Solutions FORM 12

Problem 1.

a: 4, 9, 14 b: 2, 5, 12 c: 6, 8, 10 d: 7 e: 10, 11, 13 f: 1, 3 g: 1

0,5 from each right choice altogether 16x0.5 = 8 points

remarks: no point reduction, if in c 11 is given

in e also 6 is acceptable

Problem 2.

a. $Ca(s) + 2H_2O \rightarrow Ca^{2+}(aq) + 2OH^-(aq) + H_2(g)$

$2K(s) + 2H_2O \rightarrow 2K^+(aq) + 2OH^-(aq) + H_2(g)$

b. $2Al(s) + 6H_3O^+(aq) \rightarrow 2Al^{3+}(aq) + 6H_2O) + 3H_2(g)$

$Zn(s) + 2H_3O^+(aq) \rightarrow Zn^{2+}(aq) + 2H_2O) + H_2(g)$

$Fe(s) + 2H_3O^+(aq) \rightarrow 2Fe^{2+}(aq) + 2H_2O) + H_2(g)$

c. $2Al(s) + 6H_2O + 2OH^-(aq) \rightarrow 2Al(OH)_4^-(aq) + 3H_2(g)$

$Zn(s) + 2H_2O + 2OH^-(aq) \rightarrow Zn(OH)_4^{2-}(aq) + H_2(g)$

d. $3Ag(s) + HNO_3(aq) + 3H_3O^+(aq) \rightarrow 3Ag^+(aq) + NO(g) + 5H_2O$

$3Cu(s) + 2HNO_3(aq) + 6H_3O^+(aq) \rightarrow 3Cu^{2+}(aq) + 2NO(g) + 10H_2O$ 1 point/reaction

Problem 3.

a $NH_4NO_3(s) \rightarrow N_2O(g) + H_2O$ 2 point

b Nitrogen from -3 to +1 in oxidation and from +5 to +1 in reduction 2 points

c Because it is linear and polar the arrangement must be NNO, because linear NON had to be nonpolar 2 points

d in N=N=O-molecule the central N-atom has sp- hybridization 1 point

e $n(N_2O)$ = 1.00 L x101 kPa/(8.31 J/(K·mol) x 298 K) = 0.0408 mol

from reaction $n(N_2O) = n(NH_4NO_3)$ = 0.0408 mol

$m(NH_4NO_3)$ = 0.0408 mol x 80,1 g/mol = <u>3.27 g</u> 2 points

Problem 4.

If m(carboh) = a g then $m(carboh)_{compl}$ = 0.45·a g and $m(carboh)_{anaer}$ = 0.10·a g

$n(gas)_{total}$ = $16 \cdot 10^3$ L x 101 kPa/ ((8.31 J/(K·mol) x 298 K) = 652 mol in a day 1 point

Reactions: comp. (1) $(CH_2O)_n + nO_2(g) \rightarrow nCO_2(g) + nH_2O(l)$

anaer. (2) $(CH_2O)_n + nO_2(g) \rightarrow n/2 \cdot CO_2(g) + n/2 \cdot CH_4(g)$ 2 point

From (1) => $n(gas)_{total(1)} = n(CO_2)_{(1)} = n(carboh)_{compl}$ = 0.45·a / M(carboh)

From (2) => $n(gas)_{total(2)} = n(CO_2)_{(2)} + n(CH_4)_{(2)}$ = 0.10·a/ M(carboh)

$n(gas)_{total(1)+(2)}$ = 0.45·a g/30,0 g/mol + 0.10·a g/30.0 g/mol = 0.55·a/30 g = 652 mol a = 35560 g 2 point

a. $m(carboh)_{left}$ = 0.45 x 35.60 kg = <u>16 kg</u> 1 point

b. $n(CH_4) = ½ \cdot n(carboh)_{(2)} = ½ \cdot 0.10$ x 35600 g/ 30.0 g/mol = 59.3 mol

E_{heat} = 59.3 mol · 882 kJ/mol = <u>52 MJ</u> 2 points

c. V_{wastew} = 35600 g/ $250 \cdot 10^{-3}$ g/dm^3 = 142 000 dm^3 = <u>140 m^3</u> 1 point

Problem 5.

a. **M** = Mg (magnesium); **X** = CO_2 (carbondioxide); **A** = MgO (magnesium oxide)

B = C (carbon); **Y** = O_2 (oxygen); **Z** = N_2 (nitrogen); **C** = Mg_3N_2 (magnesium nitride)

D = $Mg(OH)_2$ (magnesium hydroxide); **E** = NH_3 (ammonia)

F = $MgCO_3$ (magnesium carbonate) 10 x 0.7 points = 7 points

b. $2Mg(s) + CO_2(g) \rightarrow 2MgO(s) + C(s)$ 1 point

$3Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$ 1 point

$Mg_3N_2(s) + 6H_2O \rightarrow 2NH_3(g) + 3Mg(OH)_2(s)$ 1 point