40th International Chemistry Olympiad

Official Report

2008

Budapest, Hungary

40th International Chemistry Olympiad
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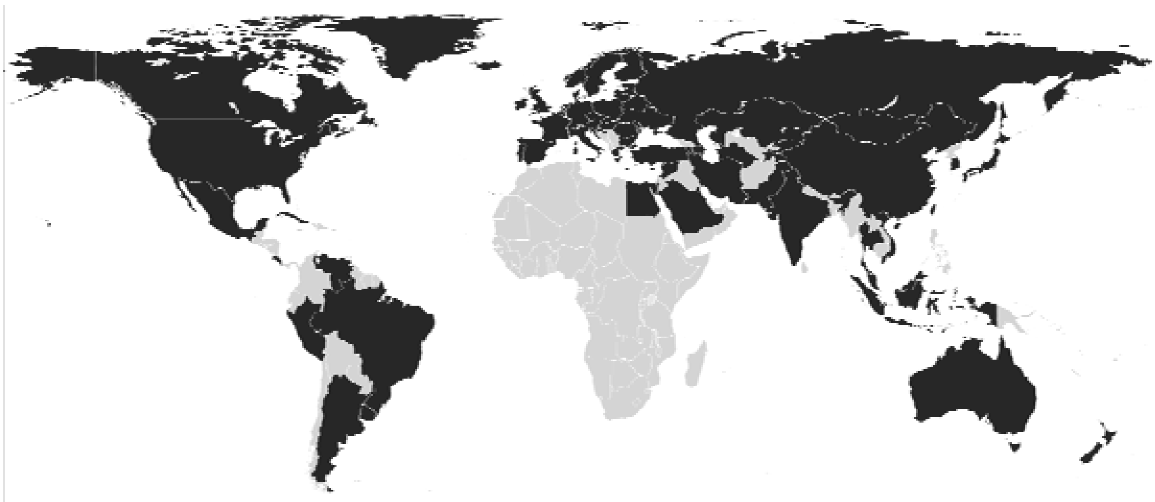
Overview of the 40th IChO

Period	**July 12-21, 2008-11-12**
Hosting institution and Venue	**Eötvös Loránd University, Budapest**
Co-organizer	**Hungarian Chemical Society**

Support

Main sponsors	Ministry of Education and Culture Gedeon Richter Pharmaceuticals PLC
Sponsors	Les Laboratoires Servier MOL (Hungarian Oil and Gas PLC) EGIS Pharmaceuticals PLC
Partners	Heidolph Instruments GmbH IUPAC Sigma-Aldrich Cerbona Food and Trading Co. Festékipari Kutató Kft. Microsoft

Participation information



Countries	66 participating, 3 observing (Costa Rica, Saudi Arabia and Syria) Egypt invited, but missing
Students	257
Mentors	129
Scientific Observers	57
Guests	17

Results

Gold medals	30
Silver medals	52
Bronze medals	79
Honorable Mentions	10

Operational staff — 168 persons

Organizing Committee	12
Science Committee	37
Lab assistants	21
Catalyzer team	10
Guides	88

Students' accommodation

Dormitory of the Szent István University, Gödöllő

Mentors', Scientific observers' and Guests' accommodation

Danubius Health Spa Resort Margitsziget and
Danubius Grand Hotel Margitsziget

Participating Countries

1.	Argentina	ARG		36.	Kyrgyzstan	KGZ
2.	Armenia	ARM		37.	Latvia	LVA
3.	Australia	AUS		38.	Lithuania	LTU
4.	Austria	AUT		39.	Malaysia	MYS
5.	Azerbaijan	AZE		40.	Mexico	MEX
6.	Belarus	BLR		41.	Moldova	MDA
7.	Belgium	BEL		42.	Mongolia	MNG
8.	Brazil	BRA		43.	Netherlands	NDL
9.	Bulgaria	BGR		44.	New Zealand	NZL
10.	Canada	CAN		45.	Norway	NOR
11.	China	CHN		46.	Pakistan	PAK
12.	Chinese Taipei	TPE		47.	Peru	PER
13.	Costa Rica (observing)	CRI		48.	Poland	POL
14.	Croatia	HRV		49.	Portugal	PRT
15.	Cuba	CUB		50.	Romania	ROU
16.	Cyprus	CYP		51.	Russian Federation	RUS
17.	Czech Republic	CZE		52.	Saudi Arabia (observing)	SAU
18.	Denmark	DNK		53.	Singapore	SGP
19.	Estonia	EST		54.	Slovakia	SVK
20.	Finland	FIN		55.	Slovenia	SVN
21.	France	FRA		56.	Spain	ESP
22.	Germany	DEU		57.	Sweden	SWE
23.	Greece	GRC		58.	Switzerland	CHE
24.	Hungary	HUN		59.	Syria (observing)	SYR
25.	Iceland	ISL		60.	Tajikistan	TJK
26.	India	IND		61.	Thailand	THA
27.	Indonesia	IDN		62.	Turkey	TUR
28.	Iran	IRN		63.	Turkmenistan	TKM
29.	Ireland	IRL		64.	Ukraine	UKR
30.	Israel	ISR		65.	United Kingdom	GBR
31.	Italy	ITA		66.	United States	USA
32.	Japan	JPN		67.	Uruguay	URY
33.	Kazakhstan	KAZ		68.	Venezuela	VEN
34.	Korea Republic	KOR		69.	Vietnam	VNM
35.	Kuwait	KWT				

Programs

Students

July 12, Saturday

Whole day	Arrivals

July 13, Sunday

09:00	Departure for the Opening Ceremony
10:00-11:30	Opening Ceremony, Madách Theatre
12:00-14:00	Welcome reception, Eötvös Loránd University
14:00-18:00	Sightseeing
21:00-22:00	Lab safety instruction

July 14, Monday

Whole day	Excursion to Lake Balaton

July 15, Tuesday

08:00	Departure for the practical exam
09:00 -14:00	Practical exam, Eötvös Loránd University
Afternoon	Free time

July 16, Wednesday

Whole day	Sport- and team-building day

July 17, Thursday

08:00	Departure for the theoretical exam
09:00 -14:00	Theoretical exam, Eötvös Loránd University
15:00-17:00	Free time
18:00-22:00	Re-union party, Európa Ship

July 18, Friday

Whole day	Excursion to Visegrád and Szentendre

July 19, Saturday

Whole day	Excursion to Eger and Szilvásvárad

July 20, Sunday

13:00	Departure for the Closing Ceremony
15:00-17:00	Closing Ceremony, Eötvös Loránd University
18:00-22:00	Banquet, Railway Museum

July 21, Monday

Whole day	Departures

Mentors

July 12, Saturday

Whole day	Arrivals

July 13, Sunday

09:00	Departure for the Opening Ceremony
10:00-11:30	Opening Ceremony, Madách Theatre
12:00-14:00	Welcome reception, Eötvös Loránd University
14:00-15:00	Lab inspection, Eötvös Loránd University
16:30-17:30	Meeting with authors, hotel
19:00-23:00	1st Jury Meeting, hotel

July 14, Monday

09:00-17:30	Translation, hotel
18:00-22:00	Dinner with wine in Szentendre

July 15, Tuesday

09:00-12:00	Sightseeing
14:00-17:30	Discussion with authors, hotel
19:00-23:00	2nd Jury Meeting, hotel

July 16, Wednesday

Whole day	Translation, hotel

July 17, Thursday

08:00-16:00	Excursion to Győr and Pannonhalma
18:00-22:00	Re-union party, Európa Ship

July 18, Friday

13:00-14:00	3rd Jury Meeting, hotel
17:00-22:00	Excursion to Visegrád

July 19, Saturday

Whole day	Arbitration, hotel
19:30-22:00	4th Jury Meeting, hotel

July 20, Sunday

13:00	Departure for the Closing Ceremony
15:00-17:00	Closing Ceremony, Eötvös Loránd University
18:00-22:00	Banquet, Railway Museum

July 21, Monday

Whole day	Departures

Guests

July 12, Saturday

Whole day	Arrivals

July 13, Sunday

09:00	Departure for the Opening Ceremony
10:00-11:30	Opening Ceremony, Madách Theatre
12:00-14:00	Welcome reception, Eötvös Loránd University
14:30-18:00	Guided walk in the city centre

July 14, Monday

Whole day	Excursion to Szentendre
18:00-22:00	Dinner with wine in Szentendre, together with the mentors

July 15, Tuesday

09:00-12:00	Sightseeing
15:00-16:00	Visiting the House of Parliament

July 16, Wednesday

Whole day	Puszta-tour

July 17, Thursday

08:00-16:00	Excursion to Győr and Pannonhalma, together with the mentors
18:00-22:00	Re-union party, Európa Ship

July 18, Friday

10:00-17:00	Excursion to Esztergom
17:00-22:00	Excursion to Visegrád, together with the mentors

July 19, Saturday

Whole day	Excursion to Eger and Szilvásvárad

July 20, Sunday

13:00	Departure for the Closing Ceremony
15:00-17:00	Closing Ceremony, Eötvös Loránd University
18:00-22:00	Banquet, Railway Museum

July 21, Monday

Whole day	Departures

Theoretical problems

Instructions

- Write your name and code on each page.
- You have 5 hours to work on the problems. Begin only when the START command is given.
- Use only the pen and calculator provided.
- All results must be written in the appropriate boxes. Anything written elsewhere will not be graded. Use the reverse of the sheets if you need scratch paper.
- Write relevant calculations in the appropriate boxes when necessary. If you provide only correct end results for complicated problems, you receive no score.
- When you have finished the examination, you must put your papers into the envelope provided. Do not seal the envelope.
- You must stop your work immediately when the STOP command is given. A delay in doing this by 3 minutes may lead to cancellation of your exam.
- Do not leave your seat until permitted by the supervisors.
- This examination has 26 pages.
- The official English version of this examination is available on request only for clarification.

Constants and Formulae

Avogadro constant:	$N_A = 6.022 \cdot 10^{23}$ mol^{-1}	Ideal gas equation:	$pV = nRT$
Gas constant:	$R = 8.314$ J K^{-1} mol^{-1}	Gibbs energy:	$G = H - TS$
Faraday constant:	$F = 96485$ C mol^{-1}	$\Delta_r G^o = -RT \ln K = -nFE^o_{cell}$	
Planck constant:	$h = 6.626 \cdot 10^{-34}$ J s	Nernst equation:	$E = E^o + \frac{RT}{zF} \ln \frac{c_{ox}}{c_{red}}$
Speed of light:	$c = 3.000 \cdot 10^8$ m s^{-1}	Energy of a photon:	$E = \frac{hc}{\lambda}$
Zero of the Celsius scale:	273.15 K	Lambert-Beer law:	$A = \log \frac{I_0}{I} = \varepsilon cl$

In equilibrium constant calculations all concentrations are referenced to a standard concentration of 1 mol/dm^3. Consider all gases ideal throughout the exam.

Periodic table with relative atomic masses

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.008																	2 He 4.003
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.96	43 Tc -	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-71	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po -	85 At -	86 Rn -
87 Fr -	88 Ra -	89-103	104 Rf -	105 Db -	106 Sg -	107 Bh -	108 Hs -	109 Mt -	110 Ds -	111 Rg -							

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm -	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
89 Ac -	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np -	94 Pu -	95 Am -	96 Cm -	97 Bk -	98 Cf -	99 Es -	100 Fm -	101 Md -	102 No -	103 Lr -

Problem 1 6% of the total

1a	1b	1c	1d	Task 1
4	2	8	8	22

The label on a bottle containing a dilute aqueous solution of an acid became damaged. Only its concentration was readable. A pH meter was nearby, and a quick measurement showed that the hydrogen ion concentration is equal to the value on the label.

a) Give the formulae of four acids that could have been in the solution if the pH changed one unit after a tenfold dilution.

Any univalent, strong acid (HCl, HBr, HI, HNO_3, $HClO_4$) is acceptable. HF is not!

b) Could it be possible that the dilute solution contained sulfuric acid?

Sulfuric acid: $pK_{a2} = 1.99$

☐ Yes ☐ No

If yes, calculate the pH (or at least try to estimate it) and show your work.

No, the first dissociation step can be regarded as complete in aqueous solutions, thus $[H^+] > c_{acid.}$

2 points are given for 'No'.
No text or calculations are needed later, and no pts will be given here.

pH:

c) Could it be possible that the solution contained acetic acid?

Acetic acid: $pK_a = 4.76$

☐ Yes ☐ No

If yes, calculate the pH (or at least try to estimate it) and show your work.

Yes, but only in quite dilute solutions can this happen. 1 pt for ticking yes

c = [HA] + [A^-] = [H^+] (1 pt)

[H^+] = [A^-] + [OH^-] (1 pt)

This means that [HA] = [OH^-]

Formula:

$$K = \frac{[H^+][A^-]}{[HA]} = \frac{[H^+]([H^+]-[OH^-])}{[OH^-]} = \frac{[H^+]^3}{K_w} - [H^+]$$ (2 pt)

} a sum of 4 pts

The pH of the solution must be acidic, but close to 7.

6.5 is a good guess. (1 pt for reasonable guess – between 6 and 7)

A good approximation is: $[H^+] = \sqrt[3]{(KK_w)}$

The full equation can be solved through iteration: $[H^+] = \sqrt[3]{(K + [H^+])K_w}$

Starting with a neutral solution two cycles of iteration give identical results: $5.64 \cdot 10^{-7}$ mol/dm^3 as the required concentration. Exact pH is 6.25. 3 pts

pH:

d) Could it be possible that the solution contained EDTA (ethylene diamino tetraacetic acid)? You may use reasonable approximations.

EDTA: pK_{a1} = 1.70, pK_{a2} = 2.60, pK_{a3} = 6.30, pK_{a4} = 10.60

☐ Yes ☐ No

If yes, calculate the concentration.

Yes (1 pt)

We can suppose that this solution would be quite acidic, so the 3rd and 4th dissociation steps can be disregarded. (1 pt) The following equations are thus true:

c = [H_4A] + [H_3A^-] + [H_2A^{2-}] = [H^+] (1 pt)

[H^+] = [H_3A^-] + 2[H_2A^{2-}] (1 pt)

This means that [H_4A] = [H_2A^{2-}] (1 pt)

$$K_1K_2 = \frac{[H^+]^2[H_2A^{2-}]}{[H_4A]} = [H^+]^2$$ (or pH = (pK_1 + pK_2) / 2 = 2.15) (2 pts)

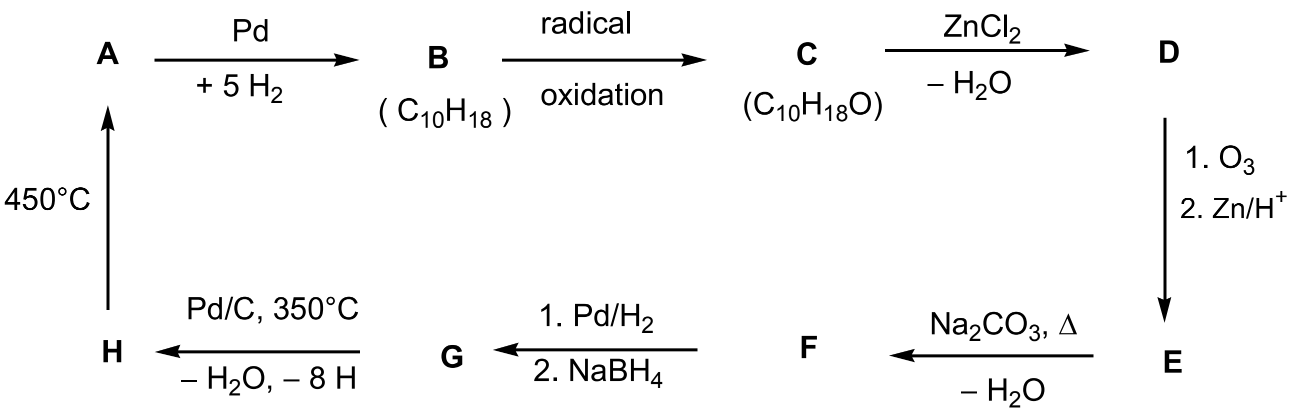
c = 0.0071 mol/dm^3 (1 pt)

c_{EDTA}:

Problem 2 7% of the total

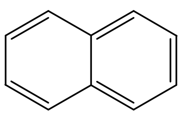
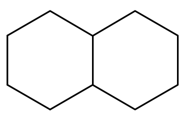
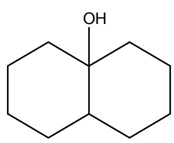
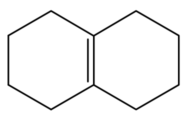
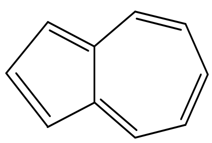
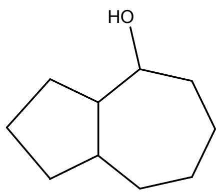
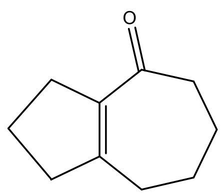
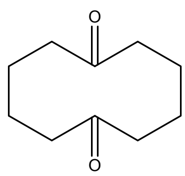
Task 2
18

<u>Determine</u> the structure of the compounds **A-H** (stereochemistry is not expected), based on the information given in the following reaction scheme:



Hints:

- **A** is a well-known aromatic hydrocarbon.
- A <u>hexane</u> solution of **C** reacts with sodium (gas evolution can be observed), but **C** does not react with chromic acid.
- ^{13}C NMR spectroscopy shows that **D** and **E** contain only two kinds of CH_2 groups.
- When a solution of **E** is heated with sodium carbonate an unstable intermediate forms at first, which gives **F** on dehydration.

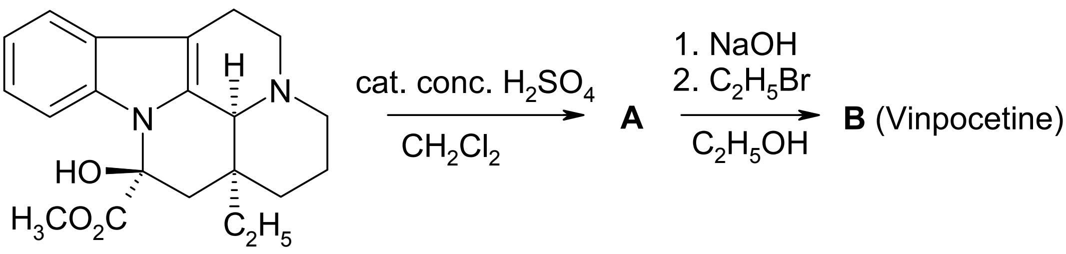
A	**B**	**C**	**D**
			
H	**G**	**F**	**E**
			

2 pts each, 4 pts for **F**

Problem 3 6% of the total

3a	3b	3c	Task 3
4	8	2	14

Vinpocetine (Cavinton®, Calan®) is one of the best selling original drugs developed in Hungary. Its preparation relies on a natural precursor, (+)-vincamine ($C_{21}H_{26}N_2O_3$), which is isolated from the vine plant, *vinca minor*. The transformation of (+)-vincamine to vinpocetine is achieved in two steps depicted below.



Vincamine

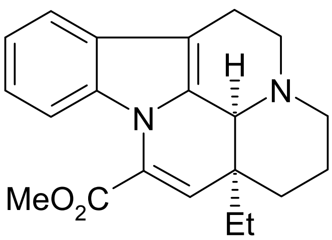
All compounds (**A** to **F**) are enantiomerically pure compounds.

The elementary composition of **A** is: C 74.97%, H 7.19%, N 8.33%, O 9.55%.

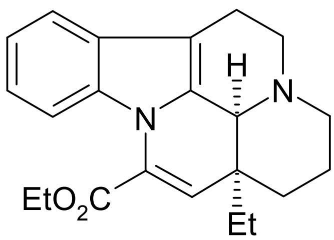
B has 3 other stereoisomers.

a) Propose structures for the intermediate **A** and vinpocetine (**B**).

A **B**



A



B

A study of the metabolism of any drug forms a substantial part of its documentation. There are four major metabolites each formed from vinpocetine (**B**): **C** and **D** are formed in hydrolysis or hydration reactions, while **E** and **F** are oxidation products.

Hints:

The acidity of the metabolites decreases in the order **C** >> **E** >> **D**. **F** does not contain an acidic hydrogen.

C and **E** each have 3 other stereoisomers, while **D** and **F** each have 7 other stereoisomers.

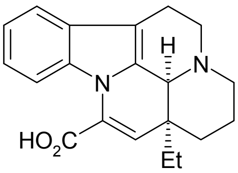
F is a pentacyclic zwitterion and it has the same elementary analysis as **E**: C 72.11%, H 7.15%, N 7.64%, O 13.10%.

The formation of **E** from **B** follows an electrophilic pattern.

The formation of **D** from **B** is both regio- and stereoselective.

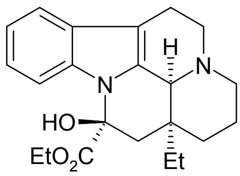
b) Propose one ***possible*** structure for each of the metabolites **C**, **D**, **E** and **F**!

C



C apovincaminic acid

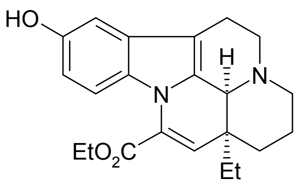
D



D ethyl vincaminate

Both stereoisomers around the new chiral center are acceptable.

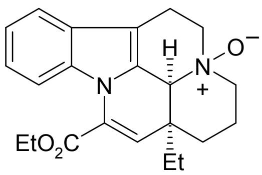
E



E 10-hydroxyvinpocetine

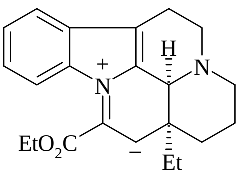
All aromatic positions for the OH are acceptable in **E**.

F



F vinpocetine N-oxide

c) Draw a resonance structure for **B** that explains the regioselective formation of **D** and the absence of the alternate regioisomer in particular.



Problem 4 6% of the total

4a	4b	4c	4d	4e	Task 4
6	2	6	8	6	28

A major transformation route for oxiranes (epoxides) is ring opening. This may be accomplished in various ways.

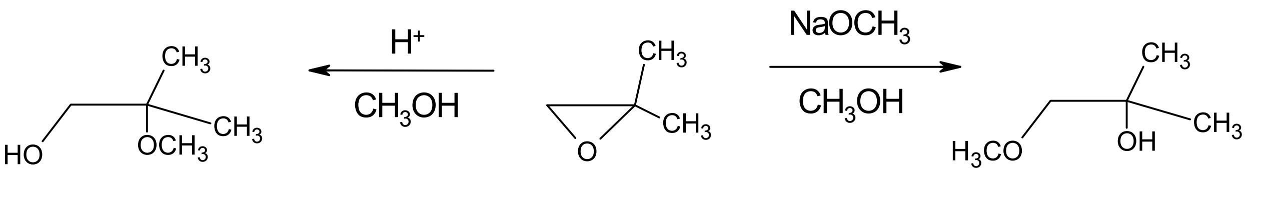
On acid catalysis the reactions proceed through cation-like (carbenium ion-like) species. For substituted oxiranes the direction of ring opening (which C–O bond is cleaved) depends on the stability of the intermediate carbenium ion. The more stable the intermediate carbenium ion the more probable its formation. However, an open carbenium ion (with a planar structure) only forms if it is tertiary, benzylic or allylic.

On base catalysis the sterically less hindered C–O bond is cleaved predominantly.

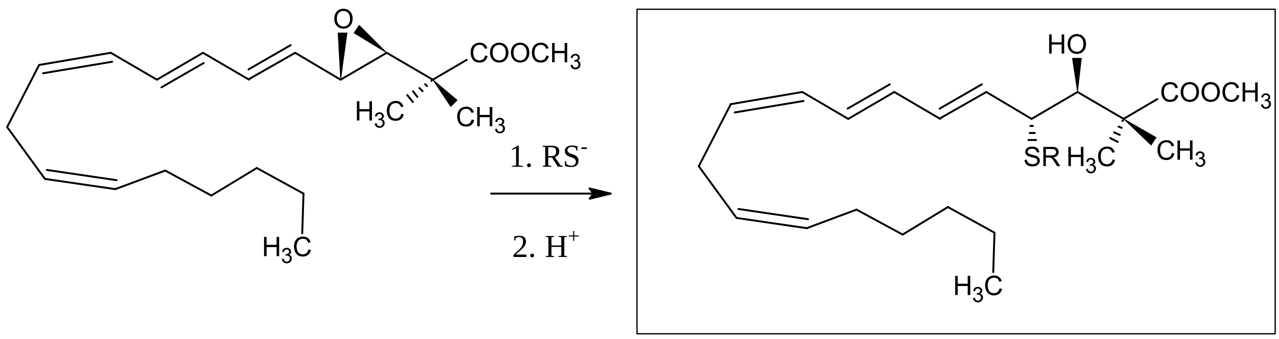
Keep stereochemistry in mind throughout the whole problem. To depict stereochemistry use only the  bond symbols and nothing else where necessary.

a) Draw the structure of the reactant and the predominant products when 2,2-dimethyl-oxirane (1,2-epoxy-2-methylpropane) reacts with methanol at low temperatures, catalysed by
(i) sulfuric acid
(ii) $NaOCH_3$.

2,2-dimethyloxirane

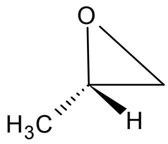


b) Draw the structure of the predominant product when the epoxide ring of the following leukotriene derivative is opened with a thiolate (RS^-).

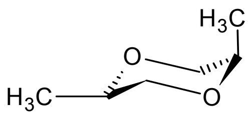


Different porous **acidic** aluminosilicates can also be used to catalyse the transformation of alkyl oxiranes. In addition to ring opening, cyclic dimerisation is found to be the main reaction pathway producing mainly 1,4-dioxane derivatives (six-membered saturated rings with two oxygen atoms in positions 1,4).

c) <u>Draw</u> the structure(s) of the most probable 1,4-dioxane derivative(s) when the starting compound is (*S*)-2-methyloxirane ((*S*)-1,2-epoxypropane). <u>Give</u> the structure of the reactant as well.



(*S*)-2-methyloxirane



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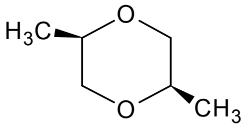
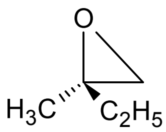


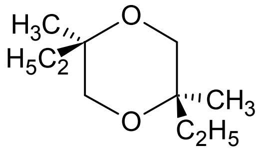
product

reactant 2 pts, product 2 pts, product stereochemistry 2 pts

d) <u>Draw</u> the structure(s) of the substituted 1,4-dioxane(s) when the epoxide reacting is (*R*)-1,2-epoxy-2-methylbutane ((*R*)-2-ethyl-2-methyloxirane). <u>Give</u> the structure of the reactant as well.

(*R*)-1,2-epoxy-2-methylbutane:





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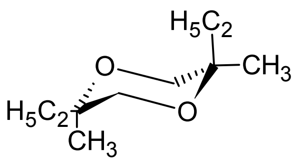
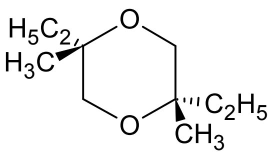


R,R



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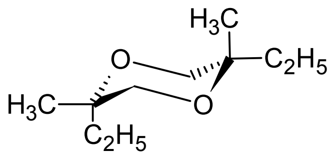
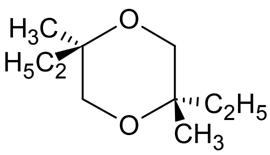


S,S



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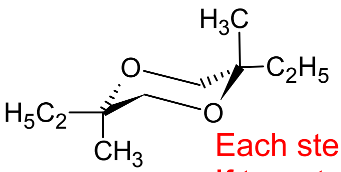
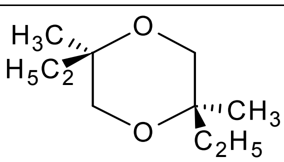


R,S

Each stereoisomer 2 pts
If two structures given for the R,S (meso) product: 1 pt

e) <u>Give</u> the structure(s) of the substituted 1,4-dioxane(s) when this reaction is carried out with racemic 1,2-epoxy-2-methylbutane (2-ethyl-2-methyloxirane).



