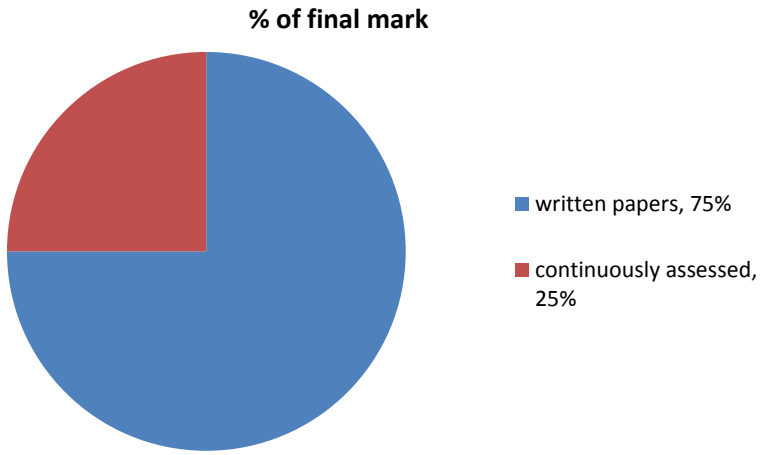
How Part II is assessed and classed

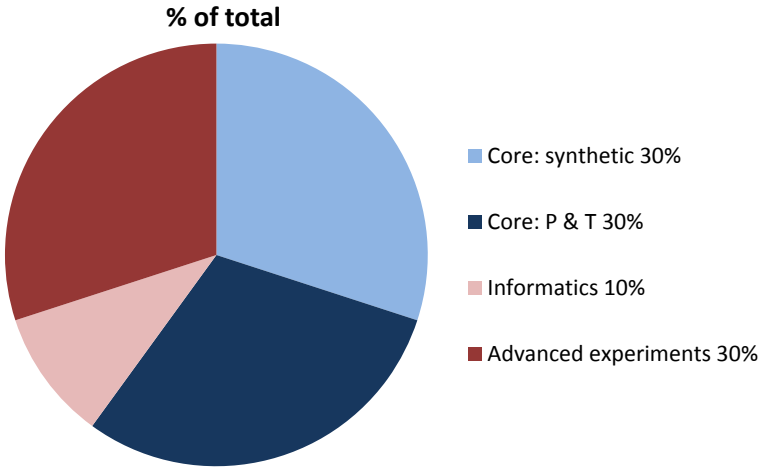
Examiners

- Whole process is overseen by *six* Examiners taken from across the Department
- In addition there are *three* External Examiners whose role is to see 'fair play', to ensure comparable standards, and ultimately to sign-off on the class list
- External Examiners decide on, and conduct, any orals

How the marks are split



Continuously assessed work



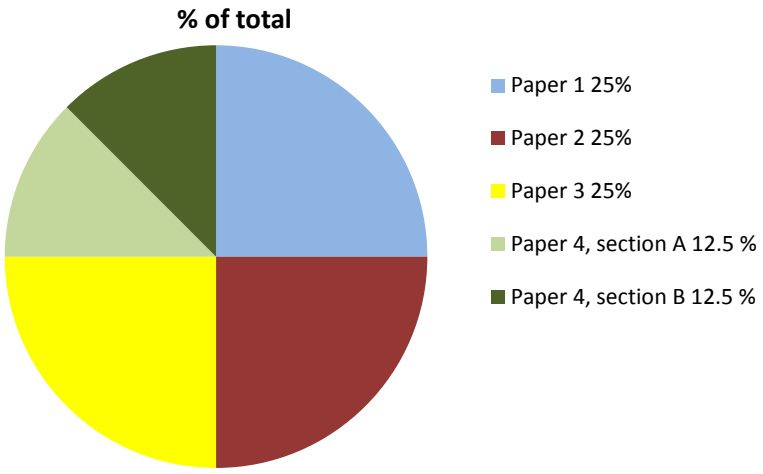
Advanced experiments

- Total of 6 (each 5%), with the following substitutions allowed
  1. Language option : subs. for 4
  2. Programming option: subs. for 2
  3. Mathematical Methods: subs. for 3

