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| **A Guide to CA2 Model Documentation, Analysis and Reporting** |

**April 2018**

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**Introduction to CA2 Model Documentation, Analysis and Reporting**

This guide should help answer most of the questions you may have about subject CA2 including:

* the format of the online exam
* administrative information
* technical information.

If you have any further questions that are not covered in this handbook please contact the Education Services Team at [education.services@actuaries.org.uk](mailto:education.services@actuaries.org.uk)

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| **Important note:**  **Most of the sample CA2 projects and past exam papers on the website, and the one included here at Appendix 4, assess all of the CA2 syllabus using one exam paper.**  **As the objectives for CA2 have not changed under the 2015 two paper exam format, these examples continue to provide valuable practice for the CA2 exam.** |

# What is the CA2 exam?

This practical exam provides actuaries with more ‘rounded’ business skills and the prime emphasis is on good communication when using and presenting spreadsheet work.

The focus of CA2 is about making clear what you have done, so that it can be followed by others. You are required to use judgement and state your assumptions.

The solutions to past exams on the website demonstrate what is required for a good pass standard over the two papers.

**How has CA2 been developed?**

CA2 has been influenced by external pressures: the Technical Actuarial Standards (TASs), the Actuaries’ Code, the regulators, Sarbanes Oxley and Solvency II requirements.

* **Technical Actuarial Standards (TASs)**  
  The Financial Reporting Council has introduced generic technical standards to cover data, modelling and reporting. Actuaries need to be compliant with the requirements.
  + TAS(M) emphasises the need to document a model and to report on what it does, and on its limitations;
  + TAS(D) requires the data to be checked and to be reasonable;
  + TAS(R) sets out reporting requirements. These three generic technical standards are covered in more detail later in this guide.

The FRC plans to replace them within a single TAS 100 in due course, but the principles applicable to CA2 are not expected to change.

* **The Actuaries’ Code**   
  The Code requires us to “perform professional duties competently and with care” and to “ensure that the communication is clear”.
* **The regulators**In reviewing a firm’s practices, the regulators expect to see acceptable standards of documentation, agreed by the firm, and documented.
* **Sarbanes Oxley (SOX or SarBox)**   
  This is American legislation that governs the need for full documentation of internal processes and controls.
* **Solvency II**   
  This framework for insurance companies includes emphasis on documentation and evidencing of the calculation work undertaken.

# The timing of the CA2 exams

**The CA2 exam is run to UK times only, so that we can provide assistance and technical support if required.**

The exam takes place over two consecutive day’s and exam times will be confirmed at the time of booking. The format of the exam will be as follows:

* Day 1: AM - 3 hours 15 minutes
* Day 1: AM - 3 hours 15 minutes

# What is the format of the CA2 exam?

This brief overview of the CA2 exam should be read in conjunction with the Syllabus in Appendix 1, the main elements of which can be summarised as:

1. analysis of data
2. development of a model with clear documentation (including an audit trail for a fellow student and senior actuary) and including appropriate checks
3. ability to analyse the methods used and the model’s outputs, including checks on the results
4. ability to apply and interpret the results
5. communication of the approach, results and conclusions to a senior actuary

The CA2 exam consists of two 3 hour papers (each with 15 minutes additional reading time):

* Paper 1 will largely focus on elements (I) and (II)
* Paper 2 will largely focus on elements (III), (IV) and (V)

**Each paper will use a different model.**

Relevant Core Reading will be available during the exam. Additional guidance (if required) will be included with the exam instructions to cover key technical or modelling aspects needed for the particular situation in the problem to be modelled.

**Paper 1**

In Paper 1, you will be given a problem to model, including data to analyse. You will need to include appropriate checks, and to provide a clear audit trail for:

* a fellow student, and
* a senior actuary.

You should assume that:

* a fellow student has about the same level of knowledge as you
* a senior actuary will know the actuarial aspects and will need an overview of the actuarial, technical and assumption elements. They will not need the Excel details (especially in the summary).

**Paper 2**

In Paper 2, you will be given a model plus audit trail to review and will be asked to perform some further work. You will need to provide a summary of the whole project which will be for the senior actuary only.

**Remember**

* Take care to give sufficient detail of your approach, methods and assumptions in both the audit trail and the summary.
* The fellow student needs enough detail in the audit trail to be able to follow and amend/take forward what you have done.
* The senior actuary needs enough detail in each of the audit trail and the summary to be able to follow, and critique, what you have done.

# What exams should I have passed before sitting CA2?

There are no eligibility requirements for CA2.

However, the models can be based on any of the Core Technical subjects CT1-CT8. CA2 also uses the principles in CA1 and some features of CP3.

You may therefore prefer to wait until you have tackled the CTs (CT 1, 3, 4, 5 & 6 recommended), CA1 and CP3 before sitting this exam.

**I want to sit the exam, what do I need to do?**

Login to the website to book your exam, or complete and return an application form to the Education Services Team [education.services@actuaries.org.uk](mailto:education.services@actuaries.org.uk).

All exam material will be made available to you at the start of the exam including electronic copies of the Core Reading for CT1-CT8 and CA1.

There may be additional guidance included where appropriate. If you have previously taken this exam then this additional guidance was formerly referred to as ‘hint sheets’ which were provided by the assessor. Marks will not be deducted if the additional guidance is used.

**The CA2 exam**

The online exam is accessed through a secure community area on the Institute and Faculty of Actuaries’ Virtual Learning Environment (VLE).

In order to sit the CA2 exam online you will need the following:

**Technical requirements**

* Internet connection – we recommend that this is a wired connection
* Up to date web browser – please ensure that you are using the latest version of your web browser
* **Adobe Reader – the CA2 exam papers will only be available in PDF format.** To ensure that you are able to open these documents, please ensure that you have the latest version of Adobe Reader (<http://get.adobe.com/reader/>)
* Microsoft Office 2007 – your exam submissions will only be accepted in Word (.docx) and Excel (.xlsx) formats. Microsoft Office 2007 is the minimum version acceptable, any later versions of Microsoft Office will be sufficient. **PDF submissions will not be accepted.**
* As this is a web based exam environment, both Mac and Windows will be suitable.

