and alkalis (such as hydrochloric acid or sodium hydroxide solution) are left out on purpose; a teacher who wants them should follow local guidance for concentrations.
- **Colours vary.** Red cabbage colours depend on the cabbage, the water and how strong the extract is. Test every liquid yourself the day before and use your own results as the answer key. The colours given here are typical, not guaranteed.
- **Tap water varies** from place to place and may not read exactly 7.
- **Simplifications:** "acid + alkali → salt + water" is taught as a word equation only. Hydrogen ions, the logarithmic pH scale (one pH step is a tenfold change) and weak versus strong acids are introduced only as stretch ideas and are covered properly in grades 9–10.
- The ocean pH figures (about 8.15 in 1950 to about 8.05 now) come from Wikipedia's "Ocean acidification" article; check a current scientific source before quoting them as exact.

Lesson 1 — Can you tell by looking? Making a red cabbage indicator

Back to unit

Goal

Students see that acidic, neutral and alkaline liquids can look the same, make a natural indicator from red cabbage, and use it to sort eight everyday liquids into three groups.

Materials

- Eye protection for everyone.
- Red cabbage extract, made by the teacher before the lesson or as a demonstration: chop about a quarter of a red cabbage, cover it with just-boiled water from a kettle in a heatproof jug, leave 10–15 minutes until the water is deep purple, then sieve and cool. Store covered in a fridge for up to two days.
- Per group: 8 clear cups or a spotting tile, a dropper of cabbage extract, a white sheet of paper underneath, a record table.
- Eight labelled liquids, about 20 ml each per group:
- A lemon juice
- B white vinegar
- C fizzy (carbonated) water, freshly opened
- D tap water
- E salt solution (1 teaspoon table salt in 100 ml water)
- F baking soda solution (1 teaspoon sodium hydrogencarbonate in 100 ml water)
- G milk of magnesia (shake well, then dilute 1 part to 4 parts water)
- H washing soda solution (made up dilute by the teacher: 1 teaspoon sodium carbonate in 200 ml water)

Steps

✎ Opening (5 min)

Hold up two cups of clear liquid: one of tap water and one of white vinegar diluted to look the same. Ask: "Which one is safe to drink? How could we find out without tasting or touching?" Take ideas. Establish the rule for the whole unit: **in science we never taste or touch unknown liquids.** We need a safe way to "read" a liquid.

✎ Main activity (30 min)

1. **The cabbage changes colour (teacher demo, 5 min).** Pour a little purple cabbage extract into three cups. Add a few drops of vinegar to one (it turns pink-red) and a pinch of baking soda to another (it turns blue-green). Leave the third alone. Ask: "What made the colour change? Did the cabbage turn the vinegar into something else?" Explain: the cabbage contains a coloured pigment (an anthocyanin) that is one colour

in acidic liquids, another in neutral ones and others in alkaline ones. A dye like this is called an **indicator**.
2. **Predict (5 min).** Groups look at the eight liquids and predict each one: acid, neutral or alkali. They write predictions in pen before testing.
3. **Test (15 min).** Put about 1 cm of each liquid in a cup (or a few drops in a spotting tile well). Add 5 drops of cabbage extract. Swirl. Record the colour against the white paper.

Liquid	Prediction	Colour with cabbage	Group (acid / neutral / alkali)
A lemon juice			
B vinegar			
C fizzy water			
D tap water			
E salt solution			
F baking soda			
G milk of magnesia			
H washing soda			

1. **Build the colour key (5 min).** As a class, line the cups up from red through purple to green-yellow. The typical pattern:
2. **red / pink / magenta** = acidic (lemon juice, vinegar; fizzy water is usually a paler pink-purple)
3. **purple** = about neutral (salt solution; tap water is usually purple or close to it)
4. **blue / green** = alkaline (baking soda, milk of magnesia)
5. **green-yellow** = more strongly alkaline (washing soda)

Teacher: use your own results from testing the day before. Colours vary with the cabbage and water.

✓ Discussion questions (10 min)

1. **Were any of your predictions wrong? Which ones surprised you?** Example answer: "We thought fizzy water would be neutral because it's just water, but it went pinkish so it's slightly acidic." (Carbon dioxide dissolves in water and makes it slightly acidic — the same idea as the bromothymol blue tubes in grade 7.)
2. **Salt solution and tap water look the same as vinegar. Why can't we use our eyes?** Example answer: "Acids and alkalis are often colourless; you can only tell with a test."
3. **Is lemon juice dangerous? Is washing soda safe?** Example answer: "Lemon juice is an acid but we eat it, so not all acids are dangerous. Washing soda is an alkali and it can hurt your eyes and skin, so alkalis are not automatically safe." (Strength and concentration matter more than the label "acid" or "alkali".)
4. **Did the cabbage turn the vinegar into an acid?** Example answer: "No. The vinegar was already an acid. The cabbage just shows it by changing colour."

✓ Closing check (5 min, answers below)

1. What is an indicator?

2. A liquid turns cabbage indicator green. Is it acidic, neutral or alkaline?
3. Name one acidic and one alkaline liquid from today.

Answers: 1. A substance (often a dye) that changes colour depending on whether a liquid is acidic, neutral or alkaline. 2. Alkaline. 3. Acidic: lemon juice, vinegar or fizzy water. Alkaline: baking soda solution, milk of magnesia or washing soda solution.

Vocabulary

acid, alkali, neutral, indicator, pigment, anthocyanin, prediction

Differentiation

- **Support:** give a printed colour strip (red → purple → green → yellow) with "acid", "neutral" and "alkali" labels to match against. Reduce to five liquids (A, B, D, F, H).
- **Stretch:** try other coloured plant juices the teacher has prepared (for example blueberry juice) and compare them with cabbage. Blueberry juice also turns redder with acid and more blue-violet with alkali. Which indicator shows the difference more clearly?

⚠ Safety

- Eye protection on throughout. If anything goes in an eye, rinse with plenty of clean water and tell the teacher.
- **Never taste** any liquid in the lab, even ones that are food at home.
- The teacher handles the kettle and hot water. Let the extract cool before students use it.
- Washing soda solution is an irritant: the teacher makes it up dilute, students wear eye protection, and spills are wiped up straight away. Wash hands after the lesson.
- **Never use bleach, oven cleaner or drain cleaner** in this lesson. Drain cleaners often contain sodium hydroxide, which is highly corrosive. Never mix household cleaning products.
- Cabbage extract stains clothes and benches; use trays.

Teacher notes and misconceptions

- **"All acids burn."** Many acids are weak or dilute and are in food (citric acid in lemons, acetic acid in vinegar). Strong, concentrated acids are dangerous.
- **"Alkalis are safe because they're not acids."** Strong alkalis such as sodium hydroxide are as dangerous as strong acids.
- **"Neutral means no chemicals in it."** Salt solution is neutral and is full of dissolved salt. Neutral describes acidity, not purity.
- **"The indicator makes the liquid acidic."** The indicator only shows what is already there.
- Fizzy water loses its carbon dioxide once opened, so it may drift towards purple over a lesson. Open it just before use.
- Milk of magnesia is cloudy; let it settle a moment and look at the colour of the liquid above, or dilute it more.

Lesson 2 — The pH scale and universal indicator

Back to unit

Goal

Students use universal indicator to give liquids a pH number, place them on the 0–14 scale, and compare three indicators (cabbage, litmus, universal indicator) to see what each can and cannot tell us.

