

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 1994 examination which has been released to  
the public by the administering organizations.

SPRING 1994  
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.

Data for Question 1

Price of a bond: 90% of face amount.

Date of purchase: 1/1/94.

Term of the bond: 15 years.

Date of first coupon payment: 12/31/94.

Frequency of coupon payments: Annual.

Yield to maturity: 6% per year, compounded annually.

Question 1

In what range is the annual coupon rate?

- [A] Less than 4.70%
- [B] 4.70% but less than 4.80%
- [C] 4.80% but less than 4.90%
- [D] 4.90% but less than 5.00%
- [E] 5.00% or more

1994

Data for Question 2

Interest rate:  $i\%$  per year, compounded annually.

Selected commutation functions:

$$R_x = 69,651,728$$

$$S_x = 6,765,983,984$$

$$S_{x+1} = 6,313,352,030$$

Question 2

In what range is  $i\%$ ?

- [A] Less than 5.51%
- [B] 5.51% but less than 5.76%
- [C] 5.76% but less than 6.01%
- [D] 6.01% but less than 6.26%
- [E] 6.26% or more

1994

Data for Question 3

Retirees A and B are both exactly age 90 on 1/1/94.

P is the probability as of 1/1/94 that A will die before 1/1/96, B will die before 1/1/97, and A will die before B.

Selected values:

<u>x</u>	<u><math>q_x</math></u>
90	0.18
91	0.20
92	0.22

Question 3

In what range is P?

- [A] Less than 0.10
- [B] 0.10 but less than 0.12
- [C] 0.12 but less than 0.14
- [D] 0.14 but less than 0.16
- [E] 0.16 or more

Data for Question 4

As of 1/1/94, the present value of an increasing perpetuity with annual payments of \$1, \$3, \$5, \$7, . . . payable each 1/1 commencing 1/1/94 is 25 times the present value of a level perpetuity with annual payments of \$1 payable each 1/1 commencing 1/1/94.

Question 4

In what range is the effective annual rate of interest?

- [A] Less than 7%
- [B] 7% but less than 8%
- [C] 8% but less than 9%
- [D] 9% but less than 10%
- [E] 10% or more

1994

Data for Question 5

Date of a loan: 1/1/94.

Amount of loan: \$1,000.

Payment option 1: Level payments of \$96.34 each 12/31 for A + B years.

Payment option 2: Level payments of \$129.51 each 12/31 for B years.

Payment option 3: Level payments of \$P each 12/31 for A years,  
followed by level payments of \$2P each 12/31 for B  
years.

Selected value:

$$i \times a_{\overline{A}|} \times a_{\overline{B}|} = 1.67$$

Question 5

In what range is \$P?

- [A] Less than \$50
- [B] \$50 but less than \$58
- [C] \$58 but less than \$66
- [D] \$66 but less than \$74
- [E] \$74 or more

Data for Question 6

$q_x^{(T)}$  is the probability that an employee age  $x$  will withdraw from service or die in service between ages  $x$  and  $x+1$ .

$q'_x{}^{(d)}$  is the absolute rate of death in service for an employee age  $x$ .

$q_x^{(w)}$  is the probability that an employee age  $x$  will withdraw from service between ages  $x$  and  $x+1$ .

Selected values:

$$q_x^{(T)} = .300 \quad q'_x{}^{(d)} = .022$$

Question 6

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

- [A] Less than .274
- [B] .274 but less than .277
- [C] .277 but less than .280
- [D] .280 but less than .283
- [E] .283 or more



1994

Data for Question 7

Selected values:

$$l_x = A - B \cdot x \quad l_{100} = 0$$

Question 7

In what range is the complete expectation of life at age 50?

- [A] Less than 18.6
- [B] 18.6 but less than 20.6
- [C] 20.6 but less than 22.6
- [D] 22.6 but less than 24.6
- [E] 24.6 or more

1994

Data for Question 8

Interest rate: 7% per year, compounded annually.

Selected values:

$$a_{45:\overline{20}|} = 10.84$$

$$q_{63} = 0.0187$$

Question 8

In what range is  ${}_{18}V_{45:\overline{20}|}$  ?

