

CT5 – P MA – 16

Mock Exam A

ActEd Study Materials: 2016 Examinations

Subject CT5

Contents

Mock Exam A Questions

If you think that any pages are missing from this pack, please contact ActEd's admin team by email at ActEd@bpp.com.

How to use Mock Exam A

Guidance on how and when to use Mock Exam A is set out in the *Study Guide for the 2016 exams*. The recommended date and deadline date for submission of Mock Exam A are listed on a summary page at the back of this pack.

We strongly recommend that you work to the recommended date.

Please note that we only accept the current version of Mock Exam A for marking, ie you can only submit this mock exam in the sessions leading to the 2016 exams. However, if you wish to submit your script for marking in 2016, but do not have the latest version of Mock Exam A, please let us know and we will send, free of charge, an up-to-date version for you to attempt and submit.

Important: Copyright Agreement

This study material is copyright and is sold for the exclusive use of the purchaser. You may not hire out, lend, give out, sell, store or transmit electronically or photocopy any part of it. You must take care of your material to ensure that it is not used or copied by anybody else. By opening this pack you agree to these conditions.

ISBN 178-1-4727-0096-2



1 781472 700962

All study material produced by ActEd is copyright and is sold for the exclusive use of the purchaser. The copyright is owned by Institute and Faculty Education Limited, a subsidiary of the Institute and Faculty of Actuaries.

Unless prior authority is granted by ActEd, you may not hire out, lend, give out, sell, store or transmit electronically or photocopy any part of the study material.

You must take care of your study material to ensure that it is not used or copied by anybody else.

Legal action will be taken if these terms are infringed. In addition, we may seek to take disciplinary action through the profession or through your employer.

These conditions remain in force after you have finished using the course.

Subject CT5: Mock Exam A

2016 Examinations

Time allowed: 3 hours

Instructions to the candidate

1. *Please:*

- *attempt all of the questions, as far as possible under exam conditions*
- *begin your answer to each question on a new page*
- *leave at least 2cm margin on all borders*
- *write in black ink using a medium-sized nib because we will be unable to mark illegible scripts*
- *note that mock exam marking is not included in the price of the Course Materials. Please purchase Mock Exam Marking or Marking Vouchers before submitting your script.*
- *note that we only accept the current version of mock exams for marking, ie you can only submit this mock exam in the sessions leading to the 2016 exams.*

2. *Please **do not**:*

- *use headed paper*
- *use highlighting in your script.*

At the end of the mock exam

If your script is being marked by ActEd, please follow the instructions on the reverse of this page.

In addition to this paper, you should have available actuarial tables and an electronic calculator.

Submission for marking

You should aim to submit this script for marking by the recommended submission date. The recommended and deadline dates for submission of this mock exam are listed on the summary page at the back of this pack and on our website at www.ActEd.co.uk.

Scripts received after the deadline date will not be marked, unless you are using a Marking Voucher. *It is your responsibility to ensure that scripts reach ActEd in good time.* ActEd will not be responsible for scripts lost or damaged in the post, or for scripts received after the deadline date. If you are using Marking Vouchers, then please make sure that your script reaches us by the Marking Voucher deadline date to give us enough time to mark and return the script before the exam.

When submitting your script, please:

- complete the cover sheet, including the checklist
- scan your script and cover sheet (and Marking Voucher if applicable) to a pdf document, then email it to: [**ActEdMarking@bpp.com**](mailto:ActEdMarking@bpp.com)
- **do not submit a photograph of your script**
- **do not include the question paper in the scan.**

In addition, please note the following:

- Please title the email to ensure that the subject and mock exam are clear *eg* “CT5 Mock Exam A No. 12345”, inserting your ActEd Student Number for 12345.
- The mock exam should be scanned the **right way up** (so that it can be read normally without rotation) and as a single document. We cannot accept individual files for each page.
- Please set the resolution so that the script is legible and the resulting PDF is less than 3 MB in size. **The file size cannot exceed 4 MB.**
- Do not protect the PDF in any way (otherwise the marker cannot return the script to ActEd, which causes delays).
- Please include the “feedback from marker” sheet when scanning.
- Before emailing to ActEd, please check that your scanned mock exam includes all pages and conforms to the above.

