



Institute
and Faculty
of Actuaries

EXAMINERS' REPORT

CM1 – Actuarial Mathematics

Core Principles

Paper A

September 2022

Introduction

The Examiners' Report is written by the Chief Examiner with the aim of helping candidates, both those who are sitting the examination for the first time and using past papers as a revision aid and also those who have previously failed the subject.

The Examiners are charged by Council with examining the published syllabus. The Examiners have access to the Core Reading, which is designed to interpret the syllabus, and will generally base questions around it but are not required to examine the content of Core Reading specifically or exclusively.

For numerical questions the Examiners' preferred approach to the solution is reproduced in this report; other valid approaches are given appropriate credit. For essay-style questions, particularly the open-ended questions in the Specialist Advanced (SA) and Specialist Principles (SP) subjects, the report may contain more points than the Examiners will expect from a solution that scores full marks.

The report is written based on the legislative and regulatory context pertaining to the date that the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

Sarah Hutchinson
Chair of the Board of Examiners
December 2022

A. General comments on the aims of this subject and how it is marked

CM1 provides a grounding in the principles of modelling as applied to actuarial work - focusing particularly on deterministic models which can be used to model and value known cashflows as well as those which are dependent on death, survival, or other uncertain risks.

Please note that different answers may be obtained to those shown in these solutions depending on whether figures obtained from tables or from calculators are used in the calculations, but candidates are not penalised for this. However, candidates may not be awarded full marks where excessive rounding has been used or where insufficient working is shown.

Although the solutions show full actuarial notation, candidates were generally expected to use standard keystrokes in their solutions.

Candidates should pay attention to any instructions included in questions. Failure to do so can lead to fewer marks being awarded. In particular, where the instruction, “*showing all working*” is included and the candidate shows little or no working, then the candidate will be awarded very few marks even if the final answer is correct.

Where a question specifies a method to use (e.g. *determine the present value of income using annuity functions*) then, if a candidate uses a different method, the candidate will not be awarded full marks.

Candidates are advised to familiarise themselves with the meaning of the command verbs (e.g. state, determine, calculate). These identify what needs to be included in answers in order to be awarded full marks.

B. Comments on candidate performance in this diet of the examination.

The comments that follow the questions concentrate on areas where candidates could have improved their performance. Where no comment is made, the question was generally answered well. The examiners look most closely at the performance of the candidates close to the pass mark and the comments therefore often relate to those candidates.

As in previous exam diets, there appeared to be a large number of insufficiently prepared candidates who had underestimated the quantity of study required for the subject.

The nature of the online exam format meant that there was little on the paper that could be answered via bookwork knowledge alone.

Where candidates made numerical errors, the examiners awarded marks for the correct method used and also for the parts of the calculation that were correct. However, many candidates often did not show enough of their working to fully benefit from this.

The Examiners felt that the “open book” nature of the online exam led some candidates to rely on their notes much more than if the exam had been “closed book”. The Examiners

strongly recommend that candidates prepare for online exams just as thoroughly as they would do if the exam were of the traditional “closed book” format. Candidates are recommended to use their notes only as a tool to check or confirm answers where necessary, rather than as a source for looking up the answers.

C. Pass Mark

The Pass Mark for this exam was 58.
1,419 presented themselves and 419 passed.

Solutions for Subject CM1 Paper A– September 2022

Q1

$$\begin{aligned}
 {}_{3.5}q_{56.25} &= 1 - {}_{3.5}p_{56.25} && [1/2] \\
 &= 1 - {}_{0.75}p_{56.25} \times {}_2p_{57} \times {}_{0.75}p_{59} && [1/2] \\
 {}_{0.75}p_{56.25} &= (p_{56})^{0.75} = (93,583/94,082)^{0.75} = 0.99602 && [1] \\
 {}_2p_{57} &= 92,415/93,583 = 0.98752 && [1/2] \\
 {}_{0.75}p_{59} &= (p_{59})^{0.75} = (91,732/92,415)^{0.75} = 0.99445 && [1/2] \\
 {}_{3.5}p_{56.25} &= 0.99602 \times 0.98752 \times 0.99445 = 0.97813 && [1/2] \\
 \text{Therefore, } {}_{3.5}q_{56.25} &= 1 - 0.97813 = 0.02187 && [1/2]
 \end{aligned}$$

This question was generally well answered.

