1. *a)* Chloride ion (Cl^-).
   b) Carbonate ion (CO_3^{2-}).
   c) Hydrogenosulfate ion (HSO_4^-).
   d) Hydrazine (N_2H_4).

2. *a)* Nitric acid (HNO_3).
   b) Water (H_2O).
   c) Hydronium ion (H_3O^+).
   d) Carbonic acid (H_2CO_3).

3. *1. Calculation of the pOH:*
   $pH + pOH = 14$
   $pOH = 14 - pH = 14 - 11.9 = 2.1$

   2. Calculation of the concentration of hydroxide ions:
   $pOH = -\log[OH^-]$
   $[OH^-] = 10^{-pOH} = 10^{-2.1} = 7.94 \times 10^{-3}\ mol/L$

   Answer: The pOH is 2.1 and the concentration of the hydroxide ions (OH^-) is 7.9×10^{-3} mol/L.

4. *a)* Hydrochloric acid (HCl) dissociates completely into ions; therefore, it will have the same concentration as the acid, 4.5 mol/L.

   b) $C_1V_1 = C_2V_2$

   $$C_2 = \frac{C_1V_1}{V_2} = \frac{4.5\ mol/L \cdot 30\ \cancel{mL}}{100\ \cancel{mL}} = 1.35\ mol/L$$

   Since the hydrogen bromide (HBr) dissociates completely into ions, it will have the same concentration as the acid, 1.35 mol/L.

5. *1. Calculation of the pH:*
   $pH = -\log[H_3O^+] = -\log(3.98 \times 10^{-7}) = 6.400$

   2. Calculation of the concentration of hydroxide ions:
   $K_{water} = [H_3O^+] \cdot [OH^-] = 1 \times 10^{-14}$

   $$[OH^-] = \frac{1 \times 10^{-14}}{[H_3O^+]} = \frac{1 \times 10^{-14}}{3.98 \times 10^{-7}} = 2.51 \times 10^{-8}$$

   Answer: The milk is mildly acidic, because its pH is 6.40. The concentration of the hydroxide ions (OH^-) is 2.51×10^{-8} mol/L.

6. Note: Question **6 b** should read:
   "$Cl^-_{(aq)} + H_2O_{(l)} \rightleftharpoons HCl_{(aq)} + OH^-_{(aq)}$."
   a) HS^-/H_2S and H_2O/OH^-
   b) Cl^-/HCl and H_2O/OH^-
   c) H_2S/HS^- and NH_3/NH_4^+
   d) H_2SO_4/HSO_4^- and H_2O/H_3O^+

7. *1. Calculation of the concentration of hydronium ions:*

$$pH = -\log[H_3O^+] = 10^{-pH} = 10^{-4.72}$$
$$= 1.9054 \times 10^{-5}\ mol/L$$

2. Calculation of the concentration of hydroxide ions:

$$K_{water} = [H_3O^+] \cdot [OH^-] = 1 \times 10^{-14}$$
$$[OH^-] = \frac{1 \times 10^{-14}}{[H_3O^+]} = \frac{1 \times 10^{-14}}{1.9054 \times 10^{-5}}$$
$$= 5.248 \times 10^{-10}\ mol/L$$

3. Calculation of the pOH:

$$pOH = -\log[OH^-] = -\log(5.248 \times 10^{-10}) = 9.28$$

Answer: The phenol solution (C_6H_6O) is acidic. The concentration of the hydronium ions (H_3O^+) is 1.9×10^{-5} mol/L, the concentration of the hydroxide ions (OH^-) is 5.2×10^{-10} mol/L and the pOH is 9.28.

