1. **Learning Objectives:**
   1. The candidate will understand the key considerations for general insurance actuarial analysis.

**Learning Outcomes:**
(1k) Estimate written, earned and unearned premiums.

**Sources:**

**Commentary on Question:**
*This question tests the candidate’s understanding of written premiums, earned premiums, unearned premiums, and in-force premiums.*

**Solution:**
(a) Calculate written premium for calendar years 2015 and 2016.

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>Policy Term</th>
<th>Premium</th>
<th>% Written in Calendar Year 2015</th>
<th>% Written in Calendar Year 2016</th>
<th>(4) = (1)(2)</th>
<th>(5) = (1)(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr. 1, 2014</td>
<td>2-year</td>
<td>4,000</td>
<td>0%</td>
<td>0%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Jan. 1, 2015</td>
<td>1-year</td>
<td>7,000</td>
<td>100%</td>
<td>0%</td>
<td>7,000</td>
<td>0</td>
</tr>
<tr>
<td>Apr. 1, 2015</td>
<td>2-year</td>
<td>8,000</td>
<td>100%</td>
<td>0%</td>
<td>8,000</td>
<td>0</td>
</tr>
<tr>
<td>Oct. 1, 2015</td>
<td>6-month</td>
<td>6,000</td>
<td>100%</td>
<td>0%</td>
<td>6,000</td>
<td>0</td>
</tr>
<tr>
<td>Feb. 1, 2016</td>
<td>1-year</td>
<td>6,000</td>
<td>0%</td>
<td>100%</td>
<td>0</td>
<td>6,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>21,000</strong></td>
<td><strong>6,000</strong></td>
</tr>
</tbody>
</table>
1. **Continued**

(b) Calculate earned premium for calendar years 2015 and 2016.

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>Policy Term</th>
<th>Premium</th>
<th>% Earned in Calendar Year 2015</th>
<th>% Earned in Calendar Year 2016</th>
<th>Earned Premium Calendar Year 2015</th>
<th>Earned Premium Calendar Year 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr. 1, 2014</td>
<td>2-year</td>
<td>4,000</td>
<td>50.0%</td>
<td>12.5%</td>
<td>2,000</td>
<td>500</td>
</tr>
<tr>
<td>Jan. 1, 2015</td>
<td>1-year</td>
<td>7,000</td>
<td>100.0%</td>
<td>0.0%</td>
<td>7,000</td>
<td>0</td>
</tr>
<tr>
<td>Apr. 1, 2015</td>
<td>2-year</td>
<td>8,000</td>
<td>37.5%</td>
<td>50.0%</td>
<td>3,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Oct. 1, 2015</td>
<td>6-month</td>
<td>6,000</td>
<td>50.0%</td>
<td>50.0%</td>
<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Feb. 1, 2016</td>
<td>1-year</td>
<td>6,000</td>
<td>0.0%</td>
<td>91.67%</td>
<td>0</td>
<td>5,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>15,000</strong></td>
<td><strong>13,000</strong></td>
</tr>
</tbody>
</table>

(c) Calculate the unearned premium at December 31, 2016.

Only the third and fifth policies have unearned premiums as of December 31, 2016.

Unearned premium = \(\frac{3}{24}(8,000) + \frac{1}{12}(6,000) = 1,500\)

(d) Calculate the in-force premiums at January 1, 2016.

The first, third and fourth policies are in-force on January 1, 2016:

In-force premiums at January 1, 2016 = 4,000 + 8,000 + 6,000 = 18,000

(e) Explain why earned premium might be different if ABC wrote motorcycle policies in a winter climate instead of general liability policies.

Motorcycles written in a winter climate would typically only have exposure to loss in the spring, summer and fall months. As a result, the insurer might recognize this difference by modifying the even earnings throughout the policy term.
2. **Learning Objectives:**
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(5h) Calculate deductible factors, increased limits factors, and coinsurance penalties.
(5i) Calculate rates for large accounts.

**Sources:**

**Commentary on Question:**
This question tests the candidate’s understanding of deductibles.

**Solution:**
(a) Define the following terms:

(i) Morale Hazard

(ii) Risk Control

(i) An insured's indifference to loss because they have insurance protection.

(ii) Any process, procedure or method that manages risk.

(b) State how a deductible can limit losses to an insurer for each term in part (a).

(i) Morale Hazard: A deductible which is paid by the insured would reduce this indifference.

(ii) Risk Control: A deductible can encourage loss control measures because the insured retains some of the loss; they have a financial incentive to minimize losses.

(c) State two other ways in which a deductible can limit loss exposure to an insurer.

- Eliminate the processing costs associated with small claims
- Reduce exposure to catastrophic claims
2. Continued

(d) Explain two alternative deductible applications for a 10,000 per claim deductible.

Alternative 1: Assumes all losses submitted to insurer are one claim
Result: 10,000 retained by the insured, 190,000 claim to insurance company

Alternative 2: Assumes there were four tornadoes and each is considered a separate claim
Result: 40,000 retained by the insured, 160,000 claim to insurance company

(e) Calculate the losses retained by the insured and the insurer’s claims for each deductible shown below, stating any assumptions.

(i) 10,000 per occurrence

(ii) 10,000 per location

10,000 Per Occurrence:
10,000 retained by the insured, 190,000 claim to insurance company
Assumes all losses resulting from the hurricane are one occurrence.

10,000 Per Location:
40,000 retained by the insured, 160,000 claim to insurance company
(10,000 per restaurant = 40,000 total)

(f) Explain why aggregate deductibles are more common for commercial insureds than for individual insureds.

Commercial insureds are exposed to multiple incidents within a policy year which can result in multiple claims. Individuals are less likely to have multiple incidents within a policy year.

(g) Describe how each of the following typically affect policy limits:

(i) A large deductible

(ii) A self-insured retention (SIR)

(i) Deductibles typically erode the limit – the claim amount is the policy limit less the deductible.

(ii) The SIR does not erode the limit. The insured claim is the policy limit after the SIR has been applied.
2. Continued

(h) Calculate the amount retained by the insured and the insurer’s claims for each of the following:

(i) Large deductible of 100,000

(ii) SIR of 100,000

(i) 200,000 retained by insured, 900,000 claim to insurance company. Insured retains the first 100,000 for the deductible. The deductible erodes the policy limit, so the insurer pays the next 900,000 in claims. The insured is responsible for the remaining 100,000 of loss.

(ii) 100,000 retained by insured, 1,000,000 claim to insurance company. The SIR does not erode the policy limit.
3. **Learning Objectives:**
   2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**
(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**

**Commentary on Question:**
This question tests the estimation of ultimate claims using the Cape Cod method.

**Solution:**
(a) Explain the difference between inputs to the Bornhuetter Ferguson method and the Cape Cod method.

The expected value for Bornhuetter Ferguson method is based on an independent a priori estimate which can incorporate significant professional judgement.

The expected value for Cape Cod method is based on trended historical experience. No judgment is involved.

