SOCIETY OF ACTUARIES

AMERICAN SOCIETY OF PENSION ACTUARIES

JOINT BOARD FOR THE ENROLLMENT OF ACTUARIES

COURSE 141 (EA1) SEGMENT A

JOINT BOARD BASIC EXAMINATION

This is the May 1996 examination which has been released to the public by the administering organizations.

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1996

Conditions Generally Applicable to
All EA-1 Segment A Examination Questions

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 preretirement death benefits.

(4) Actuarial equivalence is based on the mortality table and interest rate assumed for funding purposes.

(5) Interest rates which are compounded more frequently than annually are expressed as nominal rates.

1996

Data for Question 1

In a two decrement table, $l_x^{(j)}$ is the number of lives at age x who will eventually be removed by cause j.

$l_x^{(1)}$ = 2 times (100 - x) for x<100; 0 for x≥100

$l_x^{(2)}$ = 5 times (120 - x) for x<120; 0 for x≥120

Question 1

In what range is the value of 100 times $\mu_{50}^{(2)}$?

[A] Less than 1.2

[B] 1.2 but less than 1.3

[C] 1.3 but less than 1.4

[D] 1.4 but less than 1.5

[E] 1.5 or more

1996

Data for Question 2

Date of a loan: 1/1/96.

Date of first repayment: 12/31/96.

Frequency of repayments: Annually.

Term of loan: 3 years.

Interest rate: 6% per year, compounded annually.

Repayments: $900 on 12/31/96, decreasing by $300 each year thereafter.

Part of each annual repayment is used to pay the interest on the loan. The remaining portion of each annual repayment is deposited into a sinking fund earning 5% per year, compounded annually.

Question 2

In what range is the amount of the loan as of 1/1/96?

[A] Less than $1,600

[B] $1,600 but less than $1,620

[C] $1,620 but less than $1,640

[D] $1,640 but less than $1,660

[E] $1,660 or more

1996

Data for Question 3

A term insurance policy pays $50,000 at the end of the year of death, if death occurs during the first three years.

Age at issue: 55.

Interest rate: 7% per year, compounded annually.

Selected probabilities:

$_3p_{55} = .97057$

$_{k|}q_{55} = 1.084^k \times q_{55}$, for $k > 0$

Question 3

In what range is the single premium for the insurance policy?

[A] Less than $1,200

[B] $1,200 but less than $1,250

[C] $1,250 but less than $1,300

[D] $1,300 but less than $1,350

[E] $1,350 or more

1996

Data for Question 4

Type of insurance policy: Whole life.

Issue age: 45.

Death benefit: $50,000, payable at end of year of death.

Commissions included in gross annual premium:

75% of first year premium
10% of second through fifth year premiums
5% of all premiums thereafter

Additional expenses included in gross annual premium:

$10 per $1,000 of insurance for first year
$2 per $1,000 of insurance for each subsequent year
$5 per $1,000 of insurance for cost of settlement

Selected commutation functions:

$D_{45} = 502$ $N_{45} = 9{,}500$ $N_{50} = 7{,}070$ $M_{45} = 50$

Question 4

In what range is the gross annual premium?

[A] Less than $250

[B] $250 but less than $300

[C] $300 but less than $350

[D] $350 but less than $400

[E] $400 or more

1996

Data for Question 5

Market value of a pension fund:

Date	Value
1/01/96	$1,200,000
4/01/96	1,400,000
8/01/96	1,000,000
11/01/96	1,600,000
12/31/96	1,800,000

Cash flow in fund:

Date	Contributions	Benefit Payments
3/31/96	$100,000	$150,000
7/31/96	250,000	150,000
10/31/96	350,000	150,000

Question 5

In what range is the absolute value of the difference between the dollar-weighted rate of return and the time-weighted rate of return?

[A] Less than 5.70%

[B] 5.70% but less than 5.80%

[C] 5.80% but less than 5.90%

[D] 5.90% but less than 6.00%

[E] 6.00% or more

1996

Data for Question 6

Terms of three annuity contracts:

	Contract 1	Contract 2	Contract 3
Age at issue	40	70	50
Net single premium	$19,000	$4,400	$X
Age at first annuity payment	50	70	50
Type of annuity	Temporary Life, 20 Years Maximum	Life	Life
Frequency of annuity payments	Annually	Annually	Annually
Amount of each annuity payment	$2,000	$500	$1,000

All annuity payments are made at the beginning of the year.

