SOCIETY OF ACTUARIES

AMERICAN SOCIETY OF PENSION ACTUARIES

JOINT BOARD FOR THE ENROLLMENT OF ACTUARIES

COURSE 141 (EA1) Segment A

JOINT BOARD BASIC EXAMINATION

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90
SPRING
EA-1A

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

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

1990

Data for Question 1

Selected values under a mortality table:

$l_0 = 100{,}000 \qquad l_{35} = 44{,}000$

$$s(x) = \frac{c - x}{c + x}$$

Smith and Brown are both age 40 as of 1/1/90.

Question 1

In what range is the probability as of 1/1/90 that Smith and Brown will both survive to age 45 and that at least one of them will survive to age 60?

(A) Less than .55

(B) .55 but less than .60

(C) .60 but less than .65

(D) .65 but less than .70

(E) .70 or more

1990

Data for Question 2

Face amount of bond: $10,000.

Purchase date: 1/1/85.

Maturity value: $10,000.

Maturity date: 12/31/09.

Coupon rate: 8% per year, compounded annually.

Coupon date: 12/31.

Purchaser's yield to maturity: 10% per year, compounded annually.

Assumed probability of the bond being called at each 12/31 after 1/1/90 or being redeemed at maturity: 5%.

Question 2

In what range is the amortized value of the bond as of 1/1/90?

(A) Less than $8,600

(B) $8,600 but less than $8,900

(C) $8,900 but less than $9,200

(D) $9,200 but less than $9,500

(E) $9,500 or more

1990

Data for Question 3

Selected values under a three-decrement table:

$l^{T}_{30} = 1{,}000{,}000$ $\quad d^{(1)}_{30} = 2{,}680$ $\quad d^{(2)}_{30} = 824$ $\quad d^{(3)}_{30} = 100{,}000$

$q^{(1)}_{30+t} = 1.02\, q^{(1)}_{30+t-1}$ $\quad q^{(2)}_{30+t} = 1.04\, q^{(2)}_{30+t-1}$ $\quad q^{(3)}_{30+t} = q^{(3)}_{30+t-1}$

Question 3

In what range is ${}_3q^{(2)}_{31}$?

(A) Less than .00205

(B) .00205 but less than .00220

(C) .00220 but less than .00235

(D) .00235 but less than .00250

(E) .00250 or more

1990

Data for Question 4

Annuity A: $1,000 per year, payable at the end of each year for N years, with no deferral period.

Annuity B: $2,000 per year, payable at the end of each year for 2N years, with a deferral period of M years.

Annuity C: Level annual amount, payable at the end of each year for (M+N) years, with no deferral period.

Annuity C is equivalent in value to Annuities A and B combined.

Selected annuity values:

$a_{\overline{M}|} = 8.273$ $\quad a_{\overline{N}|} = 11.101$ $\quad a_{\overline{M+N}|} = 12.780$

Question 4

In what range is the annual payment for Annuity C?

(A) Less than $1,675

(B) $1,675 but less than $1,700

(C) $1,700 but less than $1,725

(D) $1,725 but less than $1,750

(E) $1,750 or more

1990

Data for Question 5

Plan effective date: 1/1/90.

Assumed interest rate: 7% per year.

Death benefit: $1,000 per year payable on each 12/31 for 5 years certain, commencing on 12/31 of the calendar year of death; payable only if participant dies within the first 5 years of participation.

Data for sole participant:

Date of birth	1/1/50
Date of hire	1/1/70
Status as of 1/1/90	Active

Selected commutation functions:

x	D_x	N_x
40	69,444	928,377
41	64,763	858,933
45	48,876	625,035
46	45,523	576,159

Question 5

In what range is the present value of the death benefit as of 1/1/90?

(A) Less than $42.50

(B) $42.50 but less than $44.00

(C) $44.00 but less than $45.50

(D) $45.50 but less than $47.00

(E) $47.00 or more

1990

Data for Question 6

Normal retirement benefit: $300 per month.

Normal form of payment: Life annuity with 5 years certain.

Early retirement benefit: Actuarial equivalent to normal retirement benefit.

Basis for conversion between forms of payment: Actuarial equivalence.

Data for sole participant:

Date of birth	1/1/30
Date of retirement	1/1/90
Spouse's date of birth	1/1/25
Form of payment elected	Monthly benefit for life, with 100% continuing to surviving spouse for life

Selected commutation functions and annuity values:

$D_{60} = 148{,}633$	$N_{60}^{(12)} = 1{,}458{,}832$	$\ddot{a}_{60:65}^{(12)} = 7.434$
$D_{65} = 97{,}178$	$N_{65}^{(12)} = 848{,}930$	$\ddot{a}_{65:70}^{(12)} = 6.265$
$D_{70} = 60{,}339$	$N_{70}^{(12)} = 458{,}709$	$\ddot{a}_{\overline{5}\rceil}^{(12)} = 4.254$

Question 6

In what range is the monthly benefit payable to the participant?