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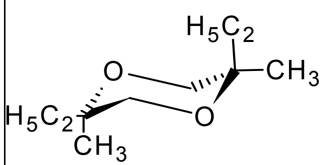
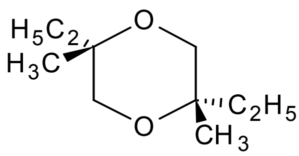


R,R



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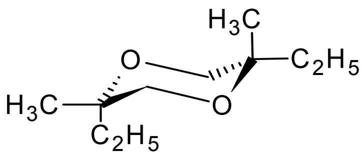
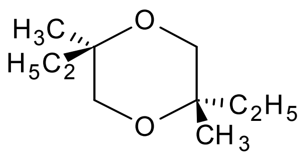


S,S



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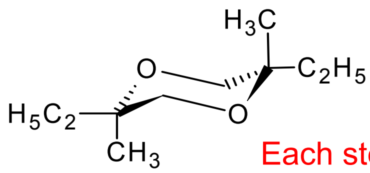


R,S

Each stereoisomer 2 pts
If two structures given for the R,S (meso) product: 1 pt

Problem 5 7% of the total

5a	5b	Task 5
67	33	100

A and **B** are white crystalline substances. Both are highly soluble in water and can be moderately heated (up to 200 °C) without change but both decompose at higher temperatures. If an aqueous solution of 20.00 g **A** (which is slightly basic, pH ≈ 8.5-9) is added to an aqueous solution of 11.52 g **B** (which is slightly acidic, pH ≈ 4.5-5) a white precipitate **C** forms that weighs 20.35 g after filtering, washing and drying. The filtrate is essentially neutral and gives a brown colour reaction with an acidified KI solution. When boiled, the filtrate evaporates without the appearance of any residue.

The white solid **D** can be prepared by the heating of **A** in the absence of air. The exothermic reaction of **D** with water gives a colourless solution. This solution, if kept in an open container, slowly precipitates a white solid **E** and leaves water. Upon prolonged exposure to air at room temperature, solid **D** is transformed into **E** as well. However, heating **D** in air at 500 °C produces a different white substance **F**, which is barely soluble in water and has a mass of only 85.8% of the **E** formed from the same amount of **D**. **F** gives a brown colour reaction with an acidified solution of KI.

E can be converted back into **D** but ignition above 1400 °C is required for this purpose. The reaction of **B** and **D** in water forms the precipitate **C** and is accompanied by a characteristic odour.

a) Give the formulae of the substances **A** - **F**

A $Ba(NO_2)_2$ 8 pts	**B** $(NH_4)_2SO_4$ 8 pts	**C** $BaSO_4$ 4 pts	25 bonus points if both **A** and **B** are identified correctly.
D BaO 4 pts	**E** $BaCO_3$ 4 pts	**F** BaO_2 14 pts	

b) Write balanced equations for **all the reactions mentioned**. (The equation for the thermal decomposition of **B** is not required.)

Equations:

Suggestions for the treatment of some errors:
If the student chooses Ca or Sr for the cation in **A**, the solution may be qualitatively partly correct but it contradicts the stoichiometric data. In this case the student loses the points for the Ba containing species but gets full points for all otherwise correct equations, with the obvious exception of the peroxide formation. The choice of any other metal nullifies the points for all formulae and equations featuring the metal. The choice of HPO_4^{2-} for the anion of **B** is treated similarly.
Minor errors in the equations (charges, coefficients etc.) will be penalized with 1p each (but obviously no negative score for any item).

$Ba(NO_2)_2 = BaO + NO + NO_2$	6 pts
$(NH_4)_2SO_4 = NH_4HSO_4 + NH_3$	0 pts

(*Remark:* NH_4HSO_4 boils without further decomposition at 490 °C. This is not a widely taught fact and its knowledge cannot be expected from the students.)

$Ba^{2+} + SO_4^{2-} = BaSO_4$	2 pts
$2\ NO_2^- + 2\ I^- + 4\ H^+ = 2\ NO + I_2 + 2\ H_2O$	4 pts
$NH_4^+ + NO_2^- = N_2 + 2\ H_2O$	8 pts
$BaO + H_2O = Ba^{2+} + 2\ OH^-$	1 pt
$Ba^{2+} + 2\ OH^- + CO_2 = BaCO_3 + H_2O$	1 pt
$BaO + CO_2 = BaCO_3$	1 pt
$2\ BaO + O_2 = 2\ BaO_2$	4 pts
$BaO_2 + 2\ I^- + 4\ H^+ = Ba^{2+} + I_2 + 2\ H_2O$	4 pts
$BaCO_3 = BaO + CO_2$	1 pt
$NH_4^+ + OH^- = NH_3 + H_2O$	1 pt

Detailed solution:
The problem contains quite a number of clues to the identification of the compounds. It is clear that **A**, **D**, **E**, and **F** all contain the same element; with a water-soluble solid compound stable at 1400 °C, probably a metal. The aqueous solution of a metal compound giving a precipitate and pure water upon standing in the air strongly hints at the formation of a carbonate, possibly from a soluble hydroxide. A likely conclusion is that **D** is an oxide, limiting the choice of the metal to Sr or Ba. (One might also consider Li, Ca, or Tl which are less satisfactory because $Ca(OH)_2$ is poorly soluble while the solubilities of Li_2CO_3 and Tl_2CO_3 are quite significant.) If **E** is an alkaline earth metal carbonate, then the molar mass of **F** could be either M_{Ca} + 45.8, or M_{Sr} + 39.05, or M_{Ba} + 32. Since **F** is formed by heating the oxide in air, the former two do not make any sense while the latter is consistent with BaO_2. This is confirmed by the oxidative capability of **F**.
The odour appearing in the reaction of **B** with $Ba(OH)_2$ indicates that the former might be an ammonium salt. Assuming that the reaction of **A** and **B** is a simple precipitation between a barium salt and an ammonium salt, we get an equivalent mass of 48 for the anion of the precipitate. This might be either SO_4^{2-} or HPO_4^{2-} but the acidity of **B** is consistent with the former and, in addition, $(NH_4)_2HPO_4$ would not give the same $BaHPO_4$ precipitate with $Ba(OH)_2$ as with $Ba(NO_2)_2$. If we accept that **B** is $(NH_4)_2SO_4$, we obtain an equivalent mass of 46 for the anion of **A**. This and the surrounding chemistry are consistent with the nitrite ion.

Problem 6 7% of the total

6a	6b	6c	6d	6e	6f	6g	Task 6
3	5	3	6	6	12	10	45

A feathery, greenish solid precipitate can be observed if chlorine gas is bubbled into water close to its freezing point. Similar precipitates form with other gases such as methane and noble gases. These materials are interesting because vast quantities of the so-called methane-hydrates are supposed to exist in nature (comparable in quantity with other natural gas deposits).

These precipitates all have related structures. The molecules of water just above its freezing point form a hydrogen-bonded structure. The gas molecules stabilize this framework by filling in the rather large cavities in the water structure forming clathrates.

The crystals of chlorine and methane clathrates have the same structure. Their main characteristics are dodecahedra formed from 20 water molecules. The unit cell of the crystal can be thought as a body-centered cubic arrangement built from these dodecahedra which are almost spherical objects. The dodecahedra are connected via additional water molecules located on the faces of the unit cell. Two water molecules can be found on each face of the unit cell. The unit cell has an edge dimension of 1.182 nm.

There are two types of cavities in this structure. One is the internal space in the dodecahedra (**A**). These are somewhat smaller than the other type of voids (**B**), of which there are 6 for each unit cell.

a) How many type **A** cavities can be found in a unit cell?

2

b) How many water molecules are there in a unit cell?

46 = 20x2 (dodecahedra) + 6x2 /2 (faces)

c) If all cavities contain a guest molecule, what is the ratio of the number of water to the number of guest molecules?

46:8 = 5.75

d) Methane hydrate is formed with the structure in **c)** at temperatures between 0-10 °C. What is the density of the clathrate?

A unit cell has a volume of 1.182^3 nm^3 = 1.651 nm^3. 2 pt
It contains 8 methane and 46 water molecules with a mass of 957 g mol^{-1}/ N_A = $1.589 \cdot 10^{-21}$ g. 2 pt
The density is 1.589/1.651 = 0.962 g/cm^3. 2 pt

Density:

e) The density of chlorine hydrate is 1.26 g/cm^3. What is the ratio of the number of water and guest molecules in the crystal?

The mass of a unit cell with this density is: 1.651 $nm^3 \cdot 1.26\ g/cm^3 = 2.081 \cdot 10^{-21}$ g, meaning 1253 g/mol for the contents.
Substracting the waters, this means 424.3 g/mol for the chlorine atoms, giving 11.97 chlorine atoms in a unit cell. 2 pts
The ratio is then 6 (5.98) chlorine molecules for the 46 waters, or a ratio of 7.68. 1 pts
It is expected that only the 6 larger B type cavities contain chlorine. 3 pts

Ratio:

Which cavities are likely to be filled in a perfect chlorine hydrate crystal? Mark one or more.

☐ Some **A** ☐ Some **B** ☐ All **A** ☐ All **B**

Covalent radii reflect atomic distances when the atoms are covalently bonded. Nonbonded or van der Waals radii give a measure of the atomic size when they are not bonded covalently (modeled as hard spheres).

Atom	Covalent radius (pm)	Nonbonded radius (pm)
H	37	120
C	77	185
O	73	140
Cl	99	180

f) Based on the covalent and nonbonded radii of these atoms estimate lower and upper bounds for the average radii of the cavities where possible. Show your reasoning.

Methane fits in both cavities, its radius is appr. 37 + 77 + 120 pm = 234 pm. 3 pts
The chlorine molecule, with a radius of 180 + 99 pm = 279 pm, fits only in **B**. 3 pts
Thus 234 pm < r(**A**) < 279 pm and 279 pm < r(**B**)
2 pts 2 pts 2 pts

< r (**A**) < < r(**B**)

Let us consider the following processes

$H_2O(l) \rightarrow H_2O(s)$ (1)

$x\ CH_4(g) + H_2O\ (l) \rightarrow xCH_4.1H_2O(\text{clathrate})$ (2)

g) What are the signs of the following molar quantities referring to these reactions in the given direction at 4 °C? Mark with a –, 0 or +.

	sign
$\Delta G_m(1)$	
$\Delta G_m(2)$	
$\Delta H_m(1)$	
$\Delta H_m(2)$	
$\Delta S_m(1)$	
$\Delta S_m(2)$	
$\Delta S_m(2) - \Delta S_m(1)$	
$\Delta H_m(2) - \Delta H_m(1)$	

+, –, –, –, –, –, –, –,
Under these conditions, methane clathrate forms, while ice melts to water, so the Gibbs energy changes are of opposite signs.
Freezing is an exothermic process with an entropy decrease in both cases.
The entropy decrease of the clathrate formation is larger in magnitude, as it involves a gas-solid transition.
The relation of the reaction enthalpies can be inferred from these facts:

$\Delta G_m(1) > \Delta G_m(2)$

$\Delta H_m(1) - T\,\Delta S_m(1) > \Delta H_m(2) - T\,\Delta S_m(2)$

$T\,(\Delta S_m(2) - \Delta S_m(1)) > \Delta H_m(2) - \Delta H_m(1)$

a negative quantity $> \Delta H_m(2) - \Delta H_m(1)$

1 pt each, the last 3 pts.

Problem 7 8% of the total

7a	7b	7c	7d	7e	7f	7g	7h	Task 7
2	1	4	2	8	5	8	12	42

The dithionate ion ($S_2O_6^{2-}$) is a rather inert inorganic ion. It can be prepared by bubbling sulphur-dioxide continously into ice-cooled water to which manganese dioxide is added in small increments. Dithionate and sulphate ions are formed under these circumstances.

a) Write the balanced chemical equations for the two reactions.

$MnO_2 + 2SO_2 \rightarrow Mn^{2+} + S_2O_6^{2-}$

$MnO_2 + SO_2 \rightarrow Mn^{2+} + SO_4^{2-}$ 1 pt each

After the reaction is complete, $Ba(OH)_2$ is added to the mixture until the sulphate ions are fully precipitated. This is followed by the addition of Na_2CO_3.

b) Write the balanced equation for the reaction that takes place upon addition of Na_2CO_3.

$MnS_2O_6 + Na_2CO_3 \rightarrow Na_2S_2O_6 + \underline{MnCO_3}$ 1 pt

Sodium dithionate is then crystallized by evaporating some of the solvent. The prepared crystals dissolve readily in water and do not give a precipitate with $BaCl_2$ solution. When the solid is heated and maintained at 130 °C, 14.88 % weight loss is observed. The resulting white powder dissolves in water and does not give a precipitate with $BaCl_2$ solution. When another sample of the original crystals is kept at 300 °C for a few hours, 41.34 % weight loss occurs. The resulting white powder dissolves in water and gives a white precipitate with $BaCl_2$ solution.

c) Give the composition of the prepared crystals and write balanced equations for the two processes that occur during heating.

Formula: $Na_2S_2O_6 \cdot 2H_2O$ (2 pts only for the correct formula)

Equation (130 °C): $Na_2S_2O_6 \cdot 2H_2O \rightarrow Na_2S_2O_6 + 2H_2O$ (1 pt)

Equation (300 °C): $Na_2S_2O_6 \rightarrow Na_2SO_4 + SO_2$ or with H_2O (1 pt)

Although dithionate ion is a fairly good reducing agent thermodynamically, it does not react with oxidants in solution at room temperature. At 75 °C, however, it can be oxidized in acidic solutions. A series of kinetic experiments were carried out with bromine as an oxidant.

d) Write the balanced chemical equation for the reaction between bromine and dithionate ion.

$S_2O_6^{2-} + Br_2 + 2H_2O \rightarrow 2SO_4^{2-} + 2Br^- + 4H^+$ 2 pts

The initial rates (v_0) of the reaction were determined in a number of experiments at 75 °C.

$[Br_2]_0$ (mmol/dm^3)	$[Na_2S_2O_6]_0$ (mol/dm^3)	$[H^+]_0$ (mol/dm^3)	v_0 (nmol dm^{-3}s^{-1})
0.500	0.0500	0.500	640
0.500	0.0400	0.500	511
0.500	0.0300	0.500	387
0.500	0.0200	0.500	252
0.500	0.0100	0.500	129
0.400	0.0500	0.500	642
0.300	0.0500	0.500	635
0.200	0.0500	0.500	639
0.100	0.0500	0.500	641
0.500	0.0500	0.400	511
0.500	0.0500	0.300	383
0.500	0.0500	0.200	257
0.500	0.0500	0.100	128

e) Determine the order of the reaction with respect to Br_2, H^+ and $S_2O_6^{2-}$, the experimental rate equation, and the value and unit of the rate constant.

Reaction order for Br_2: for H^+: for $S_2O_6^{2-}$:

0 1 1

(2 pts each)

Experimental rate equation:

$v = k[S_2O_6^{2-}][H^+]$ (1 pt)

k:

$k = 2.56 \cdot 10^{-5}$ dm^{3}mol^{-1}s^{-1} (1 pt: no point if unit is incorrect; unorthodox but correct unit acceptable)

In similar experiments, chlorine, bromate ion, hydrogen peroxide and chromate ion have all been used as oxidizing agents at 75 °C. The rate equations for these processes are analogous to the one observed with bromine, the units of all rate constants are the same, the values are $2.53 \cdot 10^{-5}$ (Cl_2), $2.60 \cdot 10^{-5}$ (BrO_3^-), $2.56 \cdot 10^{-5}$ (H_2O_2), and $2.54 \cdot 10^{-5}$ ($Cr_2O_7^{2-}$).

Experiments were also carried out in acidic sodium dithionate solution without any oxidizing agent. When following the processes by UV spectrophotometry, the slow appearance of a new absorption band around 275 nm was observed. Although hydrogen sulphate ion is a detectable product of the reaction, it does not absorb any light above 200 nm.

f) Give the formula of the major species causing the new absorption band and write the balanced equation of the chemical reaction occurring in the absence of oxidants.

Species:	SO_2 (or H_2SO_3) 3pts (2 pt for HSO_3^- or SO_3^{2-})
Reaction:	$S_2O_6^{2-} + H^+ \rightarrow HSO_4^- + SO_2$ 2pts (if sulfur(IV) product is different but consistent with the previous answer also 2 pts)

An experiment was carried out to follow the absorbance at 275 nm with initial concentrations: [$Na_2S_2O_6$] = 0.0022 mol/dm^3, [$HClO_4$] = 0.70 mol/dm^3, and the temperature was 75 °C. A pseudo first-order kinetic curve was found with a half-life of 10 hours and 45 minutes.

g) Calculate the rate constant of the reaction.

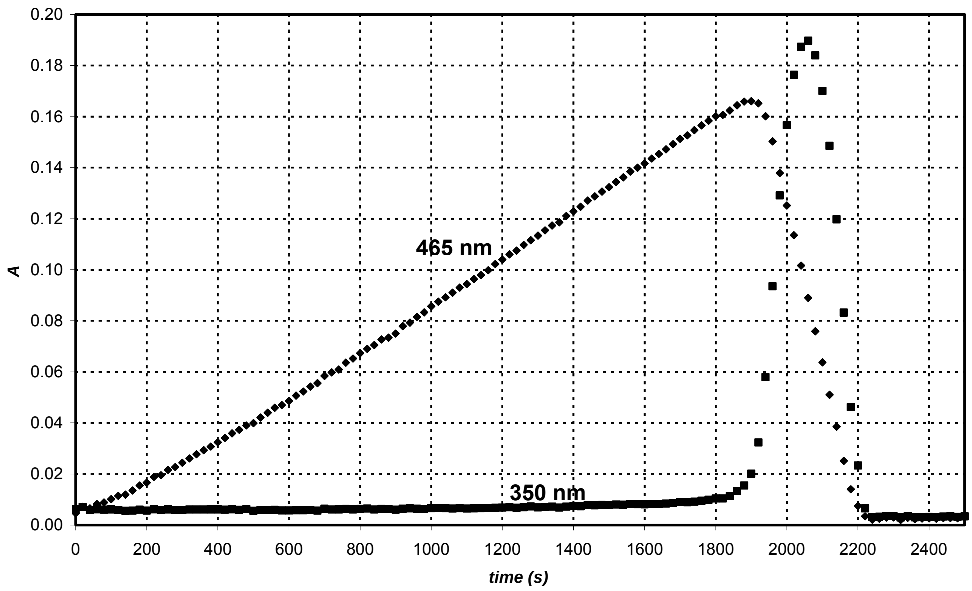
$t_{½}$ = 10 h 45 min = $3.87 \cdot 10^4$ s
$k_{obs} = \ln 2 / t_{½} = 1.79 \cdot 10^{-5}$ s^{-1} 2 pts
$k = k_{obs}/[H^+] = 2.56 \cdot 10^{-5}$ dm^{3}mol^{-1}s^{-1} 2 pts (other consistent units also acceptable)

k:

Suggest a balanced chemical equation for the rate determining step of the reactions that used an oxidizing agent.

Rate determining step: $S_2O_6^{2-} + H^+ \rightarrow HSO_4^- + SO_2$ 4 pts

When periodate ion (which is present as $H_4IO_6^-$ in aqueous solution) was used as an oxidant for dithionate ion, the two kinetic curves depicted in the graph were detected at 75 °C in the same experiment at two different wavelengths. The initial concentrations were [$H_4IO_6^-$] = $5.3 \cdot 10^{-4}$ mol/dm^3, [$Na_2S_2O_6$] = 0.0519 mol/dm^3, [$HClO_4$] = 0.728 mol/dm^3 At 465 nm, only I_2 absorbs and its molar absorption coefficient is 715 dm^{3}mol^{-1}cm^{-1}. At 350 nm, only I_3^- absorbs and its molar absorption coefficient is 11000 dm^{3}mol^{-1}cm^{-1}. The optical path length was 0.874 cm.



h) Write balanced chemical equations for the reactions that occur in the region where the absorbance increases at 465 nm, and in the region where the absorbance decreases at 465 nm.

Increase:	$2\ H_4IO_6^- + 7\ S_2O_6^{2-} + 2\ H_2O + 2\ H^+ \rightarrow\ 14\ HSO_4^- + I_2$ 2 pts
Decrease:	$I_2 + S_2O_6^{2-} + 2\ H_2O \rightarrow\ 2\ HSO_4^- + 2\ I^- + 2\ H^+$ 2 pts

Calculate the expected time for the maximum absorbance of the kinetic curve measured at 465 nm.

$$t_{max} = \frac{7}{2}\frac{[H_4IO_6^-]_0}{k[S_2O_6^{2-}]_0[H^+]_0} = \frac{7 \times 5.3 \times 10^{-4}\ M}{2 \times 2.56 \times 10^{-5}\ M^{-1}s^{-1} \times 0.0519\ M \times 0.728\ M} = 1900\ s$$

5 pts

t_{max}:

Estimate the expected ratio of the slopes of the increasing and decreasing regions in the kinetic curve measured at 465 nm

slope ratio: 1: –7 (it reflects the stoichiometry)
3 pts

Slope ratio:

Problem 8 7 % of the total

8a	8b	8c	8d	8e	8f	8g	8h	8i	Task 8
3	3	4	2	3	2	7	3	5	32

Ms. Z was a bright student, whose research project was to measure the complexation of all lanthanide(III) ions with newly designed complexing ligands. One day she monitored the UV-vis absorption with Ce(III) and a particularly poor complexing ligand in a spectrophotometer. She noticed that some small bubbles had formed in the closed cell by the end of the 12-hour experiment. Soon she realized that the presence of the ligand is not necessary to see the bubble formation, and continued her experiments with an acidified $CeCl_3$ solution. Bubble formation never occurred when she just kept the solution in the spectrophotometer without turning on the instrument. Next, Ms. Z used a small quartz flask, in which she dipped a chloride ion selective electrode and could also withdraw samples regularly for spectrophotometric measurements. She calibrated the chloride ion selective electrode using two different NaCl solutions and obtained the following results:

c_{NaCl} (mol/dm^3)	E (mV)
0.1000	26.9
1.000	–32.2

a) Give a formula to calculate the chloride ion concentration of an unknown sample based on the electrode voltage reading (E).

$[Cl^-]$ = $[Cl^-] = 10^{-(E+32.2 mV)/59.1 mV}$

Ms. Z also determined the molar absorption coefficient for Ce^{3+} (ε = 35.2 dm^{3}mol^{-1}cm^{-1}) at 295 nm, and, as a precaution, also for Ce^{4+} (ε = 3967 dm^{3}mol^{-1}cm^{-1}).

b) Give a formula to calculate the Ce^{3+} concentration from an absorbance reading at 295 nm (A) measured in a solution containing $CeCl_3$ (cuvette path length: 1.000 cm).

$[Ce^{3+}]$ = $[Ce^{3+}] = \dfrac{A_{295nm}}{35.2\,dm^3mol^{-1}}$

Ms. Z prepared a solution which contained 0.0100 mol/dm^3 $CeCl_3$ and 0.1050 mol/dm^3 HCl, and began her experiment by turning on a quartz lamp. HCl does not absorb at 295 nm.

c) What were the expected initial absorbance and voltage readings?

A_{295nm}= $[Ce^{3+}]$ = 0.0100 mol/dm^3 $\Rightarrow$ A_{295nm}= 0.352

E = $[Cl^-]$ = 3·0.0100 mol/dm^3 + 0.1050 mol/dm^3 = 0.1350 mol/dm^3 $\Rightarrow$ E = 19.2 mV

Before the quantitative experiment Ms. Z collected the gas formed into a carefully neutralized solution of methyl orange (acid-base and redox indicator). Although she saw bubbles going through the solution, the colour did not change or fade even after a day.

d) Give the formula of two gases, comprised of elements in the illuminated sample, which could not be present given the results of this experiment.

HCl, Cl_2, (O_3, ClO_2) (no oxidation of indicator)

During her quantitative experiment she recorded the absorbance and voltage values regularly. The uncertainty of the spectophotometric measurements is ±0.002 and the accuracy of the voltage measurements is ±0.3 mV.

time (min)	0	120	240	360	480
$A_{295\ nm}$	0.3496	0.3488	0.3504	0.3489	0.3499
E (mV)	19.0	18.8	18.8	19.1	19.2

e) Estimate the average rate of change in the concentrations of Ce^{3+}, Cl^-, and H^+.

$d[Ce^{3+}]/dt$ =

$d[Cl^-]/dt$ =

$d[H^+]/dt$ =

No significant change in either Cl^- or Ce^{3+} concentrations.
$[H^+] = [Cl^-] - 3\,[Ce^{3+}]$, no significant change.
All three values zero. 1 pt each.

The following day, Ms. Z used an intense monochromatic light beam (254 nm) with an intensity of 0.0500 W. She passed this light through a 5-cm long quartz photoreactor filled with the same acidic $CeCl_3$ solution she had used before. She measured the molar absorption coefficient for Ce^{3+} (ε = 2400 $dm^3mol^{-1}cm^{-1}$) at 254 nm.

f) What percentage of the light is absorbed in this experimental setup?

$A = 2400\ dm^3mol^{-1}cm^{-1} \cdot 5\ cm \cdot 0.0100\ M = 120 \Rightarrow (100 - 10^{-118})\% \approx 100\%$

The equipment allowed her to lead the gas first through a drying tube that removed traces of water vapour and then into a closed chamber, whose volume was 68 cm^3. The chamber was equipped with a high-precision manometer and an igniter. She first filled the chamber with dry argon to a pressure of 102165 Pa and then she turned on the lamp. In 18.00 hours, the pressure reached 114075 Pa. The temperature of the equipment was 22.0 °C.

g) Estimate the amount of substance of the gas collected in the chamber.

$p_{partial} = p_{final} - p_{initial}$ = 114075 Pa – 102165 Pa = 11910 Pa

$n = p_{partial} V/(RT)$ = 11910 Pa·0.000068 m^3 /(8.314 J/mol/K·295.15 K) = 3.3·10^{-4} mol
2 pts

n_{gas}:

At this point, Ms. Z turned off the light and pressed the ignition button. When the chamber cooled down to the initial temperature, the final pressure was 104740 Pa.

Suggest the formula(s) of the gas(es) formed and collected, and give the balanced equation for the original chemical reaction taking place under illumination.

Gas(es):

identity of gases: H_2, O_2 4 pts

reaction: $2H_2O \xrightarrow{h\nu} 2H_2 + O_2$ 1pt

Reaction:

h) What would be the final pressure after the ignition if the chamber was being filled for 24 hours before ignition?

Final pressure: 104740 Pa (saturated water vapour)

p =

i) Estimate the quantum yield of product formation in the Ce(III) solution.

Quantum yield:
3.3·10^{-4} mol gas formed altogether: 2.2·10^{-4} mol H_2 and 1.1·10^{-4} mol O_2.

Light beam intensity 0.0500 Js^{-1} $\Rightarrow \dfrac{0.0500\ \text{J/s}\ \lambda}{hcN_A} = 1.06 \cdot 10^{-7}\text{mols}^{-1}$ photon

Total time 18.00 h = 64800 s
Total number of absorbed photons: 64800 s·1.06·10^{-7} mols^{-1} = 6.87·10^{-3} mol

Quantum yield for H_2 production: Φ = 2.2·10^{-4} mol / 6.87·10^{-3} mol = 0.032
Quantum yield for O_2 production: Φ = 1.1·10^{-4} mol / 6.87·10^{-3} mol = 0.016

Either value or the quantum yield of the gas production (0.048) is acceptable when demonstrated in a calculation.

Quantum yield:

Problem 9 6 % of the total

9a	9b	9c	9d	Task 9
12	21	15	9	57

Thallium exists in two different oxidation states: Tl^+ and Tl^{3+}. Iodide ions can combine with iodine to form tri-iodide ions (I_3^-) in aqueous solutions,
The standard redox potentials for some relevant reactions are:

$Tl^+(aq) + e^- \rightarrow Tl(s)$ $E^o_1 = -0.336$ V
$Tl^{3+}(aq) + 3e^- \rightarrow Tl(s)$ $E^o_2 = +0.728$ V
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$ $E^o_3 = +0.540$ V

The equilibrium constant for the reaction $I_2(s) + I^-(aq) \rightarrow I_3^-(aq)$: $K_1 = 0.459$.

Use T=25 °C throughout this problem.

a) Calculate the redox potential for the following reactions:

$Tl^{3+}(aq) + 2 e^- \rightarrow Tl^+(aq)$ E^o_4

$$E_4^\circ = \frac{3E_2^\circ - E_1^\circ}{2} = 1.26 \text{ V}$$ 6 pts

E^o_4 =

$I_3^-(aq) + 2 e^- \rightarrow 3 I^-(aq)$ E^o_5

$E^o_5 = E^o_3 + 0.059/2 \lg(1/K_1) = 0.550$ V 6 pts

E^o_5 =

b) Write empirical formulae for all theoretically possible neutral compounds that contain one thallium ion and any number of iodide and/or tri-iodide ion(s) as anion(s).