Materials

- Eye protection for everyone.
- Per group: universal indicator paper cut into 1 cm strips (or universal indicator solution and a spotting tile), the colour chart supplied with it, tweezers or a glass rod, a white tile.
- Red and blue litmus paper (a few strips per group).
- The eight liquids from lesson 1 (A–H), freshly poured.
- A long paper strip or masking tape line across the board, marked 0 to 14.
- "pH cards" for the closing sort (see Main activity part 4).

Steps

✎ Opening (5 min)

Show last lesson's cabbage results. Ask: "Lemon juice and fizzy water were both 'acid'. Are they equally acidic? How could we tell?" Take ideas. Explain that scientists use a number scale, the **pH scale**, which usually runs from 0 to 14:

- below 7 = **acidic** (the lower the number, the more acidic)
- 7 = **neutral** (pure water at room temperature)
- above 7 = **alkaline** (the higher the number, the more alkaline)

✎ Main activity (30 min)

1. **Universal indicator (15 min).** Universal indicator is a mixture of several indicators, so it changes through many colours instead of two or three. Show the colour chart: red, orange and yellow mean acidic; green means neutral; blue and violet mean alkaline. For each liquid, dip a rod in and touch it onto a fresh strip of paper (or add 2 drops of indicator solution to a few drops of liquid). Match the colour to the chart **within 30 seconds** and record the pH number.

Liquid	Cabbage group (lesson 1)	Universal indicator colour	pH (from chart)
A lemon juice			
B vinegar			
C fizzy water			

Liquid	Cabbage group (lesson 1)	Universal indicator colour	pH (from chart)
D tap water			
E salt solution			
F baking soda			
G milk of magnesia			
H washing soda			

1. **Line them up (5 min).** Each group sends one person to stick a label for each liquid on the class 0–14 line. Discuss disagreements: "Why might two groups get different numbers for the same liquid?" (Reading colours is a judgement; strips can be left too long; liquids were poured at different times.) Agree a class value for each liquid and mark ranges where groups disagree.
2. **Litmus: a yes/no indicator (5 min).** Give red and blue litmus paper. Students test lemon juice, salt solution and baking soda solution. Blue litmus turns red in acid; red litmus turns blue in alkali; in a neutral liquid neither changes much. Ask: "What can universal indicator tell you that litmus can't?" (How acidic or alkaline: a number, not just acid or alkali.)
3. **pH cards (5 min).** Groups place these cards on the class line. The values are typical figures from reference sources:
4. pure water: 7
5. human blood: about 7.4 (slightly alkaline)
6. seawater: about 8.05 (slightly alkaline)
7. most drinking water: between 6.5 and 8.5
8. acid rain: on average about 4 to 5
9. citrus fruit and vinegar: below 4.6

✓ Discussion questions (10 min)

1. **Which indicator would you choose to check whether a swimming pool is slightly too acidic, and why?** Example answer: "Universal indicator, because it gives a number. Litmus would only say acid or not."
2. **Blood is about 7.4. Is blood acidic, neutral or alkaline?** Example answer: "Slightly alkaline, because it's just above 7."
3. **Acid rain has a pH of about 4 to 5. Why might that harm a lake?** Example answer: "It makes the lake water more acidic than normal, and the living things there are used to water around neutral." (Acid rain is linked to harm to fish, forests and soils.)
4. **Some indicators have only two colours (litmus; phenolphthalein, which is colourless in acid and pink in alkali). Why might a scientist still use them?** Example answer: "When you only need to know if you've gone past a certain point, like when an acid has been neutralised, a sharp change from one colour to another is easier to see."

✓ Closing check (5 min, answers below)

1. A liquid has pH 3. Another has pH 6. Which is more acidic?
2. What colour would universal indicator turn in a neutral liquid?

3. Give one advantage of universal indicator over litmus.

Answers: 1. pH 3 (lower number = more acidic). 2. Green. 3. It shows how acidic or alkaline something is (a pH number), not just whether it is acidic or alkaline.

Vocabulary

pH, pH scale, universal indicator, litmus, phenolphthalein, colour chart, range

Differentiation

- **Support:** give a pre-printed 0–14 line coloured like the universal indicator chart, with "acid", "neutral" and "alkali" bands. Students stick small coloured dots for each liquid.
- **Stretch:** the pH scale is not like a ruler. Each step of 1 means a **tenfold** change in acidity. So pH 3 is 10 times more acidic than pH 4, and 100 times more acidic than pH 5. How many times more acidic is acid rain at pH 4 than water at pH 6? (100 times.) This is a simplified introduction; the reason (hydrogen ion concentration and logarithms) comes in later grades.

⚠ Safety

- Eye protection on throughout.
- Never taste the liquids. Universal indicator solution is often made in alcohol, which is flammable: keep it away from flames.
- Universal indicator and cabbage stain skin; use tweezers or a rod, not fingers. Wash hands at the end.
- Dispose of used strips in the bin, not the sink.

Teacher notes and misconceptions

- **"pH 7 always means water."** pH 7 means neutral; salt solution is also about 7.
- **"A higher pH number means more acid."** It is the opposite. Many students think "higher = more". Use the line repeatedly.
- **"The pH scale stops at 0 and 14."** It is usually drawn from 0 to 14, but very concentrated strong acids and alkalis can go beyond it. Mention only if students ask.
- Universal indicator paper keeps changing colour if left; reading quickly matters.
- Tap water results vary by area. Accept your own measured value.

Lesson 3 — Cancelling out: neutralisation by drops

Back to unit

Goal

Students neutralise an acid by adding an alkaline solution drop by drop, watching the indicator change, and carry out a repeated, fair comparison of two acids (vinegar and lemon juice) using the median number of drops.

Materials

- Eye protection for everyone.
- Per group: two clear cups or small beakers; a white tile or paper underneath; two 10 ml plastic syringes (no needles) or small measuring cylinders; one dropper used only for the baking soda solution; cabbage indicator from lesson 1; a stirring rod or spoon; a record table.
- White vinegar and lemon juice (bottled lemon juice gives more consistent results than fresh lemons).
- Baking soda solution: 1 level teaspoon (about 5 g) sodium hydrogencarbonate stirred into 100 ml water, made up fresh. Make one large batch for the whole class so every group uses the same solution.
- Water for diluting.

Teacher trial: do the whole method the day before. With 1 ml of acid, expect something in the region of 20–40 drops, but the number depends on your vinegar (vinegar can contain anywhere from about 4% to 18% acetic acid), your lemon juice, your teaspoon and your dropper. Adjust the acid volume so groups need roughly 15–40 drops.

Steps

✎ Opening (5 min)

Recap: acids are below 7, alkalis above 7. Ask: "What do you think happens if you mix an acid and an alkali?" Take predictions ("they explode", "they fizz", "you get something in the middle"). Tell students they will find out, and count exactly how much it takes.

✎ Main activity (30 min)

1. **Watch it happen (teacher demo, 5 min).** Put 1 ml of vinegar and 10 ml of water in a cup with 10 drops of cabbage indicator: it is pink-red. Add baking soda solution a few drops at a time, swirling. Students see:
2. **fizzing** — a gas is given off (carbon dioxide; links to grade 5's bicarbonate and vinegar balloon);
3. the colour moving from pink towards **purple** (neutral);

4. if you keep going, it turns **blue-green** (now alkaline: too much has been added).

Explain: the acid and the alkali **cancel each other out**. This is called **neutralisation**. The general word equation is:

acid + alkali → salt + water

Baking soda is a hydrogencarbonate, so here there is also a gas:

acid + hydrogencarbonate → salt + water + carbon dioxide

("Salt" is a family of substances; table salt is only one of them.)

