Part III 2012

Examiners Comments

Q2

This was a straightforward question, and the standard of answers was extremely high. Almost all of the answers indicated a good knowledge of the fundamental differences between neutron and x-ray diffraction required in part (a), with most showing a comprehensive appreciation of the various processes contributing to a neutron diffraction event. Also, nearly all showed good awareness of the approximations inherent in the use of the conventional x-ray scattering factor. All the answers to part (b) were correct, and almost all had very little difficulty in deriving the structure factor in part (c) and hence explaining the line intensities.

Virtually all the answers were first class, and even with very stringent marking, the average mark was still higher than that recommended. I think that it would be unfair to the students to reduce it any further.

Number of scripts : 13 Average mark : 15.2/20

Q3

This question was answered by 29 candidates. Answers were generally good, but a small number of candidates couldn't work out S for $Mn^{3+/4+}$ or for the whole clusters. Many candidates fell into the trap of not recognizing that the energy barrier for reversal of magnetization in a single molecule magnet with half-integer total spin will be $D(S\text{-}1/2)^2$.

Q 5

54 answers. This was generally well answered although the 3D depictions of the transition states were often poor. Almost all candidates correctly identified the (*E*)-selective enolisation of the aryl ester, although there was quite a spread of answers on the aldol step with many not assigning the product stereochemistry correctly. Some candidates offered "arrow-pushing" answers without a rigorous stereochemical analysis.

Q5

Broadly speaking this question was answered relatively well and there is no real comment

Q 7(c)

I had thought this question might be too easy – since it asked for the reproduction of a figure given in the lecture handout and a description of the physical basis of the features in the plot, also mentioned in the lecture. However, in the event, the question was very badly answered, with only two candidates (out of 9) giving a completely correct figure (showing the downward curvature in the Arrhenius plot of ionic conductivity above the glass-transition temperature – with no discontinuity) and none giving the correct reasons for the behaviour in both the glassy and supercooled liquid states, although some answers were partially correct.

Q8

Part (a) Isoniazid as a TB drug, 11 scripts Range of answers. Several people attempted the questions to do part (b) and had no idea about the first part, so there were some very low marks for this part. Of those who attempted the question seriously, most but not all go the initial radical structure for compound 2. Most had an oxidized nicotinamide ring in the adduct 3. Several knew about InhA and it being an enoyl reductase. Few went on to speculate on how this killed TB.

Q8b

(Average 72.1% (7.21/10) based on 12 answers. Range = 4.00/10 – 9.50/10)

Most students answered this part of the question correctly, giving thorough answers on all points requested. The Rules of 5 and 3 were given correctly in most cases, and the comparisons between HTS and FBS were fully argumented.

Q9a

This question was attempted by 40 candidates though, on the whole, the quality of answers was not high. The lithiation reaction on which the question was based was explicitly covered in the lectures and there was lengthy discussion of how a tertiary amide coordinates the metal in the resulting lithiate. In spite of this a large number of candidates failed to suggest any interaction between the directing group and the metal. Many candidates appeared to mis-read the question or, at least, to interpret the wording very selectively. "Comment on whether the solid-state and solution structures are the same" does not mean "use the solution NMR data to help arrive at a solid-state structure". This oversight led many candidates to draw a solid-state structure of the PMDTA complex that incorporated a C-Li bond. Most candidates correctly saw that using sparteine encouraged C-Li bond formation, though a significant number overlooked the temperature independence of the two doublets. Of those that commented on this, only the top 10% noted the relevance of using a chiral ligand. A mean mark of 6.4 was achieved for this half of Qu. 9.

Q10

This question was not really answered very well and I was struggling to make the average. Although the question was designed to make the students think they seemed to desperately apply the reactions that they learnt in the notes rather than think about the question.

Q11

Scripts: 54 Average mark: 13.1/20

Answers to this question varied in quality from 6/20 through to 18/20 so there was a good spread from which it was easy to find the right average mark.