TlI, TlI_3, TlI_5, TlI_7, TlI_9 1 pt each

There is an empirical formula that could belong to two different compounds. Which one?

TlI_3 can be either $Tl^{3+}(I^-)_3$ or $Tl^+(I_3^-)$ 4 pts

Based on the standard redox potentials, which of the two isomers mentioned above is the stable one at standard conditions? Write the chemical reaction for the isomerisation of the other isomer of thallium iodide.

More stable:

$Tl^{+}(I_3^{-})$
as $E^o_4 > E^o_5$ or E^o_3, 6 pts

Isomerisation:

$Tl^{3+} + 3I^{-} = Tl^{+} + I_3^{-}$ 6 pts
3 pts for $TlI_3 = Tl(I_3)$; 0 pts for $Tl^{3+} + 3I^{-} = Tl^{+} + I_2$

Complex formation can shift this equilibrium. The cumulative complex formation constant for the reaction $Tl^{3+} + 4I^{-} \rightarrow TlI_4^{-}$ is $\beta_4 = 10^{35.7}$

c) Write the reaction that takes place when a solution of the more stable isomer of thallium iodide is treated with an excess of KI. Calculate the equilibrium constant for this reaction.

Reaction:

$Tl^{+} + I_3^{-} + I^{-} \rightarrow TlI_4^{-}$ 3 pts

This reaction could be regarded as sum of three reactions:

$Tl^{+}(aq) \rightarrow Tl^{3+}(aq) + 2e^{-}$ $-E^o_4 = -1.26$ V, thus $\Delta_r G_4^o = nFE_4^o = 243.1$ kJ/mol

$I_3^{-}(aq) + 2e^{-} \rightarrow 3I^{-}(aq)$ $E^o_5 = 0.550$ V, thus $\Delta_r G_5^o = -nFE_5^o = -106.1$ kJ/mol

$Tl^{3+} + 4I^{-} \rightarrow TlI_4^{-}$ $\beta_4 = 10^{35.7}$ thus $\Delta_r G_6^o = -RT\ln\beta_4 = -203.8$ kJ/mol

The net free enthalpy change is $\Delta_r G_7^o = \Delta_r G_4^o + \Delta_r G_5^o + \Delta_r G_6^o = -66.8$ kJ/mol

Thus $K_2 = \exp\left(-\frac{\Delta_r G_7}{RT}\right) = 4.96 \cdot 10^{11}$

3 pts each for $\Delta_r G^o_{(4\text{-}6)}$ and for K_2.

K_2:

If the solution of the more stable isomer is treated with a strong basic reagent precipitation of a black substance can be observed. After the water content of the precipitate is removed, the remaining material contains 89.5% thallium (by mass).

d) What is the empirical formula of this compound? Show your calculations. Write a balanced equation for its formation.

Supposing that the substance contains Tl and an anion, the formula of the compound is Tl_aX_b and the following equation holds:

$$\frac{a \cdot 204.4}{a \cdot 204.4 + bM_X} = 0.895$$

From the values b = 1, 3 and a = 1, 2, 3 only b = 3, a =2 gives a realistic M_X = 16.0 g/mol.
X is oxygen. 4 pts

Formula:

Tl_2O_3. 2 pts

Equation:

$2\ TlI_3 + 6\ OH^{-} \rightarrow Tl_2O_3 + 6\ I^{-} + 3\ H_2O$ 3 pts
2 pts if H^{+} or H_3O^{+} ions are written at the right side of the equation.

Practical Problems

Instructions

- This examination has **10** pages and **5** pages of answer sheets (8+4 for Task 1-2, 2+1 for Task 3).
- You have **3 hours** to complete **Tasks 1 and 2**. After that you will have to leave the laboratory for a short **break** while the assistants exchange your glassware and chemicals. You will then have **2 hours** to work on **Task 3**.
- Begin only when the START command is given. You must stop your work immediately when the STOP command is given after each part. A delay in doing this by 3 minutes will lead to cancellation of your experimental exam.
- Follow **safety rules** given in the IChO regulations. At all times while you are in the laboratory you must wear **safety glasses** or your own glasses if they have been approved, and use the **pipette filler bulb** provided. Use **gloves** when handling the organic liquids.
- You will receive only **ONE WARNING** from the laboratory supervisor if you break safety rules. On the second occasion you will be dismissed from the laboratory with a resultant zero score for the entire experimental examination.
- Do not hesitate to ask a demonstrator if you have any questions concerning safety issues or if you need to leave the room.
- Use only the pen and calculator provided.
- Write your **name and code on each answer sheet**. Do not attempt to separate the sheets.
- All results must be written in the appropriate areas on the answer sheets. Anything written elsewhere will not be graded. Use the reverse of the sheets if you need scratch paper.
- You will need to reuse some glassware during the exam. Clean them carefully at the sink closest to you.
- Use the labeled **waste containers** under the hood for the disposal of organic liquids from Task 1 and all liquids from Task 3.
- The number of **significant figures** in numerical answers must conform to the rules of evaluation of experimental errors. Mistakes will result in penalty points, even if your experimental technique is flawless.
- Chemicals and laboratory ware are not supposed to be **refilled or replaced**. Each such incident (other than the first, which you will be allowed) will result in the **loss of 1 point** from your 40 practical points.
- When you have finished a part of the examination, you must put your answer sheets into the envelope provided. Do not seal the envelope.
- The official English version of this examination is available on request only for clarification.

Apparatus

For common use in the lab:
Heating block preadjusted to 70 °C under the hood
Distilled water (H_2O) in jugs for refill
Latex gloves (ask for a replacement if allergic to latex)
Labeled waste containers for Task 1 (organic liquids) and Task 3 (all liquids)
Container for broken glass and capillaries
On each desk:
Goggles
Heat gun
Permanent marker
Pencil and ruler
Stopwatch, ask supervisor about operation if needed. (You can keep it.)
Tweezers
Spatula
Glass rod
Ceramic tile
Paper tissue
Spray bottle with distilled water
9 Eppendorf vials in a foam stand
TLC plate in labeled ziplock bag
Plastic syringe (100 cm^3) with polypropylene filter disc
Pipette bulb
14 graduated plastic Pasteur pipettes
Petri dish with etched competitor code
Burette
Stand and clamp
Pipette (10 cm^3)
2 beakers (400 cm^3)
Beaker and watchglass lid with filter paper piece for TLC
10 capillaries
2 graduated cylinders (25 cm^3)
3 Erlenmeyer flasks (200 cm^3)
Beaker (250 cm^3)
2 beakers (100 cm^3)
Funnel
Volumetric flask (100 cm^3)
30 test tubes in stand*
Indicator paper pieces and pH scale in ziplock bag*
Wooden test tube clamp*
2 plugs for test tubes*

* Only handed out for Task 3

Chemicals

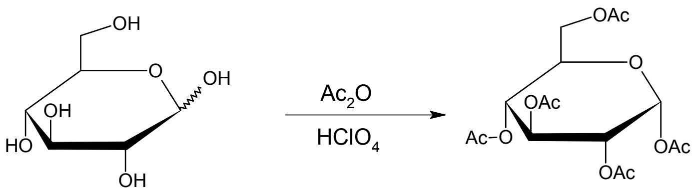
Sets for 4-6 people	**R phrases**	**S phrases**
0.025 mol/dm^3 ferroin solution	52/53	
0.2 % diphenylamine, $(C_6H_5)_2NH$ solution in conc. H_2SO_4	23/24/25-33-35-50/53	26-30-36/37-45-60-61
0.1 mol/dm^3 $K_3[Fe(CN)_6]$ solution	32	
Pumice stone		
On each desk:		
50 mg anhydrous $ZnCl_2$ in a small test tube (in the foam stand, labeled with code)	22-34-50/53	36/37/39-26-45-60-61
100 mg β-D-glucopyranose pentaacetate (labelled as BPAG)		
3.00 g anhydrous glucose, $C_6H_{12}O_6$, preweighed in vial		
$(CH_3CO)_2O$ in Erlenmeyer flask (12 cm^3)	10-20/22-34	26-36/37/39-45
$(CH_3CO)_2O$ in vial (10 cm^3)	10-20/22-34	26-36/37/39-45
CH_3COOH in vial (15 cm^3)	10-35	23-26-45
CH_3OH in vial (10 cm^3)	11-23/24/25-39	7-16-36/37-45
30 % $HClO_4$ in CH_3COOH in vial (1 cm^3)	10-35	26-36/37/39-45
1:1 isobutyl acetate – isoamyl acetate in vial (20 cm^3), labeled as ELUENT	11-66	16-23-25-33
solid $K_4[Fe(CN)_6].3H_2O$ sample with code in small flask	32	22-24/25
$ZnSO_4$ solution labeled with code and concentration (200 cm^3)	52/53	61
0.05136 mol/dm^3 Ce^{4+} solution (80 cm^3)	36/38	26-36
1.0 mol/dm^3 H_2SO_4 solution (200 cm^3)	35	26-30-45
Sample solutions for Task 3 (to be handed out at the start of Task 3)	1-26/27/28-32-35-50/53	24/25-36/39-61

Risk and Safety Phrases

Indication of Particular Risks			
1	Explosive when dry	33	Danger of cumulative effects
10	Flammable	34	Causes burns
11	Highly Flammable	35	Causes severe burns
22	Harmful if swallowed	39	Danger of very serious irreversible effects
32	Contact with concentrated acids liberates very toxic gas		
Combination of Particular Risks			
20/22	Harmful by inhalation and if swallowed	36/38	Irritating to eyes and skin
23/24/25	Toxic by inhalation, in contact with skin and if swallowed	50/53	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment
26/27/28	Very Toxic by inhalation, in contact with skin and if swallowed	52/53	Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment
Indication of Safety Precautions			
7	Keep container tightly closed	30	Never add water to this product
16	Keep away from sources of ignition - No smoking	33	Take precautionary measures against static discharges
22	Do not breathe dust	36	Wear suitable protective clothing
23	Do not breathe fumes/vapour	45	In case of accident or if you feel unwell, seek medical advice immediately (show label where possible)
25	Avoid contact with eyes	60	This material and/or its container must be disposed of as hazardous waste
26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice	61	Avoid release to the environment.
Combination of Safety Precautions			
24/25	Avoid contact with skin and eyes	36/37/39	Wear suitable protective clothing, gloves and eye/face protection
36/37	Wear suitable protective clothing and gloves		

Task 1

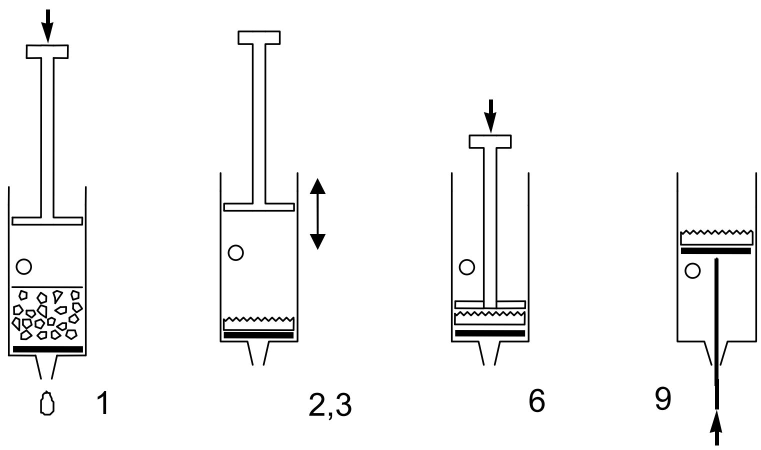
Synthesis of α-D-glucopyranose pentaacetate



Caution: Use gloves while manipulating acetic acid and acetic anhydride. Let the lab supervisors know if any is spilled.

Add and mix 12 cm^3 of pure acetic acid to 12 cm^3 of acetic anhydride (provided in an Erlenmeyer flask) and add 3.00 g glucose (acetic anhydride is used in excess). Add with a Pasteur-pipette 5 drops of 30% $HClO_4$ dissolved in acetic acid. After the addition of the catalyst the solution might warm up considerably.
Let the mixture rest covered for 10 minutes and swirl it from time to time. Pour the reaction mixture into 100 cm^3 of water in a beaker. Scratch the wall of the beaker with a glass rod to initiate crystallization, and let it crystallize for 10 minutes. Filter and wash the product two times with 10 cm^3 of water using the syringe and the porous polypropylene filter disc.

Filtration using a plastic syringe



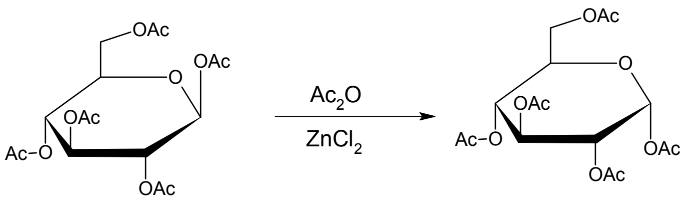
1. Pull out the piston. Fill the syringe from above with the suspension to be filtered. The syringe can be filled to the level of the hole. Replace piston.
2. Cover the hole with your finger and press in the piston as far as the hole.
3. Open the hole and draw the piston back. Do not draw in air through the filter.
4. Repeat steps 2-3 a few times to expel the liquid.
5. Repeat steps 1-4 until all solids are on the filter.
6. Press the piston against the filter cake and squeeze out the liquid.
7. Wash the product twice with 10 cm^3 of water repeating steps 1-4.
8. Press the piston against the filter cake and squeeze out the water.
9. Pull the piston out with the hole closed to lift out the filter cake. (Pushing with the end of the spatula can help.)

a) Place your product in the open Petri dish marked with your code. Leave it on your table. The organizers will dry it, weigh it and check it for purity.

b) Calculate the theoretical yield (mass) of your product in g. (*M*(C) = 12 g/mol, *M*(O) = 16 g/mol, *M*(H)= 1.0 g/mol

Synthesis of α-D-glucopyranose pentaacetate from β-D-glucopyranose pentaacetate

An alternative synthesis of α-D-glucopyranose pentaacetate starts from readily available β-D-glucopyranose pentaacetate. In this experiment we will study the kinetics of this reaction with thin layer chromatography.



Add 1.5 cm^3 acetic anhydride to 50 mg of anhydrous $ZnCl_2$ (preweighed in a test tube). Add 100 mg of pure β-D-glucopyranose pentaacetate (BPAG) and swirl until dissolved. Take three drops from this mixture into an Eppendorf tube, add 0.5 cm^3 methanol and save it.
Place the test tube in the heating apparatus under the hood closest to your desk. Place the test tube in the heating block preadjusted to 70ºC. Mix the contents of the test tube from time to time. During the reaction take three drops of sample from the mixture with a Pasteur pipet after 2, 5, 10, and 30 minutes. Mix immediately each sample with 0.5 cm^3 of methanol to stop the reaction in an Eppendorf tube.
Prepare a silica TLC plate with the collected samples to study the reaction kinetics. Apply the necessary reference compounds as well to help identification of the spots on the plate. Mark the spots with a pencil, and develop the plate in isobutyl acetate/ isoamyl acetate (1:1) eluent. Heat the plates with a heat-gun (under the hood!) to visualise the spots (the colour is stable). You can ask for a second plate without penalty points if needed for proper evaluation.

c) Copy your plate on the answer sheet and place your plate in the labeled ziplock bag.

d) Interpret your experimental findings answering the questions on the answer sheet.

Task 2

Insert this remark in your translation if your students do not know this kind of pipette.
Hint: The pipette has two graduation marks. Stop at the second mark to measure out exact volumes. Do not let all the solution to run out.
When potassium hexacyanoferrate(II), $K_4[Fe(CN)_6]$ is added to a solution containing zinc ions, an insoluble precipitate forms immediately. Your task is to find out the composition of the stoichiometric precipitate that contains no water of crystallization.
The precipitation reaction is quantitative and so quick that it can be used in a titration. The end point can be detected using redox indication, but first the concentration of the potassium hexacyanoferrate(II) solution has to be determined.

Preparation of $K_4[Fe(CN)_6]$ solution and determination of its exact concentration

Dissolve the solid $K_4[Fe(CN)_6].3H_2O$ (M = 422.41 g/mol) sample in the small Erlenmeyer flask and quantitatively transfer it into the 100.00 cm^3 volumetric flask. Take 10.00 cm^3 portions of the hexacyanoferrate(II) solution. Add 20 cm^3 1 mol/dm^3 sulfuric acid and two drops of the ferroin indicator solution to each sample before titration. Titrate with the 0.05136 mol/dm^3 Ce^{4+} solution. Repeat titration as necessary. Cerium(IV) is a strong oxidant under acidic conditions forming Ce(III).

a) Report the Ce^{4+} solution volumes consumed.

b) Give the equation for the titration reaction. What was the mass of your $K_4[Fe(CN)_6].3H_2O$ sample?

The reaction between zinc ions and potassium hexacyanoferrate(II)

Take 10.00 cm^3 of the hexacyanoferrate(II) solution and add 20 cm^3 1 mol/dm^3 sulfuric acid. Add three drops of indicator solution (diphenyl amine) and two drops of $K_3[Fe(CN)_6]$ solution. The indicator only works if the sample contains some hexacyanoferrate(III), $[Fe(CN)_6]^{3-}$. Titrate slowly with the zinc solution. Continue until a bluish violet colour appears. Repeat titration as necessary.

c) Report the zinc solution volumes consumed.

d) Interpret the titration answering the questions on the answer sheet.

e) Determine the formula of the precipitate.

Caveat: Best marks are not necessarily awarded to measurements reproducing theoretically expected values.

Task 3

Caution: Handle all unknown solutions as if they were toxic and corrosive. Discard them only in the appropriate waste container.
The heat gun heats the expelled air up to 500 °C. Do not direct the stream towards combustible materials or body parts. Be careful with the hot nozzle.
Always place a single piece of pumice into liquids before heating to avoid bumping. Never point the mouth of a heated test tube towards a person.

You have eight unknown aqueous solutions. Each solution contains only one compound. The same ion may appear in more than one solution. Every compound formally consists of one type of cation and one type of anion from the following list:

Cations: H^+, NH_4^+, Li^+, Na^+, Mg^{2+}, Al^{3+}, K^+, Ca^{2+}, Cr^{3+}, Mn^{2+}, Fe^{2+}, Fe^{3+}, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Sr^{2+}, Ag^+, Sn^{2+}, Sn^{4+}, Sb^{3+}, Ba^{2+}, Pb^{2+}, Bi^{3+}

Anions: OH^-, CO_3^{2-}, HCO_3^-, CH_3COO^-, $C_2O_4^{2-}$, NO_2^-, NO_3^-, F^-, PO_4^{3-}, HPO_4^{2-}, $H_2PO_4^-$, SO_4^{2-}, HSO_4^-, S^{2-}, HS^-, Cl^-, ClO_4^-, MnO_4^-, Br^-, I^-

You have test tubes and heating but no additional reagents apart from distilled water and pH paper.

<u>Identify</u> the compounds in the solutions **1**-**8**. You can use the solubility table for some of the anions on the next page. If you are unable to identify an ion exactly, give the narrowest selection possible.

Remarks:

The unknown solutions may contain minor impurities arising from their exposure to air. The concentration of all solutions is around 5 % by mass so you can expect clearly observable precipitates from the main components. In some cases, precipitation does not occur instantaneously; some substances may remain in an oversaturated solution for a while. Don’t draw negative conclusions too hastily, wait 1-2 minutes where necessary. Always look carefully for all signs of a reaction.

Keep in mind that heating accelerates all processes, increases the solubility of most substances, and may start reactions that do not take place at room temperature.

Solubility Table at 25 °C

	NH_4^+	Li^+	Na^+	Mg^{2+}	Al^{3+}	K^+	Ca^{2+}	Cr^{3+}	Mn^{2+}	Fe^{2+}	Fe^{3+}	Co^{2+}	Ni^{2+}	Cu^{2+}	Zn^{2+}	Sr^{2+}	Ag^+	Sn^{2+}	Sn^{4+}	Sb^{3+}	Ba^{2+}	Pb^{2+}	Bi^{3+}
CH_3COO^-														HR			1.0	↓	↓	↓			↓
$C_2O_4^{2-}$			3.6	↓			↓		↓	↓ (Y)	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
NO_2^-	HR				HR			HR		↓ R				HR	↓		0.41 ((Y))	↓ R	↓	↓			↓
NO_3^-																							
F^-		0.13		↓	0.5		↓	4.0	1.0	↓ (W)	↓ (W)	1.4	2.6	↓	1.6	↓			↓		0.16	↓	↓
SO_4^{2-}							0.21									↓	0.84		↓		↓	↓	
PO_4^{3-}	HR	↓		↓	↓		↓	↓	↓	↓ (W)	↓	↓ (P)	↓	↓	↓	↓	↓ (Y)	↓	↓	↓	↓	↓	↓
HPO_4^{2-}		↓		↓	↓		↓	↓	↓	↓ (W)	↓ (W)	↓ (P)	↓	↓	↓	↓	↓ (Y)	↓	↓	↓	↓	↓	↓
$H_2PO_4^-$					HR		1.0	HR	HR		↓ (W)	HR		↓	↓	HR	↓ (Y)	↓	↓	↓	HR	↓	↓
ClO_4^-						2.1																	
MnO_4^-	HR							HR	↓ R	R		HR					0.91	R		R		↓ R	
Br^-																	↓ ((Y))					0.98	
I^-											R			↓ R			↓ (Y)	1.0				↓ (Y)	↓ (B)

No entry: Soluble compound ↓: Insoluble compound **R**: Redox reaction at room temperature
HR: Soluble at room temperature. In hot solution a reaction with an observable effect (not necessarily a precipitate) takes place.
Solubilities in g (substance) / 100 g water. Accurately known values between 0.1 and 4 are shown only.
Precipitates whose colour significantly differs from that of their hydrated ions: (**B**) = black, (**P**) = purple, (**W**) = white, ((**Y**)) = pale yellow, (**Y**) = yellow.

Task 1 10% of the total

1a	1b	1c	1d	Task 1
30	2	12	4	48

a) Yield of the product in g, measured by the organizer:

The samples are dried by the organisers. Full pts for a 60-100% yield, linear scale between 0-60% yield. The typical yield is 70%.
Purity is checked by solubility (acetone) and TLC. If there is no insoluble material and no impurity is detectable by TLC, the full points for the yield are received.
If there is a considerable (easily visible) amount of insoluble material or impurity on the TLC plate, then 0 point is received for the yield (only possible in case of intentional contamination).
5 points off if filter disc is submitted.

b) Calculate the theoretical yield of your product in g.

$C_6H_{12}O_6 \rightarrow C_{16}H_{22}O_{11}$

$$m = \frac{3.00\,\text{g} \cdot 390\,\text{g/mol}}{180\,\text{g/mol}} = 6.5\text{ g}$$

Theoretical yield:

c) Sketch your developed TLC plate and leave on your desk to be evaluated,

If both standards and all samples are present and labeled: 5 pts
If any sample is missing: 2 pts, if more than one is missing: 0 pt.
Loading of the plate: if over- or underloading does not interfere with the evaluability: 4 pts, if interfering, but evaluation is still possible: 2 pts, if evaluation is not possible: 0 pt
If the development is appropriate (minor tilting is acceptable): 3 pts. If erratically developed, but still evaluable (the two isomers separate): 1 pt, otherwise 0 pt.

d) **Interpret your experiment** and choose the correct answer.

The acetylation reaction of glucose is exothermic.

- ☐ a) Yes
- ☐ b) No
- ☐ c) Cannot be decided based on these experiments

The isomerisation reaction of β-D-glucopyranose pentaacetate can be used for the preparation of pure α-D-glucopyranose pentaacetate.

- ☐ a) Yes
- ☐ b) No
- ☐ c) Cannot be decided based on these experiments

Solutions: a, a (2 pts. each)

Task 2 — 15 % of the total

2a	2b	2c	2d	2e	Task 2
25	4	25	6	5	65

a) Ce^{4+} consumptions:

Full marks (25 pts.) if V_1 is within 0.15 cm^3 of the expected value recalculated from the $K_4[Fe(CN)_6]$ mass. Zero marks if deviation is more than 0.50 cm^3. Linear scale is applied in between.

Average volume consumed (V_1):

b) The titration reaction:

$Ce^{4+} + [Fe(CN)_6]^{4-} = Ce^{3+} + [Fe(CN)_6]^{3-}$ 2 pts.

or

$Ce^{4+} + Fe^{2+} = Ce^{3+} + Fe^{3+}$ 1 pt.

Calculation of sample mass:

$m = c_{Ce}\ V_1\ 10 \cdot M$ 2 pts.

Actual sample masses will be distributed with the exam copies.

$K_4[Fe(CN)_6].3H_2O$ mass (m):

c) Zinc consumptions:

Full marks (25 pts.) if V_2 is within 0.15 cm^3 of the expected value recalculated from $K_4[Fe(CN)_6]$ mass, zinc concentrations and empirical ratio. Zero marks if the deviation is more than 0.50 cm^3. Linear scale is applied in between.

Average volume consumed (V_2):

d) Mark the correct answer.

The diphenyl amine indicator changes in colour at the end point

- ☐ a) because the concentration of the Zn^{2+} ions increases.
- ☐ b) because the concentration of the $[Fe(CN)_6]^{4-}$ ions decreases.
- ☐ c) because the concentration of the $[Fe(CN)_6]^{3-}$ ions increases.
- ☐ d) because the indicator is liberated from its complex.

Which form of the indicator is present before the end point?

- ☐ a) Oxidized
- ☐ b) Reduced
- ☐ c) Complexed to a metal ion

At the beginning of the titration the redox potential for the hexacyanoferrate(II) - hexacyanoferrate(III) system is lower than the redox potential of the diphenyl amine indicator.

- ☐ a) True
- ☐ b) False

Solutions: b, b, a (2 pts. each)

e) Determine the formula of the precipitate. Show your work.

The mole ratio of the zinc:hexacyanoferrate(II) in the precipitate can be evaluated as:

$$n_{Zn}/n_{Fe(CN)_6} = \frac{10c_{Zn}V_2M}{m}$$

Values for c_{Zn} are distributed according to country color (found on seating plan)
Red/Pink: 0.0500 Green: 0.0450 Blue: 0.0475 Yellow/Ivory: 0.0525

The empirical ratio obtained from the experiments is 1.489.
Calculating the zinc/hexacyanoferrate(II) ratio: 3 pts.
Cations are needed to make the precipitate neutral and only potassium is present.
The precipitate is $K_2Zn_3[Fe(CN)_6]_2$. 2 pts.
Any other reasonable calculation giving the same result is accepted.

Hydrogen instead of potassium ($H_2Zn_3[Fe(CN)_6]_2$ or $KHZn_3[Fe(CN)_6]_2$) is also acceptable.

Mistakes in units, dilution factors, significant figures (not 3 or 4 in 2b) carry a penalty of 1 pt. in each calculation.

The formula of the precipitate:

Items replaced or refilled: Student signature: Supervisor signature:

Task 3 15 % of the total

Task 3
108

Only fill out this table when you are ready with all your assignments.

	1	2	3	4	5	6	7	8
Cation								
Anion								

6 pts for each correctly identified ion except for HCO_3^- and HS^- which are worth 12 pts, bringing up the total to 108 points.

Partial points will be awarded in the following cases:

Anions:
$AgNO_3$: Full points if NO_3^- is the only anion shown. 3 pts for ClO_4^- only. 3 pts if fluoride appears together with nitrate and/or perchlorate. Otherwise 0 pt.
$Pb(CH_3COO)_2$: 3 pts if NO_3^- and/or ClO_4^- appear together with CH_3COO^-. 1 pt for nitrate and/or perchlorate on their own. Otherwise 0 pt.
3 pts for CO_3^{2-} instead of HCO_3^-, and for S^{2-} instead of HS^-.

Cations:
In the case of all alkali metal compounds, 2 pts for an incorrect alkali metal.
1 pt for Ca^{2+} or Sr^{2+} instead of Ba^{2+}.

Solution

The solutions received by the students contain the following compounds. The country colours can be found on the laboratory seating plan.

