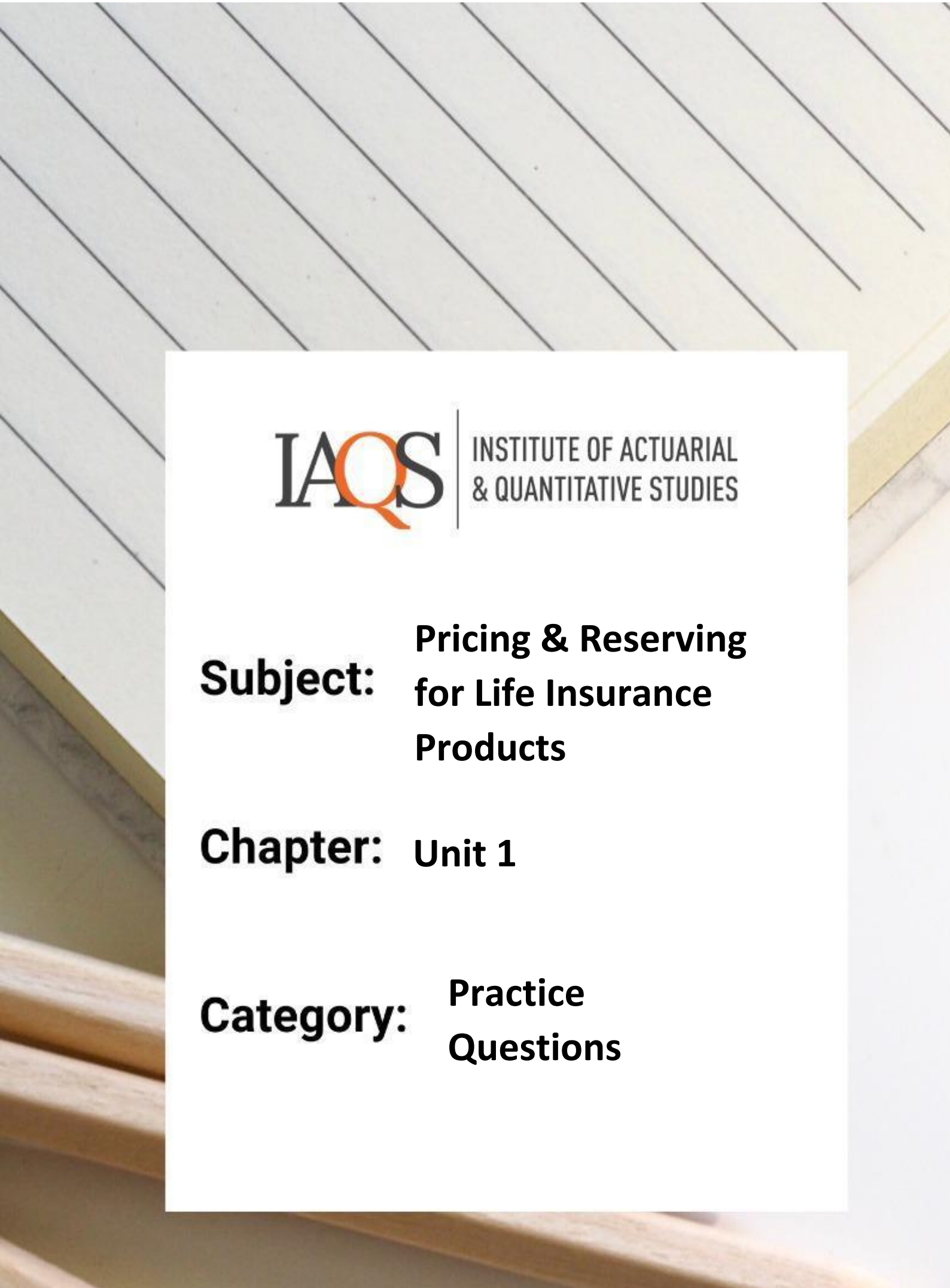

IAQS | INSTITUTE OF ACTUARIAL & QUANTITATIVE STUDIES

Subject: Pricing & Reserving for Life Insurance Products

Chapter: Unit 1

Category: Practice Questions

1. CT5 September 2012 Q4

Calculate ${}_3p_{55.75}$ using the assumption of Uniform Distribution of Deaths.

