

Actuarial Society of South Africa

WRITTEN EXAMINATION

3 OCTOBER 2022

Subject A213 — Contingencies

Time allowed:

Examination time - Two hours and fifteen minutes

Scan and upload time - Twenty minutes (at the end of the examination)

INSTRUCTIONS TO THE CANDIDATE

1. *Once you have entered the ASSA Exam Platform, ensure that you have accessed the **Video Room** Invigilation link with both your camera and microphone switched on before you attempt the examination.*
2. *Your computer must be placed, and camera angled, so that your writing area on your desk is visible to the invigilator. Readjust your camera if you bump or move your computer by accident.*
3. *Ensure that you have your exam permit handy. It reflects your candidate number to input as **part of the two hours 15 minutes examination and not before the start of the examination**. Write your candidate number at the top of each page. Do not use your name or member number anywhere on your answer script.*
4. *Your cell phone that will be used to scan your final answer script must be switched **OFF** during the two hours and 15 minutes examination time. Place your cell phone at the top of your examination pad / writing pages in view of the invigilator.*
5. *You are strongly encouraged to use the first 15 minutes as reading time only, however, you may start answering the paper whenever you are ready.*
6. *The question paper is only available on the ASSA Exam Platform as a PDF download and may not be printed.*
7. *You are required to write your answers on a clean A4 examination pad. Write only on one side of the paper and number your pages.*
8. *Attempt all questions, beginning your answer to each question on a new page.*
9. *Write in black or dark blue pen.*
10. *Show calculations where appropriate. You may use blank paper to make notes. This paper must not be scanned as part of your answer script.*
11. *You may not access any file from your computer, use any other computer program (e.g. Email, MS Word or Excel), or open any browser during the examination.*

12. *You may not use any other material (e.g. a Formulae and Tables book) during the examination. Any such information that may be required will be provided to you in the examination.*
13. *Mark allocations are shown in brackets.*
14. *Assume that months are all equal length, unless otherwise stated.*
15. *At the end of the two hours and 15 minutes examination time, you must stop writing and start scanning and uploading your script. **You may NOT continue to write or review your script during this time.***
16. *Scan ALL your answer pages to PDF so that your candidate number is clear at the top of each page.*
17. *Save your PDF scanned file using your candidate number as file name. Do not use your name or member number as file name.*
18. *Transfer your scanned script file to your computer and upload it to the ASSA Exam Platform.*
19. *Click on the **Upload Answers** link below the examination paper link. Ensure you click on **Finish** below the upload box and again on **Finish All and Submit**, before the 20-minute upload time is up. (After submission the number of files successfully submitted will be reflected.)*

Note: The Actuarial Society of South Africa will not be held responsible for any late submissions or loss of data where candidates have not followed instructions as set out above.

END OF INSTRUCTIONS

QUESTION 1

Explain the terms 'unit fund' and 'non-unit fund' in the context of a unit-linked life assurance contract and the various items that make up the non-unit fund.

[Total 4]

QUESTION 2

Derive the expected present value of a benefit of R500 000 payable immediately on death in respect of a life currently aged 65 exactly, if death occurs within the next year.

Assume the force of mortality is constant between consecutive integer ages.

Basis:

Mortality AM92 Ultimate

Interest rate 4.8% per annum.

[Total 5]

QUESTION 3

A life insurance company issues an immediate annuity to a retiring individual aged 63 exactly. The following terms regarding the annuity payment were agreed upon:

- The annuity is payable annually in advance.
- The annuity payments are made for as long as the life is alive but guaranteed for a minimum period of 7 years.

The purchase price is R2 000 000.

Calculate the annual annuity payment amount.

Basis:

Mortality AM92 Ultimate

Interest 4% per annum

Expenses None

[Total 5]

QUESTION 4

A life insurance company issues an annuity contract to two lives in return for a single premium. The annuity payment of R200 000 per annum is payable annually in advance while at least one of the lives is alive. The first life is aged 60 exactly and the second life is aged 58 exactly at the inception of the policy.

PLEASE TURN OVER

- a) Write down an expression for the future loss random variable at the outset for this policy. [3]
- b) Calculate the single premium. [4]

Basis:

Mortality	PFA92C20 for the first life PMA92C20 for the second life
Interest	4% per annum
Expenses	None

- c) State what the impact on the premium would be and explain your reasoning if:
- (i) An interest rate of 6% per annum were used.
- (ii) PMA92C20 were used for both lives.

No further calculations are necessary.

[4]

[Total 11]

QUESTION 5

- a) In the context of with-profit policies, describe the super compound method of adding bonuses. [3]
- b) Suggest a reason why a life insurance company might use the super compound method of adding bonuses as opposed to the compound method, all else being equal. [1]

A life aged 40 exactly purchases a 20-year with-profit endowment assurance policy from a life insurer. The sum assured of R800 000 plus declared reversionary bonuses are payable at maturity or at the end of the year of death if earlier. Level premiums are payable quarterly in advance whilst the policyholder is alive.

