SOCIETY OF ACTUARIES

Foundations of CFE Exam

Exam CFEFD

Date: Thursday, April 29, 2021

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 9 questions numbered 1 through 9 with a total of 100 points.

   The points for each question are indicated at the beginning of the question. Questions 1 – 9 pertain to the Case Study.

2. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions provided this document.

Written-Answer Instructions

1. Each question part or subpart should be answered either in the Word document or the Excel file as directed. Graders will only look at work in the indicated file.

   a) In the Word document, answers should be entered in the box marked ANSWER. The box will expand as lines of text are added. There is no need to use special characters or subscripts (though they may be used). For example, β_1 can be typed as beta_1 (and ^ used to indicate a superscript).

   b) In the Excel document formulas should be entered. Performing calculations on scratch paper or with a calculator and then entering the answer in the cell will not earn full credit. Formatting of cells or rounding is not required for credit.

   c) Individual exams may provide additional directions that apply throughout the exam or to individual items.

2. The answer should be confined to the question as set.

3. Prior to uploading your Word and Excel files, each file should be saved and renamed with your five-digit candidate number in the filename.

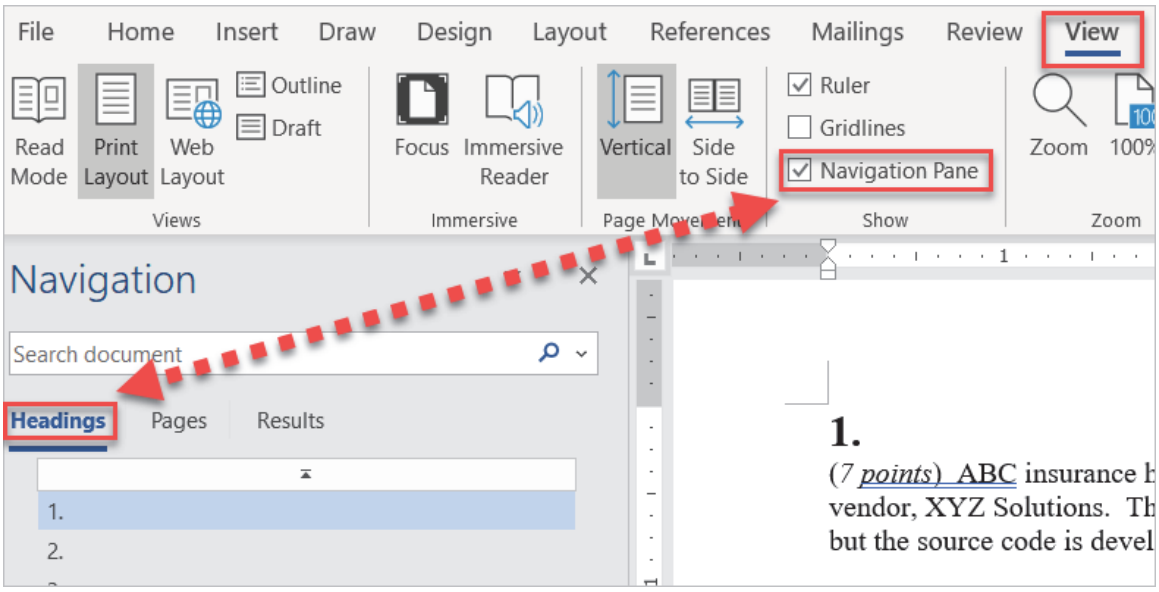
4. The Word and Excel files that contain your answers must be uploaded before time expires.

Recognized by the Canadian Institute of Actuaries.

Navigation Instructions

Open the Navigation Pane to jump to questions.

Press Ctrl+F, or click View > Navigation Pane:



CASE STUDY INSTRUCTIONS

The case study will be used as a basis for some examination questions. Be sure to answer the question asked by referring to the case study. For example, when asked for advantages of a particular plan design to a company referenced in the case study, your response should be limited to that company. Other advantages should not be listed, as they are extraneous to the question and will result in no additional credit. Further, if they conflict with the applicable advantages, no credit will be given.

Questions 1 through 9 pertain to the Case Study.
Each question should be answered independently.

1.

(*11 points*) You have been assigned to assist Blue Ocean with its expansion project to grow its pet and travel insurance divisions (Case Study Section 5.3).

(a) (*1 point*) Recommend a cost of capital rate to use for the pet and travel expansion project. Justify your recommendation.