Some students used the uniform distribution of deaths (UDD) approach rather than the required constant force of mortality approach and were awarded fewer marks.

Q2

From the investor's perspective:

For a cash on deposit investment, the timings of the future positive cashflows are known, they will receive interest payments when the deposit sum is withdrawn and will withdraw the deposit at the end of the 5-year period [1]

There is an initial negative cashflow at time $t=0$ when the investor makes the deposit.

Both the size and the timing of this cashflow are known [1]

It is possible that the investor may make an early withdrawal of the deposit, in which Case the timing of future positive cashflows will be unknown [1]

Irrespective of when the deposit is withdrawn, the amounts of the interest payments are unknown as interest is added at the variable market interest rate [1]

The amount of the final withdrawal payment is unknown, it will be equal to the initial amount deposited plus the added interest payments which are unknown [1]

[Marks available 5, maximum 4]

This question was poorly answered.

The question clearly specified what the examiners expected candidates to comment on. By focussing on that and using logical thinking, candidates should have been able to generate many of the points in the marking schedule.

Poor attempts commonly included several points from bookwork, that were either irrelevant or too general. Candidates were not given credit for this.

Q3

$$1,000,000 \times (1.005)^{25 \times 2} = 1,283,225.814935 \quad [1]$$

$$i = 2.5\% \Rightarrow d^{(12)} = 2.4667\%$$

$$1,283,225.814935 = 12X \times \ddot{s}_{10|}^{(12)} \times (1.025)^{15} + 24X \times \ddot{s}_{15|}^{(12)} \quad [2\frac{1}{2}]$$

$$\ddot{s}_{10|}^{(12)} = 11.354521903 \quad [1/2]$$

$$\ddot{s}_{15|}^{(12)} = 18.173838778 \quad [1/2]$$

$$1,283,225.814935 = X \times 633.508929702$$

$$X = 2,025.584415 = \$2,025.58 \quad [1/2]$$

This question was generally well answered.

Common errors included: -

- *Taking the \$1,000,000 as the value at time 0*
- *Using present values rather than accumulation factors for the annuity payments (without also discounting \$1,283,225.81 back to time 0)*
- *Trying to incorporate mortality when no such assumption was mentioned*
- *Dealing incorrectly with inflation (it was given as a half-yearly effective rate)*
- *Treating X as the annual payment per year, even though the question defined it as the monthly payment.*

Q4

(i)

Expected present value of a payment 1... [1/2]

...payable immediately on the death of the 45 year old... [1/2]

...provided this occurs in the next 20 years and... [1/2]

...that the 50 year old has already died. [1/2]

(ii)

The required probability is given by:

$$\int_0^{\infty} {}_tP_x \times {}_{t+3}P_y \times \mu_{x+t} dt \quad [1\frac{1}{2}]$$

$$= \int_0^{\infty} e^{-0.025t} \times e^{-0.02 \times (t+3)} \times 0.025 dt \quad [1\frac{1}{2}]$$

$$= 0.025e^{-0.06} \times \int_0^{\infty} e^{-0.045t} dt$$

$$= 0.025e^{-0.06} \times \left[\frac{e^{-0.045t}}{-0.045} \right]_{t=0}^{t=\infty}$$

$$= \frac{0.025e^{-0.06}}{0.045}$$

$$= 0.52320 \quad [2]$$

Alternative:

$$\text{Probability} = \int_3^{\infty} {}_t p_y \times \mu_{y+t} (1 - {}_{t-3} p_x) dt$$

