Solubility: teacher guidance

This resource forms part of the **Review my learning** series from the Royal Society of Chemistry. The worksheets assess learner's understanding of content from common 11–14 and 14–16 curriculums. They can be used to identify knowledge gaps and misconceptions once that part of the curriculum has been taught.

The Solubility worksheets cover the following topics:

- terminology associated with solubility
- dilute and concentrated solutions
- measuring the concentration of solutions
- calculating masses of solute in a given volume of solution
- saturated solutions
- precipitate formation
- methods of separation based on solubilities.

If learners successfully answer questions on these topics, they can attempt the extension question. This requires learners to deduce information from solubility curves.

Scaffolding

Level 1 (*) is a scaffolded worksheet which supports learners in a variety of ways, such as selecting words from a word bank, providing answer options to choose from or completed examples. Level 2 (**) is a partially scaffolded worksheet with a reduced level of support, such as partially completed sentences or a wider range of answer options to select from. Level 3 (***) is an unscaffolded worksheet in which most of the tasks involve answering questions with a minimum of prompts.

Metacognition

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.

Below you will find model answers for each level and guidance on learners' misconceptions. Learners can use the model answers to self- or peer assess.

When to use

The worksheets can be used in a variety of ways:

- To assess learners' knowledge at the beginning or end of a period of teaching. Match the level of the worksheet to the support needs of the learners.
- To assess knowledge during a period of teaching once learners have completed the relevant topic.

- As part of revision.
- As a refresher exercise for teachers or non-subject specialists.

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

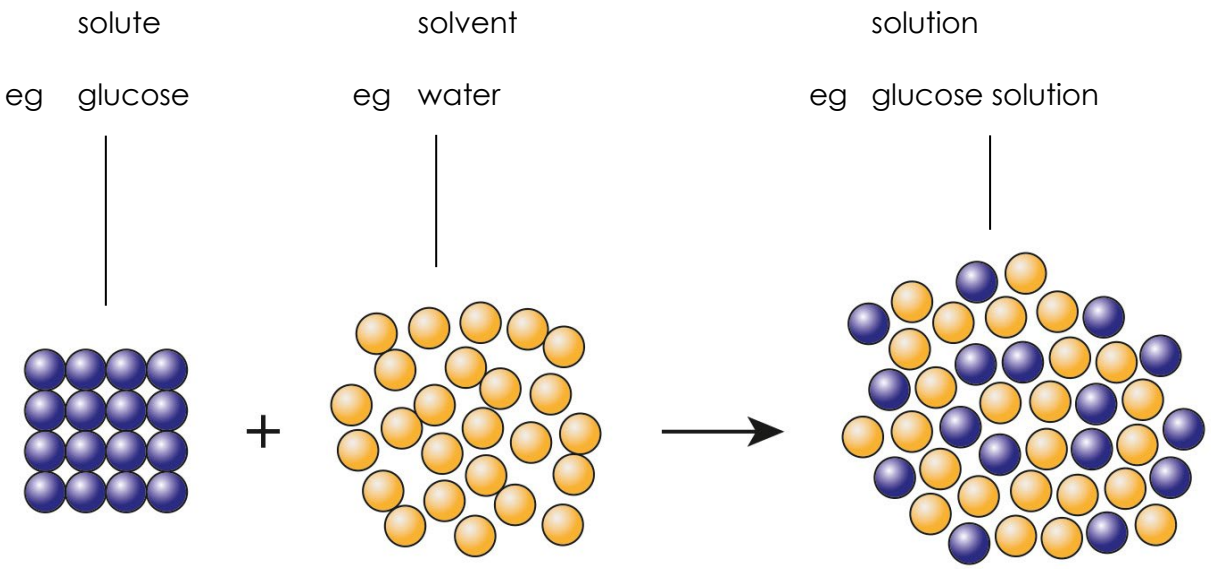
Further support

For more resources to support teaching of this topic and address any misconceptions identified, go to **rsc.li/3wMLKDO**.

Answers

Solubility: knowledge check

1.1 (Level 1, 2 and 3)



Guidance: For level 3 (unscaffolded), allow any soluble compound as a solute (eg ionic salts or sugar) and any suitable solvent (eg water or ethanol). The example chosen here (glucose) is a soluble covalent compound. Soluble ionic compounds dissolve in water, into positive and negative ions.

Misconceptions include:

- misrepresenting a solution as solute particles and solvent particles in another medium
- thinking that a solute changes into a liquid when it dissolves
- thinking that a solute losses mass when it dissolves
- thinking that a solution is a single substance.

1.2 (Level 1, 2 and 3)

A substance that will dissolve in a solvent.	**soluble**
A substance that will not dissolve in a solvent.	**insoluble**
A solution that contains a high amount of solute dissolved in it.	**concentrated**
A solution that contains a relatively low amount of solute dissolved in it.	**dilute**
A solution that has the maximum mass of solute dissolved in it.	**saturated**

Guidance: Learners should be familiar with these terms from lower secondary.

Compiling a glossary of terms may help some learners.

1.3 (Level 1)

(a) False

(b) False

(c) True

(d) True

(e) False

(Level 2)

(a) False

(b) False

(c) True

(d) True

(e) False

(Level 3)

(a) The concentration of a solution can be measured in **g dm^{-3}.**

(b) 1 dm^3 is the same volume as **1000** cm^3.

(c) If a solution has a concentration of 4.50 g dm^{-3}, 500 cm^3 of that solution will contain **2.25** g of solute.

