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 10, 2016
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 "ℓ_x" will be used to represent the number of lives at age x.

5. This examination consists of 31 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 2016
February 23, 2016

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

CONDITIONS GENERALLY APPLICABLE TO ALL EA-1 EXAMINATION QUESTIONS

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)

The present value of a perpetuity that pays \$1.00 at the end of each year is equal to $2a_{\overline{9}|}$.

Question 1

In what range is $\ddot{a}_{\overline{9}|}$?

(A)   Less than 6.10

(B)   6.10 but less than 6.30

(C)   6.30 but less than 6.50

(D)   6.50 but less than 6.70

(E)   6.70 or more

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Data for Question 2 (2 points)

Consider the following select and ultimate mortality table:

x	$\ell_{[x]}$	$\ell_{[x]+1}$	$\ell_{[x]+2}$	$\ell_{[x]+3}$	$x+3$
40	4,256	4,246	4,234	4,215	43
41	4,238	4,228	4,214	4,192	44
42	4,219	4,208	4,192	4,166	45
43	4,197	4,185	4,167	4,134	46
44	4,173	4,160	4,140	4,103	47

$X=$ the probability a life now age 41 select one year ago dies between ages 42 and 44.

Question 2

In what range is X?

(A)   Less than 0.006

(B)   0.006 but less than 0.007

(C)   0.007 but less than 0.008

(D)   0.008 but less than 0.009

(E)   0.009 or more

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Data for Question 3 (3 points)

Smith is age 50; Jones is age 60.

Smith is to receive a continuous life annuity at the rate of 1 per year under the following conditions:

> (1) Smith receives payments before age 60 only if Jones is dead.
> (2) Smith receives payments after age 60 only if Jones is alive.

Selected values:

$$\bar{a}_{50} = 9.0 \qquad \bar{a}_{50:\overline{10|}} = 6.0$$
$$\bar{a}_{60} = 7.0 \qquad \bar{a}_{60:\overline{10|}} = 5.0$$
$$\bar{a}_{50:60} = 5.0 \qquad \bar{a}_{50:60:\overline{10|}} = 3.0$$

X = the single benefit premium for this annuity.

Question 3

In what range is X?

(A)   Less than 5.5

(B)   5.5 but less than 6.5

(C)   6.5 but less than 7.5

(D)   7.5 but less than 8.5

(E)   8.5 or more

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Data for Question 4 (4 points)

In a triple decrement table you are given the following:

$$\ell_x^{(1)} = 3(100 - x); \qquad 0 \leq x \leq 100$$

$$\ell_x^{(2)} = 4(110 - x); \qquad 0 \leq x \leq 110$$

$$\ell_x^{(3)} = 5(120 - x); \qquad 0 \leq x \leq 120$$

Question 4

In what range is $\mu_{50}^{(2)}$?

(A)   Less than 0.0050

(B)   0.0050 but less than 0.0090

(C)   0.0090 but less than 0.0130

(D)   0.0130 but less than 0.0170

(E)   0.0170 or more

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Data for Question 5 (3 points)

The year-end financial statement of a trust fund includes the following:

Date	Contribution	Benefit Payment	Balance
1/1 before benefit payment			$1,000,000
1/1		$300,000	
4/1	$250,000	300,000	
7/1	250,000	300,000	
10/1	500,000	300,000	
12/31	500,000		
12/31 after contribution			1,400,000

X = the dollar-weighted rate of return earned by the trust fund during the calendar year, assuming simple interest throughout the period.

Question 5

In what range is X?

(A)   Less than 9.5%

(B)   9.5% but less than 11.0%

(C)   11.0% but less than 12.5%

(D)   12.5% but less than 14.0%

(E)   14.0% or more

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Data for Question 6 (4 points)

A pension plan established with 1,000 active employees at age 35 is subject to three decrements.

The associated independent single decrement assumptions are as follows:

Mortality: Deaths are uniformly distributed over ages 0 to 100.

Withdrawal: At the end of every year of attained age from 35 to 55,
                5% of the then active employees terminate employment.