ANSWER:

(b) (*2 points*) Explain four reasons that the cost of capital rate of Blue Ocean's competitors might be different than what you recommended in (a).

ANSWER:

(c) (*1 point*) Explain two non-financial factors that could have an impact on the cost of capital rate Blue Ocean ultimately uses for the expansion project.

ANSWER:

(d) (*2 points*) Recommend how Blue Ocean should finance its pet and travel expansion project. Justify your recommendation.

ANSWER:

1. Continued

Blue Ocean is considering reinsurance for the pet insurance and travel insurance expansion.

(e) (*3 points*)

(i) Explain how Blue Ocean can use reinsurance to mitigate agency conflict between policyholders and shareholders.

(ii) Explain how Blue Ocean would view reinsurance if it were a mutual company.

(iii) Evaluate the effectiveness of securitization compared to reinsurance for pet insurance and travel insurance.

ANSWER:

(f) (*2 points*) Critique the capital Blue Ocean is holding with respect to its minimum regulatory capital requirement.

ANSWER:

Questions 1 - 9 pertain to the Case Study.
Each question should be answered independently.

2.

(*12 points*) You are an actuary working with Jane Smith, the CRO at Darwin Life. Smith has asked you to address the concerns that CEO Brandon Kaladin raised on the proposed Indexed Universal Life product (Case Study Section 7.7.1).

You reviewed the pricing analysis, which includes a distribution of the statutory IRR under a set of equally likely scenarios. You plan a response to Kaladin's question, *"Have you settled on new risk metrics and what will be on the risk dashboard?"*

(a) (*1 point*) Describe the four characteristics of a coherent risk measure.

ANSWER:

Smith suggests using the 5% VaR of statutory distributable income to quantify the risk in the portfolio.

(b) (*2 points*)

(i) Determine the 5% VaR for the following portfolios.

I. IULF – Fixed Rate Account
II. IULV – Indexed Account
III. IUL product consisting of both fixed and indexed accounts
IV. Current UL portfolio

(ii) Assess the appropriateness of the selected measure to quantify the risk in the proposed product.

ANSWER:

2. Continued

Smith suggests the risk dashboard show the economic capital allocated to each of the Universal Life portfolios: IULF, IULV, and the Current UL. You have allocated the economic capital to these three portfolios, reflecting the diversification benefit with both the first-in method and the marginal last-in method. Smith suggests using Shapley values.

(c) (*6 points*)

(i) Calculate the economic capital allocation for each of the three portfolios using Shapley values to reflect the diversification benefit. Show your work.

The response for this part is to be provided in the Excel spreadsheet.

(ii) Explain two advantages and two limitations of using Shapley values.

ANSWER:

You meet with Smith to discuss concerns raised in Kaladin's email about the stochastic models used for the IUL analysis.

(d) (*3 points*) Critique the use of stochastic models for management decision making purposes regarding the IUL product launch.

ANSWER:

Questions 1 - 9 pertain to the Case Study.
Each question should be answered independently.

3.

(*13 points*) Snappy Life (Case Study Section 8) wants to increase market share by offering more complex products. However, Snappy is aware that it does not have sufficient capital and lacks underwriting expertise on complex products.

Darwin Life (Case Study Section 7) wants to create an online distribution channel for life insurance products but it lacks expertise.

Snappy and Darwin enter into a partnership and are in the process of forming a new Insurtech company, DEF. Snappy and Darwin plan to start with simple, low premium products, such as Term, before adding Whole Life and, ultimately, Universal Life in the future.

(a) (*3 points*)

(i) Identify the four dimensions of key product attributes.

(ii) Describe an example for each dimension in (i) that Darwin should consider in its venture with Snappy.

ANSWER:

Within the strategy hierarchy, the third level deals with functional strategies.

(b) (*3 points*)

(i) Identify three primary functions for most organizations.

(ii) Explain what DEF needs to consider as it develops a functional strategy for each function in (i).

ANSWER:

3. Continued

(c) (*3 points*)

(i) Identify the five elements of the process of transforming input into output for DEF.

(ii) Recommend how Darwin should apply the five elements in (i) to work with Snappy on product development. Justify your recommendation.

ANSWER:

(d) (*2 points*) Propose two examples each of appropriate financial, internal, and external measures for DEF. Justify your answers.

ANSWER:

(e) (*2 points*) Apply the supply chain risk management process to the risk of an IT breakdown within DEF.