1. **The question (2 min).** "Which needs more baking soda solution to neutralise it: 1 ml of vinegar or 1 ml of lemon juice?" Students predict and give a reason.
2. **Plan it fairly (3 min).** Ask what must stay the same: the volume of acid (1 ml, measured with a syringe), the added water (10 ml), the number of indicator drops (10), the same dropper, the same baking soda batch, and the same end point (**the first time the colour stays purple for 10 seconds after swirling**). What changes: the type of acid. What we measure: the number of drops.
3. **Do it (15 min).** Each group does **three repeats for each acid**, rinsing the cup between runs. Add one drop at a time, swirl, wait, then add the next.

Acid	Run 1 (drops)	Run 2	Run 3	Median
Vinegar				
Lemon juice				

Example results (made-up numbers to show the method, not a prediction):

Acid	Run 1	Run 2	Run 3	Median
Vinegar	31	29	30	**30**
Lemon juice	25	27	41	**27**

Point out the 41: it is far from the other two. The group probably overshot the purple and went into blue. The median (27) is not dragged up by the mistake, which is why we use it.

1. **Conclude (5 min).** Each group writes one sentence: "The ___ needed more drops of baking soda solution (median ___ drops compared with ___), so 1 ml of it contained more acid to cancel out." Compare across groups. Do all groups agree on which needs more?

✓ Discussion questions (10 min)

1. **Why do we count drops instead of just saying "a bit more"?** Example answer: "Numbers let us compare fairly and check if other groups got the same result."
2. **Why did we use the same baking soda batch and the same dropper for everyone?** Example answer: "If one group's solution was stronger or their drops were bigger, they'd need fewer drops, and it wouldn't be a fair comparison."
3. **When the mixture is purple, are there still chemicals in it?** Example answer: "Yes. There's water and a salt dissolved in it. Neutral doesn't mean empty."

4. **Where did the fizz come from, and where did it go?** Example answer: "Carbon dioxide gas was made when the baking soda reacted with the acid, and it escaped into the air."

✓ Closing check (5 min, answers below)

1. Complete: acid + alkali → _____ + _____.
2. A group's results for one acid are 18, 19 and 33 drops. What is the median, and which result is probably a mistake?
3. What colour shows that the cabbage-indicator mixture has just been neutralised?

Answers: 1. Salt + water. 2. Median 19; the 33 is probably a mistake (overshooting the end point). 3. Purple.

Vocabulary

neutralisation, salt, word equation, end point, hydrogencarbonate, carbon dioxide, median, repeat

Differentiation

- **Support:** give a step card with pictures (measure 1 ml → add 10 ml water → add 10 drops indicator → add baking soda one drop at a time → stop at purple). Do two repeats instead of three.
- **Stretch:** name the salts. Vinegar contains acetic acid, so the salt is sodium acetate; lemon juice contains mainly citric acid, so the salt is sodium citrate. Why might two acids need different amounts even if they are the same volume? (They may be different concentrations, and different acids can cancel out different amounts of alkali per molecule. This is covered properly in grades 9–10.)

⚠ Safety

- Eye protection on throughout.
- Syringes have **no needles**.
- Never taste any mixture, even though the ingredients come from a kitchen.
- Wipe spills straight away; the fizzing mixture can bubble over if baking soda is added too fast.
- Mixtures can go down the sink with plenty of water. Wash hands at the end.

Teacher notes and misconceptions

- **"Neutralisation destroys the chemicals."** It makes new substances (a salt and water, plus carbon dioxide here). Mass is not lost; the carbon dioxide escapes into the air.
- **"Acid + alkali always fizzes."** Only acids with carbonates or hydrogencarbonates give carbon dioxide. Acid + an alkali such as sodium hydroxide gives no gas.
- **"Purple means pure water."** It means neutral.

- Overshooting is the most common error: insist on one drop at a time near the end, and swirling. The colour change near neutral can be gradual; agree as a class what "purple" looks like by keeping one neutral cup (salt solution + indicator) as a reference.
- Results differ between brands of vinegar and lemon juice, so the class answer is "which needed more with our bottles", not a general rule.

Lesson 4 — Neutralisation at work: stomachs, soils and seas

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Goal

Students measure the pH of real soil samples, watch a model of how an antacid works, and use real data to explain what "ocean acidification" means and what it does not mean.

Materials

- Eye protection for everyone.
- Three soil samples, labelled X, Y and Z, collected by the teacher (for example: garden or field soil, peat-free compost, and soil from under conifers or from a heather or rhododendron bed if available). About 2 tablespoons of each per group.
- Per group: three clear cups or jars with lids, distilled or deionised water (tap water can change the result), filter paper and a funnel (or a coffee filter), universal indicator paper and chart, a teaspoon, a record table.
- Teacher demonstration: a clear jug or large beaker, white vinegar diluted about 1 part to 10 parts water, cabbage indicator, and either one antacid tablet or 1–2 teaspoons of milk of magnesia.
- Printed ocean pH card (see part 3).

Steps

✎ Opening (5 min)

Ask: "Where outside a lab might people want to neutralise something?" Take ideas. Introduce the three places in today's lesson: **inside your stomach, in the soil, and in the sea.**

✎ Main activity (30 min)

1. **Soil pH (15 min).**
2. Put 1 heaped teaspoon of soil in a cup. Add about 50 ml of distilled water. Put the lid on and shake for 30 seconds. Leave it to settle for 5 minutes.
3. Filter the cloudy water into a clean cup (it does not have to be perfectly clear).
4. Test the liquid with universal indicator paper. Record the colour and pH.
5. Repeat for all three soils.

Soil	Where it came from	Indicator colour	pH
X			
Y			
Z			

Then share some facts about soils: - Soil pH matters because it controls which nutrients plants can take up. Most plants grow best between about **pH 5.5 and 7.5**. - Some plants prefer **acidic** soil: rhododendrons, heathers (Erica), Scots pine. Others prefer **limey (alkaline)** soil: ash trees, lilac, clematis. - Farmers and gardeners can **neutralise acidic soil** by adding lime (calcium hydroxide) or crushed limestone (calcium carbonate). Soil that is too alkaline can be made more acidic with sulfur.

Ask: "Which of our soils would suit a rhododendron? Which would a farmer want to lime?"

1. **A model of an antacid (teacher demo, 7 min).** Explain: your stomach makes acid to help digest food. Sometimes it causes discomfort (heartburn, indigestion). An **antacid** is a medicine that neutralises some of the stomach acid. Many contain an alkaline substance such as magnesium hydroxide (milk of magnesia) or a carbonate.
2. Pour the dilute vinegar into the jug and add cabbage indicator: pink-red. "This is our pretend stomach acid." (Real stomach acid is hydrochloric acid and much more acidic. Vinegar is only a safe stand-in.)
3. Crush and add the antacid tablet, or stir in the milk of magnesia. Stir and wait. The colour moves towards purple, or beyond into blue. If the tablet contains a carbonate, it fizzes.

4. Ask: "Which word equation from last lesson is this?" (acid + alkali → salt + water; with a carbonate, also carbon dioxide.)

5. **What is happening to the sea? (8 min).** Hand out the ocean pH card:

   Between 1950 and today, the average pH of the ocean surface fell from about **8.15** to about **8.05**. The main cause is carbon dioxide from human activities: some of the extra carbon dioxide in the air dissolves in the sea and makes it slightly more acidic. Seawater is **still alkaline** (above pH 8). This change is called **ocean acidification**. Animals that build shells or skeletons from calcium carbonate, such as corals and molluscs, are especially at risk.