**Joining instructions**

If you are sitting your exam online, you will receive an email two weeks before the start of the exam session, informing you of the:

* instructions for accessing the VLE
* the date of each paper

# Professional conduct during the CA2 exam

It is important to note that professional conduct is required at all times and the following will apply:

* The Exam Regulations apply to you when taking this exam, and these can be found at  
  <http://www.actuaries.org.uk/documents/exam-regulations-fellowship-and-associateship>
* Inappropriate behaviour during the CA2 exam may lead to expulsion from the exam, with disciplinary consequences.
* You must not discuss the exam assignment, or disclose its contents to anyone. Failure to comply with this can result in disciplinary action being taken.
* You are not permitted to use pre-prepared or copied electronic material in your exam submission.
* **Only your first exam submissions will be accepted. Any exam submissions that are found to be modified or submitted after the exam deadline will not be accepted.**

# What should I know before sitting CA2?

You should have the following knowledge

**Spreadsheets**

**Word processing**

**Excel knowledge**

**Suitable knowledge**

Excel is the software package used for the modelling aspects of CA2. Although detailed knowledge of Excel is not part of the examination (and hence extensive knowledge of Excel functions is not necessary), students will be expected to model calculations effectively using this software.

Therefore, a CA2 student should have experience of using Excel and, importantly, creating a spreadsheet from the very beginning. Students who have limited experience or rarely have an opportunity to create spreadsheets are encouraged to practise before attending the examination; the exam assignments on the IFoA’s website offer a good opportunity for such practice.

Exam assignments are constructed so as not to require advanced Excel techniques. However, students should be able to use the following Excel functions:

|  |  |  |  |
| --- | --- | --- | --- |
| AVERAGE  STDEV  MIN / MAX  MEDIAN  LARGE / SMALL | SUM  PRODUCT  SUMPRODUCT  SUMIF  COUNT | COUNTIF  VLOOKUP / HLOOKUP  INDEX  OFFSET  IF  GOALSEEK | AND / OR  NOT  ROUND  ABS  INT |

As well as the above built-in functions, students should know how to sort data and how to create and modify charts.

There is any number of Excel reference books available in addition to the Help facility provided in Excel. Students are recommended to research details of how to use the above features before the exam.

**Good practice**

* In Excel, or any other modelling package, there are good practice steps that should be followed. These help to: reduce the risk of errors within the model
* assist others to use the model, and
* facilitate checking and correction of the model.

The following principles should be followed in building any computer model and should be demonstrated in the exam assignment:

* Adopt an approach that is as simple as possible.
* Ensure the model is easy to change.
* Make constants explicit as parameters rather than hard code them into formulae.
* Separate inputs, calculations and results.
* Structure a spreadsheet so that it can be read from left to right and from top to bottom.
* Keep all formulae as simple as possible – the calculations do not need to be performed in one formula and intermediate calculations can facilitate checking.
* In spreadsheets, avoid changes in cell formulae along rows/down columns. If this is not practical, make sure the changes are clearly flagged to other users who may have to make amendments.
* Avoid manual intervention wherever possible and try to ensure that the final result is updated whenever a change is made. If this is not possible, ensure that other users know what manual intervention is required and when.

**A warning**

There are many documents and articles which discuss good spreadsheet practice. However, a number of these contradict each other in some of their recommendations.

In part, this is due to considering different types of spreadsheet users with different needs. A spreadsheet designed to be used on a regular basis by non-experts needs different considerations to a model designed for use by a limited number of other users with a comparable level of technical knowledge to the developer.

Some general reading on this topic may be found in the following article from the Actuary magazine for March 2010: <http://www.theactuary.com/archive/2010/03/> (see p29 of the PDF).

A more detailed discussion, that looks at the needs of different users, may be found in the following article:

<http://www.soa.org/library/journals/actuarial-practice-forum/2010/february/apf-2010-02-campbell.pdf>

# How do I pass CA2?

**Preparation is the key!**

You need to be well practised in basic Excel skills.

You also need to be ready to turn a basic actuarial problem into a spreadsheet model. If you are familiar with updating an existing spreadsheet, but not with creating a model in a spreadsheet from the very beginning, you should practise this by attempting past papers.

The type of problems that are asked in CA2 have been published on the website. Review the sample solutions, plus the comments from the Examiners (where these are provided)

<http://www.actuaries.org.uk/studying/plan-my-study-route/fellowshipassociateship/core-applications-subjects/ca2-model-0>

It is also helpful to review how the CA2 exam is marked.. Further information is available in the next section.

You may also wish to undertake training from a provider such as ActEd (BPP).

**Essential skills**

The following information highlights some of the skills required to pass this exam:

**Use of time**

Think about the time you have to complete all of the modelling and documentation.

**For Paper 1**

* Allocate time at the beginning of the exam for:
  + planning the model
  + creating the model itself, and
  + maintaining the audit trail (perhaps in sections).
* A possible split is:
  + reading – 15 minutes (you will be able to make notes and plan during this time)
  + planning – 30 minutes
  + modelling – 1.5 hours
  + audit trail – 1 hour

**For Paper 2**

* Allocate time for:
  + planning the spreadsheet work required
  + doing this work, and
  + writing the summary.
* A possible split is:
  + Reading – 15 minutes (you will be able to make notes and plan during this time)
  + Working through the model and planning the extra work – 30 minutes
  + Spreadsheet work – 30 minutes
  + Summary – 2 hours

**Paper 1**

**For the model in Paper 1**

* Read the question very carefully to ensure you know what is being asked. Note the results required and plan your approach well.
  + We recommend you spend about 45 minutes on reading and planning before you start your model.
* Keep your model simple and show all the calculations.
* Do not spend too long working with the data (unless this is clearly indicated in the question) but make sure that you do some basic checks, as required by TAS(D).
* Do not get too involved in the detail of the model. If you get stuck, make a reasonable assumption, document it, and move on.
* Include adequate signposting and labelling in your model and audit trail so that the work on each sheet is clear, and is clearly referenced.
* Be alert for checks you can apply. Test output frequently for accuracy and reasonableness – as you would do at work – and document these checks. If an answer does not look reasonable, check your formulae against the question. If you cannot find the error, note it in your audit trail and move on.
  + Remember: CA2 is not about determining the ‘right’ answer.

