



Bridging between computer-aided assessment and traditional pen-and-paper exams

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Friday the 13th of March: university life changes completely

<https://www.youtube.com/watch?v=TYVDI3WJtLg>

Examination before corona crisis

Small groups



Large groups



Corona crisis policy at UvA and the Faculty of Science

Other stakeholders than lecturers step in and make decisions (with the best intentions)

- UvA wide and faculty wide crisis team
 - Chief Information Security Officer
 - Privacy Officer
- Programme directors
- Examination boards

Corona exams in April

- Online proctoring is prohibited by the faculty management
(until further notice; Central Student Council is against it, students lost their case at the Amsterdam Court)
- Online invigilation is best avoided or it has to be done in Zoom



Suggestions for examination from *Keep on Teaching* site 1/2

Things to consider

■ Fraud – make it unappealing

Unproctored online (remote) exams are by definition *open book*.

An unproctored online exam should require higher order knowledge skills and preferably be strictly timed, making collaboration and plagiarism unappealing.

■ Technical failure – keep it simple

As the technical sophistication of the online exam increases, so does the risk of failure.

Extra stress for teaching staff, support staff, and students.

■ Stress of students – what can you do?

They get an examination method they were not expecting and preparing for: use a mock exam to let them practise.

They worry about time pressure, connection problems and disturbances at home during an online exam, ...

Keep on Teaching site: <https://canvas.uva.nl/courses/16651>

Suggestions for examination from *Keep on Teaching* site 2/2

Alternatives to on-campus exams

- Timed take-home exams
essay questions or hard (mathematical) problem sets without one unambiguous answer.
- Written exam: an elaborate writing assignment with a submission deadline.
- Online oral exam: focussing on higher-order knowledge skills, with restricted time.
- Use of fully parameterised open questions in an online assessment
- Manually parameterised closed questions or short-answer questions in an online test, with questions drawn from an item bank

“Please note that these options are not necessarily available or supported at your faculty.”

Keep on Teaching site: <https://canvas.uva.nl/courses/16651>

But what about mathematics exams? Math is done on paper!

In the *bachelor of mathematics* ‘business as usual’ with remote invigilation via Zoom without recording

- Pen-and-paper exams (student scan and upload their work)
- Take-home exams and oral exams occasionally in year 3

In *mathematics service education* the online environment SOWISO is used already for years (see EAMS 2016).

Example

Calculate the following integral via the substitution rule:

$$\int_4^9 \frac{1}{x + \sqrt{x}} dx$$

Answer:
We apply the substitution rule for integration with $u = \sqrt{x}$.
By differentiating u we find $du = \frac{1}{2\sqrt{x}} dx$, that is, $dx = 2u du$.
The integration bounds change to $\sqrt{4} = 2$ and $\sqrt{9} = 3$.
So

$$\int_4^9 \frac{1}{x + \sqrt{x}} dx = \int_2^3 \frac{2u}{u^2 + u} du$$

substitution rule with $u = \sqrt{x}$ and $du = \frac{1}{2\sqrt{x}} dx$, that is, $dx = 2u du$

$$= \int_2^3 \frac{2}{u + 1} du$$

simplification

$$= \left[2 \ln(u + 1) \right]_2^3$$

primitive of the integrand

$$= 2 \cdot \ln(4) - 2 \cdot \ln(3)$$

substitution of integration bounds

$$= \ln\left(\frac{16}{9}\right)$$

simplification

new example

What about mathematics exams?

In *mathematics service education* using the online environment SOWISO almost 'as usual', but

- more randomisation of questions (from 2 to 25-100 versions)
- change of style of questioning (to get around softwares like WolframAlpha)
- students scan and upload paperwork in SOWISO
- Zoom chat as communication channel between students and teacher
- Zoom for remote invigilation (no recording)

Example: Basis Mathematics in Psychobiology

- Online teaching, learning, and examination (3hrs) since 2015 in SOWISO (see EAMS 2016)
- Online exam: 2hrs, less questions, 200 students
Less time to reduce risk of technical problems & staff workload
- Students solve problems with pen and paper, enter final answers in SOWISO, upload paperwork within 15 minutes after submission of online work
- Paperwork is mainly used for marking when the final answer is wrong; then a question is marked by a staff member for partial credit

Why paperwork?