(a) Parts (i) and (ii) Most people went for a Vilsmeier acylation in this case, followed by a variety of ring forming processes to generate the imidazole moiety. Those who did not use ortho lithiation before the Vilsmeier and who did not flag up that this was an unlikely reaction to occur, based on the ring electronics, were awarded the least credit. Those who used ortho lithiation and discussed exactly how this occurred with their chosen reagents had more credit and those who selected DMF as the acylating agent received the most. If the incorrect reagents were chosen but a good attempt was made at a mechanism with those reagents, credit was also given for this part. (2/20 for reagents, 6/20 for mechanisms)
Part (iii) One mark awarded if they knew the basic difference between the two, two marks if they pointed out any further difference between the two. (2/20)

(b) Step 3: The greater proportion of students recognised that DIC was an activating reagent and attached it via carbon to either the amide or the carboxylic acid. If they had this first step right, they then tended to get the rest of the mechanism correct as well and the best students pointed out the ring closure in terms of Baldwin's rules and that the product was an aromatic zwitterion. (4/20)
Step 4: This was difficult and required a lot of imagination to get through to the product if students were tempted by the Diels-Alder option, which in some ways was the most obvious starting point. Those who did either a stepwise approach or a 1,3-dipolar addition fared the best on this though, as both can fairly readily lead to the given product, with loss of NO_2^- and CO_2. (6/20)

Q14

The question was answered well and most students demonstrated a good understanding of the concepts covered in the course (metal-ligand self-assembly, H-bonding, the hydrophobic effect, host-guest chemistry etc). Marks were awarded in the range 5-20 (out of 20) with a mean of 13.3. A couple of students gave exceptional answers and were rewarded accordingly while at the lower end it was clear that some students had not had time to attempt the final part of the question.

Q18

27 scripts: Mean mark (out of 25) 16.6

Maximum mark 24/25 lowest mark 9.5/25

13 1st class marks, 5 x 2:1, 5 x 2:2, 4 x 3rd.

Many more than usual answered questions on this course this year.

First marking: the results were rather low 13/25 mean mark and many of what I considered to be first class papers were not getting first class marks.

I remarked the script changing the maximum mark for a number of questions where even the top candidates were not getting full marks: This meant it was marked / 42 rather than 50.

A very large spread of marks. Perhaps this reflects the much larger number of candidates attempting this question. The top class candidates were excellent – five candidates scored ≥80%. Some of the lowest scoring scripts showed clear signs of the candidate answering this question last and having little time to answer it.

Parts (d. e and g) were the questions that showed which candidates had a really good grip of the material.

Q19

14 candidates answered this question and there was a good spread of marks from 8 to 21 out of 25. The average was 15.6 close to the 16.25 requested. The best scripts showed a very high level of understanding of the course material and could also apply this knowledge and correctly interpret data given in the question. The poor scripts were in general very patchy in terms of the answers to the five parts of the questions. Sometimes, correct answers were given, sometimes not, sometimes no answers at all. Surprisingly, part a) which was drawn directly from a lot of the course material was frequently not answered very well. In many cases, candidates simply wrote out a list of experimental techniques used to characterise the structures of native states of proteins, and did not give any thought to whether the techniques could be applied to oligomers and fibrils. Part b) was in general answered very well, only a few candidates struggled to understand the problem. Part c) and d) (which were not worth many marks and which were straightforward) were answered very well. In contrast Part e) was answered poorly by approximately half the candidates who did not figure out that the problem was one of kinetics not thermodynamics. In this case, the answers often illustrated quite confused thinking.