- [A] Less than 0.820
- [B] 0.820 but less than 0.830
- [C] 0.830 but less than 0.840
- [D] 0.840 but less than 0.850
- [E] 0.850 or more

1994

Data for Question 9

\$1,000,000 is deposited on 1/1/94 to provide the following annuity:

A payment each 12/31 from 12/31/94 through 12/31/2023 which will increase by 4% annually,

plus

a payment on 12/31/2023 equal to \$1,000,000 accumulated from 1/1/94 at 2% per year, compounded annually.

Interest rate: 10% per year, compounded semiannually.

Question 9

In what range is the total payment due on 12/31/2023?

- [A] Less than \$2,000,000
- [B] \$2,000,000 but less than \$2,010,000
- [C] \$2,010,000 but less than \$2,020,000
- [D] \$2,020,000 but less than \$2,030,000
- [E] \$2,030,000 or more

1994

Data for Question 10

Type of insurance policy: Whole life, with benefit payable at end of year of death.

Date of issue: 1/1/94.

Premium options:

Annual premiums payable each 1/1.

Quarterly premiums payable each 1/1, 4/1, 7/1, and 10/1.

Age of policyholder at issue:  $x$ .

Selected values:

$$A_x = 0.7 \quad a_x = 5$$

Question 10

In what range is the additional annual cost per \$1,000 of life insurance for the policyholder to pay quarterly premiums instead of annual premiums?

- [A] Less than \$10.00
- [B] \$10.00 but less than \$11.00
- [C] \$11.00 but less than \$12.00
- [D] \$12.00 but less than \$13.00
- [E] \$13.00 or more

1994

Data for Question 11

Value of assets in a trust fund:

As of 01/01/94: \$100,000.  
As of 04/01/94: \$150,000.  
As of 07/01/94: \$120,000.  
As of 10/01/94: \$200,000.  
As of 12/31/94: \$200,000.

Contributions in 1994:

\$10,000 paid on 3/31/94.  
\$30,000 paid on 6/30/94.  
\$50,000 paid on 9/30/94.

Payments in 1994:

\$10,000 paid on 3/31/94.  
\$10,000 paid on 6/30/94.  
\$10,000 paid on 9/30/94.

Question 11

In what range is the absolute value of the difference between the time-weighted rate of return on assets and the dollar-weighted rate of return on assets in 1994?

- [A] Less than 2%
- [B] 2% but less than 4%
- [C] 4% but less than 6%
- [D] 6% but less than 8%
- [E] 8% or more

1994

Data for Question 12

Selected commutation functions:

<u>x</u>	<u>D<sub>x</sub></u>	<u>M<sub>x</sub></u>
64	1,056,232	716,531
65	995,688	686,751

Question 12In what range is  $q_{64}$ ?

- [A] Less than .0270
- [B] .0270 but less than .0276
- [C] .0276 but less than .0282
- [D] .0282 but less than .0288
- [E] .0288 or more

1994

Data for Question 13

Actuarially equivalent optional annuities:

Annuity A: \$10,000 payable each 1/1 for 10 years certain.

Annuity B: \$7,600 payable each 1/1 for life with 10 years certain.

Annuity C: \$P payable each 1/1 for 10 years certain; after the certain period, 110% of \$P payable each 1/1 for life.

Question 13

In what range is \$P?

- [A] Less than \$7,000
- [B] \$7,000 but less than \$7,150
- [C] \$7,150 but less than \$7,300
- [D] \$7,300 but less than \$7,450
- [E] \$7,450 or more

1994

Data for Question 14

Date of a loan: 1/1/94.

Amount of loan: \$100,000.

Frequency of payments: Monthly.

Date of first payment: 1/31/94.

Amount of each payment: \$1,000.

Interest rate: 6% per year, compounded monthly.

On 1/1/95, the loan is renegotiated. The interest rate remains the same, but the term of the loan is lengthened so that it is fully paid off in 30 years from 1/1/94.

Question 14

In what range is the reduction in the monthly payment due to the renegotiation of the loan?

