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Friday@2 Preparing for Prelims exams

Richard Earl – Director of Undergraduate Studies
Vicky Neale – Whitehead Lecturer
Beth Thomas – Second-year student

24 May 2019

Oxford Mathematics

Plan of today's session

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- How the exams work
- Revision
- A student's perspective
- Wellbeing
- Exam technique

A copy of these slides will be emailed to all Prelims students.

Caution!

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- Don’t read more into today’s remarks than is intended.
- We are **not** hinting at what may or may not be on the papers.
- Your tutors know you and can give you personalised advice – listen to them!

How the exams work

Exam timetable

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Check when your exams are!

- Prelims Maths: Week 9

Notice to Candidates

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You have been sent the Notice to Candidates. It might look boring…

…but it contains crucial information.

Please read the Notice to Candidates!

Exam paper structure

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Check the details carefully for each paper as they are not all the same length, nor have the same structure.

- How long is the exam?
- How many questions should you do?
- How many questions to choose from?
- The structure changed in 2016.

Can find details in Notice to Candidates

Exam rules

- Formulae books, dictionaries and calculators are not allowed
- You are not allowed to write in pencil
- Mobile phones cannot be taken into the exam and should be handed to an invigilator

Question structure

- Each question is marked out of 20, and divided into several parts.
- The marks available for each part are given on the question paper.
- The first few marks on a question are probably easier to get than the last few.

University Standardised Marks (USMs)

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- Your script is given raw marks.
- The raw mark on each paper is converted into a USM.
- This process is done to make papers comparable (they might have been of different difficulties).
- Full details of scaling are in Examiners' Reports (on the department website).

Allocation of class

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- Possible outcomes:

  Distinction, Pass, Partial Pass, Fail

- USM on each paper corresponds to
  - First class: 70 to 100
  - Upper second class: 60 to 69
  - Lower second class: 50 to 59
  - Third class: 40 to 49
  - Fail: 0 to 39

Allocation of class

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- To pass, you must pass every paper.
- There are Prelims resits in September.
- Av_1: marks for Computational Maths projects are scaled to count as 1/3 of a paper and then averaged with the weighted USMs on the 5 written papers
- Av_2: the weighted average on the 5 written papers
- See Notice to Candidates for full details

Allocation of class

- Distinction: Av_1 ≥ 70 and Av_2 ≥ 70
- Pass: At least 40 on each paper
- Partial pass: Less than 40 on one or two papers
- Fail: Less than 40 on more than two papers

So you must revise evenly across the papers!

(These all relate to USMs, not raw marks)

Percentages in Prelims results

	2018	2017	2016	2015	2014
Distinction	29.44	30.85	30.89	30.73	30.9
Pass	63.96	61.69	62.3	58.55	57.87
Partial Pass	5.08	6.47	3.66	7.26	6.74
Fail	1.52	0.99	3.14	3.35	4.49

Revision

How do you revise?

- Now you know how the exams work, you can plan your revision.
- You are already experts at taking exams.
- What strategies have you found effective in the past? What strategies have you heard friends find effective?

Some revision strategies

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- Write summary notes
- Use flashcards (on paper or electronic)
- Create mind maps/concept maps
- Put post-it notes in strategic places
- Walk round recalling arguments
- Test yourself and get friends to test you
- Mix up topics, don’t always go in the same order

How to revise

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"Memory is the residue of thought" (Willingham)

You need to find ways to actively think about the material.

Understanding helps…

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- Examiners are looking for understanding.
- Examiners are not trying to catch you out.
- Understanding the material helps you to learn it, and to adapt it to unfamiliar exam questions.
- Understanding the material also helps you with future courses. You need a firm basis for next year

…but practise questions too

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- Get used to the style (and length) of the papers
- Find a balance between working on notes and trying past questions
- Later on, try timed questions/papers
- Practise choosing questions too
- There are lots of past questions online (Prelims, Prelims Resits)

Differences from school/college

- You might need to learn more material.
- The style of questions might be different.
- You need stamina and confidence to keep going without many clues.
- You need to know and understand definitions and theorems, know how to use them and how to prove the results.