Letting $u = t - 3$ then $\frac{du}{dt} = 1$ and:

$$\text{Probability} = \int_0^{\infty} {}_{u+3} p_y \times \mu_{y+u+3} du - \int_0^{\infty} {}_{u+3} p_y \times \mu_{y+u+3} \times {}_u p_x du$$

$$= {}_3 p_y \int_0^{\infty} {}_u p_{y+3} \times \mu_{y+u+3} du - {}_3 p_y \int_0^{\infty} {}_u p_{y+3} \times \mu_{y+u+3} \times {}_u p_x du$$

$$= {}_3 p_y \left(\int_0^{\infty} e^{-0.02u} \times 0.02 (1 - e^{-0.025u}) du \right)$$

$$= e^{-0.06} \times 0.02 \times \int_0^{\infty} (e^{-0.02u} - e^{-0.045u}) du$$

$$= e^{-0.06} \times 0.02 \times \left[\frac{e^{-0.02u}}{-0.02} - \frac{e^{-0.045u}}{-0.045} \right]_0^{\infty}$$

$$= e^{-0.06} \times 0.02 \times \left(\frac{1}{0.02} - \frac{1}{0.045} \right)$$

$$= e^{-0.06} \times \left(1 - \frac{0.02}{0.045} \right)$$

$$= 0.52320$$

Part (i) was done reasonably well, but the first point was often overlooked.

Part (ii) was often not attempted. Joint lives as a topic remains a challenge to many candidates. However, starting from first principles, several marks were available for writing down exactly what was asked for in notation form.

Q5

(i)

Let H denote PV of the benefit

Then, we have:

$$H =$$

$$90,000v_{6.5\%} = 84,507.04 \quad \text{with probability} \quad q_{62} = 0.010112 \quad [1]$$

$$50,000v_{6.5\%}^2 = 44,082.96 \quad \text{with probability} \quad {}_1q_{62} = \frac{d_{63}}{l_{62}} = \frac{102.5202}{9,129.7170} = 0.011229 \quad [2]$$

Thus, we have:

$$E(H) = 84,507.04 \times 0.010112 + 44,082.96 \times 0.011229 = \text{£}1,349.54 \quad [1]$$

$$E(H^2) = 84,507.04^2 \times 0.010112 + 44,082.96^2 \times 0.011229 = 94,035,637.73 \quad [1]$$

And, thus, we have:

$$\text{var}(H) = E(H^2) - [E(H)]^2 = \text{£}^2 92,214,379.52 = (\text{£}9,602.83)^2 \quad [1]$$

(ii)

(a)

If the life had been older than 62 then the mortality probabilities would have increased and so the mean would have increased [1]

(b)

If select mortality had been used then the mortality probabilities would have decreased and so the mean would have decreased [1]

Both parts (i) and (ii) were generally well answered.

In cases where the term of the policy is very short, candidates would do well to remember that working from first principles is often the quickest way to answer the question.

Q6

(i)

$$P(1 + y_3)^{-3} = 100(1 + y_4)^{-4} \\ \Rightarrow 95(1 + y_3)^{-3} = 100(1.035)^{-4} \quad [1]$$

$$X = y_3 = 2.9188682\% \text{ per annum} \quad [1/2]$$

$$(1 + y_2)^2 \times (1 + f_{2,2})^2 = (1 + y_4)^4 \quad [1/2]$$

$$(1.028)^2 \times (1 + f_{2,2})^2 = (1.035)^4 \quad [1/2]$$

$$\Rightarrow (1 + f_{2,2})^2 = 1.085863$$

$$f_{2,2} = 4.2047665\% \text{ per annum} \quad [1/2]$$

(ii)

$$9(v_{y_1} + v_{y_2}^2 + v_{y_3}^3 + v_{y_4}^4 + v_{y_5}^5) + 110v_{y_5}^5 \quad [1]$$

$$= 40.63487 + 88.26962 = 128.9045 \quad [1/2]$$

$$P = 9a_{\overline{5}|} + 110v^5 @ 4.29\% \quad [1/2]$$

$$= 128.903978978 \approx 128.9044815 \quad [1/2]$$

$$\Rightarrow GRY \approx 4.29\% \quad [1/2]$$

(iii)