Q20

Parts (a), (b) and (c) of this question were dealt with in the lectures, although the first was described using a slightly different methodology.
Most answers dealt with the different picture of the diffracted beam amplitude in a satisfactory manner, and had little difficulty in deriving the correct expression for the image intensity. There were several distressing mistakes in the algebra required in part (b), but even when this occurred, the candidates had the sense to realise their errors and use the correct formula from memory. Part (c) also caused few difficulties, apart from a lack of understanding of hexagonal symmetry displayed by two candidates. Part (d), where they had to think, was however disappointing, as only two answers showed a real understanding of the contrast problem, and even those did not see fit to evaluate the signs of the principle Fourier components.

Number of scripts : 8 Average mark : 16.5/25

Q21

Answers to this question were generally good, indicating an awareness of all the problems of indexing patterns with symmetry lower than cubic. Only one or two showed real deficiencies in part (a), although very few showed a real appreciation of the advantages of powder diffraction methods. None had any problems with part (b), but part (c) proved more testing. Few candidates had problems with finding values for the cell constants, but only three saw that there were two possible cells, and only one raised the question of which was the true cell. Rather surprisingly, a few could not evaluate the correct composition of the tetragonal phase. For part (d), almost all concluded that the final phase was a body-centred cubic structure, but none were that clear on how the two structures were related.

Number of scripts : 12 Average mark : 16.5/25

Q22

This question was answered by 16 candidates and there were some significant difficulties despite the material being similar to examples in the lectures. In part 9C0 candidates disn't appreciate that dimerisation of the ligand would lead to a weakly antiferromagneticaly coupled Ni^{2+} dimer with a Curie constant significantly different from the parent (undimerised) molecule. The Kambé vector coupling in (e) was particularly poorly done despite being almost identical to an example in the lecture handout.

Q23

This question was answered by 27 candidates. Answers to part (a) were good but some candidates had difficulty with the application of mean field theory in part (b). Answers to part (c) were satisfactory, with candidates seeing that dipolar interactions were required for long range order but no candidate totally exploited all of the data presented in this part.

Q25

The question was answered by 6 students.
As is usual with optional theory questions, those who chose to answer the question knew what they were doing and as a result the scores were high.
The question consisted of 5 parts.
Part a) (deriving the linearised Poisson-Boltzmann equation from the general case) was answered correctly by all. This is hardly surprising because this part of the question tested if the students were familiar with the content of the lectures/lecture notes.
Part b) (computing the Debye screening length of demineralised water at pH 7, given the screening length for 1 molar NaCl) was answered correctly by most. However, only a minority cunningly exploited the fact that the answer for NaCl was given - something that hugely simplified matters.
Part c) (relating the form of the potential to the charge density on two capacitor plates at distance L) was not in the lecture notes, but it was straightforward and answered correctly by all.
Part d) was another, relatively straightforward mathematical exercise to derive an expression for the pressure. Again, this was no problem for those who answered the question.
Part e) should have followed almost directly from part d) but even though part d) was answered correctly by all, part e) was not. This part of the question (worth 10%) tested insight to apply course material in a (slightly) unusual context.

Q 26

46 answers. This produced a reasonably good spread of marks. Several struggled with the first part, with many of these not recognizing the Johnson-Claisen rearrangement. Almost all candidates recognised the need for an Evans aldol reaction, but a significant number invoked a lithium rather than boron-mediated reaction. The transformation involving the selenoxide elimination produced quite a wide range of answers. In the final part of the question, most correctly identified that the reaction proceeded through two Diels-Alder type cycloadditions but many did not take the trouble to carefully explain the origin of the stereocontrol and some of the conformational representations were distinctly on the abstract side.

Q27

This question was split into three parts. In general parts b and c were answered well and part a not so well. It was a reasonable question, although quite long. Not that many people answered it. I would say that it was a mixture of a difficult application of notes a one part that stretched the understanding a bit

Q28

Two students answered this question. It doesn't appear that there was any misunderstanding over part (c), which had been the subject of a query during the exam. Both candidates who submitted an answer appear to have understood what was required, although only one completed the calculation correctly.

Q30

This question was answered by 5 candidates, about 20% of the class.