Basis:

Mortality ELT15 (Females)

Ans: 0.98274

2. CT5 September 2013 Q18

Show, using the random variable approach, that the expected present value of an annuity of 1 per annum payable annually in arrears to a life now aged x, deferred for n years is equal to a_x - $a_{x:\underline{n}|}$.

Ans: -

3. CT5 April 2013 Q10

A special whole life assurance policy issued to a life aged 40 exact provides a benefit of £1,000 on death within 20 years of inception, £2,000 on death between 20 and 40 years from inception and £3,000 on death thereafter. Benefits are payable at the end of the year of death.

Calculate the expected present value and variance of the present value of this policy.

Basis:

Mortality AM92 Ultimate

Interest 4% per annum

Ans:

Expected = £509 to nearer £

Variance = 13,926 = $(£118)^2$

4. CT5 September 2014 Q7

A life aged 40 exact purchases an endowment assurance policy whereby the sum assured on survival at age 60 exact is £20,000 and the benefit payable on death during the term is £10,000. Death benefits are payable at the end of the year of death.

Calculate the expected present value and variance of the benefits under this policy.

Basis: Mortality AM92 Select

Interest 4% per annum

Expenses Ignore

Ans:

EPV = 8943.6

Variance = $(807)^2$

5. CT5 September 2014 Q8

(i) In the context of random variables define T_x and K_x.

(ii) State the random variable for the following expected values:

(a) $\bar{A}_x$

(b) a_x

(c) $A_{[x]:\,\overline{n}|}$

(d) ${}_{5|}\ddot{a}_x$

Ans:

(i) T_x is the total future lifetime of an ultimate life aged x

K_x is the curtate future lifetime of an ultimate life aged x

(ii) (a) v^{Tx}

(b) $a_{\overline{K_x|}}$

(c) $v^{\min\,[K_{[x]}+1,n]}$

(d) $v^5\,\ddot{a}_{\overline{K_x-4|}}$ if $K_x \geq 5$

0 otherwise

6. CT5 April 2016 Q1

Calculate ${}_{0.5}p_{90.25}$ using the method of Uniform Distribution of Deaths. Show all your workings.

Basis:

Mortality ELT15 (Males)

Ans: 0.892158

7. CT5 April 2016 Q3

(a) ${}_{25}p_{30}$

(b) $\ddot{a}^{(4)}_{[40]:\overline{15}|}$

(c) $A^{1}_{50:\overline{20}|}$

Basis:

Mortality	AM92
Rate of interest	4% per annum

Ans:

(a) 0.962984

(b) 11.287

(c) 0.10162

8. CT5 April 2016 Q6

(i) Prove that $\underline{A}_{x:\underline{n}|} = 1 - \delta\underline{a}_{x:\underline{n}|}$ for the following basis.

Basis:

Force of mortality	μ_x is constant for all x
Force of interest	δ throughout

An endowment assurance pays a sum assured of 10,000 immediately on death or on survival to the end of the term of the policy.

(ii) Calculate, showing all your workings, the premium payable continuously for a life aged 40 exact for an endowment assurance with a term of 20 years.

Basis:

Mortality $\mu_x = 0.01$ for all x

Rate of interest 5% per annum

Ans:

(i) -

(ii) £362.4

9. CT5 September 2016 Q1

A whole life assurance policy provides a benefit of 100,000 payable immediately on the death of a male life who is now aged 45 exact.

Calculate, showing all your workings:

(a) the expected present value of this policy.

(b) the variance of the value of this policy.

