Solutions: Chapter 1 Problems

3. (a) mW = milliwatt = 10^{-3} watt
(b) pm = picometer = 10^{-12} meter
(c) kΩ = kiloohms = 10^{3} ohm
(d) μF = micofarad = 10^{-6} farad
(e) TJ = tersjoule = 10^{12} joule
(f) ns = nanosecond = 10^{-9} second
(g) fg = femtogram = 10^{-15} gram
(h) dPa= decipascal = 10^{-1} pascal

4. (a) 100fJ or 0.1pJ
(b) 43.1728 nF
(c) 299.79 THz
(d) 0.1 nm or 100 pm
(e) 21 TW
(f) 0.483 amol or 483 zmol

13. (a) molarity = solute moles per liter of solution.
(b) molality = moles of solute per kilogram of solvent.
(c) density = grams of substance per millilier of it.
(d) wt% = (mass of solute/mass of mixture) x 100.
(e) vol% = (volume of solute/ volume of mixture) x 100.
(f) ppm = (mass of solute/ mass of mixture) x 10^{6}.
(g) ppb = (mass of solute/ mass of mixture) x 10^{9}.
(h) formality = formula mass per liter of solution.

14. 0.01F is description of the solution concentration with no consideration to the actual form of existence of species. A 1 F solution is 1 formula unit per litre. Molarity is often used to describe formality. In the strictest sense molarity of each species should be expressed separately. In case of acetic acid molarity of acetic acid molecules is less than 0.01M because of dissociation.

20. 1 ppm = $\frac{1\cdot gm\_solute}{10^{6}\cdot gm\_solution}$

Assume density of dilute aqueous solution 1 g/mL; 1mL weighs 1g.

$$\frac{1\cdot gm\_solute}{10^{6}\cdot g\_solution} = \frac{1\cdot gm}{10^{6}\cdot cm^{3}} = \frac{1\cdot gm}{10^{3}\cdot liter} \qquad \frac{1\cdot gm}{10^{3}\cdot liter} = 1\times 10^{-3}\,\frac{gm}{liter}$$

$$\frac{1\cdot gm}{10^{3}\cdot liter}\cdot\frac{10^{6}\cdot \mu g}{1\cdot gm} = 1\times 10^{3}\,\frac{\mu g}{liter}$$

$$\frac{1\cdot gm}{10^{3}\cdot liter}\cdot\frac{10^{6}\cdot \mu g}{1\cdot gm}\cdot\frac{1\cdot liter}{10^{3}\cdot cm^{3}} = 1\,\frac{\mu g}{cm^{3}} \qquad \frac{1\cdot gm}{10^{3}\cdot liter}\cdot\frac{10^{3}\cdot mg}{1\cdot gm} = 1\,\frac{mg}{liter}$$

23. (a) $1.67\cdot\frac{gm}{mL}\cdot 1000\cdot mL = 1.67\times 10^{3}\, gm$

(b) $1.67\cdot 10^{3}\cdot gm\cdot\frac{70.5}{100} = 1.177\times 10^{3}\, gm$

(c) $FW_{HClO4} := 100.458\cdot\frac{gm}{mole}$ $\frac{1.177\cdot 10^{3}\cdot gm}{FW_{HClO4}} = 11.716\, mole$

29. Total mass of resevoir:

$density := 1.0\cdot\frac{gm}{cm^{3}}$ $FW_{NaF} := (22.989 + 18.998)\cdot\frac{gm}{mole}$ $FW_{F} := 18.998\cdot\frac{gm}{mole}$

$diameter := 450.0\cdot m$ $depth := 10.0\cdot m$

$solventmass := \pi\cdot\left(\frac{diameter}{2}\right)^{2}\cdot depth\cdot density$

Let mass of floride ions required be = m_F mass of NaF = m_{NaF}

Set up: $\frac{m_F}{solventmass}\cdot 10^{6} = 1.6$

solve for m_F $m_F := 1.6\cdot 10^{-6}\cdot solventmass$ $m_F = 2.545\times 10^{3}\, kg$

For NaF $\frac{m_F}{m_{NaF}} = \frac{FW_F}{FW_{NaF}}$

$m_{NaF} := 5.263\cdot 10^{-2}\cdot m_F\cdot mole\cdot\frac{FW_{NaF}}{gm}$ $m_{NaF} = 5.623\times 10^{3}\, kg$

30. Let the mass (g)of boric acid required for 2.00L = $m_{boricacid}$

$FW_{boricacid} := 61.83\cdot\frac{gm}{mole}$

Then, $\frac{m_{boricacid}}{FW_{boricacid}}\cdot\frac{1}{2.00\cdot liter} = 0.0500\cdot\frac{mole}{liter}$

Solving $m_{boricacid} := .1\cdot mole\cdot FW_{boricacid}$

$m_{boricacid} = 6.183\, gm$ 6.18g in a 2L flask to contain TC, i.e. 2L volumetric flask.

34. Volume V_1, of the original sulfuric acid of concentratiom M_1,required to produce a volume V_2, of and concentration M_2 would be;

$$M_1 := 18.0 \cdot \frac{mole}{liter} \qquad V_2 := 1.00 \cdot liter \qquad M_2 := 1.00 \cdot \frac{mole}{liter}$$

Dilution formula: $V_1 \cdot M_1 = V_2 \cdot M_2$

$$V_1 := V_2 \cdot \frac{M_2}{M_1} \qquad V_1 = 55.556\,mL$$

Ans. 55.56 ml

b. molarity of 98.0 wt% sulfuric acid is 18.0 molar

18.0 moles of sulfuric acid and 20.0g of water per 1000 ml; gives a density

$$\frac{(20.0 + 18.0 \cdot 94.10) \cdot gm}{1000 \cdot cm^3} = 1.714 \frac{gm}{cm^3}$$

36. From the stoichimetry of the reaction, for the reaction 4 moles of fluoride is needed per mole of Th(IV) ion. Total amount of thorium ion in the sample:

$$0.0250 \cdot liter \cdot 0.0236 \cdot \frac{mole}{liter} = 5.9 \times 10^{-4} mole$$

Stoichiometric amount of HF required = $\left(5.9 \cdot 10^{-4} \cdot mole\right) \cdot 4 = 2.360 \times 10^{-3} mole$

50% excess = $0.5 \cdot 2.360 \cdot 10^{-3} \cdot mole = 1.18 \times 10^{-3} mole$

Total HF required = $\left(1.18 \cdot 10^{-3} + 2.36 \cdot 10^{-3}\right) \cdot mole = 3.54 \times 10^{-3} mole$

Mass of HF needed = $3.54 \cdot 10^{-3} \cdot mole \cdot 20.01 \cdot \frac{gm}{mole} = 0.071\,gm$

Mass of 0.491 wt% HF to be used = $0.071 \cdot gm \cdot \frac{100 \cdot gm}{0.491 \cdot gm} = 14.46\,gm$

$\mu g \equiv 1 \cdot 10^{-6} \cdot gm$ global definition

$\mu M \equiv 1 \cdot 10^{-6} \cdot \frac{mole}{liter}$ global definition