GRY is lower than highest spot rate [1/2]

GRY is weighted average of spot rates [1]

The 5-year spot rate is the highest spot rate and has largest weight as the redemption value of 110 is large relative to coupon values of 9 [2]

[Marks available 3½, maximum 3]

[Total 9]

Part (i) (a) was very poorly answered. A common error was to forget that the 3-year spot rate starts at time $t=0$ and is the annual rate applicable over a 3-year period. Many candidates calculated $f_{3,1}$ as the answer to the required spot rate.

Part (i) (b) was generally well answered.

Part(ii) was generally well answered. However, when the instruction in the question is “Show that...”, the examiners expect candidates to perform all the calculations and to demonstrate that they have been performed (by writing down sufficient workings and a final answer). The question states that the answer is “approximately 4.29%”, so examiners expect to see the candidates' exact answer, which should then be compared to the value given in the question to demonstrate the approximate equality.

Q7

(i)

Defining P to be the purchase price and n to be the term of a bond.

$$P = (1 - t_1) Da_n^{(p)} + Rv^n \quad [1]$$

Where there is a capital gain ($R > P$), taxing the gain will only ever move P closer to R , but never above it (for all positive tax rates under 100%).

This means we can ignore capital gains tax in the equation for the price of a bond. [1]

If $P < R$ then there is a capital gain on redemption of the bond. [½]

That is $R > (1 - t_1) Da_n^{(p)} + Rv^n$ [½]

$$\Rightarrow R - Rv^n > (1 - t_1) D \left(\frac{1 - v^n}{i^{(p)}} \right)$$

$$\Rightarrow i^{(p)} > (1 - t_1) \frac{D(1 - v^n)}{R(1 - v^n)} \Rightarrow i^{(p)} > (1 - t_1) D/R \quad [1]$$

Thus if $i^{(p)} > (1 - t_1) D/R$ then there is a capital gain on redemption.

(ii)

Situation 1:

The test needs doing to see whether capital gains tax should be included in the equation for the price of the bond [½]

The equation of value for a bond with a capital gain allowing for CGT is

$P = (1 - t_1) Da_n^{(p)} + Rv^n - t_2 (R - P)v^n$ where t_2 is the CGT rate. The payment of CGT reduces the amount of the redemption which goes to the investor [1]

If there is a capital GAIN and this is not allowed for in calculating the price the investor should pay, then they will pay too much. [½]

If there is a capital LOSS and the equation including the CGT element is used, the price will again be overstated as the $(R - P)$ term becomes negative (and we cannot assume that the investor can automatically offset that loss against gains elsewhere in their portfolio) [½]

Situation 2

If the redemption date of the bonds is variable, the capital gains test needs applying to determine which redemption date should be chosen to satisfy the investment criterion	[½]
Irrespective of whether the investor pays CGT or not	[½]
For a bond with a variable redemption date, the price of the bond for a given return will (nearly always) depend upon the redemption date	[½]
If there is a capital gain, this is more valuable the sooner it is redeemed (conversely it is best to defer a loss for as long as possible)	[1]
If the redemption date is not at the discretion of the investor and they want to meet a certain investment criterion such as a minimum return	[½]
then they should assume the least favourable redemption date in their calculations.	[½]
If any other date is subsequently chosen, they will get a better return than shown in their worst-case scenario calculation	[½]
	[Marks available 6½, maximum 6]
	[Total 10]

Part (i) was done reasonably well. This is a knowledge question where the answer is available in the core reading. The examiners expected candidates to include all the details.

Part (ii) was poorly done with many candidates scoring very low marks. Candidates should pay attention to the mark allocations for questions. This part was allocated 6 marks. The basic knowledge required to answer the question therefore needed to be expanded upon to gain full credit.

