SOCIETY OF ACTUARIES

AMERICAN SOCIETY OF PENSION ACTUARIES

JOINT BOARD FOR THE ENROLLMENT OF ACTUARIES

ENROLLED ACTUARIES BASIC EXAMINATION

MAY 2014 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".

2014

Data for Question 1 (4 points)

Terms of an annuity:

Payments are made annually at the end of each year.

Amount of payments

$1,500 per year, payable for the first n years
$2,500 per year, payable for the next m years
$3,500 per year, payable for the next $2n$ years

Selected annuity values:

$$a_{\overline{n}|} = 8.559$$

$$a_{\overline{m}|} = 9.818$$

$$v^m = 0.215$$

$\boldsymbol{X}$ = present value of the annuity.

Question 1

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

(A) Less than $18,000

(B) $18,000 but less than $19,500

(C) $19,500 but less than $21,000

(D) $21,000 but less than $22,500

(E) $22,500 or more

2014

Data for Question 2 (4 points)

The current basic life table follows the formula:

$$l_x = 1000(110 - x)$$

To reflect mortality improvement, the applicable rates ***t*** years hence are as follows:

$$q_x^{PROJECTED} = q_x^{BASIC}\left(0.95\right)^t,\ t = 0,1,2,\ldots$$

Smith, now age 50, is to receive a 3-year annuity-immediate of $10,000 per year, payable annually.

Interest: 5% per year, compounded annually.

X = the single premium for this annuity.

Question 2

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

(A) Less than $26,350

(B) $26,350 but less than $27,350

(C) $27,350 but less than $28,350

(D) $28,350 but less than $29,350

(E) $29,350 or more

2014

Data for Question 3 (3 points)

From a 1-year select and ultimate mortality table:

$$p_x = 0.96$$
$$q_{[x]} = 0.75q_x$$

Interest rate: 5.0% per year, compounded annually.

$A_x = 0.60$

X = the single premium for a \$1 per year annuity-due, payable annually, to [x] for life.

Question 3

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

(A) Less than \$8.45

(B) \$8.45 but less than \$8.55

(C) \$8.55 but less than \$8.65

(D) \$8.65 but less than \$8.75

(E) \$8.75 or more

Data for Question 4 (3 points)

$$\ddot{a}_{\overline{10}|} - \ddot{a}_{\overline{9}|} = 0.50$$

$$\boldsymbol{X} = \frac{\left(s_{\overline{19}|} - s_{\overline{18}|}\right)^2}{\left(\ddot{s}_{\overline{9}|} - \ddot{s}_{\overline{8}|}\right)^3}$$

Question 4

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

(A) Less than 1.50

(B) 1.50 but less than 1.70

(C) 1.70 but less than 1.90

(D) 1.90 but less than 2.10

(E) 2.10 or more

Data for Question 5 (3 points)

A survival function is defined as follows:

$$S(x) = \left(1 - \frac{x}{250}\right) \qquad 0 \le x < 25$$

$$\ell_x = 1000(100 - x) \qquad x \ge 25$$

$\boldsymbol{X} = {}_{30|10}q_{10}$

Question 5

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

(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

2014

Data for Question 6 (4 points)

Smith buys a 10-year decreasing annuity-immediate with annual payments of 10, 9, 8, … , 1.

On the same date, Smith buys a perpetuity-immediate with annual payments.

For the first 11 years, payments of the perpetuity-immediate are 1, 2, 3, … , 11. After year 11, payments remain constant at 11.

At an annual effective interest rate of i, both annuities have a present value equal to $\boldsymbol{X}$.

Question 6

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

(A) Less than \$26

(B) \$26 but less than \$28

(C) \$28 but less than \$30

(D) \$30 but less than \$32

(E) \$32 or more

2014

Data for Question 7 (3 points)

Smith takes out a $200,000 loan to be repaid in equal monthly installments over 30 years. The first payment is due one month after the loan is made.

Immediately after the 60th payment is made, Smith makes an additional payment of $50,000 and refinances the remaining balance in equal monthly installments over 10 years, with the first payment due at the beginning of the month following the refinancing.

Interest rate of original loan:	6.0% per year, compounded monthly.
Interest rate of refinanced amount:	5.0% per year, compounded monthly.

X = the monthly payment amount after refinancing.

