



SwissChO

Practical Exam 2017

Proposed Solutions and Grading Scheme

Task 1. Perfect gases and molecular mass (4 points)

Let's call m_0 the mass of the empty flask (without air).

$m_1 = m_0 + m(\text{air}) = 144.450 \text{ g}$, maybe. Exact value unimportant – calculation simulated for 300 mL flask with wide neck

$m_2 =$ not needed for calculation, only to check that enough dry ice has been added

$m_3 = m_0 + m(\text{gas}) = 144.645 \text{ g}$;

$\Delta m = m_3 - m_1 = 0.195 \text{ g}$:

If $0.17 < \Delta m < 0.21 \text{ g}$ **1 pt**

If $0.15 < \Delta m \leq 0.17 \text{ g}$ **only ½ pt**

$V(\text{air}) = 315 \text{ mL}$, maybe. Exact value unimportant.

$n(\text{air}) = pV/RT = 10^5 \text{ Pa} \cdot 3.15 \cdot 10^{-4} \text{ m}^3 / (8.314 \text{ J K}^{-1} \text{ mol}^{-1} \cdot 293 \text{ K}) = 0.0129 \text{ mol}$

If $0.0123 < n < 0.0136 \text{ mol}$ **1 pt**

Two equivalent ways for going ahead.

a) First method, via calculation of m_0

$m(\text{air}) = n \cdot M = 0.0129 \cdot 28.9 = 0.373 \text{ g}$

$m_0 = 144.450 \text{ g} - 0.373 \text{ g} = 144.077 \text{ g}$

$m(\text{gas}) = m_3 - m_0 = 144.645 \text{ g} - 144.077 \text{ g} = 0.568 \text{ g}$

$M(\text{gas}) = m(\text{gas})/n(\text{gas}) = 0.568 \text{ g}/0.0129 \text{ mol} = 44.0 \text{ g/mol}$

b) Second method, without concrete calculation of m_0 .

$$\begin{aligned} M &= \frac{m_3 - m_0}{pV/RT} = \frac{m_3 - [m_2 - (pV/RT) \cdot 28.9]}{pV/RT} \\ &= \Delta m \cdot \frac{RT}{pV} + 28.9 = \frac{0.195}{0.0129} + 28.9 = 44.0 \text{ g/mol} \end{aligned}$$

In theory, M should be 44.0 g/mol . However it is hardly ever obtained, only if reacted fast once all dry ice has evaporated. It doesn't really matter here as the focus rest on their reasoning.

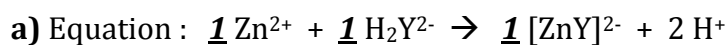
Realisation that air has to and is completely displaced **1 pt**

Final score, with any method, If $42 < M < 45 \text{ g/mol}$ **1 pt**

If $40 < M < 42 \text{ g/mol}$ **only ½ pt**

Problem 2 – Titrations (9 pts)

2.1. Backtitration Zn+Cu/EDTA/Zn



Idem Cu. Accepted : H_2Y^{2-} instead of EDTA

½ pt each

b) $n_0(\text{EDTA}) = c \cdot V = 0.0500 \text{ M} \cdot 0.025 \text{ L} = 1.25 \text{ mmol}$

1 pt

c) $V(\text{Zn})$: 4.9 mL, 4.8 mL, 5.0 mL. Average : 4.9 mL

$n(\text{Zn}) = n(\text{EDTA})_{\text{excess}} = c \cdot V = 0.0500 \text{ M} \cdot 0.0049 \text{ L} = 0.245 \text{ mmol}$

If within 5 %

1 pt

If within 10 %

½ pt

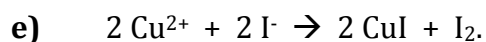
d) $n(\text{Zn+Cu}) = n_0(\text{EDTA}) - n(\text{EDTA})_{\text{excess}} = 1.25 - 0.245 = 1.005 \text{ mmol}$

$[\text{Zn}^{2+} + \text{Cu}^{2+}] = n/V = 1.005 \text{ mmol}/10 \text{ mL} = 0.1005 \text{ M}$

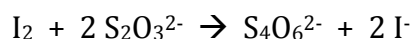
If correctly calculated

1 pt

2.2. Redox Cu/I₂/thiosulfate



½ pt



½ pt

f) $V(\text{thio})$: 10.1 mL, 10.0 mL, 10.2 mL. Average : 10.1 mL

$n(\text{thio}) = c \cdot V = 0.100 \text{ M} \cdot 0.0101 \text{ L} = 0.00101 \text{ mol} = 1.01 \text{ mmol}$

