BOSWELL-BÈTA

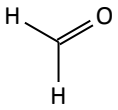
James Boswell Exam

Chemistry VWO

Markscheme

Date:	Example exam 1
Time:	1:00 pm – 4:00 pm (3:00 hours)
Number of questions:	5
Number of subquestions:	28
Total number of points:	75

Question 1.a



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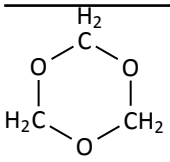
Question 1.b



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Question 1.c

polymer chains have different length because the moment of initiation and the moment of termination is different for each individual chain **1**

Question 1.d

molecular mass monomer: $2 \times 1.008 + 12.01 + 16.00 = 30.03\,\text{g/mol}$ **1**

degree of polymerization $= \dfrac{\text{average molecular mass of polymer}}{\text{molecular mass monomer}}$ **1**

insight that the masses of the ends must be subtracted from the average molecular mass of polymer **1**

atomic mass of deuterium correctly used **1**

this gives:

$$\frac{440.4 - (2 \times 2.014 + 16.00)}{30.03} = 14$$

Question 1.e

take 1 L, then 400 mL is methanal and 600 mL water **1**

1 L formalin has a mass of 815 g **1**

water in 1 L formalin has mass 600 g **1**

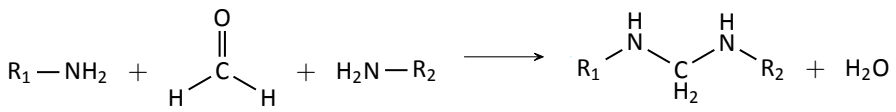
the mass then becomes $815 - 600 = 215$ g **1**

Question 1.f

insight that this can only be amino acids with an NH_2-group in the side chaini **1**

two of Gln, Asn, Arg, of Lys **2**

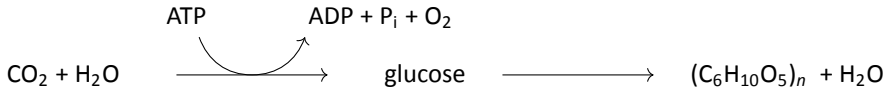
Question 1.g



number R, C, N and H atoms/groups correct **1**

correct product **1**

Question 2.a



Photosynthesis needs CO_2 and H_2O nodig, O_2 is formed **1**
H_2O is released **1**

Question 2.b

$4 \times -2 = -8$, total charge is $2-$, giving ($2 \times$ S heeft een oxidatiegetal getal van) +6 **1**
the oxidation number of S is +3 **1**

Question 2.c

As oxidizing agent: $S_2O_4^{2-} + H_2O + 2\,e \longrightarrow S_2O_3^{2-} + 2\,OH^-$
dithionite left of the arrow and thiosulfate after the arrow **1**
balanced equation **1**
As reducing agent: $S_2O_4^{2-} + 2\,OH^- \longrightarrow 2\,HSO_3^- + 2\,e$
dithionite left of the arrow and monohydrogen sulfite after the arrow **1**
balanced equation **1**

Question 2.d

when a piece of DNA is read to much, the associated protein is expressed too much (this is called over-expression) **1**
over-expression disrupts the balance of protein in the cell **1**

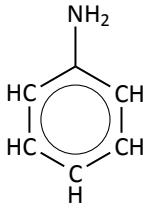
Question 2.e

HOO^- is responsible for bleaching/ de-coloring **1**
H_2O_2 is such a weak acid that that HOO^- is hardly formed. S^{2-} is a strong weak base **1**
S^{2-} reacts with H_3O^+ thus shifting the equilibrium to the right. This gives more HOO^- (which increases bleaching strength) **1**