Selected commutation functions:

x	D_x
40	6,000
50	5,000
70	3,000

Question 6

In what range is the net single premium for Contract 3?

[A] Less than $16,000

[B] $16,000 but less than $19,000

[C] $19,000 but less than $22,000

[D] $22,000 but less than $25,000

[E] $25,000 or more

1996

Data for Question 7

Type of annuity contract: Deferred life.

Age at issue: 45.

Type of premiums: Level.

Frequency of premiums: Annually, at the beginning of each year.

Number of premiums: 20.

Age at first annuity payment: 65.

Frequency of annuity payments: Monthly.

If the insured dies before age 65, all premiums paid are returned at the end of the year of death with interest at 7%.

Interest rate: 7% per year, compounded annually.

Contract reserve at end of fifth year: $10,000.

Selected annuity value:

$$\ddot{a}_{65}^{(12)} = 8.74$$

Question 7

In what range is the monthly annuity payment?

[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

1996

Data for Question 8

A portfolio of assets consists of the following:

A $1000 par value bond with a coupon of $80 payable each 12/31 and a maturity date of 12/31/97.

A $1000 zero coupon bond maturing on 12/31/2005.

Interest rate: 9% per year, compounded annually.

Question 8

In what range is the modified duration for this portfolio as of 1/1/96?

[A] Less than 3.70 years

[B] 3.70 but less than 3.90 years

[C] 3.90 but less than 4.10 years

[D] 4.10 but less than 4.30 years

[E] 4.30 years or more

1996

Data for Question 9

Terms of a deferred life annuity contract:

Age at first premium payment: 55.

Gross annual premium: $P.

Number of premium payments: 10.

Commissions: 60% of $P in year 1 and
10% of $P in each subsequent year.

Expenses: $2 for each annuity payment.

Age at first annuity payment: 65.

Frequency of annuity payments: Monthly.

Amount of each annuity payment: $100.

Death benefit: None.

Selected commutation functions:

$D_{55} = 1{,}600$ $N_{55} = 24{,}000$

$D_{65} = 1{,}000$ $N_{65} = 10{,}600$

Question 9

In what range is $P?

[A] Less than $1,110

[B] $1,110 but less than $1,130

[C] $1,130 but less than $1,150

[D] $1,150 but less than $1,170

[E] $1,170 or more

1996

Data for Question 10

A decedent's will provides for $1,000,000 to be paid to his favorite charity upon his death. On each December 31 following the decedent's death, the charity is required to pay the decedent's spouse $70,000 for the spouse's remaining lifetime. The charity's fund is assumed to earn 8% each calendar year.

Date of death: 1/1/96.

Age at death: 65.

Spouse's age at 1/1/96: 65.

Selected commutation functions:

x	D_x	N_x
65	94,414	868,052
66	86,246	773,638

Question 10

In what range is the present value of the charity's interest in the fund as of 1/1/96?

[A] Less than $300,000

[B] $300,000 but less than $350,000

[C] $350,000 but less than $400,000

[D] $400,000 but less than $450,000

[E] $450,000 or more

1996

Data for Question 11

Smith establishes a savings account in 1996 to which he will deposit each December 31 an amount equal to the lesser of $30,000 or 20% of his compensation for the year.

Actuarial assumptions:

Interest rate: 7% per year, compounded annually.
Compensation increases: 4% per year, effective each 1/1.
Mortality: None.

Smith's compensation for 1996: $60,000.

Smith is assumed to make no withdrawals from his account for at least 30 years.

Question 11

In what range is Smith's projected account balance as of 1/1/2025?

[A] Less than $1,285,000

[B] $1,285,000 but less than $1,385,000

[C] $1,385,000 but less than $1,485,000

[D] $1,485,000 but less than $1,585,000

[E] $1,585,000 or more

1996

Data for Question 12

Terms of an increasing life insurance policy:

Issue age: 65.
Initial death benefit: $1,000, payable at end of year of death.
Annual increase in death benefit: $1,000.
Net single premium: $8,500.
Interest rate: 5% per year, compounded annually.

Terms of an increasing annuity:

Issue age: 65.
Initial payment: $500.
Frequency of payments: Annually.
Annual increase in payment: $500.
Age at first payment: 65.
Net single premium: $40,000.
Interest rate: 5% per year, compounded annually.