ANSWER:

Questions 1 through 9 pertain to the Case Study.
Each question should be answered independently.

4.

(*13 points*) Blue Jay Tire (BJT) is considering the two options for its product expansion project (Case Study Section 3.4). You are an analyst at BJT.

(a) (*2 points*)

(i) Calculate the Net Present Value (NPV) for each of the two alternatives of the product expansion project. Show your work.

(ii) Recommend which alternative BJT should select based on your calculation in (i). Justify your recommendation.

ANSWER:

"That's too simplistic," argues the COO. "There is a 1/3rd chance that we will be unsuccessful. That $10 million average profit is really $15 million if we succeed and $0 if we fail. We need some relief if we are not successful."

To address the COO's concern, labor union leaders of TNT have agreed to negotiate future employment levels. If profits prove disappointing after year 2, the labor union will allow BJT to lower its expenses by reducing staff in exchange for a one-time $6 million buy-out. Whitewall Consulting (WC) estimates that the reduced labor costs would allow BJT's profit to be $3 million per year.

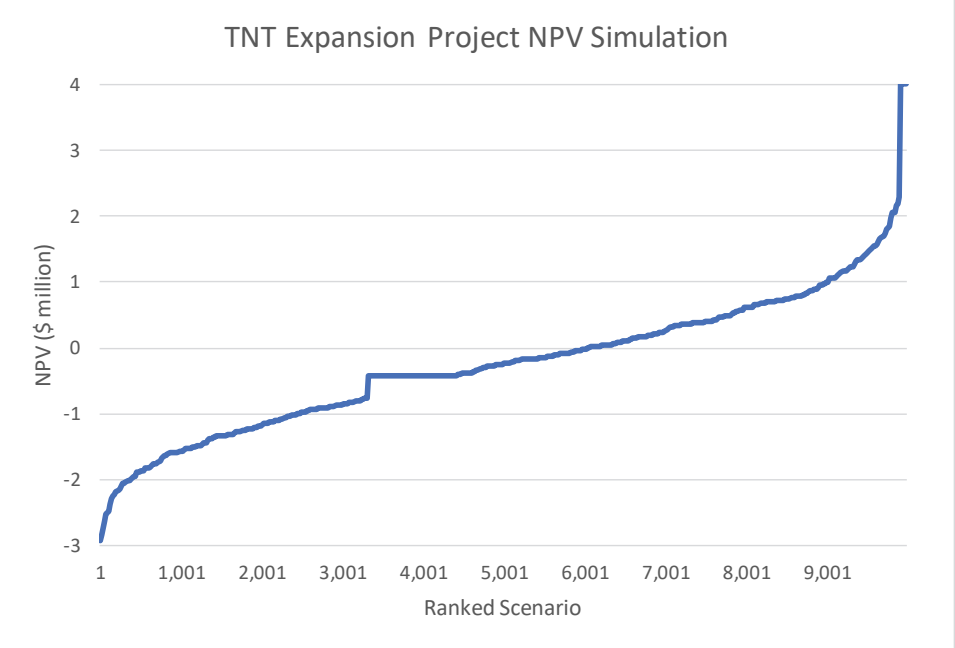
(b) (*2 points*) Calculate the value of the option for BJT to reduce staff. Show your work.

ANSWER:

4. Continued

WC has also built a multi-variate stochastic model to calculate the NPV of acquiring TNT. This model allows for the state of the economy, and therefore BJT's sales and other measures, to vary over the projection. A summary of the results and a graphical representation of 10,000 simulations run on this model is shown below.

NPV ($ millions)				
Average	0.2711		VaR(35)	0.1078
Median	0.2432		VaR(50)	-0.2432
Minimum	-3.0464		VaR(65)	-0.4210
Maximum	2.9268		VaR(95)	-1.8833
CTE(65)	-0.8034		VaR(99)	-2.5309



(c) (*3 points*) Analyze the results of WC's stochastic model.

ANSWER:

(d) (*1 point*) Describe three shortfalls of using a stochastic model for decision making.

ANSWER:

4. Continued

"This is all too complicated," states BJT's Head of Sales. "There are so many factors and assumptions that we are just fooling ourselves. We should use a simple rule-of-thumb to compare our alternatives," he suggests.

(e) (*2 points*) Using your information from part (a)

(i) Calculate the highest hurdle rate that would allow BJT to accept the expansion project under the alternative to buy TNT. Show your work.