Country colour	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Blue	$AgNO_3$	$KHCO_3$	NH_4ClO_4	NaOH	NaHS	$Pb(OAc)_2$	BaI_2	$MgSO_4$
Green	$Pb(OAc)_2$	NH_4ClO_4	NaOH	NaHS	$MgSO_4$	$KHCO_3$	$AgNO_3$	BaI_2
Ivory	NH_4ClO_4	$Pb(OAc)_2$	$KHCO_3$	BaI_2	$AgNO_3$	$MgSO_4$	NaHS	NaOH
L.Blue	NaHS	$MgSO_4$	BaI_2	NH_4ClO_4	$Pb(OAc)_2$	$AgNO_3$	NaOH	$KHCO_3$
L.Green	BaI_2	NaHS	$MgSO_4$	$AgNO_3$	NaOH	NH_4ClO_4	$KHCO_3$	$Pb(OAc)_2$
Pink	$MgSO_4$	NaOH	$AgNO_3$	$Pb(OAc)_2$	$KHCO_3$	BaI_2	NH_4ClO_4	NaHS
Red	NaOH	BaI_2	$Pb(OAc)_2$	$KHCO_3$	NH_4ClO_4	NaHS	$MgSO_4$	$AgNO_3$
Yellow	$KHCO_3$	$AgNO_3$	NaHS	$MgSO_4$	BaI_2	NaOH	$Pb(OAc)_2$	NH_4ClO_4

The problem can be approached in many ways. Intuition is very helpful in the tentative assignment of some compounds in the early phases of the work. A systematic solution is given here for the blue Country colour.

All solutions are colourless (NaHS may be slightly yellowish because of polysulfide impurity). Solutions **1**, **3**, **6**, **7**, and **8** are practically neutral (pH paper reading about 5-6). Solution **2** is basic (pH = 9) while solutions **4** and **5** are very strongly basic (pH > 11).

We can exclude all ions that only form coloured compounds in aqueous solutions: Cr^{3+}, Fe^{2+}, Fe^{3+}, Co^{2+}, Ni^{2+}, Cu^{2+}, and MnO_4^-. (In principle we should also exclude Mn^{2+} but its solutions have a very light pink colour that might be mistaken for colourless. The yellowish solution is strongly basic hence its colour cannot be attributed to iron.) The compounds of H^+, Sn^{2+}, Sn^{4+}, Sb^{3+}, Bi^{3+}, and HSO_4^- with the possible counter-ions could only exist in markedly acidic solutions; therefore they can also be safely excluded.

Thus the list of possible ions is:

Cations: NH_4^+, Li^+, Na^+, Mg^{2+}, Al^{3+}, K^+, Ca^{2+}, Mn^{2+}, Zn^{2+}, Sr^{2+}, Ag^+, Ba^{2+}, Pb^{2+}.

Anions: OH^-, CO_3^{2-}, HCO_3^-, CH_3COO^-, $C_2O_4^{2-}$, NO_2^-, NO_3^-, F^-, PO_4^{3-}, HPO_4^{2-}, $H_2PO_4^-$, SO_4^{2-}, S^{2-}, HS^-, Cl^-, ClO_4^-, Br^-, I^-.

The unknown solutions react with each other as follows (↓ = precipitate; ↑ = volatile product; “no change” means even when boiled, unless indicated otherwise):

	1 $AgNO_3$	**2** $KHCO_3$	**3** NH_4ClO_4	**4** NaOH	**5** NaHS	**6** $Pb(OAc)_2$	**7** BaI_2	**8** $MgSO_4$
1 $AgNO_3$	—	—	—	—	—	—	—	—
2 $KHCO_3$	↓ light yellow ↑ neutral, odourless	—	—	—	—	—	—	—
3 NH_4ClO_4	no change	↓ white crystals (*)	—	—	—	—	—	—
4 NaOH	↓ brown-black	no change	boiling: ↑ basic, odour of ammonia	—	—	—	—	—
5 NaHS	↓ black solution turns acidic	no change	boiling: ↑ basic, odour of NH_3, H_2S	no change	—	—	—	—
6 $Pb(OAc)_2$	↓ white crystals	↓ white ↑ neutral, odourless	no change	↓ white	↓ black	—	—	—
7 BaI_2	↓ yellow	↓ white ↑ (**)	no change	no change	no change	↓ yellow	—	—
8 $MgSO_4$	↓ white crystals	no change (***)	no change	↓ white	no change (****)	↓ white	↓ white	—

(*): upon boiling, the formation of NH_3 is detectable by its odour and by pH paper.
(**): gas bubbles are usually not observed when **2** is in excess.
(***): upon boiling, an odourless gas evolves and a white precipitate forms.
(****): upon boiling, a white precipitate forms and the odour of H_2S appears.

$2\ Ag^+ + 2\ HCO_3^- = Ag_2CO_3 + CO_2 + H_2O$

$Pb^{2+} + 2\ HCO_3^- = PbCO_3 + CO_2 + H_2O$

$Ba^{2+} + 2\ HCO_3^- = BaCO_3 + CO_2 + H_2O$

$Mg^{2+} + 2\ HCO_3^- = MgCO_3 + CO_2 + H_2O$ (more accurately, basic carbonates of variable composition are formed)

$Ag^+ + I^- = AgI$; $2\ Ag^+ + SO_4^{2-} = Ag_2SO_4$; $Ag^+ + CH_3COO^- = CH_3COOAg$

$Pb^{2+} + 2\ OH^- = Pb(OH)_2$; $Pb^{2+} + 2\ I^- = PbI_2$; $Pb^{2+} + SO_4^{2-} = PbSO_4$

$K^+ + ClO_4^- = KClO_4$; $Ba^{2+} + SO_4^{2-} = BaSO_4$; $Mg^{2+} + 2\ OH^- = Mg(OH)_2$

$2\ Ag^+ + 2\ OH^- = Ag_2O + H_2O$

$2\ Ag^+ + HS^- = Ag_2S + H^+$; $Pb^{2+} + HS^- = PbS + H^+$; $CH_3COO^- + H^+ = CH_3COOH$

$NH_4^+ + OH^- = NH_3 + H_2O$

$NH_4^+ + HCO_3^- = NH_3 + CO_2 + H_2O$

Two groups of the observed phenomena give instant clues to the identification of some of the ions.

First, the reactions of **2** are often accompanied with the formation of a colourless and odourless gas that can only be CO_2.Thus **2** contains CO_3^{2-} or HCO_3^-.

Second, there are only 3 dark precipitates that can form from the given ions: Ag_2O, Ag_2S, and PbS. This fact, together with the pH of the solutions, instantly identifies the cation of **1** as $\mathbf{Ag^+}$, the cation of **6** as $\mathbf{Pb^{2+}}$, the anion of **4** as $\mathbf{OH^-}$, and the anion of **5** as sulfide or hydrosulfide (confirmed by the distinct smell of the solution).

The choice between the latter two can be made by measuring the pH of the solution formed in the reaction of **5** with an excess of **1** or **6**. In the case of **1**, the reaction mixture is strongly acidic. Thus the anion of **5** is $\mathbf{HS^-}$.

The evolution of CO_2 in the reaction with Ag^+ and Pb^{2+} also identifies the anion of **2** as $\mathbf{HCO_3^-}$. (in accord with the moderately basic pH)

The reaction of **3** and **4** yields ammonia. **4** is obviously not a solution of NH_3 itself. Thus the cation of **3** is $\mathbf{NH_4^+}$.

2+**4** do not form either a precipitate or ammonia. The cations of **2** and **4** are Na^+ or K^+.

2+**5** do not form either a precipitate or ammonia. The cation of **5** is an alkali metal.

3 is the only solution that does not give a precipitate with Ag^+. Accordingly, it can be ammonium nitrate, fluoride, or perchlorate. But it does give a precipitate with **2**, a hydrocarbonate of Na^+ or K^+. Thus the anion of **3** is $\mathbf{ClO_4^-}$ and the cation of **2** is $\mathbf{K^+}$.

4 does not give a precipitate with NH_4ClO_4. The cation of **4** is $\mathbf{Na^+}$.

5 does not give a precipitate either with NH_4ClO_4 (K^+) or with a mixture of $KHCO_3$ and NaOH (Li^+). The cation of **5** is $\mathbf{Na^+}$.

7 forms no precipitate or ammonia with NaOH but gives a precipitate with $KHCO_3$. **7** cannot be an alkali metal perchlorate because it forms yellow precipitates with **1** and **6**. Thus the cation of **7** is $\mathbf{Ba^{2+}}$ and the anion of **7** is $\mathbf{I^-}$.

At room temperature **8** gives a precipitate with OH^- but not with HS^- which means it can only be a salt of a Group 2A metal. Thus the reaction of **8** with BaI_2 is obviously one between Ba^{2+} and the anion of **8**. The latter is very likely SO_4^{2-} but HCO_3^- and $H_2PO_4^-$ are also theoretically possible. The solution of **8** is unchanged upon boiling and gives a white precipitate with Ag^+. This excludes both HCO_3^- and $H_2PO_4^-$. Thus the anion of **8** is $\mathbf{SO_4^{2-}}$. This instantly identifies the cation of **8** as $\mathbf{Mg^{2+}}$.

6 is a soluble compound of lead. The anion could be CH_3COO^-, NO_2^-, NO_3^-, or ClO_4^-. The slight odour of acetic acid might give a clue. Unlike **1**, the reaction of an excess of **6** with HS^- does not yield a markedly acidic solution which shows that **6** is a salt of a weak acid. If **6** were a nitrite, it would give a yellowish precipitate with Ag^+. It would also react with NH_4ClO_4 upon heating with the evolution of N_2 (and nitrogen oxides from the reaction with HS^- would also be noticeable). The absence of these reactions indicates that the anion of **6** is $\mathbf{CH_3COO^-}$.

Soluble salts of silver are even less numerous, the only choices are NO_3^-, F^-, and ClO_4^-. The anion can be examined if one removes the silver ions from the solution of **1** with an excess of NaOH. The Ag_2O precipitate quickly separates from the solution which can be easily poured off. This solution, containing the anion of **1**, does not give a precipitate with BaI_2 which rules out F^-. The solubility of $KClO_4$ is quite significant; therefore the absence of a precipitate with $KHCO_3$ is inconclusive. The anion of **1** is therefore either $\mathbf{NO_3^-}$ or $\mathbf{ClO_4^-}$.

Results and Ranking

Recipient of the Gedeon Richter Prize, the Servier-Egis Prize and the MOL Prize:

Yongping Fu, China

Commendation of the Organizers for Theoretical Work:

Li Qian Yeong, Singapore

Commendation of the Organizers for Practical Work

János Sarka, Hungary

Rank	Medal	Name	Country	Theory	Practice	Total
1	**Gold**	Yongping Fu	CHN	53,222	33,745	86,967
2	**Gold**	Li Qian Yeong	SGP	52,053	30,208	82,261
3	**Gold**	Andrey Bogorodskiy	RUS	49,179	29,095	78,274
4	**Gold**	Xiqian Jiang	CHN	50,494	27,654	78,148
5	**Gold**	Sergey Nikitin	RUS	44,828	32,847	77,676
6	**Gold**	Woo Je Cho	KOR	47,655	29,583	77,239
7	**Gold**	Xiuyuan Li	CHN	51,968	24,692	76,660
8	**Gold**	Stefan Michael Pusch	GER	46,428	29,243	75,671
9	**Gold**	Linh Bui Tuan	VIE	49,070	26,426	75,496
10	**Gold**	Ihor Stepanenko	UKR	45,311	29,907	75,218
11	**Gold**	Oskar Szymon Sala	POL	42,546	32,342	74,887
12	**Gold**	Ostap Chervak	UKR	50,608	23,877	74,484
13	**Gold**	Romans Caplinskis	LAT	45,091	28,674	73,766
14	**Gold**	Soon Gu Kwak	KOR	47,460	24,070	71,530
15	**Gold**	Kyrylo Kolesnikov	UKR	39,691	30,903	70,594
16	**Gold**	Pavel Chulkin	BLR	44,370	26,120	70,489
17	**Gold**	Chau Vu Minh	VIE	50,433	20,022	70,455
18	**Gold**	Yury Timchenko	RUS	44,973	24,957	69,930
19	**Gold**	Phakpoom Angpanitcharoen	THA	39,884	29,941	69,826
20	**Gold**	Chi Zhang	CHN	42,682	26,342	69,024
21	**Gold**	Cheng-Ting Tsai	TPE	38,932	29,941	68,872
22	**Gold**	Sarka János	HUN	35,286	33,457	68,743
23	**Gold**	Jae Hoon Jung	KOR	41,053	27,645	68,699
24	**Gold**	Kelvin Anggara	INA	39,313	28,595	67,908
25	**Gold**	Matías Daniel Gómez Elías	ARG	39,652	28,009	67,661
26	**Gold**	Amin Ahmadzadehbejastani	IRI	41,037	26,263	67,300
27	**Gold**	Po-Chieh Ting	TPE	40,696	26,444	67,141
28	**Gold**	Roberta Poceviciute	LTU	37,197	29,746	66,944
29	**Gold**	Tomasz Andrzej Biczel	POL	33,779	32,909	66,688
30	**Gold**	Vladimir Poddubnyy	RUS	39,325	27,351	66,676
31	**Silver**	Chalermchai Komaenthammasophon	THA	41,251	25,329	66,580
32	**Silver**	Techin Chuladesa	THA	34,910	31,106	66,016
33	**Silver**	Andrew Kononov	BLR	45,667	20,272	65,939
34	**Silver**	Vlad Alexandru Puscasu	ROU	34,773	31,022	65,795

Rank	Medal	Name	Country	Theory	Practice	Total
35	**Silver**	Tanatorn Khotavivattana	THA	36,086	29,273	65,359
36	**Silver**	Johann Novacek	AUT	32,056	32,877	64,932
37	**Silver**	Martin Lukačišin	SVK	38,211	26,642	64,853
38	**Silver**	Mina Taheri	IRI	36,986	27,843	64,830
39	**Silver**	Sanzhar Karatayev	KAZ	38,214	26,596	64,810
40	**Silver**	Gerardo Ojeda Carralero	CUB	34,819	29,980	64,799
41	**Silver**	Yong Jin Wang	SGP	33,856	30,306	64,162
42	**Silver**	Ioana Aron	ROU	35,011	28,475	63,486
43	**Silver**	Hubert Kalaus	AUT	33,371	29,917	63,288
44	**Silver**	Huseyin Erguven	TUR	35,010	28,000	63,010
45	**Silver**	Thais Macedo Bezerra Terceiro Jorge	BRA	30,959	31,782	62,741
46	**Silver**	Assaf Mauda	ISR	36,912	25,776	62,688
47	**Silver**	Roman Prytulyak	UKR	33,588	28,694	62,283
48	**Silver**	Gautam Agrawal	IND	32,673	29,396	62,069
49	**Silver**	Mohammad Zargarpoor	IRI	32,067	30,002	62,069
50	**Silver**	Cheng-Yo Lai	TPE	43,805	18,223	62,028
51	**Silver**	Zhanbolat Zholgeldiev	KAZ	34,048	27,848	61,896
52	**Silver**	Vörös Tamás	HUN	33,605	27,833	61,438
53	**Silver**	Daren Tan	AUS	34,627	26,260	60,887
54	**Silver**	Valeryia Kasneryk	BLR	35,382	25,244	60,627
55	**Silver**	Taavi Pungas	EST	33,618	26,976	60,594
56	**Silver**	Tomaž Mohorič	SLO	33,763	26,261	60,024
57	**Silver**	Srujan Meesala	IND	42,493	17,453	59,946
58	**Silver**	Liudmila Budanitskaya	BLR	43,649	16,038	59,687
59	**Silver**	Mingyue Tang Kardashinsky	AUS	32,063	27,595	59,657
60	**Silver**	Sultan Aitekenov	KAZ	37,324	22,166	59,490
61	**Silver**	Alberto Lena	ITA	31,069	28,102	59,171
62	**Silver**	Batki Júlia	HUN	30,542	28,592	59,134
63	**Silver**	Yufeng Shi	AUS	27,919	31,000	58,919
64	**Silver**	Markus Nadlinger	AUT	27,363	31,376	58,739
65	**Silver**	John William Roger Morgan	GBR	31,967	26,699	58,666
66	**Silver**	Praneeth Srikanti	IND	35,405	23,101	58,507
67	**Silver**	Eduardo Alejandro Romero-Montalvo	MEX	29,691	28,780	58,471
68	**Silver**	Erik Andris	SVK	32,381	25,991	58,372
69	**Silver**	Yerbolat Ablemetov	KAZ	39,455	18,790	58,244
70	**Silver**	Jonathan David Lee	USA	33,635	24,338	57,973
71	**Silver**	Andres Laan	EST	36,820	21,122	57,941
72	**Silver**	Mahmut Tekin	TUR	38,414	19,304	57,719
73	**Silver**	Sadig Aghazade	AZE	30,761	26,916	57,678
74	**Silver**	Kovács Bertalan	HUN	28,316	29,201	57,518
75	**Silver**	Stephan Pribitzer	AUT	28,134	29,295	57,429
76	**Silver**	Elise Duboué-Dijon	FRA	35,636	21,788	57,424
77	**Silver**	Nilpesh Nilpesh Patel	GBR	33,246	23,858	57,104
78	**Silver**	Ioana Teodora Tofoleanu	ROU	37,424	19,582	57,007
79	**Silver**	Alan Liška	CZE	29,263	27,223	56,487
80	**Silver**	Lukás Pogány	SVK	27,292	29,157	56,449

Rank	Medal	Name	Country	Theory	Practice	Total
81	**Silver**	Simone Calvello	ITA	33,730	22,610	56,340
82	**Silver**	Vincensius Jeremy Suhardi	INA	36,256	19,896	56,151
83	**Silver**	Hyeonjin (Gordon) Bae	CAN	36,768	19,248	56,016
84	**Bronze**	Bruno Matos Paz	BRA	30,146	25,618	55,764
85	**Bronze**	Emily Christine Adlam	NZL	27,698	28,053	55,750
86	**Bronze**	Tuan Pham Anh	VIE	37,375	18,321	55,695
87	**Bronze**	Maximilian Beyer	GER	27,689	27,956	55,645
88	**Bronze**	Markus Robert Mittnenzweig	GER	32,747	22,800	55,547
89	**Bronze**	Yuxin Xie	USA	31,547	23,923	55,471
90	**Bronze**	Rafael Kricievski	CAN	35,832	19,607	55,439
91	**Bronze**	Naoya Ozawa	JPN	28,487	26,517	55,004
92	**Bronze**	Mei Hua Fiona Foo	SGP	31,455	23,463	54,918
93	**Bronze**	Sandra Stanionyte	LTU	28,731	25,826	54,557
94	**Bronze**	Muammer Yusuf Yaman	TUR	29,386	25,122	54,508
95	**Bronze**	Anupam Dev Goel	IND	34,242	20,054	54,296
96	**Bronze**	Dong Hwan Kim	KOR	37,463	16,817	54,281
97	**Bronze**	Mindaugas Jakutis	LTU	29,428	24,541	53,969
98	**Bronze**	Daniel Hollas	CZE	27,161	26,735	53,896
99	**Bronze**	Jhe-Hao Li	TPE	30,520	22,780	53,300
100	**Bronze**	Alexander John Kasas	GBR	27,944	25,343	53,287
101	**Bronze**	William Cedar Jackson	AUS	29,371	23,769	53,140
102	**Bronze**	Andreas Frutiger	SUI	26,651	26,381	53,032
103	**Bronze**	Sava Mihic	NZL	30,743	22,195	52,938
104	**Bronze**	Robert Bai	CAN	33,519	19,316	52,836
105	**Bronze**	Timothy Andre Vogel	NZL	25,580	27,133	52,713
106	**Bronze**	Lukasz Krawiec	POL	27,006	25,466	52,472
107	**Bronze**	Rasmus Faber	DEN	29,472	22,773	52,245
108	**Bronze**	Svetlana Chupova	EST	28,293	23,935	52,228
109	**Bronze**	Luis Ángel Martínez-Martínez	MEX	28,549	23,199	51,747
110	**Bronze**	Anh Chu Thi Ngoc	VIE	26,803	24,622	51,425
111	**Bronze**	Vincenzo Spalluto	ITA	27,214	23,435	50,649
112	**Bronze**	Lukáš Konečný	SVK	29,300	21,003	50,302
113	**Bronze**	Jakub Hubert Mroz	POL	26,715	23,172	49,887
114	**Bronze**	Aleksandrs Sorokins	LAT	30,567	19,122	49,689
115	**Bronze**	Sammy El Ghazzal	FRA	27,523	22,102	49,625
116	**Bronze**	Luca Zucchini	ITA	22,784	26,826	49,610
117	**Bronze**	Seiichi Azuma	JPN	39,225	10,379	49,604
118	**Bronze**	Mehmet Vural	TUR	30,985	18,573	49,558
119	**Bronze**	Nemanja Aničić	SLO	29,892	19,514	49,406
120	**Bronze**	Pedram Bakhshaei shahr babaki	IRI	25,307	24,035	49,342
121	**Bronze**	Nikoline Borgermann	DEN	20,425	28,804	49,230
122	**Bronze**	Juraj Ahel	CRO	24,861	24,054	48,915
123	**Bronze**	Benjamin Bousquet	FRA	27,913	20,373	48,286
124	**Bronze**	Hyungjin Lee	CAN	24,839	23,431	48,270
125	**Bronze**	Victor Tsuneichi Chida Paiva	BRA	27,927	20,060	47,987
126	**Bronze**	Wenyi Yi	NZL	26,073	21,637	47,709
127	**Bronze**	Daria Ewa Struska	SWE	28,378	19,089	47,467

Rank	Medal	Name	Country	Theory	Practice	Total
128	**Bronze**	Andrei Ungureanu	ROU	25,753	21,686	47,439
129	**Bronze**	Ignas Anikevicius	LTU	25,962	21,458	47,421
130	**Bronze**	Yuta Suzuki	JPN	25,281	22,126	47,407
131	**Bronze**	Petr Motloch	CZE	20,153	26,890	47,043
132	**Bronze**	Lu Jenny	USA	31,503	15,439	46,942
133	**Bronze**	Hjalte Daugaard Jensen	DEN	20,787	26,134	46,921
134	**Bronze**	Yanira Mendez Gómez	CUB	20,502	26,305	46,807
135	**Bronze**	Kiril Milenov Stoyanov	BUL	24,199	22,536	46,736
136	**Bronze**	Kasper Mackeprang	DEN	22,756	23,563	46,318
137	**Bronze**	Andrew Zhangyanchu Liu	USA	29,335	16,681	46,016
138	**Bronze**	Jörgen Metsik	EST	27,031	18,547	45,578
139	**Bronze**	Urandelger Tuvshindorj	MGL	21,047	24,496	45,543
140	**Bronze**	Yair Ezequiel Litman	ARG	22,368	22,900	45,269
141	**Bronze**	Kang Ruey Gregory Lau	SGP	26,558	17,697	44,255
142	**Bronze**	Narek Dshkhunyan	ARM	29,765	14,477	44,242
143	**Bronze**	Ariana Dwi Candra	INA	27,339	16,721	44,060
144	**Bronze**	Irénée Frérot	FRA	28,966	15,047	44,014
145	**Bronze**	Peter Luke Aisher	GBR	30,202	13,750	43,952
146	**Bronze**	Norihito Fukui	JPN	26,242	17,667	43,909
147	**Bronze**	Peter Pinski	GER	24,910	18,392	43,302
148	**Bronze**	Emma Louise Wilkinson	IRL	17,585	25,537	43,121
149	**Bronze**	Toms Rekis	LAT	15,004	27,690	42,694
150	**Bronze**	Goh Jun Yan	MAS	24,123	18,457	42,580
151	**Bronze**	Sarvar Khaidarov	KGZ	23,245	19,299	42,544
152	**Bronze**	Gašper Gregorič	SLO	17,048	25,454	42,502
153	**Bronze**	Dan Liraz Lidji	ISR	26,698	15,793	42,491
154	**Bronze**	Ochri Halimi	ISR	17,016	25,207	42,223
155	**Bronze**	Toni Portolan	CRO	23,822	18,168	41,990
156	**Bronze**	Jasper Landman	NED	16,115	25,669	41,784
157	**Bronze**	Cees de Boer	NED	19,879	21,531	41,409
158	**Bronze**	Eduardo Ansaldo Giné	ESP	14,164	27,225	41,390
159	**Bronze**	Toghrul Almammadov	AZE	28,676	12,669	41,346
160	**Bronze**	Chai Yi Kang	MAS	15,850	25,228	41,078
161	**Bronze**	Walter Collyer Braga	BRA	19,442	21,497	40,938
162	**Bronze**	Rafael Alberto Prato Modestino	VEN	20,615	20,168	40,783
163	**Honorable**	Guðni Þór Þrándarson	ISL	19,446	20,861	40,307
164	**Honorable**	Timothy Michael Cronin	IRL	19,676	20,409	40,085
165	**Honorable**	Luis Ignacio Granone	ARG	20,611	19,402	40,012
166	**Honorable**	Dilmurat Moldobaev	KGZ	25,459	14,461	39,920
167	**Honorable**	Gabriel Riquelme	ARG	23,772	16,134	39,905
168	**Honorable**	Astron Rigel Martínez-Rosas	MEX	16,404	23,484	39,888
169	**Honorable**	Petr Stadlbauer	CZE	22,113	17,564	39,676
170	**Honorable**	Janis Jermaks	LAT	19,029	20,624	39,654
171	**Honorable**	Begench Saparov	TKM	22,019	17,492	39,512
172	**Honorable**	Muhamad azri Muhamad Marican	MAS	18,978	20,176	39,153
173		Petra Vizjak	CRO	20,189	18,635	38,824
174		Mehman Bunyatov	AZE	24,717	13,951	38,668

Rank	Medal	Name	Country	Theory	Practice	Total
175		Maha Malik	PAK	12,585	26,031	38,616
176		Nazar Mammedov	TKM	22,967	15,201	38,168
177		Juan Antonio Primitivo Rodríguez	ESP	14,285	23,676	37,961
178		Sohbet Hojamuhammedov	TKM	16,103	21,822	37,925
179		Florian De Roose	BEL	26,022	11,590	37,612
180		Turbat Enkhbaatar	MGL	16,404	21,042	37,446
181		Matin Huseynli	AZE	24,496	12,631	37,128
182		Muhammad Zulqarnaen	INA	22,368	14,417	36,785
183		Uyanga Dagvadorj	MGL	20,519	16,215	36,734
184		Yordan Hristov Georgiev	BUL	6,816	29,827	36,643
185		Amanmyrat Abdullayev	TKM	23,975	12,145	36,119
186		Olli Samuli Lainiala	FIN	11,180	24,759	35,939
187		Jérôme Jules Christian Alexandre Ghislain Dohet-Eraly	BEL	18,221	17,717	35,938
188		Arshavir Ghahramanyan	ARM	21,999	13,915	35,913
189		Zamirbek Akimbekov	KGZ	19,427	16,484	35,912
190		Itzel Condado-Morales	MEX	20,692	15,211	35,903
191		Spyridon Gasparatos	GRE	16,800	19,076	35,877
192		Erik Kvam Måland	NOR	16,952	18,913	35,865
193		David Dupont	BEL	15,250	20,292	35,542
194		Leif David Schelin	SWE	21,968	12,366	34,334
195		Stefan Bozhidarov Angelov	BUL	15,240	18,858	34,098
196		Sihan Wang	SWE	13,280	20,598	33,878
197		Jaíme Mª Medina Manresa	ESP	17,320	15,867	33,186
198		Valeriu Valeriu Scutelnic	MDA	22,075	10,892	32,967
199		Dimitar Tomov Yordanov	BUL	12,718	20,174	32,892
200		Konstantinos Hadjipetrou	CYP	12,144	20,601	32,746
201		Mario López Moya	ESP	18,760	13,924	32,684
202		Ariel Shaul Markhovsky	ISR	9,803	22,798	32,601
203		Dmitrii Mihail Mazur	MDA	17,585	14,832	32,417
204		Arni Aleksi Lehto	FIN	11,971	20,207	32,178
205		Hannah Patricia Cagney	IRL	13,731	18,433	32,164
206		Adam John Samuel Johnston	IRL	17,609	14,534	32,143
207		Ioannis Botis	GRE	17,216	14,541	31,757
208		Gibran Moshtaq Hashmi	PAK	7,338	24,395	31,733
209		Niels Kouwenhoven	NED	21,595	9,609	31,204
210		Tim Evers	NED	14,524	16,038	30,562
211		Marte van der Linden	NOR	15,156	14,338	29,494
212		Charis Dimitriou	CYP	10,399	19,032	29,431
213		Nika Anžiček	SLO	14,352	15,025	29,376
214		Jessica Susanna Bernsteen	SWE	12,413	16,939	29,352
215		Nina Zargari	SUI	10,509	18,807	29,315
216		Vera Alexandra Fonseca Patrício	POR	11,364	17,819	29,183
217		Marica Malenica	CRO	18,465	10,443	28,908
218		Ganchimeg Lkhamsuren	MGL	16,525	12,348	28,873
219		Gunnsteinn Finnsson	ISL	13,275	15,181	28,455

Rank	Medal	Name	Country	Theory	Practice	Total
220		Mario Silvester Könz	SUI	17,947	10,488	28,436
221		Ana Inés Silva	URY	12,363	15,909	28,272
222		Camilla Espedal	NOR	14,059	13,691	27,750
223		Haykaz Gharibyan	ARM	12,305	14,905	27,210
224		Sindri Davíðsson	ISL	10,604	16,518	27,122
225		Vésteinn Snæbjarnarson	ISL	10,965	15,964	26,929
226		Armando Rafael León Silva	VEN	7,991	18,849	26,840
227		Michalis Rossides	CYP	8,472	18,351	26,823
228		Ali Kamran Ahmad	PAK	14,321	12,327	26,648
229		Matthias Roman Rüdt	SUI	15,580	10,794	26,374
230		Henri Ilmari Stenberg	FIN	14,526	11,737	26,263
231		Sofía Velazco	URY	12,349	13,610	25,959
232		Grigoris Katsiolides	CYP	12,900	12,736	25,636
233		Dan Grigore Negrescu	MDA	8,320	17,256	25,576
234		Lucía Castellano	URY	12,558	12,404	24,962
235		Inês Maria Pacheco Soares Carneiro	POR	9,666	15,111	24,776
236		Marianthi Elmaloglou	GRE	10,870	13,636	24,507
237		Dumitru Valeriu Samohvalov	MDA	13,647	10,775	24,422
238		Ayesha Ahmed	PAK	11,058	13,066	24,123
239		Joana Marta Miguel Lourenço	POR	8,838	15,092	23,930
240		Stein-Olav Hagen Davidsen	NOR	14,139	9,644	23,782
241		Jyrki Tapani Mikkola	FIN	8,683	14,907	23,590
242		Muhammad Hafiz Abdul Karim	MAS	12,729	10,357	23,086
243		Tatevik Aloyan	ARM	13,656	7,153	20,809
244		Blandine Emmanuelle Cambron	BEL	12,930	7,620	20,550
245		Susana Isabel Brito Santos	POR	6,715	12,990	19,705
246		James Miguel Cabrera Guevara	PER	11,928	5,551	17,480
247		Iordanis Savvidis	GRE	6,400	9,464	15,864
248		Robinson Junior León Urrego	PER	6,507	7,897	14,404
249		Mohammed Khalil Albloushei	KUW	3,447	10,573	14,020
250		Ahmad Fahed Alrashidi	KUW	1,168	11,436	12,604
251		Abdullah Saleh Alshemali	KUW	2,305	8,522	10,827
252		Ameer Sami Alqallaf	KUW	5,908	4,911	10,819
253		Nathaly Gastelo Cuadros	PER	4,818	5,862	10,679
254		Umedjon Qodirov	TJK	0.000	0.000	0.000
255		Khursand Yorov	TJK	0.000	0.000	0.000
256		Parviz Khakimov	TJK	0.000	0.000	0.000
257		Timur Ashirov	TJK	0.000	0.000	0.000

Detailed results

All values reported are percentages except for the practical penalty points for replaced items.

