

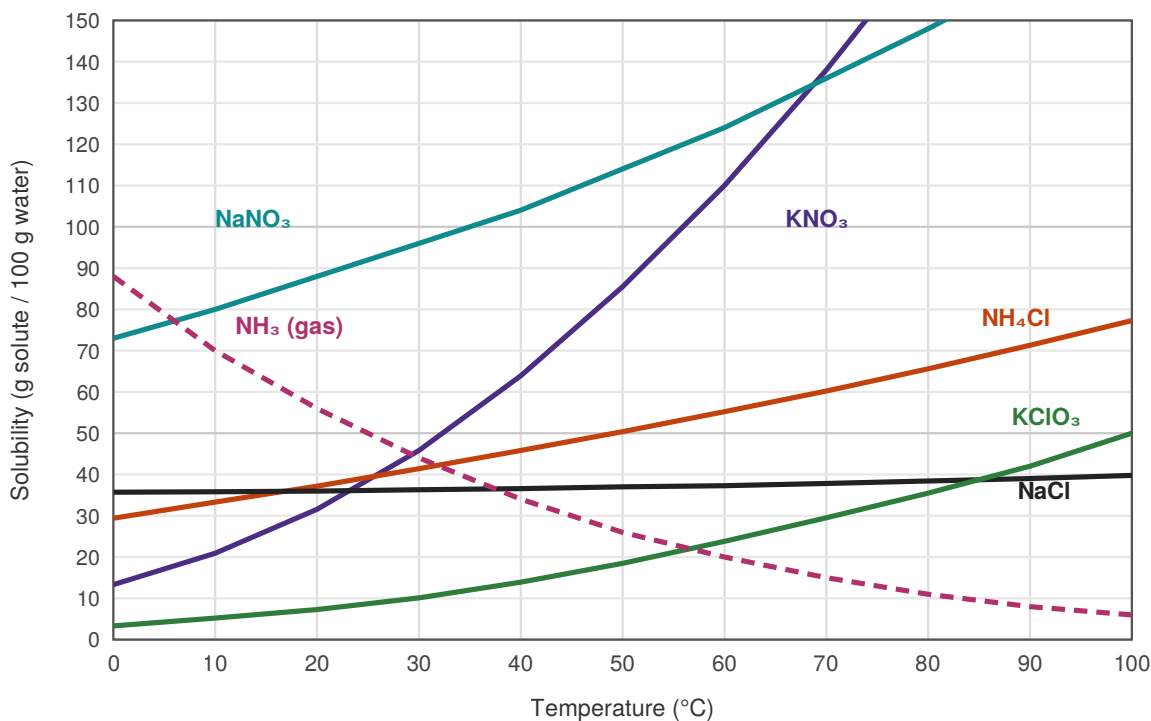
Solubility Curves

Key ideas

Solubility = the maximum mass of solute that dissolves in 100 g of water at a given temperature.

On the curve = saturated · **below** = unsaturated · **above** = supersaturated (or saturated with undissolved solid).

Scaling: mass that dissolves = solubility $\times$ (mass of water $\div$ 100 g). · **% by mass** = mass of solute $\div$ mass of solution $\times$ 100%.



Values based on standard solubility tables (approximate). Use this graph for every question.

A Reading the graph

6 marks

- What is the solubility of KNO₃ at 50 °C?

- At what temperature does 50 g of NH₄Cl dissolve in 100 g of water?

- Which substance's solubility changes the least as temperature rises?

- Which substance is the least soluble at 20 °C?

- Which curve slopes downward? What does this tell you about that substance?

- At what temperature do KNO₃ and NaNO₃ have the same solubility?

B Saturated, unsaturated and crystallization

5 marks

- 60 g of KNO₃ is dissolved in 100 g of water at 40 °C. Is the solution saturated or unsaturated? Explain.

8. 40 g of NaCl is stirred into 100 g of water at 20 °C. Is the solution saturated? How much NaCl stays undissolved?

