CALCULATIONS RELATED TO STOICHIOMETRY

STB type calculations

1. Determine the oxidation numbers of each atoms for H_2S.
   Answer: +1, -2
2. Determine the oxidation numbers of each atoms for calcium carbonate $CaCO_3$.
   Answer: +2, +4, -2
3. Determine the oxidation numbers of each atoms for sodium nitrate $NaNO_3$.
   Answer: +1, +5, -2
4. Determine the oxidation numbers of each atoms for sodium dichromate K_2CrO_7.
   Answer: +1, +6, -2
5. Determine the oxidation numbers of each atoms for ammonium ion NH_4^+.
   Answer: -3, +1
6. Determine the oxidation numbers of each atoms for manganate ion MnO_4^{2-}.
   Answer: +6, -2
7. Determine the oxidation numbers of each atoms for hydrogen peroxide H_2O_2.
   Answer: +1, -1
8. Determine the oxidation numbers of each atoms for sodium superoxide NaO_2.
   Answer: +1, -0.5
9. Determine the oxidation numbers of each atoms for calcium hydride CaH_2.
   Answer: +2, -1

STC type calculations

1. Determine the oxidation state of carbon in ethane CH_3-CH_3.
   Answer: 0, 0
2. Determine the oxidation state of carbon in propane $CH_3-CH_2-CH_3$.
   Answer: 0, 0, 0
3. Determine the oxidation state of carbon in ethanol CH_3-CH_2-OH.
   Answer: 0, +1
4. Determine the oxidation state of carbon in chloroethane CH_3-CH_2-Cl.
   Answer: 0, +1
5. Determine the oxidation state of carbon in dimethyl ether CH_3-O-CH_3.
   Answer: +1, +1
6. Determine the oxidation state of carbon in 1,2-dibromoethane $Br-CH_2-CH_2-Br$.
   Answer: +1, +1
7. Determine the oxidation state of carbon in acetaldehyde $CH_3-CH=O$.
   Answer: 0, +2
8. Determine the oxidation state of carbon in acetone $CH_3-C(=O)-CH_3$.
   Answer: 0, +2, 0
9. Determine the oxidation state of carbon in 1,1-dibromoethane Br_2CH-CH_3.
   Answer: +2, 0
10. Determine the oxidation state of carbon in acetic acid $CH_3-C(=O)OH$.
    Answer: 0, +3
11. Determine the oxidation state of carbon in chloroacetic acid $Cl-CH_2-C(=O)OH$.
    Answer: +1, +3
12. Determine the oxidation state of carbon in acetyl chloride $CH_3-C(=O)Cl$.
    Answer: 0, +3

13. Determine the oxidation state of carbon in 1,1,1-trichloroethane Cl_3C-CH_3.
Answer: +3, 0

14. Determine the oxidation state of carbon in tetrachloromethane (or carbon tetrachloride) CCl_4.
Answer: +4

STD type calculations

1. Balance the following equation:

$$MnO_4^- + (COOH)_2 + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$$

Answer: $2MnO_4^- + 5(COOH)_2 + 6H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

2. Balance the following equation:

$$Mn^{2+} + PbO_2 + H^+ \longrightarrow MnO_4^- + Pb^{2+} + H_2O$$

Answer: $2Mn^{2+} + 5PbO_2 + 4H^+ \longrightarrow 2MnO_4^- + 5Pb^{2+} + 2H_2O$

3. Balance the following equation:

$$Pb + HNO_3 \longrightarrow Pb(NO_3)_2 + NO_2 + H_2O$$

Answer: $1Pb + 4HNO_3 \longrightarrow 1Pb(NO_3)_2 + 2NO_2 + 2H_2O$

4. Balance the following equation:

$$I^- + IO_3^- + H^+ \longrightarrow I_2$$

Answer: $5I^- + 1IO_3^- + 6H^+ \longrightarrow 3I_2 + 3H_2O$

5. Balance the following equation:

$$Cl_2 + NaOH \longrightarrow NaCl + HOCl$$

Answer: $1Cl_2 + 1NaOH \longrightarrow 1NaCl + 1HOCl$

6. Balance the following equation:

$$I_2 + S_2O_3^{2-} \longrightarrow I^- + S_4O_6^{2-}$$

Answer: $I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$

Titration type calculations

1. The concentration of oxalic acid can be determined by titration with sodium hydroxide. Calculate the concentration of the oxalic acid solution if a volume of 20.00 cm^3 reacts with 24,15 cm^3 sodium hydroxide solution of 0.09987 mol/dm^3 molarity according to the following balanced equation:

$$(COOH)_2 2 + 2NaOH = (COONa)_2 + 2H_2O$$

Answer: 0.06030 mol/dm^3

2. Calculate the silver ion (Ag^+) concentration in the silver nitrate (AgNO3) solution, if a volume of 25.00 cm^3 was titrated (based on precipitation) with 22.73 cm^3, 0.05525 mol/dm^3 sodium phosphate (Na_3PO_4) solution according to the following balanced equation:

$$3Ag^+ + PO_4^{3-} = Ag_3PO_4$$

Answer: 0.1507 mol/dm^3

3. The concentration of $K_2Cr_2O_7$ can be determined by titrating it with KI. Calculate the concentration of $K_2Cr_2O_7$ in the solution if 50.05 cm^3 of it reacts with 29.30 cm^3 KI solution of 0.1081 mol/dm^3 molarity according to the following balanced equation:

$$Cr_2O_7^{2-} + 6\,I^- + 14\,H^+ \longrightarrow 2\,Cr^{3+} + 3\,I_2 + 7\,H_2O$$

Answer: 0.01055 mol/dm^3

Entrance calculations

1. Calculate the concentration of the solution containing Fe^{2+}, when 20.0 cm^3 of it reacts with 19.2 cm^3 $K_2Cr_2O_7$ solution of 0.104 mol/dm^3 molarity according to the following balanced equation:

$$Cr_2O_7^{2-} + 6\,Fe^{2+} + 14\,H^+ \longrightarrow 2\,Cr^{3+} + 6\,Fe^{3+} + 7\,H_2O$$

   Answer: 0.599 mol/dm^3

2. The concentration of iodine can be determined by titration with arseneous acid. Calculate the concentration of the I_2 solution if 0.360 g H_3AsO_3 reacts with 27.7 cm^3 I_2 solution according to the following balanced equation and $M_r(H_3AsO_3)$=125.9:

$$I_2 + H_3AsO_3 + H_2O \longrightarrow 2\,I^- + H_3AsO_4 + 2\,H^+$$

   Answer: 0.103 mol/dm^3

3. The concentration of $K_2Cr_2O_7$ can be determined by titrating it with KI. Calculate the concentration of $K_2Cr_2O_7$ in the solution if 50.5 cm^3 of it reacts with 28.3 cm^3 KI solution of 0.102 mol/dm^3 molarity according to the following balanced equation:

$$Cr_2O_7^{2-} + 6\,I^- + 14\,H^+ \longrightarrow 2\,Cr^{3+} + 3\,I_2 + 7\,H_2O$$

   Answer: 9.53×10^{-3} mol/dm^3

4. Calculate the volume (in dm^3) of N_2 gas evolved at 60048 Pa pressure and 299 K temperature upon the dissolution of 42.0 g cobalt in concentrated nitric acid according to the following balanced equation with A_r(Co)=58.93 and R=8.314 J/(mol K)

$$5\,Co + 12\,HNO_3 \longrightarrow 5\,Co(NO_3)_2 + N_2 + 6\,H_2O$$

   Answer: 5.90 dm^3

5. Calculate the volume (in dm^3) of NO gas evolved at 10^5 Pa pressure and 290 K temperature upon the dissolution of 53.5 g vanadium in concentrated nitric acid according to the following balanced equation with A_r(V)=50.94 and R=8.314 J/(mol K)

$$6\,V + 10\,HNO_3 \longrightarrow 3\,V_2O_5 + 10\,NO + 5\,H_2O$$

   Answer: 42.2 dm^3

6. Calculate the concentration of Ag^+ in the $AgNO_3$ solution if 20.0 cm^3 of it reacts with 3.45 cm^3 Na_3PO_4 solution of 0.102 mol/dm^3 molarity according to the following balanced equation: $3\,Ag^+ + PO_4^{3-} \longrightarrow \underline{Ag_3PO_4}$
   Answer: 0.0528 mol/dm^3

7. Calculate the concentration of $(COOH)_2$ in a solution if 10.12 cm^3 of it reacts with 13.02 cm^3 $KMnO_4$ solution of 0.0199 mol/dm^3 molarity according to the following balanced equation:

$$2\,KMnO_4 + 5\,(COOH)_2 + 3H_2SO_4 \longrightarrow 2\,MnSO_4 + K_2SO_4 + 10\,CO_2 + 8\,H_2O$$

   Answer: 0.0640 mol/dm^3