(b) Calculate the projected ultimate claims for all accident years using the Cape Cod method.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>On-Level Earned Premium</th>
<th>Reported Cumulative Development Factors</th>
<th>Expected Percent Reported</th>
<th>Used-Up On-Level Earned Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>16,700</td>
<td>1.40</td>
<td>0.7143</td>
<td>11,929</td>
</tr>
<tr>
<td>2015</td>
<td>16,200</td>
<td>2.00</td>
<td>0.5000</td>
<td>8,100</td>
</tr>
<tr>
<td>2016</td>
<td>15,800</td>
<td>4.50</td>
<td>0.2222</td>
<td>3,511</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>23,540</td>
</tr>
</tbody>
</table>
3. Continued

Claim Adjustment Factors

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Reported Claims</th>
<th>Trend at 2%</th>
<th>Tort Reform</th>
<th>Adjusted Claims</th>
<th>Expected Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>8,200</td>
<td>1.0404</td>
<td>0.95</td>
<td>8,105</td>
<td>11,574</td>
</tr>
<tr>
<td>2015</td>
<td>5,700</td>
<td>1.0200</td>
<td>0.95</td>
<td>5,523</td>
<td>11,452</td>
</tr>
<tr>
<td>2016</td>
<td>2,500</td>
<td>1.0000</td>
<td>1.00</td>
<td>2,500</td>
<td>10,823</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>16,128</td>
<td>33,849</td>
</tr>
</tbody>
</table>

Adjusted Expected Claim Ratio = $16,128/23,540 = 68.5\% \quad (A)$

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Expected Percent Unreported</th>
<th>Expected Unreported Claims</th>
<th>Projected Ultimate Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>0.2857</td>
<td>3,307</td>
<td>11,507</td>
</tr>
<tr>
<td>2015</td>
<td>0.5000</td>
<td>5,726</td>
<td>11,426</td>
</tr>
<tr>
<td>2016</td>
<td>0.7778</td>
<td>8,418</td>
<td>10,918</td>
</tr>
</tbody>
</table>

(c) Calculate the accident year 2016 IBNR using the Generalized Cape Cod method and a decay factor of 0%.

If decay is 0, the Generalized Cape Cod method returns the development method because all other accident years receive a weight of zero and only the current accident year enters the calculation.

Accident year 2016 IBNR from development method:

\[ = (2,500 \times 4.500) - 2,500 = 8,750 \]
4. Learning Objectives:
7. The candidate will understand the nature and application of catastrophe models used to manage risks from natural disasters.

Learning Outcomes:
(7b) Apply catastrophe models to insurance ratemaking, portfolio management, and risk financing.

Sources:

Commentary on Question:
This question tests the candidate’s understanding of risk financing for catastrophe losses.

Solution:
(a) State three alternatives to reinsurance that R30 might consider to improve its risk/return profile.

Any three of the following are acceptable:
• maintaining a cash or other liquid reserve
• borrowing
• issuing debt
• issuing equity
• securitization

(b) Calculate the risk and return measures for both of the reinsurance schemes.

Scheme (i):
\[ P_{MEB} = 1.3[15(0.08) + 30(0.06) + 60(0.04) + 125(0.02)] = 1.3(7.9) = 10.27 \]
Risk = Pr(10.27 + LR30 > 150) = 0.04 + 0.02 = 0.06
\[ E[LR30] = 25(0.8) + 115(0.08) + 130(0.06) + 160(0.04) + 225(0.02) = 47.90 \]
Return = 100 – 10.27 – 47.9 = 41.83

Scheme (ii):
\[ P_{MEB} = 1.3[20(0.04) + 150(0.02)] = 1.3(3.8) = 4.94 \]
Risk = Pr(4.94 + LR30 > 150) = 0.06 + 0.04 + 0.02 = 0.12
\[ E[LR30] = 25(0.8) + 130(0.08) + 160(0.06) + 200(0.04) + 200(0.02) = 52 \]
Return = 100 – 4.94 – 52 = 43.06
4. Continued

(c) Determine, using an efficient-frontier approach, which, if either, of the two reinsurance schemes present viable options for R30.

Compared to no reinsurance, scheme (i) has lower return and lower risk, and is therefore viable.

Compared to no reinsurance, scheme (ii) has lower return but the same risk, and is therefore not viable.
5. Learning Objectives:
2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.
3. The candidate will understand financial reporting of claim liabilities and premium liabilities.

Learning Outcomes:
(2c) Estimate claims-related expenses and recoveries.
(3a) Describe the key assumptions underlying ratio and count-based methods for estimating unpaid unallocated loss adjustment expenses.

Sources:

Commentary on Question:
This question tests the candidate’s understanding of estimating unpaid ULAE.

Solution:
(a) Describe why unallocated loss adjustment expenses (ULAE) are usually analyzed on a calendar year basis.

ULAE expenses are not usually allocated or assigned to a specific claim. Therefore, ULAE cannot be tracked on an accident year basis.

(b) Describe an approach you would use to estimate unpaid ULAE if you believed that carried claim reserves might be low or inadequate.

Either of the following options are acceptable:
- Use the Wendy Johnson method because it is a count-based/transaction-based method so it will not be distorted by inadequate carried reserves.
- Use the classical paid-to-paid method to estimate a ULAE ratio so it is not affected by reserves and apply it to indicated reserves rather than carried reserves.

(c) Provide two disadvantages of using a classical paid-to-paid method to estimate unpaid ULAE for RIC.

Any two of the following are acceptable:
- It overestimates unpaid ULAE for a growing company.
- It overestimates unpaid ULAE in an inflationary environment.
- Historical ratio may not be appropriate due to new system change.
- Classical paid-to-paid method assumes 50% of expenses relate to opening a claim and 50% relate to maintaining & closing a claim. This is not the case for RIC.
5. Continued

(d) Calculate unpaid ULAE as of December 31, 2016 using the Kittel refinement to the classical paid-to-paid method.

\[
\text{Ratio of Paid ULAE to Claims} = \frac{1}{2} \left[ \text{Gross Paid Claims} + \text{Gross Reported Claims} \right]
\]

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>(1) Gross Paid Claims</th>
<th>(2) Gross Reported Claims</th>
<th>Kittel Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>14.4%</td>
<td>13.2%</td>
<td>13.80%</td>
</tr>
<tr>
<td>2015</td>
<td>10.7%</td>
<td>11.8%</td>
<td>11.25%</td>
</tr>
<tr>
<td>2016</td>
<td>11.3%</td>
<td>9.8%</td>
<td>10.55%</td>
</tr>
<tr>
<td>Total</td>
<td>12.0%</td>
<td>11.5%</td>
<td>11.75%</td>
</tr>
</tbody>
</table>

*Selected:* 10.55%

The Kittel method uses an average of the paid-to-paid ratio and the paid-to-reported ratio.

Selected ratio is based on calendar year 2016 to reflect the decreasing trend.

