

AMERICAN SOCIETY OF PENSION PROFESSIONALS & ACTUARIES  
JOINT BOARD FOR THE ENROLLMENT OF ACTUARIES  
SOCIETY OF ACTUARIES

Enrolled Actuaries Basic Examination

**EA-1**

Date: Tuesday, May 2, 2017  
Time: 8:30 a.m. – 11:00 a.m.

INSTRUCTIONS TO CANDIDATES

1. Write your candidate number here \_\_\_\_\_. Your name must not appear.
2. Do not break the seal of this book until the supervisor tells you to do so.
3. Special conditions generally applicable to all questions on this examination are found at the front of this book.
4. On this examination the symbol “ $a$ ” will be used to represent an annuity. On this examination the symbol “ $\ell_x$ ” will be used to represent the number of lives at age  $x$ .
5. This examination consists of 32 multiple-choice questions worth a total of 100 points. The point value for each question is shown in parentheses at the beginning of the question.
6. Your score will be based on the point values of questions that you answer correctly. No credit will be given for omitted answers and no credit will be lost for wrong answers; hence, you should answer all questions even those for which you have to guess.
7. A separate answer sheet is inside the front cover of this book. During the time allotted for this examination, record all your answers on side 2 of the answer sheet. **NO ADDITIONAL TIME WILL BE ALLOWED FOR THIS PURPOSE.** No credit will be given for anything indicated in the examination book but not transferred to the answer sheet. Failure to stop writing or coding your answer sheet after time is called will result in the disqualification of your answer sheet or further disciplinary action.
8. Five answer choices are given with each question, each answer choice being identified by a key letter (A to E). For each question, blacken the oval on the answer sheet that corresponds to the key letter of the answer choice that you select.
9. Use a soft-lead pencil to mark the answer sheet. To facilitate correct mechanical scoring, be sure that, for each question, your pencil mark is dark and completely fills only the intended oval. Make no stray marks on the answer sheet. If you have to erase, do so completely.
10. Do not spend too much time on any one question. If a question seems too difficult, leave it and go on.
11. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.
12. Clearly indicated answer choices in the test book can be an aid in grading examinations in the unlikely event of a lost answer sheet.
13. Use the blank portions of each page for your scratch work. Extra blank pages are provided at the back of the examination book.
14. When the supervisor tells you to do so, break the seal on the book and remove the answer sheet.  
  
On the front of the answer sheet, space is provided to write and code candidate information. Complete the information requested by printing in the squares and blackening the circles (one in each column) corresponding to the letters or numbers printed. For each empty box blacken the small circle immediately above the “A” circle. Fill out the boxes titled:
  - (a) Name  
(Include last name, first name and middle initial)
  - (b) Candidate Number  
(Candidate/Eligibility Number, use leading zeros if needed to make it a five digit number)
  - (c) Test Site Code  
(The supervisor will supply the number.)
  - (d) Examination Part  
(Code the examination that you are taking by blackening the circle to the left of "Exam EA-1")
  - (e) Booklet Number  
(The booklet number can be found in the upper right-hand corner of this examination book. Use leading zeros if needed to make it a four digit number.)  
In the box titled “Complete this section only if instructed to do so”, fill in the circle to indicate if you are using a calculator and write in the make and model number.  
  
In the box titled “Signature and Date” sign your name and write today's date. **If the answer sheet is not signed, it will not be graded.**  
  
Leave the boxes titled “Test Code” and “Form Code” blank.  
  
On the back of the answer sheet fill in the Booklet Number in the space provided.
15. After the examination, the supervisor will collect this book and the answer sheet separately. **DO NOT ENCLOSE THE ANSWER SHEET IN THE BOOK.** All books and answer sheets must be returned. **THE QUESTIONS ARE CONFIDENTIAL AND MAY NOT BE TAKEN FROM THE EXAMINATION ROOM.**

**Answer Key EA-1 Spring 2017**  
**February 20, 2017**

<b>Question</b>	<b>Answer</b>		<b>Question</b>	<b>Answer</b>
1	D		31	D
2	E		32	B
3	A			
4	B			
5	D			
6	B			
7	E			
8	A			
9	D			
10	D			
11	B			
12	D			
13	D			
14	C			
15	C			
16	E			
17	B			
18	C			
19	D			
20	C			
21	A			
22	B			
23	A			
24	A			
25	C			
26	B			
27	B			
28	D			
29	C			
30	A			

