

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 1993 examination which has been released to
the public by the administering organizations.

93
SPRING
EA-1A

**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.

1993

Data for Question 1

Effective date of an annuity certain: 1/1/93.

Date of first payment: 1/1/93.

Frequency of payments: Annual.

Amount of each payment: \$50,000.

Number of payments: 20.

Effective date of a perpetuity: 1/1/93.

Date of first payment: 1/1/93.

Frequency of payments: Monthly.

Amount of each payment: \$X.

Interest rate: 8% per year, compounded semiannually.

The perpetuity is actuarially equivalent to the annuity certain.

Question 1

In what range is \$X?

- [A] Less than \$3,380
- [B] \$3,380 but less than \$3,430
- [C] \$3,430 but less than \$3,480
- [D] \$3,480 but less than \$3,530
- [E] \$3,530 or more

1993

Data for Question 2

Date of a loan: 1/1/93.

Amount of loan: \$100,000.

Date of first payment: 6/30/93.

Frequency of payments: Semiannual.

Number of payments: 60.

Interest rate: 8% per year, compounded quarterly.

After the first calendar year, payments for each calendar year are 3% higher than payments for the preceding calendar year. Both payments within each calendar year are the same.

Question 2

In what range is the final payment due on 12/31/2022?

- (A) Less than \$7,700
- (B) \$7,700 but less than \$7,800
- (C) \$7,800 but less than \$7,900
- (D) \$7,900 but less than \$8,000
- (E) \$8,000 or more

1993

Data for Question 3

Selected absolute rates of decrement from a table with three decrements [1,2,3]:

$$q_x^{[1]} = 0.20$$

$$q_x^{[2]} = 0.20$$

$$q_x^{[3]} = 0.40$$

Question 3

In what range is $q_x^{[T]}$?

- [A] Less than 0.625
- [B] 0.625 but less than 0.685
- [C] 0.685 but less than 0.745
- [D] 0.745 but less than 0.805
- [E] 0.805 or more

1993

Data for Question 4

Interest rate: 7% per year, compounded annually.

Selected commutation functions:

<u>x</u>	<u>D_x</u>
65	950
66	880

Question 4

In what range is $a_{65:65:\overline{1}|}$?

- [A] Less than .915
- [B] .915 but less than .920
- [C] .920 but less than .925
- [D] .925 but less than .930
- [E] .930 or more

1993

Data for Question 5

Face amount of a bond: \$100,000.

Date of purchase: 1/1/87.

Date of first coupon payment: 1/31/87.

Frequency of coupon payments: Monthly.

Date of maturity: 12/31/2004.

Coupon rate: 12% per year, compounded monthly.

The bond was purchased to yield 9% per year, compounded monthly, to maturity. On 1/1/93, the bond was sold at a price which would yield the buyer 15% per year, compounded monthly, to maturity.

Question 5

In what range is the loss, based on amortized value, incurred by the seller?

- [A] Less than \$36,000
- [B] \$36,000 but less than \$38,000
- [C] \$38,000 but less than \$40,000
- [D] \$40,000 but less than \$42,000
- [E] \$42,000 or more

1993

Data for Question 6

Date of a loan: 1/1/91.

Amount of loan: \$5,000.

Date of first payment: 12/31/91.

Frequency of payments: Annual.

Number of payments: 5.

Interest rate: 10% per year, compounded annually.

As of 12/31/92, the borrower paid the outstanding balance of the loan plus a prepayment penalty of \$225.

Question 6

In what range is the effective annual yield to the lender?

- (A) Less than 11.50%
- (B) 11.50% but less than 11.75%
- (C) 11.75% but less than 12.00%
- (D) 12.00% but less than 12.25%
- (E) 12.25% or more

1993 ...

Data for Question 7

Interest rate: 6% per year, compounded annually.

Selected commutation functions:

<u>x</u>	<u>S_x</u>
27	4,582,339
28	4,264,046
29	3,965,539
30	3,685,672
31	3,423,366

Question 7

In what range is A_{28} ?

- [A] Less than .085
- [B] .085 but less than .090
- [C] .090 but less than .095
- [D] .095 but less than .100
- [E] .100 or more

1993...

Data for Question 8

Form of annuity payable to Smith: Level annual payments for life, payable at the end of each year commencing 12/31/93.