Link to grade 7: the bromothymol blue tubes turned yellow when students breathed carbon dioxide into them. The same thing happens, very slowly, to the ocean.

Ask: "Is the sea now acidic?" (No. It is still alkaline, just less alkaline than before. "Acidification" means moving towards the acidic end, not arriving there.)

✓ Discussion questions (10 min)

1. **Why did we shake the soil with distilled water instead of tap water?** Example answer: "Tap water has its own pH, which might change the result. Distilled water doesn't add anything."
2. **A gardener's soil is pH 4.5 and her vegetables grow badly. What could she do, and why does it work?** Example answer: "Add lime. It's alkaline, so it neutralises some of the acid in the soil and raises the pH towards the 5.5 to 7.5 that most plants like."
3. **Why is vinegar only a model of stomach acid?** Example answer: "Real stomach acid is a different, stronger acid. Vinegar is safe to use in class, but it doesn't behave exactly the same."

4. **A headline says "The oceans are turning to acid." What is right and wrong about it?** Example answer: "Right: the pH is going down, so the sea is becoming more acidic. Wrong: the sea is still alkaline, above 8, not an acid."

✓ Closing check (5 min, answers below)

1. What type of substance is used to treat soil that is too acidic?
2. What does an antacid do in the stomach?
3. The ocean's surface pH went from about 8.15 to about 8.05. Did it become more acidic or more alkaline? Is it acidic now?

Answers: 1. An alkaline substance or a carbonate, such as lime or crushed limestone. 2. It neutralises some of the stomach acid. 3. More acidic (the pH went down); no, it is still alkaline (above 7).

Vocabulary

soil pH, lime, limestone, antacid, indigestion, ocean acidification, calcium carbonate, model

Differentiation

- **Support:** test two soils instead of three; give a sentence frame for the ocean question ("The pH went ___, so the sea became more ___. It is still ___ because its pH is above 7.").
- **Stretch:** the ocean's pH fell by only 0.1. Using the "each step of 1 is ten times" rule from lesson 2, a drop of 0.1 is about a 26% increase in acidity (because 10 to the power 0.1 is about 1.26). Why might a small-looking change in pH still matter to sea life? Acid rain (lesson 2) has been reduced in Europe and North America since the 1970s by laws cutting sulfur dioxide and nitrogen oxide emissions. What would cutting ocean acidification need?

⚠ Safety

- Eye protection on throughout.
- **Students do not handle antacid tablets or other medicines.** The teacher does the antacid demonstration and disposes of any leftover tablet safely. Students should never take medicine without an adult's permission.
- Wear gloves or wash hands well after handling soil. Collect soil only from places free of animal droppings, sharp objects and garden chemicals. Cover cuts.
- Never taste any of the mixtures.

Teacher notes and misconceptions

- **"Ocean acidification means the sea is acid."** The sea is still alkaline; the pH is falling.
- **"Plants all like neutral soil."** Many plants are adapted to acidic or alkaline soils; the "best" pH depends on the plant.
- **"Antacids get rid of all the acid."** They neutralise some of it; the stomach needs acid to digest food.

- Soil results depend on the soil-to-water ratio and on the soil itself. A cheap soil-testing kit from a garden centre can be used instead of indicator paper.
- If compost results look surprising, that is a good discussion point: many composts and potting mixes are deliberately adjusted by the manufacturer.

Lesson 5 — Acids and alkalis in the world + unit check

Back to unit

Goal

Students pull the unit together by sorting real-life situations, then complete a 10-question unit check (20 marks).

Materials

- A set of 10 situation cards per group (listed below).
- Three large labels per group: ACIDIC, NEUTRAL, ALKALINE, plus a fourth: NEUTRALISATION.
- Printed unit check (questions below), one per student.

Steps

✎ Opening (5 min)

Quick-fire recall: teacher calls out a colour and an indicator ("green with universal indicator", "pink with cabbage", "red litmus turns blue") and students hold up A (acid), N (neutral) or K (alkali) cards.

✎ Main activity: situation sort (15 min)

Groups place each card under ACIDIC, NEUTRAL, ALKALINE or NEUTRALISATION and write one reason on a sticky note.

1. Lemon juice in a salad dressing. (Acidic: citric acid.)
2. A bottle of drain cleaner containing sodium hydroxide. (Alkaline, and highly corrosive.)
3. Salt dissolved in pure water. (Neutral.)
4. A person takes an antacid for indigestion. (Neutralisation.)
5. Rain with a pH of 4.5 falling on a forest. (Acidic: acid rain.)
6. A farmer spreading crushed limestone on a field. (Neutralisation of acidic soil.)
7. Human blood at pH about 7.4. (Slightly alkaline.)
8. Vinegar used to pickle vegetables. (Acidic: acetic acid.)
9. Seawater at pH about 8.05. (Alkaline, though becoming less so.)
10. Baking soda added to a cake mixture with an acidic ingredient so that it fizzes and rises. (Neutralisation, giving carbon dioxide.)

Discuss: card 2 and card 1 are both "chemicals from home", but one is food and one is dangerous. What makes the difference? (Strength and concentration, not whether it is an acid or alkali.)

✓ Unit check (25 min)

Students work alone. Calculators are not needed.

Q1. What is an indicator? (2 marks)

Q2. Red cabbage indicator turns: red/pink in liquid P, purple in liquid Q, green in liquid R. Label each as acidic, neutral or alkaline. (2 marks)

Q3. Put these in order from most acidic to most alkaline: blood (pH about 7.4), lemon juice (pH about 2.2), pure water (pH 7), acid rain (pH about 4.5 to 5), washing soda solution (strongly alkaline). (2 marks)

Q4. Give one advantage of universal indicator over litmus paper. (2 marks)

Q5. Complete the word equations. (2 marks) (a) acid + alkali → _____ + _____ (b) acid + hydrogencarbonate → salt + water + _____

Q6. A group neutralised 1 ml of vinegar with baking soda solution three times. They needed 22, 24 and 37 drops. (a) What is the median? (1 mark) (b) Which result is probably a mistake, and what might have caused it? (1 mark)

Q7. In the neutralisation investigation, name two things that must be kept the same to make it a fair comparison. (2 marks)

Q8. A gardener tests her soil and finds it is pH 4.5. Most of her plants grow best between pH 5.5 and 7.5. What could she add, and why does it work? (2 marks)

Q9. A student says: "Alkalis are safe, it's acids you have to be careful with." Do you agree? Explain with an example. (2 marks)

Q10. A news article says: "Ocean acidification means the sea has become an acid." The ocean's average surface pH has fallen from about 8.15 to about 8.05. Explain what is right and what is wrong in the article. (2 marks)

Answer guide and marking notes

Q1. 1 mark: a substance that changes colour. 1 mark: depending on whether a liquid is acidic, neutral or alkaline (or depending on pH). "A colour" alone = 0.

Q2. All three correct (P acidic, Q neutral, R alkaline) = 2 marks; two correct = 1 mark.

Q3. Correct order: lemon juice, acid rain, pure water, blood, washing soda solution. 2 marks for the full order; 1 mark if only one adjacent pair is swapped. (Lemon juice at about pH 2.2 is clearly more acidic than acid rain at about 4.5 to 5. The 2.2 figure is from the Wikipedia "PH" article; real lemons vary a little.)

