



# Calculating pH and pOH Practice 1

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  $2 \text{ mol dm}^{-3}$  HCl?
- 2) What is the pH of  $2 \text{ mol dm}^{-3}$   $\text{H}_2\text{SO}_4$ ?
- 3) What is the pH of  $1 \times 10^{-3} \text{ mol dm}^{-3}$   $\text{HNO}_3$ ?
- 4) What is the pH of  $2 \text{ mol dm}^{-3}$  NaOH?
- 5) What is the pH of  $0.25 \text{ mol dm}^{-3}$   $\text{Ca}(\text{OH})_2$ ?
- 6) What is the pH of  $5 \times 10^{-3} \text{ mol dm}^{-3}$  KOH?
- 7) What is the pH of a mixture of  $50 \text{ cm}^3$   $0.1 \text{ mol dm}^{-3}$  HCl and  $30 \text{ cm}^3$  of  $0.1 \text{ mol dm}^{-3}$  NaOH?



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## Solutions

### Keep in mind:

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

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

$$\text{pOH} = -\log[\text{OH}^-]$$
$$-\log(8 \times 10^{-x}) = x.1$$

1) What is the pH of 2 mol dm<sup>-3</sup> 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<sup>-3</sup> H<sub>2</sub>SO<sub>4</sub>?

H<sub>2</sub>SO<sub>4</sub> donates two H<sup>+</sup> 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<sup>-3</sup> mol dm<sup>-3</sup> HNO<sub>3</sub>?

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

4) What is the pH of 2 mol dm<sup>-3</sup> 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  $50 \text{ cm}^3 0.1 \text{ mol dm}^{-3} \text{ HCl}$  and  $30 \text{ cm}^3$  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  $30 \text{ cm}^3$  of NaOH will be neutralised by  $30 \text{ cm}^3$  (out of  $50 \text{ cm}^3$ ) of HCl, leaving  $20 \text{ cm}^3$  of HCl left unreacted.

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