## CONDITIONS GENERALLY APPLICABLE TO ALL EA-1 EXAMINATION QUESTIONS

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If applicable, the following conditions should be considered a part of the data for each question, unless otherwise stated or implied:

- (1) The normal retirement age is 65.
- (2) Retirement pensions commence at normal retirement age and are paid monthly for life at the beginning of each month.
- (3) There are no pre-retirement death or disability benefits.
- (4) Actuarial equivalence is based on the mortality table and interest rate assumed for funding purposes.
- (5) Interest rates that are compounded more frequently than annually are expressed as nominal rates.
- (6) Where multiple lives are involved, future lifetimes are assumed to be independent of each other.
- (7) The term “gross single premium” is equivalent to “contract single premium;” the term “net single premium” is equivalent to “single benefit premium;” the term “gross annual premium” is equivalent to “annual contract premium;” the term “net annual premium” is equivalent to “annual benefit premium.”
- (8) There are no policy loans in effect.
- (9) For a bond, the face amount and the redemption value are the same.
- (10) Interest rate equals yield rate.
- (11) The term “duration” means “Macaulay duration”.

Data for Question 1 (2 points)

Summary of pension fund activity for a given calendar year:

<u>Date</u>	<u>Contributions</u>	<u>Benefit payments</u>	<u>Market value of assets after transactions</u>
1/1	-	-	\$5,000,000
6/30	\$900,000	-	6,200,000
12/31	-	\$550,000	6,450,000

$X$  = the dollar-weighted rate of return for the year

Question 1

In what range is  $X$ ?

- (A) Less than 18.00%
- (B) 18.00% but less than 19.00%
- (C) 19.00% but less than 20.00%
- (D) 20.00% but less than 21.00%
- (E) 21.00% or more

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Data for Question 2 (2 points)

Selected probabilities:

$x$	$p_x$
55-59	0.99
60-64	0.95
65	0.90

Interest rate: 7.0% per year, compounded annually

$$a_{65} = 8.194$$

$$X = {}_{10}\ddot{a}_{55}$$

Question 2

In what range is  $X$ ?

- (A) Less than 3.1
- (B) 3.1 but less than 3.2
- (C) 3.2 but less than 3.3
- (D) 3.3 but less than 3.4
- (E) 3.4 or more

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Data for Question 3 (3 points)

Interest rate: 3.0% per year, compounded annually

Selected commutation functions:

<u><math>x</math></u>	<u><math>S_x</math></u>
60	8,522
61	7,532
62	6,631
63	5,813

$X$  = the expected number of deaths between ages 60 and 61 out of 10,000 alive at age 60

Question 3

In what range is  $X$ ?

- (A) Less than 400
- (B) 400 but less than 500
- (C) 500 but less than 600
- (D) 600 but less than 700
- (E) 700 or more



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Data for Question 4 (3 points)

$$v^{11} = 0.50$$

$$X = 100 |i^{(4)} - d^{(4)}|$$

Question 4

In what range is  $X$ ?

- (A) Less than 0.07
- (B) 0.07 but less than 0.14
- (C) 0.14 but less than 0.21
- (D) 0.21 but less than 0.28
- (E) 0.28 or more

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Data for Question 5 (3 points)

Smith pays \$950.00 for an investment that returns \$500.00 at the end of year 3 and \$700.00 at the end of year 4.

Term structure of interest rates:

<u>Term</u>	<u>Spot rate</u>
2 years	5.00%
4 years	7.00%

$X$  = the year 3 forward rate

Question 5

In what range is  $X$ ?

- (A) Less than 7.10%
- (B) 7.10% but less than 7.80%
- (C) 7.80% but less than 8.50%
- (D) 8.50% but less than 9.20%
- (E) 9.20% or more

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Data for Question 6 (4 points)

Selected values for independent lives:

$${}_n p_{xx} = 0.25$$

$$p_{x+n} = 0.50$$

$$X = {}_n q_x + {}_n q_{xx} - {}_n | q_{xxx}$$

Question 6

In what range is  $X$ ?