**For the audit trail in Paper 1**

* Make your audit trail as comprehensive as you can, making sure that you cover:
  + all steps in your methods
  + the assumptions, and
  + the reasons for your decisions.
* Include your checks – auto-checks and reasonableness checks on the various scenarios.
* Highlight any areas where special care needs to be taken, e.g. where a ‘goalseek’ has been used.
* Keep in mind the requirements of your two audiences:
  + a fellow student, and
  + a senior actuary.

**Paper 2**

**For the spreadsheet work in Paper 2**

* Read the question very carefully to ensure you know what has been modelled and the additional work which is required. Note the results required and plan your approach.
  + We recommend you spend about 30 minutes working through the model and planning the additional work before you start work on the spreadsheet.
* Keep your spreadsheet work simple and show all the calculations.
* Do not get too involved in the detail of the model. If you get stuck, make a reasonable assumption, document it in your summary, and move on.
* Be alert for checks you can apply. Test your output for accuracy and reasonableness – as you would do at work – and use the results of the reasonableness checks in your summary. If an answer does not look reasonable, check your formulae against the question. If you cannot find the error, note it in your summary.
  + Remember: CA2 is not about determining the ‘right’ answer.
* You will not be required to add to the audit trail provided for this paper, but your summary will need to cover the whole project in the question, not just the additional work you have carried out.

**For the summary in Paper 2**

* Focus on using the summary as a communication to your audience, a senior actuary.
* Include the approaches you have used for the whole project, not just for the additional work you have carried out. Give sufficient and accurate details of these (and the data) so that a senior actuary could check your methods and assumptions.
* Do not simply ‘copy and paste’ the text given to you in the audit, but amend the content to be appropriate to a senior actuary. Similarly, adjust any text copied from the exam instructions.
* Follow the instructions in the question carefully. In particular, ensure you include all the results which have been requested for the whole project.
* You need to include any added value comments that explain the results you have obtained and conclusions on the results. Any comments will follow from the reasonableness checks.
* You also should include a comprehensive set of possible next steps.

# Why do candidates fail CA2?

As students have asked for feedback on why candidates fail CA2, the Examiners have provided the following summary:

* Some candidates misread or misinterpret the instructions and so build an incorrect or overly complicated model. It is important to follow the instructions, use the information accurately and **plan the work before starting**.
* The weakest candidates do not seem to have understood what is involved in the assignment. They struggle to explain the work they have done in both the audit trail and the summary.
* There is sufficient time for the exam assignment, but candidates need to plan their time as for any other piece of work/exam.
* Some candidates do not apply enough checks to their work. Checks are often restricted to basic checks on the data, and other checks are omitted. In particular, checks that results are reasonable, including those from different scenarios, are necessary. These will also lead to comments in the summary.
* Many candidates omit key details from the audit trail.
* Similarly, for the summary, which needs to be a concise, yet comprehensive, account for a senior actuary. In particular, sufficient detail on your approach, method and assumptions is needed so that a senior actuary can follow, and critique, what you have done.
* Your submissions will be typed but can still be hard to read – give a few minutes thought to layout.
  + Eight pages of densely typed text in 8 point font will not produce an easy to follow or intelligible audit trail. For a CA2 assignment such detail would be excessive.
  + For the audit trail, consider the use of white space, sub-headings and highlighting key areas. Do not waste time making the format over-elaborate but invest some time in making it clear to follow and read.
  + Similarly the summary should be clearly laid out.
* Proof read the intended submission, and use the spell checker, to make sure it says what you want it to say.
* **Remember your audience for both pieces of documentation.**

# Guidance on how CA2 is marked

To aid your preparation for the CA2 Model Documentation, Analysis and Reporting exam, this simple guide has been created to help you:

* gain an understanding of how the scripts for Paper 1 and Paper 2 will be marked, and
* be more knowledgeable in your approach to the exam.

The guide sets out the criterion for passing CA2, together with the general format of the marking schedule which will be used by markers in assessing a candidate’s submissions.

**The CA2 examiners will assess a candidate’s overall performance over both papers. A candidate, therefore, does not have to produce a pass standard for each separate paper, but does need to demonstrate a pass standard overall according to the following criterion:**

|  |
| --- |
| The audit trail in Paper 1 and the summary in Paper 2 give a reasonable overview of the model and the results with the main focus for each paper being:   * Paper 1: a clear audit trail, including checks, which could be followed by a senior actuary and would enable the model to be worked on and corrected by a fellow student * Paper 2: a clear summary of the model and the results for a senior actuary |

It is difficult to meet this criterion unless both the audit trail and the summary give comprehensive coverage of the objectives. The main reasons for failing are:

* producing a poor audit trail that would not allow a colleague to carry out a proper check of the work. The candidate needs to demonstrate a good depth of understanding of the model, with robust reasonableness checks, and with methods clearly explained.
* producing an inadequate summary of the work for a senior actuary, for example, with insufficient details of the methods for scrutiny purposes, or few added value comments and conclusions on the different scenarios.

There are a number of past exams on the CA2 web pages and we recommend that students work through these to appreciate the overall coverage which is required.

**Remember:**

Most of the sample CA2 projects and past exam papers on the website, and the one included here in Appendix 4, assess all of the CA2 syllabus using one exam paper.

As the objectives for CA2 have not changed under the 2015 two paper exam format, these examples continue to provide valuable practice for the CA2 exam.

**Marking schedule**

In assessing CA2 submissions, the following marking schedule will be used.

