Acids and bases: teacher guidance

This resource forms part of the **Review my learning** series from the *Royal Society of Chemistry*. Additional support for addressing misconceptions identified using these worksheets can be found at rsc.li/3mm0IeW.

These worksheets assess content from the 11–14 and 14–16 specifications. They can be used to identify learners' knowledge gaps and misconceptions following the completion of that part of the curriculum.

The Acids and bases worksheets cover the following topics:

- the pH scale
- the pH of acidic and alkaline solutions
- common acids and alkalis
- general word equations for the reactions of an acid with a metal, metal oxide, metal hydroxide and a metal carbonate
- chemical formulas of common laboratory acids
- types of salts produced from reactions with hydrochloric acid, sulfuric acid and nitric acid
- universal and litmus indicators.

If learners successfully answer questions on these topics, they can attempt the extension questions. These cover:

- word equations for the reactions between an acid and a metal, metal oxide, metal hydroxide or metal carbonate
- symbol equations for the reactions between an acid and a metal, metal oxide, metal hydroxide or metal carbonate.

Level 1 (★) is a scaffolded worksheet in which learners select words from a word list to complete sentences. Level 2 (★★) is a partially scaffolded worksheet in which learners complete sentences. Level 3 (★★★) is an unscaffolded worksheet in which most of the tasks involve answering questions with a minimum of prompts.

The worksheets can be used in a variety of ways:

- as an assessment of learners' knowledge at the beginning or end of a period of teaching – the level of the worksheet used can be matched to the ability of the learners
- as an assessment of knowledge during a period of teaching and after learners have completed the relevant section of the specification
- as a revision tool prior to the relevant examination
- as a refresher exercise for teachers or non-subject specialists.

There is also scope to increase the level of the worksheets used as learners progress through their curriculum.

The 'What do I understand?' page is common to all levels of worksheet and can be used both to identify areas needing whole class attention and as an indicator for learners to help guide their revision.

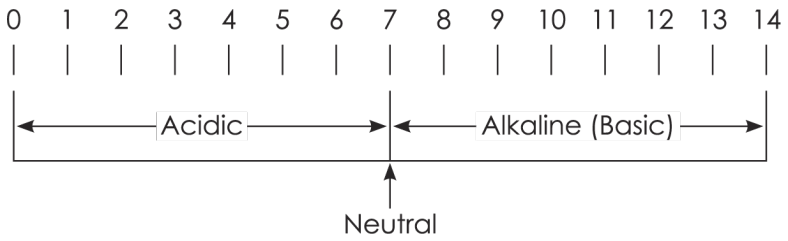
The Teacher guidance provides model answers for each level and guidance on learners' misconceptions. Learners can use the model answers to self- or peer assess.

Answers

Acids and bases: knowledge check

1.1 *scaffolded/partially scaffolded/unscaffolded*

(a)–(c)



Guidance: Some learners will only label pH 1 and pH 14 as acidic or alkaline. Emphasise that acids have pH values from 1 to 6 and alkalis from 8 to 14. Learners may refer to strong and weak acids and alkalis. At this stage, they are probably just referring to the pH of the solution. Understanding strong and weak acids and alkalis and concentrated and dilute acids and alkalis requires knowledge on a particle level, which learners have probably not yet encountered.

1.2 *scaffolded/partially scaffolded*

(a) The pH scale measures the **acidity** or **alkalinity** of a solution.

(b) **Acidic** solutions have a pH less than 7.

(c) **Neutral** solutions have a pH of 7.

(d) **Alkaline** solutions have a pH greater than 7.

unscaffolded

(a) The pH scale measures the acidity or alkalinity of a solution.

(b) acid/acidic solutions

(c) neutral solutions

(d) alkali/alkaline solutions

Guidance: The knowledge required to answer this question is a repeat from question 1.1, but learners need to be familiar with using similar terms, such as alkaline and alkalinity. Learners also need to be aware that water is not the only neutral substance. Many liquids and solutions have pH values of 7, such as ethanol and sodium chloride solution.

1.3 *scaffolded/partially scaffolded*

(a) Three acids commonly found in school laboratories are **hydrochloric acid**, **nitric acid** and **sulfuric acid**.

(b) An alkali commonly found in school laboratories is **sodium hydroxide solution**.

