



Institute
and Faculty
of Actuaries

A Guide to CP2 Modelling Practice for the 2019 exams

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Introduction to CP2 Modelling Practice

This guide should help answer your questions about subject CP2, including:

- the format of the online exam;
- guidance on how to pass the exam;
- administrative information; and
- technical information.

If you have any further questions that are not covered in this guide, please contact the Education Services Team: education.services@actuaries.org.uk

Important note:

Most of the sample CP2 past exam papers on the IFoA website assess the entire CP2 syllabus using one exam paper.

The objectives for CP2 have changed slightly under the new 2019 curriculum, the updated objectives and syllabus are included in Appendix 1. Past CA2 exam papers prior to the Curriculum 2019 changes still provide valuable practice for the CP2 exam (similarly, papers prior to the CA2 exam changing in 2015 to a two paper exam format provide valuable practise for the current exam).

What is the CP2 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 CP2 is about making clear what you have done, so that it can be followed by others. You are required to use judgment and state your assumptions.

The solutions to past exams (available on the IFoA website) show approaches that would qualify as a good pass standard over the two papers. However, it should be noted that these include more detail than would ordinarily be possible within the time allowed for the examination.

How has CP2 been developed?

CP2 has been influenced by external pressures: the Actuarial Profession Standards (APSS), the International Standard of Actuarial Practice, the Actuaries’ Code, the regulators, Sarbanes Oxley and Solvency II requirements. A summary of these are set out for reference below.

- **Actuarial Profession Standards (APSS)**

The latest standards can be found on the IFoA website:

<https://www.actuaries.org.uk/upholding-standards/standards-and-guidance/actuarial-profession-standards-apss>

These are standards which apply to all IFoA members regardless of location.

- APS X1 sets out how to determine which standards are applicable to actuarial work. In particular, 2.1: [IFoA] Members should ensure that their Actuarial Work is carried out in a way that is substantially consistent with ISAP 1.

- **The Actuaries’ Code**

The latest Actuaries Code can be found on the IFoA website:

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

The Code requires us to “perform professional duties competently and with care” and to “ensure that their communication, whether written or oral, is clear...”.

- **International Standards of Actuarial Practice (ISAP)**

The latest ISAPs can be found on the International Actuarial Association’s website:

https://www.actuaries.org/IAA/Documents/CTTEES_ASC/Final_ISAPs_Posted/ISAP1_Review_adopted_1Dec2018.pdf

- ISAP 1: General Actuarial Practice. This is a model standard for actuarial standard-setting bodies to consider when setting standards relating to the guidance to actuaries when performing actuarial services. The interpretation of the standard varies by geographic location, but given the above requirements of APS X1 the following are relevant to CP2:
 - Under 2.5, any data is required to be reliable for the purpose of the actuarial services provided, that is the data is materially accurate. Validation of data is required and consideration of any deficiencies in the data should be considered. Both of these areas should be documented in a report.

- The assumptions and methodology used (including, but not limited to, models and modelling techniques) are disclosed appropriately.
- Section 3 sets out the communication standards and in particular the reporting requirements.
 - ISAP 1A: Governance of Models. This provides guidance to actuaries on model governance when performing actuarial services involving models.
- The IFoA considers the framework of standards applying to its members is substantially consistent with ISAP 1.
- **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 CP2 exams

The CP2 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 days 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 2: AM - 3 hours 15 minutes

Note: from 2019 onwards the 15 minutes reading time that was available will now be included in the overall exam time. It is therefore up to candidates to manage their time between reading the scenario provided and modelling, writing etc. The CP2 examiners however, expect successful candidates will spend an appropriate amount of time reading the scenario provided and planning their response.

What is the format of the CP2 exam?

This brief overview of the CP2 exam should be read alongside the Syllabus in Appendix 1, the main elements of which can be summarised as:

- 1 Prepare and summarise data and undertake exploratory data analysis and visualisation.
- 2 Construct an actuarial model to solve a realistic problem.
- 3 Document the model by constructing an audit trail.
- 4 Analyse the methods used, and outputs generated.
- 5 Apply and interpret the results.
- 6 Communicate the results.