(A) Less than $145

(B) $145 but less than $150

(C) $150 but less than $155

(D) $155 but less than $160

(E) $160 or more

1990

Data for Question 7

Original provisions of loan:

Date of loan: 1/1/80.
Date of first payment: 12/31/80.
Frequency of payments: Annually.
Number of payments: 20.
Amount of each payment: $5,000.
Interest rate: 10% per year, compounded annually.

The loan is renegotiated on 1/1/90.

Renegotiated provisions of loan:

Amount of loan: Outstanding balance of original loan as of 1/1/90.
Date of first payment: 1/31/90.
Frequency of payments: Monthly.
Number of payments: 60.
Interest rate: 7.5% per year, compounded annually.

Question 7

In what range is the amount payable on 1/31/90?

(A) Less than $615

(B) $615 but less than $630

(C) $630 but less than $645

(D) $645 but less than $660

(E) $660 or more

1990

Data for Question 8

As of 1/1/90, Smith (age x) and Brown (age y) are entitled to a joint and survivor annuity with payments made at the end of each year in the following amounts:

If both are alive: \$5,000.

If only Smith is alive on 12/31/(90 + t): (\$400 + \$200t)

If only Brown is alive on 12/31/(90 + t): (\$400 + \$100t)

If neither are alive: \$0.

Selected annuity values:

a_x	= 13.7	$(Ia)_x$	= 144.8
a_y	= 11.6	$(Ia)_y$	= 107.5
$a_{x:y}$	= 9.4	$(Ia)_{x:y}$	= 72.2

Question 8

In what range is the present value of the annuity as of 1/1/90?

(A) Less than \$67,600

(B) \$67,600 but less than \$68,600

(C) \$68,600 but less than \$69,600

(D) \$69,600 but less than \$70,600

(E) \$70,600 or more

1990

Data for Question 9

Date of birth for Smith: 1/1/30.

Date of birth for Brown: 1/1/35.

Selected life expectancies:

x	e_x	$e_{x:60}$	$e_{x:61}$
54	22.786	14.580	14.164
55	21.989	14.330	13.931
56	21.203	14.068	13.687

Question 9

In what range is the probability as of 1/1/90 that the calendar year of death for Smith is later than the calendar year of death for Brown?

(A) Less than .18

(B) .18 but less than .25

(C) .25 but less than .32

(D) .32 but less than .39

(E) .39 or more

1990

Data for Question 10

As of 1/1/90, Smith (age x) and Brown (age y) are entitled to a joint and survivor annuity providing $100 at the beginning of each month during Smith's lifetime and $50 during Brown's lifetime after Smith dies.

Selected annuity values:

$\ddot{a}_x^{(12)} = 7.602$

$\ddot{a}_{x:\overline{10|}}^{(12)} = 6.044$

$\ddot{a}_y^{(12)} = 6.417$

$\ddot{a}_{y:\overline{10|}}^{(12)} = 5.497$

$\ddot{a}_{\overline{10|}}^{(12)} = 7.287$

$\ddot{a}_{x:y:\overline{10|}}^{(12)} = 4.701$

$\ddot{a}_{x:y}^{(12)} = 5.098$

Question 10

In what range is the additional amount needed as of 1/1/90 to provide for a 10-year guarantee of $100 per month?

(A) Less than $500

(B) $500 but less than $650

(C) $650 but less than $800

(D) $800 but less than $950

(E) $950 or more

1990

Data for Question 11

Sole deposit to a fund: $1,000 paid on 1/1/90.

There have been no withdrawals from the fund.

Interest rate for 1990 through 1993: 8% per year, compounded quarterly.

Discount rate for 1994 through 1998: 6% per year, compounded every 4 months.

Force of interest for 1999 through 2001: 5% per year.

Selected value:

$e = 2.71828$

Question 11

In what range is the value of the fund as of 1/1/2002?

(A) Less than $2,135

(B) $2,135 but less than $2,145

(C) $2,145 but less than $2,155

(D) $2,155 but less than $2,165

(E) $2,165 or more

1990

Data for Question 12

Date of loan: 1/1/90.

Date of first payment: 12/31/90.

Frequency of payments: Annual.

Number of payments: 10.

Amount of each payment: $10,000.

Interest rate: 6% per year, compounded annually.

The interest portion of each payment is invested in a separate account which earns 10% per year, compounded annually.

Question 12

In what range is the amount in the separate account as of 1/1/2000?

(A) Less than $45,000

(B) $45,000 but less than $50,000

(C) $50,000 but less than $55,000

(D) $55,000 but less than $60,000

(E) $60,000 or more

1990

Data for Question 13

Type of plan: Money purchase.