Unpaid ULAE = \((\text{ULAE ratio} \times \text{IBNR}) + (\text{ULAE ratio} \times \text{multiplier} \times \text{case estimates})\)
\[
= (\text{ULAE ratio} \times \text{IBNYR}) + [\text{ULAE ratio} \times \text{multiplier} \times (\text{case estimates} + \text{IBNER})]
= (0.1055\times2,500) + [0.1055\times0.60\times(15,300+10,000)] = 1,865
(gross unpaid claims are used)

(e) Describe the input for the Mango and Allen smoothing adjustment.

The ULAE ratio is determined as paid ULAE to expected paid claims (and/or reported claims) rather than actual claims.

(f) Provide two reasons to justify using a Mango and Allen smoothing adjustment in this case.

Any two of the following are acceptable:
- Mango & Allen is advantageous for long-tail lines of business which this is (i.e., line of business is professional liability).
- Mango & Allen is advantageous for a changing exposure volume which this is (i.e., RIC is a growing company).
- Mango & Allen is advantageous when data is volatile which this is (i.e., downward trend in ratios).
- Mango & Allen replaces actual claims with expected claims, so it's a good method anytime actual claims may include a distortion or volatility.
6. **Learning Objectives:**

   4. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

   5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**

(4a) Identify the time periods associated with trending procedures.

(4e) Choose trend rates and calculate trend factors for exposures.

(5b) Calculate expenses used in ratemaking analyses including expense trending procedures.

**Sources:**


**Commentary on Question:**

This question tests the candidate’s understanding of expenses used for ratemaking, including trending of fixed expenses.

**Solution:**

(a) Explain how a premium-based expense ratio analysis may be distorted if countrywide expense ratios are used to project fixed expenses for State X.

If a significant variation exists in average rates across the states, a disproportionate share of projected fixed expenses will be allocated to the higher-than-average premium states. Thus, the estimated fixed expenses will be overstated in higher-than-average premium states and understated in the lower-than-average premium states.

(b) Assess the reasonableness of using the publicly available cost index for this line of business by comparing it with the historical trend in fixed expenses.

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Fixed Expense per On-Level Earned Premium</th>
<th>Change in Fixed Expense per On-Level Earned Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>4.20%</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>4.58%</td>
<td>9.05%</td>
</tr>
<tr>
<td>2015</td>
<td>4.95%</td>
<td>8.08%</td>
</tr>
<tr>
<td>2016</td>
<td>5.38%</td>
<td>8.69%</td>
</tr>
</tbody>
</table>

Assessment: Due to the company trend being so much higher, the publicly available cost index is likely not reasonable as it is too low.
6. Continued

(c) Recommend the annual fixed expense trend. Justify your recommendation.

Recommend 8.6%, based on all year average.

Justification: Since there are no outliers, the average is reasonable. Publicly available cost index is too different, indicating that company data should be given more weight.

(d) Calculate the fixed expense ratio to be used in ratemaking, based on the average of 2015 and 2016.

Commentary on Question:
Candidates can alternatively trend the fixed expense ratios calculated in part (b) to determine the fixed expense ratio to be used in ratemaking.

<table>
<thead>
<tr>
<th>Calendar Year</th>
<th>Average Incurred Date</th>
<th>Trend Period (years)</th>
<th>Trend Factors</th>
<th>Trended Fixed Expenses</th>
<th>Fixed Expense per On-Level Earned Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>7/1/2015</td>
<td>42/12</td>
<td>1.3348</td>
<td>66,740</td>
<td>6.61%</td>
</tr>
<tr>
<td>2016</td>
<td>7/1/2016</td>
<td>30/12</td>
<td>1.2291</td>
<td>61,455</td>
<td>6.62%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Average</strong> 6.62%</td>
</tr>
</tbody>
</table>

Notes:
- trend from average incurred date (midpoint of each year)
- trend to average incurred date in forecast period (average date between April 1, 2018 to 6 months after March 31, 2019, or 9 months after April 1, 2018)
7. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(2d) Explain the effect of changing conditions on the projection methods cited in (2b).

(2e) Assess the appropriateness of the projection methods cited in (2b) in varying circumstances.

**Sources:**

**Commentary on Question:**

*This question tests the candidate’s understanding of changing conditions on different projection methods.*

**Solution:**

(a) Explain how each of the following methods is likely to be affected by each of the recent changes at Old Co:

(i) Expected method

(ii) Reported development method

(iii) Reported Bornhuetter Ferguson method

(i) Expected method:
- Increased claim ratio: this method is not responsive, unless expected claim ratio changes, therefore it will underestimate ultimate claims
- Volume increase: this method is responsive
- Change in reporting pattern: this method is not responsive, but the results will be reasonable if expected ultimate claims ratio is correct

(ii) Reported development method:
- Increased claim ratio: this method should be responsive to changing claim ratio
- Volume increase: this method should be responsive to a volume increase
- Change in reporting pattern: this method will distort the factors and underestimate ultimate claims
7. Continued

(iii) Reported Bornhuetter Ferguson method:
- Increased claim ratio: the changing claim ratio is only reflected to extent it is already reflected in reported claims – the IBNR will be understated
- Volume increase: this method should be responsive to this, though increasing volume will increase understatement from claims ratio effect
- Change in reporting pattern: this method will distort factors, and under estimate ultimate claims, but not as much as reported development

All three methods will underestimate ultimate claims.

(b) Provide two reasons why actuaries use multiple methods to estimate ultimate claims.

Any two of the following are acceptable:
- Required by actuarial standards
- Each method has different underlying assumptions, none of which are usually perfectly true
- To allow the results of different methods to be compared
- To better reflect the complexities of the business being modelled
- To identify sensitivity to the underlying assumptions

(c) Explain whether or not the reported Cape Cod method is likely to produce a more accurate estimate than the reported Bornhuetter Ferguson based on the recent changes at Old Co.

- Increased claim ratio: the reported Cape Cod method is better than Bornhuetter Ferguson method, since past experience will adjust expected future claim ratio. It will underestimate ultimate claims by less.
- Volume increase: the reported Cape Cod method is the same as Bornhuetter Ferguson method
- Change in reporting pattern: the reported Cape Cod method is worse than the Bornhuetter Ferguson method, influenced by reporting factors more

On balance, the change in reporting factors seems to be larger than change in claim ratio and therefore suspect reported Cape Cod method will be overall worse than the Bornhuetter Ferguson method (i.e., underestimate more).
8. Learning Objectives:
2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

Learning Outcomes:
(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

Sources:

Commentary on Question:
This question tests the candidate’s ability to estimate ultimate claims using Berquist-Sherman adjustments when there has been a change in case reserve adequacy.

Solution:
(a) Recalculate the average case estimate triangle, eliminating the effects of the settlement.