Date of purchase: 1/1/93.

Net single premium: \$10,000.

Interest rate: 6% per year, compounded annually.

Date of birth for Smith: 1/1/33.

Selected commutation functions:

<u>x</u>	<u>N_x</u>	<u>x</u>	<u>N_x</u>
59	30,329	65	16,891
60	27,665	66	15,184
61	25,182	67	13,608
62	22,873	68	12,156
63	20,727	69	10,821
64	18,736	70	9,597

Question 8

In what range is the probability as of 1/1/93 that Smith will receive total annuity payments of at least \$5,500?

- [A] Less than .875
- [B] .875 but less than .885
- [C] .885 but less than .895
- [D] .895 but less than .905
- [E] .905 or more

1993

Data for Question 9

Interest rate: 7% per year, compounded annually.

Selected probabilities:

$${}_n p_{65} = .90 - .02 \times [n - 1], \text{ for } 1 \leq n \leq 45$$

$${}_n p_{65} = 0, \text{ for } n > 45$$

Question 9

In what range is \ddot{a}_{65} ?

- [A] Less than 9.0
- [B] 9.0 but less than 9.3
- [C] 9.3 but less than 9.6
- [D] 9.6 but less than 9.9
- [E] 9.9 or more

1993

Data for Question 10

Annuity for participant Smith: Level monthly payments of \$K for life, payable at the end of each month commencing 1/31/93.

Annuity for participant Brown: Level monthly payments of \$800 for five years as long as Brown remains alive, payable at the end of each month commencing 1/31/93.

Smith's age as of 1/1/93: 62.

Brown's age as of 1/1/93: 45.

As of 1/1/93, the present value of Brown's annuity is equal to 75% of the present value of Smith's annuity.

Selected commutation functions:

<u>x</u>	<u>N_x</u>	<u>x</u>	<u>N_x</u>	<u>x</u>	<u>N_x</u>
45	5,691	50	3,752	62	1,206
46	5,245	51	3,442	63	1,084

Question 10

In what range is \$K?

- [A] Less than \$470
- [B] \$470 but less than \$480
- [C] \$480 but less than \$490
- [D] \$490 but less than \$500
- [E] \$500 or more

1993

Data for Question 11

Terms of a whole life insurance policy:

Issue date: 1/1/93.

Death benefit: \$1,000.

Date of first premium: 1/1/93.

Frequency of premiums: Annual.

Interest rate: 7% per year, compounded annually.

Age of insured at issue: 40.

Selected values:

$$q_{40} = 0.0021 \quad q_{41} = 0.0023 \quad \ddot{a}_{40} = 13.37$$

Question 11

In what range is the net level premium reserve for the policy at the end of the second year?

- [A] Less than \$15
- [B] \$15 but less than \$16
- [C] \$16 but less than \$17
- [D] \$17 but less than \$18
- [E] \$18 or more

1993

Data for Question 12

The following actuarially equivalent annuities are available to a participant at retirement:

Annuity A: Monthly payments of \$1,000 for life.

Annuity B: Monthly payments of \$750 for life, with monthly payments of \$500 continuing for the life of the surviving spouse.

Annuity C: Monthly payments of \$K for life, with monthly payments of \$.75K continuing for the life of the surviving spouse.

Question 12

In what range is \$K?

- [A] Less than \$710
- [B] \$710 but less than \$720
- [C] \$720 but less than \$730
- [D] \$730 but less than \$740
- [E] \$740 or more

1993

Data for Question 13

Terms of a deferred annuity contract:

Monthly benefit: \$300.

Benefit commencement age: 65.

Death benefit prior to age 65: None.

Form of annuity: Life annuity with 10 years certain.

Annual premium payment date: 1/1.

Number of annual premiums: 10.

Interest rate: 7% per year, compounded annually.

Age of annuitant at issue: 55.

Selected commutation functions:

<u>x</u>	<u>D_x</u>	<u>N_x</u>
55	227	2547
65	100	919
75	36	247

Question 13

In what range is the net annual premium?