Student	Country	T1	T2	T3	T4	T5	T6	T7	T8	T9	P1	P2	P3	Pen	Theory	Practice	Total	Med
Matías Daniel Gómez Elías	Argentina	63.6	94.4	78.6	78.6	20.0	55.6	69.0	53.1	87.7	83.3	81.2	50.0	0	66.09	70.02	67.66	G
Luis Ignacio Granone	Argentina	63.6	72.2	42.9	71.4	0.0	35.6	28.6	0.0	1.8	97.3	19.1	45.4	0	34.35	48.50	40.01	H
Yair Ezequiel Litman	Argentina	50.0	50.0	0.0	28.6	0.0	46.7	42.9	34.4	84.2	74.3	80.0	23.1	0	37.28	57.25	45.27	B
Gabriel Riquelme	Argentina	27.3	88.9	21.4	42.9	0.0	24.4	42.9	28.1	82.5	57.9	29.2	39.8	0	39.62	40.33	39.91	H
Haykaz Gharibyan	Armenia	13.6	61.1	7.1	28.6	0.0	8.9	16.7	21.9	26.3	65.0	47.7	8.3	0	20.51	37.26	27.21	
Arshavir Ghahramanyan	Armenia	27.3	55.6	42.9	53.6	0.0	33.3	57.1	37.5	19.3	70.8	44.6	0.9	0	36.66	34.79	35.91	
Tatevik Aloyan	Armenia	9.1	44.4	0.0	17.9	0.0	22.2	33.3	28.1	45.6	68.8	0.0	1.9	0	22.76	17.88	20.81	
Narek Dshkhunyan	Armenia	31.8	77.8	21.4	67.9	88.0	0.0	69.0	40.6	42.1	36.2	49.2	23.1	0	49.61	36.19	44.24	B
Daren Tan	Australia	40.9	55.6	50.0	28.6	18.0	91.1	59.5	84.4	87.7	63.0	92.3	40.7	0	57.71	65.65	60.89	S
William Cedar Jackson	Australia	50.0	88.9	17.9	35.7	16.0	68.9	33.3	43.8	87.7	80.5	49.2	55.6	0	48.95	59.42	53.14	B
Yufeng Shi	Australia	63.6	66.7	3.6	57.1	0.0	46.7	52.4	46.9	84.2	68.8	96.9	63.9	0	46.53	77.50	58.92	S
Mingyue Tang Kardashinsky	Australia	63.6	72.2	0.0	92.9	0.0	62.2	47.6	71.9	73.7	72.7	93.8	41.7	0	53.44	68.99	59.66	S
Hubert Kalaus	Austria	50.0	100.0	42.9	57.1	0.0	57.8	57.1	46.9	91.2	89.6	70.3	69.4	0	55.62	74.79	63.29	S
Markus Nadlinger	Austria	40.9	55.6	14.3	85.7	6.0	71.1	59.5	46.9	26.3	93.8	89.2	57.4	0	45.61	78.44	58.74	S
Johann Novacek	Austria	40.9	66.7	71.4	53.6	0.0	62.2	50.0	50.0	93.0	83.8	93.8	69.4	0	53.43	82.19	64.93	S
Stephan Pribitzer	Austria	40.9	61.1	21.4	57.1	10.0	64.4	64.3	46.9	50.9	56.3	93.8	63.9	0	46.89	73.24	57.43	S
Sadig Aghazade	Azerbaijan	27.3	94.4	78.6	42.9	0.0	46.7	54.8	40.6	78.9	59.4	86.2	53.7	0	51.27	67.29	57.68	S
Matin Huseynli	Azerbaijan	18.2	55.6	71.4	75.0	4.0	0.0	47.6	43.8	59.6	71.3	6.2	30.6	0	40.83	31.58	37.13	
Toghrul Almammadov	Azerbaijan	18.2	100.0	64.3	64.3	0.0	24.4	59.5	31.3	70.2	60.6	15.4	28.7	0	47.79	31.67	41.35	B
Mehman Bunyatov	Azerbaijan	22.7	61.1	42.9	78.6	14.0	8.9	59.5	21.9	64.9	62.7	7.7	43.5	0	41.20	34.88	38.67	
David Dupont	Belgium	45.5	44.4	7.1	21.4	2.0	42.2	28.6	0.0	38.6	32.6	67.2	46.3	0	25.42	50.73	35.54	
Florian De Roose	Belgium	63.6	100.0	7.1	71.4	0.0	15.6	31.0	31.3	78.9	65.9	0.0	33.3	0	43.37	28.97	37.61	
Jérôme Jules Christian Alexandre Ghislain Dohet-Eraly	Belgium	31.8	27.8	21.4	42.9	0.0	68.9	33.3	28.1	17.5	61.2	47.7	29.6	0	30.37	44.29	35.94	
Blandine Emmanuelle Cambron	Belgium	13.6	27.8	7.1	32.1	0.0	33.3	23.8	37.5	15.8	4.2	41.5	6.5	0	21.55	19.05	20.55	
Andrew Kononov	Belarus	86.4	100.0	57.1	78.6	100.0	55.6	76.2	56.3	73.7	10.6	79.0	49.1	0	76.11	50.68	65.94	S
Pavel Chulkin	Belarus	95.5	94.4	71.4	89.3	0.0	75.6	92.9	75.0	73.7	86.6	87.7	28.7	0	73.95	65.30	70.49	G

Student	Country	T1	T2	T3	T4	T5	T6	T7	T8	T9	P1	P2	P3	Pen	Theory	Practice	Total	Med
Liudmila Budanitskaya	Belarus	81.8	100.0	64.3	53.6	99.0	44.4	59.5	68.8	84.2	62.0	50.8	14.8	0	72.75	40.09	59.69	S
Valeryia Kasneryk	Belarus	90.9	100.0	42.9	75.0	0.0	46.7	57.1	46.9	78.9	89.3	86.7	28.7	-1	58.97	63.11	60.63	S
Thais Macedo Bezerra Terceiro Jorge	Brazil	72.7	66.7	14.3	82.1	0.0	6.7	71.4	65.6	89.5	58.5	96.9	75.9	0	51.60	79.45	62.74	S
Victor Tsuneichi Chida Paiva	Brazil	45.5	61.1	57.1	71.4	4.0	42.2	38.1	31.3	78.9	56.2	41.7	54.6	0	46.54	50.15	47.99	B
Walter Collyer Braga	Brazil	27.3	0.0	42.9	67.9	0.0	20.0	42.9	46.9	50.9	35.4	83.1	50.0	-2	32.40	53.74	40.94	B
Bruno Matos Paz	Brazil	22.7	100.0	28.6	82.1	0.0	57.8	54.8	31.3	75.4	60.3	90.8	39.8	0	50.24	64.05	55.76	B
Kiril Milenov Stoyanov	Bulgaria	50.0	61.1	42.9	78.6	0.0	4.4	57.1	6.3	71.9	73.7	44.6	56.5	0	40.33	56.34	46.74	B
Yordan Hristov Georgiev	Bulgaria	22.7	0.0	0.0	32.1	0.0	0.0	19.0	0.0	33.3	67.7	90.8	63.0	0	11.36	74.57	36.64	
Dimitar Tomov Yordanov	Bulgaria	59.1	22.2	0.0	46.4	0.0	22.2	2.4	12.5	36.8	81.1	46.2	34.3	0	21.20	50.44	32.89	
Stefan Bozhidarov Angelov	Bulgaria	0.0	44.4	42.9	53.6	0.0	15.6	31.0	15.6	28.1	10.4	83.6	35.2	0	25.40	47.15	34.10	
Robert Bai	Canada	68.2	55.6	57.1	67.9	2.0	66.7	54.8	43.8	96.5	74.9	49.2	29.6	0	55.87	48.29	52.84	B
Hyeonjin (Gordon) Bae	Canada	27.3	100.0	28.6	82.1	72.0	53.3	59.5	62.5	59.6	72.6	69.7	10.2	0	61.28	48.12	56.02	B
Rafael Kricievski	Canada	81.8	100.0	50.0	42.9	2.0	71.1	50.0	68.8	73.7	77.1	76.5	2.8	0	59.72	49.02	55.44	B
Hyungjin Lee	Canada	27.3	50.0	57.1	39.3	2.0	40.0	47.6	43.8	68.4	77.9	83.9	20.4	0	41.40	58.58	48.27	B
Yongping Fu	China	100.0	100.0	92.9	78.6	97.0	82.2	83.3	75.0	91.2	79.6	96.9	75.0	0	88.70	84.36	86.97	G
Xiuyuan Li	China	100.0	100.0	92.9	71.4	96.0	86.7	61.9	81.3	94.7	93.7	98.5	3.7	0	86.61	61.73	76.66	G
Chi Zhang	China	59.1	100.0	71.4	78.6	0.0	80.0	97.6	56.3	96.5	64.8	95.4	37.0	0	71.14	65.86	69.02	G
Xiqian Jiang	China	36.4	100.0	85.7	100.0	99.0	82.2	85.7	78.1	86.0	63.5	92.9	49.1	0	84.16	69.14	78.15	G
Petra Vizjak	Croatia	18.2	55.6	7.1	50.0	0.0	13.3	47.6	34.4	77.2	68.8	50.6	27.8	0	33.65	46.59	38.82	
Marica Malenica	Croatia	22.7	44.4	14.3	57.1	0.0	20.0	47.6	28.1	42.1	61.9	10.8	17.6	0	30.78	26.11	28.91	
Toni Portolan	Croatia	13.6	61.1	71.4	82.1	0.0	33.3	47.6	0.0	56.1	74.5	49.2	22.2	0	39.70	45.42	41.99	B
Juraj Ahel	Croatia	36.4	61.1	0.0	71.4	0.0	71.1	52.4	0.0	82.5	27.1	92.3	50.0	0	41.43	60.14	48.92	B
Yanira Mendez Gómez	Cuba	36.4	50.0	42.9	71.4	0.0	42.2	28.6	34.4	5.3	81.3	77.7	43.5	0	34.17	65.76	46.81	B
Gerardo Ojeda Carralero	Cuba	40.9	100.0	85.7	92.9	0.0	37.8	57.1	25.0	94.7	89.6	93.8	46.3	0	58.03	74.95	64.80	S
Grigoris Katsiolides	Cyprus	36.4	0.0	0.0	0.0	0.0	55.6	33.3	21.9	43.9	55.2	4.6	43.5	0	21.50	31.84	25.64	
Michalis Rossides	Cyprus	36.4	0.0	0.0	0.0	1.0	24.4	21.4	21.9	21.1	74.5	62.5	10.2	0	14.12	45.88	26.82	
Charis Dimitriou	Cyprus	31.8	0.0	0.0	0.0	0.0	37.8	26.2	25.0	33.3	57.8	49.4	38.9	0	17.33	47.58	29.43	
Konstantinos Hadjipetrou	Cyprus	22.7	0.0	0.0	0.0	0.0	73.3	42.9	3.1	33.3	85.4	50.8	29.6	0	20.24	51.50	32.75	
Daniel Hollas	Czech Rep.	31.8	100.0	0.0	42.9	0.0	82.2	57.1	34.4	49.1	62.2	96.9	39.8	0	45.27	66.84	53.90	B
Alan Liška	Czech Rep.	31.8	55.6	0.0	39.3	94.0	53.3	45.2	46.9	64.9	81.4	89.2	38.0	0	48.77	68.06	56.49	S
Petr Motloch	Czech Rep.	27.3	44.4	0.0	71.4	4.0	40.0	11.9	53.1	56.1	81.8	92.3	32.4	0	33.59	67.22	47.04	B

Student	Country	T1	T2	T3	T4	T5	T6	T7	T8	T9	P1	P2	P3	Pen	Theory	Practice	Total	Med
Petr Stadlbauer	Czech Rep.	36.4	100.0	14.3	57.1	0.0	0.0	47.6	37.5	36.8	18.8	76.8	27.8	0	36.85	43.91	39.68	H
Hjalte Daugaard Jensen	Denmark	81.8	33.3	21.4	60.7	0.0	57.8	57.1	0.0	0.0	70.8	83.5	43.5	0	34.64	65.34	46.92	B
Rasmus Faber	Denmark	54.5	55.6	0.0	64.3	2.0	84.4	33.3	59.4	93.0	42.3	71.8	51.9	0	49.12	56.93	52.24	B
Nikoline Borgermann	Denmark	45.5	44.4	0.0	42.9	9.0	31.1	45.2	43.8	42.1	86.1	84.6	50.0	0	34.04	72.01	49.23	B
Kasper Mackeprang	Denmark	45.5	50.0	17.9	42.9	4.0	15.6	59.5	46.9	57.9	56.0	63.3	56.5	0	37.93	58.91	46.32	B
Jörgen Metsik	Estonia	0.0	100.0	0.0	75.0	0.0	62.2	54.8	21.9	87.7	62.5	38.5	43.5	0	45.05	46.37	45.58	B
Andres Laan	Estonia	45.5	100.0	57.1	57.1	6.0	86.7	61.9	62.5	73.7	66.1	52.3	44.4	0	61.37	52.80	57.94	S
Svetlana Chupova	Estonia	72.7	55.6	21.4	42.9	0.0	66.7	64.3	21.9	80.7	92.8	52.3	45.4	0	47.15	59.84	52.23	B
Taavi Pungas	Estonia	50.0	100.0	14.3	50.0	30.0	22.2	71.4	68.8	93.0	54.4	90.8	52.8	0	56.03	67.44	60.59	S
Olli Samuli Lainiala	Finland	31.8	0.0	0.0	0.0	3.0	44.4	16.7	34.4	36.8	78.6	92.3	20.4	0	18.63	61.90	35.94	
Arni Aleksi Lehto	Finland	40.9	0.0	14.3	25.0	0.0	24.4	31.0	9.4	38.6	67.3	81.5	8.3	0	19.95	50.52	32.18	
Henri Ilmari Stenberg	Finland	36.4	22.2	0.0	10.7	0.0	26.7	19.0	46.9	57.9	36.8	13.0	40.7	0	24.21	29.34	26.26	
Jyrki Tapani Mikkola	Finland	13.6	44.4	0.0	32.1	5.0	11.1	11.9	3.1	8.8	59.9	52.1	7.4	0	14.47	37.27	23.59	
Benjamin Bousquet	France	54.5	100.0	14.3	32.1	0.0	40.0	47.6	53.1	75.4	50.4	84.6	17.6	0	46.52	50.93	48.29	B
Elise Duboué-Dijon	France	72.7	100.0	64.3	92.9	0.0	46.7	47.6	71.9	45.6	56.7	95.4	12.0	0	59.39	54.47	57.42	S
Irénée Frérot	France	59.1	100.0	0.0	71.4	0.0	64.4	57.1	0.0	84.2	61.5	43.6	15.7	0	48.28	37.62	44.01	B
Sammy El Ghazzal	France	22.7	38.9	57.1	64.3	0.0	84.4	38.1	53.1	57.9	71.4	87.7	12.0	0	45.87	55.26	49.62	B
Maximilian Beyer	Germany	40.9	55.6	0.0	78.6	0.0	73.3	26.2	53.1	94.7	78.6	83.1	50.9	0	46.15	69.89	55.65	B
Markus Robert Mittnenzweig	Germany	18.2	44.4	64.3	64.3	0.0	73.3	88.1	46.9	89.5	83.8	46.2	50.0	0	54.58	57.00	55.55	B
Peter Pinski	Germany	45.5	55.6	42.9	64.3	0.0	0.0	59.5	59.4	49.1	93.4	44.6	15.7	0	41.52	45.98	43.30	B
Stefan Michael Pusch	Germany	27.3	100.0	92.9	78.6	47.0	71.1	92.9	87.5	94.7	87.3	96.9	39.8	0	77.38	73.11	75.67	G
Ioannis Botis	Greece	31.8	0.0	0.0	82.1	0.0	28.9	45.2	0.0	78.9	65.6	46.2	20.4	-2	28.69	36.35	31.76	
Marianthi Elmaloglou	Greece	36.4	38.9	0.0	0.0	2.0	24.4	23.8	0.0	36.8	59.2	43.1	8.3	0	18.12	34.09	24.51	
Iordanis Savvidis	Greece	9.1	27.8	0.0	3.6	0.0	17.8	21.4	0.0	12.3	59.3	17.3	13.0	-1	10.67	23.66	15.86	
Spyridon Gasparatos	Greece	27.3	44.4	50.0	14.3	10.0	24.4	38.1	0.0	45.6	63.7	47.7	37.0	0	28.00	47.69	35.88	
Sarka János	Hungary	36.4	44.4	14.3	50.0	97.0	66.7	52.4	65.6	98.2	90.1	100.0	63.0	0	58.81	83.64	68.74	G
Kovács Bertalan	Hungary	86.4	27.8	7.1	42.9	12.0	51.1	57.1	56.3	87.7	79.0	93.8	48.1	0	47.19	73.00	57.52	S
Batki Júlia	Hungary	95.5	33.3	7.1	64.3	2.0	62.2	57.1	68.8	71.9	81.3	93.8	42.6	0	50.90	71.48	59.13	S
Vörös Tamás	Hungary	90.9	61.1	0.0	21.4	83.0	75.6	61.9	43.8	57.9	56.6	96.9	50.9	0	56.01	69.58	61.44	S
Vincensius Jeremy Suhardi	Indonesia	45.5	94.4	50.0	82.1	0.0	88.9	38.1	53.1	100.0	53.4	55.4	41.7	0	60.43	49.74	56.15	S
Ariana Dwi Candra	Indonesia	18.2	100.0	57.1	42.9	2.0	0.0	66.7	34.4	89.5	58.8	65.8	6.5	0	45.56	41.80	44.06	B
Muhammad Zulqarnaen	Indonesia	18.2	100.0	0.0	42.9	0.0	4.4	50.0	50.0	64.9	49.0	47.7	15.7	0	37.28	36.04	36.79	
Kelvin Anggara	Indonesia	63.6	94.4	42.9	82.1	46.0	44.4	85.7	34.4	96.5	61.4	92.3	57.4	0	65.52	71.49	67.91	G

Student	Country	T1	T2	T3	T4	T5	T6	T7	T8	T9	P1	P2	P3	Pen	Theory	Practice	Total	Med
Anupam Dev Goel	India	81.8	61.1	28.6	89.3	2.0	77.8	54.8	46.9	78.9	74.3	61.5	42.6	-3	57.07	50.13	54.30	B
Gautam Agrawal	India	31.8	94.4	57.1	82.1	0.0	42.2	52.4	46.9	89.5	70.3	90.8	58.3	0	54.46	73.49	62.07	S
Praneeth Srikanti	India	81.8	100.0	28.6	60.7	37.0	31.1	64.3	46.9	82.5	77.1	50.8	51.9	0	59.01	57.75	58.51	S
Srujan Meesala	India	63.6	100.0	71.4	100.0	0.0	84.4	78.6	53.1	91.2	57.2	52.3	25.9	0	70.82	43.63	59.95	S
Mina Taheri	Iran	27.3	55.6	78.6	78.6	0.0	100.0	78.6	43.8	94.7	63.2	100.0	43.5	0	61.64	69.61	64.83	S
Mohammad Zargarpoor	Iran	95.5	61.1	28.6	78.6	10.0	20.0	59.5	53.1	84.2	54.6	96.9	66.7	0	53.44	75.00	62.07	S
Pedram Bakhshaei shahr babaki	Iran	36.4	55.6	0.0	67.9	0.0	60.0	45.2	31.3	86.0	64.2	87.8	29.6	0	42.18	60.09	49.34	B
Amin Ahmadzadehbejastani	Iran	77.3	100.0	50.0	82.1	2.0	95.6	64.3	50.0	100.0	77.2	77.3	46.3	0	68.39	65.66	67.30	G
Hannah Patricia Cagney	Ireland	18.2	33.3	0.0	28.6	0.0	28.9	28.6	28.1	38.6	91.5	46.2	15.7	0	22.89	46.08	32.16	
Emma Louise Wilkinson	Ireland	36.4	61.1	0.0	28.6	0.0	40.0	33.3	18.8	43.9	78.9	76.0	41.7	0	29.31	63.84	43.12	B
Adam John Samuel Johnston	Ireland	36.4	22.2	0.0	50.0	0.0	37.8	35.7	40.6	42.1	54.4	37.5	23.1	0	29.35	36.33	32.14	
Timothy Michael Cronin	Ireland	40.9	50.0	14.3	17.9	2.0	46.7	42.9	43.8	31.6	91.7	40.7	34.3	0	32.79	51.02	40.08	H
Vésteinn Snæbjarnarson	Iceland	50.0	0.0	0.0	0.0	0.0	40.0	21.4	31.3	21.1	70.5	44.6	14.8	0	18.27	39.91	26.93	
Gunnsteinn Finnsson	Iceland	45.5	27.8	0.0	0.0	0.0	37.8	26.2	28.1	31.6	52.3	47.8	18.5	0	22.12	37.95	28.46	
Sindri Davíðsson	Iceland	27.3	22.2	7.1	21.4	0.0	20.0	21.4	21.9	17.5	74.2	38.5	22.2	0	17.67	41.29	27.12	
Guðni Þór Þrándarson	Iceland	40.9	50.0	28.6	57.1	0.0	60.0	19.0	37.5	0.0	81.0	46.2	38.9	0	32.41	52.15	40.31	H
Ariel Shaul Markhovsky	Israel	27.3	38.9	0.0	0.0	0.0	40.0	11.9	3.1	24.6	47.9	96.9	23.1	0	16.34	56.99	32.60	
Ochri Halimi	Israel	27.3	16.7	21.4	78.6	0.0	2.2	40.5	31.3	43.9	87.5	52.3	57.4	0	28.36	63.02	42.22	B
Assaf Mauda	Israel	27.3	100.0	92.9	78.6	13.0	42.2	64.3	53.1	87.7	60.5	95.4	36.1	0	61.52	64.44	62.69	S
Dan Liraz Lidji	Israel	40.9	55.6	14.3	53.6	0.0	64.4	57.1	56.3	54.4	24.3	69.7	19.4	0	44.50	39.48	42.49	B
Luca Zucchini	Italy	95.5	44.4	0.0	64.3	0.0	6.7	64.3	21.9	49.1	72.8	87.7	42.6	0	37.97	67.07	49.61	B
Alberto Lena	Italy	18.2	100.0	28.6	71.4	14.0	46.7	88.1	0.0	94.7	68.8	88.7	52.8	0	51.78	70.25	59.17	S
Vincenzo Spalluto	Italy	27.3	100.0	14.3	46.4	0.0	64.4	54.8	56.3	35.1	53.4	87.7	46.3	-2	45.36	58.59	50.65	B
Simone Calvello	Italy	27.3	100.0	71.4	71.4	0.0	71.1	61.9	25.0	80.7	61.3	90.8	32.4	-2	56.22	56.52	56.34	S
Seiichi Azuma	Japan	90.9	94.4	57.1	71.4	4.0	84.4	57.1	59.4	75.4	54.3	15.4	17.6	0	65.38	25.95	49.60	B
Norihito Fukui	Japan	22.7	44.4	14.3	64.3	7.0	55.6	50.0	56.3	78.9	84.3	42.1	19.4	0	43.74	44.17	43.91	B
Naoya Ozawa	Japan	50.0	44.4	28.6	85.7	12.0	48.9	40.5	46.9	78.9	68.3	88.7	42.6	0	47.48	66.29	55.00	B
Yuta Suzuki	Japan	18.2	55.6	28.6	57.1	0.0	57.8	33.3	50.0	82.5	23.5	89.2	42.6	0	42.14	55.32	47.41	B
Yerbolat Ablemetov	Kazakhstan	72.7	100.0	71.4	82.1	88.0	28.9	71.4	12.5	68.4	8.3	71.6	48.1	0	65.76	46.97	58.24	S
Zhanbolat Zholgeldiev	Kazakhstan	54.5	100.0	0.0	78.6	9.0	42.2	90.5	50.0	78.9	34.9	93.8	68.5	0	56.75	69.62	61.90	S
Sanzhar Karatayev	Kazakhstan	63.6	100.0	42.9	75.0	80.0	0.0	59.5	65.6	89.5	39.1	95.7	55.6	0	63.69	66.49	64.81	S