Subject CT5: Mock Exam A

2016 Examinations

Please complete the following information:																			
Name: Email address: ActEd Student Number (see Note below): <table border="1" style="width: 100%; height: 30px; border-collapse: collapse;"> <tr> <td style="width: 20%;"></td> <td style="width: 20%;"></td> <td style="width: 20%;"></td> <td style="width: 20%;"></td> <td style="width: 20%;"></td> </tr> </table> <p>Note: Your ActEd Student Number is printed on all personal correspondence from ActEd. Quoting it will help us to process your scripts quickly. If you do not know your ActEd Student Number, please email us at ActEd@bpp.com.</p> <p>Your ActEd Student Number is not the same as your IFoA Actuarial Reference Number or ARN.</p>													Number of following pages: _____ Please put a tick in this box if you have solutions and a cross if you do not: <input type="checkbox"/> Please tick here if you are allowed extra time or other special conditions in the profession's exams: <input type="checkbox"/> Time to do mock exam (see Note below): _____ hrs _____ mins Under exam conditions (delete as applicable): yes / nearly / no Note: If you take more than 3 hours, you should indicate how much you completed within this time so that the marker can provide useful feedback on your chances of success in the exam.						
Score and grade for this mock exam (to be completed by marker):																			
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Total						
2	3	3	4	5	5	7	9	9	9	14	14	16	100	= _____ %					
<div style="display: flex; justify-content: space-between;"> Grade: A B C D E Marker's initials: _____ </div>																			
Please tick the following checklist so that your script can be marked quickly. Have you:																			
<div style="display: flex;"> <div style="width: 5%; text-align: center;">[]</div> <div>Checked that you are using the latest version of the mock exam, <i>ie</i> 2016 for the sessions leading to the 2016 exams?</div> </div> <div style="display: flex;"> <div style="width: 5%; text-align: center;">[]</div> <div>Written your full name and email address in the box above?</div> </div> <div style="display: flex;"> <div style="width: 5%; text-align: center;">[]</div> <div>Completed your ActEd Student Number in the box above?</div> </div> <div style="display: flex;"> <div style="width: 5%; text-align: center;">[]</div> <div>Recorded your attempt conditions?</div> </div> <div style="display: flex;"> <div style="width: 5%; text-align: center;">[]</div> <div>Numbered all pages of your script (excluding this cover sheet)?</div> </div> <div style="display: flex;"> <div style="width: 5%; text-align: center;">[]</div> <div>Written the total number of pages (excluding the cover sheet) in the space above?</div> </div> <div style="display: flex;"> <div style="width: 5%; text-align: center;">[]</div> <div>Included your Marking Voucher or ordered Mock Exam Marking?</div> </div>																			

Please follow the instructions on the previous page when submitting your script for marking.

This page has been left blank in case you wish to submit your script by fax.

Feedback from marker

Notes on marker's section

The main objective of marking is to provide specific advice on how to improve your chances of success in the exam. The most useful aspect of the marking is the comments the marker makes throughout the script, however you will also be given a percentage score. Based on this score, the marker assigns a grade representing how this script would have fared in an exam. The grades are as follows:

A = Clear Pass B = Probable Pass C = Borderline D = Probable Fail E = Clear Fail

Please note that you can provide feedback on the marking of this mock exam at:

www.ActEd.co.uk/marking

This page has been left blank in case you wish to submit your script by fax.

1 State what it means for a decrement to have a selective effect, giving an example. [2]

2 A five-year unit-linked contract, issued to a life aged 52 exact at entry, has the following vector of in-force expected cashflows:

$$(-518, 175, -70, -161, 1890)$$

Using consistent assumptions, the projected unit fund values at the end of the year for this policy are:

$$(1051, 2416, 4187, 6009, 8377)$$

Use the above information to calculate the total reserves (both unit and non-unit combined) that the insurer would hold for a single policy in force at the end of year 1, according to the following assumptions:

Mortality: AM92 Select

Interest: 2% *pa* effective

[3]

3 (a) Define ${}_{10|4}q_{[49]+1}$ in words.

(b) Calculate its value.