Question 7

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

(A) Less than $1,250

(B) $1,250 but less than $1,500

(C) $1,500 but less than $1,750

(D) $1,750 but less than $2,000

(E) $2,000 or more

Data for Question 8 (2 points)

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

$$q_{x+1}^{(1)} = 0.3333$$

$${}_{1|}q_{x}^{(1)} = 0.2292$$

$$q_{x}^{(2)} = 0.1250$$

Question 8

In what range is $q_x^{(1)}$?

(A) Less than 0.1000

(B) 0.1000 but less than 0.2000

(C) 0.2000 but less than 0.3000

(D) 0.3000 but less than 0.4000

(E) 0.4000 or more

2014

Data for Question 9 (2 points)

Terms of a bond:

Face value	$1,000
Coupon rate	6.0% annual, payable at end of year
Call date	Any time between 10 and 15 years after purchase date
Redemption amount	Par

X = the maximum amount a purchaser would pay to guarantee a yield rate of at least 5.0% per annum.

Question 9

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

(A) Less than $1,080

(B) $1,080 but less than $1,100

(C) $1,100 but less than $1,120

(D) $1,120 but less than $1,140

(E) $1,140 or more

2014

Data for Question 10 (3 points)

Deaths are uniformly distributed over each year of age.

For a given integer age $\boldsymbol{x}$:

$$q_x = 0.400$$
$$q_{x+1} = 0.500$$

$\boldsymbol{X} = q_{x+0.5}$

Question 10

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

(A) Less than 0.405

(B) 0.405 but less than 0.425

(C) 0.425 but less than 0.445

(D) 0.445 but less than 0.465

(E) 0.465 or more

Data for Question 11 (4 points)

Selected commutation functions:

x	N_x
64	294,298
65	263,044
66	234,434
67	208,299
68	184,481

Interest rate: 7.0% per year, compounded annually.

$\boldsymbol{X} = a_{64:65:\overline{2}|}$

Question 11

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

(A) Less than 1.55

(B) 1.55 but less than 1.65

(C) 1.65 but less than 1.75

(D) 1.75 but less than 1.85

(E) 1.85 or more

2014

Data for Question 12 (3 points)

Pension fund information:

Date	Fund balance	Contribution	Distribution
01/01/2013	$100,000	–	–
03/31/2013	–	–	$10,000
04/01/2013	$100,000	–	–
06/30/2013	–	$50,000	$10,000
07/01/2013	$150,000	–	–
09/30/2013	–	–	$10,000
10/01/2013	$140,000	–	–
12/31/2013	–	–	$10,000
01/01/2014	$130,000	–	–

X = the dollar-weighted rate of return in 2013.

Question 12

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

(A) Less than 17.9%

(B) 17.9% but less than 18.9%

(C) 18.9% but less than 19.9%

(D) 19.9% but less than 20.9%

(E) 20.9% or more

Data for Question 13 (3 points)

Selected values:

x	e_x
63	9.5
64	9.0
65	8.5

Question 13

In what range is ${}_2q_{63}$?

(A) Less than 0.099

(B) 0.099 but less than 0.104

(C) 0.104 but less than 0.109

(D) 0.109 but less than 0.114

(E) 0.114 or more

2014

Data for Question 14 (2 points)

Terms of a bond:

Face amount	$1,000
Term to maturity	3 years
Coupon rate	6.0% per year, payable annually

Term structure of interest rates:

Term (years)	Annual spot interest rate
1	7.0%
2	8.0%
3	9.0%

X = the value of the bond.

Question 14

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

(A) Less than $906

(B) $906 but less than $924

(C) $924 but less than $942

(D) $942 but less than $960

(E) $960 or more

2014

Data for Question 15 (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 15

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

(A) Less than 7.1%

(B) 7.1% but less than 7.8%

(C) 7.8% but less than 8.5%

(D) 8.5% but less than 9.2%

(E) 9.2% or more

2014

Data for Question 16 (3 points)

A service table has three decrements: death (d), withdrawal (w), retirement (r).

Deaths are uniformly distributed over each year of age.

All retirements occur at the start of the year.

All withdrawals occur at mid-year.

Under the associated single-decrement tables, rates at age 63 are:

$$q_{63}'^{(d)} = 0.020$$
$$q_{63}'^{(w)} = 0.125$$
$$q_{63}'^{(r)} = 0.200$$

Question 16

In what range is $q_{63}^{(d)}$?