Student	Country	T1	T2	T3	T4	T5	T6	T7	T8	T9	P1	P2	P3	Pen	Theory	Practice	Total	Med
Sultan Aitekenov	Kazakhstan	36.4	100.0	71.4	71.4	8.0	71.1	76.2	56.3	66.7	40.6	89.2	31.5	0	62.21	55.42	59.49	S
Dilmurat Moldobaev	Kyrgyzstan	0.0	100.0	35.7	32.1	0.0	44.4	47.6	37.5	80.7	51.4	58.5	3.7	0	42.43	36.15	39.92	H
Sarvar Khaidarov	Kyrgyzstan	27.3	55.6	14.3	75.0	4.0	37.8	42.9	43.8	49.1	54.3	58.2	34.3	0	38.74	48.25	42.54	B
Zamirbek Akimbekov	Kyrgyzstan	40.9	100.0	14.3	28.6	0.0	11.1	35.7	31.3	26.3	62.0	56.5	12.0	0	32.38	41.21	35.91	
Woo Je Cho	Korea Rep.	22.7	100.0	71.4	100.0	53.0	86.7	83.3	93.8	100.0	79.2	100.0	44.4	0	79.43	73.96	77.24	G
Dong Hwan Kim	Korea Rep.	22.7	100.0	42.9	78.6	1.0	71.1	88.1	53.1	100.0	68.2	0.0	66.7	0	62.44	42.04	54.28	B
Soon Gu Kwak	Korea Rep.	100.0	100.0	78.6	100.0	0.0	93.3	88.1	62.5	96.5	53.7	72.1	59.3	-1	79.10	60.17	71.53	G
Jae Hoon Jung	Korea Rep.	100.0	61.1	78.6	92.9	6.0	93.3	47.6	56.3	96.5	66.0	87.7	59.3	-1	68.42	69.11	68.70	G
Ameer Sami Alqallaf	Kuwait	27.3	22.2	0.0	0.0	0.0	2.2	14.3	18.8	1.8	4.3	29.9	0.0	0	9.85	12.28	10.82	
Abdullah Saleh Alshemali	Kuwait	18.2	0.0	0.0	0.0	0.0	8.9	4.8	0.0	3.5	62.1	6.2	9.3	0	3.84	21.30	10.83	
Mohammed Khalil Albloushei	Kuwait	13.6	0.0	0.0	0.0	4.0	4.4	11.9	12.5	3.5	32.6	41.3	7.4	0	5.75	26.43	14.02	
Ahmad Fahed Alrashidi	Kuwait	9.1	0.0	0.0	0.0	0.0	8.9	0.0	0.0	0.0	43.3	44.6	2.8	0	1.95	28.59	12.60	
Romans Caplinskis	Latvia	95.5	100.0	42.9	75.0	46.0	71.1	90.5	65.6	87.7	86.3	93.8	39.8	0	75.15	71.69	73.77	G
Aleksandrs Sorokins	Latvia	77.3	44.4	7.1	78.6	0.0	60.0	50.0	81.3	63.2	62.7	38.5	47.2	0	50.95	47.80	49.69	B
Janis Jermaks	Latvia	27.3	27.8	42.9	32.1	0.0	48.9	38.1	21.9	49.1	61.3	51.2	45.4	0	31.72	51.56	39.65	H
Toms Rekis	Latvia	50.0	0.0	0.0	0.0	0.0	35.6	45.2	40.6	50.9	70.8	89.2	48.1	0	25.01	69.23	42.69	B
Ignas Anikevicius	Lithuania	77.3	50.0	0.0	53.6	0.0	75.6	33.3	9.4	100.0	63.6	92.3	8.3	0	43.27	53.65	47.42	B
Mindaugas Jakutis	Lithuania	31.8	72.2	28.6	53.6	0.0	53.3	73.8	40.6	84.2	27.8	96.9	48.1	0	49.05	61.35	53.97	B
Roberta Poceviciute	Lithuania	90.9	100.0	14.3	64.3	4.0	68.9	59.5	62.5	96.5	71.5	96.9	53.7	0	62.00	74.37	66.94	G
Sandra Stanionyte	Lithuania	59.1	50.0	28.6	75.0	2.0	26.7	66.7	50.0	77.2	69.8	87.7	38.0	0	47.89	64.56	54.56	B
Chai Yi Kang	Malaysia	22.7	44.4	14.3	21.4	0.0	62.2	33.3	0.0	36.8	69.6	81.0	40.7	0	26.42	63.07	41.08	B
Goh Jun Yan	Malaysia	45.5	38.9	0.0	60.7	0.0	48.9	47.6	43.8	78.9	79.7	47.7	22.2	0	40.21	46.14	42.58	B
Muhammad Hafiz Abdul Karim	Malaysia	31.8	22.2	7.1	32.1	0.0	44.4	26.2	6.3	21.1	39.1	6.9	36.1	0	21.21	25.89	23.09	
Muhamad azri Muhamad Marican	Malaysia	36.4	38.9	14.3	53.6	0.0	44.4	40.5	28.1	28.1	81.8	73.5	6.5	0	31.63	50.44	39.15	
Dumitru Valeriu Samohvalov	Moldova	22.7	0.0	50.0	53.6	0.0	6.7	35.7	3.1	42.1	52.7	10.8	25.9	0	22.74	26.94	24.42	
Dmitrii Mihail Mazur	Moldova	18.2	61.1	57.1	32.1	0.0	20.0	19.0	15.6	47.4	62.7	15.4	41.7	0	29.31	37.08	32.42	
Valeriu Valeriu Scutelnic	Moldova	18.2	88.9	28.6	75.0	51.0	71.1	0.0	0.0	0.0	53.3	15.8	21.3	0	36.79	27.23	32.97	
Dan Grigore Negrescu	Moldova	59.1	0.0	0.0	0.0	0.0	31.1	2.4	34.4	0.0	48.8	76.9	5.6	0	13.87	43.14	25.58	
Itzel Condado-Morales	Mexico	40.9	55.6	64.3	71.4	0.0	0.0	38.1	0.0	52.6	56.9	43.1	20.4	0	34.49	38.03	35.90	
Luis Ángel Martínez-Martínez	Mexico	59.1	100.0	0.0	60.7	0.0	60.0	57.1	43.8	42.1	66.7	90.8	19.4	0	47.58	58.00	51.75	B
Eduardo Alejandro Romero-Montalvo	Mexico	36.4	100.0	28.6	67.9	20.0	37.8	66.7	31.3	52.6	81.3	87.7	50.0	0	49.48	71.95	58.47	S

Student	Country	T1	T2	T3	T4	T5	T6	T7	T8	T9	P1	P2	P3	Pen	Theory	Practice	Total	Med
Astron Rigel Martínez-Rosas	Mexico	27.3	55.6	14.3	67.9	0.0	6.7	23.8	0.0	59.6	89.6	55.2	41.7	0	27.34	58.71	39.89	H
Ganchimeg Lkhamsuren	Mongolia	18.2	66.7	28.6	67.9	2.0	0.0	40.5	9.4	15.8	35.6	21.5	37.0	0	27.54	30.87	28.87	
Urandelger Tuvshindorj	Mongolia	31.8	44.4	7.1	71.4	0.0	42.2	50.0	15.6	54.4	70.8	89.2	26.9	0	35.08	61.24	45.54	B
Uyanga Dagvadorj	Mongolia	31.8	44.4	57.1	35.7	84.0	33.3	21.4	0.0	0.0	60.0	43.1	25.0	0	34.20	40.54	36.73	
Turbat Enkhbaatar	Mongolia	36.4	22.2	42.9	14.3	0.0	13.3	47.6	28.1	42.1	60.3	60.3	39.8	0	27.34	52.60	37.45	
Niels Kouwenhoven	Netherlands	13.6	38.9	42.9	28.6	0.0	48.9	42.9	68.8	35.1	25.0	44.6	2.8	0	35.99	24.02	31.20	
Tim Evers	Netherlands	22.7	27.8	0.0	35.7	13.0	6.7	42.9	21.9	45.6	33.7	71.5	13.0	0	24.21	40.10	30.56	
Cees de Boer	Netherlands	45.5	38.9	0.0	60.7	0.0	15.6	38.1	46.9	56.1	22.9	87.5	40.7	0	33.13	53.83	41.41	B
Jasper Landman	Netherlands	31.8	44.4	14.3	71.4	0.0	28.9	33.3	0.0	21.1	56.2	84.6	49.1	0	26.86	64.17	41.78	B
Erik Kvam Måland	Norway	27.3	50.0	7.1	46.4	2.0	6.7	38.1	0.0	82.5	50.9	69.0	23.1	0	28.25	47.28	35.86	
Marte van der Linden	Norway	18.2	22.2	7.1	35.7	2.0	60.0	28.6	18.8	33.3	49.6	47.7	14.8	0	25.26	35.84	29.49	
Camilla Espedal	Norway	18.2	55.6	0.0	17.9	4.0	31.1	23.8	25.0	31.6	80.9	7.7	29.6	0	23.43	34.23	27.75	
Stein-Olav Hagen Davidsen	Norway	27.3	44.4	0.0	7.1	0.0	37.8	19.0	21.9	54.4	75.6	4.6	9.3	0	23.56	24.11	23.78	
Sava Mihic	New Zealand	77.3	61.1	0.0	28.6	8.0	68.9	69.0	59.4	84.2	51.3	86.9	26.9	0	51.24	55.49	52.94	B
Emily Christine Adlam	New Zealand	45.5	61.1	0.0	53.6	0.0	53.3	64.3	68.8	63.2	65.2	90.8	52.8	0	46.16	70.13	55.75	B
Wenyi Yi	New Zealand	50.0	61.1	21.4	50.0	0.0	42.2	66.7	43.8	52.6	84.7	67.4	20.4	0	43.45	54.09	47.71	B
Timothy Andre Vogel	New Zealand	40.9	27.8	35.7	50.0	8.0	62.2	33.3	53.1	78.9	66.7	89.2	47.2	0	42.63	67.83	52.71	B
Maha Malik	Pakistan	22.7	27.8	0.0	10.7	0.0	20.0	33.3	15.6	57.9	72.8	95.4	29.6	0	20.98	65.08	38.62	
Ali Kamran Ahmad	Pakistan	36.4	5.6	0.0	21.4	2.0	20.0	50.0	31.3	45.6	15.6	52.3	19.4	0	23.87	30.82	26.65	
Ayesha Ahmed	Pakistan	22.7	44.4	7.1	0.0	0.0	51.1	19.0	0.0	17.5	77.5	17.3	31.5	-2	18.43	32.66	24.12	
Gibran Moshtaq Hashmi	Pakistan	9.1	27.8	0.0	3.6	0.0	0.0	19.0	21.9	26.3	65.6	84.6	34.3	0	12.23	60.99	31.73	
James Miguel Cabrera Guevara	Peru	13.6	33.3	0.0	7.1	0.0	55.6	21.4	3.1	42.1	47.2	0.0	5.6	0	19.88	13.88	17.48	
Nathaly Gastelo Cuadros	Peru	13.6	0.0	0.0	7.1	0.0	13.3	16.7	15.6	3.5	31.8	3.1	14.8	0	8.03	14.65	10.68	
Robinson Junior León Urrego	Peru	22.7	27.8	0.0	0.0	0.0	8.9	19.0	0.0	17.5	8.3	41.5	5.6	0	10.84	19.74	14.40	
Tomasz Andrzej Biczel	Poland	18.2	100.0	57.1	78.6	0.0	64.4	52.4	40.6	100.0	80.9	96.9	68.5	0	56.30	82.27	66.69	G
Oskar Szymon Sala	Poland	77.3	100.0	57.1	60.7	93.0	66.7	38.1	53.1	98.2	74.8	100.0	65.7	0	70.91	80.85	74.89	G
Jakub Hubert Mroz	Poland	36.4	55.6	50.0	75.0	2.0	48.9	64.3	46.9	19.3	86.1	39.7	57.4	0	44.52	57.93	49.89	B
Lukasz Krawiec	Poland	54.5	55.6	57.1	53.6	2.0	53.3	40.5	34.4	61.4	8.3	93.8	70.4	0	45.01	63.66	52.47	B
Joana Marta Miguel Lourenço	Portugal	31.8	22.2	0.0	0.0	0.0	8.9	26.2	9.4	33.3	87.0	17.6	25.0	0	14.73	37.73	23.93	

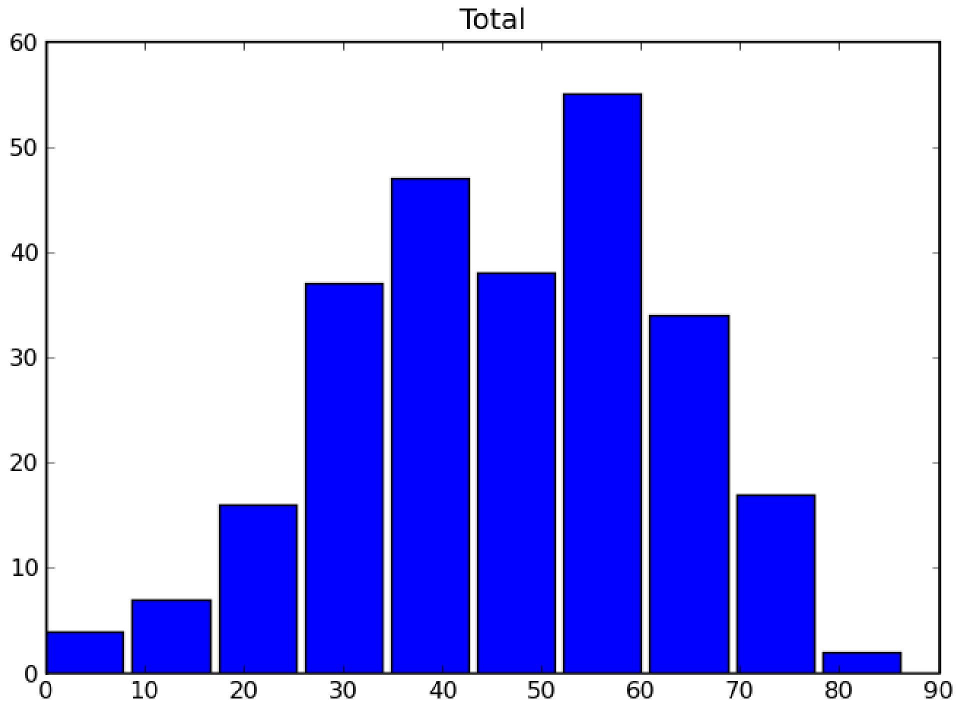
Student	Country	T1	T2	T3	T4	T5	T6	T7	T8	T9	P1	P2	P3	Pen	Theory	Practice	Total	Med
Vera Alexandra Fonseca Patrício	Portugal	22.7	22.2	0.0	0.0	0.0	33.3	16.7	15.6	61.4	73.8	32.6	37.0	0	18.94	44.55	29.18	
Susana Isabel Brito Santos	Portugal	22.7	0.0	0.0	14.3	0.0	8.9	9.5	21.9	26.3	41.1	43.5	15.7	0	11.19	32.47	19.70	
Inês Maria Pacheco Soares Carneiro	Portugal	31.8	0.0	0.0	21.4	0.0	24.4	26.2	12.5	29.8	77.1	37.3	12.0	0	16.11	37.78	24.78	
Ioana Teodora Tofoleanu	Romania	63.6	100.0	100.0	100.0	1.0	71.1	42.9	9.4	91.2	56.3	52.3	40.7	0	62.37	48.96	57.01	S
Andrei Ungureanu	Romania	27.3	94.4	14.3	50.0	0.0	53.3	33.3	34.4	80.7	77.4	44.8	48.1	0	42.92	54.22	47.44	B
Vlad Alexandru Puscasu	Romania	50.0	100.0	28.6	85.7	0.0	55.6	54.8	65.6	84.2	76.4	93.8	62.0	0	57.96	77.55	65.80	S
Ioana Aron	Romania	27.3	100.0	57.1	85.7	8.0	55.6	54.8	50.0	91.2	87.5	84.3	47.2	0	58.35	71.19	63.49	S
Andrey Bogorodskiy	Russian Federation	68.2	94.4	78.6	60.7	47.0	95.6	100.0	93.8	93.0	70.1	100.0	47.2	0	81.97	72.74	78.27	G
Yury Timchenko	Russian Federation	59.1	100.0	75.0	75.0	100.0	40.0	57.1	81.3	89.5	68.8	58.5	62.0	0	74.95	62.39	69.93	G
Vladimir Poddubnyy	Russian Federation	59.1	100.0	14.3	71.4	0.0	100.0	73.8	78.1	87.7	78.9	94.6	35.2	0	65.54	68.38	66.68	G
Sergey Nikitin	Russian Federation	100.0	100.0	78.6	82.1	22.0	71.1	61.9	71.9	94.7	89.6	100.0	59.3	0	74.71	82.12	77.68	G
Li Qian Yeong	Singapore	86.4	100.0	78.6	75.0	100.0	73.3	69.0	100.0	100.0	60.6	87.9	73.1	0	86.76	75.52	82.26	G
Yong Jin Wang	Singapore	72.7	61.1	14.3	82.1	16.0	57.8	78.6	71.9	49.1	83.1	93.8	52.8	0	56.43	75.77	64.16	S
Mei Hua Fiona Foo	Singapore	31.8	55.6	28.6	67.9	10.0	66.7	50.0	71.9	91.2	75.8	93.8	12.0	0	52.43	58.66	54.92	B
Kang Ruey Gregory Lau	Singapore	63.6	55.6	7.1	71.4	0.0	37.8	45.2	71.9	47.4	18.6	90.8	14.8	0	44.26	44.24	44.25	B
Gašper Gregorič	Slovenia	27.3	55.6	7.1	39.3	0.0	60.0	28.6	15.6	19.3	60.5	87.7	41.7	0	28.41	63.63	42.50	B
Nemanja Aničić	Slovenia	22.7	61.1	50.0	71.4	0.0	73.3	45.2	40.6	89.5	77.3	55.4	23.1	0	49.82	48.78	49.41	B
Tomaž Mohorič	Slovenia	50.0	100.0	57.1	75.0	0.0	66.7	50.0	43.8	68.4	52.2	87.7	59.3	-1	56.27	65.65	60.02	S
Nika Anžiček	Slovenia	27.3	44.4	0.0	7.1	5.0	57.8	38.1	18.8	7.0	80.0	20.0	26.9	0	23.92	37.56	29.38	
Mario Silvester Könz	Switzerland	31.8	27.8	0.0	67.9	12.0	60.0	33.3	0.0	38.6	59.6	15.4	14.8	0	29.91	26.22	28.44	
Matthias Roman Rüdt	Switzerland	27.3	50.0	0.0	57.1	0.0	31.1	38.1	0.0	29.8	20.4	44.5	13.9	0	25.97	26.98	26.37	
Nina Zargari	Switzerland	31.8	27.8	0.0	7.1	0.0	6.7	23.8	25.0	35.1	57.1	49.5	44.4	-1	17.51	47.02	29.32	
Andreas Frutiger	Switzerland	40.9	55.6	14.3	35.7	2.0	66.7	57.1	53.1	70.2	72.1	86.2	41.7	0	44.42	65.95	53.03	B
Erik Andris	Slovakia	50.0	100.0	0.0	75.0	0.0	40.0	59.5	81.3	77.2	86.9	84.8	30.6	0	53.97	64.98	58.37	S
Lukáš Konečný	Slovakia	50.0	55.6	57.1	67.9	0.0	55.6	45.2	53.1	61.4	61.5	48.1	50.9	0	48.83	52.51	50.30	B
Martin Lukačišin	Slovakia	72.7	100.0	92.9	82.1	1.0	64.4	35.7	65.6	71.9	52.5	90.8	51.9	0	63.69	66.60	64.85	S
Lukás Pogány	Slovakia	54.5	72.2	0.0	75.0	4.0	24.4	59.5	50.0	70.2	80.0	93.8	47.2	0	45.49	72.89	56.45	S
Eduardo Ansaldo Giné	Spain	27.3	22.2	0.0	0.0	0.0	64.4	45.2	0.0	47.4	63.9	90.8	48.1	0	23.61	68.06	41.39	B
Mario López Moya	Spain	27.3	44.4	0.0	10.7	2.0	75.6	21.4	6.3	96.5	69.8	0.0	46.3	0	31.27	34.81	32.68	

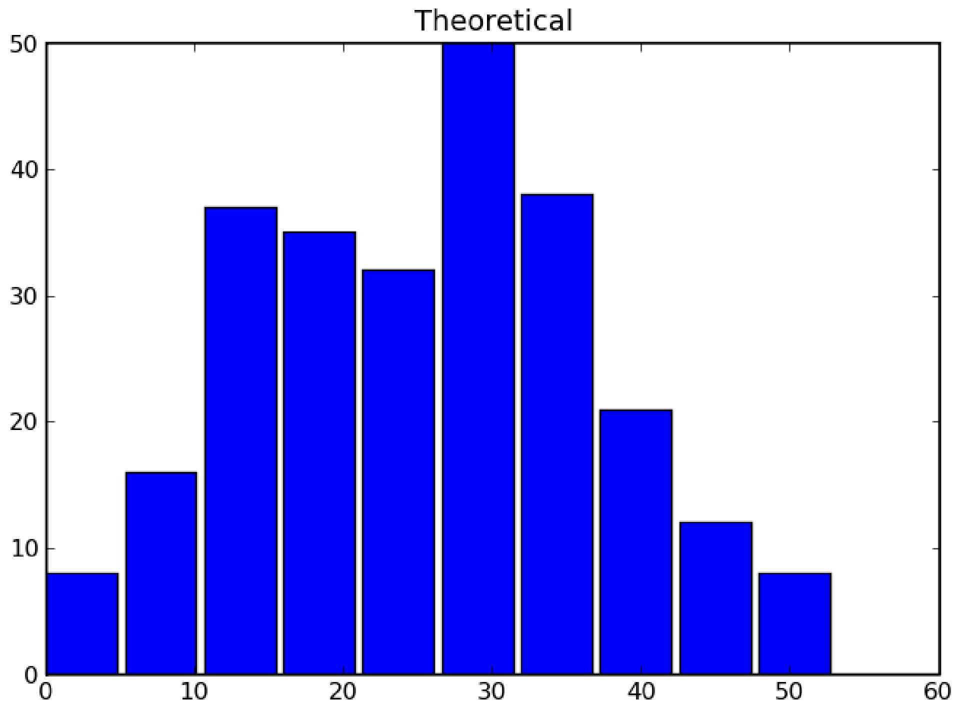
Student	Country	T1	T2	T3	T4	T5	T6	T7	T8	T9	P1	P2	P3	Pen	Theory	Practice	Total	Med
Jaíme Mª Medina Manresa	Spain	9.1	33.3	0.0	14.3	1.0	44.4	52.4	40.6	56.1	35.5	62.6	19.4	0	28.87	39.67	33.19	
Juan Antonio Primitivo Rodríguez	Spain	40.9	27.8	0.0	0.0	0.0	8.9	35.7	34.4	66.7	71.0	93.8	16.7	0	23.81	59.19	37.96	
Leif David Schelin	Sweden	31.8	50.0	0.0	39.3	0.0	11.1	66.7	34.4	94.7	43.3	46.2	7.4	0	36.61	30.91	34.33	
Daria Ewa Struska	Sweden	59.1	55.6	0.0	78.6	0.0	28.9	73.8	75.0	50.9	79.6	63.1	11.1	0	47.30	47.72	47.47	B
Sihan Wang	Sweden	13.6	33.3	0.0	60.7	9.0	13.3	26.2	34.4	7.0	31.3	72.9	43.5	0	22.13	51.49	33.88	
Jessica Susanna Bernsteen	Sweden	31.8	0.0	7.1	17.9	0.0	20.0	45.2	34.4	26.3	61.6	57.0	14.8	0	20.69	42.35	29.35	
Chalermchai Komaenthammasophon	Thailand	95.5	100.0	85.7	71.4	0.0	44.4	81.0	53.1	96.5	34.7	93.8	51.9	0	68.75	63.32	66.58	S
Techin Chuladesa	Thailand	77.3	61.1	28.6	82.1	0.0	71.1	50.0	62.5	100.0	73.6	100.0	58.3	0	58.18	77.76	66.02	S
Tanatorn Khotavivattana	Thailand	50.0	100.0	0.0	50.0	14.0	73.3	81.0	68.8	94.7	77.5	91.7	51.9	0	60.14	73.18	65.36	S
Phakpoom Angpanitcharoen	Thailand	45.5	94.4	85.7	75.0	28.0	84.4	69.0	53.1	63.2	82.3	98.5	46.3	0	66.47	74.85	69.83	G
Umedjon Qodirov	Tajikistan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	0.00	
Khursand Yorov	Tajikistan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	0.00	
Parviz Khakimov	Tajikistan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	0.00	
Timur Ashirov	Tajikistan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	0.00	
Begench Saparov	Turkmenistan	27.3	61.1	0.0	39.3	8.0	31.1	47.6	56.3	54.4	56.3	53.2	25.9	0	36.70	43.73	39.51	H
Amanmyrat Abdullayev	Turkmenistan	27.3	88.9	28.6	75.0	2.0	26.7	35.7	34.4	43.9	67.3	9.2	26.9	0	39.96	30.36	36.12	
Nazar Mammedov	Turkmenistan	72.7	44.4	14.3	82.1	0.0	44.4	38.1	28.1	26.3	57.8	55.4	7.4	0	38.28	38.00	38.17	
Sohbet Hojamuhammedov	Turkmenistan	9.1	88.9	35.7	3.6	2.0	15.6	45.2	9.4	24.6	58.2	45.6	61.1	0	26.84	54.56	37.93	
Jhe-Hao Li	Chinese Taipei	22.7	55.6	64.3	75.0	2.0	62.2	50.0	37.5	96.5	20.8	95.4	42.6	0	50.87	56.95	53.30	B
Cheng-Ting Tsai	Chinese Taipei	31.8	100.0	64.3	78.6	2.0	66.7	64.3	90.6	86.0	74.4	100.0	50.0	0	64.89	74.85	68.87	G
Cheng-Yo Lai	Chinese Taipei	36.4	100.0	71.4	85.7	10.0	93.3	81.0	84.4	93.0	66.1	20.0	57.4	0	73.01	45.56	62.03	S
Po-Chieh Ting	Chinese Taipei	59.1	100.0	50.0	100.0	0.0	57.8	78.6	71.9	96.5	70.9	93.8	35.2	0	67.83	66.11	67.14	G
Muammer Yusuf Yaman	Turkey	45.5	100.0	42.9	42.9	6.0	33.3	52.4	37.5	82.5	76.2	82.4	34.3	0	48.98	62.81	54.51	B
Huseyin Erguven	Turkey	27.3	100.0	71.4	78.6	26.0	77.8	83.3	28.1	24.6	81.3	76.9	55.6	0	58.35	70.00	63.01	S
Mehmet Vural	Turkey	45.5	100.0	64.3	57.1	2.0	57.8	42.9	56.3	40.4	71.5	16.9	59.3	0	51.64	46.43	49.56	B
Mahmut Tekin	Turkey	81.8	100.0	71.4	78.6	2.0	33.3	69.0	53.1	96.5	93.8	52.3	13.9	0	64.02	48.26	57.72	S
Ostap Chervak	Ukraine	100.0	100.0	78.6	85.7	84.0	95.6	57.1	71.9	93.0	26.7	96.9	44.4	0	84.35	59.69	74.48	G
Kyrylo Kolesnikov	Ukraine	68.2	100.0	14.3	78.6	87.0	46.7	69.0	56.3	70.2	61.8	100.0	64.8	0	66.15	77.26	70.59	G