8. *1. Calculation of the concentration of hydronium and hydroxide ions:*

$$K_{water} = [H_3O^+] \cdot [OH^-] = 2.5 \times 10^{-14}$$
$$= x^2 = 2.5 \times 10^{-14}$$
$$x = \sqrt{2.5 \times 10^{-14}} = 1.58 \times 10^{-7}$$
$$[OH^-] = [H_3O^+] = 1.6 \times 10^{-7}\ mol/L$$

2. Calculation of the pH:

$$pH = -\log[H_3O^+] = -\log(1.6 \times 10^{-7}) = 6.8$$

Answer: Since the concentration of the two ions is the same, the pH and the pOH will be the same and will be close to 7. As a result, at 37°C, pure water is neutral. The value of 6.8 is due to uncertainties in calculations and measurements.

9. *1. Calculation of the concentration of hydroxide ions:*

$$pOH = -\log[OH^-]$$
$$[OH^-] = 10^{-pOH} = 10^{-5.81} = 1.548 \times 10^{-6}\ mol/L$$

2. Calculation of the concentration of hydronium ions:

$$K_{water} = [H_3O^+] \cdot [OH^-] = 1 \times 10^{-14}$$
$$[H_3O^+] = \frac{1 \times 10^{-14}}{[OH^-]} = \frac{1 \times 10^{-14}}{1.548 \times 10^{-6}\ mol/L}$$
$$= 6.545 \times 10^{-9}\ mol/L$$

3. Calculation of the pH:

$$pH = -\log[H_3O^+] = -\log(6.545 \times 10^{-9}) = 8.18$$

Answer: The sodium bicarbonate ($NaHCO_3$) solution is basic. The concentration of the hydronium ions (H_3O^+) is 6.5×10^{-9} mol/L, the concentration of the hydroxide ions (OH^-) is 1.5×10^{-6} mol/L and the pH is 8.18.

11. *1. Calculation of the concentration of hydronium ions:*

$$pH = -\log[H_3O^+]$$

$$[H_3O^+] = 10^{-pH} = 10^{-2.73} = 1.862 \times 10^{-3}\ \text{mol/L}$$

2. Calculation of the concentration of hydroxide ions:

$$K_{water} = [H_3O^+] \cdot [OH^-] = 1 \times 10^{-14}$$

$$[OH^-] = \frac{1 \times 10^{-14}}{[H_3O^+]} = \frac{1 \times 10^{-14}}{1.862 \times 10^{-3}}$$

$$= 5.37 \times 10^{-12}\ \text{mol/L}$$

Answer: The concentration of the hydronium ions (H_3O^+) is 1.9×10^{-3} mol/L and the concentration of the hydroxide ions (OH^-) is 5.4×10^{-12} mol/L.

12. $pH = -\log[H_3O^+] = -\log(2.9 \times 10^{-4}) = 3.54$

Answer: This juice is acidic, because its pH is 3.54.

15. *a)* Since all of the acid dissolves, the concentration of the hydronium ions is 0.45 mol/L.

$$K_{water} = [H_3O^+] \cdot [OH^-] = 1 \times 10^{-14}$$

$$[OH^-] = \frac{1 \times 10^{-14}}{[H_3O^+]} = \frac{1 \times 10^{-14}}{0.45}$$

$$= 2.2 \times 10^{-14}\ \text{mol/L}$$

Answer: The concentration of the hydronium ions (H_3O^+) is 0.45 mol/L and the concentration of the hydroxide ions (OH^-) is 2.2×10^{-14} mol/L.

b) Since all of the base dissolves, the concentration of the hydroxide ions is 1.1 mol/L.

$$K_{water} = [H_3O^+] \cdot [OH^-] = 1 \times 10^{-14}$$

$$[H_3O^+] = \frac{1 \times 10^{-14}}{[OH^-]} = \frac{1 \times 10^{-14}}{1.1}$$

$$= 9.1 \times 10^{-15}\ \text{mol/L}$$

Answer: The concentration of the hydronium ions (H_3O^+) is 9.1×10^{-15} mol/L, and the concentration of the hydroxide ions (OH^-) is 1.1 mol/L.