(ii) Calculate the profitability index value for BJT's expansion project under the alternative to build its own plant. Show your work.

(iii) Recommend which alternative Blue Jay Tire should select based on the above rules of thumb. Justify your recommendation.

ANSWER:

You summarize results from (a), (b), (c), and (e) and formulate a recommendation to the COO.

(f) (*3 points*) Recommend a course of action for BJT including your summary of results. Justify your recommendation.

ANSWER:

Questions 1 through 9 pertain to the Case Study.
Each question should be answered independently.

5.

(*12 points*) RPPC, a company that reports in euro (EUR), has hired you to make sure that Big Ben Bank (Big Ben) is reflected appropriately in its consolidated financial statements (Case Study Section 6.4 Exhibit A).

(a) (*2 points*) Explain four considerations relevant to Big Ben when determining its functional currency.

ANSWER:

5. Continued

Big Ben declared a dividend of 22 million pounds sterling (GBP) on 10/01/2019 to be paid on 12/31/2019. GBP and EUR exchange rates for select dates and time periods are provided below.

Date	EUR per GBP
1/1/2019	1.20
4/1/2019	1.22
7/1/2019	1.15
10/1/2019	1.13
12/31/2019	1.10
Avg. 1955-2018	1.30
Avg. 2019	1.18

You have been provided:

- The average exchange rate when Big Ben acquired inventory, plant, property, and equipment was 1.18 EUR per GBP.
- The average exchange rate when Big Ben received capital contributions from equity and long-term debt was 1.25 EUR per GBP.
- Big Ben's pre-2019 retained earnings were realized at an average exchange rate of 1.21 EUR per GBP.
- Big Ben's "Other Assets" are not measured at Current Value, but "Other Liabilities" are.

(b) (*4 points*) Calculate Big Ben's 2019 foreign currency Cumulative Translation Adjustment that should be included on RPPC's 2019 financial statements, including AOCI and Retained Earnings. Show your work.

The response for this part is to be provided in the Excel spreadsheet.

5. Continued

(c) (*2 points*) Assess the directional impact of 2019 currency movements on the following if management were to determine that Big Ben's functional currency is EUR:

(i) Big Ben's translated assets

(ii) Big Ben's translated revenues

(iii) Big Ben's translated net income

(iv) Big Ben's income statement and/or balance sheet foreign currency translations

Show your work.

ANSWER:

(d) (*3 points*) Recommend three specific actions to decrease foreign exchange volatility on RPPC's financial statements assuming Big Ben's functional currency is EUR. Justify your recommendation.

ANSWER:

(e) (*1 point*) Explain how investors can objectively compare RPPC's financial results to its competitors despite foreign exchange volatility.

ANSWER:

Questions 1 - 9 pertain to the Case Study.
Each question should be answered independently.

6.

(*9 points*) A global pandemic has caused many countries to declare a temporary state of emergency, forcing employees to work from home, some businesses to shut down while people practice physical distancing, and major delays of global imports at borders. No country is considered safe from the impacts of the pandemic.

(a) (*1 point*) Define supply chain disruption.

ANSWER:

Blue Jay Tire (BJT) wants to analyze its supply chain disruption (Case Study Section 3.2) by using the Flow and Process Method. It will examine the series of nodes of the supply chain (representing transformation processes) with connecting arcs (representing flows of information and products).

(b) (*2 points*) Describe two disruptions that the global pandemic may cause to BJT's supply chain.

ANSWER:

(c) (*4 points*)

(i) Recommend two risk management strategies that could help BJT mitigate future global pandemic supply chain disruptions. Justify your answer.

(ii) Evaluate the tradeoffs to the recommendations in (i) with respect to BJT's supply chain.

ANSWER:

The Board of BJT would like to reduce the damage caused by a similar supply chain disruption event in the future.

(d) (*2 points*) Describe two tools the BJT Board could use to oversee the operational risk from future global pandemic supply chain disruptions.

ANSWER:

Questions 1 - 9 pertain to the Case Study.
Each question should be answered independently.

7.

(*13 points*) Big Ben is exploring the Solar Energy Financing Business opportunity (Case Study Section 6.4, Section 6.5 Exhibit B, C and D) in three different cities. Big Ben will allocate at least 20% of its planned loan amount of $10M to each city. Big Ben is building a model to maximize projected total cash payments received from the investment over the loan period based on different allocations to each city.