(A) Less than 0.01495

(B) 0.01495 but less than 0.01595

(C) 0.01595 but less than 0.01695

(D) 0.01695 but less than 0.01795

(E) 0.01795 or more

Data for Question 17 (3 points)

Data for a single premium life insurance policy:

Age at issue	40
Benefit	\$10,000 payable at end of year of death

If death occurs before age 50, an additional benefit equal to 50% of the single premium accumulated with interest at 5.0%, compounded annually, is payable at the end of the year of death.

Selected actuarial values:

$$A_{40} = 0.31549$$
$${}_5E_{40} = 0.71823$$
$${}_5E_{45} = 0.71230$$

Interest rate: 5.0% per year, compounded annually.

Question 17

In what range is the net single premium?

(A) Less than \$3,300

(B) \$3,300 but less than \$3,700

(C) \$3,700 but less than \$4,100

(D) \$4,100 but less than \$4,500

(E) \$4,500 or more

Data for Question 18 (4 points)

Smith (age 55) is entitled to a pension benefit at the beginning of each month of $750 for life commencing immediately.

Smith elects a "Social Security level income option" under a pension plan such that the total of Smith's monthly income from the pension plan plus the amount Smith receives from Social Security remains level for Smith's lifetime.

Smith's monthly Social Security benefit is $1,400, commencing at age 62.

Selected actuarial values:

$$\ddot{a}_{55}^{(12)} = 13.728$$
$$\ddot{a}_{62}^{(12)} = 12.218$$
$${}_7E_{55} = 0.656$$

X = the monthly benefit payable to Smith from the pension plan from age 55 to age 62 under the Social Security level income option.

Question 18

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

(A) Less than $1,520

(B) $1,520 but less than $1,550

(C) $1,550 but less than $1,580

(D) $1,580 but less than $1,610

(E) $1,610 or more

2014

Data for Question 19 (4 points)

Terms of a mortgage:

Interest rate	4.50% per year, convertible monthly
Payments	Level monthly, payable at the end of each month
Term	20 years

X = the modified duration of the mortgage.

Question 19

In what range is X?

(A) Less than 8.492

(B) 8.492 but less than 8.517

(C) 8.517 but less than 8.542

(D) 8.542 but less than 8.567

(E) 8.567 or more

2014

Data for Question 20 (3 points)

Employee Smith earns an annual salary in 2014 of $50,000.

Smith's assumed salary increases: 3% each year, beginning 1/1/2015.

At the end of each year, beginning with 2014, 5% of Smith's annual salary is deposited into a fund earning an annual rate of interest of 6%.

It is assumed that Smith will remain employed until 2035.

X = the projected amount in Smith's fund on 1/1/2035.

Question 20

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

(A) Less than $122,000

(B) $122,000 but less than $126,000

(C) $126,000 but less than $130,000

(D) $130,000 but less than $134,000

(E) $134,000 or more

2014

Data for Question 21 (4 points)

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

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:

$a_{64} = 25.00$

$a_{64:64} = 15.00$

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

$\boldsymbol{X}$ = the net single premium for this annuity.

Question 21

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

(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

Data for Question 22 (2 points)

Assume deaths are uniformly distributed over each year of age.

$$q_{60} = 0.0200$$
$$q_{61} = 0.0220$$

$$\boldsymbol{X} = {}_{1.5}q_{60}$$

Question 22

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

(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

2014

Data for Question 23 (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 23

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

(A) Less than $25

(B) $25 but less than $30

(C) $30 but less than $35

(D) $35 but less than $40

(E) $40 or more

Data for Question 24 (4 points)

Smith (age 60) is scheduled to receive an annuity-immediate of $10,000 per year, payable annually for life and continuing for 10 years after Smith's death.

$\ddot{a}_{60} = 12.70$

Interest rate: 5% per year, compounded annually.

X = the present value of this annuity.

Question 24

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

(A) Less than $148,000

(B) $148,000 but less than $149,000

(C) $149,000 but less than $150,000

(D) $150,000 but less than $151,000

(E) $151,000 or more

2014

Data for Question 25 (3 points)

The following actuarially equivalent annuities are available to Smith:

1. Monthly payments of $100 for Smith's life

2. Monthly payments of $94 for Smith's life, with monthly payments of $47 continuing for the life of Smith's surviving spouse

3. Monthly payments of X for Smith's life, with monthly payments of $0.75X$ continuing for the life of Smith's surviving spouse

Question 25

In what range is X?

