Artificial Photosynthesis - Answer Sheet

6% of total									
Question	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	**Total**
Points	3	4	3	2	6	6	1	4	**29**
Score									

3.1 (3 pt)
Calculate the enthalpy of the reaction $\mathrm{H_2(g) \longrightarrow 2H^+(aq) + 2e^-}$.

3.2 (4 pt)

Calculate (a) the water splitting reaction entropy ΔS°_R at 25 °C of 1 mol of H_2O and (b) the voltage at which water splitting is thermoneutral.

(a) $\Delta S^\circ_R =$ _____ J mol^{-1} K^{-1}

(b) _____ V

3.3 (3 pt)

- **Determine** the oxidation state of the cobalt atom in salcomin.
- **Determine** the geometric structure around the cobalt center of salcomin, choosing from these three possibilities: tetrahedral, square planar or octahedral. **Fill in** the corresponding checkbox.

Oxidation number:

Geometric structure (**Fill in** the corresponding checkbox):

☐ tetrahedral

☐ square planar

☐ octahedral

3.4 (2 pt)
Draw the resulting structure.

3.5 (6 pt)

Write down two possible variations of the catalytic cycle with charges of the complex and oxidations states of the Co center. The oxidation state on the Co center should not be larger than +III. **Mark** the hydride formation step with an asterisk and **label** H^+ uptake with **C** (chemical reaction), and electron uptake with **E** (electrochemical reaction), see example cycle in **Figure 2** in the question sheet. [Co^{II}] stands for the Cobalt-salen complex.

3.6 (6 pt)

- Using the redox potential values of different cobalt complexes given in **Table 1**, **write down** which complex is suitable for **a)** water oxidation at neutral pH **b)** water reduction at neutral pH.
- The half-cell potential for the proton reduction at pH = 7, T = 298 K is -0.41 V.

a)

b)

- **Write down** the corresponding overall reaction for both processes (only for the complexes, capable of performing it) and **calculate** the cell potentials at neutral pH.

a)

b)

3.7 (1 pt)

Draw the structure of $NADP^+$.

3.8 (4 pt)

Assuming an efficiency (photon to hydrogen H atom) of $\phi = 20\%$ at a 680 nm photon flux of 100 nE s^{-1} cm^{-2} (1 E = 1 mol of photons), **calculate** a) the number of photons per second and b) the concentration of chlorophyll in a 1x1x1 cm cell needed to get a turnover frequency of 1 nmol H_2 per second.

_____ M