Q4. 1 mark: universal indicator gives a pH number / shows how acidic or alkaline. 1 mark: litmus only shows acid or alkali (or a full comparison sentence).

Q5. (a) salt + water (1 mark for both). (b) carbon dioxide (1 mark).

Q6. (a) 24. (b) 37; overshooting the end point / adding too many drops past purple / adding drops too quickly (any sensible cause).

Q7. Any two, 1 mark each: volume of acid; volume of added water; number of indicator drops; same dropper; same baking soda solution / batch; same end point colour. "The amount" without saying of what = 0.

Q8. 1 mark: lime / crushed limestone / an alkali or a carbonate. 1 mark: it neutralises some of the acid in the soil and raises the pH (towards 5.5–7.5).

Q9. 1 mark: disagree. 1 mark: an example, such as sodium hydroxide / drain cleaner is a highly corrosive alkali; or washing soda can irritate eyes and skin. Accept "it depends on strength and concentration" with an example.

Q10. 1 mark (right): the pH has fallen, so the sea has become more acidic. 1 mark (wrong): seawater is still alkaline (pH above 7, about 8), so it is not an acid.

Total: 20 marks. No pass mark is set; use the results to see which ideas need revisiting. Common gaps to look for: thinking a higher pH means more acidic (Q3); thinking neutralisation needs no measuring (Q6–Q7); thinking "acidification" means "acidic" (Q10).

Vocabulary review

acid, alkali, neutral, indicator, pH scale, universal indicator, litmus, neutralisation, salt, antacid, lime, ocean acidification

Differentiation

- **Support:** read questions aloud; provide the word bank above; allow Q3 to be done by placing labelled cards on a pH line.
- **Stretch:** add a bonus question (not marked out of 20): "Acid rain at pH 4 is how many times more acidic than water at pH 6?" (100 times.)

⚠ Safety

- No practical work in this lesson.

Teacher notes

- Card 10 (baking soda in a cake) links to the sodium bicarbonate fact that baking powder contains an acid ingredient so that the reaction happens without adding vinegar.
- Card 9's pH figure and Q10's figures come from the Wikipedia "Ocean acidification" article (see unit sources); check a current scientific source before quoting them as exact.
- If students did not get clear results in lesson 3, let them use the example data table from lesson 3 for Q6–Q7 discussion afterwards.

From claim to conclusion: checking information

Subject: History, geography and society Grade: 8 Lessons: 5 Time per lesson: about 55–60 minutes

Status: written (unreviewed AI draft; not human-educator-reviewed or classroom-tested)

Author: GPT-5.6 Sol

Big idea

A careful conclusion connects a precise claim to relevant evidence whose origin, date, context and independence have been checked. Good investigators also say what remains uncertain and what new evidence could change their conclusion.

What students should be able to do

- Distinguish a claim, a piece of evidence and an inference, and test whether evidence supports the precise claim made.
- Trace information toward its original source while separating source type, firsthand access, expertise and reliability.
- Check event, observation, publication and update dates and restore missing quotation or image context.
- Corroborate across genuinely independent sources and detect several reports that all repeat one source.
- Communicate a calibrated conclusion—supported, contradicted or not enough information—and name evidence that could change it.

What students should already know

Students should be able to summarize a short paragraph, compare two statements and explain a reason in a complete sentence. No live-web research skill is assumed.

Use this short diagnostic as a conversation, not an admission gate:

1. “The path is wet” is written in a note. Is that sentence a claim, evidence, or both?
2. Two posts repeat the same sentence. Must that mean two people checked it?
3. What is one question to ask before sharing an old photograph as current?

Diagnostic guide: (1) It is a claim in the note; the note itself can also be evidence that someone made that claim. It is not automatically proof that the path was wet. (2) No; both may copy one source. (3) Ask when the scene was observed or photographed, not only when a repost was published. Accept equivalent questions. Revisit these distinctions during the unit rather than excluding students.

Lesson list

1. Claim, evidence, inference: separate the three roles and test relevance to a precise claim.

2. Follow the information trail: trace provenance and ask what a source could directly know.
3. Date and context: distinguish four kinds of time and restore cropped context.
4. Independent corroboration: compare sources without double-counting copies.
5. A conclusion with room to change: synthesize an evidence packet and complete an eight-task assessment.

Materials (whole unit)

Printed or digital copies of the fictional source cards in each lesson, paper or note-taking device, highlighters or tactile markers, and a board. All cards are included as plain text. Offer large print, screen-reader-compatible text and oral response. No live internet, account, purchase, personal data or image file is required.

Assessment

Lesson 5 contains a compact fictional evidence packet, eight checkable tasks and a worked guide. Students may respond in writing, orally or with a structured table; do not score speed, handwriting or accent. Judge each claim-evidence connection separately. There is no validated pass threshold, and this short assessment does not measure all information-literacy skills.

Sources

Consulted November 4, 2026:

- Civic Online Reasoning, Digital Inquiry Group (formerly Stanford History Education Group) informed the emphasis on leaving an unfamiliar page to investigate its source and compare independent coverage. This is a pedagogical influence, not a claim of alignment or endorsement.
- Library of Congress primary-source analysis guides informed the observe–reflect–question pattern and attention to what a source shows versus what a reader infers.
- UNESCO Media and Information Literate Citizens curriculum informed the broader emphasis on evaluating, using and communicating information responsibly.

All fictional cards, cases, questions and explanations in this unit are original CC0 material. Linked works remain under their own terms.

Known gaps and cautions

Pacing and reading load are untested. A qualified local educator should check language, accessibility, cultural context and curriculum requirements before classroom use. Agent peer review is not human educator review.

The unit uses prepared text rather than a changing live web, does not cover advanced verification such as geolocation or forensic media analysis, and cannot make students immune to deception. It deliberately avoids classifying whole sources as simply “good” or “bad”: reliability depends on the particular claim, method and context. Credentials, source type, domain name, polish, popularity, search rank, screenshots and repetition are clues, not automatic proof. Safety examples avoid real-person accusations and political persuasion; teachers should not substitute sensitive local rumors without appropriate safeguards.

Lesson 1: Claim, evidence, inference

Time: about 55–60 minutes (untested estimate)

Status: unreviewed AI draft; not classroom-tested. Author: GPT-5.6 Sol.

Goal

Distinguish claims, evidence and inferences, then decide whether evidence supports the precise claim being evaluated.

Materials

Lesson cards below, paper or note-taking device, and optional three-column organizer labelled Claim / Evidence / Inference.

Steps

✎ 1. Opening — 7 minutes

Display: “The courtyard fountain was running at 08:10.” Ask students to underline what would need checking. Then add: “Amina wrote at 08:12, ‘I heard splashing through the library window.’” Ask: What does the message support directly, and what still requires an inference?

2. Build the distinctions — 10 minutes

Use these working definitions:

- A **claim** is a statement that could be accepted, rejected or left uncertain.
- **Evidence** is information used to evaluate a claim. Evidence can be strong for one claim and weak for another.
- An **inference** is a reasoned step from evidence toward a conclusion.

The message is direct evidence that Amina reported hearing splashing. Inferring that the fountain caused it is plausible, but a sprinkler, rain or another source could also explain the sound. A message can be evidence that a person made a claim without proving that the claim is true.

3. Card sort — 15 minutes

Read the fictional case:

Claim C: “The north greenhouse exceeded 30°C before noon on Tuesday.”

