

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

September 2017

Subject ST2 – Life Insurance Specialist Technical

Introduction

The Examiners' Report is written by the Principal 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 later 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.

Luke Hatter
Chair of the Board of Examiners
December 2017

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

1. The aim of the Life Insurance Specialist Technical subject is to instil in successful candidates principles of actuarial planning and control, and mathematical and economic techniques, relevant to life insurance companies. The student should gain the ability to apply the knowledge and understanding, in simple situations, to the operation, on sound financial lines, of life insurance companies. The life insurance products covered by this subject exclude health and care insurance products covered by the Health and Care Specialist Technical subject.
2. The Examiners' Report covers more points than would be expected to get full marks. This is so that alternative approaches to questions by different candidates can be accommodated. Candidates are expected to show knowledge of the relevant content of the Core Reading.

B. General comments on *student performance in this diet of the examination*

As with previous papers, questions that focussed on knowledge of the Core Reading were well answered by well-prepared students. In the higher mark application questions, candidates tended to restrict themselves by generating only a narrow range of points rather than thinking more widely, e.g. questions 1 part (ii) and 2 part (i). Stronger candidates considered the specifics of the question and used these in their answers e.g. in questions 3 and 5 part (ii). The numerical questions proved challenging for a large proportion of candidates, e.g. questions 6 parts (ii) and (iii).

C. Pass Mark

The Pass Mark for this exam was 63.

Solutions

- Q1 (i)** To show the financial effect of divergences between the valuation assumptions and the actual experience, ... [1]
 ... exposing which assumptions are the more financially significant. [1]
 To show the financial effect of writing new business. [1]
 To provide a check on the valuation data and process... [1]
 ... if carried out independently. [1]
 To identify non-recurring components of surplus, [1]
 thus enabling appropriate decisions to be made about the distribution of surplus to with profits policyholders. [1]
 To give management information on trends in the experience of the company... [1]
 ...and take any required corrective action. [1]
 To comply with regulatory requirements. [1]
 To assist in deciding on executive remuneration. [1]
 [Maximum 6]
- (ii)** The company should first check its analysis to ensure that the conclusions were correct. [2]
 It might check whether similar adverse experience was observed on other product lines. [2]
- It needs to investigate the cause of the adverse experience, if possible. [1]
 E.g. investigate change by rating factor: age, gender, distribution channel [1]
 It needs to determine whether the experience was exceptional in the year... [2]
 ... or whether it is likely to persist. [1]
- If it is exceptional, e.g. the result of an epidemic... [1]
 ... or due to deaths amongst some very high individual sum assureds... [1]
 ... then no action may be necessary. [2]
- Otherwise, the company should consider strengthening its valuation basis ... [2]
 ... including increasing the prudential margins. [1]
- Or it may decide to wait to see further evidence from future experience. [1]
- It may consider changing its pricing basis. [1]
 It may consider introducing more mortality rating factors to improve its pricing. [1]
 It may increase its pricing margins to allow for greater uncertainty over mortality experience. [2]
- It might seek the advice of its reinsurers or other external sources [1]
 It may decide to take out reinsurance to reduce mortality volatility [2]
 e.g. excess of loss to protect against large individual claims or stop loss to cap overall loss. [1]
 Or reduce retention limits if it already has reinsurance in place. [1]

The company may review the quality of its underwriting	[2]
And possibly change its underwriting approach.	[1]
It may decide to change its target market to avoid high risk groups	[1]
And similarly it may decide to change its distribution channel	[1]
It may decide to change the product design for future new business to reduce mortality risk	[1]
E.g. make premiums or mortality charges reviewable rather than guaranteed.	[1]
E.g. reduce the maximum sum assured limit.	[1]
It should put in place regular ongoing mortality monitoring processes.	[1]
It may decide to stop selling this type of business.	[1]
	[Maximum 16]
	[Total 22]

Part (i) of the question was largely knowledge-based and was answered fairly well by most candidates. The strongest candidates considered a wide range of points in part (ii) including both internal (e.g. pricing and valuation) and external (e.g. target market) changes.