Basis:

Mortality AM92 Ultimate

Rate of interest 4% per annum

Ans:

EPV = 28151.7

Variance = $(13825)^2$

10. CT5 September 2016 Q4

Calculate, showing all your workings:

(a) ${}_{10|5}q_{65}$

(b) $\ddot{a}^{(12)}_{[30]:\underline{15|}}$

Basis:

Mortality AM92

Rate of interest 4% per annum

Ans:

(a) 0.18282

(b) 11.307

11. CT5 September 2016 Q6

(i) Show, using the method of Uniform Distribution of Deaths, that:

$${}_{2.5}q_{80.75} = \frac{10}{117}$$

(ii) Calculate, showing all your workings, $\ddot{a}_{80:\overline{4}|}$

Basis:

Mortality $l_x = 110 - x$ for all x

Rate of interest 5% per annum

Ans:

(i) -

(ii) 3.545 to 3 decimal places

12. CT5 April 2017 Q1

Calculate ${}_{2.75}p_{77.4}$ assuming a Uniform Distribution of Deaths.

Basis:

Mortality PMA92C20

Ans: 0.88550

13. CT5 April 2017 Q3

Calculate:

(a) ${}_{12}p_{73}$

(b) ${}_{10|}a_{56}$

(c) $A_{64:\overline{10}|}$

Basis:

Mortality AM92

Rate of interest 4% per annum

Ans:

(a) 0.45728

(b) 6.727

(c) 0.69809

14. CT5 September 2017 Q3

Calculate ${}_{2.25}q_{85.5}$ using the method of Uniform Distribution of Deaths.

Basis: ELT15 (Males)

Ans: 0.31964

15. CT5 September 2017 Q6

(i) Calculate $\ddot{a}_{40:\overline{4}|}$

(ii) Derive the value of $A^{1}_{40:\overline{4}|}$ using your result from part (i).

Basis:

Interest 5% per annum

From the following life table extract

x	l_x
40	100,000
41	99,200
42	98,100
43	96,700
44	94,700

Ans:

(i) 3.6699

(ii) -

16. CT5 September 2017 Q9

A special whole life assurance policy is issued on a life aged 50 exact.

Under this policy the sum assured, payable at the end of the year of death, is 1 unit for the first 10 years decreasing to 0.75 units thereafter.

(i) Calculate the expected present value of the benefit.

(ii) Determine the variance of the present value of the benefit.

Basis:

Mortality AM92 Ultimate

Interest 4% per annum

Ans:

(i) 0.25536

(ii) $(0.14192)^2$

17. CT5 September 2018 Q5

A two-year term assurance policy is issued to a life aged x. Under this policy an immediate payment of 100,000 is made if death occurs in the first year, rising to 150,000 if death occurs in the second year.

Calculate the expected present value of this policy.

Basis:

Mortality p_x = 0.99 and p_{x+1} = 0.975

The force of mortality can be assumed to be constant over each year of age

Force of Interest 5%

Ans: 4421 rounded

18. CT5 September 2018 Q7

Calculate $\bar{A}_{70.75}$ assuming a constant force of mortality between ages 70 and 71 only.

Basis:

Mortality PMA92C20

Rate of Interest 4% per annum

Ans: 0.578754

19. CT5 September 2018 Q3

A life insurance company sells a special immediate annuity policy to a life aged 65 exact. The policy provides an annuity of 30,000 a year payable monthly in advance.

Payment is guaranteed for the first five years and thereafter ceases immediately on the death of the policyholder.

Calculate the expected present value of this annuity.

Basis:

Mortality PFA92C20

Rate of Interest 4% per annum

Expenses Ignore

Ans: 434,189

20. CM1A April 2019 Q3

Describe the main features of an endowment assurance contract.

Ans:

An endowment assurance provides a survival benefit at the end of the term, but it also provides a lump sum benefit on death before the end of the term.

The benefits are provided in return for a series of regular premiums (or a single premium).

The sum assured payable on death or survival need not be the same, although they often are.