Retirement: At age 60, 40% of the then active employees retire.
                At age 65, 100% of the then active employees retire.

X = the expected number of the original active population who retire directly from active status.

Question 6

In what range is *X*?

(A)   Less than 225

(B)   225 but less than 250

(C)   250 but less than 275

(D)   275 but less than 300

(E)   300 or more

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Data for Question 7 (4 points)

Values from a mortality table with a 2-year select period:

$$\ell_x \quad = \quad 1000(100\text{-}x)$$

$$q_{[x]} \quad = \quad 0.8q_x$$

$$q_{[x]+1} = \quad 0.9q_{x+1}$$

Question 7

In what range is $\ell_{[20]}$?

(A)   Less than 79,500

(B)   79,500 but less than 79,720

(C)   79,720 but less than 79,940

(D)   79,940 but less than 80,160

(E)   80,160 or more

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Data for Question 8 (3 points)

Smith deposits $1,000 into a fund at the beginning of each year for five years.

Each deposit earns a constant rate of simple interest equal to 7.00% per year from the date of deposit.

X = the total amount in the fund on the last day of the fifth year.

Question 8

In what range is X?

(A)   Less than $5,850

(B) $5,850 but less than $5,960

(C) $5,960 but less than $6,070

(D) $6,070 but less than $6,180

(E) $6,180 or more

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Data for Question 9 (4 points)

Smith retires and receives a retirement benefit as an annuity payable at the end of each month for a period certain of 20 years.

The benefit for the first year is $2,000 per month. This monthly benefit is increased at the beginning of each year to be 5.00% larger than the monthly payment in the prior year.

Interest rate: 6.00% per year, compounded monthly.

X = the present value at retirement of Smith's retirement benefit.

Question 9

In what range is X?

(A)   Less than $405,000

(B) $405,000 but less than $410,000

(C) $410,000 but less than $415,000

(D) $415,000 but less than $420,000

(E) $420,000 or more

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Data for Question 10 (3 points)

Smith (age 65) has elected to retire with a pension benefit and may choose between the following actuarially equivalent forms of payment:

Standard form of payment: $3,000 per month beginning at age 65, payable in the form of a single life annuity.

Optional form of payment: X per month beginning at age 70, payable in the form of a single life annuity with 60 guaranteed payments.

Selected commutation functions:

x	D_x	N_x
65	500	4,950
70	365	---
75	200	1,580

Mortality is uniformly distributed between integral ages.

Interest rate: 6.00% per year, compounded annually.

Question 10

In what range is X?

(A)   Less than $4,475

(B) $4,475 but less than $4,525

(C) $4,525 but less than $4,575

(D) $4,575 but less than $4,625

(E) $4,625 or more

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$q_{90} = 0.20$

$q_{91} = 0.25$

Deaths are uniformly distributed over each year of age between consecutive integral ages.

$X =$ the probability that an individual aged 90.25 years will die within one year.

In what range is X?

(A)   Less than 0.2030

(B)   0.2030 but less than 0.2060

(C)   0.2060 but less than 0.2090

(D)   0.2090 but less than 0.2120

(E)   0.2120 or more

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Data for Question 12 (4 points)

Smith purchased a 20-year bond that has the following terms:

      Par value: $1,000
      Coupon rate: 6.00% per year, payable semi-annually
      Yield rate: 5.00% per year, compounded annually

When Smith received each coupon, Smith immediately reinvested it at a rate of interest of 6.00% per annum compounded quarterly.

X = Smith's effective annual rate of return over the term of the bond.

Question 12

In what range is X?

(A)   Less than 5.20%

(B)   5.20% but less than 5.30%

(C)   5.30% but less than 5.40%

(D)   5.40% but less than 5.50%

(E)   5.50% or more

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Data for Question 13 (3 points)

Selected values:

x	N_x
80	1,396
81	1,149
82	936
83	753
84	599
85	470
86	364

Interest rate: 3.00% per year, compounded annually.

Question 13

In what range is $_{3|2}q_{80}$?