- [A] Less than \$2,095
- [B] \$2,095 but less than \$2,105
- [C] \$2,105 but less than \$2,115
- [D] \$2,115 but less than \$2,125
- [E] \$2,125 or more

1993

Data for Question 14

Selected values:

$$A_{\overline{30:30}|} = 0.2$$

$$A_{30} = 0.1$$

$$A_{60} = 0.4$$

Question 14

In what range is $A_{\overline{30:30}|}^1$?

- [A] Less than 0.02
- [B] 0.02 but less than 0.04
- [C] 0.04 but less than 0.06
- [D] 0.06 but less than 0.08
- [E] 0.08 or more

1993

Data for Question 15

Date of a loan: 1/1/93.

Date of first payment: 1/31/93.

Frequency of payments: Monthly.

Number of payments: 36.

Interest rate: 12% per year, compounded monthly.

Total principal repaid in 1993: \$3,000.

Question 15

In what range is the amount of the loan?

- [A] Less than \$9,950
- [B] \$9,950 but less than \$10,050
- [C] \$10,050 but less than \$10,150
- [D] \$10,150 but less than \$10,250
- [E] \$10,250 or more

1993

Data for Question 16

Terms of an annuity policy:

Issue date: 1/1/93.

Annual benefit: \$12,000.

Date of first payment: 12/31/93.

Frequency of payments: Annual.

Form of payment: Life annuity.

Net single premium: \$134,400.

Interest rate: 7% per year, compounded annually.

Age of annuitant as of 1/1/93: 50.

On 1/1/94, a \$100,000 whole life insurance policy based on the same interest rate and mortality table is issued to the annuitant.

Selected mortality rate:

$$q_{50} = 0.01$$

Question 16

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

- [A] Less than \$19,750
- [B] \$19,750 but less than \$20,250
- [C] \$20,250 but less than \$20,750
- [D] \$20,750 but less than \$21,250
- [E] \$21,250 or more

1993

Data for Question 17

The following actuarially equivalent annuities are available to an individual age 60 on 1/1/93:

Annuity A:

Annuity commencement date: 1/1/93.
 Frequency of payments: Annual.
 Initial payment: \$5,000.
 Subsequent payments: Increasing 7% per year, compounded annually.
 Payment date: 1/1.
 Form of payment: Life annuity.

Annuity B:

Annuity commencement date: 1/1/98.
 Frequency of payments: Annual.
 Initial payment: \$K.
 Subsequent payments: Increasing 7% per year, compounded annually.
 Payment date: 1/1.
 Form of payment: Life annuity.
 Death benefit prior to age 65: None.

Interest rate: 7% per year, compounded annually.

Selected commutation functions and life expectancies:

\underline{x}	$\underline{N_x}$	$\underline{e_x}$	\underline{x}	$\underline{N_x}$	$\underline{e_x}$
60	1484	15.5	65	868	12.9
61	1339		66	774	

Question 17

In what range is \$K?

- [A] Less than \$9,000
- [B] \$9,000 but less than \$9,100
- [C] \$9,100 but less than \$9,200
- [D] \$9,200 but less than \$9,300
- [E] \$9,300 or more

1993

Data for Question 18

Prior to 1/1/70, a stationary population of 600,000 was maintained by 12,500 births each year. 35% of the total population was under age 20.

On 1/1/70, the annual birth rate increased to 13,000 and remained constant at that level thereafter. The mortality rates at all ages were unchanged.

Question 18

In what range was the total population as of 1/1/90?

- (A) Less than 605,000
- (B) 605,000 but less than 607,000
- (C) 607,000 but less than 609,000
- (D) 609,000 but less than 611,000
- (E) 611,000 or more

1993

Data for Question 19

Terms of an annuity payable to three lives, ages x , y , and z :

Issue date: 1/1/93.

Date of first payment: 12/31/93.

Frequency of payments: Annual.

Total annual payment if there are exactly three survivors: \$4,000.

Total annual payment if there are exactly two survivors: \$6,000.

Annual payment if there is exactly one survivor: \$12,000.

Selected annuity values:

$$\begin{array}{lll} a_x = 13.18 & a_{xy} = 12.16 & a_{xyz} = 11.06 \\ a_y = 12.83 & a_{xz} = 11.78 & \\ a_z = 12.37 & a_{yz} = 11.53 & \end{array}$$

Question 19

In what range is the total present value as of 1/1/93 of all payments that are expected to be paid while the life age x survives?