Part (a) was standard bookwork, and part (b) was similar although the last part needed a deeper physical understanding. Part (ci) was a new exercise for the students of a method described in the notes and included in the problems, and although algebraically a bit involved, was reasonably straightforward. Part (cii) was a little more searching and part c(iii) could be inferred as a modification of that of a 3-parallel circuit shown in lectures, but utilising the answers obtained in (cii). Part (d) was a numerical exercise of an approach shown in lectures.

The standard of answers was high, with 2 candidates giving nearly perfect answers.

Average mark = 19.2/25

Q31

No of scripts: 8
Marks/25: 23.5, 22, 22, 20.5, 19.5, 17.5, 10.5, 9.5 mean mark= 16.875

Section (a) of the question was relatively straightforward and required careful reading of the lecture notes. The students answered this part mainly correctly. However, examples of solids in which diffusion occurs by direct and indirect mechanisms were not always given.
Section (b) was based on the use of virtual-crystal approximation (which has been mentioned by none students) and required comparison of the exponential terms in general expression for diffusion coefficient. The majority of the students attempted this part of the question got correct answers.

Q32

Question around key ideas for enzyme inhibition for drug discovery, 6 scripts?

The question was divided into bit sized parts to make it easier to do.
Part (a) was not done particularly well. Some mention of transition states, little mention of relative concentration of species on the enzyme.
Part (b) done better than expected, although few got the (trivial) calculation out.
(c) Mixed. Some saw kon as very slow, but very few connected this to the low abundance of the DFG loop out conformation (which actually ties back to part (a)). Most got a KI value.
(d) Some knew how to derive this.
(e) Mixed answers. First part disappointing. Poor knowledge of slow binding inhibition. Some knew issue of IC50s approximating to enzyme conc.
(f) Rather patchy answers. The DFG loop out part was generally good, but other aspects less well done - e.g role of urea motif, solubilising group etc.

Q33

(Average 64.8% (16.21/25) based on 12 answers. Range = 8.00/25 – 21.00/25)
a) Most students answered this part of the question easily, however did not always draw out all arrows to protonation steps or the structure of the urea-based leaving group.
Average 5.08/5.50
b) On the whole, answers to this part of the question were satisfactory. However, most did not fully draw out the resonance structure of the thiopyridine leaving group. Nevertheless students captured the overall mechanism correctly.
Average 3.75/4.50
c) This question was also answered well in general. In some cases however, the structure of ethanolamine was not drawn correctly or the choice of the electrophile species it reacts to was mistaken.
Average 1.71/2.50
d) Most answers did not explain how the final coupling value (15,000 RU) is measured from the sensogram. In some cases, redundant explanations of how the RU response is measured in general were attempted. Overall however the schematic sensogram was drawn correctly in most cases.
Average 2.96/4.50
e) This question was divided in four parts:
i. Students correctly explained that *k*on, *k*off – and hence Kd or Ka can be obtained. However only very few students correctly pointed out to the fact that the association part of the curve relates to *k*obs = *k*on [L] - *k*off
ii. This part was answered correctly overall.
iii. This part was answered correctly overall, however few students referred to the Arrhenius equation to explain why an increase in temperature results in an increase of the rate constants *k*on, *k*off.
iv. To answer this question the students should have used the value of 15,000 RU

given in point (d) – however many did not. They assumed a stoichiometry of $n = 1$ and unknown RU of coupled protein, and remained puzzled. Importantly however, there was a mistake in the text of question (e) in that the molecular weight of the protein should have been "30,000 Da" or "30 kDa", not "30,000 kDa" as incorrectly written in the text (as far as I am aware there is no known protein of size as big as 30 MDa!). One student spotted this – and said it should have been 30,000 Da and hence $n = 0.67$; well done! Others gave the correct answer but based on the 30,000 kDa value – i.e. $n = 667$.
I contacted James Keeler and he suggested that I should mark as correct a calculation either using 30,000 Da or 30,000 kDa – and that I should not mark down those people that were muddled about how to interpret the 667 active sites.
So I did.
Average 2.71/5.50