Employer contribution: Lesser of 25% of compensation or $30,000, payable on 12/31.

Actuarial assumptions:

Interest rate: 7% per year.
Compensation increases: 5% per year.
Preretirement deaths and terminations: None.
Retirement age: 65.

Data for sole participant:

Date of birth	1/1/45
Date of hire	1/1/90
1990 compensation	$50,000
Status as of 1/1/90	Active

Question 13

In what range is the accumulated value of employer contributions as of 1/1/2010?

(A) Less than $750,000

(B) $750,000 but less than $760,000

(C) $760,000 but less than $770,000

(D) $770,000 but less than $780,000

(E) $780,000 or more

1990

Data for Question 14

Smith, Brown, and Green retire effective 1/1/90. Each elects an annuity payable annually.

Participant data:

	Age on 1/1/90	Form of Annuity	Date of First Payment	Annual Payment
Smith	50	10 year temporary	1/1/90	$4,000
Brown	50	10 year temporary	12/31/90	4,000
Green	50	Life, deferred 10 years	1/1/2000	5,000

As of 1/1/90, the present value of Brown's annuity is $1,975 less than the present value of Smith's annuity.

Selected commutation functions:

x	N_x
59	77,505
60	70,493
61	63,973

Question 14

In what range is the present value of Green's annuity as of 1/1/90?

(A) Less than $25,000

(B) $25,000 but less than $26,000

(C) $26,000 but less than $27,000

(D) $27,000 but less than $28,000

(E) $28,000 or more

1990

Data for Question 15

Selected values:

$A_{60} = .2895$ $A_{61} = .3028$ $A_{60:\overline{1}|} = .9128$

Question 15

In what range is q_{60} ?

(A) Less than .014

(B) .014 but less than .016

(C) .016 but less than .018

(D) .018 but less than .020

(E) .020 or more

1990

Data for Question 16

Normal retirement benefit: $200 per month.

Form of payment: Joint and 100% survivor annuity.

Preretirement death benefit: None.

Actuarial assumptions:

Interest rate: 5% per year.
Preretirement terminations other than deaths: None.
Retirement age: 65.

Data for sole participant:

Date of birth	1/1/45
Beneficiary's date of birth	1/1/50
Status as of 1/1/90	Active

Selected annuity values and probabilities:

$\ddot{a}^{(12)}_{60} = 11.5$ $\ddot{a}^{(12)}_{65} = 10.0$

$\ddot{a}^{(12)}_{60:65} = 6.0$ $\ddot{a}^{(12)}_{65:65} = 5.5$

${}_{20}P_{40} = .89$ ${}_{20}P_{45} = .83$ ${}_{25}P_{40} = .82$

Question 16

In what range is the present value of the normal retirement benefit as of 1/1/90?

(A) Less than $10,400

(B) $10,400 but less than $11,200

(C) $11,200 but less than $12,000

(D) $12,000 but less than $12,800

(E) $12,800 or more

1990

Data for Question 17

Value of assets in trust fund:

1/1/90	$100,000
4/1/90	160,000
10/1/90	130,000
12/31/90	130,000

Contributions for 1990: $50,000 paid on 3/31/90.

Payments for 1990: $30,000 paid on 9/30/90.

Consider the following methods for determining the fund's rate of return:

I. Time-weighted method.

II. Uniform distribution throughout the year of all contributions and payments is assumed; simple interest is used.

III. Dollar-weighted method; simple interest is used.

Question 17

Which, if any, of the following rankings reflects the relative magnitude of the calculated rate of return under each method?

(A) I > II > III

(B) I > III > II

(C) II > I > III

(D) II > III > I

(E) The correct answer is not given by (A), (B), (C), or (D) above.

1990

Data for Question 18

Type of plan: Contributory.

Preretirement death benefit: Return of accumulated employee contributions with interest at 9% per year to date of death, payable on date of death.

Actuarial assumptions:

Interest rate: 9% per year.
Retirement age: 65.

Data for sole participant:

Date of birth	1/1/28
Date of hire	1/1/88
Status as of 1/1/90	Active

Accumulated employee contributions with interest as of 1/1/90: $1,500.

Selected commutation functions:

x	$D_x^{(T)}$	$\bar{C}_x^{(d)}$
62	13,445	220.7
63	12,139	223.3
64	10,943	224.4

Question 18

In what range is the present value as of 1/1/90 of the preretirement death benefit attributable to employee contributions paid before 1/1/90?

(A) Less than $75

(B) $75 but less than $78

(C) $78 but less than $81

(D) $81 but less than $84

(E) $84 or more

1990

Data for Question 19

Normal retirement benefit: $1,000 per month.

Normal form of payment: Monthly benefit for life with 50% continuing to the participant's surviving spouse for life.