The CP2 exam consists of two 3 hour 15 minute papers:

- Paper 1 will largely focus on elements 1, 2 and 3.
- Paper 2 will largely focus on elements 4, 5 and 6.

Each paper will use a different model.

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; and
- 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.

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 the summary.
- The senior actuary needs enough detail in the summary to be able to follow, and critique, what you have done.

What exams should I have passed before sitting CP2?

There are no eligibility requirements for CP2.

However, the models can be based on any of the Core Principles subjects: CM1, CM2, CS1 and CS2. CP2 also uses the principles in the Core Practices subject CP1, and it also uses some features of the Core Practices subject CP3.

You may therefore prefer to wait until you have tackled CM1, CM2, CS1, CS2, CP1 and CP3 before sitting this exam.

I want to sit the exam. What do I need to do?

Information can be found on the IFoA website with respect to:

- how to book an exam;

The relevant page is:

<https://www.actuaries.org.uk/studying/exam-bookings>

Professional conduct during the CP2 exam

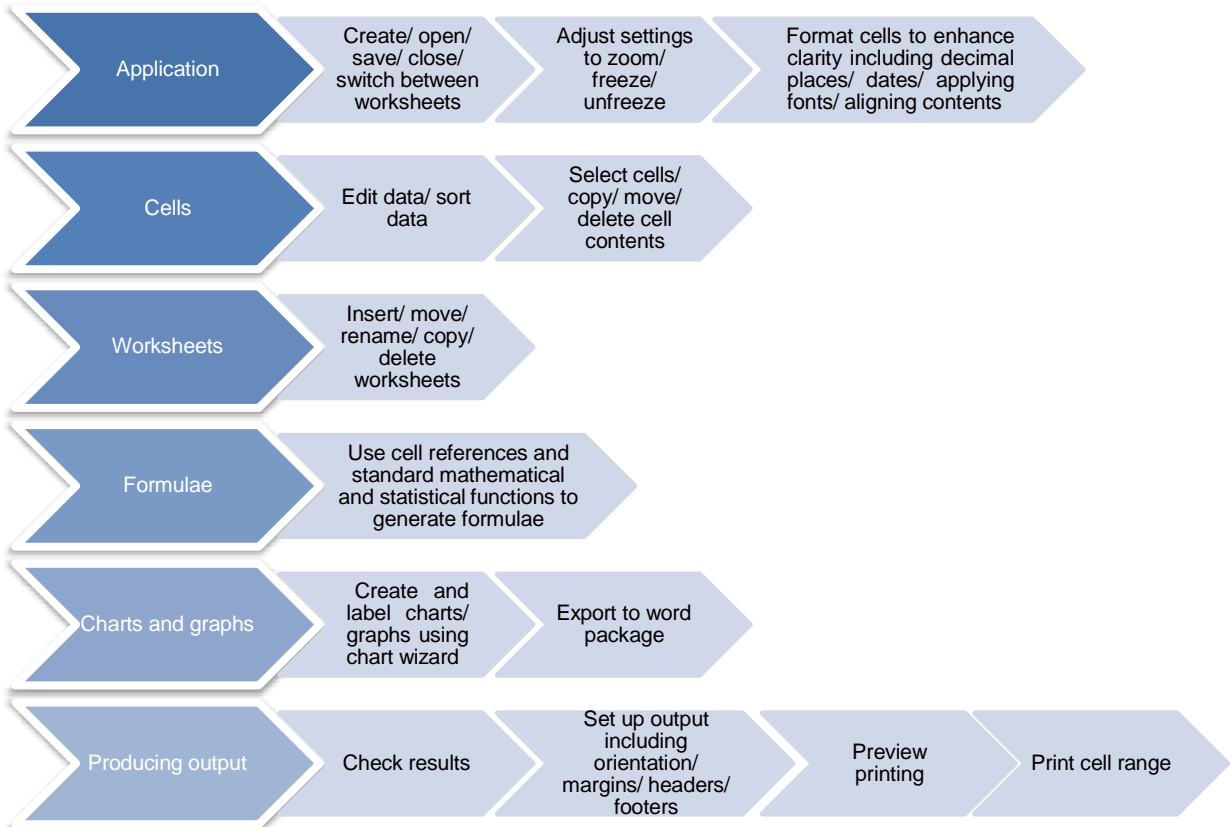
It is important to note that professional conduct is required at all times and the following will apply:

- The Assessment 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 CP2 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 electronic material that has been pre-prepared or copied in your exam submission (for example, pre-prepared Word or Excel documents). A specific example that would not be permitted is a pre-prepared generic list of next steps copied and used without explanation or lacking appropriateness to a given scenario in a paper. This approach will gain little credit from the CP2 examiners.
- In Paper 2, you must write the Summary document without the use of template headings and without copying large sections from the Examination Question (including the audit trail found within this paper). Candidates who copy large sections of the information in the exam question and/or the audit trail provided into their Summary document, without consideration of the purpose of the Summary document or the target audience, are likely to gain very little credit from the examiners.
- 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.

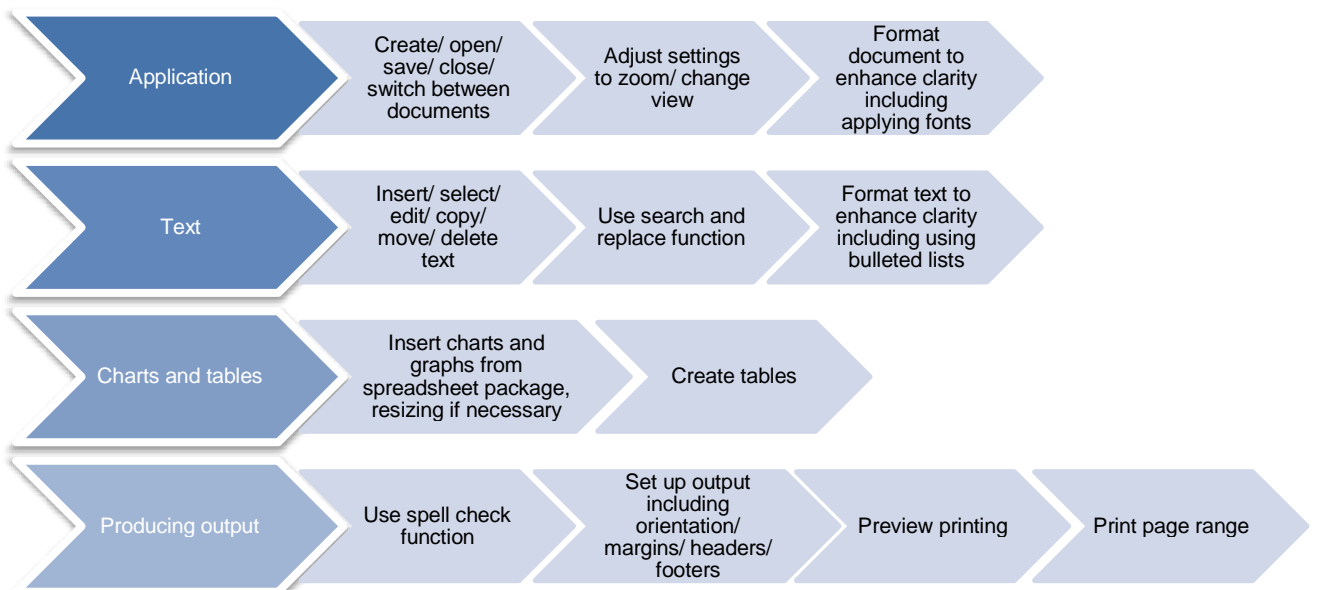
What should I know before sitting CP2?

You should have the following knowledge

Spreadsheets



Word processing



Excel knowledge

Suitable knowledge

Excel is the software package used for the modelling aspects of CP2. Although detailed knowledge of Excel is not part of the examination (and hence extensive knowledge of Excel functions is not necessary), candidates will be expected to model calculations effectively using this software.