Q34

Overall, I was disappointed by the way this question was tackled. Part a revealed several candidates who didn't know what an aromatic tertiary amide was and the vast majority of the candidates made little or no mention of some of the specifics of metal coordination and how it affects the directing group. The material was explicitly covered in detail in the lectures. For the most part, Section b was done well. Most candidates tackled the descriptive elements well and also correctly identified the agostic bonding in zincate A. Part c revealed a wide range in the quality of answers. The best candidates tackled it very well and only the very best correctly identified why the reaction stoichiometry changes as a function of base (though this is in the handout in detail). Most candidates had a pretty good go at the mechanism though a significant minority of candidates used the Li to replace hydrogen, suggesting that they had not grasped the role of the second metal. This was concerning given the prominence of bases like A and Z in the course and the fact that they should be easily recognisable. With some remarking a mean mark of 15.8 was achieved. The question was attempted by 20 candidates.

Q37

This was a fairly routine question, although the quality of the answers varied dramatically. Although the way to make the molecule was fairly obvious choosing the correct route was not so clear. Many small reactivity factors were routinely overlooked. Overall, reasonably well answered in what was probably a fairly achievable question.

Q38

Scripts: 43   Average: 16.35/25

Generally, this question was done very well and it was easy to mark and get the right average.

(a) (a)(i) A good variety of reagent choice here, often based on disconnection ideas, sometimes overly long even if basically correct. If reagents were not a good choice, credit was still awarded for any mechanism that was basically right. (8/25)
(ii) Several different orders of events could be considered in this case. Those who did not mention relative difficulty of ring closure were awarded less credit, as were those who made minor mistakes (e.g. using E2 elimination, where E1cB would be more likely). (3/25)

(iii) Only reagents were asked for here and therefore, there was no credit available for mechanisms. Answers varied a lot: if a set of reagents was given that was plausible but would not work for some reason in practice, one mark was given. (2/25)

(b) (i) Generally, this was answered with the correct mechanism so most candidates got full credit. (3/25)
(ii) Most students knew that at low temperature, lithiation would be favoured in the 2-position. Many of them did not use NBS as a steady state source of bromine though and rather used it as a source of Br^+ directly. In terms of explaining the selectivity found in the formation of **M**, however, ideas varied a lot but mainly did not include a ring opening-ring closing process (only one student suggested this!). Generally, it was assumed that it was a kinetic vs. thermodynamic argument. For the most convincing of these arguments, the most credit was awarded. For students who only said it as a general statement, with no back-up as to why this was, minimum credit was awarded (though still some because at least they had thought about it just a bit). (7/25)

(iii) For the two marks to be given, students needed to mention any two types of chemistries they knew could be carried out on halogenated heterocycles (e.g. metal-mediated couplings, attack by nucleophiles). (2/25)

Q39

Scripts: 19 Average mark: 15.79/25

General comment: Answers to this question varied in quality from 9/25 right through to 23/25. Because there were fewer answers, it was slightly more difficult to find the right average but with a slight adjustment to the credit given for each part, the average is slightly low but within the right ball-park.

(a) Variation in quality of answers here, with some ignoring entirely the need to convert oxygen into a leaving group prior to reaction with a nucleophile and/or suggesting impossible reagents for the synthesis. (6/25)

(b) Even if students had fallen into the making the mistakes outlined (or others) for part (a), if their mechanisms were sensible, it was possible to be awarded full credit here. If the reagents didn't really work, more credit was given to those who pointed this out than to students who just fudged the answer. (6/25)

(c) Any five issues and considerations could be mentioned here to get the full marks available for this part. Most people scored well. (5/25)

(d) Students needed to point out all the problems (or not) with their route to get both marks for this. (2/25)

(e) Variable quality here. Those who suggested a benzyne formation mainly, though not always, went on to give plausible mechanisms for the remainder. Those who did not suggest a benzyne intermediate often gave mechanisms that did not entirely make sense. Credit awarded accordingly. (6/25)

Q40

This question was attempted by 28 candidates.