21. CM1A September 2020 Q2

Calculate, using standard approximations where necessary:

(a) ${}_{10|4}q_{[36]}$

(b) $\bar{A}^{1}_{46:\overline{25}|}$

Basis

Mortality: AM92

Interest rate: 4% per annum

Ans:

(a) 0.007574

(b) 0.10276

22. CM1A April 2021 Q5

The force of mortality, μ_x^*, experienced by a particular population at all ages x (where x is not necessarily an integer) is 20% higher than that under the PMA92C20 table.

Calculate the following, based on μ_x^*, assuming a rate of interest of 7% p.a.

(i) $\ddot{a}_{70:\overline{3}|}$

(ii) $A_{70:\overline{3}|}$

Ans:

(i) 2.762234

(ii) 0.819293

23. CM1A April 2021 Q6

A special whole life assurance policy is issued to a life aged 45 exact. The policy provides a benefit of $40,000 on death within 15 years of inception, and $50,000 on death thereafter. Benefits are payable at the end of the year of death.

(i) Calculate the expected present value of the benefit payments.

(ii) Calculate the variance of the present value of the benefit payments.

Basis:

Mortality: AM92 Ultimate

Interest: 6% p.a.

Ans:

(i) EPV = $ 7,670.11

(ii) ($5,372)^2

24. CM1A April 2022 Q4

(a) Write down the formula for the variance of the present value of an n-year temporary annuity of £1 p.a. payable at the end of each year, issued to a life aged x exact.

(b) Calculate, showing all working, the variance of the present value of a 20-year temporary annuity of £5,000 p.a., payable at the end of each year, issued to a life aged 44 exact.

Basis:

Mortality AM92 Ultimate

Interest 4% p.a. effective

Ans:

a. $\text{Variance} = \frac{1}{d^2}\left[{}^2A_{\overline{x:n+1}|} - \left(A_{\overline{x:n+1}|}\right)^2\right]$ where ${}^2A_{\overline{x:n+1}|}$ *is* $A_{\overline{x:n+1}|}$ calculated at $i' = (1+i)^2 - 1$

b. $£^2 57.69m$

25. CM1A September 2022 Q1

Calculate, showing all working, ${}_{3.5}q_{56.25}$, assuming a constant force of mortality between integer ages.

Basis: Mortality ELT15 (females)

Ans: 0.02187

26. CT5 September 2012 Q1

Calculate:

(a) ${}_{12}p_{43}$

(b) ${}_{10|5}q_{55}$

(c) $\ddot{a}_{45:\overline{10}|}$

Basis:

Mortality AM92

Rate of interest 6% per annum

Ans:

a. 0.97269

b. 0.08027

c. 7.740

27. CM1 April 2023 Q1

(i) Describe in words ${}_{a|b}q_{[x]+1}$

(ii) Calculate, showing all working, ${}_{5|3}q_{[38]+1}$

Basis:

Mortality AM92 (select)

Ans:

(i) The probability that a life aged *x+1 exact* who entered the select population at age *x exact* will survive *a* years and then die within the following *b* years, that is, they will die between exact ages *x+1+a* and *x+1+a+b.*

(ii) 0.00485161

28. CM1 April 2023 Q3

Calculate $a^{(4)}_{82\frac{1}{4}}$, showing all working.

Basis:

Mortality PMA92C20

Interest 4% per annum effective

Ans: 6.0957

29. CM1 September 2023 Q1

A mortality table gives the value of A_{50} = 0.3 at an interest rate of 5% p.a. effective.

Calculate, using appropriate approximations where necessary and showing all

working, the values for:

(a)$\bar{A}_{50}$

(b)a_{50}

(c) $\bar{a}_{50}$

(d) $\ddot{a}_{50}^{(4)}$

using the same basis.

Ans:

(a) 0.307409

(b) 13.7

(c) 14.2

(d) 14.325

30. CM1 April 2024 Q1

Calculate ${}_{4.25}q_{87.25}$ assuming PMA92C20 mortality and that there is a uniform distribution of deaths between integer ages. You should show your working.

Ans: 0.458800