

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

ENROLLED ACTUARIES BASIC EXAMINATION

MAY 2012 EA-1 EXAMINATION

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”.

2012

Data for Question 1 (2 points)

Deaths are uniformly distributed between integral ages.

$$q_{60} = 0.0200$$

$$q_{61} = 0.0220$$

Question 1

In what range is ${}_{1.5}q_{60}$?

- (A) Less than 0.0297
- (B) 0.0297 but less than 0.0309
- (C) 0.0309 but less than 0.0321
- (D) 0.0321 but less than 0.0333
- (E) 0.0333 or more

2012

Data for Question 2 (4 points)

Over a 3-year period, a series of deposits are made to a savings account.

All deposits within a given year are equal in size and are made at the beginning of each relevant period.

Deposits for each year total \$1,200.

The following chart shows the frequency of deposits and the interest rate credited for each year:

<u>Year</u>	<u>Frequency of deposits</u>	<u>Interest rate credited during year</u>
1	Semi-annually	$d^{(12)} = 6.0\%$
2	Quarterly	$i^{(3)} = 8.0\%$
3	Every 2 months	$\delta = 7.0\%$

X = the value of the account at the end of the 3rd year.

Question 2

In what range is X ?

- (A) Less than \$3,989
- (B) \$3,989 but less than \$4,017
- (C) \$4,017 but less than \$4,045
- (D) \$4,045 but less than \$4,073
- (E) \$4,073 or more

2012

Data for Question 3 (3 points)

Smith is currently age 105.

If Smith survives until age 106, Smith will receive a 2-year certain and life annuity that pays \$1,000 at the end of each year.

Given:

$$l_{105+t} = 950(1 - 0.2t), \quad 0 \leq t \leq 5$$

$$i = 7.0\%, \text{ compounded annually}$$

X = the present value of this annuity at Smith's current age.

Question 3

In what range is X ?

- (A) Less than \$1,490
- (B) \$1,490 but less than \$1,600
- (C) \$1,600 but less than \$1,710
- (D) \$1,710 but less than \$1,820
- (E) \$1,820 or more

2012

Data for Question 4 (4 points)

Terms of two actuarially equivalent annuities:

	<u>Annuity A</u>	<u>Annuity B</u>
Issue age	40	40
Type of annuity	Perpetuity	Life annuity
Frequency of payment	Monthly	Monthly
Timing of payment	End of Month	End of Month
Amount of each payment	<i>P</i>	1,000

Selected values:

x	q_x	D_x	N_x
40	0.002125	651	8700
41	0.002327	607	8049

Question 4

In what range is ***P***?

- (A) Less than \$860
- (B) \$860 but less than \$875
- (C) \$875 but less than \$890
- (D) \$890 but less than \$905
- (E) \$905 or more

2012

Data for Question 5 (3 points)

Terms of a loan:

Amount of loan	\$12,000
Repayment period	120 months
Payments	Level monthly payments, payable at the end of each month
Interest rate	12.0% per year, compounded monthly

The first 48 monthly payments were made on the date due.

The next 12 payments were not made.

Level monthly payments were recalculated without changing the original loan maturity date or the interest rate.

X = the recalculated monthly payment.

Question 5

In what range is X ?

- (A) Less than \$195
- (B) \$195 but less than \$205
- (C) \$205 but less than \$215
- (D) \$215 but less than \$225
- (E) \$225 or more

2012

Data for Question 6 (4 points)

A participant will retire at age 80.

Selected data:

$$p_{80} = 0.9521 \quad \text{using unprojected mortality}$$

$$p_{81} = 0.9461 \quad \text{using unprojected mortality}$$

$$i = 6.0\%, \quad \text{compounded annually}$$

$$X = {}_{20|2}a_{60} \quad \text{using unprojected mortality}$$

$$Y = {}_{20|2}a_{60} \quad \text{using post-retirement mortality that is projected with 1\% annual mortality improvements from this participant's age 60. Pre-retirement mortality is not projected.}$$

Question 6

In what range is Y / X ?