(c) **Hydrogen** ions are present in all acid solutions.

unscaffolded

(a) hydrochloric acid, nitric acid, sulfuric acid

(b) hydrogen ions

Guidance: Familiarisation with laboratory reagents will help learners remember chemical names. Because the word 'acid' is commonly used in fiction and the media, learners usually have some familiarity with the term. 'Base' and 'alkali' are not commonly used terms and learners will not be so familiar with them.

Although hydrogen ions are present in all acid solutions, most hydrogen-containing compounds are not acids. Simple models can be used to illustrate that acids dissociate in solution to give hydrogen ions.

Learners commonly misuse the term 'molecular'. Acid solutions contain hydrogen ions and are not molecular. Likewise, alkaline solutions contain hydroxide ions and are not molecular.

1.4 *scaffolded/partially scaffolded*

(a) acid + metal → **salt** + hydrogen

(b) acid + metal oxide → salt + **water**

(c) acid + metal hydroxide → salt + **water**

(d) acid + metal carbonate → salt + **water** + **carbon dioxide**

unscaffolded

(a) acid + metal → **salt** + **hydrogen**

(b) acid + metal oxide → **salt** + **water**

(c) acid + metal hydroxide → **salt** + **water**

(d) acid + metal carbonate → **salt** + **water** + **carbon dioxide**

Guidance: Learners need to realise that sodium chloride is not the only salt. A salt is produced when the hydrogen in an acid is replaced by a metal. Simple models can be used to represent the equations.

1.5 *scaffolded/partially scaffolded*

(a) Two everyday acids you might find in your home are vinegar and **lemon juice.**

(b) Two everyday bases you might find in your home are **laundry detergent** and baking soda.

unscaffolded

(a) Two everyday acids you might find in your home are **vinegar** and **lemon juice.**

(b) Two everyday bases you might find in your home are **laundry detergent** and **baking soda**.

Guidance: Learners confuse alkalis and bases. See the Teacher guidance for questions 2.5 and 2.6. Many learners consider acids to be very corrosive and 'eat things away' (an idea fuelled by fiction and the media). Acids commonly found in the home are mostly weak acids with pH values greater than 3. Battery acid is an exception.

Acids and bases: test myself

2.1 *scaffolded/partially scaffolded/unscaffolded*

An indicator is a substance that changes **colour** depending on the **pH** of the solution.

Guidance: Learners need to understand it is the indicator that changes colour, not the acid or alkali solution.

2.2 *scaffolded/partially scaffolded/unscaffolded*

(a) Universal indicator is **red** in acidic solution.

(b) Universal indicator is **blue** in alkaline solution.

(c) Universal indicator is **green** in a neutral solution.

Guidance: This is recall of knowledge. The two indicators learners are probably familiar with are universal indicator and litmus. Both turn red in solutions with a pH of 1 and blue in solutions with a pH of 10–14. Learners need to appreciate that there are other indicators which have different colour changes to universal indicator and litmus.

2.3 *scaffolded/partially scaffolded/unscaffolded*

Universal indicator is **red** in a solution with a pH of 1.

Guidance: Learners could use the pH scale from the Knowledge check worksheet to colour in the colours of universal indicator in different pH solutions.

2.4 *scaffolded/partially scaffolded/unscaffolded*

Litmus indicator solution turns red in acidic solutions and blue in alkaline solutions.

Guidance: If learners are investigating this practically, they may find it easier to use both red and blue litmus paper to see the colours.

2.5 *scaffolded/partially scaffolded*

A base is any substance that **reacts** with an acid to form a **salt** and **water**. For example, **copper oxide** is a base.

unscaffolded

A base is any substance that reacts with an acid to form a salt and water.

2.6 *scaffolded/partially scaffolded/unscaffolded*

Alkalis are soluble bases and have a pH greater than 7. For example, sodium hydroxide is an alkali.

Guidance: Learners may get confused with the terms 'base' and 'alkali'. They are probably only familiar with using the alkali sodium hydroxide solution. They need to know that bases are chemicals which react with acids in neutralisation reactions. They are usually metal oxides, metal hydroxides or metal carbonates. Examples are copper oxide and copper carbonate. Many bases are insoluble in water, but if the base is soluble in water, it is also called an 'alkali'.