If within 10 %

1 pt

g) $n(\text{I}_2) = \frac{1}{2} n(\text{thio}) = 0.505 \text{ mmol}$

If $n(\text{I}_2) = n(\text{thio})/2$

1 pt

h) $n(\text{Cu}) = 2 n(\text{I}_2) = 1.01 \text{ mmol}$

If $n(\text{Cu}) = n(\text{thio})$

½ pt

$[\text{Cu}^{2+}] = n(\text{Cu})/0.050 \text{ L} = 0.0202 \text{ M}$

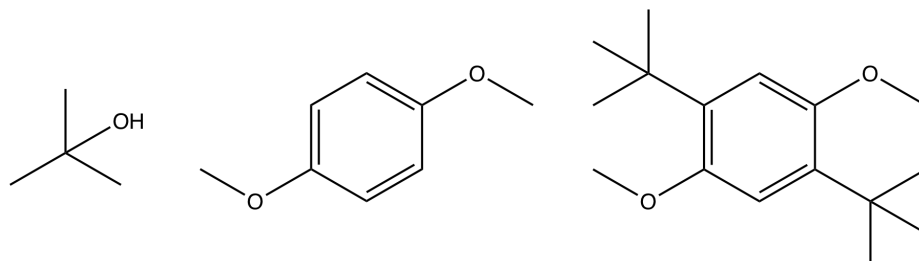
½ pt

i) $[\text{Zn}^{2+}] = 0.1005 \text{ M} - 0.0202 \text{ M} = 0.0803 \text{ M}$

1 pt

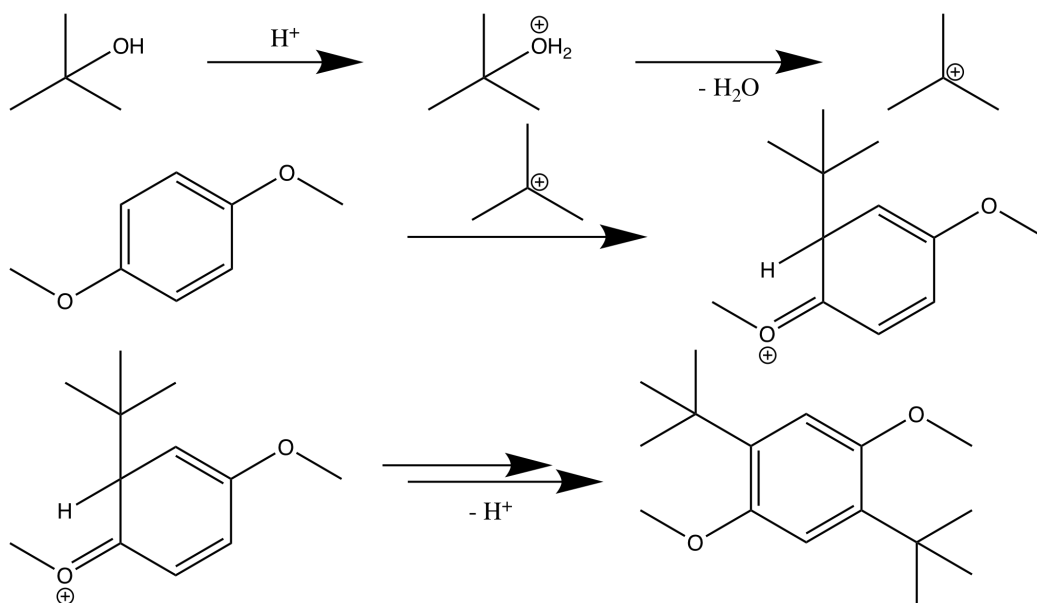
Problem 3 – Organic Synthesis (9 pts).

a)



1 pt each

b)



very roughly sketched

carbocation

½ pt

arenium intermediate

1 pt

realisation reaction 2x

½ pt

c) $C_{16}H_{26}O_2$

$M = 250 \text{ g/mol}$

1 pt

d) 5 mmol

$m = 0.005 \cdot 250 \text{ g} = 1.25 \text{ g}$

1 pt

e) Weight of powder after drying for 1.5 h in oven at XX °C

If $m > 1.1 \text{ g}$

2 pt

If $m > 0.9 \text{ g}$

1 pt only

f) Melting point after drying for 1.5 h in oven at XX °C

If within 2 % of ref.

1 pt

If within 5 % of ref.

½ pt