SOCIETY OF ACTUARIES

AMERICAN SOCIETY OF PENSION ACTUARIES

JOINT BOARD FOR THE ENROLLMENT OF ACTUARIES

ENROLLED ACTUARIES BASIC EXAMINATION

MAY 2004 EA-1 EXAMINATION

EA1-10-04 **Printed in U.S.A.**

2004

Data for Question 1 (3 points)

On 1/1/2005, Smith purchases a 20-year bond with a par value of $1,000. The bond pays semi-annual coupons at an annual rate of 6%. The bond is purchased to yield 5% per annum effective. When each coupon is received, it is immediately reinvested at a rate of interest of 6% per annum convertible quarterly.

Question 1

In what range is Smith's effective annual rate of return over the term of the bond?

(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

Data for Question 2 (4 points)

On 1/1/2004, Smith purchases an annuity certain that has three semi-annual payments of $500 each, with the first payment to be made 7/1/2009. The force of interest at time t is given by:

$$\delta_t = \frac{1}{(50+2t)}$$ where $t \geq 0$; t is measured in years from 1/1/2004

Question 2

In what range is the present value of the annuity on 1/1/2004?

(A) Less than $1,350

(B) $1,350 but less than $1,355

(C) $1,355 but less than $1,360

(D) $1,360 but less than $1,365

(E) $1,365 or more

Data for Question 3 (3 points)

Type of Annuity: Annuity-immediate, with 19 annual payments.

Annual Payments: First payment is $1, increasing each year by $1 until payment reaches $10, then decreasing by $1 each year to the final payment of $1.

i = 5% per annum, effective.

Question 3

In what range is the present value of this annuity at the date of purchase?

(A) Less than $57

(B) $57 but less than $60

(C) $60 but less than $63

(D) $63 but less than $66

(E) $66 or more

Data for Question 4 (2 points)

Face value of bond: $1,000.

Coupon rate: 6% annual, payable at end of year.

Call date: Any time between 1/1/2014 and 1/1/2019.

Redemption amount: Par.

Purchase date: 1/1/2004.

X = the maximum amount a purchaser would pay to guarantee a yield rate of at least 5% per annum.

Question 4

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

Data for Question 5 (3 points)

Form of annuity:	Annuity-immediate payable annually.
Annual payment:	$1,000.
Period of payment:	For lifetime of annuitant age 65, and continuing for 10 years after death.
Interest rate:	5% per annum, effective.

Given:

$a_{65} = 10.17548$

$a_{75} = 8.16109$

${}_{10}p_{65} = 0.71429$

Question 5

In what range is the present value of this annuity at date of purchase?

(A) Less than $12,800

(B) $12,800 but less than $13,300

(C) $13,300 but less than $13,800

(D) $13,800 but less than $14,300

(E) $14,300 or more

Data for Question 6 (3 points)

Form of annuity: Life annuity-due.

Amount of annuity: $1,000 per month.

To whom payable: Smith, age 65.

In lieu of this annuity, Smith and Jones (age 63) elect an actuarially equivalent joint and survivor annuity-due providing:

(i) P per month while both are alive.

(ii) If Smith dies before Jones, P/2 for Jones' remaining lifetime after Smith's death.

(iii) If Jones dies before Smith, $1,000 per month for Smith's remaining lifetime after Jones' death.

Given:

$$\ddot{a}^{(12)}_{65} = 11.5$$

$$\ddot{a}^{(12)}_{63} = 12.1$$

$$\ddot{a}^{(12)}_{65:63} = 9.0$$

Question 6

In what range is P?

(A) Less than $780

(B) $780 but less than $810

(C) $810 but less than $840

(D) $840 but less than $870

(E) $870 or more

Data for Question 7 (4 points)

Details on a loan made on 1/1/2004:

Number of payments: 10.

Amount of each payment: $5,000.

Date of first payment: 12/31/2004.

Interest rate: 8% compounded annually.

Immediately after the sixth payment, an additional $10,000 payment is made. The loan is reamortized over a longer term to provide for annual payments of $1,000 and a final smaller payment of X paid one year after the last $1,000 payment.

Question 7

In what range is X?

(A) Less than $350

(B) $350 but less than $450

(C) $450 but less than $550

(D) $550 but less than $650

(E) $650 or more

Data for Question 8 (2 points)

The present value of a 15-year monthly annuity-immediate is $20,600.

Payments are as follows:

Years	Monthly Annuity Payment
1-7	X
8-15	X+$300

Interest rate: 8%, compounded annually.

Question 8

In what range is X?