- (A) Less than 1.14
- (B) 1.14 but less than 1.16
- (C) 1.16 but less than 1.18
- (D) 1.18 but less than 1.20
- (E) 1.20 or more

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Data for Question 7 (3 points)

Smith (age 62) is entitled to an annual life annuity-due of \$30,000 commencing immediately.

Instead of the life annuity, Smith elects an actuarially equivalent benefit that pays the following:

1. A \$50,000 lump sum payable immediately, plus
2. A 5-year term certain annuity-due that pays  $X$  per year starting at age 65, if Smith survives to age 65.

Interest: 7.0% per year, compounded annually

$$\ddot{a}_{62} = 12.67977$$

$${}_n p_x = 0.99^n, x \leq 65$$

Question 7

In what range is  $X$ ?

- (A) Less than \$80,000
- (B) \$80,000 but less than \$85,000
- (C) \$85,000 but less than \$90,000
- (D) \$90,000 but less than \$95,000
- (E) \$95,000 or more



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Data for Question 8 (3 points)

Terms of a bond:

Face amount \$21,000

Coupon rate 5.0% per year, payable semiannually

Redemption schedule:

<u>Term</u>	<u>Amount</u>
2 years	\$7,000
4 years	7,000
6 years	7,000

Yield rate to purchaser: 6.0% per year, compounded quarterly

$X$  = the purchase price of the bond

Question 8

In what range is  $X$ ?

- (A) Less than \$20,400
- (B) \$20,400 but less than \$20,600
- (C) \$20,600 but less than \$20,800
- (D) \$20,800 but less than \$21,000
- (E) \$21,000 or more

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Data for Question 9 (4 points)

A portfolio of assets consists of the following:

1. An annuity with 20 annual payments of \$2,000, with the first payment in one year
2. A \$10,000 zero coupon bond maturing in five years

The interest rate is 8.0% per year, compounded annually.

$X$  = the modified duration of this portfolio

Question 9

In what range is  $X$ ?

- (A) Less than 5.5 years
- (B) 5.5 years but less than 6.0 years
- (C) 6.0 years but less than 6.5 years
- (D) 6.5 years but less than 7.0 years
- (E) 7.0 years or more

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Data for Question 10 (3 points)

$$\ell_x = 115 - x, x \leq 115$$

Interest rate: 7.0% per year, compounded annually

$$X = 1000 \ddot{a}_{70}$$

Question 10

In what range is  $X$ ?

- (A) Less than 9,800
- (B) 9,800 but less than 10,100
- (C) 10,100 but less than 10,400
- (D) 10,400 but less than 10,700
- (E) 10,700 or more

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Data for Question 11 (3 points)

Terms of an annuity-immediate, payable for life to a life age  $x$ :

Payment: \$100,000 per year payable annually

Interest: 5.0% per year, compounded annually

Current mortality rates:

$$q_x = 0.051$$

$$q_{x+1} = 0.057$$

$$q_{x+2} = 0.063$$

Mortality rates are projected to improve by 1.0% per year, compounded annually.

$X$  = the present value, computed at age  $x$ , of the third payment

Question 11

In what range is  $X$ ?

- (A) Less than \$72,570
- (B) \$72,570 but less than \$72,600
- (C) \$72,600 but less than \$72,630
- (D) \$72,630 but less than \$72,660
- (E) \$72,660 or more



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Data for Question 12 (4 points)

Smith purchases an annuity-certain immediate for 20 years:

1. In each of the first 10 years, an annual total of \$50,000 is paid in equal monthly installments.
2. In each of the last 10 years, an annual total of \$25,000 is paid in equal quarterly installments.
3. Interest rate: 4.00% per year nominal convertible semi-annually for the 20 years.

$X$  = the single premium paid by Smith

Question 12

In what range is  $X$ ?

- (A) Less than \$525,000
- (B) \$525,000 but less than \$535,000
- (C) \$535,000 but less than \$545,000
- (D) \$545,000 but less than \$555,000
- (E) \$555,000 or more

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Data for Question 13 (3 points)

Selected values from a life table:

$$\ell_x = 7,024$$

$$\ell_{x+1} = 6,912$$

Deaths are uniformly distributed between integral ages.