Q8

(i)

Gross Future Loss Random Variable (GFLRV) where P is the gross annual premium is given by

$$GFLRV = \begin{cases} (300,000 + 75)v^{K_{[x]}+1} & K_{[x]} < 20 \text{ or } K_{[x]} \leq 19 \\ 0 & K_{[x]} \geq 20 \text{ or } K_{[x]} > 19 \end{cases} \quad [2]$$

$$+200 + 50\ddot{a}_{\overline{\min(K_{[x]}+1, 20)}} + 0.235P + 0.015P\ddot{a}_{\overline{\min(K_{[x]}+1, 20)}} - P\ddot{a}_{\overline{\min(K_{[x]}+1, 20)}} \quad [2]$$

(ii)

If $E[GFLRV]=4\%$ of the expected present value of the premium income, then we have:

$$300,075A_{\overline{[45]:20}}^1 + 200 + 50\ddot{a}_{\overline{[45]:20}} + 0.235P - 0.985P\ddot{a}_{\overline{[45]:20}} = 0.04P\ddot{a}_{\overline{[45]:20}} \quad [4\frac{1}{2}]$$

Re-arranging gives

$$(1.025\ddot{a}_{\overline{[45]:20}} - 0.235)P = 300,075A_{\overline{[45]:20}}^1 + 200 + 50\ddot{a}_{\overline{[45]:20}}$$

$$\ddot{a}_{\overline{[45]:20}} = 13.785 \quad [1\frac{1}{2}]$$

$$A_{[45]:20}^1 = 0.46982 - v^{20} \frac{l_{65}}{l_{45}} = 0.46982 - 0.45639 \frac{8,821.2612}{9,798.0837} = 0.05893$$

[1]

$$13.894625P = 17,683.42 + 200 + 689.25$$

$$P = \frac{18,572.67}{13.894625} = 1,336.68$$

[1]

Premium is £1,337

Part (i) was reasonably well answered by many candidates, with many candidates gaining some credit. Common errors included: -

- *Ignoring the GFLRV for $K_{[x]} \geq 20$*
- *In the GFLRV for $K_{[x]} \geq 20$ using incorrect terms for the renewal expenses and renewal commission*
- *Using an incorrect term for the annuities in advance*

Many candidates having made errors in part (i) then dealt correctly with the same elements in part (ii). A common error was excluding the profit criterion or including it incorrectly.

Q9

(i)

Required provisions:

The provisions required at the end of year 2 and year 1 are:

$${}_2V = \frac{39}{1.03} = 37.86$$

[1]

$${}_1V = \frac{25}{1.03} + 0.98 \times \frac{37.86}{1.03} = 60.30$$

[2]

(i) (a)

NPV of profits before zeroisation (based on a risk discount rate of 8% pa) is:

$$NPV = \frac{-22}{1.08} + \frac{-25 \times 0.98}{1.08^2} + \frac{-39 \times 0.98^2}{1.08^3} + \frac{55 \times 0.98^3}{1.08^4} + \frac{70 \times 0.98^4}{1.08^5} = 10.88$$

[2]

(i) (b)

NPV of profits after zeroisation:

The profit in year 1 will become:

$$\text{Profit in year 1} = -22 - \frac{25 \times 0.98}{1.03} - \frac{39 \times 0.98^2}{1.03^2} = -81.09$$

[2]

So the profit vector will become:

Year	In force profit
1	-81.09
2	0
3	0
4	55
5	70

The NPV after zeroisation will be:

$$\frac{-81.09}{1.08} + 0 + 0 + \frac{55 \times 0.98^3}{1.08^4} + \frac{70 \times 0.98^4}{1.08^5} = 6.91$$

[2]

(iii)

As expected, the NPV after zeroisation is smaller... [½]

...because the emergence of the profits has been deferred (i.e. the losses have been brought forward) ... [1]

...and the risk discount rate is greater than the non-unit accumulation rate [1]

[Marks available 2½, maximum 2]

[Total 11]

This question was well answered.