Assume that future simple reversionary bonuses will be declared at the rate of 5% per annum vesting at the end of each policy year (i.e. the death benefit does not include any bonus relating to the policy year in which death occurred).

- c) Calculate the expected present value of all benefits from this policy. [6]
- d) Calculate the expected present value of all expenses and commission for this policy. [3]
- e) Calculate the quarterly premium. [4]

PLEASE TURN OVER

Basis:

Mortality	AM92 Select
Interest	6% per annum
Initial expenses	R2 000 at inception
Initial commission	20% of the gross annual premium
Renewal expenses	R500 per annum payable annually in advance commencing at the start of the second policy year
Claims expenses	R1 000 on death R1 200 on maturity

The life insurer sells a range of different products.

- f) Explain whether the premium would have been larger, the same or smaller than in (e) above if the insurer now assumes lower volumes of new business sales for this product.

[4]

[Total 21]

QUESTION 6

A life insurance company specialising in retirement products issues a reversionary annuity contract. The terms of the contract are as follow:

- An annuity of R100 000 per annum is payable annually to a female life, whilst alive, following the death of a male life.
- Annuity payments will commence at the end of the year of death of the male life.
- Premiums are to be paid monthly in advance until the annuity commences or the contract ceases, if earlier.

Calculate the monthly premium required in respect of contract where the female life is age 65 exactly and the male life is age 68 exactly at inception.

Basis:

Mortality	PFA92C20 for the female PMA92C20 for the male
Interest	4% per annum
Expenses	0.5% of each premium payment 7.5% of each annuity payment

[Total 6]

PLEASE TURN OVER

QUESTION 7

A life insurance company issues the following policies:

- 20-year term assurances with a sum assured of R500 000 where the death benefit is payable at the end of the year of death
- 20-year pure endowment assurances with a sum assured of R200 000
- 8-year temporary immediate annuities with an annual benefit payable in arrear of R100 000

On 1 January 2017, the company sold the following policies:

Product	Policyholder age exact	Number of Policies
Term Assurance	40	100
Pure Endowment Assurance	40	200
Temporary Immediate Annuity	57	50

The premiums in respect of the term assurance and pure endowment policies, are payable annually in advance, whereas a single premium is payable in respect of the temporary immediate annuity policies.

- a) Determine the gross premium payable for the two types of assurance policies. [3]

The company calculates reserves for all three products using the prospective reserving methodology. The calculated reserves at the end of 2019 are as follows:

Product	Reserve
Term Assurance	2 585.25
Pure Endowment Assurance	20 021.27
Temporary Immediate Annuity	355 000.00

- b) Calculate the death strain at risk for each type of policy during 2019 using these reserves. [3]

The claim records of the company reflect the following number of deaths for each full calendar year:

Product	2017	2018	2019	2020
Term Assurance	7	8	3	18
Pure Endowment Assurance	2	9	7	27
Temporary Immediate Annuity	4	6	7	14

- c) Calculate the total mortality profit or loss to the insurer in the year 2019. [11]

PLEASE TURN OVER

Basis:

Interest 4% per annum
Mortality AM92 Ultimate

d) Suggest a possible reason why there is a profit or loss to the insurer.

[1]

[Total 18]

QUESTION 8

a) Show that $\ddot{a}_x - \ddot{a}_{x:n} = v^n \cdot {}_n p_x \cdot \ddot{a}_{x+n}$. [3]

A life insurance company issues identical deferred annuities to 50 individuals aged 60 exactly. An annuity of R8 000 per annum is payable continuously from an individual's 65th birthday, if still alive at that time, and for life thereafter.

b) Calculate the expected present value of this book of business at outset.

Basis:

Mortality AM92 Ultimate
Interest 6% per annum

[3]

c) Calculate the variance of the present value of this book of business at outset, using the same basis as in part (b). [12]

[Total 18]

QUESTION 9

A life company sells 20-year with-profit endowment assurances. The death benefit is payable at the end of the year of death after the bonus amount for the current year has been added.

The basic sum assured is R1 500 000 and compound bonuses of 1.9231% are added to the sum assured at the end of the year. Level premiums of R5 500 are payable monthly for a 40-year-old with the first monthly premium being due immediately.

Basis:

Mortality AM92 Ultimate
Interest rate 6% per annum
Initial expense 45% of the first year's total premiums at the start of the policy
Renewable expense 3% of all annual premiums, including the first year, payable at the start of each year

i) Calculate the gross premium prospective reserve for a policyholder aged 40 at inception, just before the start of the 16th year of the policy, assuming that the bonuses have been declared in line with the intended rates. [9]

ii) State under what conditions the prospective and retrospective gross premium reserves would be equal for a without-profits policy. [3]

[Total 12]

[GRAND TOTAL 100]

END OF EXAMINATION