(A) Less than $74.50

(B) $74.50 but less than $75.50

(C) $75.50 but less than $76.50

(D) $76.50 but less than $77.50

(E) $77.50 or more

Data for Question 9 (3 points)

Amount of loan:	$10,000.
Term of loan:	20 years.
Interest rate on loan:	5% per annum, effective.
Terms of loan repayment:	20 annual payments beginning at the end of year 1 consisting of $500 principal plus interest on the outstanding balance of the loan.

Question 9

In what range is the total amount of interest and principal paid over the term of the loan?

(A) Less than $15,000

(B) $15,000 but less than $15,400

(C) $15,400 but less than $15,800

(D) $15,800 but less than $16,200

(E) $16,200 or more

Data for Question 10 (3 points)

Date	Market value of fund	Contributions	Withdrawals
1/1/2004	$100,000	None	None
4/1/2004	85,000	$30,000	None
8/1/2004	100,000	None	$20,000
12/31/2004	80,000	None	None

Market value of fund is prior to contributions and withdrawals.

A = Time Weighted Return

B = Dollar Weighted Return

Question 10

In what range is the absolute value of A+B?

(A) Less than 45.00%

(B) 45.00% but less than 48.00%

(C) 48.00% but less than 51.00%

(D) 51.00% but less than 54.00%

(E) 54.00% or more

Data for Question 11 (2 points)

$l_{x+1} = 960$

$L_x = 975$

Assume a uniform distribution of deaths between x and x+1.

Question 11

In what range is $1000 * m_x$?

(A) Less than 30.0

(B) 30.0 but less than 30.5

(C) 30.5 but less than 31.0

(D) 31.0 but less than 31.5

(E) 31.5 or more

Data for Question 12 (5 points)

Consider the following actuarially equivalent annuities:

(i) Joint and 50% survivor annuity paying $100 per month, with reduction only on death of annuitant.

(ii) Joint and 50% survivor annuity paying $110 per month, with reduction on first death (annuitant or beneficiary).

(iii) Joint and 50% survivor annuity paying P per month with reduction only on death of annuitant. After death of beneficiary, 110% of P is paid for remaining life of annuitant.

Question 12

In what range is P?

(A) Less than $97.50

(B) $97.50 but less than $98.00

(C) $98.00 but less than $98.50

(D) $98.50 but less than $99.00

(E) $99.00 or more

Data for Question 13 (3 points)

Smith is entitled to an annual life annuity-due of $30,000 beginning 1/1/2004.

Instead of the life annuity, Smith elects an actuarially equivalent benefit that pays the following:

> $50,000 lump sum on 1/1/2004, plus
>
> 5-year term certain annuity-due that pays X per year starting 1/1/2007, if Smith survives to 1/1/2007.

Smith is age 62 as of 1/1/2004.

i = 7%, compounded annually

$\ddot{a}_{62} = 12.67977$

${}_np_x = 0.99^n$, for $x \leq 65$

Question 13

In what range is X?

(A) Less than $80,000

(B) $80,000 but less than $85,000

(C) $85,000 but less than $90,000

(D) $90,000 but less than $95,000

(E) $95,000 or more

Data for Question 14 (3 points)

Smith's monthly retirement benefit is as follows:

10-year certain and life annuity-due: $3,000.

Instead of this annuity, Smith elects an actuarially equivalent life annuity-due paying X per month.

Smith is age 62.

i = 7%, per annum, effective.

$\ddot{a}_{62}^{(12)} = 9.61521$

$\ddot{a}_{62:\overline{10}|}^{(12)} = 6.94029$

Question 14

In what range is X?

(A) Less than $3,050

(B) $3,050 but less than $3,100

(C) $3,100 but less than $3,150

(D) $3,150 but less than $3,200

(E) $3,200 or more

Data for Question 15 (3 points)

Annual retirement benefits for Smith and Jones are as follows:

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

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

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

Smith is age 61.

Jones is age 60.

i = 7% per annum

$\ddot{a}_{60} = 11.53496$ $\ddot{a}_{62:\overline{4}|} = 3.58056$

$\ddot{a}_{60:\overline{10}|} = 7.26514$ $p_{61} = 0.99394$

Question 15

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

Data for Question 16 (5 points)

Annuity #1	An amount payable at the end of each quarter beginning with a $1,000 payment on 3/31/2004. Each subsequent payment is 1% larger than the previous payment. The annuity is paid for 10 years.
Annuity #2	An amount payable at the end of each year beginning with an X payment on 12/31/2004. Each subsequent payment is $25 less than the previous payment. The annuity is paid for 15 years.
Interest rate	7.00%, compounded annually.

On 1/1/2006, the present value of the remaining payments of Annuity #1 equals the present value of the remaining payments of Annuity #2.

Question 16

In what range is X?