- 2 (i) 1. Higher investment return in previous year will mean the asset share is higher than previously projected. [2]
 Unless the asset share is negative in which case it will become more negative. [1]
 And the difference is likely to be significant. [2]
 The term assurance business will also generate more profit... [1]
 ... which would increase the asset shares of the with profits business. [1]
 But the additional profit would only be marginal as investment return has little effect on term assurance business [2]

 ... due to low policy values / reserves / asset shares. [1]
2. Lighter mortality experience on term assurance will mean that there would have been fewer claims on these policies than expected in the last year... [1]
 So the without profits business profits are higher... [2]
 ... thus increasing the actual asset shares of the with profits business relative to the expected level. [2]
 The magnitude of the impact may be high, since mortality has been “much” lighter [1]
 But this depends on the relative volume of without profits business compared with the with profits business. [2]
3. Higher lapse rates on the term assurance policies at later durations would generally mean that the company makes a higher profit... [1]

- ...as at later durations the cost of life cover over the outstanding period would be expected to exceed the value of level premiums which will be received by the company. [2]
- The extent of the profit arising will depend upon the reserving basis used. [1]
- If the product is reserved for on a prudent basis then more profit will be released on lapse, than if on a best estimate basis. [2]
- It will also depend upon the extent to which the term assurances were priced to make a profit. [1]
- However, if the lapses are at very early durations then the company may make a loss... [2]
- ... as initial expenses will not have been recovered. *[Also applicable for endowment assurance surrenders.]* [1]
- Either way, the additional profit or loss would be added to the with profits endowments' asset shares. [1]
4. Assuming that with profits surrender profits and losses are allowed for in the asset shares then... [1]
- Whether there is a profit or loss will depend upon when the surrender occurs... [1]
- ...and how the surrender value compares to the asset share. [2]
- If the surrender occurs early on in the policies' lifetime then there is likely to be a loss. [2]
- If it is late on then a surrender profit would be expected if the surrender value is less than the asset share... [1]
- ... for example because a penalty is applied (or due to downwards smoothing)... [1]
- ... or a loss if more than the asset share is being paid out... [1]
- ... for example due to upwards smoothing. [1]
- If the surrender value is equal to the asset share then there will be no impact. [1]
5. A higher rate of endowment assurances being made paid up will mean that the level of asset shares will be lower than projected [1]
- ... due to receiving (and thus crediting to asset shares) a lower level of premiums during the period. [1]

For 3, 4 and 5 the magnitude of the impact may be relatively low as the difference is only "little". [2]

[Maximum 18]

- (ii) Overall, the impact of the historic experience is likely to be higher asset shares than were projected [1]
- Particularly due to the much higher investment return [1]
- So it may be that future bonuses can be increased [1]
- Particularly an increase to the terminal bonus rates... [1]
- ... for policies that are shortly due to mature [1]
- However, the company may decide not to change the bonus rates... [1]
- ... but to see how "permanent" the good investment performance is [1]
- As it would not want a potentially constantly changing bonus [1]

It may also decide to smooth the high investment return downwards	[2]
The ability to change the final bonus rates will also depend upon the relationship of the asset share to the value of the sum assured and the attaching bonuses on the with profits business	[1]
Reversionary bonuses are guaranteed once declared	[1]
And so the company is less likely to increase future reversionary bonuses	[2]
Particularly as the additional investment return earned may only be temporary	[1]
Consider actions taken in the past and any expectations this has set with policyholders.	[1]
Consider if anything has been said in policyholder documents or communications.	[1]
	[Maximum 6]
	[Total 24]

Part (i) was well answered with stronger candidates being able to apply the area of experience being considered to how it would affect the specific products. Part (ii) was reasonably well answered with the better candidates thinking about the overall impact of the experience and how this could impact bonuses.

3 General

Basic process will follow previous process...	[1]
... but with some significant differences	[1]
The outsourcing agreement will directly affect the following expenses:	
• Salary and salary-related expenses	[1]
• Property expenses	[1]
• Computer costs	[1]

Outsourcer fee

The fee agreed with the outsourcer will now form the starting point for the base level of per policy expense	[2]
If there is any lag between the valuation date and the outsourcing implementation date...	[1]
... then the expense assumptions should be set as now for that first part of the projection period	[2]
The fee element of the assumptions would need to increase in line with the agreed inflation index	[2]
... which may differ from the inflation measure currently used	[2]
Given that the agreement has allowed for a reduction in the outsourced per policy fee after five years, then this may be allowed for in the future expense assumptions...	[2]
... whereas previously it may have been assumed to stay unchanged (other than inflation increases)	[1]
Although would need to consider any regulatory requirements about not anticipating any future reductions	[2]
Need to consider how assumptions should be set after the end of the agreement (i.e. after ten years).	[2]