Selected values:

$l_{65} = 6{,}800$ $\qquad$ $l_{66} = 6{,}600$

Question 12

In what range is the commutation function S_{66}?

[A] Less than 17,000

[B] 17,000 but less than 18,000

[C] 18,000 but less than 19,000

[D] 19,000 but less than 20,000

[E] 20,000 or more

1996

Data for Question 13

Face amount of a bond: $1,000.

Purchase date: 1/1/96.

Maturity value: $1,025.

Maturity date: 12/31/2015.

Coupon rate: 4% per year, payable annually.

Coupon dates: Each 12/31 beginning 12/31/96.

Call dates and amounts:

Call Date	Amount
12/31/2012	$1,050
12/31/2013	1,025
12/31/2014	1,010

Question 13

In what range is the lowest price of the bond to guarantee a yield of 5% per year, compounded annually?

[A] Less than $884

[B] $884 but less than $893

[C] $893 but less than $902

[D] $902 but less than $911

[E] $911 or more

1996

Data for Question 14

Terms for two whole life insurance policies:

	Smith	Brown
Provisions		
Issue age	42	40
Death benefit	$100,000 payable at end of year of death	$100,000 payable at end of year of death
Net single premium	$12,000	$X
Assumptions		
Mortality table	Standard	Preferred
Interest rate	8% per year	8% per year

The Preferred (P) mortality table has a two-year select period and is constructed from the Standard (S) mortality table as follows:

$$q_{[x]}^{P} = q_{[x]+1}^{P} = vq_x^{S}$$

$$q_{x+k}^{P} = q_{x+k}^{S}, \text{ for } k \geq 2$$

Selected probabilities:

$q_{40}^{S} = .010$ $\qquad$ $q_{41}^{S} = .011$

Question 14

In what range is $X?

[A] Less than $11,600

[B] $11,600 but less than $11,800

[C] $11,800 but less than $12,000

[D] $12,000 but less than $12,200

[E] $12,200 or more

1996

Data for Question 15

Terms of an annuity:

Frequency of payments: Annually, at the beginning of each year.

Amount of each payment: Account balance divided by the annuitant's curtate expectation of life.

Assumed rate of return: 7% per year, compounded annually.

Annuitant's date of birth: 1/1/24.

Account balance as of 1/1/95 (before 1/1/95 payment): $100,000.

Selected values:

x	p_x
71	.98
72	.97
73	.96

$\mathring{e}_{71} = 15.30$

Question 15

In what range is the expected annuity payment on 1/1/97?

[A] Less than $6,600

[B] $6,600 but less than $6,850

[C] $6,850 but less than $7,100

[D] $7,100 but less than $7,350

[E] $7,350 or more

1996

Data for Question 16

Repayment schedule for a loan:

> $N payable on January 1 of each year from 1995 through 2009, and an additional $N payable on January 1 of each of the following years: 1996, 1999, 2002, 2005, and 2008.

Present value of all future repayments:

> As of 1/1/94: $P.
>
> As of 1/1/97: $P - $11,061 (prior to 1/1/97 repayment).

Interest rate: 7% per year, compounded annually.

Question 16

In what range is $N?

[A] Less than $4,500

[B] $4,500 but less than $9,000

[C] $9,000 but less than $13,500

[D] $13,500 but less than $18,000

[E] $18,000 or more

1996

Data for Question 17

A single premium annuity provides Smith with a lifetime annuity of $100 per month commencing on the first day of the month next following his spouse's death, provided that his spouse dies at least 10 years after the annuity purchase date.

Age of Smith and his spouse on annuity purchase date: 25.

Selected commutation functions:

x	y	D_x	$N_x^{(12)}$	$D_{x:y}$	$N_{x:y}^{(12)}$
25	25	17,969	251,097	17,724	239,249
35	35	9,031	120,739	8,807	111,292

Question 17

In what range is the single premium for the annuity?

[A] Less than $440

[B] $440 but less than $480

[C] $480 but less than $520

[D] $520 but less than $560

[E] $560 or more

1996

Data for Question 18

Terms of a life insurance policy:

Issue age: 65.

Death benefit: Initial amount of $1,000 with each subsequent amount equal to 105% of the preceding year's amount, payable at the end of the year of death.