(A) Less than $3,550

(B) $3,550 but less than $3,850

(C) $3,850 but less than $4,150

(D) $4,150 but less than $4,450

(E) $4,450 or more

Data for Question 17 (4 points)

Loan terms: $100,000 borrowed on 1/1/2004, issued at a 5.00% annual effective interest rate.

Loan repayment: No repayments of principal or interest are made on the loan until a sinking fund has accumulated to pay the balance in full. This occurs at 12/31/2019.

Sinking fund: $10,000 annual deposits from 12/31/2004 through 12/31/2011 and $5,000 annual deposits beginning on 12/31/2012. The sinking fund accumulation rate is i% until 12/31/2011 and k% thereafter.

During calendar year 2011, interest accrued on the loan and interest earned on the sinking fund are the same.

Question 17

In what range is k%?

(A) Less than 6.10%

(B) 6.10% but less than 6.60%

(C) 6.60% but less than 7.10%

(D) 7.10% but less than 7.60%

(E) 7.60% or more

Data for Question 18 (4 points)

Initial number of lives: 1,300, all age 50.

Policy: 3-year term insurance, paying $10,000 at end of year of death.

Premium: Each insured pays a single premium based on 5% interest and mortality according to $l_x = 100-x$.

All premiums are deposited into a fund out of which all benefits are paid.

Actual experience: Over the 3-year period, the fund earns interest of 5¼% per annum and mortality follows $l_x = 102-x$.

Y = The amount remaining in the fund immediately after third year claims are paid (ignoring expenses)

Question 18

In what range is Y?

(A) Less than $0

(B) $0 but less than $10,000

(C) $10,000 but less than $20,000

(D) $20,000 but less than $30,000

(E) $30,000 or more

Data for Question 19 (3 points)

Participant age on 1/1/2004: 65.

Joint annuitant age on 1/1/2004: 64.

Interest rate: 7%, compounded annually.

Joint annuity terms: Lifetime payments of $10,000 annually with the first payment at 1/1/2004. Upon the first death of the participant or joint annuitant, the payment decreases to $6,000 and this amount is payable until the second death.

Selected values:

$1000q_{64} = 8.685$ $a_{65:64} = 8.4129$

$1000q_{65} = 9.816$ $a_{65} = 9.8207$

Question 19

In what range is the present value of the annuity on 1/1/2004?

(A) Less than $95,000

(B) $95,000 but less than $105,000

(C) $105,000 but less than $115,000

(D) $115,000 but less than $125,000

(E) $125,000 or more

Data for Question 20 (5 points)

A company's benefit plan has 1,000 active participants, all age 40 as of 1/1/2004.

The plan will provide the following benefits during 2004 and 2005:

(i) $2,000 lump-sum death benefit paid at the end of the year for death

(ii) $1,000 lump-sum severance benefit at the end of the year of withdrawal

(iii) $3,000 bonus payment to remaining employees at the end of 2005

A two-decrement service table (death and withdrawal) is used in an actuarial valuation of this plan. Selected values from the service table are:

$q_{41}^{(d)} = 0.0007$ $\qquad$ $q_{41}^{(w)} = 200\, q_{40}^{(d)}$

i = 7%, compounded annually.

2004 withdrawal benefit term cost as of 1/1/2004 = $93,084.

Present value of the bonus payments as of 1/1/2004 = $2,167,971.

X = the 2004 death benefit term cost as of January 1, 2004.

Question 20

In what range is X?

(A) Less than $770

(B) $770 but less than $795

(C) $795 but less than $820

(D) $820 but less than $845

(E) $845 or more

Data for Question 21 (2 points)

You are given:

$A_{76} = 0.8$

${}_1E_{76} = 0.9$

i = 3%, compounded annually.

Question 21

In what range is A_{77}?

(A) Less than 0.806

(B) 0.806 but less than 0.809

(C) 0.809 but less than 0.812

(D) 0.812 but less than 0.815

(E) 0.815 or more

Data for Question 22 (3 points)

Given the following values:

x	e_x
107	0.6
108	0.2
109	0.0

A new table is constructed such that the force of mortality is doubled.

Y = the value of e_{107} based on the new table.

Question 22

In what range is Y?

(A) Less than 0.25

(B) 0.25 but less than 0.27

(C) 0.27 but less than 0.29

(D) 0.29 but less than 0.31

(E) 0.31 or more

Data for Question 23 (3 points)

Face amount of bond:	$1,000.
Coupon rate:	6% payable semi-annually.
Redemption:	Bond is redeemable at par in five equal annual installments commencing at the end of the tenth year following purchase.
Yield rate:	5% per annum, effective.

Question 23

In what range is the purchase price?