Calculate case estimates affected by the class action settlement:
Outstanding accident year (AY) 2014 @ 24 months = Reported AY 2014 @ 24 months – Paid AY 2014 @ 24 months = 84,000 – 52,500 = 31,500
Outstanding AY 2015 @ 12 months = Reported AY 2015 @ 12 months – Paid AY 2015 @ 12 months = 87,800 – 33,800 = 54,000

Calculate the class action settlement:
Settlement AY 2014 @ 24 months = 31,500 × 50% / 150% = 10,500
Settlement AY 2015 @ 12 months = 54,000 × 50% / 150% = 18,000

Recalculate case estimates:
Outstanding AY 2014 @ 24 months = 31,500 – 10,500 = 21,000
Outstanding AY 2015 @ 12 months = 54,000 – 18,000 = 36,000

Recalculate the average outstanding claim:
AY 2014 @ 24 months = 21,000 / 170 = 124
AY 2015 @ 12 months = 36,000 / 200 = 180

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Revised Average Case Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2014</td>
<td>166</td>
</tr>
<tr>
<td>2015</td>
<td>180</td>
</tr>
<tr>
<td>2016</td>
<td>232</td>
</tr>
</tbody>
</table>
8.  Continued

(b) Explain whether the recalculated average case estimate triangle provides any evidence for or against the claims manager’s suspicion.

The average case estimates are increasing in the last calendar year (diagonal) at a rate much greater than severity trend. This suggests a possible increase in case reserve adequacy.

(c) Calculate the adjusted reported claims triangle, excluding the effects of the settlement.

\[
\text{Adjusted Average Case} = \frac{\text{Selected Last Diagonal from part (a), trended to each AY at 6\%}}{1.06} \\
\begin{array}{ccc}
\text{AY} & 12 & 24 & 36 \\
2014 & 207 & 176 & 158 \\
2015 & 219 & 187 & \\
2016 & 232 & \\
\end{array} \\
e.g., 219 = 232 / 1.06
\]

\[
\text{Adjusted Case} = \text{Adjusted Average Case Estimate} \times \text{Outstanding Counts}:
\begin{array}{ccc}
\text{AY} & 12 & 24 & 36 \\
2014 & 39,330 & 29,920 & 15,800 \\
2015 & 43,800 & 33,660 & \\
2016 & 48,720 & \\
\end{array} \\
e.g., 43,800 = 219 \times 200
\]

\[
\text{Adjustment to Paid for Settlement}
\begin{array}{ccc}
\text{AY} & 12 & 24 & 36 \\
2014 & & & (10,500) \\
2015 & & & (18,000) \\
2016 & & & \\
\end{array} \\
\]

\[
\text{Adjusted Reported, excluding Settlement} = \text{Adjusted Case} + \text{Paid} + \text{Adjustment to Paid for Settlement}
\begin{array}{ccc}
\text{AY} & 12 & 24 & 36 \\
2014 & 70,830 & 82,420 & 99,800 \\
2015 & 77,600 & 89,960 & \\
2016 & 85,220 & \\
\end{array} \\
e.g., 89,960 = 33,660 + 74,300 - 18,000
8. Continued

(d) Calculate the indicated IBNR for accident years 2014 through 2016 using the reported development method and the adjusted reported claims triangle from part (c).

<table>
<thead>
<tr>
<th>Development Factors</th>
<th>12 to 24</th>
<th>24 to 36</th>
<th>36 to Ultimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>AY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>1.164</td>
<td>1.211</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>1.159</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td>1.050</td>
</tr>
<tr>
<td>Average</td>
<td>1.162</td>
<td>1.211</td>
<td>1.050</td>
</tr>
<tr>
<td>Factor to Ultimate</td>
<td>1.478</td>
<td>1.272</td>
<td>1.050</td>
</tr>
</tbody>
</table>

E.g.,
- $1.164 = 82,420 / 70,830$
- $1.211 = 99,800 / 82,420$
- $1.159 = 89,960 / 77,600$

<table>
<thead>
<tr>
<th>AY</th>
<th>Factor to Ultimate</th>
<th>Reported Claims</th>
<th>Ultimate Claims</th>
<th>IBNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>1.050</td>
<td>99,800</td>
<td>104,790</td>
<td>4,990</td>
</tr>
<tr>
<td>2015</td>
<td>1.272</td>
<td>89,960</td>
<td>114,429</td>
<td>24,469</td>
</tr>
<tr>
<td>2016</td>
<td>1.478</td>
<td>85,220</td>
<td>125,955</td>
<td>40,735</td>
</tr>
</tbody>
</table>
9. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

3. The candidate will understand financial reporting of claim liabilities and premium liabilities.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

(3d) Evaluate the estimates of ultimate claims to determine claim liabilities for financial reporting.

**Sources:**


**Commentary on Question:**

This question tests the estimation of ultimate allocated loss adjustment expenses (ALAE) using the expected method and the Bornhuetter Ferguson method. This question also tests the estimation of IBNR for ALAE.

**Solution:**

(a) Calculate the projected RY 2016 ultimate ALAE using the expected method.

<table>
<thead>
<tr>
<th>Report Year</th>
<th>Earned Exposures</th>
<th>Projected Ultimate ALAE Based on Reported Development Method</th>
<th>Pure Premium</th>
<th>Trend Factors</th>
<th>Trended Pure Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>480</td>
<td>26,000</td>
<td>54.17</td>
<td>1.0927</td>
<td>59.19</td>
</tr>
<tr>
<td>2014</td>
<td>500</td>
<td>28,500</td>
<td>57.00</td>
<td>1.0609</td>
<td>60.47</td>
</tr>
<tr>
<td>2015</td>
<td>520</td>
<td>32,000</td>
<td>61.54</td>
<td>1.0300</td>
<td>63.39</td>
</tr>
<tr>
<td>2016</td>
<td>550</td>
<td>28,000</td>
<td>50.91</td>
<td>1.0000</td>
<td>50.91</td>
</tr>
</tbody>
</table>

Average (2013-2015) 61.02
Selected pure premium 61.00

2016 ultimate ALAE = 550 × 61.00 = 33,550

Note: (4) Trend factors use the annual claim trend trended to report year 2016 (i.e., 1.03³ = 1.0927).
9. Continued

(b) Calculate the projected RY 2016 ratio of ultimate ALAE to ultimate claims using the Bornhuetter Ferguson method and your results from part (a).

\[
\text{RY 2016 expected ultimate ALAE to ultimate claim ratio} = \frac{33,550}{516,040} = 0.065
\]

\[
\text{IBNR Factor} = 1 - \frac{1}{0.922} = -0.085
\]

\[
\text{RY 2016 Bornhuetter Ferguson ultimate ALAE ratio} = 0.067 + 0.065 \times -0.085 = 0.062
\]

(c) Evaluate the reasonableness of the inputs for the Bornhuetter Ferguson method in part (b) by comparing the actual reported ALAE ratio to the expected ALAE ratio.

\[
\text{Actual reported ALAE ratio} = 0.067
\]

\[
\text{Expected ultimate ALAE ratio} = 0.065
\]

\[
\text{Expected percent reported} = \frac{1}{0.922} = 1.085
\]

\[
\text{Expected reported ALAE ratio} = 0.065 \times 1.085 = 0.071
\]

\[
\text{Actual minus expected difference} = 0.067 - 0.071 = -0.004
\]

\[
\text{Difference as a percent of expected ultimate ALAE ratio} = \frac{-0.004}{0.065} = -6.2\%
\]

(d) Calculate the RY 2016 IBNR for ALAE using your results from part (b).

\[
\text{RY 2016 expected ultimate claims} = 516,040
\]

\[
\text{RY 2016 ultimate ALAE ratio from Bornhuetter Ferguson method} = 0.062
\]

\[
\text{RY 2016 Ultimate ALAE} = 516,040 \times 0.062 = 31,994
\]

\[
\text{RY 2016 actual reported ALAE} = 420,000 \times 0.067 = 28,140
\]

\[
\text{RY 2016 ALAE IBNR} = 31,994 - 28,140 = 3,854
\]
10. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

4. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

(4a) Identify the time periods associated with trending procedures.