Useful resources

- The syllabus for Prelims appears online at

  https://courses.maths.ox.ac.uk/node/37616

and individual course synopses appear on the course website. The syllabus tells you what you are supposed to know for the exam.

- It's a helpful guide for revision
- Examiners' reports are online.
- There are some videos talking through solutions to past Prelims questions.

Bookwork tips

- Learning by rote is generally inefficient
- You need to know definitions accurately
- What are the key points in a proof or method? Practise filling in the details
- Diagrams are great
- Proofs of theorems can give you ideas for solving problems

A student's perspective

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Beth Thomas

Second year Maths student at Balliol College

Wellbeing

Look after yourself

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- Set a realistic schedule – don’t overdo it
- Find ways to separate work space and living space
- Have quality breaks in between quality revision
- Mix up courses, don’t only focus on ones you like/dislike
- Keep it in proportion and be realistic

Look after yourself

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- Don’t revise up to the last minute
- Relax before bed to improve sleep quality
- Remember to eat (healthily)
- Exercise helps
- Find what works for you

Exam technique

Quick tips

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- Get your subfusc and equipment ready the day before
- Have a snack or light meal before the exam, to feed your brain
- Take your university card and candidate number
- Arrive at least 20 minutes early (to the correct place)

Read the rubric

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- Answer no more than the expected number of questions
- Don’t write in pencil (except for diagrams)
- Plain paper booklets
- Begin each question in a new answer booklet
- Hand in your answers in question order

Read the rubric

- Write the numbers of all the questions to be marked on the front cover sheet.
- If you answer fewer than the expected number of questions you must submit an empty booklet for each unanswered question.
- Cross out all rough working and any working you do not want to be marked.

A sample M1 question & solution
2013 M1 #5

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5. (a) [12 marks] What is meant by the *cycle type* of a permutation in S_n?

Prove for a cycle $(a_1\, a_2\, \ldots a_k)$ in S_n and $\rho \in S_n$ that

$$\rho^{-1}\,(a_1\, a_2\, \ldots a_k)\,\rho = (a_1\rho\ \ a_2\rho\ \ \ldots\ \ a_k\rho)\,.$$

Deduce that two permutations in S_n are conjugate if and only if they have the same cycle type.

(b) [8 marks] Let G be a group and $g \in G$. Show that the *centralizer* $C_G(g)$ of g, given by

$$C_G(g) = \{h \in G : gh = hg\}\,,$$

is a subgroup of G.

Explain why there are 18 elements of S_6 which commute with $\sigma = (123)\,(456)$ and why the centralizer $C_{S_6}(\sigma)$ is not abelian.

2013 M1 #5

(a) The cycle type is the lengths of disjoint cycles in a permutation. Vague -1 1/3

Note that

$$(a_i\rho)\,\rho^{-1}(a_1 \dots a_k)\rho = (a_i)(a_1 \dots a_k)\rho$$
$$= (a_{i+1})\rho = a_{i+1}\rho.$$

So $\rho^{-1}(a_1 \dots a_k)\rho = (a_1\rho \dots a_i\rho\, a_{i+1}\rho \dots a_k\rho)$ 3/4

Other elements that are fixed -1

If $\sigma = c_1 \dots c_r$ where the c_i are cycles

then $\rho^{-1}\sigma\rho = \rho^{-1}c_1 \dots c_r\rho$ 2/2

$$= (\rho^{-1}c_1\rho)(\rho^{-1}c_2\rho) \dots (\rho^{-1}c_r\rho)$$

and $\rho^{-1}c_i\rho$ is a cycle of same length as c_i by earlier part.