Question 2.f

of 100 g, 9 g is water, which corresponds to $\frac{9}{18} = 0.5$ mol water molecules **1**
remaining 91 g is cellulose, $\frac{91}{6.0 \times 12.01 + 10 \times 1.008 + 5 \times 16.00} = 0.56$ mol monomers **1**
per monomer there are 3 $-$OH groups, thus in total 1.68 mol $-$OH groups **1**
the average number of water molecules per OH-group then is $\frac{0.5}{1.68} = 0.30$ **1**

Question 3.a



phenylring **1**
amino group **1**

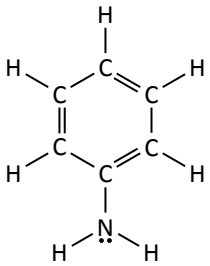
Question 3.b

$R-NH_2 + H_2O \rightleftharpoons R-NH_3^+ + OH^-$ **1**

Question 3.c

$K_b = 10^{-9.4} \left(= 3.98 \cdot 10^{-10}\right)$ **1**
Use of correct K_b and solving: $\frac{x \cdot x}{0.1 - x} = 10^{-9.4}$ **1**
to solve $x^2 = 0.1 \cdot 10^{-9.4}$ gives $x = 6.3 \cdot 10^{6}$ **1**
pOH $= 5.2$ met pH $= 8.8$ **1**

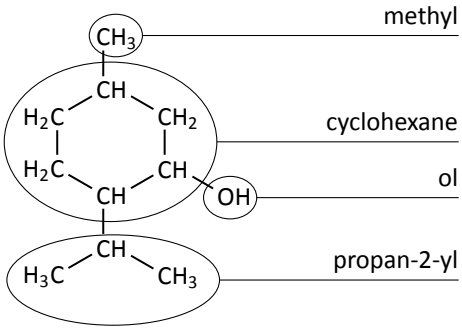
Question 3.d



correct Lewis structure of amino group **1**
the free electron pair on amine group binds H^+ (it forms a bonded pair) **1**
the free electron pair of the amine group is delocalized, which makes it: **1**

- OR less available to bind H^+
- OR delocalization must be broken which takes energy

Question 4.a



5-methyl: the position of methyl is on C-5 of the ring

2-propan: the position of the propyl is on C-2 of the ring, 2 because it must have the lowest number counted from the hydroxyl group

1-ol: the group with the highest priority determines C-1 in the ring

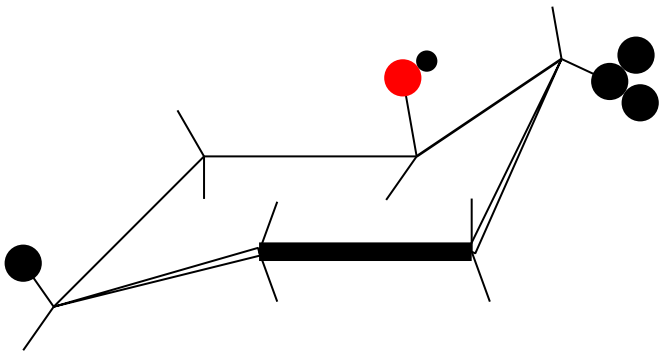
2-yl: the carbon atom in the propyl group which is bonded to the ring

correct encircling of methyl, hydroxyl and cyclohexane	**1**
correct encircling of propan-2-yl	**1**
numbers of 5-methyl and 2-propan correctly explained	**1**
1-ol correctly explained	**1**
2-yl correctly explained	**1**

Question 4.b

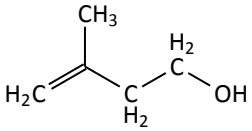
menthol has 3 chiral C-atoms (see name and structure);	**0**
$2^3 = 8$	**1**