2.7 *scaffolded/partially scaffolded/unscaffolded*

A neutralisation reaction occurs when an acid reacts with an alkali.

Guidance: This is recall of knowledge. A common view of neutralisation is that an alkali cancels out an acid – an alkali may stop the action of an acid.

2.8 *scaffolded/partially scaffolded/unscaffolded*

(a) Hydrochloric acid produces chlorides.

(b) Sulfuric acid produces sulfates.

(c) Nitric acid produces nitrates.

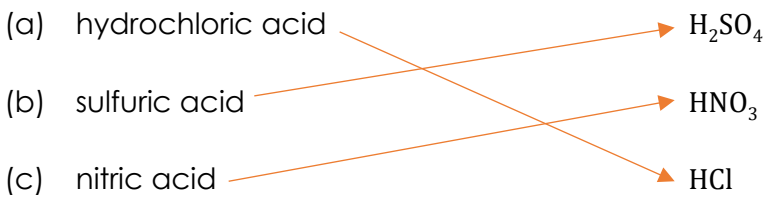
Guidance: Learners may understand that part of the name of the acid is in the name of the salt, but they need to ensure they have the correct suffixes.

2.9 *scaffolded/partially scaffolded/unscaffolded*

The salt made when copper oxide reacts with sulfuric acid is copper sulfate.

Guidance: The comments for question 2.8 also apply to question 2.9. Knowing that (in this example) the name of the salt contains a metal from the base and a non-metal part from the acid, may help learners answer this correctly.

2.10 *scaffolded/partially scaffolded*



unscaffolded

(a) hydrochloric acid: HCl

(b) sulfuric acid: H_2SO_4

(c) nitric acid: HNO_3

Guidance: Learners need to be familiar with chemical formulas to answer this correctly.

Acids and bases: feeling confident?

3.1 *scaffolded/partially scaffolded/unscaffolded*

(a) Hydrochloric acid reacting with sodium hydroxide:

hydrochloric **acid** + **sodium** hydroxide → sodium chloride + water

(b) Sulfuric acid reacting with sodium hydroxide:

sulfuric acid + sodium hydroxide → sodium **sulfate** + **water**

(c) Nitric acid reacting with sodium hydroxide:

nitric acid + **sodium hydroxide** → sodium **nitrate** + water

Guidance: The problem with writing word equations is that learners cannot always identify the elements contained in the substances from the names. They need some simple understanding of nomenclature.

3.2 *scaffolded/partially scaffolded/unscaffolded*

(a) $HCl + \mathbf{NaOH} \rightarrow NaCl + H_2O$

(b) $\mathbf{H_2SO_4} + 2NaOH \rightarrow Na_2SO_4 + \mathbf{2}H_2O$

(c) $HNO_3 + NaOH \rightarrow \mathbf{NaNO_3} + H_2O$

Guidance: Learners are required to select the correct formula and balance the symbol equations. Common errors are:

- not understanding the use of subscripts in a formula
- not understanding that a large number in front of a formula multiplies the whole formula by that number
- changing the formula of a substance to make the equation balanced
- inserting large numbers in the middle of a formula to balance the equation.

Writing and balancing chemical equations is a difficult topic for many learners and a skill that develops throughout their course.

Acids and bases: what do I understand?

Mini-topic	Assessed via:
I can describe the pH scale.	Q1.1, Q1.2
I know the pH of acidic and alkaline solutions.	Q1.1, Q1.2 Q2.5, Q2.6
I can name common acids and alkalis.	Q1.3, Q1.5 Q2.5, Q2.6
I can write general word equations for reactions of an acid with a: • metal • metal oxide • metal hydroxide • metal carbonate.	Q1.4
I know the chemical formulas for common laboratory acids.	Q2.10
I can name types of salt produced by reactions with: • hydrochloric acid • sulfuric acid • nitric acid.	Q2.8
I can use universal and litmus indicators to identify acidic, alkaline and neutral solutions.	Q2.1 (partially), Q2.2, Q2.3, Q2.4
Feeling confident? topics	**Assessed via:**
I can write word equations for reactions between an acid and a: • metal • metal oxide • metal hydroxide • metal carbonate.	Q3.1
I can write symbol equations for reactions between an acid and a: • metal • metal oxide • metal hydroxide • metal carbonate.	Q3.2