- (A) Less than 1.0140
- (B) 1.0140 but less than 1.0142
- (C) 1.0142 but less than 1.0144
- (D) 1.0144 but less than 1.0146
- (E) 1.0146 or more

2012

Data for Question 7 (3 points)

Terms of an insurance policy:

Type:	Whole life
Death benefit:	\$10,000, payable at the end of the year of death
Net single premium at age 50:	\$5,000

Interest rate used for net single premium: 8.0% per year, compounded annually

Selected values from mortality table used for determining net single premium:

x	l_x
50	100
51	95
52	90
53	85

Question 7

In what range is $10,000 \times A_{53}$?

- (A) Less than \$5,200
- (B) \$5,200 but less than \$5,400
- (C) \$5,400 but less than \$5,600
- (D) \$5,600 but less than \$5,800
- (E) \$5,800 or more

2012

Data for Question 8 (5 points)

A portfolio consists of a serial bond with the following terms:

Face amount	\$10,000
Coupon rate	5.0% per year, payable annually
Redemption	At par in two equal installments: the first payable in 9 years; the second payable in 10 years.
Yield to maturity	4.0% per year, compounded annually

X = the modified duration of the portfolio.

Question 8

In what range is X ?

- (A) Less than 7.40
- (B) 7.40 but less than 7.60
- (C) 7.60 but less than 7.80
- (D) 7.80 but less than 8.00
- (E) 8.00 or more

2012

Data for Question 9 (3 points)

A pension fund has the following values and cash flows:

<u>Date</u>	<u>Cash inflow/(outflow)</u>	<u>Market value immediately after cash flow</u>
1/1	\$0	\$2,000,000
3/31	(20,000)	2,070,000
10/31	(20,000)	2,170,000
12/31	0	2,200,000

X = dollar-weighted rate of investment return for the 1-year period ending 12/31.

Question 9

In what range is X ?

- (A) Less than 12.10%
- (B) 12.10% but less than 12.14%
- (C) 12.14% but less than 12.18%
- (D) 12.18% but less than 12.22%
- (E) 12.22% or more

2012

Data for Question 10 (3 points)

Retirement benefits for Smith (age 61) and Jones (age 60) payable annually:

Smith: a 5-year temporary life annuity-due of X

Jones: a 10-year certain and life annuity-due of \$20,000

The present value of Jones's annuity is 4 times that of the present value of Smith's annuity.

Selected actuarial factors:

$$\ddot{a}_{60} = 11.53496$$

$$\ddot{a}_{60:\overline{10}|} = 7.26514$$

$$\ddot{a}_{62:\overline{4}|} = 3.58056$$

$$p_{61} = 0.99394$$

$i = 7.0\%$ per year, compounded annually

Question 10

In what range is X ?

- (A) Less than \$13,050
- (B) \$13,050 but less than \$13,350
- (C) \$13,350 but less than \$13,650
- (D) \$13,650 but less than \$13,950
- (E) \$13,950 or more

2012

Data for Question 11 (3 points)

Selected values derived from a mortality table:

x	e_x
75	10.5
76	10.0
77	9.6

X = the number of expected survivors to age 77 out of 10,000 alive at age 75.

Question 11

In what range is X ?

- (A) Fewer than 9,000
- (B) 9,000 but fewer than 9,010
- (C) 9,010 but fewer than 9,020
- (D) 9,020 but fewer than 9,030
- (E) 9,030 or more

2012

Data for Question 12 (3 points)

Terms of two actuarially equivalent annuities:

Annuity A: \$500 at the end of each of the first 3 months, and \$1,000 at the end of each of the next 9 months

Annuity B: X at the end of each of the first 2 quarters, and $2X$ at the end of the next 2 quarters

Interest rate: 8% per year, compounded monthly

Question 12

In what range is X ?

