

Measuring acidity with the pH scale

Grade 8 science (Year 9 · Class 8) · Worksheet answers

Each answer shows the reasoning first and the result in bold. Check units and the direction in which the pH moves before you look at the number.

Level: Grade 8 science (Year 9 · Class 8) · **Curriculum:** MS-PS1-2

Problem 1 Acid, neutral or alkaline?

- pH 3 is **acidic**, pH 7 is **neutral**, pH 11 is **alkaline** and pH 6.5 is **acidic** (below 7).
- The liquid of pH 6.5 is the closest to 7 without being neutral: a **very weak acid**.

Problem 2 Litmus colours

- Blue litmus turns **red** in acid.
- Red litmus turns **blue** in an alkali.
- Neither paper changes colour in pure water, because it is neutral: **red stays red and blue stays blue**.

Problem 3 Reading universal indicator

- A (red) is about **pH 1 to 2**, B (yellow) about **pH 5 to 6**, C (green) **pH 7** and D (purple) about **pH 12 to 14**.
- Tubes A and B are **acidic**, C is neutral and D is **alkaline**.

Problem 4 Ordering by acidity

- Order from lowest to highest pH: **lemon juice, orange juice, tap water, toothpaste mixture, bleach**.
- The strongest acid is **lemon juice** (pH 2.0) and the strongest alkali is **bleach** (pH 12.5).

Problem 5 Lab safety rules

- Any three of: **wear goggles; never taste chemicals; add acid slowly to water; wash splashes with cold water; tell the teacher at once**.
- Mixing releases heat. Adding a little acid to a lot of water keeps the mixture cool, so it does not splash or spit out hot acid.

Problem 6 Finding a dilution factor

- Factor = $200 \text{ mL} \div 20 \text{ mL} = \mathbf{10}$.
- Factor = $1000 \text{ mL} \div 10 \text{ mL} = \mathbf{100}$.

Problem 7 pH after dilution

1. Factor 10 raises the pH by 1: **pH 3**.
2. Factor 1000 raises the pH by 3: **pH 5**.
3. It is still acidic, because 5 is below 7. Water alone cannot make a solution alkaline.

Problem 8 Water needed

1. pH must rise by 2, so the factor is **100**.
2. Final volume = 50 mL $\times$ 100 = **5000 mL** (5.0 L).
3. Water added = 5000 mL – 50 mL = **4950 mL**.

Problem 9 Diluting an alkali

1. Factor 100 changes pH by 2, downwards for an alkali: **pH 11**.
2. The alkali becomes weaker, so the pH **falls towards 7**, but never goes below 7 from water alone.

Problem 10 Reading a pH graph

1. The graph starts at **pH 2.0**.
2. The pH is 7.0 at **30 mL**.
3. Change = 10.5 – 7.0 = 3.5 over 5 mL, so $3.5 \div 5 =$ **0.7 pH units per mL**.

Problem 11 Indicator or pH meter?

1. Litmus shows only **acid or alkali**. Universal indicator gives a **rough pH to the nearest unit**. A pH meter gives an **exact value to 0.1**.
2. A pH meter or universal indicator, because the gardener needs a number to know how far the pH is from the ideal. Litmus is not precise enough.

Problem 12 Spot the errors

1. The difference is 3 steps, so $10 \times 10 \times 10 =$ **1000 times more acidic**, not twice.
2. Water is neutral, so dilution makes the pH approach 7 but **never pass it**. The acid cannot reach pH 9.

Problem 13 Comparing two acids

1. The difference is 3 steps: $10^3 =$ **1000 times**.
2. X would be **red** and Y would be **yellow** (orange-yellow for pH 5).

Problem 14 Word equations

1. **Hydrochloric acid + magnesium hydroxide $\rightarrow$ magnesium chloride + water.**

2. The acid is used up, so the pH moves **towards 7**.

Problem 15 Soil on a farm

1. She should spread a **base such as crushed lime** to neutralise the acid soil.
2. The pH should **rise**, from 5.0 towards 6.5.
3. Too much lime would push the pH above the ideal value and make the soil alkaline, which harms the crop.

Problem 16 Dilute to pH 4

1. pH rises by 3, so the factor is **1000**.
2. Final volume = $25 \text{ mL} \times 1000 = 25\,000 \text{ mL} = \mathbf{25.0 \text{ L}}$.
3. Water = $25\,000 \text{ mL} - 25 \text{ mL} = \mathbf{24\,975 \text{ mL}}$.

Problem 17 Two-stage dilution

1. B has volume $5.0 + 45 = 50 \text{ mL}$, so the factor is $50 \div 5.0 = \mathbf{10}$.
2. C has volume $10 + 90 = 100 \text{ mL}$, so the factor is $100 \div 10 = \mathbf{10}$.
3. Two tenfold steps raise the pH by 2: **pH 2**.
4. $10 \times 10 = \mathbf{100 \text{ times more dilute}}$.

Problem 18 Rainwater data

1. Leeds (4.6) and Mumbai (3.6) are below 5.6, so they are **Leeds and Mumbai**.
2. The difference is $5.6 - 3.6 = 2$ steps, so $10 \times 10 = \mathbf{100 \text{ times more acidic}}$.
3. 6.6 is below 7, so it is **a weak acid**. It is just 10 times less acidic than normal rain.

Problem 19 Planning an antacid test

1. Independent: **brand of tablet**. Dependent: **pH after a set time**. Controls: same volume and concentration of acid, same mass of tablet, same stirring and time.
2. Measure equal volumes of acid; record the starting pH; add one crushed tablet and stir for 2 minutes; read the pH; repeat for each brand and for repeats.
3. The best brand gives the **highest pH closest to 7**, without going far above it, averaged over repeats.

Problem 20 The swimming pool

1. pH 8.4 is above 7, so the pool is **weakly alkaline**.
2. She must add a **dilute acid**.
3. Add it slowly and in small amounts, because a big dose would overshoot and make the water too acidic; wear goggles and gloves and add acid to water, never the reverse.
4. **Blue**, since the pool is slightly alkaline.