- (A) Less than \$58,500
- (B) \$58,500 but less than \$63,500
- (C) \$63,500 but less than \$68,500
- (D) \$68,500 but less than \$73,500
- (E) \$73,500 or more

1993

Data for Question 20

Selected probabilities of decrement from a two-decrement table:

<u>x</u>	<u>$q_x^{[d]}$</u>	<u>$q_x^{[w]}$</u>
20	.001311	.05
21	.001267	.05
22	.001219	.05

All rates of decrement are calculated using standard approximations.

Question 20

In what range is ${}_2p_{20}'^{[d]}$?

- [A] Less than 0.99728
- [B] 0.99728 but less than 0.99733
- [C] 0.99733 but less than 0.99738
- [D] 0.99738 but less than 0.99743
- [E] 0.99743 or more

1993 . . .

Data for Question 21

Date of a loan: 1/1/87.

Date of first payment: 12/31/87.

Frequency of payments: Annual.

Annual payment: \$5,000.

Number of payments: 30.

On 1/1/93, the loan was renegotiated, and the borrower received an additional \$15,000 on 1/1/93. The outstanding balance of the original loan and the additional \$15,000 will be repaid by 18 level annual installments, with the first payment due 12/31/93.

Interest rate for both loans: 7% per year, compounded annually.

Question 21

In what range is the amount of interest included in the 12/31/94 payment?

- [A] Less than \$4,890
- [B] \$4,890 but less than \$4,970
- [C] \$4,970 but less than \$5,050
- [D] \$5,050 but less than \$5,130
- [E] \$5,130 or more

1993

Data for Question 22

Interest rate: 8% per year, compounded annually.

Selected values:

<u>x</u>	<u>l_x</u>
108	200
109	100
110	0

$$q_{107} = .30$$

Question 22

In what range is A_{107} ?

- [A] Less than 0.850
- [B] 0.850 but less than 0.880
- [C] 0.880 but less than 0.910
- [D] 0.910 but less than 0.940
- [E] 0.940 or more

1993

Data for Question 23

Terms of a whole life insurance policy:

Issue date: 1/1/93.

Death benefit: \$12,000, payable at the end of the year of death.

Date of first premium: 1/1/93.

Frequency of premiums: Monthly.

Interest rate: 7% per year, compounded annually.

Age of insured at issue: 50.

Selected commutation functions:

$$D_{50} = 310,647 \quad N_{50} = 3,752,218$$

Question 23

In what range is the net monthly premium?

- [A] Less than \$11.90
- [B] \$11.90 but less than \$13.90
- [C] \$13.90 but less than \$15.90
- [D] \$15.90 but less than \$17.90
- [E] \$17.90 or more

1993

Data for Question 24

Terms of a perpetuity:

Issue date: 1/1/93.

Date of first payment: 12/31/93.

Frequency of payments: Annual.

Amount of first payment: \$500.

Increase in subsequent payments: 5% per year, compounded annually.

Interest rate: 8% per year, compounded annually.

Question 24

In what range is the present value of the perpetuity as of 1/1/93?

- [A] Less than \$14,000
- [B] \$14,000 but less than \$15,000
- [C] \$15,000 but less than \$16,000
- [D] \$16,000 but less than \$17,000
- [E] \$17,000 or more

1993

Data for Question 25

Date of a loan: 1/1/93.

Date of first payment: 12/31/93.

Initial annual payment: \$1,500.

Frequency of payments: Annual.

Number of payments: 20.

Interest rate: 7% per year, compounded annually.

The loan is renegotiated immediately before the 12/31/2007 payment is made. All terms of the loan remain the same, except that the 12/31/2007 payment is \$K, with each subsequent payment 5% higher than the preceding payment.

Question 25

In what range is the payment due on 12/31/2012?

- [A] Less than \$1,650
- [B] \$1,650 but less than \$1,700
- [C] \$1,700 but less than \$1,750
- [D] \$1,750 but less than \$1,800
- [E] \$1,800 or more

ANSWER KEY

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1. B
2. C
3. A
4. B
5. C
6. E
7. C
8. D
9. E
10. B
11. C
12. C
13. D
14. B
15. D
16. D
17. C
18. C
19. B
20. C
21. B
22. B
23. E
24. D
25. C