- (A) Less than \$1,770
- (B) \$1,770 but less than \$1,800
- (C) \$1,800 but less than \$1,830
- (D) \$1,830 but less than \$1,860
- (E) \$1,860 or more

Data for Question 13 (3 points)

An annual annuity-due is provided to Smith (age x) and Jones (age y).

During the first 20 years, the annuity pays \$1.00 if at least one of Smith and Jones is alive.

After 20 years, the annuity pays \$1.00 only if both Smith and Jones are alive.

Selected values:

$$\begin{array}{ll} \ddot{a}_x &= 10.0 & {}_{20|}\ddot{a}_x &= 3.0 \\ \ddot{a}_y &= 8.4 & {}_{20|}\ddot{a}_y &= 2.5 \\ \ddot{a}_{xy} &= 6.2 & {}_{20|}\ddot{a}_{xy} &= 1.9 \end{array}$$

Question 13

In what range is the present value of this annuity?

- (A) Less than \$8.00
- (B) \$8.00 but less than \$9.00
- (C) \$9.00 but less than \$10.00
- (D) \$10.00 but less than \$11.00
- (E) \$11.00 or more

Data for Question 14 (2 points)

Selected values from a two-decrement table:

$$q_x^{(1)} = 0.03$$

$$q_x^{(2)} = 0.10$$

Each decrement is assumed to be uniformly distributed between ages x and $x+1$ in the associated single-decrement table.

Question 14

In what range is $q_x^{(\tau)}$?

- (A) Less than 0.1270
- (B) 0.1270 but less than 0.1280
- (C) 0.1280 but less than 0.1290
- (D) 0.1290 but less than 0.1300
- (E) 0.1300 or more

2012

Data for Question 15 (3 points)

A pension trust statement reported the following information:

	<u>12/31/2011</u>	<u>12/31/2012</u>
Book value of assets	\$5,000,000	<i>Y</i>
Market value of assets	<i>X</i>	\$5,335,000

Activity during 2012:

Contributions	\$600,000
Investment income	\$315,000
Benefit payments	\$250,000
Plan expenses	\$60,000
Realized gains (losses)	\$465,000
Change in unrealized gains (losses)	(\$535,000)

Question 15

In what range is $X - Y$?

- (A) Less than (\$900,000)
- (B) (\$900,000) but less than (\$300,000)
- (C) (\$300,000) but less than \$300,000
- (D) \$300,000 but less than \$900,000
- (E) \$900,000 or more

2012

Data for Question 16 (3 points)

Smith pays \$950 for an investment that returns \$500 at the end of year 3, and \$700 at the end of year 4.

The price is based on a 2-year spot rate of 5.0% and a 4-year spot rate of 7.0%.

X = the year 3 forward rate (i.e., the 2-year deferred, 1-year spot rate).

Question 16

In what range is X ?

- (A) Less than 7.0%
- (B) 7.0% but less than 7.7%
- (C) 7.7% but less than 8.4%
- (D) 8.4% but less than 9.1%
- (E) 9.1% or more

Data for Question 17 (3 points)

Given:

$$A_x = 0.18$$

$$A_{x+1} = 0.19$$

$$A_{x+2} = 0.20$$

$$1000q_{x+1} = 11.25$$

Question 17In what range is $1000q_x$?

- (A) Less than 9.89
- (B) 9.89 but less than 9.99
- (C) 9.99 but less than 10.09
- (D) 10.09 but less than 10.19
- (E) 10.19 or more

2012

Data for Question 18 (3 points)

Terms of a loan:

Amount of loan \$75,000

Repayment period 5 years

Repayment plans for loan:

Repayment Plan #1 Level annual payments at the beginning of each year

Repayment Plan #2 Level semi-annual payments at the end of each 6-month period

$$1000d^{(4)} = 76.225$$

X = the annual payment under Repayment Plan #1.

Y = the total payments in each year under Repayment Plan #2.