Premium: Initial premium of $X with each subsequent premium equal to 105% of the preceding year's premium, payable at the beginning of each policy year.

Interest rate: 5% per year, compounded annually.

Selected value:

$e_{65} = 15$

Question 18

In what range is $X?

[A] Less than $59

[B] $59 but less than $62

[C] $62 but less than $65

[D] $65 but less than $68

[E] $68 or more

1996

Data for Question 19

Date of a loan: 1/1/96.

Amount of loan: $100,000.

Date of first repayment: 1/31/96.

Frequency of repayments: Monthly.

Repayments: Each 1/1 after 1996, the monthly repayment is increased by 3% over the monthly repayment for the prior year.

Number of repayments: 180.

Interest rate: 9% per year, compounded annually.

Question 19

In what range is the monthly repayment during the year 2000?

[A] Less than $820

[B] $820 but less than $860

[C] $860 but less than $900

[D] $900 but less than $940

[E] $940 or more

Data for Question 20

Terms of an annuity:

Date of purchase: 1/1/96.
Date of first payment: 1/1/96.
Amount of each payment: $1,000.
Frequency of payments: Quarterly.
Number of payments: 80.
Interest rate: 5% per year, compounded quarterly.

All annuity payments are reinvested by the purchaser for the remaining term of the annuity at 10% per year, compounded semiannually.

Question 20

In what range is the total effective annual rate of return, compounded annually, to the purchaser of this arrangement?

[A] Less than 8.20%

[B] 8.20% but less than 8.25%

[C] 8.25% but less than 8.30%

[D] 8.30% but less than 8.35%

[E] 8.35% or more

1996

Data for Question 21

Selected values from a two decrement table:

$q'_x^{(1)} = .03$

$q_x^{(2)} = .10$

Each decrement is assumed to be uniformly distributed between ages x and x+1.

Question 21

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

[A] Less than .1270

[B] .1270 but less than .1280

[C] .1280 but less than .1290

[D] .1290 but less than .1300

[E] .1300 or more

1996

Data for Question 22

Purchase date of a serial bond: 1/1/96.

Coupon rate: 5% per year, payable semiannually on each 6/30 and 12/31.

Face amount of bond: $21,000.

Redemption dates and amounts:

Date	Amount
1/1/1998	$7,000
1/1/2000	7,000
1/1/2002	7,000

Yield rate to purchaser: 6% per year, compounded quarterly.

Question 22

In what range is the purchase price of the bond?

[A] Less than $20,400

[B] $20,400 but less than $20,600

[C] $20,600 but less than $20,800

[D] $20,800 but less than $21,000

[E] $21,000 or more

1996

Data for Question 23

Date of a loan: 1/1/84.

Amount of loan: $100,000.

Date of first repayment: 1/31/84.

Frequency of repayments: Monthly.

Number of repayments: 360.

Interest rate: 8% per year, compounded monthly.

The loan is refinanced on 1/1/96 at a revised interest rate of 7.25% per year, compounded annually. The frequency of repayments and the total number of repayments remain unchanged.

Question 23

In what range is the amount of principal repaid in the 19th year after the date of the loan?

[A] Less than $3,550

[B] $3,550 but less than $3,650

[C] $3,650 but less than $3,750

[D] $3,750 but less than $3,850

[E] $3,850 or more

1996

Data for Question 24

Before 1966, a stationary population of 800,000 was maintained by annual births of 15,000. One-half of the total population was under age 30.

After 1965, annual births increased to 16,000. However, mortality rates did not change at any age.

Question 24

In what range is the total population as of 1/1/96?

[A] Less than 810,000

[B] 810,000 but less than 820,000

[C] 820,000 but less than 830,000

[D] 830,000 but less than 840,000

[E] 840,000 or more

1996

Data for Question 25

Interest rate: 7% per year, compounded annually.

Selected values:

x	l_x
103	250
104	100
105	0

$q_{102} = .250$

Question 25

In what range is A_{102}?

[A] Less than 0.870

[B] 0.870 but less than 0.890

[C] 0.890 but less than 0.910

[D] 0.910 but less than 0.930

[E] 0.930 or more

ANSWER KEY

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1. A
2. B
3. C
4. E
5. D

6. B
7. E
8. C
9. A
10. D

11. D
12. D
13. A
14. B
15. D

16. E
17. A
18. B
19. E
20. C

21. C
22. A
23. C
24. C
25. B

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