(A)   Less than 0.18

(B)   0.18 but less than 0.19

(C)   0.19 but less than 0.20

(D)   0.20 but less than 0.21

(E)   0.21 or more

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Data for Question 14 (4 points)

Selected values:

$q_{20} = 0.10$

$q_x = 0.05$ for all $x > 20$

Interest rate: 4.00% per year, compounded annually.

Question 14

In what range is $\ddot{a}_{20}$?

(A)   Less than 9.7

(B)   9.7 but less than 10.2

(C)   10.2 but less than 10.7

(D)   10.7 but less than 11.2

(E)   11.2 or more

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At the end of each year, Smith's employer makes a contribution to a fund on his behalf.

Annual contribution:	4.00% of salary
Salary increase:	3.00% per year, compounded annually
Investment return:	6.75% per year, compounded annually
Smith's salary for the first year:	$60,000

X = the balance in the fund for Smith at the end of 20 years.

Question 15

In what range is X?

(A)   Less than $113,000

(B) $113,000 but less than $121,000

(C) $121,000 but less than $129,000

(D) $129,000 but less than $137,000

(E) $137,000 or more

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Data for Question 16 (4 points)

At time $t = 0$, spot rates are as follows:

Years (t)	Spot rate
$t = 1$	2.00%
$t = 2$	4.00%
$t \geq 3$	6.00%

Selected values:

$\ddot{a}_{90}$ = 3.50 (based on an interest rate of 6.00% per year, compounded annually)
q_{90} = 0.20
q_{91} = 0.22

X = the present value at time $t=0$ of an annual annuity-due of $100 to a life age 90.

Question 16

In what range is X?

(A)   Less than $355.50

(B) $355.50 but less than $356.50

(C) $356.50 but less than $357.50

(D) $357.50 but less than $358.50

(E) $358.50 or more

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33.00% of those who die between ages 30 and 70 die before age 50.

The probability of a person aged 30 dying before age 50 is 20.00%.

X = the probability that a person aged 50 will survive to age 70.

Question 17

In what range is X?

(A)   Less than 0.425

(B)   0.425 but less than 0.475

(C)   0.475 but less than 0.525

(D)   0.525 but less than 0.575

(E)   0.575 or more

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Data for Question 18 (3 points)

$q_x = 0.175144$

$i = 4.00\%$

Deaths are uniformly distributed throughout the year of age.

Question 18

In what range is $1000\bar{A}^1_{x:\overline{1}|}$?

(A)   Less than $165

(B) $165 but less than $168

(C) $168 but less than $171

(D) $171 but less than $174

(E) $174 or more

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Data for Question 19 (3 points)

Terms of a loan:

        Amount of loan: *X*
        Repayment period   20 years
        Payments: Level annual payments at the end of each year

The interest portion of the 11th payment is $172.01.

The interest portion of the 16th payment is $92.35.

Question 19

In what range is *X*?

(A)   Less than $9,950

(B) $9,950 but less than $10,150

(C) $10,150 but less than $10,350

(D) $10,350 but less than $10,550

(E) $10,550 or more

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Data for Question 20 (3 points)

Smith (age 65) owns a life insurance policy with a face amount of $300,000.

Smith has paid for this life insurance policy and there are no additional premiums due.

The insurance company offers Smith a one-time option to convert this insurance policy to an actuarially-equivalent single life annuity, valued at 5.00%, with payments at the end of each year.

Selected value based on an interest rate of 5.00% per year, compounded annually:

$$A_{65} = 0.3963$$

X = the annual amount Smith will receive if Smith agrees to convert this policy.

Question 20

In what range is X?

(A)   Less than $10,000

(B) $10,000 but less than $10,500

(C) $10,500 but less than $11,000

(D) $11,000 but less than $11,500

(E) $11,500 or more

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Data for Question 21 (4 points)

Provisions and gross premium (contract premium) of two $100,000 one-year term, single premium insurance policies:

	Provision	Gross premium
Policy A	Payable at the end of the year if at least one of Smith, Jones, and Brown dies during the year.	$8,000
Policy B	Payable at the end of the year if at least one of Smith and Brown dies during the year.	$5,000

Expense load for each policy: 7.00% of the net premium (benefit premium).