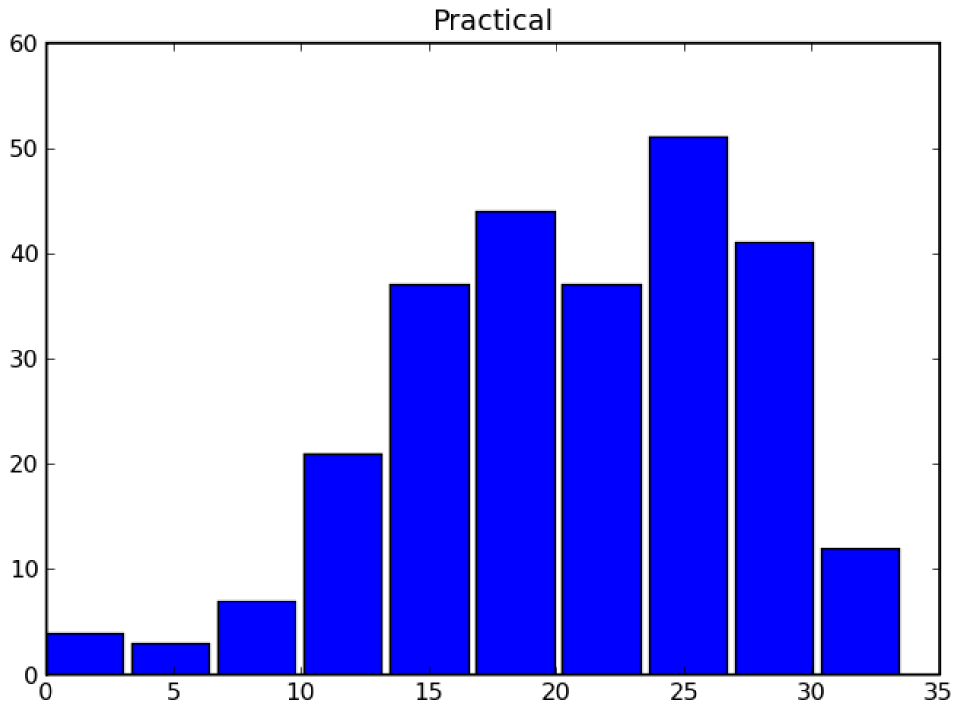
Student	Country	T1	T2	T3	T4	T5	T6	T7	T8	T9	P1	P2	P3	Pen	Theory	Practice	Total	Med
Ihor Stepanenko	Ukraine	27.3	100.0	57.1	71.4	100.0	55.6	92.9	84.4	78.9	74.5	96.9	52.8	0	75.52	74.77	75.22	G
Roman Prytulyak	Ukraine	36.4	100.0	42.9	64.3	2.0	26.7	54.8	84.4	94.7	68.8	90.8	54.6	0	55.98	71.74	62.28	S
Ana Inés Silva	Uruguay	4.5	50.0	0.0	53.6	0.0	22.2	26.2	15.6	10.5	72.7	44.6	13.0	0	20.61	39.77	28.27	
Lucía Castellano	Uruguay	27.3	33.3	0.0	32.1	0.0	42.2	38.1	9.4	0.0	50.2	49.2	0.0	0	20.93	31.01	24.96	
Sofía Velazco	Uruguay	18.2	50.0	0.0	21.4	0.0	31.1	33.3	18.8	5.3	56.4	35.5	17.6	0	20.58	34.02	25.96	
Peter Luke Aisher	United Kingdom	31.8	72.2	46.4	82.1	0.0	80.0	23.8	46.9	78.9	39.6	43.1	22.2	0	50.34	34.38	43.95	B
John William Roger Morgan	United Kingdom	59.1	61.1	71.4	42.9	0.0	91.1	54.8	40.6	61.4	68.3	90.8	41.7	0	53.28	66.75	58.67	S
Alexander John Kasas	United Kingdom	31.8	61.1	0.0	0.0	0.0	93.3	85.7	59.4	70.2	89.0	84.6	25.0	0	46.57	63.36	53.29	B
Nilpesh Nilpesh Patel	United Kingdom	31.8	61.1	57.1	71.4	0.0	75.6	61.9	59.4	82.5	31.3	75.3	63.0	0	55.41	59.64	57.10	S
Jonathan David Lee	United States	31.8	50.0	57.1	85.7	0.0	84.4	50.0	62.5	89.5	80.9	71.3	37.0	0	56.06	60.85	57.97	S
Andrew Zhangyanchu Liu	United States	59.1	77.8	57.1	75.0	2.0	26.7	47.6	28.1	77.2	84.0	10.8	44.4	0	48.89	41.70	46.02	B
Lu Jenny	United States	68.2	61.1	14.3	57.1	0.0	80.0	45.2	59.4	91.2	68.8	20.0	37.0	0	52.51	38.60	46.94	B
Yuxin Xie	United States	72.7	61.1	7.1	42.9	0.0	48.9	88.1	65.6	80.7	57.1	85.3	36.1	0	52.58	59.81	55.47	B
Armando Rafael León Silva	Venezuela	31.8	0.0	0.0	0.0	4.0	24.4	9.5	25.0	26.3	49.5	86.2	6.5	0	13.32	47.12	26.84	
Rafael Alberto Prato Modestino	Venezuela	27.3	55.6	0.0	42.9	0.0	62.2	50.0	21.9	43.9	50.7	92.3	8.3	0	34.36	50.42	40.78	H
Anh Chu Thi Ngoc	Vietnam	36.4	55.6	42.9	92.9	2.0	35.6	50.0	25.0	70.2	91.7	45.6	57.4	0	44.67	61.56	51.43	B
Chau Vu Minh	Vietnam	100.0	100.0	71.4	78.6	95.0	86.7	66.7	65.6	96.5	51.3	40.0	59.3	0	84.06	50.05	70.46	G
Linh Bui Tuan	Vietnam	100.0	100.0	14.3	78.6	98.0	86.7	76.2	81.3	96.5	88.8	93.8	23.1	0	81.78	66.06	75.50	G
Tuan Pham Anh	Vietnam	68.2	100.0	78.6	78.6	34.0	31.1	52.4	40.6	87.7	77.7	9.2	61.1	0	62.29	45.80	55.70	B

Statistical Analysis

The histograms show the number of students achieving in the indicated percentage range.






Practical
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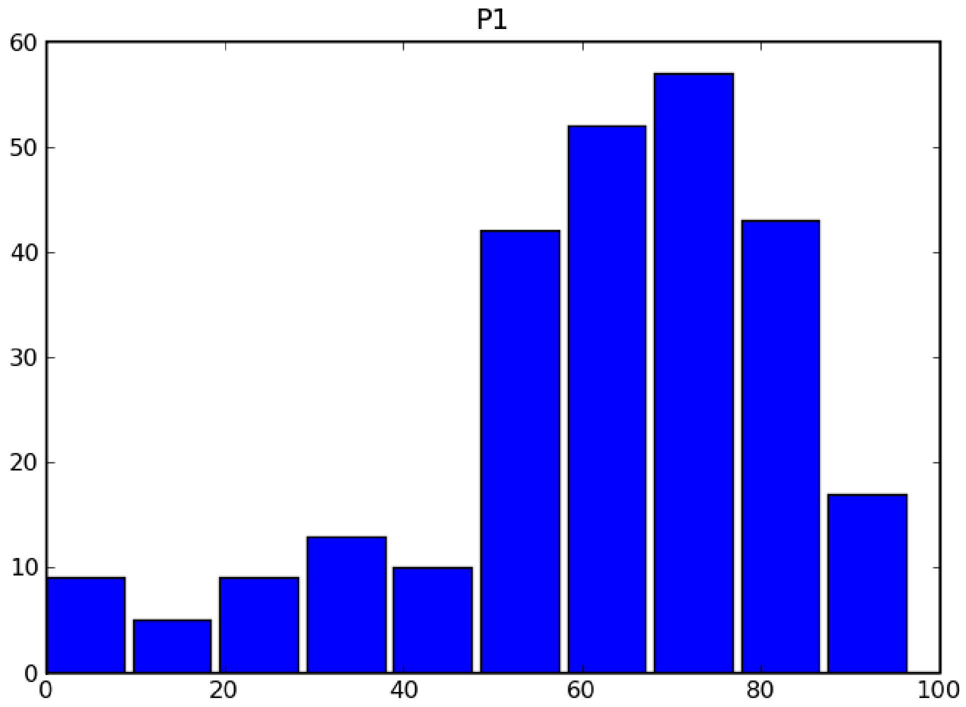
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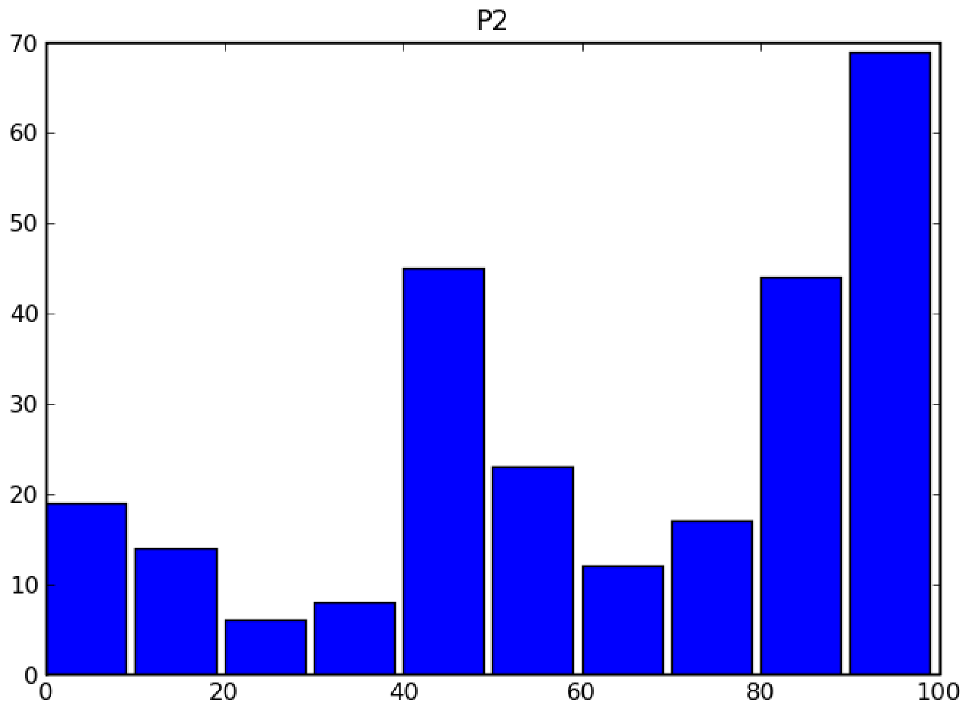
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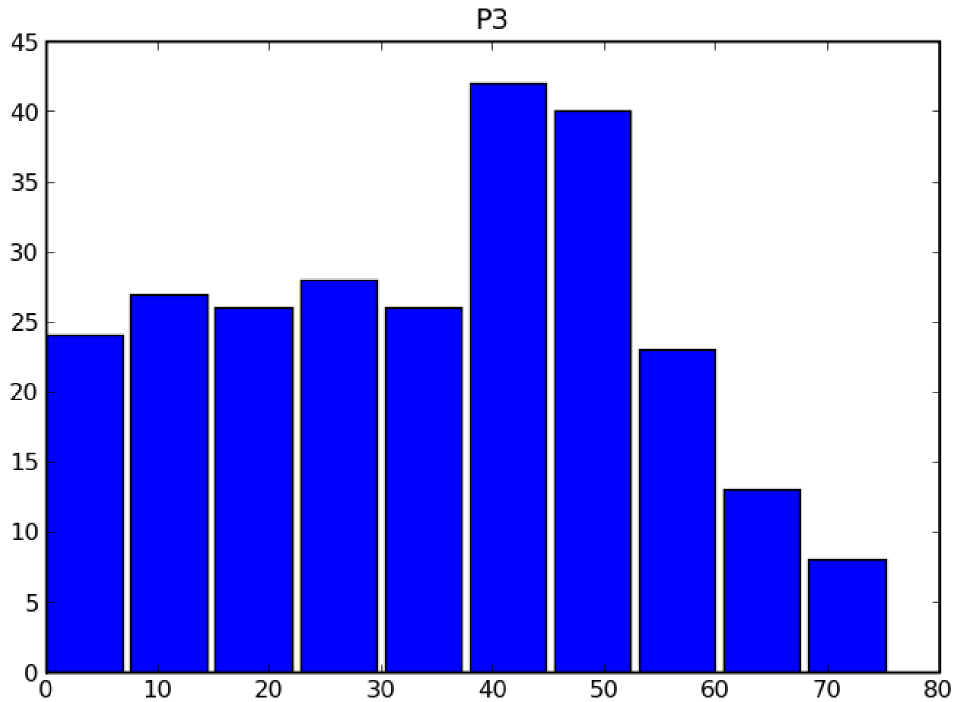
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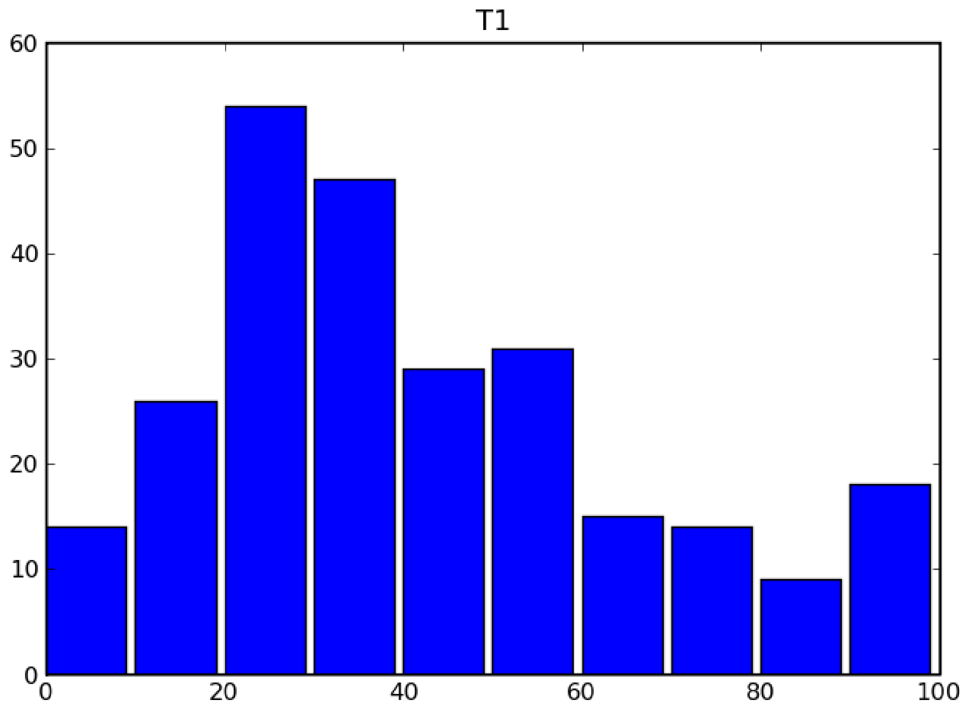
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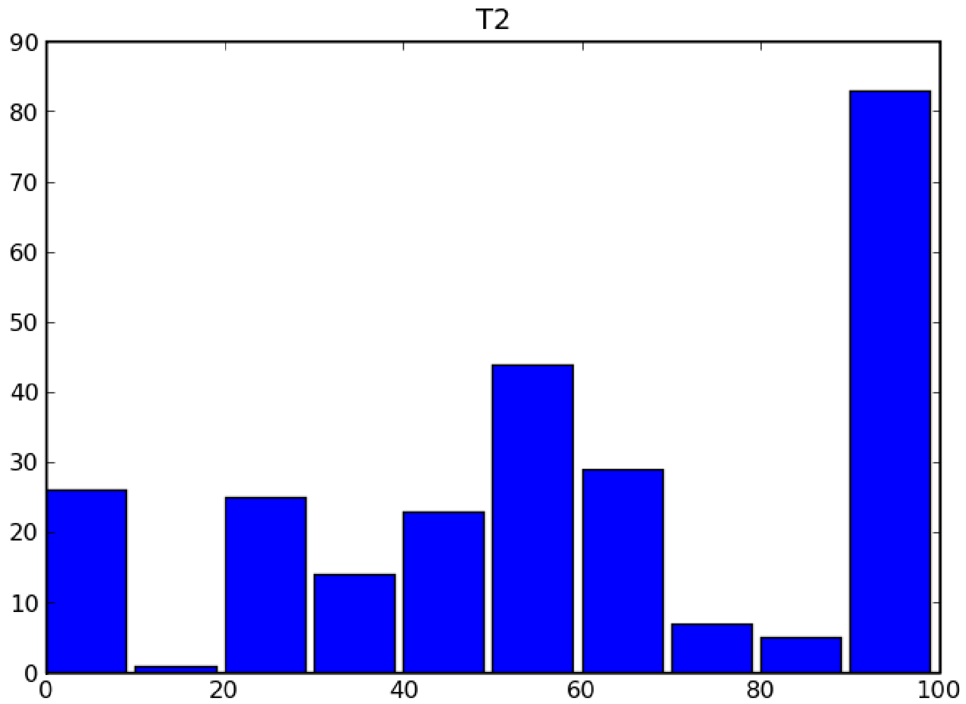
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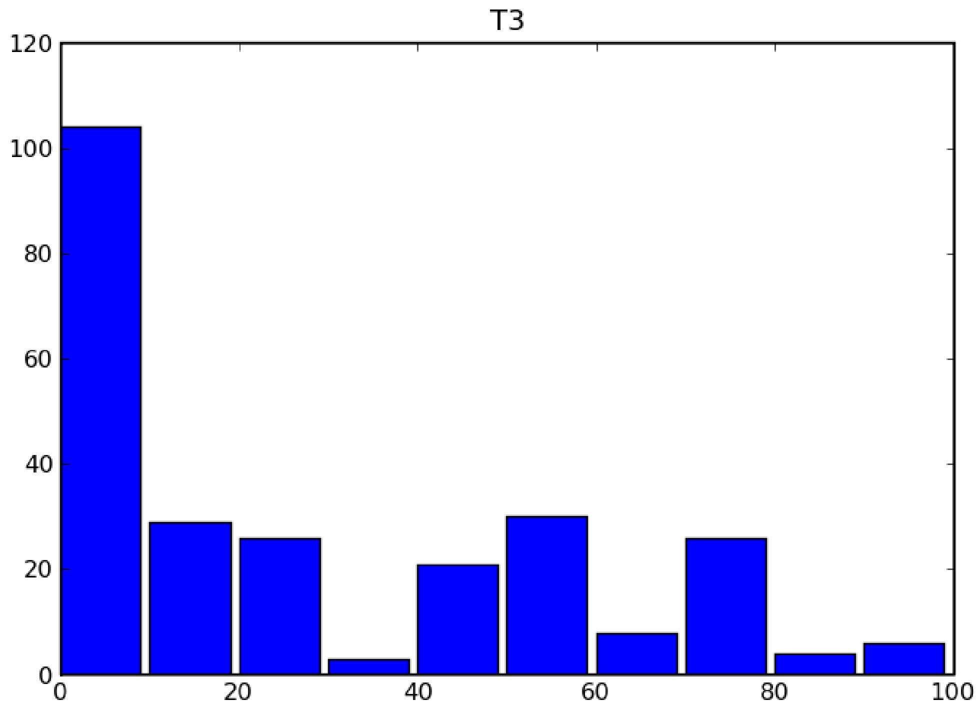
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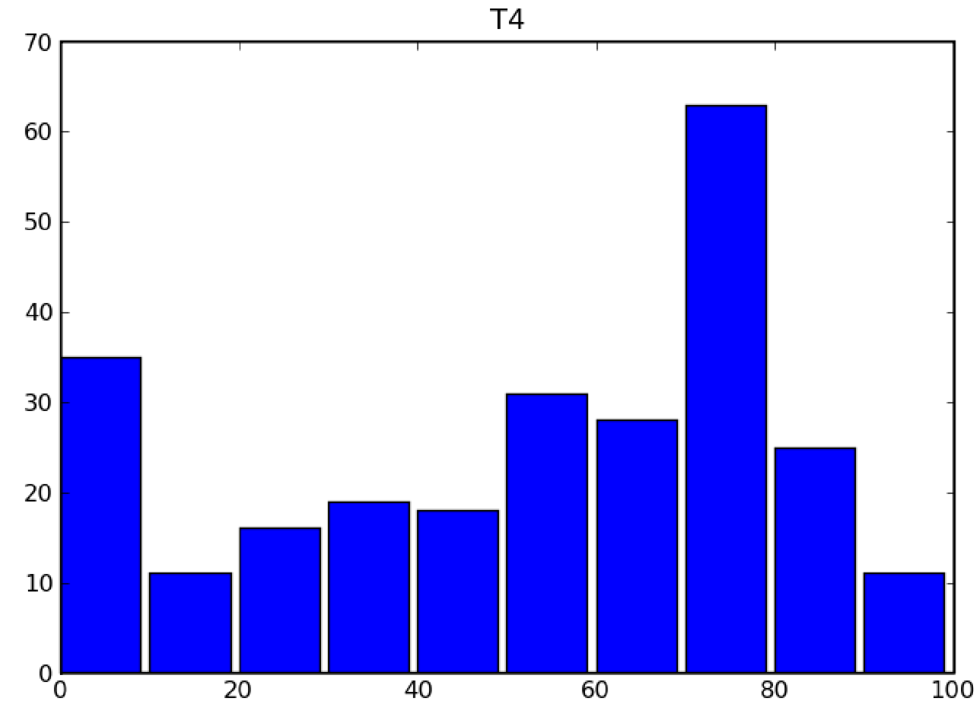
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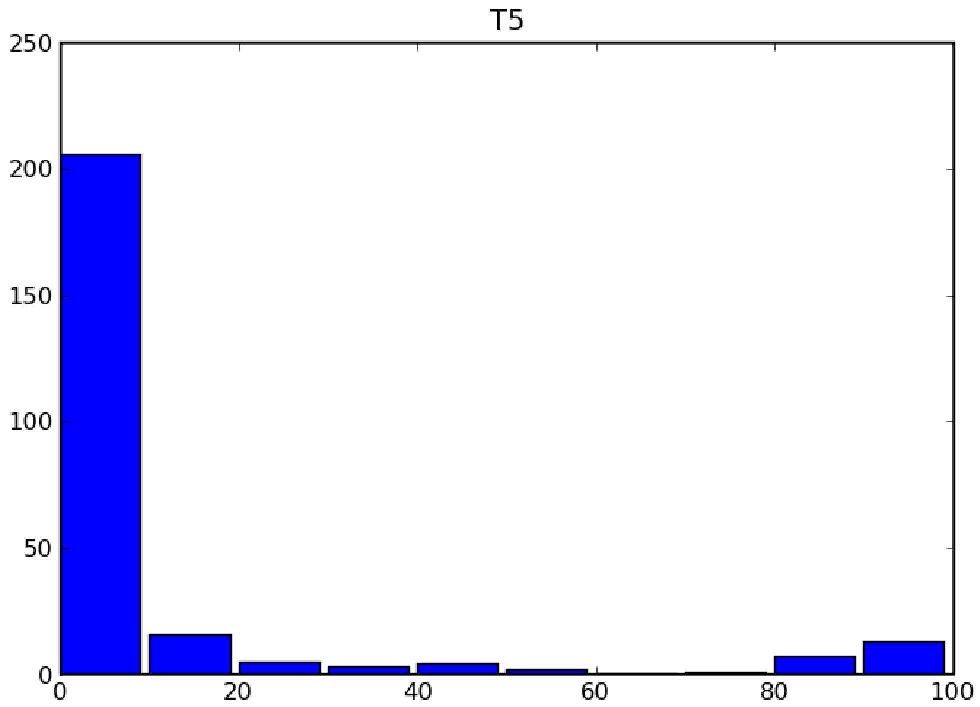
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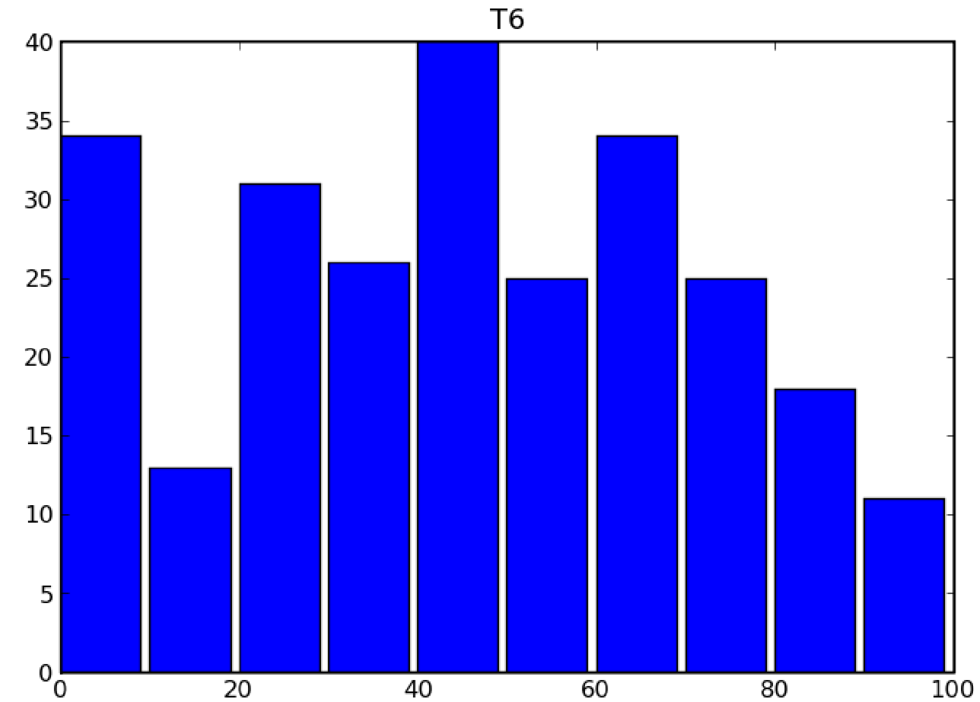
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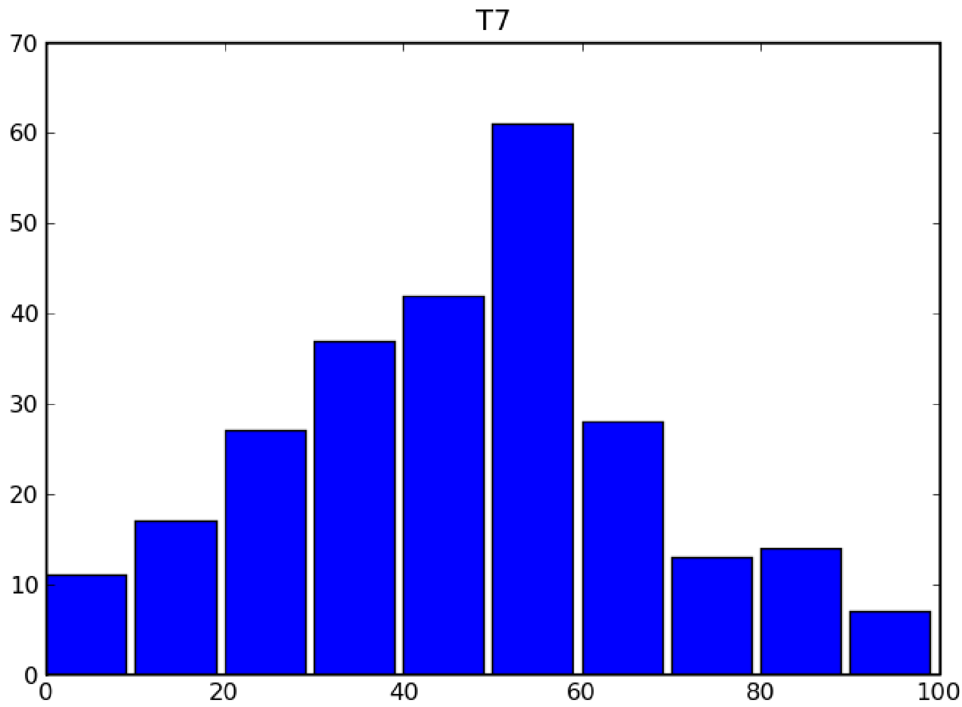
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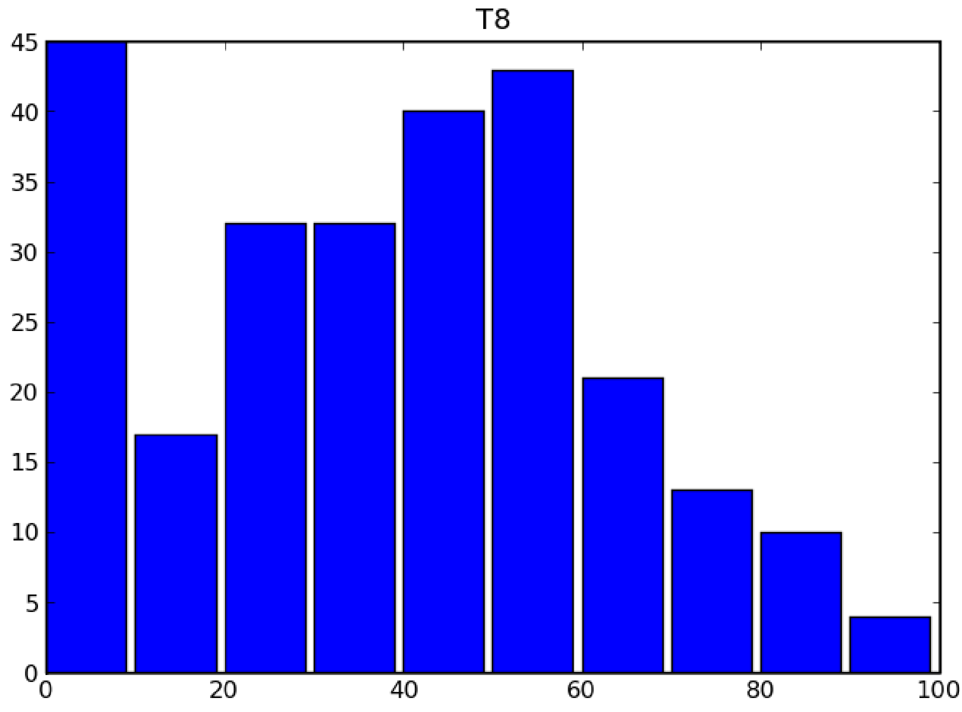
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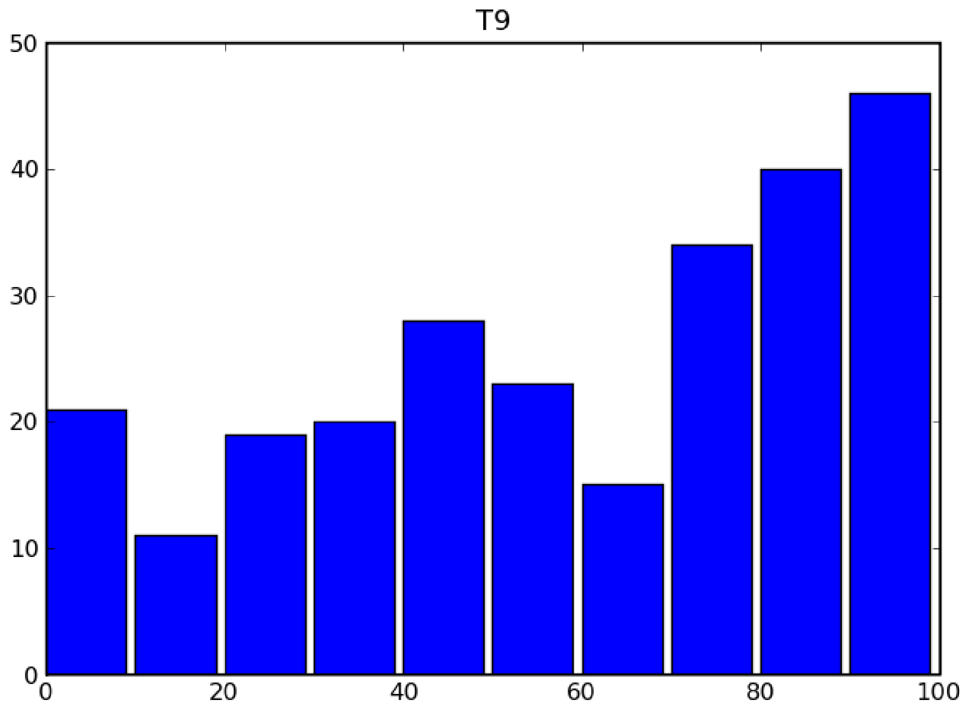
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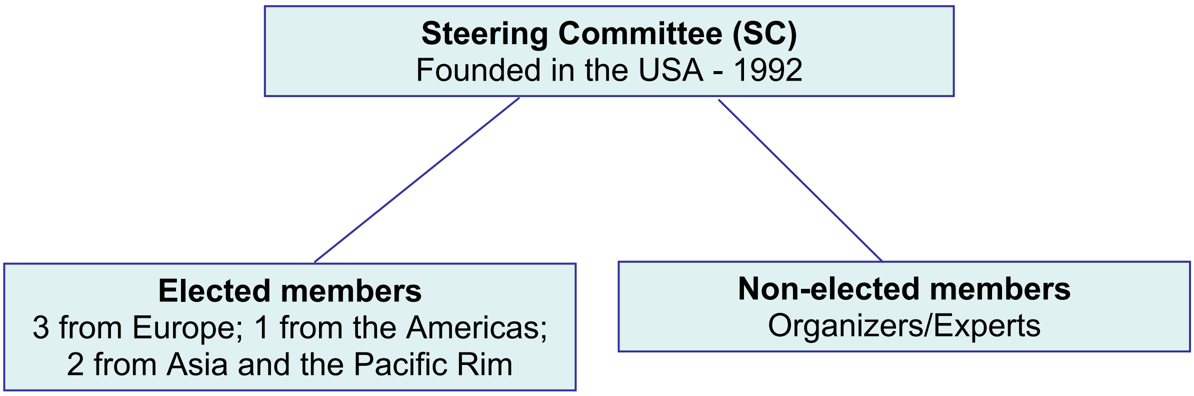
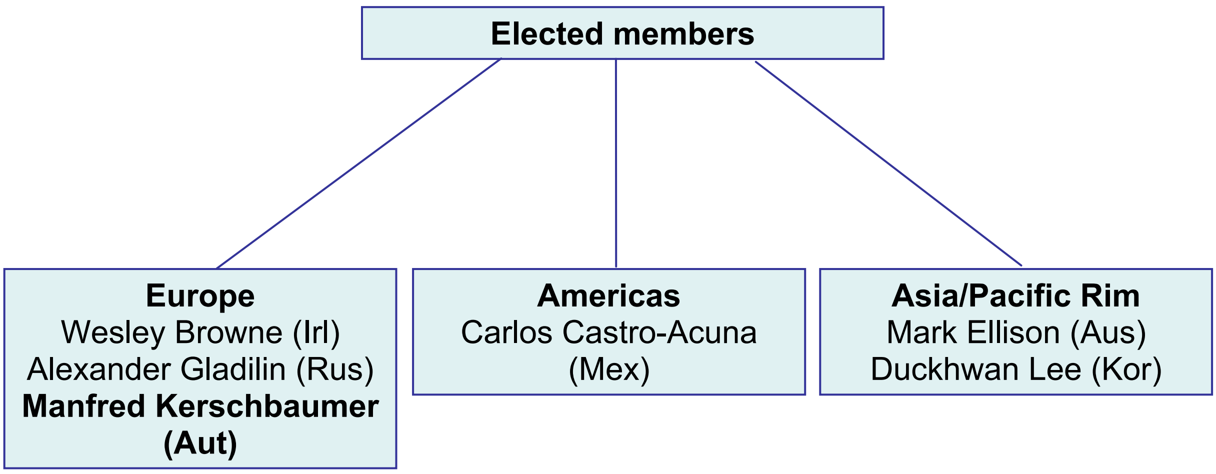
Steering Committee of the IChO