(A) Less than $90.52

(B) $90.52 but less than $91.52

(C) $91.52 but less than $92.52

(D) $92.52 but less than $93.52

(E) $93.52 or more

2014

Data for Question 26 (3 points)

Smith, age $\boldsymbol{x}$, purchases a 3-year term insurance policy of $1,000 with death benefit payable at the end of the year of death.

Selected actuarial values:

$q_x = 0.20$
$q_{x+1} = 0.25$
$q_{x+2} = 0.30$

Current price of $100 zero-coupon bond maturing in $\boldsymbol{n}$ years:

n	Price
1	$97.00
2	$93.00
3	$89.00

$\boldsymbol{X}$ = the net single premium for this insurance policy.

Question 26

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

(A) Less than $500

(B) $500 but less than $550

(C) $550 but less than $600

(D) $600 but less than $650

(E) $650 or more

Data for Question 27 (3 points)

From a 1-year select and ultimate mortality table:

$$\ddot{a}_{70} = 9.8269$$
$$p_{[70]} = 1.013\, p_{70}$$

Question 27

In what range is $\ddot{a}_{[70]}$?

(A) Less than 9.9270

(B) 9.9270 but less than 9.9370

(C) 9.9370 but less than 9.9470

(D) 9.9470 but less than 9.9570

(E) 9.9570 or more

Data for Question 28 (3 points)

Smith is 55, Jones is 45, and Brown is 40.

The underlying mortality table is assumed to be the same for all three individuals.

There is a 40% probability that Smith and Brown will both be alive in 15 years.

There is a 44% probability that Jones will die before age 70.

X = the probability that Brown will die before age 45.

Question 28

In what range is X?

(A) Less than 0.250

(B) 0.250 but less than 0.300

(C) 0.300 but less than 0.350

(D) 0.350 but less than 0.400

(E) 0.400 or more

2014

Data for Question 29 (3 points)

On 1/1/2014, a company purchases one-year corporate bonds where the expected proceeds are $2,000,000 on 12/31/2014.

The bonds have the following terms:

Each bond is redeemable at par value of $1,000.

Coupon rate: 8% per year, payable end-of-year

The probability of default during the year on each bond is 6.0%.

If a bond defaults, the recovery value at year-end is $600.

The default of any bond is independent of the default of any other bond.

$\boldsymbol{X}$ = the total number of bonds to be purchased on 1/1/2014.

Question 29

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

(A) Less than 1,900

(B) 1,900 but less than 1,905

(C) 1,905 but less than 1,910

(D) 1,910 but less than 1,915

(E) 1,915 or more

2014

Data for Question 30 (3 points)

A loan of $100,000 is to be amortized over 20 years by level annual payments at the beginning of each year.

Spot rates on the yield curve are as follows:

Years	Rate
Less than 5	4.0%
5 through 9	6.0%
10 and over	6.5%

X = the annual amortization amount.

Question 30

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

(A) Less than $7,500

(B) $7,500 but less than $8,000

(C) $8,000 but less than $8,500

(D) $8,500 but less than $9,000

(E) $9,000 or more

Data for Question 31 (3 points)

$$\ell_{[x]+t} = 100 - x - \frac{t}{2},\ 0 \le t \le 6$$
$$\ell_{x+t} = 103 - x - t,\ t > 6$$

X = the probability that a life now age 52, who entered the selection period 2 years ago, will die between ages 54 and 58.

Question 31

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

(A) Less than 0.050

(B) 0.050 but less than 0.060

(C) 0.060 but less than 0.070

(D) 0.070 but less than 0.080

(E) 0.080 or more

Data for Question 32 (3 points)

${}_{15}p_{25} = 0.8108$

${}_{15|15}q_{25} = 0.2027$

${}_{10}q_{55} = 0.2222$

$\boldsymbol{X} = {}_{30|10}q_{25}$

Question 32

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

(A) Less than 0.015

(B) 0.015 but less than 0.065

(C) 0.065 but less than 0.115

(D) 0.115 but less than 0.165

(E) 0.165 or more

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EA-1 Spring 2014

Answer Key

Updated March 3, 2014

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

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