2-1 CHEMISTRY

2-1

(a) $Al_2(SO_4)_3 \cdot 14.3\ H_2O = 2Al + 3S + 12O + 14.3\ (2H + O)$
$MW = 2 \cdot 27.0 + 3 \cdot 32.1 + 12 \cdot 16.0 + 14.3\ (2 \cdot 1.0 + 16.0) = 600$
$EW = 600/6 = 100$

(b) lime = CaO
$MW = 40.1 + 16.0 = 56.1$
$EW = 56.1/2 = 28.0$

(c) $FeSO_4 \cdot 7H_2O = Fe + S + 11O + 14H$
$MW = 55.8 + 32.1 + 11 \cdot 16.0 + 14 \cdot 1.0 = 278$
$EW = 278/2 = 139$

(d) flousilicic acid = $H_2SiF_6 = 2H + Si + 6F$
$MW = 2 \cdot 1.0 + 28.1 + 6 \cdot 19.0 = 144$
EW is not applicable since F^- is released in solution.

(e) soda ash = $Na_2CO_3 = 2Na + C + 3O$
$MW = 2 \cdot 23.0 + 12.0 + 3 \cdot 16.0 = 106$
$EW = 106/2 = 53$

2-2. (a) $NaNO_3 = Na^+ + NO_3^-$
(b) $H_2SO_4 = 2H^+ + SO_4^=$
(c) $Ca(OCl)_2 = Ca^{++} + 2OCl^-$
(d) $Na_2CO_3 = 2Na^+ + CO_3^=$ (below pH 8.3, HCO_3^-, Equation 2-7)

2-3. F concentration $= 1.0\dfrac{(6 \cdot 19.0)}{144} = 0.79$ mg/l

2-4. $\text{Hardness} = 29.0\dfrac{50}{20} + 16.4\dfrac{50}{12.2} = 140$ mg/l

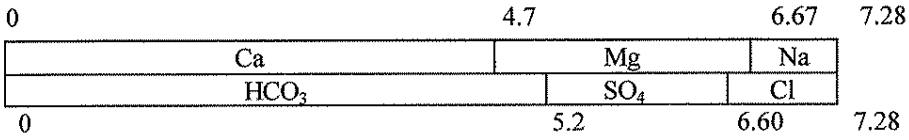
2-5. $Ca^{++} = 20\dfrac{175}{50} = 70$ mg / l

$Mg^{++} = 12.2\dfrac{40}{50} = 9.8$ mg/l

2-6. $\text{Alkalinity} = 12\dfrac{50}{30.0} + 100\dfrac{50}{61.0} = 102$ mg/l

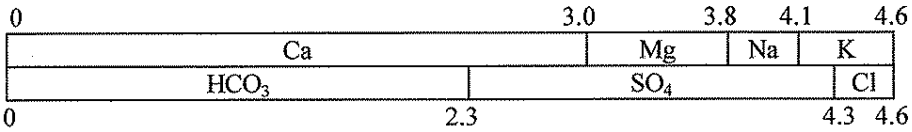
2-7. $\text{Alkalinity} = 20\dfrac{50}{30} + 34\dfrac{50}{61} = 61.2$ mg/l

2-8.
Calcium = 94/20.0 = 4.70 meq/l
Magnesium = 24/12.2 = 1.97
Sodium = 14/23.0 = 0.61
Bicarbonate = 317/61.0 = 5.20
Sulfate = 67/48.0 = 1.40
Chloride = 24/35.5 = 0.68



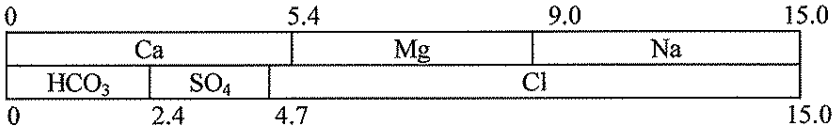
2-9.

Component	mg/l	EW	meq/l
Ca	60	20.0	3.0
Mg	10	12.2	0.8
Na	7	23.0	0.3
K	20	39.1	0.5
HCO_3(Alk)	115	50.0	2.3
SO_4	96	48.0	2.0
Cl	11	35.5	0.3



2-10.

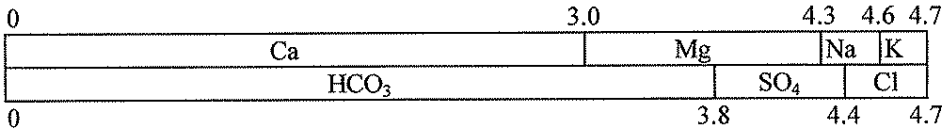
Calcium = 108/20.0 = 5.40 meq/l
Magnesium = 44/12.2 = 3.61
Sodium = 138/23.0 = 6.00
Bicarbonate = 146/61.0 = 2.39
Sulfate = 110/48.0 = 2.29
Chloride = 366/35.5 = 10.31



Carbonate hardness = 2.4 • 50 = 120 mg/l
Noncarbonate hardness = (5.4 - 2.4)50 = 150 mg/l
Total hardness = 9.0 • 50 = 450 mg/l
Alkalinity = 2.4 • 50 = 120 mg/l

2-11.

Component	Mg/l	EW	meq/l
Ca hardness	150	50.0	3.0
Mg hardness	65	50.0	1.3
Na	8	23.0	0.3
K	4	39.1	0.1
Alkalinity	190	50.0	3.8
SO_4	29	48.0	0.6
Cl	10	35.5	0.3



Hypothetical combinations: 3.0 $Ca(HCO_3)_2$; 0.8 $Mg(HCO_3)_2$; 0.5 $MgSO_4$; 0.1 Na_2SO_4; 0.2 NaCl; 0.1 KCl

2-12. $H_2SO_4 + 2CaCO_3 = Ca(HCO_3)_2 + CaSO_4$

$$\frac{X}{98.1} = \frac{20\ mg/l}{2 \times 100} \qquad X = 9.8\ mg/l\ of\ H_2SO_4$$

2-13. 2-13. $$\frac{\text{Wt. of acid / l}}{\text{MW} \cdot 1000} = \frac{10\,mg/l}{98{,}100\,mg/mole} = 0.000{,}101{,}9\ mole/l\ H^+$$

$$pH = \log\left[\frac{1}{0.000{,}101{,}9}\right] = 4.0$$

2-14. (a) $$\frac{\text{Wt. of acid/l}}{\text{MW} \cdot 1000} = \frac{3.0mg/l}{98{,}100mg/mole} = 0.000{,}030{,}6mole/l\ H^+$$

$$pH = \log\left[\frac{1}{0.000{,}030{,}6}\right] = 4.5$$

(b) $\frac{1.0}{98{,}100} = 0.000{,}010{,}2$ mole/l H^+, pH = 5.0

2-15. $CO_2 + Ca(OH)_2 = CaCO_3 + H_2O$ [Eq. 7-19]

$$\frac{X}{44.0} = \frac{35}{74.1} = \frac{Y}{100} \qquad X = 20.8\ mg/l,\ Y = 47.2\ mg/l$$

2-16. $CaCO_3 + CO_2 + H_2O = Ca(HCO_3)_2$ [Eq. 7-23]

$$\frac{47.2}{100} = \frac{X}{44.0}$$

X = 20.8 mg/l