(a) (*2 points*)

(i) Design a mathematical programming model to optimize Big Ben's allocation to each city.

ANSWER:

(ii) Explain each component of (i).

ANSWER:

(b) (*1 point*) Recommend two additional metrics Big Ben can use to evaluate the Solar Energy Financing opportunity other than the total cash payments received and IRR. Justify your recommendation.

ANSWER:

Analyst X suggests using the model that created deterministic results under Exhibit B and using the assumptions in Exhibit D to project the total cash payments received.

(c) (*2 points*) Critique Analyst X's suggestion on building the model.

ANSWER:

7. Continued

Due to model runtime concerns, Big Ben will have to limit the number of variables modelled stochastically. Given the risk factors listed in Case Study Section 6.4 and assumptions listed in Exhibit D:

(d) (*2 points*) Recommend which two risk factors should be modelled stochastically. Justify your recommendation.

ANSWER:

(e) (*1 point*) Explain which risk factors listed in Case Study Section 6.4 may be hedgeable.

ANSWER:

Analyst Y develops a set of stress tests to estimate the impact on total cash payments received if conditions deviate from model assumptions (Exhibit D). Analyst Y presents to Patel the following stress test proposal with preliminary results, based on the model used for Exhibit B.

Assumption	**Stress**	**Impact**
Loan term	-5 years	-2M
Loan interest rate	+1%	-2M
Energy retail sales rate	-25% (multiplicative)	-1M
Personal energy consumption	-25% (multiplicative)	+2M
Utility company participation	-10% (additive)	-20M

Patel says: "These stress tests are excellent! Not only do they cover all identified risks, they illustrate the adverse direction and correct magnitude of impacts. Now we know the events we need to worry about!"

(f) (*2 points*) Critique Patel's statement regarding the stress test proposal and results.

ANSWER:

7. Continued

Patel wants to know at the beginning of each month the amount that Big Ben can expect to receive at the end of the month for each of the three cities. Since weather has a significant impact on results, the analysts gather weather data for each city.

Analyst X uses 10 years of daily data to calibrate a model to replicate the incidence of sunny days. Analyst Y uses 5 years of daily data to train and 2 years of daily data to test a model to predict sunny days.

Metric	Results	
	Analyst X's Model	Analyst Y's Model
Mean Squared Error	0.01	4.25
R^2	99.7%	85.5%

(g) (*2 points*)

(i) Contrast the two models.

ANSWER:

(ii) Interpret the results of the two models.

ANSWER:

(iii) Recommend which model Big Ben should pursue. Justify your recommendation.

ANSWER:

Big Ben has limited resources for improving data and assumption quality to enhance the model accuracy.

(h) (*1 point*) Explain which assumption or data source Big Ben should invest in for quality improvement.

ANSWER:

Questions 1 - 9 pertain to the Case Study.
Each question should be answered independently.

8.

(*11 points*) Darwin has recently set up an offshore subsidiary in Happy Tax Island. The tax rate for Happy Tax Island is 30%.

You work for Brandon Kaladin and are tasked to investigate whether it is beneficial to cede Darwin's existing business to the subsidiary in Happy Tax Island via 100% coinsurance. You are given the following:

- Increase in tax reserves of Darwin is equal to its increase in GAAP reserves and separate account transfers
- Increase in tax reserve of the subsidiary is equal to 90% of its increase in GAAP reserves and separate account transfers
- Tax base of assets is the market value of assets before and after reinsurance
- The only tax implications for Darwin to cede its existing business to its offshore subsidiaries are the difference in tax reserves and tax rate

(a) (*4 points*) Calculate 2021-2024 cash tax payable, deferred tax payable, and post-tax net income for each line of business if the business is ceded to the subsidiary in Happy Tax Island. Show your work.

The response for this part is to be provided in the Excel spreadsheet.

Darwin wants to improve its short term cash flow by reducing tax payments. To start off, Kaladin wants to cede only one line of business.

(b) (*1 point*) Recommend which line of business to cede to the subsidiary in Happy Tax Island based on the results in (a). Justify your recommendation.

The response for this part is to be provided in the Excel spreadsheet.