Question 13

In what range is  $m_x$ ?

- (A) Less than 0.0150
- (B) 0.0150 but less than 0.0155
- (C) 0.0155 but less than 0.0160
- (D) 0.0160 but less than 0.0165
- (E) 0.0165 or more

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Data for Question 14 (3 points)

Deaths are uniformly distributed over each integral age.

$$q_{50} = 0.001189$$

$$q_{51} = 0.001415$$

$$q_{52} = 0.001600$$

$$X = {}_{1.50}q_{50.25}$$

Question 14

In what range is  $X$ ?

- (A) Less than 0.001700
- (B) 0.001700 but less than 0.001933
- (C) 0.001933 but less than 0.002166
- (D) 0.002166 but less than 0.002399
- (E) 0.002399 or more

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Data for Question 15 (4 points)

Smith invests in a fund as follows:

1. A deposit is made at the beginning of each calendar year for 20 years.
2. Each deposit is 7.0% of Smith's beginning of year annual salary.

Smith's initial annual salary is \$60,000, upon which the first deposit is made.

The fund earns interest at a rate of 5.0% per year, compounded semi-annually.

Smith's salary increases are 4.0% per year.

$X$  = the accumulated fund at the end of the 20<sup>th</sup> year

Question 15

In what range is  $X$ ?

- (A) Less than \$204,000
- (B) \$204,000 but less than \$205,000
- (C) \$205,000 but less than \$206,000
- (D) \$206,000 but less than \$207,000
- (E) \$207,000 or more



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Data for Question 16 (4 points)

Data from a double-decrement table:

$x$	63	66
$\ell_x^{(\tau)}$	500	0
$q_x^{(1)}$	0.050	-
${}_1 q_x^{(1)}$	0.070	-
${}_2 q_x^{(1)}$	0.042	-
$q_x^{(2)}$	0.500	-
${}_2q_x^{(2)}$	0.600	-

$$X = d_{65}^{(2)}$$

Question 16

In what range is  $X$ ?

- (A) Less than 97
- (B) 97 but less than 103
- (C) 103 but less than 109
- (D) 109 but less than 115
- (E) 115 or more

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Data for Question 17 (3 points)

Mortality is uniformly distributed between each integral year of age.

$$q_{40} = 0.010$$

$$q_{41} = 0.015$$

$$X = 1000 {}_{0.50}q_{40.75}$$

Question 17

In what range is  $X$ ?

- (A) Less than 6.255
- (B) 6.255 but less than 6.265
- (C) 6.265 but less than 6.275
- (D) 6.275 but less than 6.285
- (E) 6.285 or more

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Data for Question 18 (2 points)

Terms of a 9-year annuity-due:

Payments            \$100 per year payable annually

Interest rates      Applicable annual spot rates:

<u>Payment number</u>	<u>Applicable spot rate</u>
1 - 5	5.00%
6 - 9	6.00%

$X$  = the present value of the annuity

Question 18

In what range is  $X$ ?

- (A) Less than \$693
- (B) \$693 but less than \$713
- (C) \$713 but less than \$733
- (D) \$733 but less than \$753
- (E) \$753 or more

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Data for Question 19 (3 points)

$q_x^y$  is the probability that someone who is age  $x$  in year  $y$  dies before age  $x+1$ .

Selected values from a base mortality table as of 2014:

$x$	$q_x^{2014}$
100	0.270858
101	0.291040
102	0.311444
103	0.331900

Selected values from a two-dimensional mortality improvement scale by age and year of event:

$x$	Year of event			
	2014	2015	2016	2017
100	0.0113	0.0109	0.0104	0.0099
101	0.0105	0.0102	0.0097	0.0092
102	0.0098	0.0095	0.0090	0.0086
103	0.0090	0.0087	0.0083	0.0079

$$X = 10000 q_{100}^{2017}$$

Question 19

In what range is  $X$ ?