Generally the question was well attempted.

Part a), b) and c) were reasonably well attempted by everyone, other than minor mathematical slips and errors.

Part d) the majority could discuss the temperature at which droplet nucleation would occur and a number of candidates derived a mathematical expression for this. The discussion over the fate of the droplets was more varied and some candidates did not discuss what happened at 90C and 100C although expressly requested to do so.

Part e) was well answered by most candidates, with some good clear drawings and explanations.

Part f) was rather poorly answered although this was perhaps rather straightforward use of an equation straight from their notes.

Q41

The question was in general very well answered. In particular, the answers to part (g) of the question, which brings together many of the key ideas relating to self-assembling monolayers, were in most cases excellent. Some students encountered difficulties with part (f), but most were able to write down the correct starting point and invoke the concept of minimising the free energy of the system.

Q42

This question was well answered on the whole: the six scripts were awarded marks ranging from borderline 2.1 to high first. Most candidates answered part (a) well, although there was some vagueness in explaining the reasons for long-time decorrelation of the vibrational auto-correlation function in parts (iii) and (iv). Part
(b) was also answered well on the whole: 4 out of 6 candidates derived the expression correctly; the other 2 started off in the right direction but lost their way later on. Part (c)(i) was well answered; part (c)(ii) less so, although it was clear that this was partly the result of ambiguity in the wording of the question; I thus reduced the number marks for (c)(ii) to compensate for this.

Q43

Three students answered this question. The first two parts of this question were in general answered well, the main difference being in the clarity of the arguments being made. For the part (c), most candidates started at a more fundamental level than was needed, however I believe the question was clear.

Q44

The responses to the question ranged from excellent to very poor. Consequently there was a large range of marks, from 3 to 25 and a mean of mark of 15. Around one third of the students answered the question very well and showed an excellent understanding of the concepts covered in the course including a couple of students who gave exceptional answers and were rewarded accordingly. However one third of the students struggled with the question and showed little understanding of the course material and in many cases failed to address the data given in the question. In cases where students failed to answer the first part correctly marks were awarded in the subsequent sections for demonstrating some of the concepts covered in the course and for reasonable attempts to answer the question.

Q45

The scripts were read through once to determine the completeness of the answers provided by the candidate, before the distribution of marks was allocated. Part (a) was on the whole done well, with most of the answers addressing the key points of the question, although many candidates failed to consider the implications of the reaction conditions or to comment on all the possible conformers obtained in the reaction. Part (b) was not answered all that well as the key consideration was the nature of the non-covalent (H-bonding) that formed a ‘capsule’ and only half a dozen candidates were able to identify the interactions and the structure of the assembly. Part (c) gave candidates the opportunity to list as many characterisation techniques as they could (and thereby gain marks), and hopefully make a connection with the information they would get for the host-guest interaction alluded to in the question – this part of the question in fact provided a hint about the answer in part (b). *An average of 16.47/25 was achieved for 19 scripts*.

IDP I Atmospheric Chemistry and Climate Change

Q1

A total of 19 students attempted this question. The mean mark was 17.32 out of 25, with a standard deviation of 4.83. The marks ranged from 6 to 24. With a few notable exceptions, the overall level of understanding was high as reflected in the mean. Students with poor understanding were readily distinguished. There was less discrimination between the good and excellent students. This seems to be due to the fact that the calculations (b, c, e) were done well by many people.

Range	Number
x<7.5	1
7.5<x<10	1
10<x<12.5	0
12.5<x<15	5
15<x<17.5	2
17.5<x<20	1
20<22.5	8
22.5<25	1

Q2

The question was answered on average very well by 43 students with an average mark of 17.8 out of 25.