Data for sole participant:

Date of birth	1/1/25
Date of retirement	1/1/90
Spouse's date of birth	1/1/27

Selected commutation functions:

x	D_x	N_x	$D_{x:x-2}$	$N_{x:x-2}$
61	139	1,380	135	1,170
63	116	1,115	109	920
65	97	893	88	713
67	80	708	68	545
73	44	323	38	201
75	34	240	30	148

Question 19

In what range is the present value of the normal retirement benefit as of 1/1/90?

(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

1990

Data for Question 20

A bond is issued each quarter commencing on 1/1/90 and ending on 10/1/99.

Provisions of each bond:

Face amount: $100,000.
Maturity value: $100,000.
Coupon rate: 10% per year, compounded monthly.
Coupon dates: End of each month.
Number of coupons: 360.

Yield to maturity: 12% per year, compounded annually.

Question 20

In what range is the present value as of 1/1/90 of all future coupon payments for the series of 40 bonds?

(A) Less than $2,000,000

(B) $2,000,000 but less than $2,040,000

(C) $2,040,000 but less than $2,080,000

(D) $2,080,000 but less than $2,120,000

(E) $2,120,000 or more

1990

Data for Question 21

Plan effective date: 1/1/90.

Contributions: $4,000 per year payable on 1/1 of each year.

Preretirement death benefit: Lump sum payable at the end of the year of death equal to accumulated contributions with interest at 6% per year to end of year of death.

Actuarial assumptions:

Interest rate: 6% per year.
Preretirement terminations other than deaths: None.
Retirement age: 65.

Date of birth for sole participant (active) as of 1/1/90: 1/1/50.

Selected commutation functions:

x	N_x
39	3,778,556
40	3,524,127
41	3,284,160
64	471,006
65	422,962
66	378,659

Question 21

In what range is the present value of the preretirement death benefit as of 1/1/90?

(A) Less than $7,500

(B) $7,500 but less than $7,900

(C) $7,900 but less than $8,300

(D) $8,300 but less than $8,700

(E) $8,700 or more

1990

Data for Question 22

Selected annuity values:

$\ddot{a}_{\overline{T}|} = 7.452 \qquad \ddot{a}_{\overline{T+1}|} = 7.950$

Question 22

In what range is $\ddot{s}_{\overline{25}|}$?

(A) Less than 59

(B) 59 but less than 64

(C) 64 but less than 69

(D) 69 but less than 74

(E) 74 or more

1990

Data for Question 23

Original provisions of loan:

Amount of loan: $100,000.
Date of loan: 1/1/90.
Date of first payment: 12/31/90.
Frequency of payments: Annually.
Number of payments: 30.
Interest rate: 10% per year, compounded semiannually.

On 1/1/94, an additional $5,000 repayment is made.

The loan is renegotiated on 1/1/95.

Renegotiated provisions of loan:

Amount of loan: Outstanding balance of original loan as of 1/1/95.
Date of first payment: 12/31/95.
Frequency of payments: Annually.
Number of payments: 30.
Interest rate: 8% per year, compounded semi-annually.

Question 23

In what range is the outstanding balance of the loan as of 1/1/2020?

(A) Less than $32,300

(B) $32,300 but less than $32,700

(C) $32,700 but less than $33,100

(D) $33,100 but less than $33,500

(E) $33,500 or more

1990

Data for Question 24

Smith's age on 1/1/90: 60.

Brown's age on 1/1/90: 65.

Selected probability values:

x	y	$(y - x)P_x$
60	70	.730
60	75	.540
65	75	.706
65	80	.508
70	75	.740
75	80	.720

Question 24

In what range is the probability as of 1/1/90 that Smith and Brown will both survive 10 years but that at least one of them will not survive 15 years?

(A) Less than .23

(B) .23 but less than .28

(C) .28 but less than .33

(D) .33 but less than .38

(E) .38 or more

1990

Data for Question 25

Type of plan: Defined benefit pension plan funded partially with whole life insurance policies.

The cash value at age 65 and later is equal to the full net level premium reserve. The cash value prior to age 65 is equal to the net level premium reserve minus an amount equal to the amortization of an expense charge from issue to age 65 (using interest and mortality).

Net level premium per $1,000 of face amount at issue: $16.61529

Cash value at age 60: $423.19

Selected commutation functions:

x	D_x	N_x	$1000A_x$
60	1,293,434	16,084,767	637.79502
62	1,165,483	13,562,294	661.06886
65	979,881	10,253,150	695.23305

Question 25

In what range is the cash value at age 62 per $1,000 of face amount?

(A) Less than $458.00

(B) $458.00 but less than $462.60

(C) $462.60 but less than $467.20

(D) $467.20 but less than $471.80

(E) $471.80 or more

ANSWER KEY

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

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

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

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

21. E
22. D
23. B
24. B
25. C