- (A) Less than 2,614
- (B) 2,614 but less than 2,618
- (C) 2,618 but less than 2,622
- (D) 2,622 but less than 2,626
- (E) 2,626 or more



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Data for Question 20 (3 points)

Smith (age 65) and Jones (age 66) are offered the following actuarially equivalent annuities-due, payable annually:

1. \$5,000, payable annually to Jones only.
2.  $X$ , payable annually while both Smith and Jones are alive, reducing to  $0.75X$  after the first death of Smith and Jones and payable until the second death of Smith and Jones.

Selected commutation functions:

$x$	$N_x$	$N_{x:x+1}$
65	67,825	217,370
66	60,605	183,781
67	53,899	154,064

Question 20

In what range is  $X$ ?

- (A) Less than \$4,200
- (B) \$4,200 but less than \$4,250
- (C) \$4,250 but less than \$4,300
- (D) \$4,300 but less than \$4,350
- (E) \$4,350 or more

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Data for Question 21 (4 points)

At time  $t=0$ , a closed group of lives has 100,000 nonsmokers (NS) and 50,000 smokers (S), all of whom are age 60.

No smokers become non-smokers between age 60 and death; no non-smokers become smokers between age 60 and death.

For nonsmokers, deaths are uniformly distributed over future lifetime from age 60 to a terminal age of 110.

$${}_t p_{60}^S = \left( {}_t p_{60}^{NS} \right)^2, \quad 0 \leq t \leq 50$$

$X$  = the probability that, in 20 years, a randomly-selected survivor of the group (then age 80) will die before age 81

Question 21

In what range is  $100X$ ?

- (A) Less than 4.10
- (B) 4.10 but less than 4.25
- (C) 4.25 but less than 4.40
- (D) 4.40 but less than 4.55
- (E) 4.55 or more

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Data for Question 22 (4 points)

Terms of a bond:

Face amount	\$1,000
Term	15 years
Coupon rate	4.0%, payable annually

For a bond in good standing at the beginning of a year, the probability of default is 0.80% during that year.

$X$  = the price an investor would pay to yield 5.0% per year, compounded annually

Question 22

In what range is  $X$ ?

- (A) Less than \$810
- (B) \$810 but less than \$850
- (C) \$850 but less than \$890
- (D) \$890 but less than \$930
- (E) \$930 or more

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Data for Question 23 (3 points)

A portfolio consists of the following two bonds:

	<u>Bond A</u>	<u>Bond B</u>
Face amount	\$1,000	\$1,000
Term	10 years	13 years
Coupon amount	\$90	None
Coupon frequency	Annually	N/A
Modified duration	6.42 years	
Yield rate	9% per year, compounded annually	9% per year, compounded annually

$X$  = the modified duration of the portfolio

Question 23

In what range is  $X$ ?

- (A) Less than 7.9 years
- (B) 7.9 years but less than 8.4 years
- (C) 8.4 years but less than 8.9 years
- (D) 8.9 years but less than 9.4 years
- (E) 9.4 years or more



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Data for Question 24 (3 points)

The rates of mortality for impaired lives are 150% of the rates of standard lives.

Given the following values for standard lives:

$x$	$q_x$
95	0.3000
96	0.4000
97	0.5000
98	0.6667
99	1.0000

$X$  = the curtate life expectancy for an impaired life age 95

Question 24

In what range is  $X$ ?

- (A) Less than 0.85
- (B) 0.85 but less than 1.00
- (C) 1.00 but less than 1.15
- (D) 1.15 but less than 1.30
- (E) 1.30 or more

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Data for Question 25 (3 points)

Smith (age 65) has a fully paid-up life insurance policy with a face amount of \$300,000, with the death benefit payable at the end of the year of death.

The insurance company offers Smith a one-time option to convert this to an actuarially equivalent single life annuity with level annual payments at the end of each year.

Interest rate: 5.00% per year, compounded annually

$$A_{65} = 0.3963$$

$X$  = the annual amount Smith will receive if the policy is converted, at age 65, to a single life annuity with level annual payments at the end of each year

Question 25

In what range is  $X$ ?

- (A) Less than \$9,500
- (B) \$9,500 but less than \$10,000
- (C) \$10,000 but less than \$10,500
- (D) \$10,500 but less than \$11,000
- (E) \$11,000 or more

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Data for Question 26 (3 points)

Selected actuarial values:

$$q_x^{(1)} = 0.075$$

$$q_x^{(2)} = 0.095$$

Decrement 1 has a uniform distribution of decrement within each year of its associated single decrement table.