- Why still paperwork, scanning and uploading?

Can't students just enter intermediate results for getting partial credit?

- No, it is too procedural. It splits the task into small steps;

a student only fills in the missing intermediate results, but does not select a route to solve the problem and does not use own wording.

- We prefer to inspect the paperwork for marking,

but with large numbers of students, submission of intermediate results might be handy.

Calculate the following integral via the substitution rule:

$$\int_4^9 \frac{1}{x + \sqrt{x}} dx$$

The substitution used: $u = \sqrt{x}$

The relation between the differential dx and du becomes: $dx = 2u du$

The integration bounds change to: lower bound = 2 and upper bound = 3

So the original integral is replaced by the following definite integral in u : $\int_2^3 \frac{2}{u^2} du$

A primitive of the integrand in u is: $-\frac{2}{u}$

Substitution of integration bounds gives (after simplification): $-\frac{2}{3} - (-\frac{2}{2}) = \frac{2}{3}$

Logistics of automated marking and pen-based marking

- Easy in one environment, with two browser windows next to each other
- Marking scheme visible to students in worked out solutions

The screenshot displays the SOWISO interface. On the left, a navigation pane shows a list of questions (1-10) with colored status indicators. The main content area shows a question titled "18-05-2020 Digitale Toets Basiswiskunde in de Psychobiologie (5102BAIP3Y)". The question asks for the exact value of $\cos(\alpha)$ given $0 < \alpha < \pi$ and $\tan(\alpha) = \frac{5}{12}$. The student's answer is $\cos(\alpha) = \frac{5}{13}$, which is marked as incorrect ("Fout"). The solution section shows the correct answer $\cos(\alpha) = \frac{12}{13}$ and the derivation using the identity $\cos^2(\alpha) + \sin^2(\alpha) = 1$.

On the right, a PDF viewer shows a handwritten solution for the same problem. The student has drawn a right-angled triangle with a vertical side of 5, a horizontal side of 12, and a hypotenuse of 13. They have calculated $\cos(\alpha) = \frac{12}{13}$. Below this, they solve a linear function problem (8) and a quadratic function problem (9).

Change of style of questioning (some examples)

Before: computation

What is the standard form of $\frac{-12 - 14i}{1 + 4i}$?

$$\frac{-12 - 14i}{1 + 4i} = \underline{\hspace{2cm}}$$

Solve the quadratic equation in \mathbb{C} and write the solutions in standard form :

$$z^2 + 34 = -6z$$

Separate solutions through the logical "or" operator \vee , in other words, enter an answer of the form $z = \alpha \vee z = \beta$.

After: find a method or example

Find the exact values of a and b such that

$$\frac{-12 - 14i}{a + bi} = 1 + 4i$$

$$a = \underline{\hspace{2cm}}$$

$$b = \underline{\hspace{2cm}}$$

Find a quadratic polynomial $P(z)$ with integer coefficients that has the following complex zeros:

$$-3 + 5i \quad \text{and} \quad -3 - 5i$$

$$P(z) = \underline{\hspace{1cm}} \cdot z^2 + \underline{\hspace{1cm}} \cdot z + \underline{\hspace{1cm}}$$

Many more randomisations of questions

Before: 2 versions	After: 87 versions
<p>Calculate the following integral via integration by parts:</p> $\int x \sin(2x) dx$	<p>Calculate the following integral via integration by parts:</p> $\int \frac{2t - 3}{2\sqrt{t+5}} dt$
<p>Calculate the following integral via integration by parts:</p> $\int x \sin(3x) dx$	$\int \sqrt{t} \ln(t) dt$
	$\int t e^t dt$