- [A] Less than \$435
- [B] \$435 but less than \$465
- [C] \$465 but less than \$495
- [D] \$495 but less than \$525
- [E] \$525 or more



1994

Data for Question 15

Terms of an annuity:

\$10,000 payable each 1/1 as long as Smith is alive, plus  
\$6,000 payable each 1/1 as long as Brown is alive, plus  
\$3,000 payable each 1/1 as long as Green is alive but not beyond  
attainment of age 18.

Maximum annual payment: \$12,500.

Ages of annuitants as of 1/1/94:

Smith	45
Brown	35
Green	10

Selected annuity values:

$\ddot{a}_{45} = 15$	$\ddot{a}_{45:35} = 12$	$\ddot{a}_{35:10:\overline{8} } = 6.5$
$\ddot{a}_{35} = 20$	$\ddot{a}_{10:\overline{8} } = 7$	$\ddot{a}_{45:10:\overline{8} } = 6$
		$\ddot{a}_{45:35:10:\overline{8} } = 5$

Question 15

In what range is the present value of the annuity as of 1/1/94?

- [A] Less than \$200,000
- [B] \$200,000 but less than \$210,000
- [C] \$210,000 but less than \$220,000
- [D] \$220,000 but less than \$230,000
- [E] \$230,000 or more

1994

Data for Question 16

An account is established for Smith on 1/1/94.

Monthly normal retirement benefit: Account balance at age 65 divided by 200.

Deposits to account: 10% of compensation.

Frequency of deposits: Monthly, at end of month.

Interest credit: From date of deposit.

Actuarial assumptions:

Interest rate: 7% per year, compounded annually.

Compensation increases: 5% per year, each 1/1.

Preretirement deaths and terminations: None.

Retirement age: 65.

Data for Smith:

Date of birth	1/1/44
Date of hire	1/1/94
1994 compensation	\$60,000

Question 16

In what range is Smith's projected monthly normal retirement benefit?

- [A] Less than \$1,050
- [B] \$1,050 but less than \$1,055
- [C] \$1,055 but less than \$1,060
- [D] \$1,060 but less than \$1,065
- [E] \$1,065 or more

1994

Data for Question 17

Type of policy: Whole life, with benefit payable at end of year of death.

Face amount of policy: \$F.

Net level annual premium per \$1,000 of face amount: \$17.37.

Net level premium reserve for the policy at age 58: \$127.84.

Interest rate: 7% per year, compounded annually.

Selected commutation functions:

$x$	$N_x$	$D_x$
58	1,809,565	169,509
62	1,206,064	122,414

Question 17

In what range is the net level premium reserve for the policy at age 62?

- [A] Less than \$183
- [B] \$183 but less than \$189
- [C] \$189 but less than \$195
- [D] \$195 but less than \$201
- [E] \$201 or more

1994

Data for Question 18

$N$  is the number of members in a stationary population attaining age 55 or age 56 in a calendar year who will die before attaining age 57.

Selected values:

$l_{55}$	=	100,000
$e_{55}$	=	22.245
$e_{56}$	=	21.447
$e_{57}$	=	20.661

Question 18

In what range is  $N$ ?

- [A] Less than 1,600
- [B] 1,600 but less than 2,200
- [C] 2,200 but less than 2,800
- [D] 2,800 but less than 3,400
- [E] 3,400 or more

1994

Data of Question 19

Terms of an annuity purchased on three lives ages  $x$ ,  $y$ , and  $z$ :

Issue date: 1/1/94.

Date of first payment: 12/31/94.

Frequency of payments: Annual.

Interest rate: 7% per year, compounded annually.

Annual payment if all three are alive: \$150.

Annual payment if exactly two are alive: \$120.

Annual payment if exactly one is alive: \$100.

Annual payment in perpetuity if none is alive: \$50.

Selected annuity values:

$$a_x + a_y + a_z = 38$$

$$a_{xy} + a_{xz} + a_{yz} = 35$$

$$a_{xyz} = 11$$

Question 19

In what range is the present value of the annuity as of 1/1/94?

- [A] Less than \$1,850
- [B] \$1,850 but less than \$1,950
- [C] \$1,950 but less than \$2,050
- [D] \$2,050 but less than \$2,150
- [E] \$2,150 or more

1994

Data for Question 20

Date of a loan: 1/1/94.

Frequency of payments: Monthly.

Date of first payment: 1/31/94.

Amount of each payment: \$1,500.