Candidates would do well to heed the examiners' instructions to show all working. Very limited credit was awarded to candidates who copied and pasted an excel table with no explanation or formulae explaining how values had been calculated.

Some common errors for part (ii) included: -

- *Not including the probabilities when calculating the NPV of profits*
- *Not showing detailed formulae for calculating the adjusted cashflow at time $t=0$.*

Q10

(i)

Gross Premium Reserve at 01/01/2021 is given by: -

$${}_{15}V = (200,000 + 100)A_{55:\overline{10}|} + 25\ddot{a}_{55:\overline{10}|} - 0.99 \times 3,885\ddot{a}_{55:\overline{10}|} \quad [2]$$

$$A_{55:\overline{10}|} = 0.68388 \quad [½]$$

$$\ddot{a}_{55:\overline{10}|} = 8.219 \quad [½]$$

$${}_{15}V = 200,100(0.68388) - 3,821.15(8.219) = \text{£}105,438.36 \quad [1]$$

(ii)

Reserve at the start of the year plus gross premium less commission less actual expenses incurred rolled up by actual investment returns achieved on reserves

$$= ((105,438.36 + 0.99 \times 3,885) \times 520 - 55,000) \times 1.043 = \text{£}59,214,179.76 \quad [3]$$

$$\text{Actual Payments for Claims} + \text{expenses} = (2 \times 200,000) + (10 \times 113,000) + 200 = \text{£}1,530,200$$

[2½]

Total Reserve at year end for policies in force = $(520 - 2 - 10) \times 113,238 = \text{£}57,524,904$ [1½]

Therefore $59,214,179.76 - 1,530,200 - 57,524,904 = \text{£}159,076$ [1]

Profit earned in year is $\text{£}159,076$.

(iii)

Profit arises when actual experience differs from the reserving basis. [½]

The company expected approximately 2.3 deaths (0.004469×520). There were actually only 2 deaths. [½]

This means that the company paid out fewer death benefits than expected. [½]

So, the actual mortality experience led to a profit. [½]

The interest actually earned over the year was 4.3%, the reserve calculations allow for only 4%, so actual experience was better than expected, leading to a profit. [½]

No allowance was made for surrenders in the reserving basis. [½]

There were actually 10 surrenders. Whether these surrenders led to a profit or loss Depends on the actual surrender value paid and how it compares to the reserve held for those surrendering policies at the date the surrender value was paid [½]

Here, the surrender value per policy was $\text{£}113,000$ and the reserve at year end was $\text{£}113,238$, therefore each surrender led to a small profit. [½]

The actual renewal expenses paid were $\text{£}55,000$ which is roughly equal to $\text{£}106$ per policy. The reserving basis only allows for $\text{£}100$ per policy, therefore a loss arises on renewal expenses. [½]

The actual claim expense of $\text{£}200$ is in line with the reserving assumption. So the actual claim expense experience did not lead to a profit or loss. [½]

Renewal commission was in line with reserving basis and did not contribute to the profit. [½]

[Marks available 5½, maximum 3]

[Total 15]

Part (i) was generally well answered. A common error was using an incorrect age and term.

Part (ii) was often not attempted. Where an attempt was made, candidates typically performed poorly. Many candidates limited their answers to performing a full mortality profit calculation.

As with many non-standard questions, using the information provided in a logical way could have gained candidates many marks.

Q11

(i)

Work in quarterly time units with effective rate of interest of 1.5% per quarter.

Let R denote the initial quarterly repayment.