A CP2 candidate should have experience of using Excel and, importantly, be able to create a spreadsheet from scratch. Candidates 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 practise.

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

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

As well as the above built-in functions, candidates 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. Candidates are advised to look up the 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, considering 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 CP2?

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 scratch, you should practise this by attempting past papers.

The types of problems that are asked in CP2 have been published on the website. Review the sample solutions, plus the comments from the examiners (where these are provided)

<https://www.actuaries.org.uk/studying/prepare-your-exams/past-exam-papers-and-examiners-reports>

It is also helpful to review how the CP2 exam is marked and there is information on this 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. One area to emphasise is the importance of spending time reading and understanding the paper before beginning to answer the questions.

For Paper 1

- Allocate time at the beginning of the exam for:
 - reading and understanding the paper;
 - planning the model;
 - creating the model itself; and
 - maintaining the audit trail (perhaps in sections).
- A possible split is:
 - Reading – 15 minutes.
 - Planning – 30 minutes.
 - Modelling – 1.5 hours.
 - Audit trail – 1 hour.

For Paper 2

- Allocate time for:
 - reading and understanding the paper;
 - planning the spreadsheet work required;
 - doing this work; and
 - writing the summary.
- A possible split is:
 - Reading – 15 minutes.
 - 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.
- 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 references are provided.
- 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: CP2 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 Goal Seek 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 on 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: CP2 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 (however they do not need to be able to check your Excel spreadsheet using this document).
- 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. Have consideration of the purpose of the Summary document and the target audience. For example, the Summary document is not intended to be used to help check the model, therefore Excel references are inappropriate. Candidates who copy large sections of the information in the exam question and/or the audit trail provided into their Summary document are likely to gain very little credit from the examiners for this.
- 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, and any comments that follow from the reasonableness checks.
- You also should include a comprehensive set of possible next steps.

Why do candidates fail CP2?

Some students have asked for feedback on why candidates fail CP2, and the examiners have provided the following summary:

- Some candidates do not prepare sufficiently in advance of sitting the exam. It is vital that candidates understand for each aspect of the exam how many marks are likely to be available for that aspect, and then be prepared to spend an appropriate amount of time on it. For example, in Paper 1 there are often 30 marks available (out of a total of 100) for the student to complete the required spreadsheet modelling and checks. If the student spends more than half of the available time in the exam on this aspect, then it is highly likely they will not have sufficient time to spend on the other aspects required in the paper. This will make it very difficult for them to pass. Therefore, it is important to practise past exam papers under exam conditions to develop: a thorough structural understanding of the papers; and the techniques of planning and time management.
- 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 fully understand 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 of thought to the layout.
 - Eight pages of densely typed text in 8 point font will not produce an easy to follow or intelligible audit trail. For a CP2 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 on an elaborate format but invest some time in making it clear to follow and read.
 - Similarly the summary should be clearly laid out.
- Proofread 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 CP2 is marked

To aid your preparation for the CP2 Modelling Practice 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 CP2, together with the general format of the marking schedule which will be used by markers in assessing a candidate's submissions.

The CP2 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 CP2 section of the website and we advise candidates to work through these to appreciate the overall coverage which is required.

Remember:

Some of the sample CP2 assignments and past exam papers on the IFoA website assess all of the CP2 syllabus using one exam paper.

As mentioned in the introduction, the pre-2019 past exam papers continue to provide valuable practise opportunities for the CP2 exam.

Marking schedule

In assessing CP2 submissions, the following marking schedule will be used.

The marking schedule shows an approximate typical mark allocation over the combined papers, though the marks will vary 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	10%	
Audit trail content	19%	
Data analysis and preparation	3%	
Checks	3%	
Model development and good techniques	15%	6%
Summary description and approach		12%
Summary results		10%
Summary conclusions and next steps		17%
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.

Audit trail approach

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 fellow student who has not seen the model before ('fellow student'), the audit trail is easy to follow, and they do 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. Goal Seek, 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, including.
 - Accurate spelling.
 - Clear layout.
- 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.