(4c) Choose trend rates and calculate trend factors for claims.

**Sources:**


**Commentary on Question:**

This question tests the development-based frequency-severity method of estimating ultimate claims.

**Solution:**

(a) Calculate the annual change in severity for each year.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Ultimate Claims Based on Development Method</th>
<th>Ultimate Counts Based on Development Method</th>
<th>Earned Exposures</th>
<th>Severity</th>
<th>Change in Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>1,602,000</td>
<td>172</td>
<td>2,200</td>
<td>9,314</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>1,745,000</td>
<td>179</td>
<td>2,300</td>
<td>9,749</td>
<td>4.67%</td>
</tr>
<tr>
<td>2014</td>
<td>1,828,000</td>
<td>185</td>
<td>2,400</td>
<td>9,881</td>
<td>1.36%</td>
</tr>
<tr>
<td>2015</td>
<td>1,940,000</td>
<td>188</td>
<td>2,400</td>
<td>10,319</td>
<td>4.43%</td>
</tr>
<tr>
<td>2016</td>
<td>2,302,000</td>
<td>203</td>
<td>2,600</td>
<td>11,340</td>
<td>9.89%</td>
</tr>
</tbody>
</table>

* e.g., 4.67% = 9,749/9,314 − 1
10. Continued

(b) Recommend an annual severity trend to use for the frequency-severity method. Justify your recommendation.

All year average = 5.09%. Recommend 5% annual severity trend. Rationale is that the historical changes are somewhat erratic. The 2016 number is possibly influenced by highly leveraged development factors so not too much weight should be given to 2016. As a result, a trend similar to the average of all years is reasonable.

(c) Calculate the ultimate claims for accident year 2015 using the development based frequency-severity method.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Severity</th>
<th>Trend at 5.0%</th>
<th>Selected Severity</th>
<th>Indicated Frequency</th>
<th>Selected Ultimate Severity</th>
<th>Selected Ultimate Counts</th>
<th>Ultimate Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>9,314</td>
<td>1.2155</td>
<td>11,321</td>
<td>0.0782</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>9,749</td>
<td>1.1576</td>
<td>11,285</td>
<td>0.0778</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>9,881</td>
<td>1.1025</td>
<td>10,894</td>
<td>0.0771</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>10,319</td>
<td>1.0500</td>
<td>10,835</td>
<td>0.0783</td>
<td>10,556</td>
<td>187</td>
<td>1,973,972</td>
</tr>
<tr>
<td>2016</td>
<td>11,340</td>
<td>1.0000</td>
<td>11,340</td>
<td>0.0781</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Selection (average excl. 2016) 11,084 0.0779

Notes: 

(9) = 10,556 = 11,084 / 1.05
(10) = (3) × Selected Frequency = 2,400×0.0779
11. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

**Sources:**

**Commentary on Question:**

*This question tests the estimation of ultimate claims using the expected method.*

**Solution:**

(a) Recommend the 2016 cost and rate level expected claim ratio to be used to estimate expected claims. Justify your recommendation.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Earned Premium</th>
<th>Projected Ultimate Claims from Development Method</th>
<th>Trend Factor</th>
<th>Tort Reform</th>
<th>Premium On-Level Factors</th>
<th>Trended On-Level Claim Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>12,000</td>
<td>11,000</td>
<td>1.077</td>
<td>0.75</td>
<td>1.10</td>
<td>67.31%</td>
</tr>
<tr>
<td>2014</td>
<td>15,000</td>
<td>10,000</td>
<td>1.051</td>
<td>1.00</td>
<td>1.06</td>
<td>66.08%</td>
</tr>
<tr>
<td>2015</td>
<td>14,000</td>
<td>9,000</td>
<td>1.025</td>
<td>1.00</td>
<td>1.04</td>
<td>63.36%</td>
</tr>
<tr>
<td>2016</td>
<td>11,000</td>
<td>8,000</td>
<td>1.000</td>
<td>1.00</td>
<td>1.00</td>
<td>72.73%</td>
</tr>
</tbody>
</table>

Average of 2013-2015 = 65.6%.
Recommend claim ratio of 65.6%. 2016 is highly leveraged so this accident year should be excluded.

(b) Calculate the accident year 2015 expected claims.

AY 2015 expected claim ratio = 65.6% × 1.04 / (1.025 × 1.00) = 66.6%
AY 2015 expected claims = 66.6% × 14,000 = 9,324

(c) Explain how a development factor can highly leverage a projection.

Cumulative development factors are highly leveraged in the most immature time periods and affect the most recent year’s calculation.
11. Continued

(d) Explain how a trend factor can highly leverage a projection.

Trend factors are highly leveraged in the oldest time periods and affect the oldest year’s calculation.
12. Learning Objectives:
4. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

Learning Outcomes:
(4e) Choose trend rates and calculate trend factors for exposures.

(5h) Calculate deductible factors, increased limits factors, and coinsurance penalties.

Sources:

Commentary on Question:
This question tests the fundamental trend adjustments to premium as well as an understanding of deductibles.

Solution:
(a) State two reasons why an insurer would want to encourage insureds to increase their deductibles.

Any two of the following are acceptable (other answers are possible):
- Assist in reducing moral and morale hazard
- Encourage insureds to adhere to some measure of risk control
- Eliminate the processing costs associated with small claims
- Reduce exposure to catastrophic claims

(b) Calculate the annual change in premium for each year.

<table>
<thead>
<tr>
<th>Deductible</th>
<th>Current Differentials</th>
<th>% Earned Exposures by Deductible</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>1.10</td>
<td>50% 45% 20% 18% 15%</td>
</tr>
<tr>
<td>500</td>
<td>1.00</td>
<td>30% 32% 55% 52% 50%</td>
</tr>
<tr>
<td>1,000</td>
<td>0.90</td>
<td>20% 23% 25% 30% 35%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100% 100% 100% 100% 100%</td>
</tr>
</tbody>
</table>

Weighted average differential: 1.030(1)
Change in average differential: -0.78%(2)

Notes: (1): (0.50×1.10 + 0.30×1.00 + 0.20×0.90) = 1.030
(2): 1.022 / 1.030 – 1 = –0.78%
12. Continued

(c) Recommend the annual premium trend rate to use in adjusting from calendar year 2016 to the future rating period. Justify your recommendation.

