

(1)

SIMPLE HARDNESS

→ CaCO_3 as reference is considered

Equivalent of CaCO_3 or Hardness =
$$\frac{\left[\text{mass of hardness producing substance} \right] \times \left[\text{Chemical equivalent of } \text{CaCO}_3 \right]}{\left[\text{Chemical equivalent of hardness producing substance} \right]}$$

(Ques 1) Let given mass MgSO_4 = ~~84 ppm~~ n
~~84~~ ppm = 0.084 g/L

Hardness = $84 \text{ ppm} = 0.084 \text{ g/L}$

According to eqⁿ

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

$$\frac{0.084 \times 120}{100} = n$$

$$n = 0.1008 \text{ gram}$$

(Ques 2) Let Hardness = n
 Given mass of CaSO_4 = 204 ppm

According to eqⁿ

$$n = \frac{204 \text{ ppm} \times 100 \text{ g}}{136 \text{ g}}$$

$$= 150 \text{ ppm}$$

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Ques.
③

Constituents	Given Quantity mg/L	Multiplication factor	CaCO_3 equivalent or Hardness
M.W			10
146 $\text{Mg}(\text{HCO}_3)_2$ (TH)	14.6	$14.6 \times \frac{100}{146}$	20
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 CaCl_2 (PH)	22.2	$22.2 \times \frac{100}{111}$	20
58 NaCl	5.35	—	—

Temporary Hardness (TH) due to $\text{Mg}(\text{HCO}_3)_2 = 10 \text{ ppm}$
 Permanent Hardness (PH) due to $\text{MgCl}_2 + \text{MgSO}_4 + \text{CaCl}_2$

$$= 20 + 20 + 20$$

$$= 60 \text{ ppm}$$

$$\text{Total Hardness} = 10 + 60$$

$$= 70 \text{ ppm}$$

Ques.-
④

Constituents	Given Quantity ppm	M-F	CaCO_3 equivalent or Hardness
$\text{Mg}(\text{HCO}_3)_2$ (TH)	7.3	$7.3 \times \frac{100}{146}$	5 5
$\text{Ca}(\text{HCO}_3)_2$ (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	—	—

$$\text{TH} = 5 + 10 = 15 \text{ ppm}$$

$$\text{PH} = 10 + 10 = 20 \text{ ppm}$$

$$\text{Total H} = 15 + 10 = 35 \text{ ppm}$$

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zeolite

Ques 1 -

formula used

$$\text{Hardness} = \frac{\text{mass of NaCl used to regenerate}}{\text{eq. wt. of NaCl}} \times \frac{\text{eq. weight of CaCO}_3}{\text{eq. wt. of NaCl}}$$

for 10% NaCl solⁿ

\therefore 100 g NaCl required ⁱⁿ 1000 ml / 1 L

\therefore weight of NaCl in 60 L

$$60 \times 100 = 6000 \text{ g of NaCl}$$

According to formula

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

$$= 5128.20 \text{ g/l}$$

$$\therefore 5128.20 \times 10^3 \text{ mg}$$

Now
 \therefore 7000 litre water having hardness = 5128.20 mg
 \therefore " " " $\therefore \frac{5128.20 \times 10^3}{7000} \text{ mg/L}$
 $= \underline{\underline{732.6 \text{ mg/L}}}$

zeolite

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Ques 3:- Given

Hardness of water = 250 ppm \Rightarrow 25 g/L
 water used in softening = 5000 litre

$$\text{Hardness} = \frac{\text{mass of NaCl used}}{\text{to regenerate}} \times \frac{\text{equivalent weight of } \text{CaCO}_3}{\text{equivalent weight of NaCl}}$$

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

$$\begin{aligned} \text{mass of NaCl} \\ \text{used to regenerate} &= \frac{250 \times 58.5}{50} \\ &= 292.5 \text{ ppm} \end{aligned}$$

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

$$\therefore 1 \text{ " } = \frac{1}{100} \text{ L}$$

$$\therefore 292.5 \text{ g } " = \frac{1}{100} \times 0.2925 \text{ L}$$

$$= 0.00293 \text{ L}$$

~~per liter regenerated~~

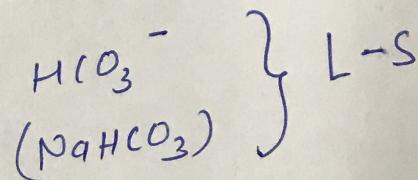
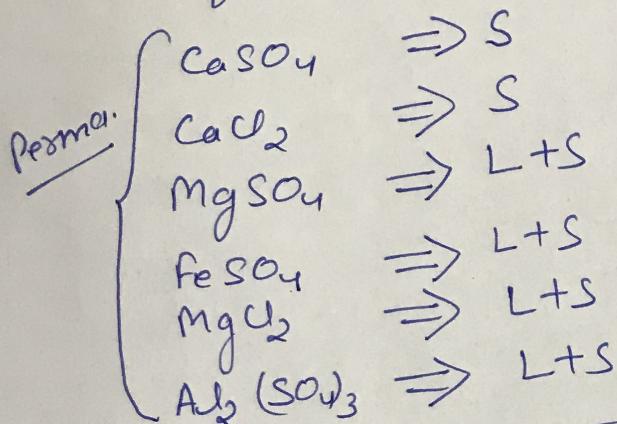
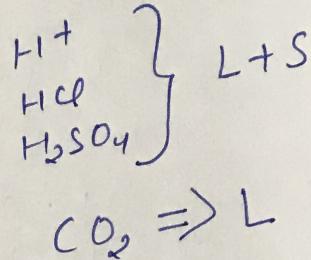
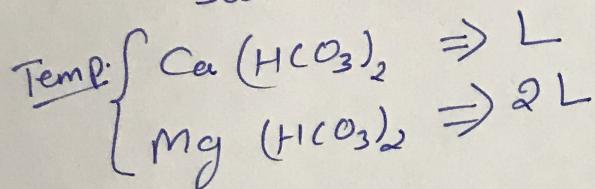
$$\therefore 1 \text{ L Hard water require } = 0.00293 \text{ L brine soln}$$

$$\therefore 5000 \text{ L } " " = 5000 \times 0.00293$$

$$= 14.7 \text{ L brine soln/NaCl}$$

Soda - Lime Numerical

Ques. For particular material, we need Lime or Soda accordingly (L - Lime) (S - Soda)



Ques - 1 -

Constituents

Quantity
mg/L

M.F.

CaCO_3 eq.
or
Hardness

Need
 L/S

$\text{Mg}(\text{HCO}_3)_2$

14.6

$$14.6 \times \frac{100}{14.6}$$

10

$L+S$

MgCl_2

19.0

$$19 \times \frac{100}{95}$$

20

$L+S$

MgSO_4

24.0

$$24 \times \frac{100}{120}$$

20

S

CaCl_2

22.2

$$22.2 \times \frac{100}{111}$$

20

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

$$= \frac{74}{100} (2 \times \text{Mg}(\text{HCO}_3)_2 + \text{MgCl}_2 + \text{MgSO}_4) \times 50000 \cancel{\text{mg}}$$

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

$$= 74 \times 60 \times 500 = 2220000 \text{ mg}$$

$$= 22.2 \text{ Kg}$$

Soda requirement

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$$= \frac{106}{100} (\text{mg Cu}_2 + \text{mg SO}_4 + \text{mg Cl}_2) \times 50000$$

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

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

$$= 3180000 \text{ mg}$$

$$= 3.18 \text{ Kg}$$