Worry about equivalence of the level of difficulty?
Test results are very similar in years

Study year	2018-2019	2019-2020
p-value question	0.43	0.63
Test mean mark	6.47	6.25
Standard deviation	1.70	1.47
Pass percentage	72%	76%

Essay question type and Note in SOWISO

Essay question

Question 6 (exercise id: 14493) Test Example SOWISO Test (1 point)

Assuming the radiative transition ($v' \rightarrow v''$) is s^{-1} with rate 1 ns , and the vibrational nonradiative relaxation rate among the excited state v' is 0.1 ps^{-1} . What will be the lifetime of the fluorescence decay from the Franck-Condon region to the ground state (indicate as red line)?

Rich text editor: **B** *I* U f(x) Formats -

Navigation: < Previous Next > Note Overview

Hotspot text question and Note to add argumentation

Rich text editor: Note **B** *I* U f(x) Formats -

Navigation: < Previous Next > Note Overview

Essay question type (or Note)

Key boards to create formulae

Assuming the radiative transition ($v' \rightarrow v''$) is s^{-1} with rate 1 ns , and the vibrational nonradiative relaxation rate among the excited state v' is 0.1 ps^{-1} . What will be the lifetime of the fluorescence decay from the Franck-Condon region to the ground state (indicate as red line)?

standard function logic vector abc unit

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Answer as drawing, formula and text

Assuming the radiative transition ($v' \rightarrow v''$) is s^{-1} with rate 1 ns , and the vibrational nonradiative relaxation rate among the excited state v' is 0.1 ps^{-1} . What will be the lifetime of the fluorescence decay from the Franck-Condon region to the ground state (indicate as red line)?

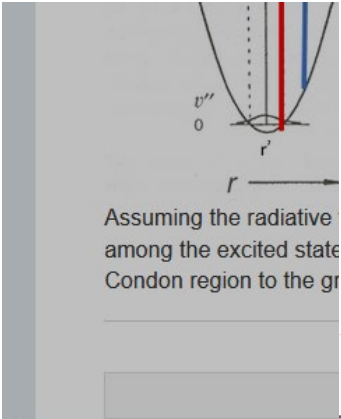
$\Delta E = \gamma \frac{hB_0}{2\pi}$ This is an example

< Previous Next >

Note Overview

Essay question

Key boards to



Add illustration
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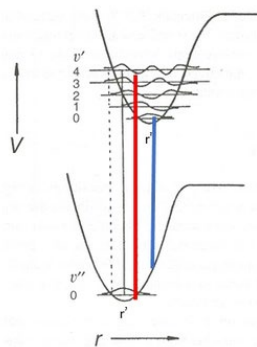
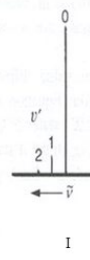
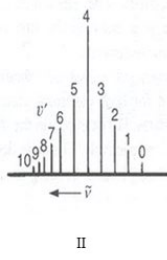
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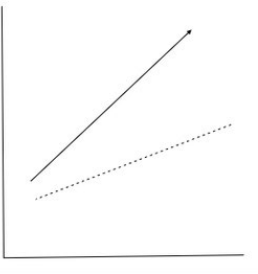
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answer as drawing, formula and text

Assuming the radiative transition $(v' \rightarrow v'')$ is 10^{-1} ns $^{-1}$ and the vibrational nonradiative relaxation rate among the excited state v' is 0.1 ps $^{-1}$. What will be the lifetime of the fluorescence decay from the Franck-Condon region to the ground state (indicate as red line)?

← →
B *I* U
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f(x)
✎
Formats -



$$\Delta E = \gamma \frac{hB_0}{2\pi}$$

This is an example

← Previous
Next →

✎ Note
🏠 Overview

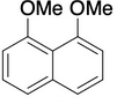
Example: Exam questions in chemistry

Deeltoets 2 Molecular Spectroscopy (5112MOSS6Y) 28-05-2020

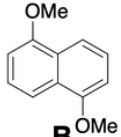
Question 10 Exercise ID: 15199

Exercise

Indicate if/how compounds A and B can be distinguished in a straightforward way using UV absorption, IR absorption, and ^{13}C NMR (normal 1D only). If none of the three gives a simple solution, suggest another spectroscopic experiment.