Question 18

In what range is $|X - Y|$?

- (A) Less than \$1,000
- (B) \$1,000 but less than \$1,025
- (C) \$1,025 but less than \$1,050
- (D) \$1,050 but less than \$1,075
- (E) \$1,075 or more

2012

Data for Question 19 (5 points)

Smith (age 45) purchases a net single premium annuity that has the following characteristics:

Payments	\$1,000 annually at the beginning of each year starting in 20 years (age 65) and payable for life
Death benefit	If death occurs before age 65, five annual payments of \$1,000 will be made with the first payment due at the end of the year of Smith's death

Selected actuarial values:

$$\ddot{a}_{45:\overline{20}|} = 10.9961$$

$$\ddot{a}_{45} = 13.1949$$

$${}_{20}p_{45} = 0.8771$$

Interest rate: 7.0%, compounded annually

Question 19

In what range is the net single premium for this annuity?

- (A) Less than \$2,425
- (B) \$2,425 but less than \$2,440
- (C) \$2,440 but less than \$2,455
- (D) \$2,455 but less than \$2,470
- (E) \$2,470 or more

2012

Data for Question 20 (5 points)

Terms of a 20-year annuity-certain:

All payments are made on 1/1

Initial payment = \$300

Each of the next 9 payments is \$300 more than the preceding payment

Each of the subsequent 10 payments is \$200 less than the preceding payment

Interest rate:

7% per year, compounded annually for the first 10 years

6% per year, compounded annually thereafter

X = the present value of the annuity immediately before the first payment is made.

Question 20

In what range is X ?

- (A) Less than \$18,600
- (B) \$18,600 but less than \$18,800
- (C) \$18,800 but less than \$19,000
- (D) \$19,000 but less than \$19,200
- (E) \$19,200 or more

2012

Data for Question 21 (3 points)

A whole life insurance policy provides a death benefit of \$1,000 payable at the end of the year of death.

i = 6.0% per year, compounded annually

a_{61} = 11.5069

q_{60} = 0.004803

X = the net single premium at age 60 for this policy

Question 21

In what range is X ?

- (A) Less than \$255
- (B) \$255 but less than \$285
- (C) \$285 but less than \$315
- (D) \$315 but less than \$345
- (E) \$345 or more

Data for Question 22 (3 points)

A survival function is defined as follows:

$$s(x) = \left(1 - \frac{x}{250}\right); \quad 0 \leq x \leq 25$$
$$l_x = 1000(100 - x); \quad x \geq 25$$

Question 22

In what range is ${}_{30|10}q_{10}$?

- (A) Less than 0.120
- (B) 0.120 but less than 0.135
- (C) 0.135 but less than 0.150
- (D) 0.150 but less than 0.165
- (E) 0.165 or more

Data for Question 23 (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 the following years for the following amounts:

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

X = the maximum amount a purchaser would pay to guarantee a yield rate of 6.0% per annum.

Question 23

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

2012

Data for Question 24 (3 points)

In a service table, you are given the following:

Number of actives at exact age 40	1,500
Number of voluntary terminations between exact ages 40 and 41	30
Number of involuntary terminations between exact ages 40 and 41	20
Number of disability retirements between exact ages 40 and 41	10
Number of deaths between exact ages 40 and 41	12

All decrements are uniform over the year of age 40 to 41.

q = rate of mortality at age 40 in the associated single decrement table.

Question 24

In what range is q ?

- (A) Less than 0.00815
- (B) 0.00815 but less than 0.00817
- (C) 0.00817 but less than 0.00819
- (D) 0.00819 but less than 0.00821
- (E) 0.00821 or more

2012

Data for Question 25 (4 points)

The terms of a defined benefit pension plan include the following retirement eligibility:

Early retirement:	Age 55 with 10 years of service
Unreduced early retirement:	Age 60 with 15 years of service
Normal retirement:	Earlier of age 62 with 10 years of service, or age 65 with 5 years of service

The following rates of retirement are used in the plan's actuarial valuation:

At age first eligible for unreduced early retirement: 0.15

At age first eligible for normal retirement: 0.40

At all other ages:

<u>Age</u>	<u>Rate of retirement</u>
55-59	0.05
60-61	0.10
62	0.30
63-65	0.25
66	1.00

All retirements occur on exact ages.