May want to assume ongoing per policy expenses would remain at levels set at the ten-year point [1]
But may want to allow an uplift for any additional renegotiation costs with either the current or a future outsourcer [2]
Remaining internal expenses then need to be added to the base fee value [1]

Salary and salary-related expenses

Direct salary expenses will be allocated as before... [1]
... but the analysis will be performed across a much smaller retained staff [2]
The method of overhead expense allocation across policies may be unchanged... [1]
... or the approximation approach used may be amended e.g. to better reflect the slimmed down operations (any sensible comment) [1]
Overhead salaries for core staff are not affected by the outsourcing arrangement and are still required. [1]
Overhead expenses would now also need to reflect the additional expenses that will be incurred by the company to monitor the outsource agreement [2]
e.g. additional compliance monitoring functions [1]
[other additional expense example] [1]
Any redundancy costs would be treated as one-off costs... [1]
... and typically removed from the expense allowances. [1]

Property expenses

The total property expenses incurred by the company would be the same as before and the allocation process should be unchanged [1]
However, the company will now receive a rental from the outsourcer which may reduce some of these costs [2]
The extent to which the company may allow for this deduction will depend on the likely period of rental [1]
.. and it may be that there could be a rental void in the future if a new tenant cannot be found [1]
... or the company may at that point move property and reduce its own expenses [1]

Computer costs

The policy administration system costs no longer need to be analysed and allocated [1]
However, there may be other systems used by the company which need to be allowed for, and allocated as before [1]
There may be additional development costs that are not included in the agreement [1]
... an allowance for these may need to be added [1]
e.g. allowance for future regulatory requirements (or other sensible example) [1]
Any amortisation of computer costs previously allowed for would need to be reconsidered and it may be that these could be amended [1]

Other expenses

Where the company had previously allowed for one-off capital costs then these are unlikely to be affected... [1]
... unless expected expenditure has now changed as a result of the arrangement (e.g. no longer purchasing a larger property) [1]
It is unlikely that investment expenses would be affected given these are likely to be part of the retained function [1]

Any renewal commission is unlikely to be payable by the outsourcer, and hence the process for allowing for renewal commission will be the same [1]

Regulation

The process is for setting supervisory valuation assumptions therefore any changes have to continue to meet regulations [1]

... including any requirements for prudence [1]

Need to reflect the fact that the outsourcing agreement will take a while to be fully embedded in the business... [1]

... so data on all expenses may not be available immediately / will take a while to gain credible volume [1]

Therefore, prudential margins may need to be increased [1]

Alternatively, it may be that the level of prudence may be reduced... [1]

... given there is now a legal agreement on a lot of costs and hence uncertainty reduced [1]

May want to add an element of prudence to allow for default of outsourcer [1]

[Total 28]

This question was poorly answered by candidates. In general not enough breadth of answer was provided with only the better candidates considering how introducing an agreement with an outsourcer would alter what activities the company would no longer need to perform and which would continue or be altered.

- 4**
- (i) An internal unit-linked fund consists of a clearly identifiable set of assets [2]
 e.g. equities, property, fixed interest securities or deposits [1]
 It is sub-divided into a number of equal units [2]
 Consisting of identical sub-sets of the fund's assets and liabilities [1]
 The prices of the units will be set by the company [1]
 ... subject to any relevant policy conditions [1]
 ... or any regulatory requirements [1]
 The price depends on the value of the underlying assets. [1]
 Some companies may create more units in their internal funds than is strictly necessary to cover unit liabilities (i.e. a "box"), [1]
 This can be useful in the management of the fund [1]
 However, in principle the company will aim to match units in issue with those allocated to unit holders as closely as possible [1]
 There could be costs reflected in the unit prices, e.g. dealing costs. [1]

[Maximum 6]
 - (ii) The basic equity principle states that the interests of unit holders not involved in a unit transaction should be unaffected by that transaction [2]

(iii) Appropriation Price

	\$
Market offer price value of assets	150,000
Add Expenses incurred in purchase of assets	3,750
Add Stamp duty incurred in purchase of assets	750
Add Current Assets: Cash on deposit	1,250
Investments sold but not yet settled	775
Deduct Current Liabilities: Loans to the fund	(575)
Investments purchased but not yet settled	(640)
Add: Accrued income	275
Deduct: Accrued tax	(300)
Total Value	155,285
Divide by Number of units in force at valuation point (before creations and cancellations)	20,000
Appropriation Price	7.76425

