SIMPLE HARDNESS

→ $CaCO_3$ as reference is considered

$$\text{Equivalent of } CaCO_3 \text{ or Hardness} = \frac{\left[\text{Mass of hardness producing substance}\right] \times \left[\text{Chemical Equivalent of } CaCO_3\right]}{\left[\text{Chemical equivalent of hardness producing substance}\right]}$$

Ques 1) Let ~~Given~~ mass $MgSO_4$ = ~~[illegible] ppm~~ x

Hardness = 84 ppm = .084 g/L

According to eq^n

$$\text{Hardness} = \frac{x \times 100}{120}$$

$$\frac{.084 \times 120}{100} = x$$

$x = 0.1008$ gram

Ques-2 Let Hardness = x

Given mass of $CaSO_4$ = 204 ppm

According to eq^n

$$x = \frac{204\,ppm \times 100\,g}{136\,g}$$

$= 150$ ppm

Ques. 3

m.w	Constituents	Given Quantity mg/L	Multiplication factor	$CaCO_3$ equivalent or Hardness
146	$Mg(HCO_3)_2$ (TH)	14.6	$14.6 \times \frac{100}{146}$	10
95	$MgCl_2$ (PH)	19.0	$19 \times \frac{100}{95}$	20
120	$MgSO_4$ (PH)	24.0	$24 \times \frac{100}{120}$	20
110.98 ⇒ 111	$CaCl_2$ (PH)	22.2	$22.2 \times \frac{100}{111}$	20
58	NaCl	5.35	—	—

Tempeorry Hardness (TH) due to $Mg(HCO_3)_2 = 10$ ppm

Permanent Hardness (PH) due to $MgCl_2 + MgSO_4 + CaCl_2$

$= 20 + 20 + 20$

$= 60$ ppm

Total Hardness $= 10 + 60$

$= 70$ ppm

Ques. 4

Constituents	Given Quantity ppm	M-F	$CaCO_3$ equivalent or Hardness
$Mg(HCO_3)_2$ (TH)	7.3	$7.3 \times \frac{100}{146}$	5
$Ca(HCO_3)_2$ (TH)	16.2	$16.2 \times \frac{100}{162}$	10
$MgSO_4$ (PH)	12.0	$12.0 \times \frac{100}{120}$	10
$CaSO_4$ (PH)	13.6	$13.6 \times \frac{100}{136}$	10
K_2SO_4	5.35	—	—

TH $= 5 + 10 = 15$ ppm

PH $= 10 + 10 = 20$ ppm

Total H $= 15 + 10 = 35$ ppm

Zeolite

Ques 1 -

Formula used

$$\text{Hardness} = \text{Mass of NaCl used to regenerate} \times \frac{\text{Eq. weight of } CaCO_3}{\text{Eq. wt. of NaCl}}$$

for 10% NaCl sol^n

∵ 100g NaCl required in 1000mL / 1L

∴ weight of NaCl in 60 L

$60 \times 100 = 6000\,g$ of NaCl

According to formula

$$\text{Hardness} = 6000 \times \frac{50}{58.5}$$

$$= 5128.20\ g$$

∴ 5128.20×10^3 mg

Now

∵ 7000 Litre water having hardness = 5128.20 mg

∴ 1 " " " $\frac{5128.20 \times 10^3}{7000}$ mg/L

$$= \underline{732.6\ mg/L}$$

Ques 3:- Given

Hardness of water = 250 ppm ⟹ .25 g/L

water used in softening = 5000 litre

$$\text{Hardness} = \text{Mass of NaCl used to regenerate} \times \frac{\text{Equivalent weight of } CaCO_3}{\text{Equivalent weight of NaCl}}$$

$$250 = \text{Mass of NaCl used to regenerate} \times \frac{50}{58.5}$$

$$\text{Mass of NaCl used to regenerate} = \frac{25\cancel{0} \times 58.5}{5\cancel{0}}$$

$$= 292.5 \text{ ppm}$$

∵ 100 g is required for 10% NaCl solⁿ in 1 L

∴ 1 " " $= \frac{1}{100}$ L

∴ .2925 g " " $\frac{1}{100} \times 0.2925$ L

$= 0.00293$ L

~~... regenerate~~

∴ 1 L Hard water require = 0.00293 L brine solⁿ

∴ 5000 L " " 5000 × 0.00293

= 14.7 L brine solⁿ/ NaCl

Soda - Lime Numerical

~~Ques:~~ For Particular material, we need Lime or Soda accordingly (L - Lime) (S - Soda)

Temp. { $Ca(HCO_3)_2 \Rightarrow L$
$Mg(HCO_3)_2 \Rightarrow 2L$ }

H^+, HCl, H_2SO_4 } L+S

$CO_2 \Rightarrow L$

Perma. {
$CaSO_4 \Rightarrow S$
$CaCl_2 \Rightarrow S$
$MgSO_4 \Rightarrow L+S$
$FeSO_4 \Rightarrow L+S$
$MgCl_2 \Rightarrow L+S$
$Al_2(SO_4)_3 \Rightarrow L+S$ }

HCO_3^-, $(NaHCO_3)$ } L-S

Ques-1-

Constituents	Quantity mg/L	M.F.	$CaCO_3$ eq. or Hardness	Need L/S
$Mg(HCO_3)_2$	14.6	$14.6 \times \frac{100}{146}$	10	2L
$MgCl_2$	19.0	$19 \times \frac{100}{95}$	20	L+S
$MgSO_4$	24.0	$24 \times \frac{100}{120}$	20	L+S
$CaCl_2$	22.2	$22.2 \times \frac{100}{111}$	20	S

Lime requirement $= \frac{74}{100}$ (where Lime needed) × Volume

$= \frac{74}{100}(2 \times Mg(HCO_3)_2 + MgCl_2 + MgSO_4) \times 50000$

$= \frac{74}{100}(2 \times 10 + 20 + 20) \times 50000$

$= 74 \times 60 \times 500 = 2220000$ mg

$= 22.2$ Kg

Soda requirement

$$= \frac{106}{100}(MgCl_2 + MgSO_4 + CaCl_2) \times 50000$$

$$= 106\ (20 + 20 + 20) \times 500$$

$$= 106 \times 60 \times 500$$

$$= 3180000\ mg$$

$$= 3.18\ Kg$$