Combining the marks for continuously assessed work

- Raw average mark for practical is high, with significant variation between components
- An average mark for the continuously assessed component which is much higher than for the written exams is not acceptable to the External Examiners
- **Action**: each component is scaled to an average of about 70%

Written examinations



Setting questions

- Question drafted by lecturer
- Checked, discussed and refined with the help of an informed party
- Question and 'model answer' provided to Examiners
- Scrutiny by Examiners (length, clarity, difficulty, appropriateness)
- Scrutiny by External Examiners
- Final revisions and 'sign off'

Marking: a highly distributed process

- Generally done by the person who drafted the question
- Expected to adhere to 'approximate division of marks' indicated in the question
- 'Any reasonable answer' gets credit; no negative marking
- If there are a significant number of answers, expected average mark of 16.25 / 25
- Deviation permitted for 'good reasons'
- Where small numbers of answers, then no particular expectation

Typical outcome

Paper	Average (%)	Standard deviation
1	65.6	14
2	64.6	14
3	64.6	13
4	62.4	14
Cont. assessed	69.5	4.4

- Consistent across papers
- Higher average/tighter distribution for cont. assessed work – as expected

Classing

- Initial classing using standard boundaries (70% for a I, 60% for a II.1, 50% for a II.2, 40% for a III; we always round up)
- For those near borderlines, examiners look at mark profile and may review scripts
- External Examiners make final decisions on borderlines, possibly with aid of orals
- *Always* to the benefit of candidates

Historic class distributions

year taking Part II	I (%)	II.1 (%)	II.2 (%)	III (%)
2004	38	41	15	6
2005	34	44	22	0
2006	30	39	19	7
2007	33	40	16	8
2008	37	40	20	3
2009	31	42	19	6
2010	31	52	10	6
2011	35	43	14	2
2012	36	43	13	3
2013	32	48	11	3

- No predetermined distribution
- Comparison with historic data
- Cohort tracking (comparison with performance at Part IA and IB)

Further information

- Teaching website – click on Examinations
  www.ch.cam.ac.uk/teaching/raven/examinations
- External examiners reports, and Department's responses
- Question by question comments from previous years
- The *Course Guide* you were given at the start of the year (also on line)

Objectives when setting exam Qs

- To reflect the spirit of the course rather than minor side topics.
- To involve the key concepts and core ideas.
- To differentiate between candidates:
  - some parts should be straightforward for all candidates
  - some parts are intentionally more difficult

Examiners are asked to categorize **each part** of the question according to the following simple scheme:

1) This part is similar to questions given out to accompany the lectures, or involves the straightforward recall of facts or explanations given in the lectures.
2) This part involves extending the material given in the course. For example the application of ideas/theories to a problem which is not the same as those given in the lectures.
3) This part requires a deeper understanding of the subject material and/or requires the student to be inventive in dealing with an unfamiliar situation.

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SECTION A

A1 Inorganic I: Structure and bonding

1

Answer ***all*** parts of the question.

1 - straightforward (a) (i) Taking $[B_6H_6]^{2-}$ as an example, illustrate the molecular orbital basis of Wade's rules.

2 - extension (ii) Use Wade's rules to show that $[Ru_6(CO)_{17}C]$ and $[R_6Al_7]^+$ (R = a bulky organic group) are valence isoelectronic. Suggest structures for both species.

1 - straightforward (iii) Explain why Wade's rules fail to predict the structures of the following compounds,

$[MeLi]_4$ $[B_4Cl_4]$ $[P_4]^{2-}$

(b) Explain the outcomes of the following reactions and identify compounds **A**–**F**.