Audit trail content

Marks are awarded for:

- All steps being clearly explained.
 - Detail is appropriate for a fellow student 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, including:
 - 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 the question).
 - Each part of the method.
 - Construction and use of charts.

Checks

- 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.

Use of appropriate techniques in model

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:

- Identification of errors or issues with the data.
- 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. This 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).

Description and approach

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.

Results

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.

Conclusions and next steps

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 the validity of each. 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.

Drafting

The summary should be understandable to 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 professional tone and style throughout.

Appendix 1

Syllabus for CP2

Aim

The aim of the Modelling Practice 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.

Competences

On the successful completion of this subject, the candidate will be able to:

1. Prepare and summarise data and undertake exploratory data analysis and visualisation.
2. Construct an actuarial model to solve a realistic problem.
3. Document the model by constructing an audit trail.
4. Analyse the methods used, and outputs generated.
5. Apply and interpret the results
6. Communicate the results.

Links to other subjects

This subject builds upon concepts introduced in **CM1 – Actuarial Mathematics 1**, and **CM2 – Actuarial Mathematics 2**. It can also use material from **CS1 – Actuarial Statistics 1**, and **CS2 – Actuarial Statistics 2**.

This subject also uses the principles in **CP1 – Actuarial Practice** and some features of the communications development in **CP3 – Communication Practices**.

Syllabus topics

- 1 Preparation and exploratory analysis of data (2%) (0% - 10%).
- 2 Development of a model (18%) (15% to 20%) with clear documentation (30%) (25% - 35%).
- 3 Analysis of methods and model outputs (10%) (10% - 20%).
- 4 Application and interpretation of results (20%) (15% - 25%).
- 5 Communication of results and conclusions (20%) (20% - 35%).

The mean weightings are indicative of the approximate balance of the assessment of this subject between the main syllabus topics, averaged over a number of examination sessions, and taking into account how the subject is to be examined in future.

In addition to the mean weightings, a range for the weightings has been provided to indicate how the typical weightings of main syllabus topics may vary in a given examination session. This reflects the variation resulting in the underlying models used and the questions asked in a given examination session.

The weightings also have a correspondence with the amount of learning material underlying each syllabus topic. However, this will also reflect aspects such as:

- the relative complexity of each topic, and hence the amount of explanation and support required for it;
- the need to provide thorough foundation understanding on which to build the other objectives;
- the extent of prior knowledge which is expected; and
- the degree to which each topic area is knowledge or application based.

Skill levels

The use of a specific command verb within a syllabus objective does not indicate that this is the only form of question which can be asked on the topic covered by that objective. The examiners may ask a question on any syllabus topic using any of the agreed command verbs, as are defined in the document “Command verbs used in the Associate and Fellowship written examinations”.

Questions may be set at any skill level: **Knowledge** (demonstration of a detailed knowledge and understanding of the topic), **Application** (demonstration of an ability to apply the principles underlying the topic within a given context) and **Higher Order** (demonstration of an ability to perform deeper analysis and assessment of situations, including forming judgements, taking into account different points of view, comparing and contrasting situations, suggesting possible solutions and actions, and making recommendations).

In the CP2 subject, the approximate split of assessment across the three skill types is 20% Knowledge, 50% Application and 30% Higher Order skills.

Detailed syllabus objectives

1 Preparation and analysis of data (10%)

- 1.1 Use appropriate tools for cleaning, restructuring and transforming data to make it suitable for analysis.
- 1.2 Summarise data using appropriate analysis, descriptive statistics and graphical representation.
- 1.3 Select and carry out appropriate statistical tests of reasonableness.
- 1.4 Make appropriate assumptions about the data provided.
- 1.5 Repair corrupt or missing data.

2 Development of a model with clear documentation (30%)

- 2.1 Plan and produce a spreadsheet model to solve a specified problem.
- 2.2 Document the results of the model including justification of key assumptions, detailing the methodology adopted, an appropriate level of reasonableness checks, sensitivities and limitations.
- 2.3 Produce an audit trail enabling detailed checking and high-level scrutiny of the model by a fellow student and a senior actuary.