[6]

(iv) Need to calculate expropriation price

[1]

	\$
Market bid price value of assets	148,000
Deduct Expenses incurred in sale of assets	(3,000)
Add Current Assets : Cash on deposit	1,250
Investments sold but not yet settled	775
Deduct Current Liabilities: Loans to the fund	(575)
Investments purchased but not yet settled	(640)
Add: Accrued Income	275
Deduct: Accrued Tax	(300)
Total Value	145,785
Divide by Number of units in force at valuation point (before creations and cancellations)	20,000
Expropriation Price	7.28925

Correct calculation of value \$145,785

[5]

Correct calculation of expropriation price of \$7.28925

[1]

Bid basis will mean that the bid price will be equal to the expropriation price (i.e. \$7.28925 unrounded). [1]

Offer price = $7.28925 \times 1.02 = £7.435035$ unrounded [1]

[Mark given if alternatively calculated as dividing by 0.98, giving 7.43801]

Rounding in favour of customer will mean bid price is rounded up, offer price is rounded down [1]

Hence rounding to 3 decimal places:

Bid price = \$7.290 [1]

Offer price = \$7.435 (or \$7.438) [1]

[Maximum 10]

- (v) The current method will mean the company will make a small loss every time there is a unit transaction... [2]
 ... both purchasing and selling. [1]
 This could aggregate to a significant amount overall if there are a lot of transactions taking place on this fund. [2]
 However, if there are relatively few transactions on this fund the total loss may be small. [1]
 And the unit prices retain three decimal places, so the inaccuracy is relatively small. [1]
 There may be a regulatory requirement in relation to rounding that the company has to follow. [2]
 The alternative of rounding against the customer in one direction and for the customer in another direction should broadly balance out over time, and therefore be profit neutral. [2]
 However, customers may not be happy to discover that there is rounding going against them. [1]
 There may be reputational damage/risk. [1]
 This could impact persistency rates... [1]
 ... and new business volumes. [1]
 Compensation may have to be provided [1]
 Particularly if the practice was not made sufficiently clear in documentation or at the point of sale. [1]
 The administration of such compensation could be onerous. [1]
 The company would need to ensure any method follows the policy conditions [1]
 It could be market practice to do this and so changing to be in line with competitors. [1]
 [Maximum 8]

- (vi) The net flow may be very small or within the company's tolerance levels. [1]
 The company wishes to wait to see whether the change in direction is more than a one-off. [2]
 Particularly if the direction of the net flow has been stable for a long time. [1]
 Changing the basis incurs costs. [2]
 And may require system changes. [1]

The financial benefits expected from making the change may be less than the costs. [2]

Frequent changes in basis may cause changes in unit prices that might generate customer complaints or queries [1]

The company may have a management box which they use to avoid frequently changing the basis. [1]

[Maximum 6]

[Total 38]

Part (i) was not very well answered. Those candidates that did score well were able to differentiate between a unit linked fund and a unit linked product. Part (ii) was a straight forward definition which was well answered. Those that knew how to answer part (iii) also scored well in part (iv). Part (v) and part (vi) were reasonably answered with better prepared students picking out the main points.

5 (i) The company is recently established so it is possible that it will have a low level of available capital. [1]

The term assurance business can be relatively capital intensive if solvency capital requirements are high... [2]

... and due to high initial costs e.g. for underwriting... [2]

... so the existing capital may already be earmarked to support new business strain on its current product line. [1]

Additional capital will be required to support any new business strain on the new product. [1]

Although the unit-linked endowment assurance product should be designed to be relatively capital efficient... [2]

.... e.g. through use of initial charges, [1]

... reserves relating to the guarantees and options may be relatively high. [1]

There may be higher reserves as a result of using prudent assumptions given there is limited or no experience to base them on. [1]

Capital also needs to be held against the risks relating to the new product. [2]

As there are no similar products in the market that the company operates in, this will be an innovative product and the company is unlikely to have any competition initially. [1]

It may therefore sell very high volumes and so needs capital to support this. [2]

There will also be a need for capital to meet the costs of designing and developing the product. [1]

The costs associated with implementing and launching the new product are also likely to be high. [2]

In particular, it will need to develop and implement a new distribution channel which is different from the one currently being used. [1]

Given the complex nature of the product it would seem unlikely that the company would continue to use direct marketing to sell the new product. [1]