2014 needs to be excluded due to the one-time initiative to encourage insureds to increase their deductibles from 200 to 500. This is not expected in the future and should not be considered in the recommended annual premium trend rate. Recommend the average of 2013, 2015 and 2016 = –0.76%.

(d) Calculate the calendar year 2012 earned premium to use for ratemaking.

Trend from experience period in 2012 to forecast period in 2016 (trend period 1), and then from forecast period in 2016 to forecast period in future rating period (trend period 2).

Trend period 1: from average earned date in 2012 to average earned date in 2016 (July 1, 2012 to July 1, 2016):

(1) Weighted average differential in 2012: 1.030
(2) Weighted average differential in 2016: 0.980
(3) Trend factor from 2012 to 2016 \([\frac{2}{1}]\) = 0.9515

Trend Period 2: from average earned date in 2016 to future rating period

(4) Average earned date in CY 2016: 1-Jul-16
(5) Average earned date in future rating period: 1-Sep-18
(6) Trending period (months): 26
(7) Trend factor = \((1 + -0.0076)^{26/12}\) = 0.9836
(8) 2012 Earned Premium @ current rate level 240,000

(9) Total 2012 trended on level EP = (8)(3)(7)
    = 240,000 \times 0.9515 \times 0.9836 = 224,615
13. **Learning Objectives:**
   
   2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

**Learning Outcomes:**

(2a) Use loss development triangles for investigative testing.

**Sources:**


**Commentary on Question:**

*This question is concerned with identifying potential issues with data triangles and what diagnostic tests can be used on data triangles.*

**Solution:**

(a) Explain three ways a development triangle can be useful in investigative testing.

Any three of the following are acceptable:

- Compare reasonableness of year to year, between types of data.
- Help with identification of data quality issues.
- Source of documentation required for information gathering phase.
- Reasonableness of management’s assertions on company’s operations.
- Determine if the qualitative information is consistent with the patterns observed in the quantitative data.
- Leads to further questions to identify additional data or information needs.

(b) Explain the value of each of the following additional investigative tests in analyzing claims data:

(i) Ratio of closed counts to reported counts

(ii) Ratio of counts closed with no payment to closed counts

(iii) Average case estimates

(i) Ratio of closed counts to reported counts:

This triangle is used to see if there are similar trends between counts and amounts when looked in in combination with paid claims to reported claims. It can indicate a possible claims processing backlog.

(ii) Ratio of counts closed with no payment to closed counts:

This triangle can be used to help identify changes in settlement practices, and look for stability in ratios.
13. Continued

(iii) Average case estimates:
This triangle can be used to determine if there have been changes in the overall adequacy of case estimates, recognizing that large claims can distort any change.

(c) Identify two anomalies in the ratio of paid claims to reported claims triangle that might require further investigation.

Commentary on Question:
Other anomalies are possible.

- The 12 month trend is increasing (down the column) while all others are decreasing.
- Across the rows, claims are being paid out faster in 2014 and 2015 than 2013.

(d) Identify two anomalies in the average reported claims triangle that might require further investigation.

Commentary on Question:
Other anomalies are possible.

- 2014 seems to be low across the durations, suggesting there might be something unique to this year.
- There is an outlier possible in 2016 at 12 months, suggesting possible large claim(s).
14. **Learning Objectives:**

4. The candidate will understand trending procedures as applied to ultimate claims, exposures and premiums.

5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**

(4a) Identify the time periods associated with trending procedures.

(4c) Choose trend rates and calculate trend factors for claims.

(5d) Calculate loadings for catastrophes and large claims.

(5f) Calculate overall rate change indications under the claims ratio and pure premium methods.

**Sources:**


**Commentary on Question:**

*This question tests the candidate’s understanding of loadings for large claims as well as basic ratemaking.*

**Solution:**

(a) Calculate a loading for ice storm claims to use in your ratemaking analysis.

Trending period for ice storm claims: trend from date of ice storm to average accident date in rating period (average date between November 1, 2017 and May 1, 2019) = March 1, 2014 to August 1, 2018 = 53 months, or 4.417 years

(1) Trended ultimate ice storm claims = 2,350,000×(1+0.04)^{53/12} = 2,794,464

(2) Total earned exposures over the 5 years = 41,300

(3) Trended ultimate ice storm claims pure premium =(1) / (2) = 67.663

(4) Ice storm pure premium for ratemaking = (3) / 2 = 33.832

{Spread the 5 year pure premium over 10 years as the question states these types of events are expected every 10 years}

(5) 2016 earned exposures = 8,600

(6) Ice storm expected claims = (4)(5) = 33.832×8,600 = 290,955

(7) Trended 2016 earned premium at current rates = 8,730,000

(8) Ice storm loading as a claim ratio = (6) / (7) = 3.33%
14. Continued

(b) Calculate the indicated rate level change based on the latest three years’ experience.

\[
\text{Pure premium trend} = (1 + 0.04)(1 - 0.01) - 1 = 2.96\%
\]

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Trend Period</th>
<th>Pure Premium Trend Factors</th>
<th>Trended Earned Premium at Current Rate Level</th>
<th>Trended Ultimate Claims excluding Ice Storm</th>
<th>Claim Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>4.0833</td>
<td>1.1265</td>
<td>8,430,000</td>
<td>6,297,135</td>
<td>74.7%</td>
</tr>
<tr>
<td>2015</td>
<td>3.0833</td>
<td>1.0941</td>
<td>8,630,000</td>
<td>6,488,013</td>
<td>75.2%</td>
</tr>
<tr>
<td>2016</td>
<td>2.0833</td>
<td>1.0627</td>
<td>8,730,000</td>
<td>6,142,406</td>
<td>70.4%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>25,790,000</td>
<td>18,927,554</td>
<td>73.4%</td>
</tr>
</tbody>
</table>

(14) Selected claim ratio = 73.4%
(8) Ice storm claim ratio (from part (a)) = 3.33%
(15) ULAE = 8% (given)
(16) Total claim ratio including ULAE = [(14) + (8)]×[1 + (15)] = 82.87%
(17) Indicated rate level change = [(16) + 0.04] / (1 – 0.19 – 0.05) – 1 = 14.30%

Notes: (9) Trend Period = July 1 each year to August 1, 2018
(12) AY 2014 trended ultimate claims excludes ultimate ice storm claims
15. **Learning Objectives:**
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(5g) Calculate risk classification changes and territorial changes.

**Sources:**
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 32.

**Commentary on Question:**
*This question tests the candidate’s understanding of risk classification.*

**Solution:**
(a) Describe how an effective risk classification system can assist an insurance system in achieving the criterion noted above.

An effective risk classification system can reduce adverse selection, which facilitates estimation of cost and its variation.