9. 80 g of NH₄Cl is added to 100 g of water at 70 °C. How much will not dissolve?

10. 100 g of KNO₃ is dissolved in 100 g of water at 70 °C and then cooled to 30 °C. What mass of crystals forms? (2 marks)

C Other masses of water

3 marks

11. What mass of KNO₃ dissolves in **50 g** of water at 40 °C?

12. What mass of NaNO₃ dissolves in **250 g** of water at 20 °C?

13. What is the minimum mass of water needed to dissolve 30 g of KClO₃ at 70 °C?

D What affects solubility

4 marks

14. Explain why gases become less soluble as water gets warmer.

15. Use your answer to explain why fish can struggle in warm water near a power plant outflow.

Questions 16–19: "like dissolves like". Predict whether each substance dissolves in water (polar). ½ mark each.

	Substance	Dissolves in water?
16.	Sodium chloride (ionic)	
17.	Vegetable oil (nonpolar)	
18.	Sugar (polar)	
19.	Iodine, I ₂ (nonpolar)	

E Concentration

2 marks

20. Calculate the percent by mass of a saturated NaCl solution at 20 °C. (2 marks)

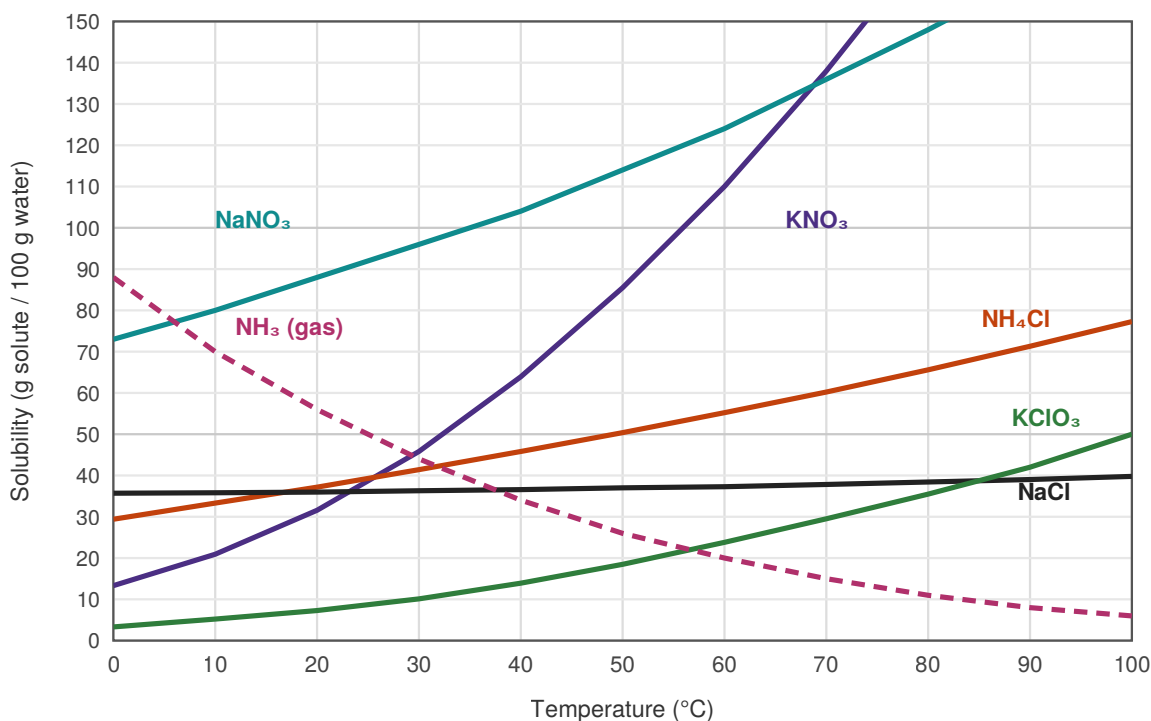
F Spot the mistake

2 marks

21. A student says: "Stirring increases the solubility of sugar in water." Explain the error and correct it.

22. A student says: "Heating a solution always lets more solute dissolve." Explain the error and correct it.

Solubility Curves

ANSWER KEY**Key ideas****Solubility** = the maximum mass of solute that dissolves in 100 g of water at a given temperature.**On the curve** = saturated · **below** = unsaturated · **above** = supersaturated (or saturated with undissolved solid).**Scaling:** mass that dissolves = solubility $\times$ (mass of water $\div$ 100 g). · **% by mass** = mass of solute $\div$ mass of solution $\times$ 100%.