3 Analysis of methods used and model outputs (15%)

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

4 Application and interpretation of results (20%)

- 4.1 Apply the results to the problem set, suggesting solutions.
- 4.2 Summarise the results using appropriate charts and tables.
- 4.3 Consider possible next steps.

5 Communication of results and conclusions (25%)

- 5.1 Plan and draft a summary document to cover the data, approach, assumptions, results, conclusions and suggested next steps for presentation to a senior actuary.
- 5.2 Create appropriate data visualisations to communicate the key conclusions of an analysis.

Assessment

Two computer based modelling assignments.

END OF SYLLABUS

Appendix 2

Background reading for CP2

Introduction

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

CP2 requires candidates to produce a model in Excel and document the model's calculations in an audit trail. Candidates are separately required to produce a summary of a second 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 IFoA has issued Actuarial Profession Standards and the International Actuarial Association has issued International Standards of Actuarial Practice that cover the issues addressed in CP2. This background reading introduces these standards and candidates 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 CP1.

UNIT 1 – MODELS

The successful student will be able to demonstrate:

- Syllabus objectives 2.1 to 2.3
- Syllabus objectives 3.1 to 3.3
- Syllabus objectives 4.1 to 4.3

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 mis-estimation 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:

<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 Actuarial Profession Standards

The IFoA is responsible for setting and maintaining ethical standards with the setting and maintaining of technical standards delegated to the relevant authority in a given country or geographic area. For example, in the UK, technical standards are the responsibility of the Financial Reporting Council (FRC).

The ethical standards set and maintained by the IFoA are the Actuarial Profession Standards (APSs). These apply to all members of the IFoA regardless of location. APSs are issued on either specific or generic topics. The specific topics include areas such as insurance or pensions. Of the generic topics **APS X1: Applying Standards to Actuarial Work**, and **APS X2: Review of Actuarial Work** are particularly relevant for CP2. They both have an impact on the modelling work performed by actuaries and they are considered in more detail in this background reading.

APS X1 sets out the principles to be applied by members to determine which standards they must or should be applying to a piece of work. It clarifies that all members, regardless of where they are located, must apply the Actuaries' Code and relevant APSs. It also sets out principles for members to follow in identifying and applying appropriate standards to their work. This is of particular relevance for those members working in geographically complex situations or where there are competing standards that might apply to their work. As an example, for members carrying out work that is within 'UK Geographic Scope', there is a requirement to apply the FRC's Technical Actuarial Standards (TASs) which can be found on their website.

APS X2 imposes requirements in relation to review of actuarial work and independent peer review.

The latest versions may be accessed from the IFoA's website:

<https://www.actuaries.org.uk/upholding-standards/standards-and-guidance/actuarial-profession-standards-apss>

3 Technical standards and CP2

In Paper 1 of the CP2 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 CP2 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, candidates should demonstrate a good understanding of the problem being modelled in the discussions of their results.

Due to geographic variations of technical standards the **International Standard of Actuarial Practice 1 (ISAP 1)** and **International Standard of Actuarial Practice 1A (ISAP 1A)** have been assumed to apply to the work of candidates in the CP2 exam (along with APS X1 and APS X2). In combination with APS X1 geographic variations of technical standards more relevant to CP2 are unlikely to depart significantly from ISAP 1 or ISAP 1A. The more relevant parts are covered below.

Consequently, candidates are required to demonstrate compliance with ISAP 1 and ISAP 1A in their exam submissions. The current version of ISAP 1 is:

www.actuaries.org/CTTEES_ASC/isaps/Final_ISAPs_posted/Conformance_Changes_Final_ISAPs_posted/ISAP1_Conformance_April2017.pdf

and the current version of ISAP 1A is:

www.actuaries.org/CTTEES_ASC/isaps/Final_ISAPs_posted/ISAP_1A_Final_November2016_Web.pdf

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, candidates may leave out any content required by ISAP 1 (section 3) 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

The successful candidates will be able to demonstrate:

- Syllabus objectives (taken from appendix 1 above) 1.1 to 1.5

ISAP 1: Subsection 2.5

Its purpose is to ensure that sufficient and reliable data is available to perform the actuarial services. Data is considered sufficient if it includes the appropriate information for the work. Data is considered reliable if that information is materially accurate.