The marking schedule shows the approximate mark allocation over the combined papers, though the marks will vary a little to reflect the precise requirements in each paper. Marks for modelling techniques and checking will form part of the marking of both papers with the approximate percentage allocation being:

|  |  |  |
| --- | --- | --- |
| **Assessment area** | **Paper 1** | **Paper 2** |
| Audit trail approach | 15% |  |
| Audit trail content - clarity and labelling | 10% |  |
| Audit trail content - coverage of methods | 10% |  |
| Audit trail content - checks | 5% | Up to 5% |
| Model techniques | 10% | 5-10% |
| Summary description and approach |  | 10% |
| Summary results |  | 10% |
| Summary conclusions and next steps |  | 15-20% |
| Summary drafting |  | 5% |
| **Total** | **50%** | **50%** |

**The spreadsheet of the model and the audit trail**

**Assessed in Paper 1, with some spreadsheet techniques and checking also assessed in Paper 2**

Marks are awarded for:

* Ability for a fellow student to review and check the methods used in the model

Marks are awarded for:

* For a newcomer, the audit trail is easy to follow and the reviewer does not have to look at the model to understand what has been done
* All the steps clearly describe how the calculations have been determined and are consistent with what has been done
* Sufficient technical and actuarial detail for a fellow student to be able to understand the approaches taken and identify any areas where corrections are required (without looking at the model)
* A well labelled workbook which is easy to navigate
* “Danger areas” highlighted e.g. goalseek, sorted data, and clear instructions included on the use of any such techniques
* Ability for a senior actuary to scrutinise and understand what has been done

Marks are awarded for:

* A good overview of the model
* Clear descriptions of data, sources, checks, adjustments
* Clear coverage of the assumptions made, with reasons where appropriate
* Clear coverage of methods, understandable by a senior actuary, in order for them to be able to gain confidence in the approaches taken (without looking at the model)
* Avoidance of excessive reproduction of Excel formulae
* Clear statements of reasonableness checks performed and their results explained
* Use of clear English
  + accurate spelling
  + well set out
* A logical order
  + data is introduced before it is referred to
  + assumptions are stated before they are used
  + methods are described in a sequential order

Marks are awarded for:

* All steps being clearly explained
  + detail is appropriate for a newcomer without having to look at the model to understand what has been done
  + methods, data plus adjustments, checks, danger areas clearly documented
* Clear signposting to the model (from the audit trail) and labelling within it
  + the audit trail allows the reviewer to follow the stages in the model
  + model labelling is consistent with the audit trail
* Each step being correctly described. Examples of the steps are:
* statement of model’s purpose
* data description/source
* data validation and adjustments
* assumptions made (not just those stated in question)
* each part of the method
* construction and use of charts
* Each distinct auto-check and reasonableness check. Possible examples of these types of checks are:
* auto-checks on data
* auto-checks on calculations (e.g. a set of probabilities summing to 1)
* auto-checks that figures are within an appropriate range e.g. probabilities between 0 and 1
* checks that a subsequent set of calculations accords with an earlier one if the parameter is changed back
* reasonableness checks that an initial result is sensible
* reasonableness checks that the result for each new scenario is sensible

Marks are awarded for the use of correct approaches, calculation of the correct results and the use of appropriate spreadsheet techniques. Follow-on errors are not penalised.

Examples of the approaches and techniques are:

* reasonable corrections to the data
* correct methods for each stage of the calculations
* correct results for each stage of the calculations
* use of cell references and parameters rather than copy/pasting or hard-coding
* flagging any “one-off” or “danger” cells
* use of simple techniques

**The summary**

**Assessed in Paper 2, with some spreadsheet techniques and checking also assessed in Paper 2**

The summary is evaluated based on its overall content for its audience, a senior actuary. The senior actuary needs to understand what has been done, and also the outputs, in order to present the results and conclusions of the project to the client(s).

Marks are awarded for accurate descriptions of the approaches used and the assumptions made in the whole project. Examples of the descriptions are:

* statement of project’s purpose
* data: nature, sources, verification and adjustments
* assumptions made in the modelling
* methods used for each stage of the calculations

Marks are awarded for appropriate presentation of the results from the whole model. Examples are:

* chart comparing adjusted data to original data (if relevant)
* appropriate charts illustrating each stage of the results
* clear statements of any other results

Marks are awarded for appropriate conclusions (based on the results for the whole project, together with next steps). Examples of comments are:

* significant caveats on the validity of results e.g. being based on very limited data, or being highly sensitive to a particular assumption
* analytical comments on each stage of the results, including explaining patterns in the results and any unusual features
* an explanation of the differences between the results under the various scenarios modelled
* overall recommendations (if appropriate)

Next steps need to be specific to the project, with some mention of why each is a valid next step. Possible examples of next steps are:

* validate the data / information
* obtain further data / information
* sensitivity / scenario test on key assumptions / parameters
* use a different model type / make the model more sophisticated

The summary should be understandable by a senior actuary. It should use appropriate language, clear formatting, accurate spelling and grammar and be in a sensible order.

Marks are awarded for:

* a clear, concise statement of the purpose and objective of the project
* a clear summary of the data and assumptions
* descriptions of the methods so that a senior actuary would understand what has been done
* clear presentation and interpretation of the results
* a clear layout
* an overall professional tone and style

# Further suggested reading for CA2

The following books may be helpful to those taking subject CA2 and can be requested from the libraries ([libraries@actuaries.org.uk](mailto:libraries@actuaries.org.uk))

* Excel 2007 formulas. Walkenbach, J. Wiley, 2007. xxxii, 804 pages. ISBN: 978-0470044025 (eBook available via the Athens portal, contact the library service for details)
* How to solve it: A new aspect of mathematical method. Polya, G. Penguin, new ed., 1990. 304 pages. ISBN: 978-0140124996
* Mastering financial mathematics in Microsoft Excel: A practical guide for business calculations. Day, A. 2nd ed. Financial Times-Prentice Hall, 2010. 384 pages. ISBN: 978-0273730330 (eBook available via the Athens portal, contact the library service for details)
* Spreadsheet check and control: 47 key practices to detect and prevent errors. O’Beirne, P. Systems Publishing, 2005. 189 pages. ISBN: 978-1905404001
* Successful ICT projects in Excel. Heathcote, P. M. 3rd ed. Payne-Gallway, 2002. 224 pages. ISBN: 978-1903112717

# Appendix 1 Syllabus for CA2

**Aim**

The aim of this subject is to ensure that the successful candidate can model data, document the work (including maintaining an audit trail for a fellow student and senior actuary), analyse the methods used and outputs generated and communicate to a senior actuary the approach, results and conclusions.

Subject CA2 – Model Documentation, Analysis and Reporting requires the student to undertake two practical modelling assignments.

Objectives I and II will be examined in part one of the exam; objectives III, IV and V will be examined in part two of the exam.

