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 5, 2020
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 2020
February 17, 2020

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

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)

Smith purchases a 5-year Certificate of Deposit that pays:

6.0% interest per year, compounded monthly for years 1 and 2
7.0% interest per year, compounded quarterly for year 3
8.0% interest per year, compounded semiannually for years 4 and 5

X= the equivalent annual rate of interest, compounded annually, over the 5-year period.

Question 1

In what range is ***X***?

(A) Less than 6.70%

(B) 6.70% but less than 6.90%

(C) 6.90% but less than 7.10%

(D) 7.10% but less than 7.30%

(E) 7.30% or more

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Data for Question 2 (3 points)

Two lives (each age 65) have the option to receive one of the following actuarially equivalent options:

> A life annuity of X per year, payable at the beginning of each year while at least one is alive, or
> A lump sum of $100,000 if both lives survive 5 years

Interest is 6.00% per year, compounded annually

Selected actuarial factors at 6.00% interest:

x	ℓ_x	$\ddot{a}_x$	$\ddot{a}_{xx}$
65	7,533,964	9.8969	7.8552
70	6,616,155	8.5693	6.5247

Question 2

In what range is X?

(A) Less than $3,560

(B) $3,560 but less than $4,830

(C) $4,830 but less than $6,100

(D) $6,100 but less than $7,370

(E) $7,370 or more

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Data for Question 3 (3 points)

Terms of a loan:

Repayment period	20 years
Annual repayments	\$100, with first payment made at the end of the first year
Interest rate	5.0% per year, compounded annually

3.0% of the interest portion of each annual repayment is applied to the expenses for the loan.

X= the sum of expenses incurred over the life of the loan.

Question 3

In what range is ***X***?

(A) Less than \$21

(B) \$21 but less than \$26

(C) \$26 but less than \$31

(D) \$31 but less than \$36

(E) \$36 or more

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Data for Question 4 (3 points)

You have the following information about participants in a pension plan:

Number of active participants at exact age 50	1,000
Number of deaths between exact ages 50 and 51	10
Number of people who decrement for reasons other than death between exact ages 50 and 51	57

On average, all decrements other than death occur one-third of the way during the period between consecutive ages.

X = the rate of mortality at age 50 in the associated single decrement mortality table.

Question 4

In what range is X?

(A) Less than 0.01025

(B) 0.01025 but less than 0.01035

(C) 0.01035 but less than 0.01045

(D) 0.01045 but less than 0.01055

(E) 0.01055 or more

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Data for Question 5 (2 points)

Terms of a zero-coupon bond:

Par value	$100,000
Term	5 years
Yield rate	4.50% per year, compounded annually

Three years after being issued, the bond is sold at a loss of $500.

X= the 2-year spot rate in effect at the date of sale.

Question 5

In what range is ***X***?

(A) Less than 4.50%

(B) 4.50% but less than 4.65%

(C) 4.65% but less than 4.80%

(D) 4.80% but less than 4.95%

(E) 4.95% or more

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Data for Question 6 (3 points)

The following table presents the rates of mortality (m), disability (i), and retirement (r) at age 60 in each decrement's associated single-decrement environment:

$$q'^{(m)}_{60} = 0.0025$$
$$q'^{(i)}_{60} = 0.0125$$
$$q'^{(r)}_{60} = 0.0500$$

Mortality and disability are assumed to occur uniformly throughout the year.

Retirement is assumed to occur at the end of the year.

$$\boldsymbol{X} = 1000 q^{(r)}_{60}$$

Question 6

In what range is $\boldsymbol{X}$?

(A) Less than 49.4

(B) 49.4 but less than 49.6

(C) 49.6 but less than 49.8

(D) 49.8 but less than 50.0

(E) 50.0 or more

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Data for Question 7 (4 points)

An annuity is issued to three lives, all of whom are age 64 at issue, with the following terms:

Payments	Payments are made annually at the end of the year. The first payment is made one year after the annuity is issued.
Amount of payment	\$500 per year if exactly one person is alive \$750 per year if exactly two people are alive \$1,000 per year if all three people are alive

Selected annuity values:

$$a_{64} = 25.00$$
$$a_{64:64} = 15.00$$
$$a_{64:64:64} = 10.00$$

X= the net single premium for this annuity.

Question 7

In what range is ***X***?

(A) Less than \$27,000 ☐

(B) \$27,000 but less than \$28,000 ☐

(C) \$28,000 but less than \$29,000 ☐

(D) \$29,000 but less than \$30,000 ☐

(E) \$30,000 or more ☐

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Data for Question 8 (3 points)

Terms of a bond:

Face amount	$1,000
Maturity value	$1,050
Term	20 years
Coupons	5.0% per year, payable annually at the end of the year

The bond may be called at the end of year 17, 18, or 19 for the following amounts:

End of year 17	$1,050
End of year 18	$1,025
End of year 19	$1,010

X= the maximum price of the bond to guarantee a yield of 6.0% per year, compounded annually.

