



Calculating pH and pOH

Use mental math shortcuts for calculating pH and pOH to solve the problems below. If you get stuck, try the *Logs and Antilogs Practice 1* worksheet as a handy warmup.

- 1) What is the pH of 2 mol dm^{-3} HCl?
- 2) What is the pH of 2 mol dm^{-3} H_2SO_4 ?
- 3) What is the pH of $1 \times 10^{-3} \text{ mol dm}^{-3}$ HNO_3 ?
- 4) What is the pH of 2 mol dm^{-3} NaOH?
- 5) What is the pH of 0.25 mol dm^{-3} Ca(OH)_2 ?
- 6) What is the pH of $5 \times 10^{-3} \text{ mol dm}^{-3}$ KOH?
- 7) What is the pH of a mixture of 50 cm^3 0.1 mol dm^{-3} HCl and 30 cm^3 of 0.1 mol dm^{-3} NaOH?



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Solutions

Keep in mind:

$$14 = \text{pH} + \text{pOH}$$
$$-\log(1 \times 10^{-3}) = 3$$
$$-\log(5 \times 10^{-x}) = x.3$$

$$\text{pH} = -\log[\text{H}^+]$$
$$-\log(1 \times 10^3) = -3$$
$$-\log(8 \times 10^{-x}) = x.1$$

$$\text{pOH} = -\log[\text{OH}^-]$$
$$-\log(3 \times 10^{-x}) = x.5$$

1) What is the pH of 2 mol dm⁻³ HCl?

$$2 = 2 \times 10^0$$

$$\text{pH} = -\log[2 \times 10^0]$$

Therefore pH is between -1 and 0.

2 is between 1 and 3. Therefore pH is -1 plus a number approx. in the range 0.5 to 1. Estimate 0.7 ish. $-1 + 0.7 = -0.3$

With a calculator, answer is -0.3.

2) What is the pH of 2 mol dm⁻³ H₂SO₄?

H₂SO₄ donates two H⁺ ions, unlike 1 for the other acids featured in this worksheet. Therefore $[\text{H}^+] = 2 \times 2 \text{ mol dm}^{-3}$

$$\text{pH} = -\log(4) = -\log(4 \times 10^0)$$

Again, pH will be between -1 and 0.

4 is between 3 and 5. pH will be -1 plus a number in the range 0.3 to 0.5.

Estimate 0.4 ish. $-1 + 0.4 = -0.6$

With a calculator, answer is -0.6

3) What is the pH of 1 × 10⁻³ mol dm⁻³ HNO₃?

$$\text{pH} = -\log(1 \times 10^{-3}) = 3$$

4) What is the pH of 2 mol dm⁻³ NaOH?

$$2 = 2 \times 10^0$$

$$\text{pOH} = -\log[2 \times 10^0]$$

Therefore pOH is between -1 and 0.

2 is between 1 and 3. Therefore pOH is -1 plus a number approx. in the range 0.5 to 1. Estimate 0.7. $-1 + 0.7 = -0.3$

With a calculator, answer is -0.3.



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$$\text{pH} = 14 - \text{pOH}$$
$$\text{Therefore } 14 - (-0.3) = 14.3$$

5) What is the pH of $0.25 \text{ mol dm}^{-3} \text{ Ca(OH)}_2$?

Base has two hydroxide ions per molecule, therefore can receive two protons. $[\text{OH}^-] = 2 \times 0.25 = 0.5 \text{ mol dm}^{-3}$
 $\text{pOH} = -\log(0.5) = -\log(5 \times 10^{-1}) = 0.3$
 $\text{pH} = 14 - 0.3 = 13.7$

6) What is the pH of $5 \times 10^{-3} \text{ mol dm}^{-3} \text{ KOH}$?

$\text{pOH} = -\log(5 \times 10^{-3}) = 3.3$
 $\text{pH} = 14 - 3.3 = 10.7$

7) What is the pH of a mixture of $50 \text{ cm}^3 \text{ } 0.1 \text{ mol dm}^{-3} \text{ HCl}$ and 30 cm^3 of $0.1 \text{ mol dm}^{-3} \text{ NaOH}$?

Total volume of the solution is now $50 \text{ cm}^3 + 30 \text{ cm}^3 = 80 \text{ cm}^3$
The acid and base are the same concentration. But different volumes.

Therefore 30 cm^3 of NaOH will be neutralised by 30 cm^3 (out of 50 cm^3) of HCl, leaving 20 cm^3 of HCl left unreacted.

HCl's original concentration was 0.1 mol dm^{-3} , but it will now be diluted by 4 because 20 cm^3 is left unreacted of HCl and it is in 80 cm^3 total. ($20/80 = 4$).

HCl's new concentration is $0.1/4 = 0.025 \text{ mol dm}^{-3}$
 $\text{pH} = -\log(2.5 \times 10^{-2}) \approx 1.5$ (actual answer is 1.6)