Basis:

Mortality AM92

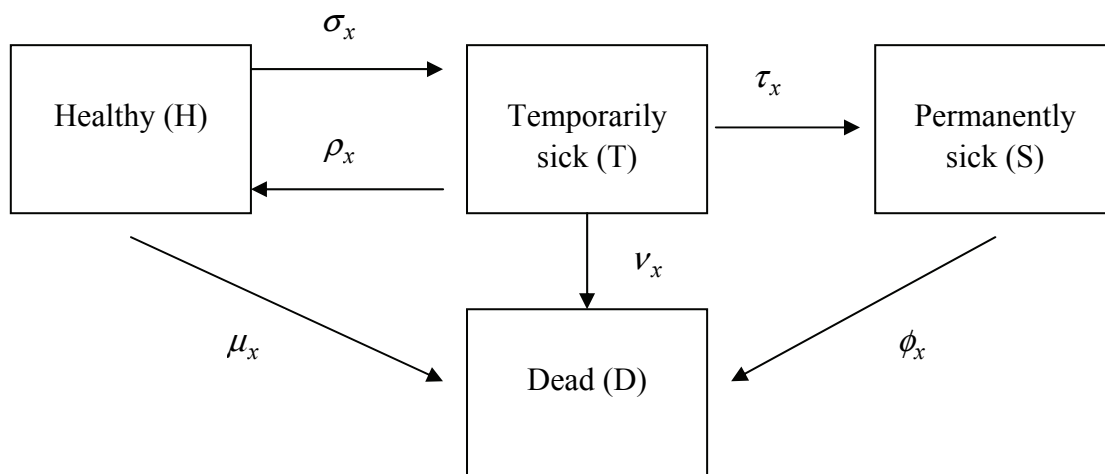
[3]

4 A sickness insurance policy pays the following benefits:

- an income of £6,000 a year payable continuously during all periods of sickness before age 65, which would be doubled during periods of permanent sickness
- on death at any time before age 65, a return of all premiums payable to date (including any waived premiums), without interest, payable immediately on death.

Level annual premiums are payable continuously to age 65 or to earlier death, except that they are waived (*ie* paid for by the insurer) during any period of sickness during that time.

The following multiple-state model is to be used:



Using the above rates of transition, and probabilities of the form:

$${}_t p_x^{ij} = P(\text{person is in state } j \text{ at age } x+t \mid \text{person is in state } i \text{ at age } x)$$

construct a formula, using integrals, for the net annual premium for this contract, for a healthy life aged exactly 45 at entry. [4]

- 5** A man aged x and a woman aged y have applied to take out a special last survivor assurance, which pays a sum assured of £250,000 immediately on the second death, but only if the second death occurs within five years of the first death.

(i) Write down an expression for the present value random variable for this benefit, in terms of the random variables T_x and T_y only. [3]

In the event, the couple decide to take out a contract that will only pay out if the woman is the second of them to die (but still provided she dies within five years of the man's death).

(ii) Write down an expression, using integrals, for the net single premium that should be paid for this contract. [2]

[Total 5]

- 6** A male aged 45 exact purchases a life assurance policy that pays a benefit of £50,000 immediately on death, provided that death occurs after age 60.

Calculate the expected present value and standard deviation of the benefits under this policy. [5]

Basis: Mortality: AM92 Select
Interest: 6% per annum

- 7** An annuity of £20,000 *pa* is payable continuously in respect of two lives – a male aged exactly 65 and a female aged exactly 61. The annuity commences immediately upon the first death, provided that this occurs within 10 years, and continues throughout the lifetime of the survivor.

Assuming that the two lives are independent with respect to mortality, calculate the expected present value of the annuity. [7]

Basis: Mortality: PA92C20
Interest: 4% per annum

8 Consider this extract from the PMA92C20 mortality table.

Age x	l_x
50	9,941.923
60	9,826.131

- (i) Calculate ${}_5q_{50}$ under each of the two following alternative assumptions:
- (a) a uniform distribution of deaths (UDD) between ages 50 and 60 years
 - (b) a constant force of mortality between ages 50 and 60 years. [3]
- (ii) Calculate the number of survivors to exact age 55 years under each of the assumptions in (i) above. [2]
- (iii) Comment on the appropriateness of the assumptions of UDD and a constant force of mortality between ages 50 and 60 years in this example. [4]
- [Total 9]