(d) A solution that contains the maximum mass of solute possible is a **saturated** solution.

(e) Most substances are more soluble at **higher** temperatures.

Guidance: Misconceptions include:

- expressing concentration as the number of moles or mass of substance in 1 dm^3 of water, and as not the number of moles or mass of substance in 1 dm^3 of solution
- thinking that substances are either soluble or insoluble, rather than the solubilities varying in different solvents
- thinking that soluble substances all have the same solubility.

1.4 (Level 1, 2 and 3)

insoluble; colour; solution; blue; iron

Guidance: Misconceptions include omitting the word solution when describing a substance. For example, learners often consider copper sulfate to mean the same as copper sulfate solution.

Solubility: test myself

2.1 (Level 1, 2 and 3)

g dm^{-3}

Guidance: Learners need to understand that the unit for concentration when only the mass of solute is given should be g dm^{-3}. Another unit for concentration is mol/dm^3 but this is used when learners are either given the number of moles of solute or when they are asked to calculate the number of moles based on the mass and molecular mass of the solute.

2.2 (Level 1, 2 and 3)

filtration

Guidance: Learners should be familiar with filtration from lower secondary. Learners should remember the meaning of the term insoluble and make sure that they know what is being separated from the solution by reading the question carefully.

2.3 (Level 1, 2 and 3)

simple distillation

Guidance: Misconceptions include thinking that filtration separates water from a solution. Filtration separates an insoluble substance from a solvent but will not separate a soluble substance from its solution (using filter paper).

2.4 (Level 1, 2 and 3)

The mass of sodium hydroxide in 100 cm^3 of solution is **1.0 g**.

Guidance: Misconceptions include:

- omitting units in answers
- confusing units, especially cm^3 and dm^3
- not knowing that 1 dm^3 = 1000 cm^3.

2.5 (Level 1, 2 and 3)

The concentration is **5.0 g dm^{-3}**.

Guidance: see guidance for question 2.4.

2.6 (Level 1)

$$\mathrm{NaCl(aq)} + \mathrm{AgNO_3(aq)} \rightarrow \mathrm{AgCl(s)} + \mathrm{NaNO_3(aq)}$$

(Level 2)

$$\mathrm{NaCl(aq)} + \mathrm{AgNO_3(aq)} \rightarrow \mathrm{AgCl(s)} + \mathrm{NaNO_3(aq)}$$

(Level 3)

$$\mathrm{NaCl(aq)} + \mathrm{AgNO_3(aq)} \rightarrow \mathrm{AgCl(s)} + \mathrm{NaNO_3(aq)}$$

Guidance: Misconceptions include:

- changing the formulas of the reactants and products
- representing solutions as liquids (l).

2.7 (Level 1)

Solution A has a concentration of **50** g dm^{-3}.

Solution B has a concentration of **35** g dm^{-3}.

The solution with the higher concentration is solution **A**.

(Level 2)

Solution A has a concentration of **20** g dm^{-3}.

Solution B has a concentration of **18** g dm^{-3}.

Solution C has a concentration of **25** g dm^{-3}.

The solution with the highest concentration is solution **C**.

(Level 3)

Solution A has a concentration of **5** g dm^{-3}.

Solution B has a concentration of **250** g dm^{-3}.

Solution C has a concentration of **40** g dm^{-3}.

Solution D has a concentration of **40** g dm^{-3}.

The solution with the highest concentration is solution **B**.

Guidance: See guidance for **question 2.4**. Tell learners to calculate the concentration in g dm^{-3} for each solution and compare them to provide extra support.

Solubility: feeling confident?

3.1 (Level 1 and 2)

The two salts have the same solubility at a temperature of **24°C**.

At a temperature of 10°C, **sodium chloride** has the higher solubility.

The solubilities of both salts **increase** as the temperature increases.

(Level 3)

Learners could make any three of the following conclusions:

- The solubilities of both salts increase as temperature increases.
- The solubilities of the two salts are the same at a temperature of 25°C.

- Up to a temperature of 25°C the solubility of sodium chloride is higher than that of potassium nitrate.
- After a temperature of 25°C the solubility of potassium nitrate is higher than that of sodium chloride.
- The change in solubility of potassium nitrate is much greater than that of sodium chloride.

Guidance: Misconceptions and errors include:

- taking values from the wrong axis
- reading the scales incorrectly.

3.2 (Level 1, 2 and 3)

Mass of potassium nitrate in 100 g water at 80°C = 163 g

Mass of potassium nitrate in 100 g water at 10°C = 20 g

Mass of potassium nitrate that crystallises out = 163 – 20 = 143 g

Guidance: Misconceptions and errors include:

- taking values from the wrong axis
- reading the scales incorrectly
- not subtracting the solubility at 20°C from the solubility at 80°C to find the mass of solute that crystallises out.

Solubility: what do I understand?

Mini-topic	Assessed via:
I can use the correct words to describe solubility and solutions.	1.1, 1.2
I know the difference between dilute and concentrated solutions.	1.2
I can measure the concentration of solutions in g dm^{-3}.	1.3, 2.1, 2.5, 2.7
I can calculate the mass of solute in different volumes of solution.	1.3, 2.4
I know how to define the term saturated solution.	1.3
I can describe precipitate formation.	1.4, 2.6
I can select the correct method of separation based on solubilities (filtration, distillation, crystallisation).	2.2, 2.3
Feeling confident? topics	**Assessed via:**
I can understand solubility curves.	3.1
I know how to use solubility curves to calculate the mass of a solute that crystallises out when a saturated solution cools.	3.2