**Links to other subjects**

The models can be based on any of the Core Technical subjects CT1 - CT8. This subject also uses the principles in Subject CA1 – Actuarial Risk Management and some features of the communications development in Subject CA3 – Communications.

**Previous related study**

For exams until February 2015 a student needs to have passed or been granted an exemption from the Institute and Faculty of Actuaries for all the CT subjects. The student must also have at least one year’s work experience with an actuarial employer.

For exams from March 2015, there are no eligibility requirements.

The student needs a working knowledge of spreadsheets and word processing packages.

**Objectives**

The successful candidate will be able to demonstrate:

Analysis of data

1. Summarise data using appropriate analysis, descriptive statistics and graphical representation.
2. Select and carry out appropriate statistical tests of reasonableness.
3. Make appropriate assumptions about the data provided.
4. Repair corrupt or missing data.

II Development of a model with clear documentation (including an audit trail for a fellow student and senior actuary)

1. Plan and produce a spreadsheet model to solve a specified problem.
2. Document the results of the model including justification of key assumptions, detailing the methodology adopted, an appropriate level of reasonableness checks, sensitivities, and limitations.
3. Produce an audit trail enabling detailed checking and high-level scrutiny of the model by both audiences.

III Ability to analyse the methods used and the model’s outputs

1. Perform checks on the results of a model, including applying sensitivity and/or scenario tests.
2. Comment on the reasonableness of the results under different scenarios.

IV Ability to apply and interpret the results

1. Apply the results to the problem set, suggesting solutions.
2. Summarise the results using appropriate charts and tables.
3. Consider possible next steps.

V Communication of the approach, results and conclusions to a senior actuary

1. Plan and draft a summary document to cover the data, approach, assumptions, results, conclusions and suggested next steps.

**END OF SYLLABUS**

# Appendix 2 Background reading for CA2

**Introduction**

This background reading has been produced by the Institute and Faculty of Actuaries.

CA2 requires students to produce a model of an actuarial nature in Excel and document the model’s calculations in an audit trail. Students are also required to produce a summary of a separate model. The emphasis of the examination is on the clear documentation and communication of the modelling work, including its results. The technical actuarial modelling aspects carry less weight. This background reading does not prescribe how that documentation and communication should be carried out. In practice, how these tasks are carried out will depend on the circumstances of the work and any requirements that the actuary’s employer may have.

The Financial Reporting Council has issued Technical Actuarial Standards (TASs) that cover the issues addressed in CA2. This background reading introduces these TASs and students are expected to read them, be aware of the requirements therein and demonstrate compliance with those requirements in their exam submissions.

The background reading also considers actuarial models in general and starts with material very similar to some of the content of the Core Reading for CA1.

**UNIT 1 – MODELS**

*Syllabus objectives*

The successful student will be able to demonstrate:

1. development of a model including appropriate checks
2. ability to analyse the methods used and the model’s outputs, including checks on the results
3. ability to apply and interpret the results

**1 Possible approaches to solving actuarial problems**

There are various approaches that can be taken to produce the solution to an actuarial problem. Simple problems can have a simple solution that is arrived at by some straightforward mathematics, for example, calculating the yield on a fixed interest asset, or the present value of a series of known cash flows.

However, the majority of problems that require actuarial skills involve taking a view on uncertain future events. It is possible to make an assumption about various parameters, such as future economic conditions or future mortality rates, and produce a single answer that is appropriate under these particular assumptions. If this is done then the communication of the solution to the client needs particular care, because of the uncertainties in the underlying assumptions.

In these circumstances the client is likely to wish to know the variability of the answer provided, should circumstances not be as estimated. To assess the effects of varying the assumptions used in producing the answer, it is normally necessary to use an actuarial model of future events.

A model can be defined as “a cut-down, simplified version of reality that captures the essential features of a problem and aids understanding”. The final phrase in this definition recognises the importance of being able to communicate the results effectively. Modelling requires a balance to be struck between realism (and hence complexity) and simplicity (for ease of application, verification and interpretation of results).

**2 Model objectives and requirements for building a model**

Models will need to satisfy the following requirements:

* The model being used must be valid, rigorous enough for its purpose and adequately documented.
* The model chosen should be capable of adequately reflecting all the relevant features of the problem being modelled.
* The parameters used must allow for all those features of the problem being modelled that could significantly affect the advice being given.
* The inputs to the parameter values should be appropriate to the problem being modelled and take into account any special features of the environment in which it exists.
* The rationale for the choice of parameters should be clearly recorded.
* The workings of the model should be easy to appreciate and communicate. The results should be displayed clearly. The model should exhibit sensible joint behaviour of model variables.
* The outputs from the model should be capable of independent verification for reasonableness and should be communicable to those to whom advice will be given.
* The model must not be overly complex so that either the results become difficult to interpret and communicate or the model becomes too long or expensive to run, unless this is required by the purpose of the model. It is important to avoid the impression that everything can be modelled.
* The model should be capable of development and refinement — nothing complex can be successfully designed and built in a single attempt.

A range of methods of implementation should be available to facilitate testing, parameterisation and focus of results.

A stochastic model can test a wider range of scenarios, particularly economic scenarios. The use of a stochastic model goes some way to illustrating the potential variability of the experience, but the results that it produces are still dependent on the accuracy of the model and its parameter values. Where there is a meaningful amount of past data available then it is often possible to determine suitable probability distributions for the key variables. However, where such data is not available then building a stochastic model is unlikely to give much additional insight.

In using any model, its limitations and their potential impact on the users’ requirements should be recognised and presented alongside the model results.

**3 Basic features of a model**

Modelling could involve the following steps:

* Specify the purpose of the investigation.
* Collect, group and verify the data.
* Modify the data where necessary.
* Choose the form of the model, identifying its parameters and variables.
* Ascribe values to the parameters using past experience and appropriate estimation techniques.
* Construct a model based on the expected cash flows.
* Check that the goodness of fit is acceptable. This can be done by running a past year and comparing the model with the actual results.
* Attempt to fit a different model if the first choice does not fit well.
* Run the model using selected values of the variables.
* Run the model using estimates of the values of variables in the future.
* Run the model several times to assess the sensitivity of the results to different parameter values.

**4 Sensitivity analysis**

The results from the models depend on the model itself and the values assigned to the parameters in the model. Models should not be treated as black boxes, the output of which is assumed to be correct.

