SOCIETY OF ACTUARIES

AMERICAN SOCIETY OF PENSION ACTUARIES

JOINT BOARD FOR THE ENROLLMENT OF ACTUARIES

ENROLLED ACTUARIES BASIC EXAMINATION

# MAY 2002 EA-1 EXAMINATION

**EA1-10-02** **Printed in U.S.A.**

Data For Question 1 (3 Points)

Loan repayment period: 5 years.

Beginning loan amount: $75,000.

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.

A = Annual payment under Repayment Plan #1.

B = Total payments in a year under Repayment Plan #2.

$1000\, d^{(4)} = 76.225$.

Question 1

In what range is the absolute value of [A – B]?

[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

Data For Question 2 (5 Points)

Annual payments into a fund: $10,000 at the end of year one, increasing by $500 per year in the second through the tenth years. After the tenth year, each payment increases by 3.5% over the prior payment.

Interest rate: 7% compounded annually.

Question 2

In what range is the accumulated value of the fund at the end of 20 years?

[A] Less than $500,000

[B] $500,000 but less than $550,000

[C] $550,000 but less than $600,000

[D] $600,000 but less than $650,000

[E] $650,000 or more

Data For Question 3 (3 Points)

Given values:

$\ddot{s}^{(m)}_{\overline{2n}|} = 180.24943$

$d^{(m)} = 0.08$

Question 3

In what range is $\ddot{s}^{(m)}_{\overline{4n}|}$?

[A] Less than 2,930

[B] 2,930 but less than 2,970

[C] 2,970 but less than 3,010

[D] 3,010 but less than 3,050

[E] 3,050 or more

Data For Question 4 (3 Points)

A 20-year immediate annuity certain is payable monthly. Immediately after the 43rd payment has been made, the present value of the remaining annuity payments is calculated to be X.

N is the number of the payment after which the present value of the remaining annuity payments is less than $\frac{X}{2}$ for the first time.

$d^{(4)} = 0.08$.

Question 4

What is N?

[A] 67

[B] 68

[C] 171

[D] 172

[E] 173

Data For Question 5 (4 Points)

Two $10,000 loans have the following repayment characteristics:

Loan 1: Level quarterly payments at the end of each quarter for five years.

Loan 2: Monthly interest payments on the original loan amount at the end of each month for 48 months plus a balloon repayment of principal at the end of the fourth year. The balloon repayment will be made using the accumulated value of a sinking fund created by level annual deposits at the beginning of each of the four years.

Effective annual interest rate on the loan: 8%.

Effective annual interest rate on the sinking fund: 9%.

A = Sum of repayments under Loan 1.

B = Sum of interest payments on Loan 2 plus sum of sinking fund payments.

Question 5

In what range is the absolute value of [A – B]?

[A] Less than $875

[B] $875 but less than $950

[C] $950 but less than $1,025

[D] $1,025 but less than $1,100

[E] $1,100 or more

Data For Question 6 (4 Points)

Smith obtains a loan for $10,000 with 40 annual payments at an effective annual interest rate of 7%. The first payment is due one year from now.

A = Sum of interest paid in the even-numbered payments.

B = Sum of principal paid in the odd-numbered payments.

Question 6

In what range is [A + B]?

[A] Less than $13,800

[B] $13,800 but less than $14,200

[C] $14,200 but less than $14,600

[D] $14,600 but less than $15,000

[E] $15,000 or more

Data For Question 7 (4 Points)

Smith purchases a house for $120,000 and agrees to put 20% down. He takes out a 30-year mortgage, with monthly payments, with the first payment one month after the date of the mortgage. The interest rate is 8% compounded monthly.

Immediately following the 180th payment, Smith refinances the outstanding balance with a new 10-year mortgage, also with monthly payments, with the first payment one month after the date of the new mortgage. The new interest rate is 7.5% compounded monthly.

A = Amount of interest paid in the 100th payment of the first mortgage.

B = Amount of principal paid in the 100th payment of the refinanced mortgage.

Question 7

In what range is [A + B]?