8. Continued

There are many innovative financial activities on Happy Tax Island. The investment department of Darwin believes having assets on Happy Tax Island could provide an additional 50 basis point yield over current investment return. Assume the following:

- Net investment income is calculated as earned rate multiplied by the market value of assets supporting statutory reserves
- Asset is marked-to-market at the point of transfer
- Market value of asset is 105% of its book value
- There is no tax implication on asset mark-to-market
- Change in earned rate would not cause changes in GAAP or statutory reserves

(c) (*3 points*) Construct the 2021-2024 income statement for Darwin if all lines of business are ceded to the subsidiary in Happy Tax Island.

The response for this part is to be provided in the Excel spreadsheet.

Kaladin is curious why cash tax has increased after ceding to a lower tax jurisdiction. He asks you to prepare a summary on 2021 cash tax payable for him to understand the impact.

Step	**Net Change**	**Total Cash Tax**
Start: cash tax payable		67,000
Plus impact due to change in tax reserves	xxx	xxx
Plus impact due to change in tax rate	xxx	xxx
Plus impact due to change in asset base	xxx	xxx
Plus impact due to change in investment yield	xxx	xxx
Unexplained	xxx	xxx

(d) (*3 points*) Complete the summary Kaladin requested. Show your work.

The response for this part is to be provided in the Excel spreadsheet.

Questions 1 - 9 pertain to the Case Study.
Each question should be answered independently.

9.

(*6 points*) ABC Company is considering purchasing a subscription that finds sales opportunities for each member of its sales teams. The subscription costs $1,000 per person per year. Rather than purchasing the subscription for each employee, the company performs a one-year experiment by purchasing it for a random sample of sales employees. If management determines the return on investment is high enough, then ABC will purchase the subscription for the entire sales team the following year.

Below are the results of the experiment:

	Sample Size	Average Sales ($k)	Sales Variance ($k)
Test Group (received subscription)	32	99.969	6.917
Control Group (did not receive subscription)	97	98.947	5.227
Baseline (prior year sales from both groups combined)	129	98.979	5.208

(a) (*1 point*) Assess whether or not the subscription led to increased sales at a 5% significance level.

ANSWER:

Your manager suggests doing another experiment the following year but with an increased sample size to reduce the uncertainty.

(b) (*1 point*) Critique your manager's suggestion.

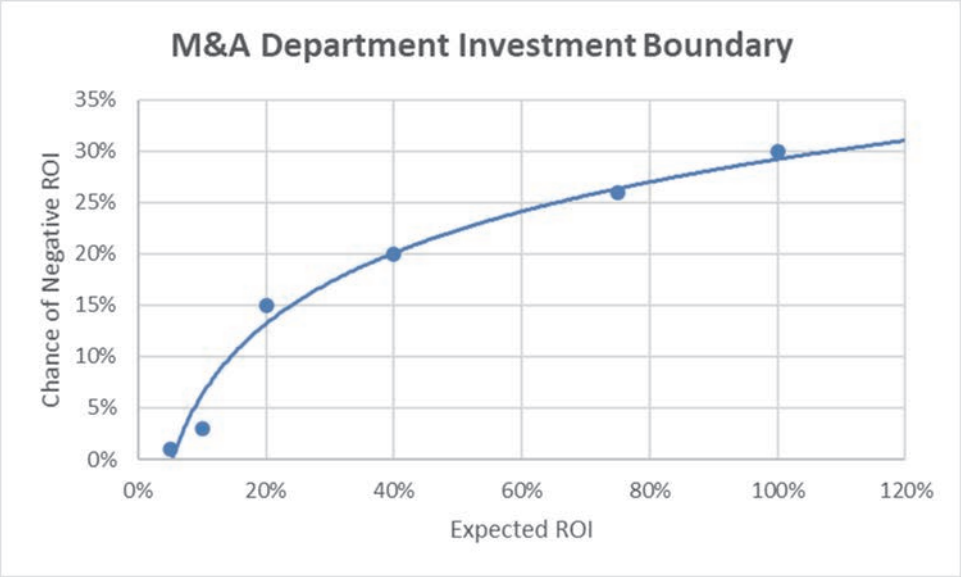
ANSWER:

(c) (*2 points*) Evaluate the use of "statistical significance" in determining whether the subscription is a good investment.

ANSWER:

9. Continued

You are concerned about using only the experiment to decide whether or not to purchase the subscription for the rest of the sales team. You are looking for a simple rule-of-thumb for decision making. Your co-worker in the Mergers and Acquisitions (M&A) department suggests you use their investment boundary chart and compare it to the ROI of the investment.



(d) (*2 points*) Critique your co-worker's suggestion.

ANSWER:

****END OF EXAMINATION****