- **Card A:** A calibrated thermometer log says “North greenhouse, Tuesday, 11:40, 32°C.” The custodian signed the entry at 11:41.
- **Card B:** A student says on Wednesday, “The greenhouse always feels hot.”
- **Card C:** The south greenhouse log says “Tuesday, 11:40, 32°C.”
- **Card D:** A Tuesday photograph shows condensation on the north greenhouse windows; no clock or thermometer is visible.

- **Card E:** The north greenhouse door was open at 12:20 Tuesday.

For each card, students choose: relevant direct support, relevant but indirect, irrelevant to this precise claim, or potentially contradictory. They must complete: “This card shows ___; to reach the claim, I would also have to assume ___.”

4. Discussion — 8 minutes

Ask:

1. Which card most directly supports Claim C? **Example good answer:** A, because it names the correct place, date, time and measurement; calibration and record integrity could still be checked.
2. Why is Card C not support? **Example:** It measures the wrong greenhouse.
3. Does Card D prove the temperature exceeded 30°C? **Example:** No. Condensation has multiple possible causes and supplies no temperature or time.
4. Can one item play more than one role? **Example:** Yes. The log entry is evidence in our investigation and contains a claim about a measurement.

✎ 5. Independent practice — 12 minutes

Evaluate: **Claim D:** “The community garden received no visitors between 14:00 and 15:00.”

- Gate counter recorded zero badge entries in that hour.
- A sign says the garden also has an unmonitored side gate.
- A camera covering both gates operated continuously and shows nobody entering or leaving; it does not show the whole garden.
- A volunteer saw no one near the tool shed at 14:30.

Students label each item and write a calibrated conclusion. Emphasize that **absence of evidence** (no badge entries in an incomplete system) is not automatically **evidence of absence**. A continuous camera covering every entrance would be evidence of no entry, but still would not prove nobody was already inside.

✓ 6. Closing check — 5 minutes

1. “Three people reposted the same weather claim.” Is the number of reposts evidence that three checks occurred?
2. Name one missing fact that would make Card A stronger.

Answer guide

- Opening: The report directly supports “Amina reported hearing splashing around 08:10.” Fountain operation is an inference needing another check.
- Card sort: A = relevant direct support; B = weak/indirect and vague; C = irrelevant to the north greenhouse; D = indirect and insufficient; E = not evidence for the before-noon temperature.
- Claim D: badge data alone is incomplete; tool-shed observation covers one place and time; the camera strengthens “no one entered or left,” but none proves no visitor was already

inside. Best conclusion: not enough information for “no visitors.” A full-site continuous record or start/end sweep could change it.
- Closing 1: No; the posts may repeat one source. 2: Examples include thermometer calibration, whether “32°C” was read correctly, or whether the entry was made at the stated time.

Vocabulary

- **Claim:** a checkable statement.
- **Evidence:** information used to evaluate a claim.
- **Inference:** a reasoned step beyond what is directly observed.
- **Relevant:** bearing on the precise claim being tested.

Differentiation

- **Extra support:** color-code who/what, place and time in both claim and card; allow oral sorting with physical labels.
- **Extra challenge:** rewrite Claim C into a narrower claim supported directly by Card A, then list two ways the record could still be mistaken.

⚠ Safety

Cases are fictional. Do not replace them with accusations about classmates or ask students to disclose private messages, location histories or personal accounts.

Teacher notes

“Evidence” does not mean “proof,” and “inference” does not mean “bad guess.” Ask whether the reasoning is warranted and what alternatives remain. A polished document, confident tone or screenshot can still contain an unsupported claim.

Unit overview · Next lesson

Lesson 2: Follow the information trail

Time: about 55–60 minutes (untested estimate)

Status: unreviewed AI draft; not classroom-tested. Author: GPT-5.6 Sol.

Goal

Trace a statement toward its original source and separate source type, access, expertise and reliability for a particular claim.

Materials

Source-chain cards below and a four-column organizer: Source / Obtained from / Could directly know / Remaining question.

Steps

✎ 1. Opening — 6 minutes

Display: “A highly ranked result with a professional logo says the bridge opened in 1924.” Ask students for clues they notice, then ask which clue actually establishes the opening year. Explain that rank, design, URL ending, popularity and confident wording may guide questions but do not settle the claim.

2. Provenance model — 10 minutes

Define **provenance** as the path showing where information came from and how it changed. Model the difference between:

- source type: diary, database, news report, summary, repost;
- firsthand access: whether the source observed or created the relevant record;
- expertise: knowledge or method relevant to interpreting it;
- reliability for this claim: the final judgment after checking the above.

A firsthand witness may misremember. An expert may rely on incomplete data. A later summary may accurately quote an original. Do not label a whole source “good” or “bad.”

3. Trace the chain — 18 minutes

All cards are fictional:

- **Card 1 — QuickFacts page, updated 2026:** “Silver Span opened in 1924,” followed by “Source: City Heritage Bulletin.”
- **Card 2 — City Heritage Bulletin, 2008:** “The bridge opened in 1924, according to historian L. Chen’s booklet River Crossings.”
- **Card 3 — River Crossings, 1986:** “A ceremony took place in 1924,” citing Archive Folder B-17.

- **Card 4 — Folder B-17:** invitation dated 3 May 1924: “Join us for the ceremonial laying of the final stone.”
- **Card 5 — Transport ledger:** first toll collected 18 November 1925.

Students draw arrows showing who cites whom. Ask which card is closest to the 1924 event, and whether it supports “opened.”

Example good answer: Card 4 is contemporaneous but describes a construction ceremony, not opening to traffic. Card 5 directly records operational use in 1925. The chain appears to have changed “final stone ceremony” into “opened.”

4. Source capability questions — 8 minutes

For Cards 4 and 5 ask:

1. What could the creator directly know?
2. Why was it created?
3. What claim does it not settle?

Example answers: The invitation establishes an announced ceremony and date, not that it occurred or that traffic began. The ledger records a toll entry and operational context, but it may not identify the first untolled crossing.

✎ 5. Independent practice — 12 minutes

Trace this second chain:

- A class poster says a pond has 14 frog species.
- Its footnote links to a newsletter saying “up to 14 amphibian species were reported.”
- The newsletter summarizes a survey table listing 9 frog species, 3 salamanders and 2 newt species.

Students identify two transformations and rewrite the narrowest supported claim.

✓ 6. Closing check — 5 minutes

1. Is an original source automatically accurate?
2. Why might opening a cited source change a conclusion?

Answer guide

- Bridge: The 1924 opening claim is not supported by the cited chain. Card 4 supports an invitation to a final-stone ceremony; Card 5 supports at least one toll collection in 1925. Exact public-opening date remains uncertain.
- Pond: “Amphibian” became “frog,” and “reported/up to” became an exact count. Supported rewrite: “The summarized table lists 14 amphibian species: 9 frogs, 3 salamanders and 2 newts.” This assumes the summary transcribes the table accurately.
- Closing: (1) No; originals can be mistaken, incomplete, staged or misunderstood. (2) A summary may narrow, broaden or alter the original claim, and the original reveals method and context.

Vocabulary

- **Provenance:** the origin and transmission path of information.
- **Original source:** the earliest accessible source in a chain, not automatically the truth.
- **Primary source:** material created during or by participants in the period or event studied.
- **Secondary source:** later analysis or synthesis; it can be more accurate for some questions.

Differentiation

- **Extra support:** provide cards already ordered and ask students to match each quoted phrase to its source.
- **Extra challenge:** explain which combination of records could distinguish construction completion, ceremonial opening and opening to traffic.