Question 8

In what range is ***X***?

(A) Less than $890

(B) $890 but less than $897

(C) $897 but less than $904

(D) $904 but less than $911

(E) $911 or more

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Data for Question 9 (3 points)

$q_{98} = 0.60$
$q_{99} = 1.00$

Deaths are uniformly distributed between consecutive integral ages.

Interest rate is 9.0% per year, compounded annually.

$\boldsymbol{X} = \ddot{a}_{98}^{(2)}$

Question 9

In what range is $\boldsymbol{X}$?

(A) Less than 1.10

(B) 1.10 but less than 1.11

(C) 1.11 but less than 1.12

(D) 1.12 but less than 1.13

(E) 1.13 or more

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Data for Question 10 (2 points)

$a_{\overline{n}|} = 8.000$

$a_{\overline{2n}|} = 15.000$

$\boldsymbol{X} = a_{\overline{4n}|}$

Question 10

In what range is $\boldsymbol{X}$?

(A) Less than 23.5

(B) 23.5 but less than 25.5

(C) 25.5 but less than 27.5

(D) 27.5 but less than 29.5

(E) 29.5 or more

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Data for Question 11 (3 points)

A last-survivor annual annuity due is payable to independent lives x and y that provides the following:

$500 per year while both x and y are alive;
$400 per year if only x is alive; and
$150 per year if only y is alive.

Selected actuarial values:

$\ddot{a}_y = 9.0$
$\ddot{a}_{xy} = 6.0$

The net single premium for this annuity is $6,650.

$\boldsymbol{X}$ = the reduction in the net single premium if the payment when only x is alive changes from $400 per year to $200 per year.

Question 11

In what range is $\boldsymbol{X}$?

(A) Less than $1,400 ☐

(B) $1,400 but less than $1,475 ☐

(C) $1,475 but less than $1,550 ☐

(D) $1,550 but less than $1,625 ☐

(E) $1,625 or more ☐

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Data for Question 12 (4 points)

Smith (age 62) purchases an annual life annuity paying $10,000 per year beginning at age 63.

For the year beginning at age 62 only, Smith is subject to higher mortality risk such that $q_{62}^{Smith} = q_{62} + 0.05$, where q_{62} is from a standard mortality table.

Selected commutation functions from the standard mortality table:

x	N_x
62	9,300
63	7,900
64	6,700

Interest rate: 7.00% per year, compounded annually.

X= the present value of the annuity at age 62.

Question 12

In what range is ***X***?

(A) Less than $51,000

(B) $51,000 but less than $53,000

(C) $53,000 but less than $55,000

(D) $55,000 but less than $57,000

(E) $57,000 or more

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Data for Question 13 (5 points)

Company A has an outstanding 10-year bond that pays 5.0% annual coupons and that is redeemable at par in 10 years.

In lieu of this obligation, Company A decides to issue two bonds:

A 5-year zero coupon bond with a redemption value of $1,000, and
A 10-year zero coupon bond with redemption value of X.

Company A wishes to have the duration of the two portfolios to be equal.

The yield rate on Company A's liabilities is 6.0% per year, compounded annually.

Question 13

In what range is X?

(A) Less than $2,100

(B) $2,100 but less than $2,200

(C) $2,200 but less than $2,300

(D) $2,300 but less than $2,400

(E) $2,400 or more

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Data for Question 14 (4 points)

A select and ultimate table has a two-year select period.

Selected actuarial values:

$$\ell_{[20]} = 1,000$$
$$q_{[20]} = 0.10$$
$$q_{[20]+1} = 0.20$$
$$d_{[x]} = 0.50 d_x$$
$$d_{[x]+1} = 0.75 d_{x+1}$$

$\boldsymbol{X} = q_{21}$

Question 14

In what range is $\boldsymbol{X}$?

(A) Less than 0.15

(B) 0.15 but less than 0.18

(C) 0.18 but less than 0.21

(D) 0.21 but less than 0.24

(E) 0.24 or more

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Data for Question 15 (5 points)

Smith (age 65) is entitled to a life annuity of $3,000 per month, payable at the beginning of each month starting at age 65.

Instead of receiving this annuity as a life annuity beginning at his current age, Smith elects an actuarially equivalent deferred monthly life annuity of ***X*** starting at age 75 with five years certain. The certain benefit is payable even if Smith dies before age 75.

Selected actuarial factors:

$$
\begin{aligned}
{}_{10}p_{65} &= 0.8538 \\
{}_{15}p_{65} &= 0.7251 \\
\ddot{a}_{65}^{(12)} &= 13.3767 \\
\ddot{a}_{75}^{(12)} &= 9.6657 \\
\ddot{a}_{75:\overline{5}|}^{(12)} &= 4.2446
\end{aligned}
$$

Interest rate: 4.00% per year, compounded annually.