No other decrements apply from ages 55 through 66.

Participant Smith is exact age 58 with exactly 13 years of service.

X = Smith's weighted average assumed retirement age.

Question 25

In what range is X ?

- (A) Less than 62.1
- (B) 62.1 but less than 62.3
- (C) 62.3 but less than 62.5
- (D) 62.5 but less than 62.7
- (E) 62.7 or more

2012

Data for Question 26 (3 points)

The market value of a fund and its cash flows at various dates in a calendar year are shown below:

<u>Date</u>	<u>Value of fund before withdrawals</u>	<u>Withdrawals</u>
1/1	\$300,000	\$0
m months after 1/1	315,000	15,000
$2m$ months before 12/31	315,000	15,000
12/31	315,000	0

The dollar-weighted rate of return for the year is 16.0%.

Question 26

In what range is m ?

- (A) Less than 2.1
- (B) 2.1 but less than 2.5
- (C) 2.5 but less than 2.9
- (D) 2.9 but less than 3.3
- (E) 3.3 or more

2012

Data for Question 27 (4 points)

An annuity is issued to three lives, all of whom are age 64 at issue.

Terms of the annuity:

Payments	Annual payments, payable at the end of the year, with the first payment made one year after the annuity is issued.
Amount paid	\$500 per year if exactly one annuitant is alive
	\$750 per year if exactly two annuitants are alive
	\$1,000 per year if exactly three annuitants 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 27

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

2012

Data for Question 28 (4 points)

Smith has the option of receiving a benefit in the form of an annuity beginning in one year.

The annuities, each of which is actuarially equivalent, are:

- | | |
|----------|--|
| Option 1 | A life annuity of \$1,000 per year |
| Option 2 | A life annuity of X per year, decreasing to 50% of X payable to Smith's spouse after Smith's death |
| Option 3 | A life annuity of \$875 per year, payable while either Smith or Smith's spouse is alive |

Question 28

In what range is X ?

- (A) Less than \$920
- (B) \$920 but less than \$925
- (C) \$925 but less than \$930
- (D) \$930 but less than \$935
- (E) \$935 or more

2012

Data for Question 29 (3 points)

An insurance company is making annual payments under the terms of a lawsuit settlement.

A payment of \$30,000 has just been made, and 15 more payments are to be made.

Future payments are assumed to increase at the rate of 2.75% per year.

Interest is 6.0% per year, compounded annually.

X = the present value of the remaining obligation immediately after the \$30,000 payment.

Question 29

In what range is X ?

- (A) Less than \$353,000
- (B) \$353,000 but less than \$357,000
- (C) \$357,000 but less than \$361,000
- (D) \$361,000 but less than \$365,000
- (E) \$365,000 or more

Data for Question 30 (3 points)

Values from a select and ultimate mortality table:

X	$q_{[x]}$	$q_{[x]+1}$	$q_{[x]+2}$	q_{x+3}	$x+3$
60	0.009913	0.012038	0.013454	0.014162	63
61	0.010856	0.013183	0.014734	0.015509	64
62	0.011907	0.014459	0.016160	0.017010	65
63	0.013080	0.015882	0.017751	0.018685	66
64	0.014362	0.017439	0.019491	0.020517	67

Question 30

In what range is ${}_6p_{[60]+1}$?

- (A) Less than 0.9110
- (B) 0.9110 but less than 0.9130
- (C) 0.9130 but less than 0.9150
- (D) 0.9150 but less than 0.9170
- (E) 0.9170 or more

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Answer Key

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

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