⚠ Safety

Use the provided fictional chains. Do not ask students to log in, expose browsing histories or investigate a real individual.

Teacher notes

“Primary” and “secondary” describe relationship to an event, not quality grades. A domain suffix, institutional name, credential or professional design is not automatic proof. Students should follow citations and inspect methods rather than rely on one visual cue.

Previous lesson · Unit overview · Next lesson

Lesson 3: Date and context

Time: about 55–60 minutes (untested estimate)

Status: unreviewed AI draft; not classroom-tested. Author: GPT-5.6 Sol.

Goal

Distinguish event, observation, publication and update times, and identify context missing from cropped text or images.

Materials

Timeline and context cards below, paper, and optional four-time organizer.

Steps

✎ 1. Opening — 6 minutes

Display: “Updated today: Harbor path closed.” Ask whether “today” proves the closure began today or is still active. Collect possibilities before defining the four times.

2. Four times — 12 minutes

- **Event time:** when the thing happened.
- **Observation time:** when someone measured, saw or recorded it.
- **Publication time:** when a report became available.
- **Update time:** when a page or record was changed; the changed part may be unrelated.

A true old item can mislead when presented as current. A new post can contain an old observation. Missing or conflicting dates warrant uncertainty, not a guessed timeline.

3. Timeline case — 14 minutes

Fictional cards:

- **A:** Path inspection form: observed 2 March, 09:00; “erosion makes east section unsafe.”
- **B:** Closure notice published 2 March, 11:30; “closed until repair inspection.”
- **C:** Reopening notice published 6 March, 16:00; “east section reopens 7 March at 08:00.”
- **D:** Screenshot of B reposted 18 March with caption “Closed today.” The screenshot crop omits B’s publication date.
- **E:** Website footer says “page updated 18 March”; change log says only the contact number changed.

Students place events on a timeline and evaluate “The path was closed on 18 March.”

Example good answer: Contradicted by the reopening notice if no later closure exists; D is authentic as an old closure notice but misleading as current. E’s update date does not refresh every claim on the page.

4. Restore quotation context — 10 minutes

Full fictional report:

> “Sensor 2 showed a sharp rise at 10:05. Because maintenance staff were testing it with a heat pad, this reading should not be used as evidence of room temperature. Sensors 1 and 3 stayed between 19°C and 21°C.”

A card quotes only: “Sensor 2 showed a sharp rise at 10:05.” Students answer:

1. Is the quoted text authentic?
2. What meaning changes when the next sentence is removed?
3. What would a fair short quotation include?

Example: The words are authentic, but the crop hides the test condition and can imply real room heating. A fair summary names the heat-pad test and the other sensors.

5. Context without an image file — 10 minutes

Card F describes a crop: “A close crop shows six people beside a bus.” Full-frame description: “The uncropped frame shows a marked drill area, two instructors and a sign reading ‘evacuation practice.’” Ask what the crop establishes and what it does not.

✓ 6. Closing check — 5 minutes

Label each date type: “measured Monday; posted Tuesday; webpage footer changed Friday.” Then write one sentence about why “updated Friday” is insufficient.

Answer guide

- Opening: Updated today does not establish event time or current status; inspect the notice body and change history.
- Timeline: event/observation 2 March, closure publication 2 March, reopening publication 6 March, reopening event 7 March, repost/update 18 March. Claim of closure on 18 March is contradicted within this packet, subject to a possible unrecorded later event.
- Quote: authentic words can be misleading through omission; include the test condition.
- Crop: it supports that six people stood beside a bus at an unknown time. It does not support an emergency rather than a drill.
- Closing: Monday = observation (and possibly event), Tuesday = publication, Friday = update. Update time may concern unrelated page content.

Vocabulary

- **Context:** surrounding information needed to interpret an item fairly.
- **Crop:** a selected portion that may omit relevant surroundings.
- **Event/observation/publication/update time:** four dates that answer different questions.

Differentiation

- **Extra support:** use four differently shaped timeline markers and read each card aloud.
- **Extra challenge:** write two captions for Card D: one accurate historical caption and one current-status caption that honestly says what is unknown.

⚠ Safety

Do not use real disaster images, distressing footage or student photographs. Discuss deceptive framing without asking students to reproduce or share misinformation publicly.

Teacher notes

“Out of context” should name the missing context, not operate as a magic dismissal. Authenticity and relevance are separate. Metadata can help but may be copied or altered; treat it as evidence to corroborate, not infallible truth.

Previous lesson · Unit overview · Next lesson

Lesson 4: Independent corroboration

Time: about 55–60 minutes (untested estimate)

Status: unreviewed AI draft; not classroom-tested. Author: GPT-5.6 Sol.

Goal

Corroborate a claim across sources and avoid double-counting reports that share one origin.

Materials

Source-network cards below, paper, and optional string or arrows for a dependency map.

Steps

✎ 1. Opening — 6 minutes

Ask: “Five pages use the exact phrase ‘record-height river.’ How many independent observations might that represent?” Accept answers from one to five, then ask what would distinguish them.

2. Independence model — 10 minutes

Corroboration is stronger when sources use separate access, data or methods. Agreement among copies may reveal popularity, not independent confirmation. Students should inspect citations, identical wording, timing and shared data.

A source can be independent for one claim but dependent for another. Two analysts may independently interpret the same public dataset, yet they are not two independent measurements of the river.

3. Dependency map — 18 minutes

Claim: “The Lark River reached 8.4 metres on 12 April.”

- **A — Gauge office dataset:** automated reading 8.4 m at 06:00; maintenance log reports normal operation.
- **B — Town bulletin:** “8.4 m,” explicitly citing A.
- **C — Valley News:** repeats the bulletin and uses the phrase “record height.”
- **D — University field team:** manual staff reading 8.3 m at 06:10; method and uncertainty ±0.1 m stated.
- **E — Photo post:** water covers the third stair; no scale, time or location metadata.
- **F — Archive table:** previous documented maximum 8.7 m in 1998.

Students draw source arrows, then answer:

1. How many independent measurements directly bear on 8.4 m?
2. Is “record height” supported?

3. Why is 8.3 ±0.1 consistent with 8.4?

Example answers: A and D are two measurement paths. B and C do not add measurements. F contradicts “record” if records are comparable. D’s interval includes 8.4.

4. Corroboration plan — 8 minutes

Groups choose one next check and say how PASS and FAIL would alter the conclusion. Examples: inspect gauge calibration; obtain a third instrument reading; verify whether 1998 used the same datum. “Search for more pages” is insufficient unless the pages add independent evidence.

✎ 5. Independent practice — 10 minutes

Claim: “All four library rooms lost power at 15:00.”

- One central alarm logged loss of mains power for rooms 1–4.
- Four dashboards each display data copied from that alarm.
- A battery clock in room 3 continued running.
- A staff note says lights went out in room 2.

Students count evidence paths and identify what is and is not contradicted. The battery clock is not a contradiction: it may run without mains power.

✓ 6. Closing check — 5 minutes

Complete: “Three articles that cite the same report count as ___ independent origin(s) for the reported observation, because ___.”

Answer guide

- Opening: possibly one; identical wording and citation trails are clues of copying.
- River: two independent measurement paths (A and D); B/C are dependent. The exact 8.4 m claim is supported within stated measurement tolerance. “Record height” is contradicted by F unless datum or record scope differs. E is weak contextual evidence only.
- Library: the four dashboards are one dependent path from one alarm, not four. The staff note independently supports room 2 only. The battery clock does not test mains power. “All four” has some support from the alarm but lacks independent room-level confirmation.
- Closing: one; repetition does not create a new observation.