(b) Define distributional bias in the context of risk classification systems, including a numerical example with a $2 \times 2$ risk classification matrix.

**Commentary on Question:**
*Any example that demonstrates distributional bias can be used.*

Distributional bias occurs when there are differences in the distribution of exposures by risk characteristic between risk classes. For example, male drivers may represent a larger percentage of young drivers than they do of old drivers.

**Numerical example:**

<table>
<thead>
<tr>
<th></th>
<th>Number of Exposures</th>
<th>Ratio of male to female:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Old</td>
<td>Young</td>
</tr>
<tr>
<td>Male</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Female</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

The ratios are not the same; therefore there is distributional bias.
15. Continued

(c) Define dependence in the context of risk classification systems, including a numerical example with a 2×2 risk classification matrix.

**Commentary on Question:**

*Any example that demonstrates dependence can be used.*

Dependence occurs when knowing the risk class of an insured within one risk characteristic changes the true relativities for the risk classes in another risk characteristic from what they would be without that knowledge. For example, the ratio of pure premium for male drivers to the pure premium for female drivers may be different for young drivers than old drivers.

Numerical example:

<table>
<thead>
<tr>
<th>Pure Premium</th>
<th>Old</th>
<th>Young</th>
<th>Ratio of male to female:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>50</td>
<td>100</td>
<td>Old 1.0</td>
</tr>
<tr>
<td>Female</td>
<td>50</td>
<td>50</td>
<td>Young 2.0</td>
</tr>
</tbody>
</table>

The ratios are not the same; therefore there is dependence.

(d) Describe an approach that can be used to resolve:

(i) Distributional bias in the context of risk classification systems

(ii) Dependence in the context of risk classification systems

(i) The minimum bias procedure can correct for distributional bias.

(ii) An alternative model is needed for dependence. One possibility would be to calculate pure premium directly for each cell.
16. **Learning Objectives:**
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

**Learning Outcomes:**
(5i) Calculate rates for large accounts.

**Sources:**

**Commentary on Question:**
*This question tests the candidate’s understanding of funding allocation for self-insurers.*

**Solution:**
(a) State two reasons why a group of schools might want to self-insure their risk.

Any two of the following are acceptable:
- Dissatisfaction with existing insurance coverage or costs
- Reduction in long-term costs
- Need for tailor-made solutions to address unique exposures to risk
- Ability to improve and enhance risk management operations
- Increased control over the risk financing function

(b) Provide an example of an experience rating program objective that might conflict with each of the following objectives of a self-insurance program:

(i) Stability in the allocations from year-to-year

(ii) An allocation formula that is simple to apply and easy to understand

(i) Experience rating formulas that hold insureds responsible for claims may not produce stable results.

(ii) A program that promotes equity among insureds may not be easy to understand.
16. Continued

(c) Explain which approach would result in an allocation that would satisfy each of
the following objectives of the self-insurance program:

(i) Stability of year-to-year allocation

(ii) Encourage the schools to participate in risk control activities

(i) Using capped losses over a longer experience period are ways to produce a
more stable allocation. Therefore, recommend using limited losses over 5
years.

(ii) Recommend using claim count percentage in this calculation because it
measures the actual experience of each school.

(d) Calculate next year’s allocation using the allocation base from part (c)(i).

<table>
<thead>
<tr>
<th>School</th>
<th>Credibility</th>
<th>Limited Claims Last 5 years</th>
<th>Experience Modification</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.45</td>
<td>0.30 - 0.70</td>
<td>1.225</td>
<td>25.6%</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
<td>0.30 - 0.70</td>
<td>1.100</td>
<td>28.7%</td>
</tr>
<tr>
<td>3</td>
<td>0.75</td>
<td>0.30 - 0.70</td>
<td>0.795</td>
<td>45.7%</td>
</tr>
</tbody>
</table>

Notes: Credibility (Z) = Squareroot(Payroll / 40,000)
Experience Modification = Z×(Limited Claims Last 3 Years % of Total)/(Payroll % of Total) + (1 – Z)
e.g., 1.225 = 0.45×0.30/0.20 + (1 – 0.45)
Allocation = (Experience Modification)(Payroll % of Total) / Sumproduct(Experience Modifications, Payroll %’s of Total)
e.g., 25.6% = (1.225×0.20) / (1.225×0.20 + 1.100×0.25 + 0.795×0.55)

(e) Explain how the allocation for School X is affected by this change in credibility.

By making the minimum credibility = 0.5, the full credibility standard would
decrease. This would increase the credibility for school 1, which would assign
more weight to the experience mod factor that is greater than 1, which increases
the allocation.
17. **Learning Objectives:**

2. The candidate will understand how to calculate projected ultimate claims and claims-related expenses.

6. The candidate will understand the need for monitoring results.

**Learning Outcomes:**

(2b) Estimate ultimate claims using various methods: development method, expected method, Bornhuetter Ferguson method, Cape Cod method, frequency-severity methods, Berquist-Sherman methods.

(6b) Analyze actual claims experience relative to expectations.

**Sources:**

**Commentary on Question:**
This question tests the development method for estimating ultimate claims. In addition, it tests the understanding of expected paid and reported claims for an interim period between actuarial analyses.

**Solution:**

(a) List the next five steps of the development method.

- Calculate average age to age factors
- Select age to age factors for each maturity age interval
- Select a tail factor
- Calculate cumulative development factors
- Project ultimate values

(b) Explain one advantage and one disadvantage for each of the following approaches:

(i) Bondy method

(ii) Algebraic method

(iii) Use of benchmark data

(i) Bondy method:
Advantage: easy to understand and explain
Disadvantage: potential to greatly underestimate the remaining development for long tail lines
17. Continued

(ii) Algebraic method:
Advantage: based on data contained within the development triangles so no additional data is required
Disadvantage: a reliable estimate of ultimate claims is required for the most mature periods and is not always available

(iii) Use of benchmark data:
Advantage: significant amount of relevant and credible data
Disadvantage: requires judgement to the appropriateness of the external data

(c) Recommend a development factor and justify your recommendation.

<table>
<thead>
<tr>
<th>Accident Year</th>
<th>Cumulative Reported Claims (000)</th>
<th>Development Factors (24/12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>2014</td>
<td>140</td>
<td>260</td>
</tr>
<tr>
<td>2015</td>
<td>230</td>
<td>395</td>
</tr>
<tr>
<td>Simple Average</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume Weighted Average</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Recommend volume-weighted average of 1.754 because it reflects the increasing exposure volume.

(d) Describe one disadvantage of using a medial average for your development factor recommendation in part (c).

The disadvantage of medial average in this case is the development factor is selected based on a sample size of one.

(e) Describe two likely explanations for the differences between the expected and actual claims in this situation.

Any two of the following are acceptable:
- The development selections (ultimate claims) are too conservative.
- There was an issue with paid claims in the first quarter that affects paid and reported development.
- There a legal decision that affected claims in all years.
18. **Learning Objectives:**
   3. The candidate will understand financial reporting of claim liabilities and premium liabilities.