(A) Less than $1,085

(B) $1,085 but less than $1,092

(C) $1,092 but less than $1,099

(D) $1,099 but less than $1,106

(E) $1,106 or more

Data for Question 24 (3 points)

Given:

$A_x = 0.18$

$A_{x+1} = 0.19$

$A_{x+2} = 0.20$

$1000q_{x+1} = 11.25$

Question 24

In 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

Data for Question 25 (3 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 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 X.

Question 25

In what range is 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

Data for Question 26 (2 points)

You are given the following data from a clinical study:

Time	Event
0.0	20 new entrants
1.1	1 death
1.5	9 terminations
2.3	1 death
3.0	1 new entrant
3.2	1 death
4.7	1 termination
6.0	2 deaths

Y = Product Limit estimate of S(6), i.e., the probability of surviving to time t = 6.

Question 26

In what range is Y?

(A) Less than 0.555

(B) 0.555 but less than 0.563

(C) 0.563 but less than 0.571

(D) 0.571 but less than 0.579

(E) 0.579 or more

Data for Question 27 (3 points)

A loan is made on 1/1/2004.

Loan repayments: 120 level monthly payments of interest and principal with the first payment at 2/1/2004.

Interest is charged on the loan at a rate of $i^{(12)}$ = 7.5%.

Amount of interest paid in the 54^{th} payment of the loan = $100.

P = Principal outstanding on the loan after the 90^{th} payment.

Question 27

In what range is P?

(A) Less than $8,005

(B) $8,005 but less than $8,020

(C) $8,020 but less than $8,035

(D) $8,035 but less than $8,050

(E) $8,050 or more

Data for Question 28 (3 points)

For a given bond:

Par value = $1,000.

Redemption value = $1,100.

Term of bond = 10 years.

Coupons = r% per year, payable semiannually.

Issue price = P if yield to maturity is 4%, compounded annually.

Issue price = (P – $95.50) if yield to maturity is 5%, compounded annually.

Question 28

In what range is r%?

(A) Less than 7.2%

(B) 7.2% but less than 7.7%

(C) 7.7% but less than 8.2%

(D) 8.2% but less than 8.7%

(E) 8.7% or more

Data for Question 29 (3 points)

Selected items related to a mortality table over the age interval [98, 99]:

$\mu_{98.55} = 0.5980$ under the uniform death distribution

${}_{y}q_{98.35} = 0.2486$ under the uniform death distribution

$Z = {}_{y}q_{98.15}$ under constant force of mortality

Question 29

In what range is Z?

(A) Less than 0.246

(B) 0.246 but less than 0.254

(C) 0.254 but less than 0.262

(D) 0.262 but less than 0.270

(E) 0.270 or more

Data for Question 30 (3 points)

A company has a stationary population of 15,000 employees. It hires 510 employees each year at the age of 24. Employees terminate employment only through death or retirement. The employees retire upon reaching age 55. The average age of the employees who die before retirement is age 50.

X = the number of employees who retire each year.

Question 30

In what range is X?

(A) Less than 380

(B) 380 but less than 420

(C) 420 but less than 460

(D) 460 but less than 500

(E) 500 or more

Data for Question 31 (2 points)

In a double decrement table, you are given:

x	$q_x^{(1)}$	$q_x^{(2)}$	$\ell_x^{(T)}$
25	0.05	0.30	
26	0.05	0.20	6,500

Z = the absolute value of the change in $d_{26}^{(1)}$ if $q_{25}^{(2)}$ changes from 0.30 to 0.25.

Question 31

In what range is Z?

(A) Less than 21.50

(B) 21.50 but less than 22.50

(C) 22.50 but less than 23.50

(D) 23.50 but less than 24.50

(E) 24.50 or more

Data for Question 32 (3 points)

	Bond A	Bond B
Face amount	$100	$100
Coupon rate	6%, payable semi-annually	5%, payable semi-annually
Redemption	Par	$125
Length of bond	20 years	20 years

Both bonds have the same purchase price and the same yield rate.

Question 32

In what range is the annual effective yield on these two bonds?

(A) Less than 2.180%

(B) 2.180% but less than 2.200%

(C) 2.200% but less than 2.220%

(D) 2.220% but less than 2.240%

(E) 2.240% or more

Course EA-1, Spring 2004

ANSWER KEY

Question #	*# of Points*	*Answer*
1	3	D
2	4	A
3	3	C
4	2	A
5	3	D
6	3	D
7	4	E
8	2	C
9	3	B
10	3	D
11	2	C
12	5	C
13	3	E
14	3	C
15	3	C
16	5	B

Question #	*# of Points*	*Answer*
17	4	A
18	4	E
19	3	C
20	5	A
21	2	C
22	3	B
23	3	C
24	3	A
25	3	D
26	2	D
27	3	A
28	3	B
29	3	A
30	3	A
31	2	E
32	3	D