9 On age retirement, a pension scheme provides a pension of 1/60th of final pensionable salary for each year of service. Final pensionable salary is defined as the average annual salary in the three years immediately preceding retirement. A member aged 50 has exactly 27 years of past service and is expected to earn £40,000 in the coming year. Using the pension scheme data in the *Tables*, calculate, in respect of this member:

- (i) the expected present value of his age retirement benefit, assuming that part years of service count proportionately. [3]
 - (ii) the expected present value of his age retirement benefit, assuming that only complete years of service count. [4]
 - (iii) the expected present value of his age retirement benefit, assuming that part years of service count proportionately and the maximum pension is 40/60ths of final pensionable salary. [2]
- [Total 9]

- 10** A life office issues 3-year term assurance policies to a group of lives aged 62 exact. The sum assured is £150,000, payable at the end of the year of death. Premiums are payable annually in advance, ceasing on earlier death.

The life office reserves on a net premium basis using an interest rate of 4% *pa* effective, and AM92 Ultimate mortality.

The life office makes the following additional assumptions when carrying out a profit test:

Mortality:	AM92 Select
Expenses:	Initial £400, renewal £50 at the start of the second and subsequent years
Interest rate:	6% <i>pa</i> effective on investments
Risk discount rate:	9% <i>pa</i> effective

Carry out a profit test to determine the premium that will produce a net present value of zero on the above basis. [9]

- 11** You are given the following mortality data for South Africa and England/Wales in 2001.

Age	South Africa		England/Wales	
	Deaths	Population (000s)	Deaths	Population (000s)
0-4	41,920	4,449.8	3,828	3,086.2
5-9	3,831	4,853.6	373	3,300.6
10-14	3,203	5,061.9	459	3,429.4
15-19	8,371	4,981.7	1,260	3,225.5
20-24	19,655	4,294.5	1,733	3,129.2
25-29	35,667	3,934.9	2,067	3,415.7
30-34	39,203	3,340.9	3,157	3,978.1
35-39	36,568	3,071.8	4,227	4,100.6
40-44	31,893	2,619.5	5,606	3,674.0
45-49	28,611	2,087.4	8,254	3,303.4
50-54	26,864	1,638.0	13,934	3,564.6
55-59	23,566	1,205.3	18,811	3,006.5
60-64	27,037	1,065.3	26,268	2,544.5
65-69	25,719	787.9	38,461	2,295.2
70-74	29,020	631.5	59,496	2,074.6
75-79	22,848	367.5	84,624	1,750.5
80-84	22,982	270.9	91,197	1,190.1
85+	23,091	157.3	166,618	1,016.1
Total	450,049	44,820	530,373	52,085

Source: Statistics South Africa, UK National Statistics Office

- (i) The child mortality rate is defined to be the crude death rate amongst children aged under 5 years.
- (a) Calculate the child mortality rates in 2001 for England/Wales and South Africa separately. Comment on the figures obtained.
- (b) State four factors that are likely to affect child mortality, and explain how those factors affect mortality. [6]
- (ii) Calculate the crude death rates for South Africa and England/Wales separately, based on the whole age range. Comment on the figures obtained. [3]

- (iii) The population structure in the 20-39 age range is very different between the two areas.
- (a) Calculate the crude death rates for the two populations for this age range only. Comment on your answers.
- (b) Calculate the directly standardised mortality rate over this age range for South Africa, using England/Wales as the standard, and comment on your answer. [5]

[Total 14]

12 Aliens on Planet X may die in one of three ways: normal death, zombie death and mutation death. A 3-year savings contract is available on Planet X that pays the following benefits:

- On normal death during the 3 years, a benefit of \$50,000 is payable immediately.
- On zombie death during the 3 years, a benefit of all premiums paid is payable immediately.
- On mutation death during the 3 years, a benefit of all premiums paid, accumulated with interest at 3% *pa*, is payable immediately.
- There is a survival benefit of \$30,000 for any alien who does not have one of these three types of death over the three years.

The contract ceases on payment of any benefit.