Number of payments: 360.

Interest rate: 6% per year, compounded monthly.

On 12/31/96, an additional \$10,000 is paid along with the regular \$1,500 payment. Monthly payments of \$1,500 will continue to be paid thereafter until the loan is fully amortized.

Question 20

In what range is the total interest saved as a result of making the additional payment on 12/31/96?

- [A] Less than \$30,000
- [B] \$30,000 but less than \$36,000
- [C] \$36,000 but less than \$42,000
- [D] \$42,000 but less than \$48,000
- [E] \$48,000 or more

1994

Data for Question 21

Selected values from a three-decrement table:

$$q_x^{(a)} = .020$$

$$q_x^{(b)} = .070$$

$$q_x^{(c)} = .060$$

$q'_x$  is the absolute rate of decrement at age  $x$ .

Question 21

In what range is  $q'_x$ ?

- [A] Less than .0715
- [B] .0715 but less than .0725
- [C] .0725 but less than .0735
- [D] .0735 but less than .0745
- [E] .0745 or more

1994

Data for Question 22

Present value of an increasing monthly perpetuity as of 1/1/94: \$320,000.

Payments: \$10 commencing 1/1/94, increasing by \$10 each month thereafter.

Interest rate:  $X\%$  per year, compounded annually ( $X$  is greater than zero).

Question 22

In what range is  $X\%$ ?

- [A] Less than 6.70%
- [B] 6.70% but less than 6.80%
- [C] 6.80% but less than 6.90%
- [D] 6.90% but less than 7.00%
- [E] 7.00% or more



1994

Data for Question 23

Type of policy: Increasing whole life.

Date of issue: 1/1/94.

Age of insured at issue: 65.

Death benefit: \$100,000, increasing by \$25,000 each 1/1 to a maximum of \$200,000, payable on 12/31 of the year of death.

Level premiums are payable each 1/1 commencing 1/1/94.

Interest rate: 6% per year, compounded annually.

Selected commutation functions:

<u>x</u>	<u><math>R_x</math></u>	<u><math>S_x</math></u>
65	9,523,140	139,445,171
66	8,732,440	
67	7,979,554	
68	7,265,066	
69	6,589,295	
70	5,952,189	

Question 23

In what range is the net annual premium?

- [A] Less than \$8,475
- [B] \$8,475 but less than \$8,500
- [C] \$8,500 but less than \$8,525
- [D] \$8,525 but less than \$8,550
- [E] \$8,550 or more

1994

Data for Question 24

Normal retirement benefit: \$1,000 payable each 1/1, increasing by 3% each 1/1.

Early retirement eligibility: Age 55.

Early retirement benefit: \$P payable each 1/1, increasing by 3% each 1/1; actuarially equivalent to normal retirement benefit.

Interest rate: 7% per year, compounded annually.

$$j\% = .04 / 1.03.$$

Selected commutation functions:

x	7%		j%	
	$D_x$	$N_x$	$D_x$	$N_x$
60	144,405	1,483,517	850,777	11,170,538
65	94,414	868,052	644,844	7,339,325

Smith retires on 1/1/94 at age 60.

Question 24

In what range is the early retirement benefit payable to Smith on 1/1/94?

- [A] Less than \$565
- [B] \$565 but less than \$605
- [C] \$605 but less than \$645
- [D] \$645 but less than \$685
- [E] \$685 or more

1994

Data for Question 25

Date of a loan: 1/1/93.

Frequency of payments: Annual.

Date of first payment: 12/31/93.

Number of payments: 3.

Interest rate: 7% per year in 1993.

Each 1/1 after 1993, the interest rate is reestablished, and the payment schedule for the outstanding balance of the loan is revised.

Interest paid on 12/31/93: \$14,700.

Interest paid on 12/31/94: \$8,681.

Final payment: \$81,600.

Question 25

In what range is the amount of interest paid on 12/31/95?

- [A] Less than \$3,000
- [B] \$3,000 but less than \$4,500
- [C] \$4,500 but less than \$6,000
- [D] \$6,000 but less than \$7,500
- [E] \$7,500 or more

ANSWER KEY

MAY 1994 COURSE 141 (EA-1) SEGMENT A

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