Interest rate: 7.00% per year, compounded annually.

X = the probability that Jones will survive for one year.

Question 21

In what range is X?

(A)   Less than 0.967

(B)   0.967 but less than 0.968

(C)   0.968 but less than 0.969

(D)   0.969 but less than 0.970

(E)   0.970 or more

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Data for Question 22 (3 points)

Terms of a 10-year bond:

Face amount	$1,000
Redemption amount	$1,000
Coupon rate	4.00% per year, payable semi-annually
Yield rate	5.00% per year, compounded semi-annually

X = the total investment return to the purchaser over the lifetime of the bond.

Question 22

In what range is X?

(A)   Less than $350

(B) $350 but less than $400

(C) $400 but less than $450

(D) $450 but less than $500

(E) $500 or more

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Data for Question 23 (3 points)

Selected interest rates:

       3-year spot rate: 8.00%

       1-year spot rate for second year: 4.00%

Payments of $100 at the end of the first year, $200 at the end of the second year, and $300 at the end of the third year have a total present value of $521.94.

X = the 2-year spot rate.

Question 23

In what range is X?

(A)   Less than 3.00%

(B)   3.00% but less than 3.30%

(C)   3.30% but less than 3.60%

(D)   3.60% but less than 3.90%

(E)   3.90% or more

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Data for Question 24 (3 points)

For a double-decrement table, you are given the following:

Deaths (decrement 1) are uniformly distributed over each integral year of age in the associated single-decrement table.

Withdrawals (decrement 2) occur only at the beginning of each year.

$$\ell_{20}^{(t)} = 1000$$
$$q_{20}^{(2)} = 0.25$$
$$d_{20}^{(1)} = 0.04 d_{20}^{(2)}$$

Question 24

In what range is $q'^{(1)}_{20}$?

(A)   Less than 0.0092

(B)   0.0092 but less than 0.0113

(C)   0.0113 but less than 0.0134

(D)   0.0134 but less than 0.0155

(E)   0.0155 or more

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Data for Question 25 (4 points)

The following actuarially equivalent forms of payment are available to Smith:

Option	Form of payment
A	A life annuity of $1,000.00 payable annually at the end of each year.
B	A life annuity of $920.08 payable annually at the beginning of each year.
C	A life annuity of X payable annually at the beginning of each year, plus a single-sum death benefit equal to $5X$, payable at the end of the year of death.

Actuarial equivalence is determined using 5.00% interest, compounded annually.

Question 25

In what range is X?

(A)   Less than $800

(B) $800 but less than $825

(C) $825 but less than $850

(D) $850 but less than $875

(E) $875 or more

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A portfolio of assets consists of two investments:

      I.   A $1,000 par value bond with a coupon of $75 payable each 12/31 and a term of 3 years. The bond is redeemable at par.

      II.   A $1,000 zero coupon bond with a term of 10 years.

The interest rate is 6.00% per year, compounded annually.

X = the modified duration of this portfolio.

Question 26

In what range is X?

(A)   Less than 4.80 years

(B)   4.80 years but less than 4.95 years

(C)   4.95 years but less than 5.10 years

(D)   5.10 years but less than 5.25 years

(E)   5.25 years or more

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In performing annuity calculations, an actuary includes the effect of generational mortality improvement on annuity values.

Assumptions:

Extract of current year mortality rates used (with an erroneous q_{86}):

x	q_x
85	0.15
86	0.61
87	0.17

Mortality improves by 5.00% annually

The valuation interest rate is 10.00%

Calculated value of $\ddot{a}_{85}$, using the erroneous q_{86}: 3.0015.

The actuary corrects the assumed current year value of q_{86} to 0.16 and recalculates the value of $\ddot{a}_{85}$.

X = the recalculated value of $\ddot{a}_{85}$

Question 27

In what range is X?