Conversely if

$$\sigma = (a_1 \dots a_r)(b_1 \dots b_s)(c_1 \dots c_t)$$
$$\tau = (\alpha_1 \dots \alpha_r)(\beta_1 \dots \beta_s)(\gamma_1 \dots \gamma_t) \quad \text{(with } a_i\rho = \alpha_i,\ b_i\rho = \beta_i,\ c_i\rho = \gamma_i\text{)}$$ 2/3

then $\tau = \rho^{-1}\sigma\rho$, with ρ as above. More detail -1

8/12

(b) $e \in C_A(g)$ as $ge = g = eg$

$h \in C_A(g)$
$\Rightarrow gh = hg \Rightarrow h^{-1}gh = g \Rightarrow h^{-1}g = gh^{-1}$
$\Rightarrow h^{-1} \in C_A(g)$

and $h_1, h_2 \in C_A(g)$
$gh_1 = h_1 g \wedge gh_2 = h_2 g$
$\Rightarrow gh_1h_2 = h_1 g h_2 = h_1 h_2 g.$
$\Rightarrow h_1h_2 \in C_A(g)$
2/3

Explanation of argument? -1

Finally $\rho(123)(456) = (123)(456)\rho$

$\Leftrightarrow (123)(456) = \rho^{-1}(123)(456)\rho$

$= (1\rho\ 2\rho\ 3\rho)(4\rho\ 5\rho\ 6\rho).$

Could have $1\rho = 1$ or 2 or 3 and $4\rho = 4$ or 5 or 6
(9 choices) or $1\rho = 4$ or 5 or 6 and $4\rho = 1$ or 2 or 3
(9 more choices). 18 choices in all.
3/3

$\rho_1 = (123)$ and $\rho_2 = (14)(25)(36) \in C_{S_6}(\sigma)$

$\rho_1\rho_2 = (152634)$

$\rho_2\rho_1 = (142536).$

2/2

7/8

15/20

Quick tips

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- Take your time: read the questions carefully, choose wisely.
- Answer the question that's been set. Don't leave out bits by mistake.
- Write legibly. Cross out neatly: make it clear what's to be marked.
- Make your answer/conclusion clear.
- Show your reasoning, quote theorems and check hypotheses carefully

Quick tips

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- Questions generally begin with definitions and bookwork. Later parts might need thinking time or more than one attempt.
- It can be a good idea to leave a question (for your subconscious) and then return to it.
- So read all the questions carefully before starting…
- …and keep an eye on time management

Quick tips

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- Each question has a mark scheme.
- No marks for writing out bookwork that's not asked for in the question.
- Think whether you've written enough for the marks available.
- Explain what you're doing. Define your notation.
- Show your working, show your reasoning.

Quick tips

- If one line follows from another because of a theorem or hypothesis, say so clearly
- If a question says that you may assume a theorem provided you state it carefully, state it carefully
- Don’t fudge!
- If you don’t get the given answer, don’t introduce another mistake to try to get the given answer.

Quick tips

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- Check your work as you go along:
  - Is that mass you just calculated positive?
  - Does that function really solve that differential equation?
  - Are the units of your answer correct for it to be energy?
  - Does your answer vary reasonably with its parameters?

Quick tips

- If you can’t get the answer given in the question, do keep going on to later parts of the question
- You are not given paper specifically for rough work. Either do it in the booklet with your answer and cross it out, or use a separate booklet and cross it out.

Tips on pure papers

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- Know the definitions and theorems
- Quote results when you apply them, and check that all the conditions hold.
- When you quote a result, give all the conditions.
- Justify what you are doing.
- These things are worth marks – “marginal gains” – don’t throw away marks for things you know!

Tips on pure papers

- Generally prove the bits that are new for this theorem.
- You can generally assume results from previous parts of the course.
- Read the question sensibly. You are often told what you can assume.
- If you are told to quote a result then you can use it from then on.

Tips on pure papers

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- If you are told that you can use a specific result, or asked to prove one, then you need to use what's in the question.
- You might have seen something slightly different before, but you need to do what's in the question, not what you'd like to be in the question.

Tips on applied papers

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- Define your notation
- Would a diagram help?
- Some bits of bookwork appear most years – learn them!
- Check your answers as you go along
- Explain what you are doing. Make your answers clear.