**Learning Outcomes:**
(3e) Describe the components of premium liabilities in the context of financial reporting.
(3f) Evaluate premium liabilities.

**Sources:**

**Commentary on Question:**
This question tests the determination of premium liabilities.

**Solution:**
(a) Calculate the net premium liabilities as of December 31, 2016.

<table>
<thead>
<tr>
<th></th>
<th>Gross of Reinsurance</th>
<th>Net of Reinsurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unearned Premiums</td>
<td>15,000</td>
<td>10,500</td>
</tr>
<tr>
<td>Net = 15,000 × 70% (after quota share)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected Claims = 15,000 × 70%</td>
<td>10,500</td>
<td>7,350</td>
</tr>
<tr>
<td>Net expected claims = 10,500 × 70%. The large claim should not be carried forward.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected ULAE = 10,500 × 9.1%</td>
<td>956</td>
<td>956</td>
</tr>
<tr>
<td>Maintenance Expenses = 15,000 × 8%</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td>Commissions are N/A because they were pre-paid</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total Claims &amp; Expenses = Net Premium Liabilities</td>
<td>9,506</td>
<td></td>
</tr>
</tbody>
</table>

(b) Determine either the premium deficiency reserve or the equity in the unearned premium as of December 31, 2016 and label accordingly.

Equity in Unearned Premium = 10,500 – 9,506 = 994.

\{Equity since the number is positive\}

(c) State the purpose of a premium deficiency reserve.

The purpose of a premium deficiency reserve is to supplement the unearned premium reserve as a liability for unexpired contractual obligations of insurance policies.
Learning Objectives:
5. The candidate will understand how to apply the fundamental ratemaking techniques of general insurance.

Learning Outcomes:
(5k) Calculate rates for claims-made coverage.

Sources:
Fundamentals of General Insurance Actuarial Analysis, J. Friedland, Chapter 34.

Commentary on Question:
This question tests the candidate’s understanding of claims-made ratemaking.

Solution:
(a) Define the following terms:

(i) trigger for coverage

(ii) retroactive date

(iii) extended reporting endorsement

(iv) prior acts coverage

(i) Event that initiates coverage (for occurrence policies this is the accident date; for claims-made policies this is the report date).

(ii) The beginning of the timeframe for which occurrences are covered under claims-made policies.

(iii) The part of a claims-made policy that covers claims reported after the policy expires or is cancelled, provided that that the occurrence is during the claims-made coverage period.

(iv) The claims-made coverage for occurrences prior to the effective date of a new policy reported during the new policy period.
19. Continued

(b) State a formula for pure premium using notation underlying the $C_{ij}$ cells in the table above for each of the following items:

(i) Occurrence policy for year 1

(ii) Third-year claims-made policy for year 3 with retroactive date January 1, year 3

(iii) Mature claims-made policy for report year 3

(iv) Extended reporting endorsement for mature claims-made policy effective January 1, year 2 terminating December 31, year 2

(i) $C_{0,1} + C_{1,2} + C_{2,3} + C_{3,4} + C_{4,5}$

(ii) $C_{0,3} + C_{1,3} + C_{2,3}$

(iii) $C_{0,3} + C_{1,3} + C_{2,3} + C_{3,3} + C_{4,3}$

(iv) $C_{1,3} + C_{2,3} + C_{3,3} + C_{4,3} + C_{4,4} + C_{3,5} + C_{4,5} + C_{4,6}$

(c) Identify the coverage gap for the following situations:

(i) First-year claims-made policy effective January 1, year 1 and second-year claims-made policy effective January 1, year 4

(ii) Occurrence policy effective January 1, year 1 and mature claims-made policy effective January 1, year 6

(i) $C_{0,2} + C_{1,2} + C_{1,3} + C_{2,3} + C_{3,4} + C_{2,4} + C_{3,4}$

(ii) $C_{0,2} + C_{0,3} + C_{1,3} + C_{0,4} + C_{1,4} + C_{2,4} + C_{0,5} + C_{1,5} + C_{2,5} + C_{3,5}$
20. Learning Objectives:
   1. The candidate will understand the key considerations for general insurance actuarial analysis.

Learning Outcomes:
(11) Adjust historical earned premiums to current rate levels.

Sources:

Commentary on Question:
This question tests the candidate’s understanding of adjusting premium to current rate level for purpose of projecting ultimate claims as well as for ratemaking analysis.

Solution:
(a) Identify two key requirements for an insurer to be able to use the extension of exposures method.

Any two of the following are acceptable:
- Sophisticated IT systems
- Comprehensive databases of prior exposures
- No new rating variables for which there is no historical data

(b) Explain why the extension of exposures method is less valuable for commercial lines that apply experience rating and/or schedule rating.

It is much more complex to reflect adjustments from experience rating and schedule rating when trying to adjust historical premiums to the current rate level for commercial lines in an extension of exposures approach.

(c) Explain how the extension of exposures method could be applied to commercial lines that apply experience rating and/or schedule rating.

Use the extension of exposures method to restate historical premium at the current base rates and capture the changes over time in rating adjustments through premium trending procedures.
20. Continued

(d) Calculate the weighted average rate level value for calendar year 2014.

Candidates do not need to draw diagram, but may find it helpful to solve the question.

\[
\begin{array}{c|c|c|c|c|c}
\text{Rate Level} & \text{Relative Value} & \text{2014} \\
\hline
A & 1.0000 & 85.9375\% \\
B & 1.0800 & 14.0625\% \\
C & 0.9720 & \ \\
D & 1.0498 & \ \\
\hline
\end{array}
\]

Weighted average rate level: \[1.01125\]

i.e., \[14.0625\% = \frac{1}{2}(9/12)(4.5/12)\]
\[1.01125 = (1 \times 0.859375) + (1.08 \times 0.140625)\]

(e) Calculate the premium on-level factor for 2014 for the purpose of:

(i) Projecting ultimate claims as of December 31, 2017

(ii) Ratemaking analysis

Weighted average rate level for calendar year 2017:

\[
\begin{array}{c|c|c}
\text{Rate Level} & \text{Relative Value} & \text{2017} \\
\hline
A & 1.0000 & \ \\
B & 1.0800 & 6.25\% \\
C & 0.9720 & 87.50\% \\
D & 1.0498 & 6.25\% \\
\hline
\end{array}
\]

Weighted average rate level: \[0.98361\]

i.e., \[0.98361 = (1.08 \times 0.0625) + (0.972 \times 0.875) + (1.0498 \times 0.0625)\]
20.  Continued

(i)  For projecting ultimate claims as of December 31 2017, need to adjust to calendar year 2017 average rate level of 0.9836.

    Premium on-level factor for 2014 = 0.9836 / 1.01125 = 0.9727

(ii) For ratemaking analysis, need to adjust to current rate level of 1.0498.

    Premium on-level factor for 2014 = 1.0498 / 1.01125 = 1.0381