There will need to be extensive training undertaken for the administration people on the new product... [1]

... and for those in or supporting the new distribution channel. [1]
 The company is also likely to need to develop the existing or purchase a new administration system... [2]
 ... as an administration system that is currently being used for term assurance is unlikely to be able to cope with the flexibility required for this new product. [1]
 Literature will need to be produced to support the new product. [1]
 The company may wish to undertake a marketing/advertising campaign. [1]
 [Maximum 12]

(ii) **Data**

The company has no experience of selling this product so there will be no company data available to base pricing assumptions on. [2]
 There will therefore be a risk that the pricing assumptions are incorrect... [1]
 ... and that the product is less profitable than expected. [1]
 Not only will there be no company data available, but as the product is innovative within the market there will be no industry data either on which to base pricing assumptions. [1]
 If other data sources are used, e.g. from similar products in overseas countries, there is a risk that the data is not suitable... [1]
 ... and that any adjustments that would need to be applied to it are not sufficient to make it appropriate for use. [1]

Mortality / claim rates

There is a risk of higher than expected mortality in relation to the guaranteed minimum death benefit. [1]
 There is a risk of higher rates of sickness... [1]
 ... and redundancy than were allowed for in the pricing of the waiver of premium benefit. [1]
 And of higher mortality than allowed for in the pricing of the additional death benefit option. [1]
 And of lower than expected mortality (i.e. higher longevity) post-maturity for those taking up the guaranteed income option. [1]
 There is a risk of greater anti-selection by the policyholder than allowed for in the pricing [1]
 ... particularly after the initial underwriting will no longer be relevant [1]
 ... and because the options and benefits can be added at any time during the policy lifetime. [2]
 E.g. a policyholder who expects redundancy and thus chooses to add the waiver of premium option [1]
 Or believes themselves to be more prone to accidents e.g. due to having taken on more hazardous pastimes (for the additional death benefit) [2]
 Higher than expected take up rates increase the guarantee cost. [1]

Investment

There is a risk of lower than expected investment returns... [1]
 ... resulting in lower charges being received to the extent that they are related to the fund value (e.g. annual management charges). [2]
 Lower investment return can cause poor persistency or low new business. [1]

The company is also at risk of poor investment performance causing the guarantee on the death and maturity benefits to bite. [2]
The company is at risk from the guaranteed income option biting at maturity if interest rates are lower than priced for at the option date. [2]
If the investment return prior to maturity is higher than expected, then this increases the cost of the guarantee. [1]

Expenses

There is a risk that the development and implementation expenses for the new product are higher than expected. [1]
There is a risk that the administration expenses related to the new product are higher than was allowed for in the pricing. [1]
There is also the risk of higher expense inflation in the future than anticipated when policy was priced. [1]
The expense risks are lower to the extent that the product has a flexible charging structure that enables it to vary the expense related charges... [2]
... or the charges are inflation-linked (e.g. policy fee). [1]

Persistency

There is likely to be the risk of higher withdrawals than allowed for in the pricing [1]
As this leads to reduced receipt of future charges [1]
There is also a risk that withdrawals are selective... [2]
... which could invalidate the mortality assumption used in pricing. [1]

New business and competition

If the product is popular with the target market then the volume of new business sales may be higher than expected [1]
This may lead to further strains on the company's capital resources and reducing its solvency levels. [1]
And it may cause administration strain. [2]
Alternatively, there is the risk that the product is not as popular with the intended target market leading to lower sales than anticipated... [1]
... and increasing the risk that the development/fixed costs are not recouped by the expense loadings in the product. [2]
As this is an innovative product and the company is likely to be the only one selling this type of product there is a risk that there will be further new entrants to the market if the product is well received. [1]
This will not occur quickly but there is a risk that the company's longer term market share is reduced. [1]
If the company builds in too many margins into the pricing basis due to the uncertainties, there is a risk that the product becomes too expensive to be affordable by the target market reducing the level of sales achieved. [2]
There is a risk that the new business mix may not be as expected... [1]
... e.g. leading to cross-subsidy risk between large and small policies. [1]

Actions of distributors

The product is too complex to sell via the existing direct marketing approach and so a change in distribution method is needed. [1]