The issuing company uses the following basis to calculate the annual premium for this policy, assuming that the forces of decrement are constant over each individual year of age:

Independent probabilities of normal death	AM92 Ultimate
Independent force of zombie death	8% per annum
Independent force of mutation death	7% per annum
Interest	3% per annum
Expenses	1% of each premium
Currency	Alien dollar (\$)

Using the principle of equivalence, calculate the level premium payable annually in advance for this contract for an alien who may be treated as being aged 50 exact. [14]

- 13** A life insurance company sells 20-year with-profit endowment assurances to lives aged 40 exact. The basic sum assured is £50,000, and compound bonuses of 1.923% are added to the sum assured at the end of each year, provided the policyholder survives to the end of the year. The death benefit is payable at the end of the year of death. Level premiums are payable monthly in advance.

The basis is as follows:

Mortality: AM92 Select

Interest: 6% *pa*

Expenses: Initial, 50% of the first year's premiums, payable at the start of the contract

Renewal, 5% of all premiums, including the first year's premiums, payable at the start of each year.

- (i) Show that the monthly premium is £182.64. [7]
- (ii) Find the gross premium prospective reserve just before the start of the fifteenth year of the policy, assuming that bonuses have been declared according to the initial assumptions. [5]
- (iii) On 1st January 2001, the company sold 500 policies of this type to a group of identical lives then aged 40 exact. On 1st January 2014, 488 of these policies were still in force. During the calendar year 2014, 2 policyholders died. Calculate the mortality profit or loss for calendar year 2014. [4]

[Total 16]

END OF MOCK EXAM

For the session leading to the April 2016 exams – CT Subjects

Marking vouchers

<i>Subjects</i>	<i>Assignments</i>	<i>Mocks</i>
CT1, CT2, CT5, CT6	16 March 2016	22 March 2016
CT3, CT4, CT7, CT8	22 March 2016	30 March 2016

Series X Assignments

<i>Subjects</i>	<i>Assignment</i>	<i>Recommended submission date</i>	<i>Final deadline date</i>
CT1, CT2, CT5, CT6	X1	18 November 2015	13 January 2016
CT3, CT4, CT7, CT8		25 November 2015	20 January 2016
CT1, CT2, CT5, CT6	X2	9 December 2015	3 February 2016
CT3, CT4, CT7, CT8		16 December 2015	10 February 2016
CT1, CT2, CT5, CT6	X3	20 January 2016	24 February 2016
CT3, CT4, CT7, CT8		27 January 2016	2 March 2016
CT1, CT2, CT5, CT6	X4	17 February 2016	9 March 2016
CT3, CT4, CT7, CT8		24 February 2016	16 March 2016

Mock Exams

<i>Subjects</i>	<i>Recommended submission date</i>	<i>Final deadline date</i>
CT1, CT2, CT5, CT6	9 March 2016	22 March 2016
CT3, CT4, CT7, CT8	16 March 2016	30 March 2016

We encourage you to work to the recommended submission dates where possible.

We strongly recommend that you submit your mock exam electronically in order for us to return your marked script to you in plenty of time before your exam. If you submit your mock on the final deadline date you are likely to receive your script back less than a week before your exam.

For the session leading to the September/October 2016 exams – CT Subjects**Marking vouchers**

Subjects	Assignments	Mocks
CT1, CT2, CT6, CT7	31 August 2016	7 September 2016
CT3, CT4, CT5, CT8	7 September 2016	14 September 2016

Series X Assignments

Subjects	Assignment	Recommended submission date	Final deadline date
CT1, CT2, CT6, CT7	X1	8 June 2016	6 July 2016
CT3, CT4, CT5, CT8		15 June 2016	13 July 2016
CT1, CT2, CT6, CT7	X2	29 June 2016	27 July 2016
CT3, CT4, CT5, CT8		6 July 2016	3 August 2016
CT1, CT2, CT6, CT7	X3	20 July 2016	10 August 2016
CT3, CT4, CT5, CT8		27 July 2016	17 August 2016
CT1, CT2, CT6, CT7	X4	3 August 2016	24 August 2016
CT3, CT4, CT5, CT8		10 August 2016	31 August 2016

Mock Exams

Subjects	Recommended submission date	Final deadline date
CT1, CT2, CT6, CT7	24 August 2016	7 September 2016
CT3, CT4, CT5, CT8	31 August 2016	14 September 2016

We encourage you to work to the recommended submission dates where possible.

We strongly recommend that you submit your mock exam electronically in order for us to return your marked script to you in plenty of time before your exam. If you submit your mock on the final deadline date you are likely to receive your script back less than a week before your exam.