[A] Less than $1,300

[B] $1,300 but less than $1,325

[C] $1,325 but less than $1,350

[D] $1,350 but less than $1,375

[E] $1,375 or more

Data For Question 8 (4 Points)

A serial bond issue bearing 6% annual coupons, payable semiannually, is to be redeemed at par value at annual intervals over a 20-year period. The first redemption will occur at the end of year 10 in the amount of $20,000. Each subsequent annual redemption will be $1,000 less than the preceding one.

Question 8

In what range is the maximum price an investor would pay for the entire issue to realize an effective annual yield of 7%?

[A] Less than $190,500

[B] $190,500 but less than $191,000

[C] $191,000 but less than $191,500

[D] $191,500 but less than $192,000

[E] $192,000 or more

Data For Question 9 (3 Points)

Face value of a bond: $1,000.

Redemption value: $1,050.

Time to maturity: 10 years.

Coupon rate: 9.00% per annum, convertible semi-annually.

Yield rate: 10.25% per annum.

The bond is not callable.

Question 9

In what range is the increase in the book value of the bond during the third year?

[A] Less than $7.00

[B] $7.00 but less than $7.50

[C] $7.50 but less than $8.00

[D] $8.00 but less than $8.50

[E] $8.50 or more

Data For Question 10 (5 Points)

A bank issues a 20-year loan for $100,000 on 1/1/2000. Level monthly payments are calculated based on a 7% annual interest rate compounded monthly, with payments due at the end of each month. The borrower can repay the loan in full without penalty on the first day of any year. On 1/1/2002, the bank sells the loan to an investor for $90,000.

Question 10

What is the latest full repayment date for which the investor's yield exceeds 8%, compounded monthly?

[A] 1/1/2009

[B] 1/1/2010

[C] 1/1/2011

[D] 1/1/2012

[E] 1/1/2013

Data For Question 11 (3 Points)

S1 = The accumulated value as of 12/31/2002 of $500 invested at the end of each month during 2002 at a nominal interest rate of 8% per year, convertible quarterly.

A1 = The present value as of 1/1/2002 of S1, at a nominal discount rate of 6% per year, convertible semiannually.

S2 = The accumulated value as of 12/31/2002 of $1,500 invested at the end of each quarter during 2002 at a nominal discount rate of 6% per year, convertible monthly.

A2 = The present value as of 1/1/2002 of S2, at a nominal interest rate of P% per year, convertible once every two years.

Question 11

In what range is P% such that A1 = A2?

[A] Less than 4.60%

[B] 4.60% but less than 4.70%

[C] 4.70% but less than 4.80%

[D] 4.80% but less than 4.90%

[E] 4.90% or more

Data For Question 12 (3 Points)

For a group of lives observed over the age interval (x,x+1], you are given:

(i) 100 lives entered observation at exact age x.

(ii) 40 of these lives are scheduled to leave observation at age x + 0.75.

(iii) 23 deaths were observed.

(iv) No other lives entered or left observation.

(v) The underlying survival distribution is Balducci.

Question 12

In what range is the moment estimate of $q_x$?

[A] Less than 0.249

[B] 0.249 but less than 0.254

[C] 0.254 but less than 0.259

[D] 0.259 but less than 0.264

[E] 0.264 or more

Data For Question 13 (3 Points)

From Mortality Table A: $l_x = 20{,}000 - 100x - x^2$.

Mortality Table B has a constant force of mortality equal to $\mu_{41}$ from Mortality Table A. In addition, from Mortality Table B, $l_{45} = 100{,}000$.

Question 13

In what range is $l_{41}$ from Mortality Table B?

[A] Less than 100,000

[B] 100,000 but less than 105,000

[C] 105,000 but less than 110,000

[D] 110,000 but less than 115,000

[E] 115,000 or more

Data For Question 14 (3 Points)

Assume a uniform distribution of decrement over each interval [x,x+1].

$_{0.5}q_{40.4} = 0.025$

$_{0.9}p_{41} = 0.955$

$\mu_{42.2} = 0.05$

$l_{43} = 100{,}000$

Question 14

In what range is $l_{40}$?

[A] Less than 116,000

[B] 116,000 but less than 116,500

[C] 116,500 but less than 117,000

[D] 117,000 but less than 117,500

[E] 117,500 or more

Data For Question 15 (5 Points)

Age of retiree on 1/1/2002: 65.

Normal form of payment: Single life annuity of $20,000 payable at the beginning of each year.