Decrement 2 has a constant force of decrement throughout each year.

$$X = {}_{0.75}P_x^{(\tau)}$$

Question 26

In what range is  $X$ ?

- (A) Less than 0.8747
- (B) 0.8747 but less than 0.8762
- (C) 0.8762 but less than 0.8777
- (D) 0.8777 but less than 0.8792
- (E) 0.8792 or more

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Data for Question 27 (3 points)

$$\ell_x = 100 - x, x \leq 100$$

There are 4 people (independent lives), all of whom are age 40.

$X$  = the probability that at least 2 of the 4 people will die within 20 years

Question 27

In what range is  $X$ ?

- (A) Less than 0.37
- (B) 0.37 but less than 0.42
- (C) 0.42 but less than 0.47
- (D) 0.47 but less than 0.52
- (E) 0.52 or more



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Data for Question 28 (3 points)

A \$100,000 loan is made with level monthly repayments payable at the end of each month.

The borrower is given the following options:

Option 1: 30 years, 6.00% nominal per year, compounded monthly

Option 2: 15 years, 4.00% nominal per year, compounded monthly

$X$  = the amount of interest saved over the life of the loan by choosing Option 2 over Option 1

Question 28

In what range is  $X$ ?

- (A) Less than \$60,500
- (B) \$60,500 but less than \$70,500
- (C) \$70,500 but less than \$80,500
- (D) \$80,500 but less than \$90,500
- (E) \$90,500 or more

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Data for Question 29 (2 points)

Given the following values from a single decrement table:

$x$	$q_x$
46	0.070
47	0.065
48	0.060
49	0.050

A 2-year select mortality table based on this single decrement table has the following characteristics:

$$q_{[x]} = 1.5q_x$$

$$q_{[x]+1} = 1.3q_{x+1}$$

$$X = {}_1|q_{[46]+1}$$

Question 29

In what range is  $X$ ?

- (A) Less than 0.0540
- (B) 0.0540 but less than 0.0545
- (C) 0.0545 but less than 0.0550
- (D) 0.0550 but less than 0.0555
- (E) 0.0555 or more

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Data for Question 30 (3 points)

Terms of a loan:

Term	30 years
Interest rate	4.0% per year, compounded annually
Repayments	Level annual payments, payable at the end of each year

Loan repayments are reinvested at the following rates of interest:

First 15 years: 5.0% per year

Next 15 years: 4.5% per year

$X$  = the annual rate of return over the 30 years

Question 30

In what range is  $X$ ?

- (A) Less than 4.40%
- (B) 4.40% but less than 4.43%
- (C) 4.43% but less than 4.46%
- (D) 4.46% but less than 4.49%
- (E) 4.49% or more

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Data for Question 31 (4 points)

Smith (age 60) buys a contract that pays the following:

1. An annuity-immediate of \$10,000 per year, payable annually for Smith's life.
2. Upon Smith's death, Smith's beneficiary will receive \$5,000 per year, continuing for 10 years certain, commencing on the contract anniversary next following Smith's death.

$$N_{60} = 6,157$$

$$N_{61} = 5,673$$

Interest rate: 4.0% per year, compounded annually

$X$  = the single premium for this contract

Question 31

In what range is  $X$ ?

- (A) Less than \$136,000
- (B) \$136,000 but less than \$137,000
- (C) \$137,000 but less than \$138,000
- (D) \$138,000 but less than \$139,000
- (E) \$139,000 or more



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Data for Question 32 (3 points)

$$\frac{C_{95}}{C_{80}} = 0.1115$$

$$q_{80} = 0.0803$$

Interest rate: 6.0% per year, compounded annually

$$X = {}_{15}q_{80}$$

Question 32

In what range is  $X$ ?

- (A) Less than 0.020
- (B) 0.020 but less than 0.022
- (C) 0.022 but less than 0.024
- (D) 0.024 but less than 0.026
- (E) 0.026 or more

**\*\*END OF EXAMINATION\*\***

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