

Name: _____

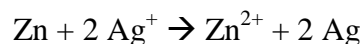
matriculation number: _____

duration: **90 min** . maximal points: 35 points

rating

excellent:	35 – 31.5 P
good:	31 – 27 P
satisfactory:	26.5 – 22.5 P
sufficient:	22 – 17.5 P
insufficient:	17. – 0 P

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1. Silver ions can be removed from a solution by addition of metallic zinc according to the following equation:



The metallic silver is deposited at the bottom of the reaction container.

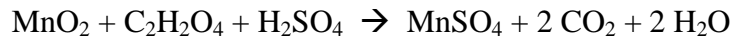
To 100 litre of a solution with a mass concentration of $\beta(\text{Ag}^+) = 3.5 \text{ g l}^{-1}$ are added 50.0 g metallic zinc.

- Which one of both reactants (Zn or Ag^+) is completely consumed?
- How many g of the other substance remain?
- Give the oxidation states of all species of the reaction equation! Which constituent is reduced, which is oxidised?

$$M(\text{Ag}) = 107.868 \text{ g}\cdot\text{mol}^{-1}; M(\text{Zn}) = 65.39 \text{ g}\cdot\text{mol}^{-1}.$$

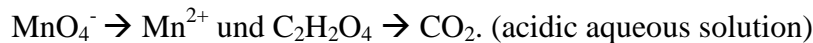
7 P

2. The compound manganese(IV)-oxide MnO_2 was prepared and its purity should be analysed. In a mixture of 100 ml oxalic acid solution with $c(\text{C}_2\text{H}_2\text{O}_4) = 0.05 \text{ mol l}^{-1}$ and 20 ml of a diluted sulphuric acid solution 365.7 mg of MnO_2 is dissolved while heating. The MnO_2 is completely reduced to Mn^{2+} according to the following reaction:



The remaining oxalic acid is titrated with KMnO_4 . 25.98 ml of a 0.02 M KMnO_4 -solution is needed. Upon titration permanganate KMnO_4 is reduced to Mn^{2+} and oxalic acid $\text{C}_2\text{H}_2\text{O}_4$ is oxidized to CO_2 .

- a) Give both the half-reactions and redox reaction of the titration reaction:



Determine the oxidation states of all involved elements!

3 P

- b) Calculate the mass fraction w (in %, 1 decimal digit) of MnO_2 -sample!

5 P

$$M(\text{Mn}) = 54.931 \text{ g mol}^{-1}; M(\text{O}) = 15.999 \text{ g mol}^{-1}.$$

3. Eine organische Verbindung, die nur aus Kohlenstoff, Wasserstoff und Sauerstoff besteht, wurde vollständig verbrannt. Bei der Verbrennung von 1,500 g dieser Verbindung wurden 1,738 g CO₂ und 0,711 g H₂O als einzige Verbrennungsprodukte erhalten.
Wie lautet die empirische Formel der Verbindung?

$$M(\text{C}) = 12,011 \text{ g}\cdot\text{mol}^{-1}; M(\text{O}) = 15,9994 \text{ g}\cdot\text{mol}^{-1}; M(\text{H}) = 1,00794 \text{ g}\cdot\text{mol}^{-1}.$$

8 P

4. Does lead(II)chloride PbCl_2 precipitate, if 20.0 ml of a solution with mit $c(\text{Pb}(\text{NO}_3)_2) = 0.015 \text{ mol l}^{-1}$ are combined with 50.0 ml of a solution with $c(\text{NaCl}) = 0.020 \text{ mol l}^{-1}$? Justify your answer!

$$M(\text{NaCl}) = 58.443 \text{ g mol}^{-1}; M(\text{Pb}(\text{NO}_3)_2) = 331.200 \text{ g mol}^{-1}; M(\text{PbCl}_2) = 278.096 \text{ g mol}^{-1}.$$

$$\text{Solubility product } K_{sp}(\text{PbCl}_2) = 1.60 \times 10^{-5} \text{ mol}^3 \text{ l}^{-3}$$

6 P

5. A solution containing 0.10 mol/l hydrazine (N_2H_4) and an unknown amount of hydrazinium chloride ($\text{N}_2\text{H}_5^+ \text{Cl}^-$) has a pH-value of 7.15.

- a) Calculate the concentration of hydrazinium chloride in the solution in mol/l!
- b) How is this kind of solutions called?
- c) To this solution some ml of a strong acid (HCl) is added. Give the relevant reaction equation!
- d) To the solution of example a) some ml of a strong base (NaOH) is added. Give the relevant reaction equation!

$$K_B(\text{N}_2\text{H}_4) = 9.8 \times 10^{-7}.$$

$$M(\text{N}_2\text{H}_4) = 32.045 \text{ g}\cdot\text{mol}^{-1}; M(\text{N}_2\text{H}_5\text{Cl}) = 68.506 \text{ g}\cdot\text{mol}^{-1}.$$

6 P