Vocabulary

- **Corroborate:** compare evidence from separate sources or methods.
- **Independent source:** one that does not merely derive the relevant observation from another source being counted.
- **Common-source problem:** apparent agreement produced by several reports copying one origin.
- **Uncertainty interval:** a stated range around a measurement.

Differentiation

- **Extra support:** provide arrows from B to A and C to B, then let students complete the map.
- **Extra challenge:** explain how A and D could share a hidden dependency, such as the same height reference marker, and propose a test.

⚠ Safety

Keep source mapping about fictional systems, not classmates' social networks. No live searching or public posting is required.

Teacher notes

Do not reward a raw source count. Ask what method or observation each source adds. Also avoid the opposite mistake: shared data can still support separate interpretations, but those interpretations should not be counted as separate measurements.

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Lesson 5: A conclusion with room to change

Time: about 60 minutes (untested estimate)

Status: unreviewed AI draft; not classroom-tested. Author: GPT-5.6 Sol.

Goal

Synthesize provenance, date, context and corroboration checks into a calibrated conclusion and state what evidence could change it.

Materials

Assessment packet and response prompts below. Students may use notes from earlier lessons.

Steps

✎ 1. Opening — 6 minutes

Introduce three conclusion labels:

- **Supported:** the available evidence warrants the precise claim, with stated limits.
- **Contradicted:** reliable relevant evidence conflicts with the claim.
- **Not enough information:** the available evidence does not distinguish plausible alternatives.

These labels describe the evidence packet now, not permanent truth. A strong conclusion names its scope, uncertainty and a mind-changing condition.

2. Model — 8 minutes

Claim: “The west hall opened at 09:00.” A door log records an authorized unlock at 09:00, but does not record whether the door physically opened. Model: “Not enough information. The log supports authorization at 09:00, not physical opening. A door-position sensor or contemporaneous observation could change the conclusion.”

3. End assessment — 36 minutes

All material below is fictional.

Packet: Bellweather reservoir path

Claim under review: “The reservoir walking path was continuously closed from Monday 4 May through Friday 8 May because the water level exceeded 4.0 metres.”

- **Source A — gauge export:** readings at 08:00 daily: Mon 4.2 m; Tue 4.1 m; Wed 3.9 m; Thu 3.8 m; Fri 3.7 m. The export was generated 9 May. Maintenance log says the gauge passed its 1 May check.

- **Source B — park notice published Monday 10:00:** “Path closed while the gauge is above 4.0 m. Staff will inspect after levels fall.”
- **Source C — repost published Friday:** screenshot of Source B cropped so its Monday publication date is absent; caption: “Still closed.”
- **Source D — inspection record:** observed Wednesday 14:00; “level below threshold; debris remains on east segment; next inspection Thursday morning.” Published to the records portal Thursday.
- **Source E — reopening notice:** “West and central segments reopened Thursday 12:00. East segment remains closed for debris removal.” Published Thursday 11:45.
- **Source F — two local pages:** both say “the whole path stayed closed all week” and both cite Source C; one copies the other’s wording.
- **Source G — walking-club log:** “Thursday 16:00, west segment walk, 2 km.” The club coordinator created the entry Thursday 17:10. No photograph is attached.
- **Source H — map note:** the path has east, west and central segments; “whole path” means all three.

Complete eight tasks:

1. Break the claim into at least three checkable subclaims.
2. For Source A, distinguish observation times from export/publication time and state what it supports.
3. Trace the provenance of F and explain how many independent observations F adds.
4. Explain why C can be authentic yet misleading.
5. Decide whether “the water level exceeded 4.0 m throughout Monday–Friday” is supported, contradicted or uncertain. Cite evidence.
6. Decide whether “the whole path was closed Thursday afternoon” is supported, contradicted or uncertain. Cite evidence and one limitation.
7. Evaluate the full claim using one of the three labels. Write 3–5 sentences with scope and uncertainty.
8. Name one specific new record that could change or sharpen your conclusion, and state how different results would matter.

Students may answer in prose, a table or orally. Do not score speed, handwriting or accent.

4. Reflection — 5 minutes

Students underline one sentence in their answer that distinguishes evidence from inference and circle one uncertainty they communicated honestly.

✓ 5. Closing check — 5 minutes

Complete: “My conclusion is ___ given ___. I would revise it if ___.”

Answer guide

1. Possible subclaims: the whole path was closed Monday through Friday; closure was continuous; water exceeded 4.0 m throughout; high water was the reason for every segment’s closure. Accept equivalent precise decomposition.
2. Observations occurred at 08:00 each day; the export was generated 9 May. A supports above 4.0 m Monday and Tuesday morning, then below 4.0 m Wednesday–Friday morning. Export time does not turn all readings into 9 May observations.

3. Both F pages derive from C, and one copies the other. They add zero independent observations of path status; at most they show the claim was repeated.
4. C may reproduce B accurately, but it omits B's Monday date and pairs it with a Friday "Still closed" caption that B itself cannot support.
5. **Contradicted.** A gives 3.9, 3.8 and 3.7 m Wednesday–Friday mornings. Note that once-daily readings do not prove the level never briefly rose between readings, but they contradict the claim that it exceeded 4.0 throughout.
6. **Contradicted** within the packet. E says west and central reopened Thursday at noon, and G independently reports a west-segment walk at 16:00. Limitation: G is a self-recorded log without a photograph, and E is an announced status rather than direct observation; nevertheless they agree and no contrary independent Thursday observation appears.
7. Model: "The full claim is contradicted by the packet. Gauge readings fell below 4.0 m by Wednesday morning, so high water did not persist through Friday. The east segment remained closed for debris, while the west and central segments were announced reopened Thursday and a separate club log reports use of the west segment. Exact closure times before Thursday are not fully documented, but the whole path was not continuously closed for the stated reason across all five days."
8. Examples: access-control or ranger status log by segment; continuous gauge series; timestamped inspection records. A segment log showing all entrances blocked Thursday would challenge E/G; a log showing west/central open would strengthen the conclusion. A continuous gauge series could detect between-reading rises but would not alone establish path status.

There is no validated pass threshold. Review tasks separately: claim decomposition (1), time/provenance (2–4), evidence judgments (5–6), synthesis (7) and mind-changing evidence (8). Re-teach the specific skill shown by an error and offer a parallel new case.

Vocabulary

- **Calibrated conclusion:** a judgment whose confidence and scope match the evidence.
- **Supported / contradicted / not enough information:** provisional evidence labels, not declarations of certainty.
- **Mind-changing condition:** a specific possible result that would cause revision.

Differentiation

- **Extra support:** give sentence frames: "Source __ directly shows __, but it does not show __." "My label is __ because __." Read the packet aloud or provide one card per page.
- **Extra challenge:** write the strongest defensible version of the original claim after correction, then identify the narrowest remaining uncertainty.

⚠ Safety

Use only the fictional packet. Avoid grading students on confidence of delivery; uncertainty stated with reasons is a strength. Do not require public posting or investigation of real local disputes.

Teacher notes

Students may think “not enough information” avoids making a decision. Require them to name competing explanations and a discriminating next check. Conversely, “supported” does not mean certain forever, and one limitation does not erase all evidence. Search rank, polished formatting, credentials, institutional domain, popularity or repetition should never substitute for the claim-specific analysis.

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