For CP2, candidates will be provided with sufficient data to complete the requested model. However, the principles of ISAP 1 still apply. In particular, candidates are expected to validate the data by taking reasonable steps to review the consistency, completeness and accuracy of the data used. To comply with the ISAP 1 requirements in 2.5.2, the validation checks must be recorded in the report.

Consideration should be given to the possible effect of any data deficiencies (such as inadequacy, inconsistency, incompleteness, inaccuracy, and unreasonableness) on the work. Where deficient data is likely to materially affect the results then 2.5.4(c) is considered to apply for CP2. In particular, the candidates should perform the work as well as possible and disclose the data deficiencies in the report (including an indication of the potential impact of those data deficiencies).

UNIT 4 – MODELLING

The successful candidate will be able to demonstrate:

- Syllabus objective 2.1 and 2.3

ISAP 1A

The purpose of ISAP 1A is to provide guidance to actuaries on model governance when performing actuarial services involving models, to give intended users confidence that:

- Actuarial services are carried out professionally and with due care.
- The results are relevant to their needs, are presented clearly and understandably, and are complete.
- The assumptions and methodology (including, but not limited to, models and modelling techniques) used are disclosed appropriately.

The ISAP addresses how modelling activities in which an actuary may be involved should be governed, rather than how these activities should be performed.

For CP2 exams, candidates are required to build, or add to, a model in Excel to address the problem given, therefore subsection 2.2 does not apply for the exam.

- For Paper 1 candidates are required to develop their own model. Subsection 2.4 requires documentation (where appropriate) of the model design, construction, and operation (including where appropriate scope, purpose, methodology, statistical quality, calibration, and fitness for intended purpose), and conditions under which it is appropriate to use the model, including any limitations of the model.
- For Paper 2 candidates are required to modify a model provided. Subsection 2.3 requires that the student understands the model and document as appropriate the changes made to, and any material impact of the changes on, the model's scope, purpose, methodology, statistical quality, calibration, fitness for intended purpose, and conditions under which it is appropriate to use the model, including any limitations of the model.

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 in ISAP 1 and ISAP 1A.

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.

ISAP 1A requires that a model be validated, which includes that it reasonably fits its intended purpose. For CP2 this should take the form of a set of checks on the results. The checks must be included in the model documentation.

UNIT 5 – REPORTING

Syllabus objectives (taken from appendix 1 above)

The successful candidate will be able to demonstrate:

- Syllabus objectives 3.1 to 3.3 (taken from appendix 1 above)
- Syllabus objectives 5.1 to 5.3 (taken from appendix 1 above)

ISAP 1: Subsection 3.2

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 CP2 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 CP2, 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; and
- indicate any material uncertainty in the results presented, including any material limitations of the model from which the results are derived.

Appendix 3

Frequently Asked Questions

Answers to questions that have been asked about the CP2 Modelling Practice exam.

Do I need any specific computer knowledge?

The assignments will require knowledge of computer spreadsheets and word processing. Guidance has been given earlier on the level of knowledge required. Past exam questions are provided to help candidates 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 the ability to:

- 1 Prepare and summarise data and undertake exploratory data analysis and visualisation.
- 2 Construct an actuarial model to solve a realistic problem.
- 3 Document the model by constructing an audit trail.
- 4 Analyse the methods used, and outputs generated.
- 5 Communicate the results.

The communication aspects are the main part of the CP2 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 CP2 is given earlier in this guide. The examiners receive training, and all papers are marked in line with guidance issued by the IFoA. Each script is marked by at least two independent assistant examiners, with borderline cases normally marked by a third examiner.

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 see 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 CP2 count towards my work-based skills log?

The development you record from experience in the office may form part of your PPD but the attendance at the exam will not count.

END