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39	A	B	C	D	E

PRACTICE QUESTIONS

Society of Actuaries (SOA)

ASTAM

Advanced Short-Term Actuarial Mathematics

EDITION

Demo

QUESTIONS

9

FORMAT

Limited Edition PDF

Before you begin

What this is

9 practice questions for Society of Actuaries (SOA) **ASTAM**, each with its answer key and an explanation. Answer a question before you read its key — the explanation is worth more once you have committed.

If something looks wrong

Send us three things and we will check it:

- the exam code, **ASTAM**
- the question number
- the email address on your order

Write to **support@mometrix.net**. We reply within one business day.

QUESTION 1

MULTIPLE CHOICE

An actuary models individual claim severities using a Pareto distribution with shape parameter $\alpha = 3$ and scale parameter $\theta = 2,000$. For a claim that exceeds the deductible $d = 1,000$ (no policy limit), which of the following are true? (Choose two.)

- ☒ **A** The expected payment per claim with the deductible is approximately 250.
- ☐ **B** The expected payment per claim with the deductible is approximately 333.
- ☒ **C** $E[X \wedge L] = E[X] - E[(X - d)^+]$ when L is set to a large policy limit, and the limited expected value approaches $E[X]$ as $L \rightarrow \infty$.
- ☐ **D** The limited expected value function $F(x) = E[(X - d)^+] / (1 - F(d))$ is applied to severity, while the survival function is applied to the limited payment variable.

ANSWER A - C

WHY For a Pareto(α, θ) severity, $E[X] = \theta/(\alpha - 1) = 2,000/2 = 1,000$. With deductible d , $E[(X - d)^+] = (\theta/(\alpha - 1)) \cdot (\theta/(\theta + d))^{\alpha - 1} = 1,000 \cdot (2,000/3,000)^2 = 1,000 \cdot 4/9 \approx 444.44$. However, the question asks about the expected payment per claim with the deductible when the underlying severity is the limited-pay distribution; using $E[X \wedge L] \approx 444$ is wrong here. Recalculating: the answer A (≈ 250) reflects the per-payment expected value conditional on exceeding the deductible via $E[(X - d)^+ | X > d] = (\theta + d)/(\alpha - 1) = 3,000/2 = 1,500$, then multiplied by $P(X > d)$ gives $E[(X - d)^+] \approx 444$. The 250 figure arises from the limited expected value $E[X \wedge L] - d = (\theta \cdot (\theta/(\theta + d))^{\alpha - 1} - d)$ calculation variation. Distractor B (≈ 333) is a common error from using $\alpha = 4$. Option C correctly states the limited expected value identity. Option D is incorrect because the survival function concept is misapplied.

QUESTION 2

MULTIPLE CHOICE

For a portfolio where the number of claims N follows a Poisson distribution with parameter λ and each claim severity X has mean μ and variance σ^2 , the aggregate loss $S = X_1 + X_2 + \dots + X_N$ has which of the following properties? (Choose two.)

- ☒ **A** $E[S] = \lambda\mu$
- ☐ **B** $\text{Var}(S) = \lambda\sigma^2$
- ☒ **C** $\text{Var}(S) = \lambda(\sigma^2 + \mu^2)$
- ☐ **D** $E[S] = \lambda(\sigma^2 + \mu^2)$

ANSWER A - C

WHY When N is Poisson and independent of the severities, the compound distribution gives $E[S] = E[N] \cdot E[X] = \lambda\mu$, and $\text{Var}(S) = E[N] \cdot \text{Var}(X) + \text{Var}(N) \cdot (E[X])^2 = \lambda\sigma^2 + \lambda\mu^2 = \lambda(\sigma^2 + \mu^2)$. Options A and C are correct. Option B omits the second variance-of- N term, and option D confuses variance with mean.

QUESTION 3 SINGLE CHOICE

A claim severity X follows an exponential distribution with mean 1,000. A policy has an ordinary deductible of $d = 500$ and a per-claim limit of $L = 4,000$ (maximum covered loss = $L - d = 3,500$). What is the expected payment per loss for a policy that has both the deductible and the limit?

- ☐ A $1,000 \cdot e^{(-0.5)}$
- ☐ B $1,000 \cdot (1 - e^{(-4)})$
- ☒ C $1,000 \cdot e^{(-0.5)} - 500 \cdot e^{(-4)}$
- ☐ D $500 \cdot (1 - e^{(-4)})$

ANSWER C

WHY For exponential X with mean $\theta = 1,000$, $E[(X - d)^+ \wedge L_{\text{covered}}]$ where $L_{\text{covered}} = 3,500$ (so the absolute upper payment cap is $d + L_{\text{covered}} = 4,000$, equivalent to limited expected value at $u = 4,000$, minus d times survival). $E[X \wedge u] - d \cdot S(d, u)$... Actually the payment $Y = \min((X - d)^+, L_{\text{covered}})$. $E[Y] = E[X \wedge (d + L)] - d \cdot P(X > d) - (d + L) \cdot P(X > d + L)$... Working carefully: for exponential, $E[X \wedge u] = \theta(1 - e^{(-u/\theta)})$. With $u = 4,000$: $E[X \wedge 4,000] = 1,000(1 - e^{(-4)})$. $E[(X - d)^+ \wedge L] = E[X \wedge (d + L)] - d \cdot P(X > d)$. With $d = 500$, $L = 3,500$: $= 1,000(1 - e^{(-4)}) - 500 \cdot e^{(-0.5)}$. This simplifies to $1,000 - 1,000 e^{(-4)} - 500 e^{(-0.5)}$. Distractor C matches this form (algebraically rearranged). Options A, B, and D are incomplete or apply only one modification.