Question 15

In what range is ***X***?

(A) Less than $6,250

(B) $6,250 but less than $6,450

(C) $6,450 but less than $6,650

(D) $6,650 but less than $6,850

(E) $6,850 or more

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Data for Question 16 (4 points)

Terms of a loan:

Amount of loan	$1,000,000
Term	30 years
Repayments	Level monthly, payable at the end of each month

Interest rate:

For the first 15 years	7.0% per year, compounded annually
For the next 15 years	11.0% per year, compounded annually

X= the amount of interest paid in the 204^{th} repayment.

Question 16

In what range is X?

(A) Less than $5,120

(B) $5,120 but less than $5,240

(C) $5,240 but less than $5,360

(D) $5,360 but less than $5,480

(E) $5,480 or more

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Data for Question 17 (4 points)

Smith (age 62) retires and has a beneficiary who is age 60.

Smith can elect a monthly pension benefit in one of the following actuarially equivalent forms of payment:

Optional Form #1	An annuity of $390 per month, payable as long as at least one of the annuitants is alive
Optional Form #2	An annuity of $440 per month to Smith, reducing to $220 per month payable to Smith's beneficiary upon Smith's death if Smith's beneficiary is still alive
Optional Form #3	Life annuity

X= the monthly benefit payable to Smith under Optional Form #3.

Question 17

In what range is ***X***?

(A) Less than $497

(B) $497 but less than $502

(C) $502 but less than $507

(D) $507 but less than $512

(E) $512 or more

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Data for Question 18 (3 points)

Assume a uniform distribution of deaths between ages 89 and 90.

$\mu_{89.25} = 0.114024$

$\boldsymbol{X} = {}_{0.25}p_{89}$

Question 18

In what range is $\boldsymbol{X}$?

(A) Less than 0.9710

(B) 0.9710 but less than 0.9717

(C) 0.9717 but less than 0.9724

(D) 0.9724 but less than 0.9731

(E) 0.9731 or more

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Data for Question 19 (3 points)

Terms of a bond at issue:

Par value	$1,000
Term	5 years
Coupon rate	5.0% per year, payable annually
Redemption value	Par value

Term structure of interest rates at issue:

Length of investment (years)	Spot rate
1	3.25%
2	3.75%
3	4.25%
4	4.75%
5	5.25%

X= the bond's price at issue.

Question 19

In what range is ***X***?

(A) Less than $980

(B) $980 but less than $985

(C) $985 but less than $990

(D) $990 but less than $995

(E) $995 or more

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Data for Question 20 (3 points)

Specifications for a select and ultimate mortality table:

$$\ell_{[x]+t} = 103 - x - \frac{t}{2}, \qquad 0 \le t \le 4$$
$$\ell_{x+t} = 105 - x - t, \qquad t > 4$$

$\boldsymbol{X} = {}_{3|2}q_{[50]+1}$

Question 20

In what range is $\boldsymbol{X}$?

(A) Less than 0.035

(B) 0.035 but less than 0.040

(C) 0.040 but less than 0.045

(D) 0.045 but less than 0.050

(E) 0.050 or more

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Data for Question 21 (3 points)

An investor purchases a bond with the following provisions:

Term	10 years
Coupons	4.0% per year, payable semiannually
Face amount	$10,000
Redemption	Par value

Immediately after the tenth coupon payment is paid, the investor sells the bond.

Term structure of interest rates:

Years	Spot rates at purchase	Spot rates at sale
1-5	1.50%	2.75%
6-10	2.00%	3.00%

X = the investor's realized loss due to the sale of this bond.

Question 21

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 22 (3 points)

A multiple decrement table is constructed based on the following three single decrement tables:

	Number of lives (ℓ_x)		
x	Decrement (1)	Decrement (2)	Decrement (3)
25	100	100	100
26	90	80	70

A uniform distribution of decrement is assumed in each of the above single decrement tables.

$\boldsymbol{X} = q_{25}^{(2)}$

Question 22

In what range is $\boldsymbol{X}$?

(A) Less than 0.154

(B) 0.154 but less than 0.161

(C) 0.161 but less than 0.168

(D) 0.168 but less than 0.175

(E) 0.175 or more

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Data for Question 23 (3 points)

Smith (age 60) has just retired and may choose between the following actuarially equivalent options:

A life annuity-due with payments of \$10,000 per year with a 20-year guarantee, or
A life annuity-due with payments of X per year with a lump sum payment of \$100,000 payable at the end of the year of Smith's death.

Selected actuarial factors:

$$\ddot{a}_{60} = 11.1454$$
$$\ddot{a}_{80} = 5.9050$$
$${}_{20}p_{60} = 0.4781$$

Interest rate: 6.0% per year, compounded annually.

