BOSWELL-BÈTA

James Boswell Exam

Chemistry VWO

Markscheme

Date:	Example exam 2
Time:	1:00 pm – 4:00 pm (3:00 hours)
Number of questions:	5
Number of subquestions:	23
Total number of points:	85

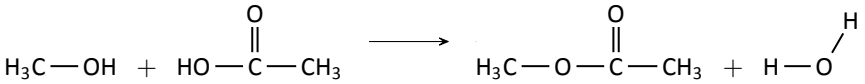
Question 1.a

A: methylethanoate **2**
B: 1-hydroxypropanone **2**

Question 1.b

Both contain polar groups, **1**
but compound **B** can form H-bonds (donate) **1**
so compound **B** will be more soluble. **1**

Question 1.c



methanol left of the arrow **1**
ethanoic acid of the arrow **1**
methylethanoate right of the arrow **1**
water right of the arrow **1**

Question 1.d

2-chloro-propan-1,2-ol **3**

Question 1.e

atom C-2 is asymmetric **1**
optical isomers are created in equal amounts from chemical reactions **1**
the mixture of products will not be optically active (racemic mixture) **1**

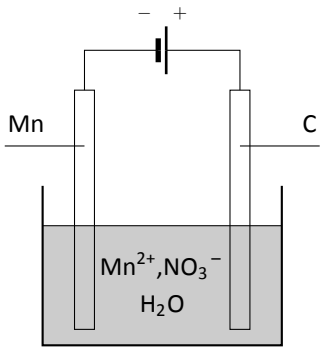
Question 2.a

Assume 100 g, of that 1.5 g is Fe^{2+}. In mole: $\frac{1.5\,\text{g}}{55.85\,\text{g/mol}} = 2.7 \cdot 10^{-2}\,\text{mol}$ **1**
moles Fe^{2+} = $CO_3{}^{2-}$: $2.7 \cdot 10^{-2}\,\text{mol} \times (12.01\,\text{g/mol} + 3 \times 16.00\,\text{g/mol}) = 1.6\,\text{g}\ CO_3{}^{2-}$ **1**
So, there is $100\,\text{g} - 1.5\,\text{g} - 1.6\,\text{g} = 96.9\,\text{g}$ $MgCO_3$ present. In moles: $\frac{96.9\,\text{g}}{114.95\,\text{g/mol}} = 0.84\,\text{mol}\ MnCO_3$ **1**
the same number of Mn^{2+} moles: $0.84\,\text{mol} \times 54.94\,\text{g/mol} = 46.2\,\text{g}Mn^{2+}$ **1**
$\frac{46.2\,\text{g}}{100\,\text{g}} \times 100\% = 46.2\%$ Mn^{2+} in rhodochrosite. **1**
When 47.1% *is answered* **max 3**

Question 2.b

In an acidic environment the carbonate will react with the acid(s) **1**
reaction: $MnCO_3$ (s) + 2 H^+ (aq) $\longrightarrow$ Mn^{2+} (aq) + H_2O (l) + CO_2 (g) **2**
completion reaction + conclusion **2**

Question 2.c



single cell with two electrodes	**1**
electrode substances indicated	**1**
substances in the electrolyte solution indicated	**1**
manganese electrode is the negative ($-$) electrode.	**2**

Question 2.d

half reaction 1: $Mn^{2+} + 2\,e^- \longrightarrow Mn$	**1**
half reaction 2: $2\,H_2O \longrightarrow O_2 + 4\,H^+ + 4\,e^-$	**1**
understanding that water decomposes	**1**
total reaction: $2\,Mn^{2+} + 2\,H_2O \longrightarrow 2\,Mn + O_2 + 4\,H^+ + 4\,e^-$	**2**

if the wrong half reaction is given instead of water 2, do not deduct points if the total reaction is correct

Question 2.e

voltage: $U_{red} - U_{ox}$	**1**
$U_{red} = 1.23\,V$	**1**
so minimum: $1.23\,V - -0.72\,V = 1.95\,V$	**1**

Question 3.a

$K = \frac{[HI]^2}{[H_2][I_2]}$	**2**
$K = \frac{1.12^2}{1.44^2} = 0.60$	**2**

Question 3.b

K increases, so the equilibrium will shift to the right (product side)	**1**
At higher T the endothermic side is favoured	**1**
Reaction to the right is endothermic	**1**