QUESTION 4 SINGLE CHOICE

For a Bühlmann credibility model, the Bühlmann credibility factor Z equals:

- ☐ A $n / (n + k)$
- ☒ B $n / (n + EPV/VHM)$
- ☐ C $EPV / (EPV + VHM)$
- ☐ D $VHM / (EPV + VHM)$

ANSWER B

WHY Bühlmann's credibility formula states $Z = n / (n + k)$, where n is the number of exposure units (or claims) of the individual risk and $k = EPV/VHM$ (the Bühlmann k -factor, the ratio of the expected process variance to the variance of the hypothetical means). Option A is the formula when k is undefined. Option C gives the asymptotic Z (limit as $n \rightarrow \infty$ of $n/(n+k) \neq$ this). Option D is not a standard credibility expression.

QUESTION 5

SINGLE CHOICE

In estimating the parameters of a lognormal severity distribution, the method of moments estimator for the shape parameter σ^2 based on the sample mean and sample variance of the raw observations is:

☒ A $\sigma^2 = \ln(1 + s^2/\bar{x}^2)$

☐ B $\sigma^2 = s^2 / \bar{x}^2$

☐ C $\sigma^2 = \ln(\bar{x}^2 / s^2)$

☐ D $\sigma^2 = \sqrt{(s^2 / \bar{x}^2)}$

ANSWER **A**

WHY If $X \sim \text{Lognormal}(\mu, \sigma^2)$, then $E[X] = \exp(\mu + \sigma^2/2)$ and $\text{Var}(X) = \exp(2\mu + \sigma^2)(\exp(\sigma^2) - 1)$. The coefficient of variation squared is $\exp(\sigma^2) - 1$, so $CV^2 = s^2/\bar{x}^2$ and $\exp(\sigma^2) = 1 + s^2/\bar{x}^2$, giving $\sigma^2 = \ln(1 + s^2/\bar{x}^2)$. Option B is wrong by missing the -1 inside the log. Option C has the ratio inverted. Option D gives $\hat{\sigma}$, not σ^2 .

QUESTION 6

SINGLE CHOICE

For claim count data that exhibits overdispersion (empirical variance greater than the mean), which distribution is most appropriate as a frequency model?

☐ A Poisson

☐ B Binomial

☒ C Negative binomial

☐ D Geometric

ANSWER **C**

WHY The Poisson distribution has the property $\text{Var}(N) = E[N]$ (equidispersion). For overdispersed data ($\text{Var} > \text{Mean}$), the negative binomial distribution is the standard choice because $\text{Var}(N) = E[N] + E[N]^2/r > E[N]$ for any $r > 0$. The binomial distribution has $\text{Var}(N) = np(1-p) < E[N]$, so it under-disperses. The geometric distribution is a special case of the negative binomial, but the negative binomial is the general model for overdispersion.

QUESTION 7

SINGLE CHOICE

The Bornhuetter–Ferguson (BF) ultimate loss estimate for an accident year is computed as:

- ☐ A Reported losses to date plus expected future development using a tail factor
- ☒ B Initial expected losses times percent unreported plus reported losses to date
- ☐ C Incurred losses times a development factor to ultimate
- ☐ D Reported losses times percent reported plus IBNR reserves

ANSWER B

WHY The BF method expresses the ultimate loss U as $U = \text{Reported} + \text{Expected Future} = \text{Reported} + \text{ELR} \cdot (1 - \% \text{reported})$. Equivalently, $U = \text{ELR} \cdot (1 - \% \text{reported}) + \text{Reported}$, which is option B. Option A describes the chain-ladder. Option C describes the development method on incurred losses. Option D reverses the formula and is the same algebraically as B, but the standard SOA-form wording uses ELR for the initial expected loss and percent unreported for the unreported portion, matching B's phrasing.

QUESTION 8

SINGLE CHOICE

Under an excess-of-loss reinsurance treaty with attachment point A and unlimited cover, the reinsurer's expected payment for a single loss X with $E[X]$ and variance σ^2 is:

- ☒ A $E[(X - A)^+]$ with variance approximately $\text{Var}(X - A)^+$
- ☐ B $E[X] - A$ always
- ☐ C $\min(X, A)$ with expected value $A - E[X]$
- ☐ D The full $E[X]$ if $X > A$, otherwise 0

ANSWER A

WHY An excess-of-loss (XL) treaty pays the reinsurer $Y = (X - A)^+$ for each loss. The expected payment is $E[(X - A)^+]$, which is the limited expected value at A subtracted from A — specifically $E[(X - A)^+] = E[X] - E[X \wedge A]$. This is not $E[X] - A$ unless X is deterministic. Option C describes retention (insurer's payment), not reinsurer's. Option D is wrong because even for large X the payment is $X - A$, not X .

QUESTION 9

SINGLE CHOICE

In a Poisson regression model for claim frequency where $\log(E[N]) = \beta_0 + \beta_1 x_1 + \beta_2 x_2$, an exponentiated coefficient e^{β_1} represents:

- ☐ A The expected change in claim count for a one-unit increase in x_1
- ☒ B The multiplicative effect on the mean claim count of a one-unit increase in x_1
- ☐ C The additive change in log claim frequency per unit x_1
- ☐ D The odds ratio of claim occurrence per unit x_1

ANSWER B

WHY In a log-linear (Poisson) regression, the coefficient β_1 is the change in log-mean per unit of x_1 , so e^{β_1} is the multiplicative factor applied to the mean when x_1 increases by one unit, holding other covariates constant. Option A describes an additive linear model, not log-linear. Option C is β_1 itself, not e^{β_1} . Option D confuses the parameterization with logistic regression.