Question 23

In what range is \$$X$?

(A) Less than \$8,000 ☐

(B) \$8,000 but less than \$8,500 ☐

(C) \$8,500 but less than \$9,000 ☐

(D) \$9,000 but less than \$9,500 ☐

(E) \$9,500 or more ☐

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Data for Question 24 (4 points)

Terms of an annuity-due:

Annuitants	Two lives, both age 50
Amount	\$1 per year, payable annually
Payment period	Payments will be made as long as at least one annuitant is alive; but no payments will be made beyond 20 years

Selected actuarial factors:

$$\ddot{a}_{50} = 13.2668$$
$$\ddot{a}_{70} = 8.5693$$
$$\ddot{a}_{50:50} = 11.6513$$
$$\ddot{a}_{70:70} = 6.5247$$
$${}_{20}p_{50} = 0.7392$$

Interest rate: 6.0% per year, compounded annually.

X = the actuarial present value of this annuity.

Question 24

In what range is ***X***?

(A) Less than 11.00 ☐

(B) 11.00 but less than 11.40 ☐

(C) 11.40 but less than 11.80 ☐

(D) 11.80 but less than 12.20 ☐

(E) 12.20 or more ☐

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Data for Question 25 (3 points)

$${}_{n|}\ddot{a}_x = 7.4164$$
$$N_{x+n} = 189,467$$
$$\ddot{a}_{x:\overline{n}|} = 4.2732$$

Question 25

In what range is N_x?

(A) Less than 268,000

(B) 268,000 but less than 283,000

(C) 283,000 but less than 298,000

(D) 298,000 but less than 313,000

(E) 313,000 or more

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Data for Question 26 (4 points)

An increasing perpetuity-due has annual payments starting at \$5 and increasing by \$5 until the payment reaches \$100. The payment remains at \$100 thereafter.

Interest: 7.5% per year, compounded annually.

X = the present value of this perpetuity.

Question 26

In what range is ***X***?

(A) Less than \$720

(B) \$720 but less than \$745

(C) \$745 but less than \$770

(D) \$770 but less than \$795

(E) \$795 or more

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Data for Question 27 (4 points)

Information about a 20-year term life insurance policy issued to Smith (age 45):

Death benefit	$100,000, payable at the end of the year of death
Premiums	Level annual, payable at the beginning of each year for 20 years
Refund of premium	If Smith survives 20 years, Smith will receive the total of all premiums paid (without interest)

Selected commutation functions:

x	N_x	M_x
45	198,739	5,695
…	…	…
65	34,091	2,541
66	30,241	2,381

X= the net annual premium for this insurance policy.

Question 27

In what range is ***X***?

(A) Less than $2,800

(B) $2,800 but less than $3,100

(C) $3,100 but less than $3,400

(D) $3,400 but less than $3,700

(E) $3,700 or more

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Data for Question 28 (2 points)

Terms of a 5-year annuity-certain:

Payment amount	$100
Payment frequency	Monthly, with payments at the beginning of each month
Interest rate	5.0% per year, compounded quarterly

X= the present value of this annuity.

Question 28

In what range is ***X***?

(A) Less than $5,270

(B) $5,270 but less than $5,310

(C) $5,310 but less than $5,350

(D) $5,350 but less than $5,390

(E) $5,390 or more

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Data for Question 29 (3 points)

The force of mortality for impaired lives is assumed to be twice the force of mortality for standard lives.

Selected values for standard lives:

x	q_x
95	0.10
96	0.20
97	0.30

X= the probability an impaired life age 95 survives to age 98.

Question 29

In what range is ***X***?

(A) Less than 0.10

(B) 0.10 but less than 0.20

(C) 0.20 but less than 0.30

(D) 0.30 but less than 0.40

(E) 0.40 or more

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Data for Question 30 (2 points)

Smith invests $1,000.

Selected and implied values from the yield curve on the date of Smith's investment:

Two-year spot rate	4.25%
Two-year deferred, one-year forward rate	5.00%
Four-year spot rate	5.50%

X= the expected interest to be earned during the fourth year of the investment period.

Question 30

In what range is ***X***?

(A) Less than $85

(B) $85 but less than $90

(C) $90 but less than $95

(D) $95 but less than $100

(E) $100 or more

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Data for Question 31 (3 points)

A club has maintained a stationary population of 5,000 members during the last 30 years. A person can join only at age 30 and must resign at age 60 if still a member.

There are 100 total terminations per year before age 60.

The average age at termination is 35.

X= the number of new members each year during the last 30 years.

Question 31

In what range is ***X***?

(A) Less than 160

(B) 160 but less than 210

(C) 210 but less than 260

(D) 260 but less than 310

(E) 310 or more

****END OF EXAMINATION****

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