(A)   Less than 4.3

(B)   4.3 but less than 4.4

(C)   4.4 but less than 4.5

(D)   4.5 but less than 4.6

(E)   4.6 or more

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A non-callable bond issued at 1/1 has the following potential 12/31 yields to maturity and unrealized gains/(losses) with corresponding probabilities:

12/31 yield to maturity	Probability	Unrealized gain/(loss)
6.00%	0.50	$10,000
6.25%	0.20	Y
6.75%	0.30	(5,000)

X = the expected 12/31 unrealized gain/(loss).

Question 28

In what range is *X*?

(A)   Less than $0

(B) $0 but less than $2,300

(C) $2,300 but less than $4,600

(D) $4,600 but less than $6,900

(E) $6,900 or more

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Smith is entitled to a single life annuity of $10,000 payable at the beginning of each year for up to 20 years.
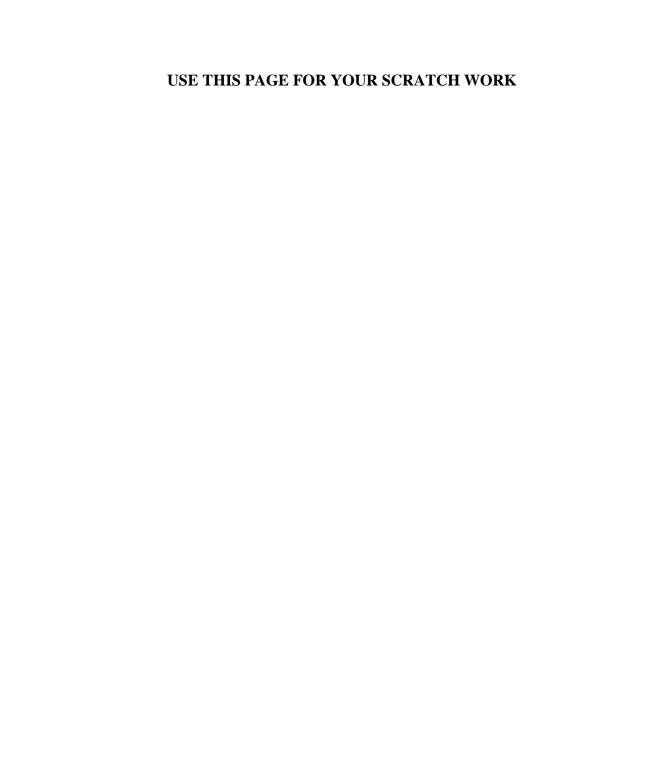
Instead of receiving $10,000 annually, Smith can elect an actuarially equivalent single life annuity benefit of X payable at the beginning of the first year, with payments in subsequent years that are 3.00% greater than the prior year's payment and payable for up to 20 years.

$p_{x+t} = 0.92$ for $t \geq 0$

$i = 5.00\%$ per year, compounded annually.

Question 29

In what range is X?

(A)   Less than $7,900

(B) $7,900 but less than $8,100

(C) $8,100 but less than $8,300

(D) $8,300 but less than $8,500

(E) $8,500 or more

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Data for Question 30 (2 points)

Selected values:

X	ℓ_x
103	250
104	100
105	0

$$q_{102} = 0.250$$

Interest rate: 7.00% per year, compounded annually.

Question 30

In what range is A_{102}?

(A)   Less than 0.87

(B)   0.87 but less than 0.89

(C)   0.89 but less than 0.91

(D)   0.91 but less than 0.93

(E)   0.93 or more

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Data for Question 31 (4 points)

Terms of a loan issued to Smith:

       Amount loaned: $100,000

       Term: 10 years

       Principal repayments: Level annual, payable at the end of each year

       Interest payments: 6.00% effective on outstanding balance,
                                    payable at the end of each year

Immediately after inception, an investor purchases Smith's loan from the bank.

$X =$ the purchase price to yield the investor 7.00% per year, compounded annually.

Question 31

In what range is X?

(A)   Less than $94,250

(B) $94,250 but less than $95,500

(C) $95,500 but less than $96,750

(D) $96,750 but less than $98,000

(E) $98,000 or more

END OF EXAMINATION

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