Optional form of payment: $X payable at the beginning of each year while the retiree is alive
and
If the retiree dies during 2003, a ten-year decreasing certain annuity starting on January 1, 2004. The initial payment on this date is $X and subsequent annual payments are each 95% of the prior payment.

Selected values:

$i = 7\%$
$p_{65} = 0.9887$
$p_{66} = 0.9873$
$\ddot{a}_{65} = 10.3316$
$\ddot{a}_{67} = 9.8614$

The optional form of payment and the single life annuity are actuarially equivalent on 1/1/2002.

Question 15

In what range is $X?

[A] Less than $18,055

[B] $18,055 but less than $18,655

[C] $18,655 but less than $19,255

[D] $19,255 but less than $19,855

[E] $19,855 or more

Data For Question 16 (3 Points)

For a group of lives, the following is given:

| $x$ | $l_x$ | $d_x$ | $L_x$ |
|---|---|---|---|
| 35 | 10,000 | 300 | 9,851 |
| 36 | 9,700 | | 9,456 |
| 37 | | 600 | 8,913 |

${}_2m_{35} = 0.0404$

There is a constant force of mortality over the interval [36, 37].

Question 16

In what range is $l_{36.5}$?

[A] Less than 9,449

[B] 9,449 but less than 9,452

[C] 9,452 but less than 9,455

[D] 9,455 but less than 9,458

[E] 9,458 or more

Data For Question 17 (4 Points)

$e_{70:\overline{5}|} = 4.66234$

$e_{70:\overline{15}|} = 11.45220$

$e_{80} = 8.26871$

$e_{75:\overline{10}|} = 7.70883$

$e_{75:\overline{5}|} = 4.43230$

$e_{80:\overline{5}|} = 4.08531$

Question 17

In what range is $e_{70}$?

[A] Less than 14.00000

[B] 14.00000 but less than 15.00000

[C] 15.00000 but less than 16.00000

[D] 16.00000 but less than 17.00000

[E] 17.00000 or more

Data For Question 18 (3 Points)

$\mu_x = 0.1$, $x>0$.

N = the average number of years lived between age 60 and age 80 by those who die between age 60 and age 80.

Question 18

In what range is N?

[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 19 (5 Points)

An employee age 65 with a spouse age 65 is retiring under one of three actuarially equivalent optional forms of payment, all of which are payable at the beginning of each month.

Option 1: Life annuity of $X per month.

Option 2: Life annuity of $Y per month with the first 60 months guaranteed.

Option 3: Joint and last survivor annuity with the following monthly payments:

a) $Y during the joint lives of the employee and spouse.

b) $X for the remaining lifetime of the employee if the spouse dies first.

c) P% of $Y for the remaining lifetime of the spouse if the employee dies first.

Selected actuarial factors:

$\ddot{a}_{65}^{(12)} = 10.0833$ $\ddot{a}_{65:65}^{(12)} = 9.5833$

${}_{5|}\ddot{a}_{65}^{(12)} = 6.0553$ i = 7%

Question 19

In what range is P%?

[A] Less than 42.00%

[B] 42.00% but less than 44.00%

[C] 44.00% but less than 46.00%

[D] 46.00% but less than 48.00%

[E] 48.00% or more

Data For Question 20 (3 Points)

Selected values from a double decrement table:

$\ell_{40}^{(T)} = 10{,}000$

$\ell_{42}^{(T)} = 7{,}000$

$q_{40}^{(1)} = 0.05$

$q_{40}^{(2)} = 0.10$

$q_{41}^{(1)} = 0.06$

$q_{41}^{(1)}$ and $q_{41}^{(2)}$ are both linear over the interval [41, 42].

Question 20

In what range is the expected number of decrements due to cause 1 between ages 41 and 42?

[A] Less than 482

[B] 482 but less than 492

[C] 492 but less than 502

[D] 502 but less than 512

[E] 512 or more

Data For Question 21 (5 Points)

Under a pension plan's actuarial equivalence definition, the interest rate is 7% and $q_x = 0.04$ for $X \geq 70$. Under the plan, there are two actuarially equivalent forms of payment:

Form 1: 10 years certain and payments for life thereafter.

Form 2:
- Payments of $X while the participant and spouse are both alive.
- Payments of 110% of $X to participant after the death of spouse.
- Payments of 50% of $X to spouse after death of participant.