The re-running of a model with different, but feasible, parameter values will produce alternative results and hence help to illustrate the potential deviations. The re-running with a series of different sets of parameter values will help to illustrate the likely range in which actual experience may lie, perhaps as far as creating a probability distribution for this experience.

There is the possibility of model error if the model developed is not appropriate for the problem being modelled. Checks of goodness of fit will be needed to assess the suitability of the model.

The effect of misestimating of parameter values can also be investigated by carrying out a sensitivity analysis. This involves assessing the effect on the output of the model of varying each of the parameter values. When doing this any correlation between different parameters should be allowed for.

**UNIT 2 – PROFESSIONAL FRAMEWORK**

The professional framework of the Institute and Faculty of Actuaries comprises both ethical or conduct standards and technical or practice standards.

**1 Professional conduct standards**

The Institute and Faculty of Actuaries’ requirements are set out in the Actuaries’ Code. Detailed knowledge of the Actuaries’ Code is not required for examination purposes. However, the Code applies to all members, be they students or actuaries, and all members should be aware of the issues that are addressed in the Code. The Code may be accessed from the profession’s website at

<http://www.actuaries.org.uk/upholding-standards/standards-and-guidance/actuaries-code>

Professional skills and detailed consideration of the Actuaries’ Code are covered on courses at various stages of an actuary’s career, and all members of the IFoA are required to keep their professional, as well as their technical, skills up to date.

Professionalism is essential in setting the scene for the context in which the actuary will operate. The basic principles of professionalism will determine the suitability of solutions to the problems raised. A reading of the Actuaries’ Code is therefore likely to aid the actuary where professional judgement is required.

**2 Technical standards**

In the UK, actuarial technical standards are the responsibility of the Financial Reporting Council (FRC). This is a body that is independent from the Institute and Faculty of Actuaries.

The FRC issues Technical Actuarial Standards (TASs). The aim of the TASs is to ensure that users of actuarial information can have confidence in “the information’s relevance, transparency of assumptions, completeness and comprehensibility” (Scope & Authority of Technical Standards Section 8 – link given below).

TASs are issued on either specific or generic topics. The specific topics include areas such as insurance or pensions. The generic standards apply to all areas of actuarial work. The three generic standards cover Data, Modelling and Reporting. These are referred to as TAS(D), TAS(M) and TAS(R) respectively and the latest version may be accessed from the FRC’s website. Each of these Generic TAS documents has an impact on the modelling work performed by actuaries and is considered in more detail in this background reading.

The FRC intends to replace the Generic TASs within a single TAS 100 in due course but the principles applicable to CA2 are not expected to change.

The applicability of the TASs is set out in the document “Scope & Authority of Technical Standards” published by the FRC and available on their website at:

<http://frc.org.uk/Our-Work/Codes-Standards/Actuarial-Policy/Technical-Actuarial-Standards/Scope-Authority-of-Technical-Actuarial-Standards.aspx>

The TASs are being developed in the context of UK legislation and regulations. They apply to work done in relation to the UK operations of entities and any non-UK operations which report into the UK. However, for the Generic TASs wider adoption is encouraged by the FRC.

Work may depart from the requirements of a TAS if the departure is considered not to be material. In this context, something is material if, at the time the work is performed, the effect of the departure (or the combined effect if there is more than one departure) could influence the decisions to be taken by the users of the resulting actuarial information.

**3 Technical standards and CA2**

In Paper 1 of the CA2 exam, candidates are presented with background information to a problem for which an actuarial model is required. Candidates are required to use the background information, and any data supplied along with it, to construct a model (in Excel). Candidates are required to document that model in an audit trail.

In Paper 2 of the CA2 exam, candidates are presented with background information to a problem, together with a model and audit trail. Candidates are required to develop the model and then prepare a summary of the work done, including the model’s results and conclusions plus possible additional modelling steps that could be carried out. In writing the summary, in particular, students should demonstrate a good understanding of the problem being modelled in the discussions of their results.

CA2 exam assignments are framed in such a way that the Scope & Authority may be considered as not being applicable. However, for the purposes of CA2 examinations, students should operate on the basis that the Generic TASs **do** apply to their work.

Consequently, students are required to demonstrate compliance with the three Generic TASs in their exam submissions. As mentioned above, the FRC intends to replace the Generic TASs within a single TAS 100 in due course but the principles applicable to CA2 are not expected to change.

The exam assignments are structured so that the purpose of the summary is to provide material to a senior actuary, who will be reporting to the client/management. Candidates are expected to provide sufficient material for the senior actuary to provide a complete report to the client, but the summary may be regarded as an internal document and not one to be sent to a client. Hence, students may leave out any content required by TAS(R) to frame the report in the context of the agreed assignment – a brief introduction for the benefit of the senior actuary to reflect the work performed is sufficient. However, candidates are expected to provide complete material on which a report to the client may be based.

**UNIT 3 – DATA**

*Syllabus objectives*

The successful student will be able to demonstrate:

1. analysis of data

**TAS(D)**

TAS(D) was first published in November 2009 to take effect from 1 July 2010, with earlier adoption encouraged.

Its purpose is to ensure that data used in actuarial work is accurate, appropriate and complete. It defines data as “facts or information usually collected from records or from experience or observation” and TAS(D) applies to all data used in preparing the actuarial information.

For CA2, candidates will be provided with sufficient data to complete the requested model. However, the principles of TAS(D) still apply. In particular, candidates are expected to validate the data to the extent possible. To comply with the TAS(D) requirements, the validation checks must be recorded in the internal documentation.

Where data is incomplete or materially inadequate, then an assessment is required as to whether the reliability of the data can be improved by adjusting or supplementing it. Any steps taken to adjust the data need to be documented both in the internal documentation and, where material, in the report to the client.

The data used needs to be reported to the client as discussed in TAS(R).

**Further required reading:**

TAS(D) at

<http://frc.org.uk/Our-Work/Codes-Standards/Actuarial-Policy/Technical-Actuarial-Standards/TAS-D-Data.aspx>

**UNIT 4 – MODELLING**

*Syllabus objectives*

The successful student will be able to demonstrate:

1. development of a model with clear documentation (including an audit trail for a fellow student and senior actuary) and including appropriate checks
2. ability to analyse the methods used and the model’s outputs, including checks on the results

**TAS(M)**

TAS(M) was first published in April 2010 and took effect from 1 April 2011 with earlier adoption encouraged.