Then, we have:

$$300,000 = Ra_{\overline{16}|} + v_{1.5\%}^{16} \times (R + 400)a_{\overline{16}|} + v_{1.5\%}^{32} \times (R + 800)a_{\overline{16}|}$$

[3]

$$\begin{aligned}
 \text{(ii)} \quad 300,000 &= Ra_{\overline{16}|} + v_{1.5\%}^{16} \times (R + 400)a_{\overline{16}|} + v_{1.5\%}^{32} \times (R + 800)a_{\overline{16}|} \\
 &= R \times 14.1313 \times (1 + 0.78803 + 0.62099) + 400 \times 14.1313 \times (0.78803 + 2 \times 0.62099) \\
 &= \frac{14.1313 \times R \times 2.40902}{+400 \times 14.1313 \times 2.03001} \\
 &= 34.04258R + 11474.67213 \\
 \Rightarrow R &= \text{£}8,475.42 \text{ per quarter}
 \end{aligned}$$

[4]

(iii)
 Interest component of first instalment is $0.015 \times \text{£}300,000 = \text{£}4,500$. [1]
 Thus, capital repaid in first instalment is $\text{£}8,475.42 - \text{£}4,500.00 = \text{£}3,975.42$ [1]

(iv)
 Next quarterly instalment is payable on 31 December 2022 and is $\text{£}8,875.42$ (i.e. $\text{£}8,475.42 + \text{£}400$).
 This amount then increases to $\text{£}9,275.42$ per quarter in arrears from 1 January 2023 for the final 4 years (or 16 quarters).

Thus, the loan outstanding on 1 October 2022 is:
 $L = 8,875.42v_{1.5\%} + v_{1.5\%} \times 9,275.42a_{\overline{16}|}$ [2½]

$$\begin{aligned}
 &= 8,875.42 \times 0.98522 + 0.98522 \times 9,275.42 \times 14.1313 && [1] \\
 &= 137,880.71 && [½]
 \end{aligned}$$

(v)
 Let R' denote the new amount of the quarterly repayment.
 Then, we have 17 quarters remaining and the effective rate of interest per quarter is
 $i = 1.075^{\frac{1}{4}} - 1 = 1.8245\%$. [1]

Thus, we have:

$$\begin{aligned}
 R' a_{\overline{17}|} @ 1.8245\% &= 137,880.71 \\
 \Rightarrow R' \times \frac{1 - v_{1.8245\%}^{17}}{0.018245\%} &= 137,880.71 \\
 \Rightarrow R' \times 14.50376 &= 137,880.71 \\
 \Rightarrow R' &= \text{£}9,506.55 \text{ per quarter}
 \end{aligned}$$

[2]

[Total 16]

This question was generally well answered with many candidates scoring full marks.

In part (i) a common error was treating R as the annual payment per year, although the question clearly defined it as the quarterly payment.

In part (ii) a common error was not showing sufficient working to gain full marks. Also several candidates failed to consistently work on either an annual or quarterly basis, leading to errors.

Some candidates used the retrospective method to calculate the loan outstanding. This gives the same answer as using the prospective method, if done correctly. However, the retrospective method is more calculation intensive and takes more time to perform. The number of marks allocated provides an indication of how long each question (or question part) should take to answer.

[Paper Total 100]

END OF EXAMINERS' REPORT



Institute and Faculty of Actuaries

Beijing

14F China World Office 1 · 1 Jianwai Avenue · Beijing · China 100004
Tel: +86 (10) 6535 0248

Edinburgh

Level 2 · Exchange Crescent · 7 Conference Square · Edinburgh · EH3 8RA
Tel: +44 (0) 131 240 1300

Hong Kong

1803 Tower One · Lippo Centre · 89 Queensway · Hong Kong
Tel: +852 2147 9418

London (registered office)

7th Floor · Holborn Gate · 326-330 High Holborn · London · WC1V 7PP
Tel: +44 (0) 20 7632 2100

Oxford

1st Floor · Belsyre Court · 57 Woodstock Road · Oxford · OX2 6HJ
Tel: +44 (0) 1865 268 200

Singapore

5 Shenton Way · UIC Building · #10-01 · Singapore 068808
Tel: +65 8778 1784

www.actuaries.org.uk

© 2021 Institute and Faculty of Actuaries