Question 3.c

Concentration HI starts at 0	**1**
Difference H_2: $2 - 1.22 = 0.78$	**1**
Concentration HI: 1.56 mol/L (ratio 1:2)	**1**
Equilibrium at t $= \pm 2.5$	**1**

Question 4.a

HNO_3: $0.86 \times 1.51\,\mathrm{g/mL} = 1.298\,\mathrm{g/mL}$, in mole: $\frac{1.298\,\mathrm{g/mL}}{63.02\,\mathrm{g/mol}} = 0.0206\,\mathrm{mol/mL}$	**1**
HCl: $0.36 \times 1.18\,\mathrm{g/mL} = 0.4248\,\mathrm{g/mL}$, in mole: $\frac{0.4248\,\mathrm{g/mL}}{36.46\,\mathrm{g/mol}} = 0.0116\,\mathrm{mol/mL}$	**1**
H^+: $0.0206\,\mathrm{mol} + 2 \times 0.0116\,\mathrm{mol} = 0.0438\,\mathrm{mol}$ per 3 mL.	**1**
$[H^+]$: $\frac{0.0438\,\mathrm{mol}}{3\,\mathrm{mL}} = 14.6\,\mathrm{mol/L}$	**1**
$\mathrm{pH} = -\log 14.6 = -1.16$	**1**

Question 4.b

half reaction NO_3^-: 0.93 V (half reaction Au: 1.50 V)	**1**
reaction proceeds if $U_{ox} - U_{red} > 0$	**1**
$0.93 - 1.50 < 0$: reaction does not proceed	**1**
bij gelijkwaardige beredenering op basis van de positie in de BINAS tabel	**max 3**

Question 4.c

Step 2: removes Au^{3+}-ions from solution	**1**
Step 1: equilibrium shifts right	**1**
(Almost) completion reaction in step 2: the gold will dissolve	**1**

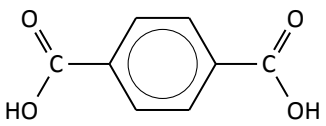
Question 4.d

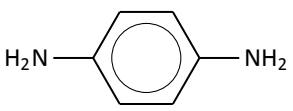
3 NO_3^- and 4 Cl^- are used up in the total reaction, equal to 7 conjugated base particles total	**1**
6 H^+ are used up in the total reaction	**1**
So the solution becomes more acidic with every drop, the use of an acid/base indicator is therefore not possible	**1**

Question 4.e

Insight that the calculation has to be performed using the nitrate-ions	**1**
Amount of added NO_3^-: $0.0206\,\mathrm{mol/mL} \times 11.4\,\mathrm{mL} = 0.235\,\mathrm{mol}$	**1**
ratio 1:3 $= \frac{0.235\,\mathrm{mol}}{3} = 0.0783\,\mathrm{mol Au}$	**1**
in gram: $0.0783\,\mathrm{mol} \times 197.0\,\mathrm{g/mol} = 15.4\,\mathrm{g}$ Au	**1**
mass percentage: $\frac{15.4\,\mathrm{g}}{24.2\,\mathrm{g}} \times 100\% = 63.7\%$	**1**

Question 5.a





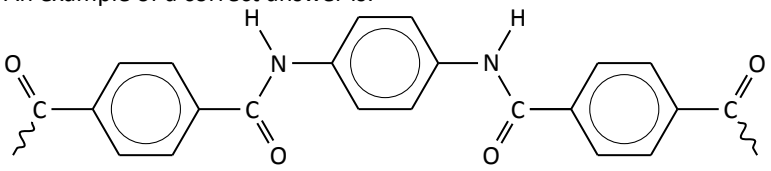
benzene-1,4-dicarboxylic acid	**2**
benzene-1,4-diamine	**2**

Question 5.b

condensation polymerisation, reaction of a dioic acid and a diamine **2**

Question 5.c

An example of a correct answer is:



correct rendering of a fragment (by ∼, — of ●) and the correct number of units **1**
alternated benzene-1,4-dicarboxylic acid and benzene-1,4-diamine **1**
correctly drawing of at least one of the amide bonds **1**
rest of the structure correctly drawn **2**

Question 5.d

molecules have two points of attachment (one growth-direction), **1**
so it will form a chain polymer (thermoplastic material) **1**

Question 5.e

Hydrogen bonds (dipole-dipole interactions and van der waals interactions/London dispersion forces), **1**
between N – H and O = **1**