Values based on standard solubility tables (approximate). Use this graph for every question.

A Reading the graph

6 marks

- What is the solubility of KNO₃ at 50 °C?
About 86 g per 100 g water (accept 82–88 g)
- At what temperature does 50 g of NH₄Cl dissolve in 100 g of water?
About 49 °C (accept 48–52 °C)
- Which substance's solubility changes the least as temperature rises?
NaCl (its curve is almost flat)
- Which substance is the least soluble at 20 °C?
KClO₃ (about 7 g)
- Which curve slopes downward? What does this tell you about that substance?
NH₃. It is a gas, and gases become less soluble as temperature increases.
- At what temperature do KNO₃ and NaNO₃ have the same solubility?
Where the curves cross: about 69 °C (accept 67–71 °C), at about 134 g

B Saturated, unsaturated and crystallization

5 marks

7. 60 g of KNO_3 is dissolved in 100 g of water at 40 °C. Is the solution saturated or unsaturated? Explain.

Unsaturated: 60 g is below the curve (64 g can dissolve at 40 °C).

8. 40 g of NaCl is stirred into 100 g of water at 20 °C. Is the solution saturated? How much NaCl stays undissolved?

Saturated; only 36 g dissolves, so about 4 g stays undissolved.

9. 80 g of NH_4Cl is added to 100 g of water at 70 °C. How much will not dissolve?

60 g dissolves, so about 20 g stays undissolved.

10. 100 g of KNO_3 is dissolved in 100 g of water at 70 °C and then cooled to 30 °C. What mass of crystals forms? (2 marks)

At 30 °C only 46 g stays dissolved, so $100 - 46 =$ about 54 g of crystals form.

C Other masses of water

3 marks

11. What mass of KNO_3 dissolves in 50 g of water at 40 °C?

$64 \times 50/100 =$ about 32 g

12. What mass of NaNO_3 dissolves in 250 g of water at 20 °C?

$88 \times 250/100 =$ 220 g

13. What is the minimum mass of water needed to dissolve 30 g of KClO_3 at 70 °C?

$30 \div 29.5 \times 100 =$ about 102 g of water

D What affects solubility

4 marks

14. Explain why gases become less soluble as water gets warmer.

Gas particles gain kinetic energy and escape from the liquid more easily.

15. Use your answer to explain why fish can struggle in warm water near a power plant outflow.

Warm water holds less dissolved oxygen, so there is less oxygen for fish to breathe.

Questions 16–19: "Like dissolves like". Predict whether each substance dissolves in water (polar). $\frac{1}{2}$ mark each.

	Substance	Dissolves in water?
16.	Sodium chloride (ionic)	Dissolves
17.	Vegetable oil (nonpolar)	Does not dissolve
18.	Sugar (polar)	Dissolves
19.	Iodine, I_2 (nonpolar)	Does not dissolve

E Concentration

2 marks

20. Calculate the percent by mass of a saturated NaCl solution at 20 °C. (2 marks)

$36.0 \text{ g} \div (100 + 36.0) \text{ g} \times 100\% = 26.5\%$

F Spot the mistake

2 marks

21. A student says: "Stirring increases the solubility of sugar in water." Explain the error and correct it.

Stirring only makes sugar dissolve faster. Solubility (the maximum that can dissolve) depends on temperature.

22. A student says: "Heating a solution always lets more solute dissolve." Explain the error and correct it.

That is true for most solids, but gases such as NH_3 and O_2 become less soluble when heated.