MINUTES
of the BUSINESS PART of the
1st JURY SESSION at the 40th ICHO/BUDAPEST

1. Introduction of the SC-members and description of the role of the SC and experts

Dr. Kerschbaumer introduces the members of the Steering Committee to the International Jury. Additionally he describes the role of the Steering Committee, especially the work of the "experts".





Role of the SC :

- to collect information about problems in the ICHO,
- to try to find solutions for these problems,
- to help the future hosts to organize the competition,
- to handle and to conduct business sessions in the ICHO,
- to decide about the IUPAC-support.
- Experts: people who contribute to and help in the organisation of ICHOs due to their experience as long time participating mentors or former hosts.

„Time table“ of the SC :

- Constitution of the new SC after elections in one of the business sessions of the International Jury
- New SC elects its chairman and decides about the experts
- December meeting at the site of the upcoming ICHO
- Whole time: intense communication via email between the SC-members
- Meeting at the next ICHO

Comment from The Netherlands: If somebody is not elected and appears afterwards as an expert, why should there be an election at all.
Reply from András Kotschy (Hun): Electing should be for not against somebody. The SC elects and nominates the experts, not the International Jury.

2. Rearranged syllabus:

Gabor Magyarfalvi will present and discuss the rearranged syllabus in the third jury meeting. The draft version was sent out with the prep-problems.

3. Honesty issues - Moscow/Budapest:

- Severe indication of cheating in the theoretical competition in Moscow by one country ⇒
- The mentors of the particular country were offered 0 points in the theoretical part, they accepted.
- There is no regulation for consequences in the case of breaking rules for future Olympiads, so the country in question was invited to Hungary.
- The SC decided in December to ask the country urgently not to send any of the persons involved in 2007 (mentors, observers, students).
- Another consequence: “Awareness of regulations….”, which every student had to sign.
- Manfred Kerschbaumer reminds all delegations to § 11, section 7 of the regulations, and makes clear that the organizer of the 40th ICHO and the SC will apply respective consequences to cheating countries and the persons involved.

4. Agenda for the Business Session (3rd Jury session) of the IChO (draft):

- Election of new SC-members: two from Europe, one from the Americas (proposals!)
- Schedule for arbitration
- Detailed information and voting on the acceptance of the restructured syllabus
- Proposal and voting about changing the participation fee
- Action to include a point in the regulations about safety

5. Agenda for the 4th jury meeting (draft):

- Report on the IUPAC support
- Allocation of the medals
- Presentations by future hosts
- Introduction of the new SC
- Miscellaneous: statements and suggestions

Dr. Manfred Kerschbaumer
Chair of the Steering Committee of the IChO

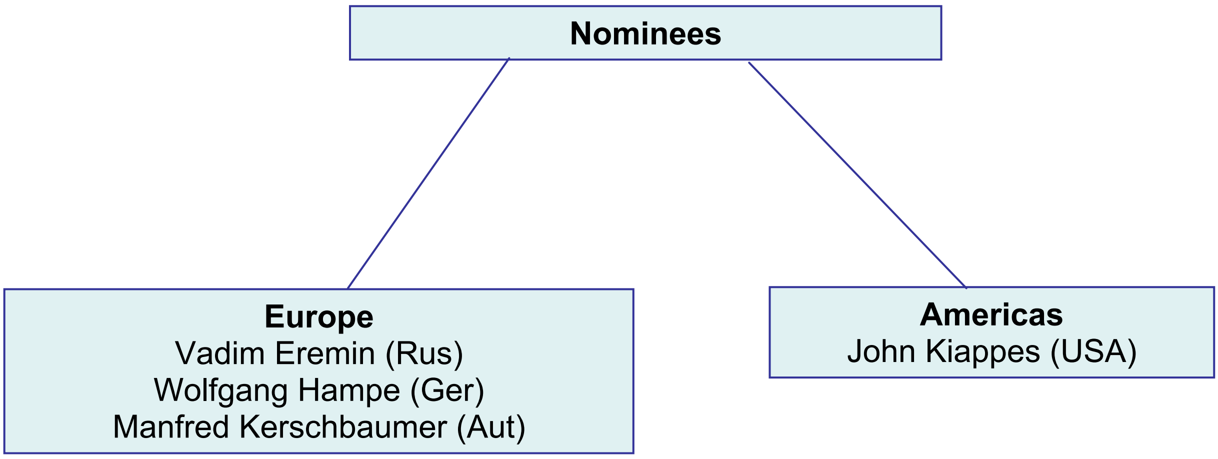
Steering Committee of the IChO

MINUTES
3rd JURY SESSION at the 40th ICHO/BUDAPEST

1. Information by Anton Sirota

Anton Sirota (Slk) informs the International Jury that he has compiled the tasks from the first 20 IChOs. Every mentor will receive a CD with the tasks and the solutions. He asks the members of the IJ to indicate the source if they want to use the content of the CD.

2. Election of new SC-members:



Carlos Castro-Acuna and Sasha Gladilin collect the voting slips which were distributed together with the red and green voting cards. On these slips every country could write two names of nominees from Europe. After counting all the votes they announce the result:
Vadim Eremin: 43 votes
Wolfgang Hampe: 47 votes
Manfred Kerschbaumer: 27 votes
Vadim and Wolfgang are the elected members from Europe for 2009 and 2010.

3. Schedule for arbitaton:

Gabor Magyarfalvi informs the International Jury about the schedule for arbitration. The countries were divided into 6 groups by random, every country has 5 minutes per task.

4. Rearranged syllabus

Gabor Magyarfalvi presents and explains the rearranged syllabus. If the syllabus is accepted there must be several changes in § 10 of the regulations. The new text of these sections in § 10 are presented on a slide.

Comment by Croatia: Others than SI-units should be allowed.

Voting about the changes in the regulations, and thus accepting the syllabus (a qualified majority is necessary):
52 votes in favour of changes
2 votes against the changes
The new syllabus and the changes are accepted.

5. Changing the participation fee:
As it is now: 100 US$ per year since entering the Olympiad or having been the host, upper limit of 2000 US$
Proposal: 200 US$ per year since entering the Olympiad or having been the host, upper limit of 2000 US$
Reason: No change in 10 years, different changes were discussed (change to €, higher upper limit)…
Long contribution and presentation from Uruguay with the aim to cancel the participation fee at all. One the major arguments: The sum of the participation fees in Moscow were a minor part of the total budget.
András (Hun): Another situation in Hungary, the participation fees amount to 8% of the total budget.
Manfred: The new fee starts with 2009!
Vadim: Participation fees in Moscow were also used as reserve in the budget.
Voting about the new proposal:
24 votes in favour of changes
30 votes against the changes
The new participation fee is rejected.
Uruguay proposes to cancel the participation fee entirely.
Peter Wothers (UK): Impossible to do that, because the money is already part of the calculated budget for 2009.
András: Consequence could be to reduce the invitation to one mentor.
Manfred: Charge for scientific observers and guests may be increased.
Head mentor from Israel asks the head mentor from Uruguay to withdraw the proposal.
Wesley Brown (Irl): There should not be a discussion about rich and poor countries, as he himself has to pay some expenses from his own pocket.
A lot of other remarks rejecting the idea about cancelling the participation fees are brought forward.
Finally the head mentor from Uruguay retrieves his proposal.
The SC will have this point on its agenda list for December 2009.

5. Information about safety:

Concerns § 12 of the regulations.

Possibility that the laws (regulations) of the host country are more strict concerning safety.

Proposal:

If this is the case, they are valid, if they are less strict, the ICHO-regulations are valid:

The more strict regulations apply!

Dr. Manfred Kerschbaumer
Chair of the Steering Committee of the IChO

Steering Committee of the IChO

MINUTES
4th JURY SESSION at the 40th ICHO/BUDAPEST

1. Report from the arbitration

Gabor Magyarfalvi reports from the arbitration which went on very smoothly. There were no long discussions with one exception. The time schedule was followed exactly.

2. Report on the IUPAC-support:

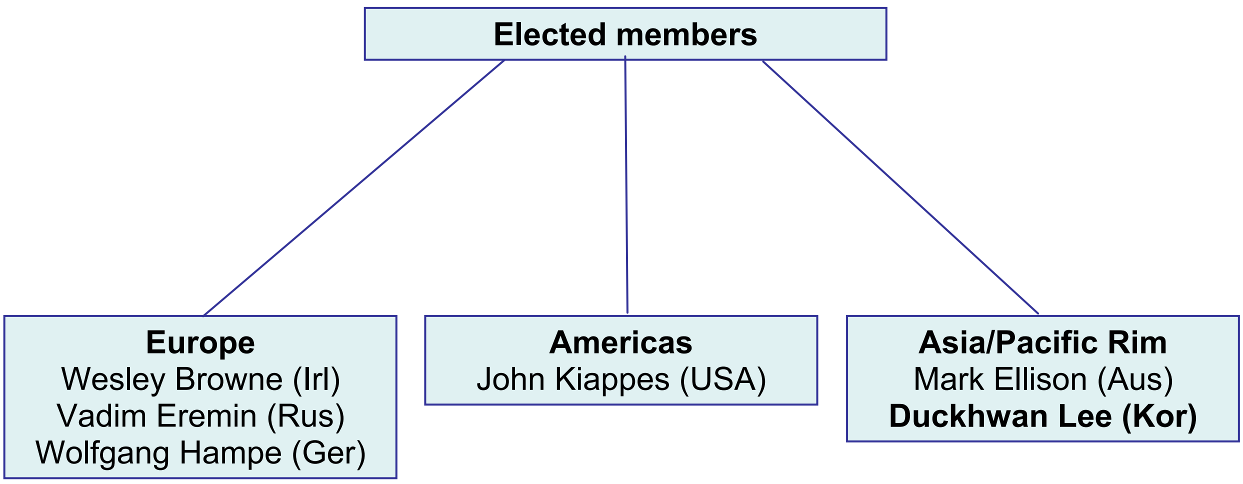
Money to be distributed: US$ 10.000
Applications: US$ 22.974

Country	Amount	Purpose
Cuba	2800	P.F. and T.E.
Kyrgyzstan	1740	P.F. and T.E.
Peru	500	P.F.
Tajikistan	1150	T.E.
Uruguay	2900	P.F. and T.E.
Venezuela	900	P.F.

P.F. = participation fee; T.E. = travel expenses

3. Presentation of the new SC:

Duckwhan Lee, the forthcoming chairman of the SC presents the newly constituted SC.



Non-elected members

Representatives of the organizers
Gabor Magyarfalvi (Hun)
Peter Wothers (UK)
Tadashi Watanabe (Jpn)
Jale Hacaloglu (Tur)

Coopted members
Juan-Antonio R. Renuncio (Spa)
Manfred Kerschbaumer (Aut)
Anton Sirota (Slo)

4. Cheating at the 40th IChO

András Kotschy reports about a case of cheating from Tajikistan. There is undisputed proof that in the hard copy version for the students (translation in Tajik) some additional information was included, whereas the electronic version (in Russian) did not contain any alterations.

András shows two examples to the International Jury concerning task No. 5 and Task No. 7.

He informs the International Jury about the decision of the organizer that the whole team of Tajikistan received 0 points on the whole competition. The International Jury now has to decide whether the country and/or the persons are banned for some time from the IChO.

Israel: proposal to ban Tajikistan as a country for 5 years, the persons involved (mentors, students) must never come again.

Ukraine: proposal to ban Tajikistan forever

Australia: This would be a very hard decision and it will prevent future clever students who are totally innocent to participate. Proposal: banning for one year, persons are expelled forever.

Support by Slovakia and other countries.

Israel draws back the original proposal and affiliates the Australian proposal.

Voting about the proposal: 52 votes in favour of the proposal

The country Tajikistan will not participate in 41st IChO in the United Kingdom.
The two mentors and the four students of the 2008 delegation of Tajikistan are expelled from the IChO forever.

5. Allocation of the medals

Gabor Magyarfalvi presents a graphic with a curve marks versus number of participant without showing the numbers at the y-axis.

According to major gaps the following numbers of medals are proposed:

Gold: 30; Silver: 52; Bronze: 79; Honourable mentions: 10

The proposal is accepted unanimously.

6. Presentation by future hosts

2009: Peter Wothers (UK) tells about the major issues of the 41st IChO in Cambridge and Oxford. The Catalyzer No. 1 will be distributed at the end of the Closing Ceremony of the 40th IChO.

2010: Tadashi Watanabe (JPN) shows a detailed presentation about the state of organization of the 42nd IChO.

The following IChOs will be held in (partly inofficial):

2011: Turkey; 2012: USA;

2013: Singapore; 2014: Vietnam; 2015: Thailand;

Closing the Business Session, the chairman of the SC, Manfred Kerschbaumer, expresses the appreciation of the whole community of the IChO for the perfect organization of the event in Budapest, and addresses his thanks especially to András Kotschy, the chairman of the organizing committee, and to Gabor Magyarfalvi, the chairman of the scientific board.

Dr. Manfred Kerschbaumer
Chair of the Steering Committee of the IChO

Steering Committee of the IChO

MINUTES
of the SC-meeting from July 20th, 2008

András Kotschy as chairman of the Organizing Committee of ICHO40 asks for a short meeting of the SC to discuss an issue concerning the Tajikistan-case.
He asks the SC about their opinion to send an official letter to the authorities of Tajikistan about the cheating affair. The organizer will write a letter anyway, the question is, whether the SC joins in signing this letter.
Short discussion in which Vadim Eremin (Rus) points out that Tajikistan is not really a democratic country, and that therefore the personel consequences for the individuals involved may really be serious.
Secret voting about the case, 8 persons entitled to vote.
Result: 4:4
The chairman decides, that the SC will not write or be part of the letter in question.

Dr. Manfred Kerschbaumer
Chair of the Steering Committee of the IChO

STEERING COMMITTEE OF THE ICHO
constituted on July 19, 2008

Elected members:

Representatives of Europe:
Vadim Eremin (Russia); e-mail: vadim@educ.chem.msu.ru
Wolfgang Hampe (Germany); e-mail: hampe@t-online.de
Wesley Browne(Ireland); e-mail: w.r.browne@rug.nl

Representative of the Americas
John Kiappes (USA); e-mail: jlkiappes@gmail.com

Representatives of Asia and the Pacific Rim:
Mark Ellison (Australia); e-mail: u3903111@anu.edu.au
Duckhwan Lee (Korea); e-mail: duckhwan@sogang.ac.kr

Non-elected members:

Representatives of the organizers:
Gabor Magyarfalvi (Hungary); e-mail: gmagyarf@chem.elte.hu
Peter Wothers (United Kingdom); e-mail: pdw12@cam.ac.uk
Tadashi Watanabe (Japan); e-mail: watanabe@iis.u-tokyo.ac.jp
Jale Hacaloglu (Turkey); e-mail: jale@metu.edu.tr

Coopted members:
Manfred Kerschbaumer (Austria); e-mail: mkersch@gmx.net
Juan-Antonio Renuncio (Spain); e-mail: renuncio@quim.ucm.es
Anton Sirota (Slovakia); e-mail: anton.sirota@stuba.sk

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Budget of the 40th IChO

EUR amounts are only approximate due to currency fluctuations.

			HUF	in EUR
		Total budget of the 40th IChO	**212 600 000**	**€ 850 400**
1.		Government sources	163 400 000	€ 653 600
2.		Sponsors	20 000 000	€ 80 000
3.		Participation fees	29 200 000	€ 116 800
		Expenditures of the 40th IChO	**212 600 000**	**€ 850 400**
1.		**Examination preparation**	**17 000 000**	**€ 68 000**
	1.1	Equipment	15 000 000	€ 60 000
	1.2	Reagents	2 000 000	€ 8 000
2.		**Accommodation and food**	**82 000 000**	**€ 328 000**
	2.1	Students	27 000 000	€ 108 000
	2.2	Mentors	55 000 000	€ 220 000
3.		**Transportation**	**11 200 000**	**€ 44 800**
	3.1	Students	7 000 000	€ 28 000
	3.2	Mentors	4 200 000	€ 16 800
4.		**Opening and closing ceremonies, banquet**	**23 400 000**	**€ 93 600**
5.		**Cultural program**	**12 000 000**	**€ 48 000**
	5.1	Students	8 500 000	€ 34 000
	5.2	Mentors	3 500 000	€ 14 000
6.		**Secretariat**	**19 000 000**	**€ 76 000**
	6.1	Staff costs	13 000 000	€ 52 000
	6.2	Equipment and services	6 000 000	€ 24 000
7.		**Guides**	**13 300 000**	**€ 53 200**
8.		**Public relations**	**5 600 000**	**€ 22 400**
	8.1	Catalyzers	1 500 000	€ 6 000
	8.2	Souvenirs	3 600 000	€ 14 400
	8.3	Presentation, mass media	500 000	€ 2 000
9.		**40th IChO IT support**	**2 500 000**	**€ 10 000**
10.		**Final report**	**300 000**	**€ 1 200**
11.		**Operational expenses**	**26 300 000**	**€ 105 200**
	11.1	Personnel	19 000 000	€ 76 000
	11.2	Consumables	7 300 000	€ 29 200

Country Participation Fees

Country	Years	Fee in USD	in EUR
Argentina	14	$1 400	€ 1 050
Armenia	3	$300	€ 225
Australia	10	$1 000	€ 750
Austria	28	$2 000	€ 1 500
Azerbaijan	9	$900	€ 675
Belarus	13	$1 300	€ 975
Belgium	25	$2 000	€ 1 500
Brazil	10	$1 000	€ 750
Bulgaria	27	$2 000	€ 1 500
Canada	11	$1 100	€ 825
China	13	$1 300	€ 975
Chinese Taipei	3	$300	€ 225
Croatia	9	$900	€ 675
Cuba	16	$1 600	€ 1 200
Cyprus	19	$1 900	€ 1 425
Czech Republic	16	$1 600	€ 1 200
Denmark	8	$800	€ 600
Egypt	7	$700	€ 525
Estonia	15	$1 500	€ 1 125
Finland	20	$2 000	€ 1 500
France	18	$1 800	€ 1 350
Germany	4	$400	€ 300
Greece	5	$500	€ 375
Hungary	21	$0	€ 0
Iceland	7	$700	€ 525
India	7	$700	€ 525
Indonesia	9	$900	€ 675
Iran	16	$1 600	€ 1 200
Ireland	11	$1 100	€ 825
Israel	3	$300	€ 225
Italy	15	$1 500	€ 1 125
Japan	6	$600	€ 450
Kazakhstan	11	$1 100	€ 825
Korea	17	$200	€ 150
Kuwait	16	$1 600	€ 1 200
Kyrgyzstan	9	$900	€ 675
Latvia	18	$1 800	€ 1 350
Lithuania	18	$1 800	€ 1 350
Malaysia	3	$300	€ 225
Mexico	17	$1 700	€ 1 275

Country	Years	Fee in USD	in EUR
Moldova	3	$200	€ 150
Mongolia	3	$300	€ 225
Netherlands	6	$600	€ 450
New Zealand	17	$1 700	€ 1 275
Norway	14	$1 400	€ 1 050
Pakistan	3	$300	€ 225
Peru	5	$500	€ 375
Poland	17	$1 700	€ 1 275
Portugal	6	$600	€ 450
Romania	25	$2 000	€ 1 500
Russia	12	$100	€ 75
Saudi Arabia	3	$300	€ 225
Singapore	19	$1 900	€ 1 425
Slovakia	16	$1 600	€ 1 200
Slovenia	18	$1 800	€ 1 350
Spain	13	$1 300	€ 975
Sweden	26	$2 000	€ 1 500
Switzerland	22	$2 000	€ 1 500
Tajikistan	5	$500	€ 375
Thailand	9	$900	€ 675
Turkey	15	$1 500	€ 1 125
Turkmenistan	7	$700	€ 525
U.S.A.	16	$1 600	€ 1 200
Ukraine	15	$1 500	€ 1 125
United Kingdom	26	$2 000	€ 1 500
Uruguay	10	$1 000	€ 750
Venezuela	16	$1 600	€ 1 200
Vietnam	13	$1 300	€ 975
TOTAL		**US$78 000,00**	**€ 58 500,00**

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A Selection from Student Surveys

When and how did you get interested in Chemistry? Was there a spark in the beginning?

- Ireland: I have always been interested in chemistry. I want to become a medicinal chemist.
- Israel: Long, long time ago when I saw fireworks on Independence Day.
- Thailand: I am not really interested in it. I prefer arts.

How did you prepare for the Olympiad?

- Ireland: By listening to Wesley (Browne)
- Hungary: Swimming, sauna, volleyball, table tennis, climbing and obviously a special diet.

What do you expect from the competition?

- Croatia: A lot of new friends.
- Switzerland: Fun, fun and fun!
- Estonia: Nothing.
- Brazil: Personal and academic improvement.

How do you like Hungary?

- Thailand: I like everything here.
- Kuwait: The weather is just great. It rains in a good way.
- Turkmenistan: There are too many trees. We don't like the food.
- New Zealand: It striked us, how dangerous the country was despite it's small size: the streets are full of mad men drivers.

What was the first thing here that caught your attention?

- Ireland: The heat.
- Lithuania: A whole bunch of "green" people. (i.e. the guides)
- Croatia: Other (female) competitors.

What do you know about Hungarian food, would you like to taste/have you ever tasted it?

- Italy: It is worse than Italian food.
- Slovenia: Hungarian food is very spicy, unhealthy and more like old-fashioned than sophisticated. I have tasted it while being here.

What was the strangest thing that you have experienced?

- Italy: During the re-union party, in a few second a terrible storm arrived. In Italy it never happens.
- Romania: That we had to wake up very early in the morning.
- Slovakia: Travelling by underground.
- Germany: The third exercise of the practical exam (qualitative analysis)

Which program did you like the most?

- Lithuania: I enjoyed most of having lunch at Eötvös University.
- Romania: The team-building games.
- Moldova: What I liked the most was the re-unoin party on Europa River Boat, it was awesome!

What will be waiting for you in your home country? Media, scholarships, etc.?

- Ireland: Probably the head of the Olympiad team with a disgusted expression on his face.
- Slovakia: My mother with good lunch.
- Israel: If we get medals, we will get prestigious scholarships.
- Thailand: Some pocket money.