3 - deep understanding

$$[2,3\text{-}C_2B_4H_6] \xrightarrow{GaMe_3} 2\mathbf{A} + \mathbf{B}$$ **A** is a colourless gas

1 - straightforward

$$[1,2\text{-}C_2B_9H_{13}] \xrightarrow{\Delta} \tfrac{1}{2}\, B_2H_6 + \mathbf{C}$$ **C** shows one B environment in its ^{11}B NMR spectrum

2-3

$$Na_2[1,2\text{-}C_2B_9H_{11}] + FeCl_2 + (C_5H_5)Na \xrightarrow{-\,2NaCl} \mathbf{D}$$

2-3

$$B_5H_9 \xrightarrow[-\,HBr]{Br_2} \mathbf{E} \xrightarrow[-\,NaBr\ -\,2CO]{NaMn(CO)_5} \mathbf{F}$$

Approximate division of marks: (a) (i) 15%, (ii) 15%, (iii) 20%, (b) 50%.

Objectives when marking exam Qs

- To reward a correct approach to answering the question even if the answer is incorrect/missing!
- To arrive at an average mark of 16.25/25
- To stick to the proposed division of marks for the question (although it is sometimes necessary to adjust this slightly such that an appropriate average is reached).

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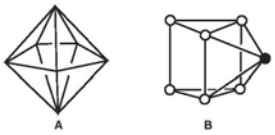
(a) Two possible geometries for the complex $Mo(CN)_7^{4-}$ are based on a pentagonal bipyramid **A** and a capped trigonal prism **B**.



In **A** the Mo atom is at the centre and each vertex is occupied by an CN. In **B** the vertices of the trigonal prism, which is shown standing on one of its triangular faces, are indicated by open circles; the closed circle indicates the position of the vertex which is centred over one of the rectangular faces. The Mo atom is at the centre of the trigonal prism, and CN ligands are placed at each vertex.

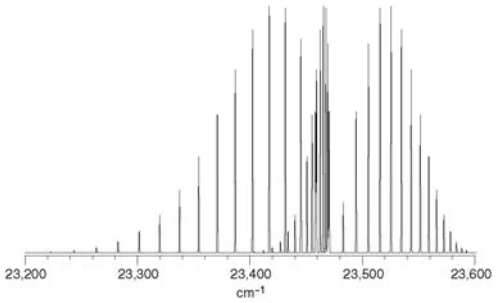
(1)/(2) (i) *Considering only the* C–N *stretches*, determine the number of features you would expect to see in the infra-red and vibrational Raman spectra of complexes with these two alternative geometries. In each case, indicate the number of coincidences you would expected to see. 8 marks

(1) (ii) The infra-red spectrum of $K_4Mo(CN)_7.2H_2O$ in the solid state shows bands in the C–N stretching region with wavenumber 2119, 2115, 2090, 2080, 2074 and 2059. When the complex is dissolved in water, just two bands are seen with wavenumber 2080 and 2040. 3 marks

Deduce what you can about the possible geometry of this complex in the solid state and in solution.

(b) (i) The electronic ground state of the diatomic species AlH is known to be a singlet. Draw up a simple MO diagram for AlH which is consistent with this observation (consider only Al orbitals from the third shell). Give each MO an appropriate symmetry label, indicate which are occupied, and determine the term symbol of the electronic ground state. (1)/(2) 4 marks

(ii) Shown below is part of the electronic emission spectrum of AlH; the transition is to the electronic ground state.



These are the parts that differentiate between candidates

(3) Explain the form of the fine structure seen in this spectrum and suggest both the electronic configuration and the associated term symbol of the excited electronic state involved. Deduce what further information you can about the excited electronic state. 7 marks

(3) (iii) The rotational constant of the electronic ground state is 6.30 cm^{-1}; *estimate* the rotational constant for the excited electronic state. 3 marks

Approximate division of marks: (a) (i) 35%, (ii) 10%, (b) (i) 15%, (ii) 30%, (iii) 10%.