

Hardness Numericals

1. Standard hard water was prepared by dissolving 0.2 g of CaCO_3 in HCl and the solution was made up to 200 mL by using deionized water. 10 mL of the standard hard water requires 10 mL of EDTA solution for titration. 20 mL of water sample collected from river Palar requires 20 mL of EDTA whereas after boiling and filtering requires 10 mL of EDTA solution. Calculate the total, carbonate and non-carbonate hardness of the water sample.

0.2g of CaCO_3 = 200 ml of water (or) 1g/L or 1mg/mL

1mg CaCO_3 = 1 ml of water

10 ml SHW = 10 ml of EDTA

10 mg CaCO_3 = 10 ml EDTA

1ml of EDTA = 1 mg CaCO_3

20ml Sample = 20 ml of EDTA

= 20 mg CaCO_3 eq

= (20mg / 20ml) x 1000 ml

Total Hardness = 1000ppm

20 ml boiled sample = 10ml EDTA

= (10mg / 20ml) x 1000ml

Permanent Hardness = 500ppm

Temp. Hardness = 1000-500 = 500ppm

2. 0.25 gm of CaCO_3 was dissolved in HCl and the solution made up to 250 ml with distilled water. 50 ml of the solution required 20 ml of EDTA solution for titration. 50 ml of hard water sample required 18 ml of EDTA and after boiling and filtering required 10 ml of EDTA solution. Calculate temporary hardness of water. **ANS: Total Hardness: 900 ppm, Permanent hardness- 500 ppm, Temp. hardness 400ppm**

3. 0.5 g of CaCO_3 was dissolved in HCl and the solution made up to 500 mL with distilled water. 20 mL of this solution required 40 mL of EDTA. 20 mL of hard water sample required 25 mL of EDTA and after boiling and filtering required 10 mL of EDTA. Calculate total, temporary and permanent hardness of the water sample. **ANS: Total Hardness: 625 ppm, Permanent hardness- 250 ppm, Temp. hardness 375ppm**

4. Standard hard water is prepared by dissolving 1.5 g of CaCO_3 per litre. 50 mL of this standard hard water consumed 20 mL of EDTA during titration. 50 mL of a sample hard water consumed 25 mL of EDTA solution. 50 mL of water after boiling and filtering consumed 18 mL of EDTA. Calculate the Total, temporary and permanent hardness of water in ppm. **ANS: Total Hardness: 1875 ppm, Permanent hardness- 1350 ppm, Temp. hardness 525ppm**

5. 0.30 g of CaCO_3 was dissolved in HCl and the solution made up to 1000 ml with distilled water. 100 ml of the solution required 30 ml of EDTA solution for titration. 100 ml of hard water sample required 35 ml of EDTA and after boiling and filtering required 12 ml of EDTA solution. Calculate temporary hardness of water. **ANS: Total Hardness 350 ppm, Permanent hardness 120 ppm, Temp. hardness 230ppm**

6. A water sample contains the following impurities: $\text{Mg}(\text{HCO}_3)_2$ = 120 mg/L; $\text{Ca}(\text{HCO}_3)_2$ = 90 mg/L; MgSO_4 = 45 mg/L; CaCl_2 = 75 mg/L; NaCl = 10 mg/L; KCl = 20 ppm; FeSO_4 = 86 ppm. Mg: 24, Ca: 40, S: 32, Na: 23, Fe: 56, Cl: 35.5. Calculate the temporary, permanent and total hardness. **Total Hardness 243 ppm, Permanent hardness 105 ppm, Temp. hardness 138ppm**

7. A standard hard water (SHW) sample contains 0.50 mg of CaCO_3 per mL. 50 mL of SHW consumed 45 mL of EDTA using EBT indicator at end point. 25 mL of sample water consumed 15 mL of EDTA, and after boiling and filtering, 25 mL of this boiled water sample consumed 4 mL of EDTA. Calculate the total, permanent and temporary hardness of water. **Total Hardness 330 ppm, Permanent hardness 88 ppm, Temp. hardness 242ppm**

8. 0.5 g of CaCO_3 was dissolved in dil. HCl and the solution was made up to 1000 mL with distilled water. 100 mL of the above solution required 28 mL of EDTA solution on titration. 100 mL of the hard water sample required 33 mL of the same EDTA solution on titration. After boiling 100 mL of this water, cooling, filtering and then titration required 10 mL of EDTA solution. Solve each type of hardness in ppm. **Total Hardness 589 ppm, Permanent hardness 178 ppm, Temp. hardness 410ppm**

9. Calculate the temporary and permanent hardness of water sample containing $\text{Mg}(\text{HCO}_3)_2 = 7.3\text{mg/L}$, $\text{Ca}(\text{HCO}_3)_2 = 16.2\text{mg/L}$, $\text{MgCl}_2 = 9.5\text{mg/L}$, $\text{CaSO}_4 = 13.6\text{mg/L}$. Solution: conversion into CaCO_3 equivalents:

Constituent	Multiplication factor	CaCO_3 equivalent
$\text{Mg}(\text{HCO}_3)_2 = 7.3\text{mg/L}$	100/146	$7.3 \times 100 / 146 = 5\text{mg/L}$
$\text{Ca}(\text{HCO}_3)_2 = 16.2\text{mg/L}$	100/162	$16.2 \times 100 / 162 = 10\text{mg/L}$
$\text{MgCl}_2 = 9.5\text{mg/L}$	100/95	$9.5 \times 100 / 95 = 10\text{mg/L}$
$\text{CaSO}_4 = 13.6\text{mg/L}$	100/136	$13.6 \times 100 / 136 = 10\text{mg/L}$

Temporary hardness of water due to $\text{Mg}(\text{HCO}_3)_2$ and $\text{Ca}(\text{HCO}_3)_2 = 5 + 10 = 15\text{mg/L}$ or 15ppm.

Permanent hardness due to MgCl_2 and $\text{CaSO}_4 = 10 + 10 = 20\text{mg/L}$ or 20ppm.

10. Calculate the temporary and total hardness of a water sample containing $\text{Mg}(\text{HCO}_3)_2 = 73\text{mg/L}$, $\text{Ca}(\text{HCO}_3)_2 = 162\text{mg/L}$, $\text{MgCl}_2 = 95\text{mg/L}$, $\text{CaSO}_4 = 136\text{mg/L}$. Solution: calculation of CaCO_3 equivalents:

Constituent	Multiplication factor	CaCO_3 equivalent
$\text{Mg}(\text{HCO}_3)_2 = 73\text{mg/L}$	100/146	$73 \times 100 / 146 = 50\text{mg/L}$
$\text{Ca}(\text{HCO}_3)_2 = 162\text{mg/L}$	100/162	$162 \times 100 / 162 = 100\text{mg/L}$
$\text{MgCl}_2 = 95\text{mg/L}$	100/95	$95 \times 100 / 95 = 100\text{mg/L}$
$\text{CaSO}_4 = 136\text{mg/L}$	100/136	$136 \times 100 / 136 = 100\text{mg/L}$

Temporary hardness of water due to $\text{Mg}(\text{HCO}_3)_2$ and $\text{Ca}(\text{HCO}_3)_2 = 50 + 100 = 150\text{mg/L}$ or 150ppm.