There is a risk of the distribution channel acting against the interest of the company. [1]
 This is increased since the company will not have any experience of operating within the new distribution channel. [2]
 There is an increased risk of mis-selling of the product... [1]
 ... as it is complex. [1]
 There is a risk that new distribution channel may not fully understand it ... [1]
 ...and the policyholder may not understand the features of the product... [2]
 ... particularly as market place does not sound very sophisticated at present. [1]
 This could lead to poor persistency for the product. [1]

Other

If the company uses reinsurance (e.g. to help with data)... [1]
 ... this will increase the level of counterparty risk exposure for the company. [1]
 There will also be counterparty risk relating to corporate bond holdings. [1]
 And distributors not passing on premiums. [1]
 The company may be at risk of having inadequate systems and controls... [1]
 ... or there may be a failure in those already in existence. [1]
 There is a risk of more processing or administration errors as the product is more complex. [1]
 There is a risk that this may lead to regulatory intervention... [1]
 ... and there may be reputational damage. [1]
 There is a risk of the policyholder acting fraudulently... [1]
 ... For example, the policyholder may have knowledge of redundancy (for the waiver of premium) or poor health and not disclose this as part of the initial underwriting process. [1]
 The company is at risk from changes to the legal, regulatory or tax regimes. [1]
 For example, the introduction of maximum charge caps.
 The company is at risk from detrimental actions of board of directors. [1]
 For example, putting pressure on to offer the benefits at unsustainable premiums in order to gain market share. [1]
 There may be an aggregation or concentration risk if a group form of the policy is sold [1]
 For example, to a large company which then undertakes a redundancy exercise. [1]
 There is a risk that policy wording is not clear, especially as the product is complex. [1]

[Maximum 36]

[Total 48]

Overall the question was well answered with candidates able to provide a wide range of points to both parts. Better prepared candidates were able to gain marks in each of the main categories of the answer in part (ii) by considering a broad range of issues.

- 6 (i) All lives eligible to take up the option will do so [2]
 The mortality experience of those who take up the option will be the Ultimate experience... [1]
 ... which corresponds to the Select experience that would have been used as a basis... [1]
 ... if underwriting had been completed as normal when the option was exercised. [1]
 [Maximum 4]

- (ii) Annual premium for the initial term assurance is calculated as:

$$\text{prem}_{\text{basic}} = 50,000 \frac{A^1_{[40]:20|}}{\ddot{a}_{[40]:20|}} \quad [1]$$

$$= 50,000 \times \frac{0.03411}{13.930}$$

$$= 122.43 \text{ (a)} \quad [1]$$

Annual premium for the policy taken out under the option, from age 50, is calculated as:

$$\text{prem}_{\text{option}} = 50,000 \frac{A^1_{[50]:10|}}{\ddot{a}_{[50]:10|}} \quad [1]$$

$$= 50,000 \times \frac{0.03367}{8.318}$$

$$= 202.39 \text{ (b)} \quad [1]$$

So expected present value of premiums is:

$$\text{EPV}_{\text{prems}} = (a)\ddot{a}_{[40]:20|} + \frac{D_{50}}{D_{[40]}}(b)\ddot{a}_{50:10|}$$

$$= 122.43 \times 13.930 + \frac{1366.61}{2052.54} \times 202.39 \times 8.314$$

$$= 2,825.86 \text{ (c)}$$

Expected present value of benefits is calculated as:

$$\text{EPV}_{\text{benefits}} = 50,000 \left\{ A^1_{[40]:20|} + \frac{D_{50}}{D_{[40]}} A^1_{50:10|} \right\}$$

$$= 50,000 \times \left\{ 0.03411 + \frac{1366.61}{2052.54} \times 0.03423 \right\}$$

$$= 2,845.04 \text{ (d)}$$

Correct calculation of the EPV of premiums and EPV of benefits [5]

Deduct 1 mark for each error in the calculations

Therefore, the expected present value of the option cost is:

$$\text{EPV}_{\text{benefits}} - \text{EPV}_{\text{prems}}$$

$$= \text{(d)} - \text{(c)}$$

$$= 2,845.04 - 2,825.86$$

$$= 19.18 \quad [1]$$

Alternative approach:

Annual premium for the policy taken out under the option, from age 50, is calculated as:

$$\text{prem}_{\text{option}} = 50,000 \frac{A^1_{[50]:10|}}{\ddot{a}_{[50]:10|}} \quad [1]$$

$$= 50,000 \times \frac{0.03367}{8.318}$$

$$= 202.39 \quad [1]$$

Expected present value of additional premiums is:

$$\text{EPV}_{\text{prems}} = \frac{D_{50}}{D_{[40]}} \text{prem}_{\text{option}} \ddot{a}_{50:10|}$$

$$= \frac{1366.61}{2052.54} \times 202.39 \times 8.314$$

$$= 1,120.36$$

Expected present value of additional benefits is calculated as:

$$\begin{aligned}
 EPV_{\text{benefits}} &= 50,000 \left\{ \frac{D_{50}}{D_{[40]}} A_{50:\overline{10}|}^1 \right\} \\
 &= 50,000 \times \left\{ \frac{1366.61}{2052.54} \times 0.03423 \right\} \\
 &= 1,139.54
 \end{aligned}$$

[6]

Therefore, the expected present value of the option cost is:

$$\begin{aligned}
 EPV_{\text{benefits}} - EPV_{\text{prems}} & \\
 &= 1,139.54 - 1,120.36 \\
 &= 19.18
 \end{aligned}$$

[1]
[Maximum 10]

- (iii) If the annual premium for the initial term assurance has not been calculated in (ii):

$$\begin{aligned}
 \text{prem}_{\text{basic}} &= 50,000 \frac{A_{[40]:\overline{20}|}^1}{\ddot{a}_{[40]:\overline{20}|}} \\
 &= 50,000 \times \frac{0.03411}{13.930} \\
 &= 122.43 \text{ (a)}
 \end{aligned}$$

[1]

If the annual premium for the initial term assurance has been calculated in (ii) and is correctly allowed for in this part. [2]

Premiums for the additional cover under the option remain as for (ii). [1]

Expected present value of premiums is calculated as:

$$\begin{aligned}
 EPV_{\text{prems}} &= (a) \ddot{a}_{[40]:\overline{10}|} + \frac{D_{50}}{D_{[40]}} \left\{ 0.5 \times (a) \ddot{a}_{50:\overline{10}|} + 0.5 \times \{(a) + (b)\} \ddot{a}_{55:\overline{10}|} \right\} \\
 &= 122.43 \times 8.395 + \frac{1366.61}{2052.54} \times \{0.5 \times 122.43 \times 8.314 + 0.5 \times \{122.43 + 202.39\} \times 8.219\} \\
 &= 2,255.48 \text{ (e)}
 \end{aligned}$$

Alternatively the above could be calculated as follows (giving the same answer, allowing for rounding):

$$EPV_{\text{prems}} = 0.5 \times (a) \ddot{a}_{[40]:20} + 0.5 \times \left\{ (a) \ddot{a}_{[40]:10} + \frac{D_{50}}{D_{[40]}} \times \{(a) + (b)\} \ddot{a}_{55:10} \right\}$$

Expected present value of benefits is calculated as:

$$\begin{aligned} EPV_{\text{benefits}} &= 50,000 \left\{ A_{[40]:10}^1 + \frac{D_{50}}{D_{[40]}} \times \{0.5 \times A_{50:10}^1 + 0.5 \times 2 \times A_{55:10}^1\} \right\} \\ &= 50,000 \left\{ 0.01132 + \frac{1366.61}{2052.54} \times \{0.5 \times 0.03423 + 0.5 \times 2 \times 0.06037\} \right\} \\ &= 3,145.53 \text{ (f)} \end{aligned}$$

Alternatively the above could be calculated as follows (giving the same answer, allowing for rounding):

$$EPV_{\text{benefits}} = 50,000 \left\{ 0.5 \times A_{[40]:20}^1 + 0.5 \times \left\{ A_{[40]:10}^1 + \frac{D_{50}}{D_{[40]}} \times 2 \times A_{55:10}^1 \right\} \right\}$$

Correct calculation of the EPV of premiums and EPV of benefits [6]
Deduct 1 mark for each error in the calculations

Therefore, the expected present value of the option cost is:

$$\begin{aligned} &EPV_{\text{benefits}} - EPV_{\text{prems}} \\ &= \text{(f)} - \text{(e)} \\ &= 3,145.53 - 2,255.48 \\ &= 890.05 \end{aligned} \quad \begin{array}{l} [1] \\ \text{[Maximum 10]} \end{array}$$

Alternative approach:

If the annual premium for the initial term assurance has not been calculated in (ii):

$$\text{prem}_{\text{basic}} = 50,000 \frac{A_{[40]:20}^1}{\ddot{a}_{[40]:20}} \quad [1]$$

$$= 50,000 \times \frac{0.03411}{13.930}$$

$$= 122.43 \text{ (a)} \quad [1]$$

If the annual premium for the initial term assurance has been calculated in (ii) and is correctly allowed for in this part. [2]

Premiums for the additional cover under the option remain as for (ii). [1]

Ignore the premiums and benefits for the 50% who do not opt, as they will offset. [1]

Expected present value of premiums for the 50% who do opt is calculated as:

$$\begin{aligned} \text{EPV}_{\text{prems}} &= 0.5 \times \left\{ (a) \ddot{a}_{[40]:10|} + \frac{D_{50}}{D_{[40]}} \times \{ (a) + (b) \} \ddot{a}_{55:10|} \right\} \\ &= 0.5 \times 122.43 \times 8.395 + 0.5 \times \frac{1366.61}{2052.54} \times \{ 122.43 + 202.39 \} \times 8.219 \\ &= 1,402.69 \text{ (e)} \end{aligned}$$

Expected present value of benefits for the 50% who do opt is calculated as:

$$\begin{aligned} \text{EPV}_{\text{benefits}} &= 50,000 \times 0.5 \times \left\{ A_{[40]:10|}^1 + \frac{D_{50}}{D_{[40]}} \times 2 \times A_{55:10|}^1 \right\} \\ &= 50,000 \times 0.5 \times \left\{ 0.01132 + \frac{1366.61}{2052.54} \times 2 \times 0.06037 \right\} \\ &= 2,292.76 \text{ (f)} \end{aligned}$$

[6]

Therefore the expected present value of the option cost is:

$$\begin{aligned} &\text{EPV}_{\text{benefits}} - \text{EPV}_{\text{prems}} \\ &= \text{(f)} - \text{(e)} \\ &= 2,292.76 - 1,402.69 \\ &= 890.07 \end{aligned}$$

[1]

[Maximum 10]

- (iv) The mortality of those taking the option being much higher than just Ultimate mortality (due to the five year addition to the age). [2]
 This will result in higher than expected benefits being paid out under the additional cover relative to what had been assumed under the conventional method [1]
 And lower premiums being received. [1]

The mortality of those who do not take up the option continuing to experience Ultimate mortality with no adjustment. [1]

This means that, on average, the lives who purchased the original term assurance will experience higher than Ultimate mortality. [2]

If those taking the option experience higher than Ultimate mortality, then it might instead have been appropriate to assume that those not taking the option would experience *lower* than Ultimate mortality. [1]

[Maximum 4]

- (v) Allowing for expenses [1]
 Including the cost of implementing the option [1]
 Actual investment return being different [1]
 In particular, a lower rate increases the cost [1]
 A higher proportion of customers could exercise the option. [2]
 Mortality prior to the option date could be different to expected... [1]
 ...lighter than expected mortality would result in higher option cost, all else being equal... [1]
 ...as more customers would live to the option date [2]

Mortality after taking the option, for those that take it, could be different to expected... [1]

...heavier mortality than expected for those who selected the option after the option is taken would increase the cost of the option. [1]

Lapses could be different... [1]

...lighter than expected leads to a higher cost of the option. [1]

[Maximum 8]

(vi) The policyholder may be in poor health [1]

And so wishes to take advantage of not having to undergo underwriting [1]

Or may not be able to obtain the additional cover at all in the wider market [1]

Even if they are not in poor health, they may not wish to undergo underwriting as it is perceived as a hassle / invasive [1]

The term assurance may have originally been to cover a mortgage and they have increased the mortgage amount (or any other loan) [1]

The policyholder has taken on additional responsibilities/liabilities that need protection [1]

For example, university fees which were not envisaged when the policy was first taken out [1]

Or taking care of an elderly relative [1]

Inflation may have eroded the value of the policyholder's existing benefits. [1]

[Maximum 4]

[Total 40]

Part (i) was reasonably well answered with most candidates able to get the first point. In part (ii) and part (iii) there are a number of different ways to get to the correct calculation; all were given credit. The candidates that scored well in parts (ii) and (iii) were generally able to associate the correct premium with benefit allowing for the correct select or ultimate mortality. Part (iv) was not well answered in general with only the better candidates not repeating the answer to part (i) and considering the calculations in the previous two parts. Parts (v) and (vi) were reasonably answered with the main points being covered by most candidates.

END OF EXAMINERS' REPORT