Part of the purpose of TAS(M) is to ensure that the models used in actuarial work are reasonable representations of the issue(s) being considered and are fit for purpose as both theoretical concepts and as practical tools. In addition, TAS(M) requires that the models be properly documented and that the significant limitations of the models are recorded, both in the model documentation and in the report to the users of the actuarial information.

The model documentation should contain sufficient detail for a technically competent person with no prior knowledge of the model to assess the judgements and assumptions made, as well as how the model actually works. The documentation should be clear, unambiguous and complete for its purpose. It is not sufficient for the model documentation to list only the model steps. The model steps and calculations must be described in sufficient detail to assist other users’ understanding.

TAS(M) requires that a model be validated as a satisfactory representation of the issue being modelled with a set of checks on the results. The checks must be included in the model documentation.

For CA2 exams, candidates are required to build, or add to, a model in Excel to address the problem given. The model must be a reasonable representation of the problem with any assumptions made by the student documented. An audit trail of the model is required and that audit trail should cover the documentation requirements of both TAS(M) and TAS(D).

**Further required reading:**

TAS(M) at

<http://frc.org.uk/Our-Work/Codes-Standards/Actuarial-Policy/Technical-Actuarial-Standards/TAS-M-Modelling.aspx>

**UNIT 5 – REPORTING**

*Syllabus objectives*

The successful student will be able to demonstrate:

1. ability to apply and interpret the results
2. communication of the approach, results and conclusions to a senior actuary

**TAS(R)**

TAS(R) was first published in September 2009, revised in November 2009, and took effect from 1 April 2010, with earlier adoption encouraged.

Its purpose is to ensure that the reporting of actuarial work allows those receiving the report to judge the relevance and implications of the report’s contents, as well as the information being presented, in a clear and comprehensible manner.

For CA2 Paper 2 exams, the summary of the work is deemed to be given to a senior actuary who will prepare and present a final report to the final user of the information. As such, candidates may produce a summary knowing that it will be read by a technically knowledgeable audience. Nevertheless, the summary should be clear and comprehensible for that audience. A summary to a senior actuary should be complete, covering all material and relevant information necessary for a report to the final user.

In CA2, candidates do not need to consider how a final report would be presented to the user of the actuarial information. However, the summary submitted should:

* + discuss any data used, the source of that data and, if applicable, any uncertainty over the accuracy of the data;
  + include a description of the material assumptions used and a rationale for those assumptions;
  + explain the calculations performed;
  + indicate any material uncertainty in the results presented, including any material limitations of the model from which the results are derived.

**Further required reading:**

TAS(R) at

<http://frc.org.uk/Our-Work/Codes-Standards/Actuarial-Policy/Technical-Actuarial-Standards/TAS-R-Reporting-Actuarial-Information.aspx>

# Appendix 3 Frequently Asked Questions

**Do I need any specific computer knowledge?**

The assignments will require knowledge of computer spreadsheets and word processing using Office 2007 or any later versions of Microsoft Office. Past exam questions are provided to help students understand the level of knowledge required. Employers are encouraged to look at these to provide guidance to students.

**What is the emphasis in the assessment?**

The emphasis is on the audit trail developed in the spreadsheet and the ability to analyse outputs and interpret the results obtained so that conclusions may be drawn. The key assessments are clear communication through both the audit trail and summary. The aims of the exam are that the successful candidate should demonstrate:

* Analysis and summary of data
* Development of a model with clear documentation (including an audit trail)
* Ability to analyse the methods used and the model's outputs
* Ability to apply and interpret the results
* Communication of the approach, results and conclusions to a senior actuary.

The communication aspects are the main part of the CA2 exam and these account for around 80% of the marks. There are relatively few marks for the techniques used in the models.

However, it will be much more difficult to present useful documentation if the model does not reflect what the client has actually asked for. Similarly it will be much more difficult to include good reasonableness checks in the audit trail and added value analysis of the results in the summary, if the results are not robust and/or do not make sense.

The sample projects illustrate what is required.

**What happens if the IT system crashes?**

For the online exam it is **your** responsibility to ensure that you have the correct IT equipment and working environment before the exam.

During the exam we stress the importance of saving your work regularly in order to avoid losing work should a technical problem occur. This scenario is very rare, and therefore each situation is dealt with on an individual basis.

Any technical issue that arises should be reported to the online team as soon as it happens so we can resolve it as quickly as possible.

**Will the marking of assessments be too subjective?**

Guidance on how the examiners mark CA2 is available on page 15of this guide. The Examiners receive training, and all results are reviewed by the Principal Examiner's team to ensure a consistent standard.**What happens if I keep failing?**

We hope that this will not happen, but exam counselling in this subject is available which may help you.

**Can I delay attendance if working on the past exam papers suggests that I am not yet competent? Will a refund be given if I don’t attend?**

If you have registered for the exam and do not feel ready, you may defer attendance but there will be some additional charge. For details of this please refer to the cancellation policy in the Student Handbook. The past exam questions on the website are intended for you to try before submitting your application.

**Can CA2 count towards my work-based skills log?**

The development in the office is likely to form part of your work-based skills but the attendance at the exam will not count.

# Appendix 4 Working through a past exam

This section uses a past exam to illustrate key aspects ofCA2. We suggest you work through this document, after you have reviewed other past exams on the website.

**As for most of the sample CA2 projects on the website, this past exam assesses all of the CA2 syllabus using one exam paper. As the objectives for CA2 have not changed under the two paper format, these examples continue to provide valuable practice for the CA2 exam.**

The requirements under the new format have been outlined on page four of this guide.

**Planning a model**

Having a good plan before you start working on any model is critical, and this is just as true in the CA2 exam.

Without doing this adequately, you are likely to build a model which does not address the problem effectively. Also, failure to plan carefully early on can lead to a model being unnecessarily complex, which also wastes time.