A sample M4 question & solution
2013 M4 #3

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3. A particle slides on the inside of the smooth sphere $x^2 + y^2 + z^2 = a^2$ under a gravitational force g acting in the negative z-direction. Initially the particle is at height $z = 0$ and is projected horizontally with speed $v = \sqrt{3ga}$. Assume the particle has unit mass $m = 1$

(a) [8 marks] Starting from Newton's second law, show that the height $z(t)$ of the particle obeys the differential equation

$$\frac{a^2\dot{z}^2}{2g} = z\left(z^2 - \frac{3}{2}az - a^2\right),$$

where a dot is used as shorthand for $\mathrm{d}/\mathrm{d}t$.

[*Standard formulae for velocity and acceleration in cylindrical polar coordinates may be quoted without proof.*]

(b) [5 marks] Deduce that the particle is constrained to move between two heights, and evaluate these heights explicitly.

(c) [7 marks] Show that the magnitude of the normal reaction exerted on the particle by the sphere is given by

$$R = \frac{3mg(a - z)}{a}.$$

2013 M4 #3

(a) N2L $\ddot{\underline{r}} = \underline{R} - g\underline{k}$ (*)

no explanation of notation

Dotting with $\dot{\underline{r}}$ obtain

$$\ddot{\underline{r}} \cdot \dot{\underline{r}} = -g\dot{z}$$

doesn't mention smoothness condition. $\underline{R} \cdot \dot{\underline{r}} = 0$.

and integrating get

$$\frac{1}{2}\dot{\underline{r}}^2 + gz = \text{constant} = \frac{3}{2}ga$$

Dotting (*) with $\underline{e}_\theta$ get ← not explained

why is $\underline{R} \cdot \underline{e}_\theta = 0$? Surface of revolution!

$$r^2\dot{\theta} = \text{constant} = a\sqrt{3ga}$$

Finally if particle remains on surface have

$r^2 + z^2 = a^2$ so $r\dot{r} + z\dot{z} = 0$.

missing $\dot{z}^2$ term

So $\frac{1}{2}(\dot{r}^2 + r^2\dot{\theta}^2) + gz = \frac{3}{2}ga$

no explanation of components $\dot{r}, r\dot{\theta}, \dot{z}$?

$$\frac{1}{2}\left(\dot{r}^2 + \frac{3ga^3}{r^2}\right) + gz = \frac{3}{2}ga$$

$$\frac{1}{2}\left(\frac{z^2\dot{z}^2}{r^2} + \frac{3ga^3}{r^2}\right) + gz = \frac{3}{2}ga$$

$$\frac{z^2\dot{z}^2 + 3ga^3}{a^2 - z^2} + 2gz = 3ga$$

Rearrange for given result.

So all this calculation is a little wrong-doing the rearrangement would have made this clear.

4/8

(b) At the extreme heights

$\dot{z} = 0$ and so $z = 0$ or

$$0 = z^2 - \frac{3}{2}az - a^2 = (z-2a)(z+a/2).$$

As $z = 2a$ is physically unreasonable then $z = -a/2$ is lower extreme and $\frac{-a}{2} \leqslant z \leqslant 0$

5/5

If it’s not going to plan…

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- Breathe, stay grounded
- Is there another question you can try? (But don’t hop around)
- Make notes when you read the question – you can refer to these later
- Keep it in proportion
- Ask an invigilator if you need (non-maths) help

And finally…

Follow-up resources

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On the department website:

- Past and specimen papers (Prelims and Prelims resits)
- Notices to candidates
- Examiners' reports
- Exam conventions
- Some solutions for Prelims questions

University's Online Resources

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- The University's *Study Skills and Training* webpage can be found at

https://www.ox.ac.uk/students/academic/guidance/skills

- And specific revision guidance is at

https://www.ox.ac.uk/students/academic/guidance/skills/revision

Be proud

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Think back to how much maths you have learned in since October.

You should be proud of that.

The exams are your opportunity to show that to the examiner.

Try to keep the exams in proportion.

Good luck!