Payments are made annually at the beginning of each year.

For a participant age 72, with a spouse age 75, the benefit amount under Form 1 is $100.

Question 21

In what range is $X for this participant?

[A] Less than $86

[B] $86 but less than $92

[C] $92 but less than $98

[D] $98 but less than $104

[E] $104 or more

Data For Question 22 (5 Points)

Age at issue for an insured: 25.

Benefit: $200,000 payable at the end of the year of death if death occurs before age 55. $X payable at the end of the year of death if death occurs on or after age 55 but before age 65.

Premiums: A total of 6 premiums consisting of $300 at age 25, doubling each year for the next four premium payments. All premiums are payable at the beginning of the year and one additional premium of $4,000 is payable at age 55.

Selected values:

| | |
|---|---|
| $1000A_{25} = 81.6496$ | $i = 6\%$ |
| $1000A_{55} = 305.1431$ | ${}_{29}p_{26} = 0.90450$ |
| $1000A_{65} = 439.7965$ | ${}_{40}p_{25} = 0.78766$ |

| $x$ | $p_x$ |
|---|---|
| 25 | 0.99877 |
| 26 | 0.99873 |
| 27 | 0.99867 |
| 28 | 0.99861 |
| 29 | 0.99854 |

Question 22

In what range is $X?

[A] Less than $110,000

[B] $110,000 but less than $114,000

[C] $114,000 but less than $118,000

[D] $118,000 but less than $122,000

[E] $122,000 or more

Data For Question 23 (3 Points)

For a study of four automobile engines, you are given:

(i) The engines are subject to a uniform survival distribution over the interval $[0, \omega]$.

(ii) Failures occurred at times 4, 5 and 7; the remaining engine was operational at time r.

(iii) The observation period was from time 3 to time r.

(iv) The maximum likelihood estimate of $\omega$ is 13.67.

Question 23

In what range is r?

[A] Less than 11.3

[B] 11.3 but less than 11.8

[C] 11.8 but less than 12.3

[D] 12.3 but less than 12.8

[E] 12.8 or more

Data For Question 24 (4 Points)

A life insurance policy provides for payment of $1,000 at the end of the year of death but provides no payment if death occurs in the first four years.

For a male age 60, the net single premium for this policy is $300.

The interest rate is 7%.

The probability of death in each of the first four years is 0.2% (i.e., $q_{60}$, $q_{61}$, $q_{62}$ and $q_{63} = 0.002$).

$P = the net single premium for a $1 annual life annuity-due with a 3-year certain period for a male age 60.

Question 24

In what range is $P?

[A] Less than $9.50

[B] $9.50 but less than $10.10

[C] $10.10 but less than $10.70

[D] $10.70 but less than $11.30

[E] $11.30 or more

Data for Question 25 (3 Points)

$$s(x) = \frac{(101 - x)^2}{101}, \quad 0 \le x \le 101$$

i = 5%

Question 25

In what range is $\ddot{a}_{\overline{80}|}$?

[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 26 (4 Points)

Interest Rate: 5% per year, compounded annually.

A term certain and life annuity issued to a person, age 65, provides $500 payable at the end of each month. The load is 8% of the gross premium. Annuity payments are payable at least until a sum equal to the gross single premium has been paid.

Selected Values:

$${}_{13|}a^{(12)}_{65} = 3.31$$

$${}_{14|}a^{(12)}_{65} = 2.92$$

$${}_{15|}a^{(12)}_{65} = 2.56$$

Question 26

In what range is the gross single premium?

[A] Less than $83,000

[B] $83,000 but less than $85,000

[C] $85,000 but less than $87,000

[D] $87,000 but less than $89,000

[E] $89,000 or more

Data For Question 27 (3 Points)

A group of lives is subject to two decrements over the interval [0,100].

Selected values:

$$m_x^{(1)} = m_x^{(2)} = (100 - x)^{-1},\ 0 < x < 100$$

Question 27

In what range is ${}_{10}q_0^{(1)}$?

[A] Less than 0.093

[B] 0.093 but less than 0.096

[C] 0.096 but less than 0.099

[D] 0.099 but less than 0.102

[E] 0.102 or more

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**2002 EA-1**
**Answer Key**

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