A



B

Answer

UV: ✘

IR: ✔

^{13}C : ✔

Give explanation in Note Field

Note

C-NMR:
both compounds contain different kind of symmetries, which will result in different kind of chemical shift values.
IR:
Both contain the same groups in para formation.
UV:
The compounds contain a different conjugation in the molecule, which will result in a different UV spectrum

Solution

IR: no; there are no characteristic bands; hydrogen-out-of-plane pattern is similar (3 H's next to each other)
UV: no; both will have red-shifted naphthalene spectrum, but it is not straightforward that there would be a difference
 ^{13}C : yes; A has 6 unique aromatic C's, B only 5; or A has 7 unique C's, B has 6, if the MeO is included

Adjusted score: 50 out of 100 Automated score: 67 out of 100 Points: 10

Save Comment

Note where argumentation can be given

Note

C-NMR:
both compounds contain different kind of symmetries, which will result in different kind of chemical shift values.
IR:
Both contain the same groups in para formation.
UV:
The compounds contain a different conjugation in the molecule, which will result in a different UV spectrum

Adjusted score 50 out of 100

Automated score 67 out of 100

Points 10

Save

Comment

Example: Exam questions in chemistry

Question 9 Exercise id: 15240

Exercise

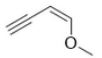
unknown compound; sub-question D

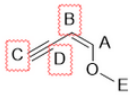
A set of spectra of an unknown compound with molecular formula C_5H_6O is given in sub-question A.

D. Derive the structure. Paste a screenshot of a ChemDraw structure into the answer field.

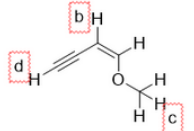
Explain your line of reasoning, and argue why the structure is in agreement with the spectral data. When referring to the NMR peaks, please use the labels in the figure.

Answer

 First, we know we have an ether, an alkyne and alkene from the IR and UV. Also, we knew we had a polyene. With the ^{13}C -NMR we knew that we have a methyl group on one end of the ether and an alkene on the other hand. The assignments of the ^{13}C -NMR are shown in the figure below.



The 1H NMR only confirmed our expectation and it showed that the alkene bond was cis orientated and not trans orientated. The assignments are shown below.



Note

Pasted structures in answer in the essay type question

1-10 Vraag 12 Opgave id: 14410

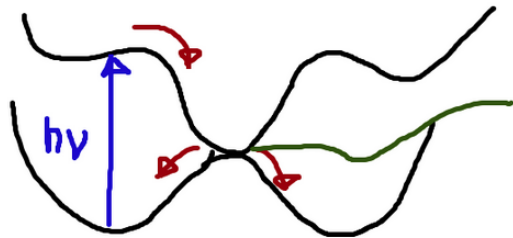
11-19 Opgave

De efficiëntie van een fotoisomerisatiereactie is vaak ongeveer 50%. Leg dit uit aan de hand van een energiediagram. Maak een simpele schets (5 p)

Antwoord

de helft komt niet over de barrière heen en 'valt' terug

Notitie



Oplossing

Aangepaste score 100 uit 100 Automatische score 0 uit 100 Punten 5

Oplossen Onmerking

Drawing in Note

Conclusion remarks

- In STEM assessments the possibility of hand writing is necessary
- SOWISO essay type question: typing text, creating formulae and drawing / hand writing in one answer field opens new possibilities
- Note for underpinning remarks at closed questions supports assessment of learning goals
- Parametrisation and randomisation gave impuls for using formative AND summative assessment in STEM courses
- Learning curve to get used to e-assessment for lecturers and students needs to be taken into account



Questions



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