We suggest you try planning the model for the following past exam, **Project S01: Cohortico. Instructions and information** [pdf]



Plan out on paper how you would model the initial assignment, adapt it for the additional information and so produce the results which have been requested. Please note that for every exam all the required information is now issued at the start of the exam.

After 30 minutes, stop work and have a break for 15 minutes (or longer). Then revisit what you have done - seeing it with fresh eyes.

Ask yourself:

* What steps are clear?
* What is missing, or unclear?
* Have the key assumptions been identified?
* Are all the requested results achievable?
* Did I use the planning time effectively?

One possible sample solution and good practice notes for the S01 planning exercises are given in the **Project S01: Cohortico. Planning handout** [pdf]



You can compare this to your own plan and improve how you tackle this part of the task.

As well as planning the structure of the model, you will also need to plan a schedule of how you are going to use your time in the exam.

In CA2, time spent on a part of a question need not be proportional to the marks available. In particular, there are relatively few marks for the technical aspects of the model, or other spreadsheet work, so a few slips should not affect the pass/fail result. You don’t need the correct results to produce good audit documentation or a good summary, but it will be much more difficult to document the work adequately if the model and results do not reflect what the client has actually asked for. Similarly, it will be much more difficult to include good reasonableness checks in the audit, and added value analysis of the results in the summary, if the results are not robust and/or do not make sense.

Take some time to draft a plan, drawing on how you found the sample projects. Good time management is as important for CA2 as it is for any other exam. You will, of course, need to be flexible and the plan will be personal to you and possible time allocations have been given earlier.

In effect, you should be creating a mini project plan to make sure that you complete all of the tasks within the time allowed.

**Spreadsheet design and audit trails**

It is important to use a good spreadsheet design and produce a clear audit trail.

A weak example is given below, **Project S01: Cohortico. Weak spreadsheet** [excel]



Take 30 minutes to review this file, concentrating on:

* How good is the spreadsheet design?
* How could this be improved?
* How good is the audit trail in telling you, as a fellow student, how to check/amend/take forward the work?
* How could this be improved?
* **Repeat the above two aspects as if you were looking at it as a senior actuary.**

Some possible improvements are given in **Weak spreadsheet possible improvements** [pdf]



**Summaries**

A key part of the work in the CA2 exam is being able to summarise and report accurately and concisely the main features of the spreadsheet work, and being able to analyse and interpret the model outputs. This is examined in Paper 2.

For the purpose of this CA2 practical exam, the information should be drafted as appropriate for a senior actuary who will be presenting it to the client. As the key audience is an actuary, you do not need to worry about avoiding the use of ‘jargon’. However, you should bear in mind that the results and conclusions sections should focus on answering the client’s questions and helping them to understand the model outputs. It would not be appropriate to include Excel detail in the summary.

The following principles and format apply, namely:

* appropriate for a senior actuary
* consistent with a professional report (not a presentation) so with appropriate structure and format
* making use of bullet points rather than lots of prose
* charts and/or other visual aids to help
* and around 5-6 pages

Your summary should cover:

* everything that has been asked for, i.e. answer all of the questions raised
* an overview of the assignment
* a summary of the data provided, including the source of the data
* a description of what has been done and the methods in sufficient detail for a senior actuary to know what has been done, and why, and gain comfort that the results presented can be relied upon
* your approach to issues where judgement has been required, such as any data problems
* the main assumptions that you have made
* the results which have been requested
* meaningful conclusions and analytical comments explaining the results (this is a very important part)
* suggested next steps

A lot of candidates lose marks by omitting one or more of the areas that they have been asked to cover. In particular, candidates often do not include sufficient analytical commentary on the results (explaining why the results are as they are) or enough distinct next steps which are tailored to the scenario. These aspects carry many marks.

A weak example is given below, **Project S01: Cohortico. Weak summary** [pdf].



Take around 10 minutes to consider why this fell short of the pass criterion.

Possible points are given in **Project S01: Cohortico. Weak summary - possible improvements** [pdf]



**Marking a sample script**

Here is a tailored marking schedule, plus electronic version for the past exam S01, **Project S01 marking schedule** [pdf] plus **Project S01 Marksheet** [excel] for assignment S01.

 

You will see that:

* There are lots of marks for the audit trail
* There are lots of marks for the summary
* There are relatively few marks for the technical aspects of the model, so a few slips should not affect the overall pass/fail result. **However**, a reasonable approach and sensible results from the model are necessary to produce good audit documentation and a good summary. If you haven’t produced the outputs and results that the client specifically asked for, or checked that your answers are reasonable, or been able to include robust commentary justifying and explaining the results, then you will lose marks in the audit trail and summary, as well as for the model’s technical content and checks.
* Since July 2014, help on an individual basis has not been given to candidates in the exam. Instead, technical help, in the form of additional guidance, has been included in all CA2 exam questions and this will continue under the new format of the exam.
* For the exams used up to February 2015, there were two separate assessments to clarify the pass criterion; the one described at the end of the marking schedule is how the assessors considered borderline scripts. So, candidates needed to satisfy both audiences and have a reasonable audit trail and summary to pass.

From March 2015, the marking schedule for Paper 1 and Paper 2 will follow the same pattern, but with the assessment spread across two papers.

**Sample script**

A sample script has been prepared for you to mark:

* **Project S01 Marking the spreadsheet** [excel]
* **Project S01 Marking the summary** [pdf]

 

Mark the sample script according to the marking schedule. Then list five (or more) aspects which you feel could be improved.

When marking, always bear in mind the overall objectives of this practical exam. In particular, the principles of audit trails, model design and communication are much more important than the detailed accuracy of the formulae, and your marking should reflect this.

For this sample script, the technical aspects rated 8/10, so you do not need to mark this element. You can also assume that the student gained 5/5 for independent working.

Overall, the script is a borderline pass. Would you agree with this assessment?

There is still room for improvement and some possible improvements are given in **Project S01 Marking - possible improvements** [pdf]



**Producing your own solution**

We now suggest you produce your own full solution to the past exam S01.

Finally, here is a good script for you to review:

* **Project S01 good spreadsheet** [excel]
* **Project S01 good summary** [pdf]

 

Please note that is just one example of what would achieve a good pass on this assignment. It is not intended to be a ‘model’ or ‘perfect’ answer. Indeed, there are some calculation errors in this example.