In question (a) an expression for the rate of formation of ozone for a given set of stratospheric reactions had to be derived. Most students answered this very well and only very few had major difficulties with this question.

Using this expression, in question (b) the present and past ozone concentrations at mid stratospheric altitudes had to be quantified. This question was less well answered and many students had difficulties with the numerical part of the question.

In question (c) the different ozone concentrations over geological time scales, as calculated in (b) had to be put into perspective with the evolutionary processes. This question was answered very well on average.

Question (d) asked to list other reaction cycles that affect stratospheric ozone, besides the “oxygen-only” reactions shown in question (a) and to describe their possible effect in a future warmer climate. This question was answered less well. Students mainly struggled to describe effects of these cycles in a future climate.

In question (e) a steady state ratio of NO_2/NO had to be derived and quantified from a given set of tropospheric reactions. This question was well answered. Some students struggled with the numerical part of the question.

In question (f) an expanded expression for the ratio of NO_2/NO had to be derived including two reactions describing peroxide reactions with NO. The effect of these peroxide reactions on ozone formation rate had to be discussed. This question was well answered. Some students struggled with incorporating the two further reactions into the expression and the discussion part.

Q 3

A total of 38 students attempted this question. The mean mark was 16.8 out of 25, with a standard deviation of 4.3. The marks ranged from 7 to 22. No-one gave an outstanding answer to part (a), because a discussion of many factors is required to answer it properly. Nearly everyone had a good attempt at (b), and the common errors in the derivation were omission of the geometric factor allowing for the different areas of the Earth that are absorbing and emitting radiation or the albedo. The marking scheme was adjusted slightly to reduce the penalty for getting the expression in part (b) wrong (see below). There was a notable difference in the answers to part (e) which depended to large degree on whether the students know that shipping fuel contains sulphur – but a surprising number also forgot it contained C and so forgot to mention CO2 emissions in their answers.

The marks used are (out of 25): (a) 8; (b) 6; (c) 3; (d) 3; and (e) 5. The division of marks is thus: (a) 32%; (b) 24%; (c) 12%; (d) 12%; and (e) 20%.

Range	Number
x<7.5	1
7.5<x<10	3
10<x<12.5	6
12.5<x<15	2
15<x<17.5	4
17.5<x<20	11
20<22.5	6
22.5<25	0

IDP3, Materials, Electronics and Renewable Energy

The paper worked well overall, giving opportunities for the chemists (4), physicists (32) and earth scientists (5) to demonstrate their skills and knowledge. (Mean marks: Overall 64%, Physics 64%, Chemistry 63%, Geology 68%.) The paper was also taken by one candidate from the M.Phil. in Scientific Computing. It was interesting to see that the geologists outperformed the others. This was not due to them being better at writing essays/brief notes, but rather because several of them tackled the "physics" question and did not get as confused as most of the physicists.

Q1

This question was not done well (average 58%). Marks were typically lost for failing to identify obvious non-idealities that would increase the land area required. The calculation for constant day and night power, although algebraically simple, required some lateral thinking; very few candidates did it right.

Q2

Both essays produced solid sets of answers (average 67%), generally reproducing copious amounts of relevant material, but with varying degrees of coherence.

Q3

(Average 66%). (a) Most candidates found enough to write about here. (b) Plenty of material was reproduced, although often rather randomly. (c) Some good answers here, but many found it difficult to come up with a meaningful examples. (d) A wide variety of quality was found for these answers, ranging from comprehensive and authoritative descriptions to vague summaries that did not demonstrate much understanding.

Second marking was performed by Dr J. Clark. Following practice in Physics, a sample of 5 papers was double-marked and the addition and entry of marks from all the scripts was checked. It was found that the marking scheme had been consistently applied, and no significant differences in marks were found.

Marks were reported separately to the Physics, Chemistry and Geology examiners. No scaling has been applied to the reported marks, although examiners in each subject are free to do so if they choose.