Question 4.c



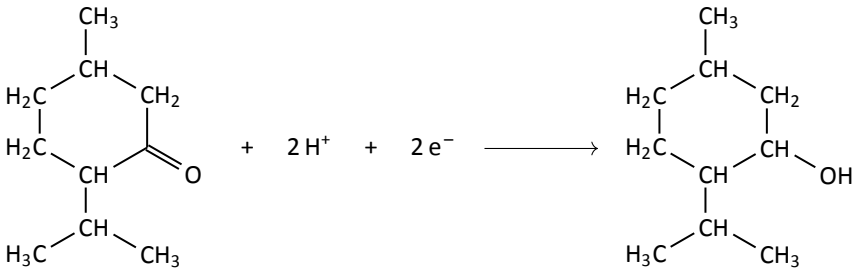
OH and propyl are drawn trans	**1**
OH and methyl are drawn cis	**1**
correct positions	**1**

Question 4.d



3-methylbut-3-ene-1-ol (old naming: 3-methyl-3-butenol) **3**

Question 4.e



balanced halfreaction **1**

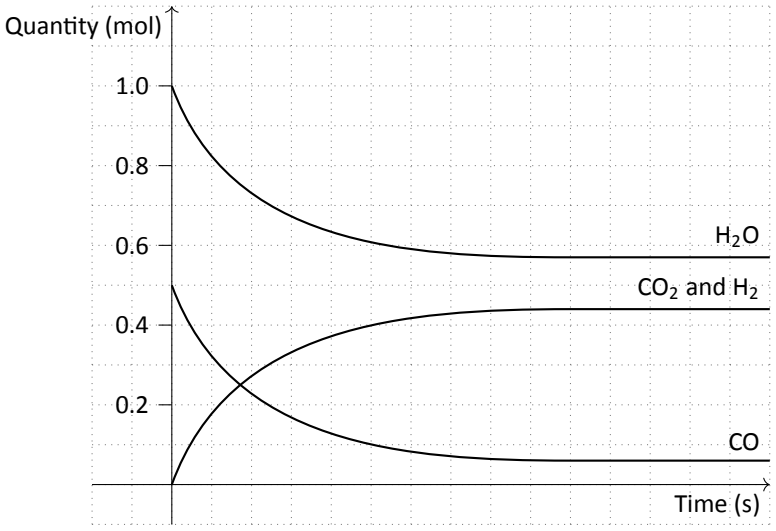
the electrons are left of the arrow / menthon accepts electrons (therefore menthon is the oxidising agent) **1**

Question 5.a

$H_2O\,(g) + CO\,(g) \rightleftharpoons H_2\,(g) + CO_2\,(g)$ **1**

$K_c = \frac{[H_2] \cdot [CO_2]}{[H_2O] \cdot [CO]}$ (water must be present in the condition for equilibrium, if not (0)) **2**

Question 5.b



from graph: decrease in $H_2O = 0.44$ (values between 0.425 end 0.449 are also correct) **1**

CO and CO_2 and H_2O correctly sketched **1**

moment of equilibrium must the same for all **1**

Question 5.c

in total the chamber has $0.06 + 2 \times 0.44 + 0.56 = 1.5$ mol (or alternatively: 1.5 mol present at start, with no change because left and right of the arrow have the same number of particles) **1**

$p = \dfrac{1.5 \times 8.3145 \times 750}{20 \cdot 10^{-3}} = 4.7 \cdot 10^5$ Pa **1**

$4.7 \cdot 10^5 = \dfrac{4.7 \cdot 10^5}{1.013 \cdot 10^5} = 4.6$ Pa **1**

Question 5.d

$K_c = \dfrac{[H_2] \cdot [CO_2]}{[H_2O] \cdot [CO]} = \dfrac{\frac{0.44}{20} \cdot \frac{0.44}{20}}{\frac{0.56}{20} \cdot \frac{0.06}{20}} = 5.76$ **1**

NB: using moles instead of concentrations is also correct

Question 5.e

Right is the exothermic side because:

when temperature is decreased the equilibrium shifts to the exothermic side **1**

when K_c increase the numerator increases (the denominator decreases) implying that the equilibrium shi9s to the right **1**

Question 5.f

right minus left **1**

$393.5 - 286 - 110.5 = -3$ kJ/mol **1**