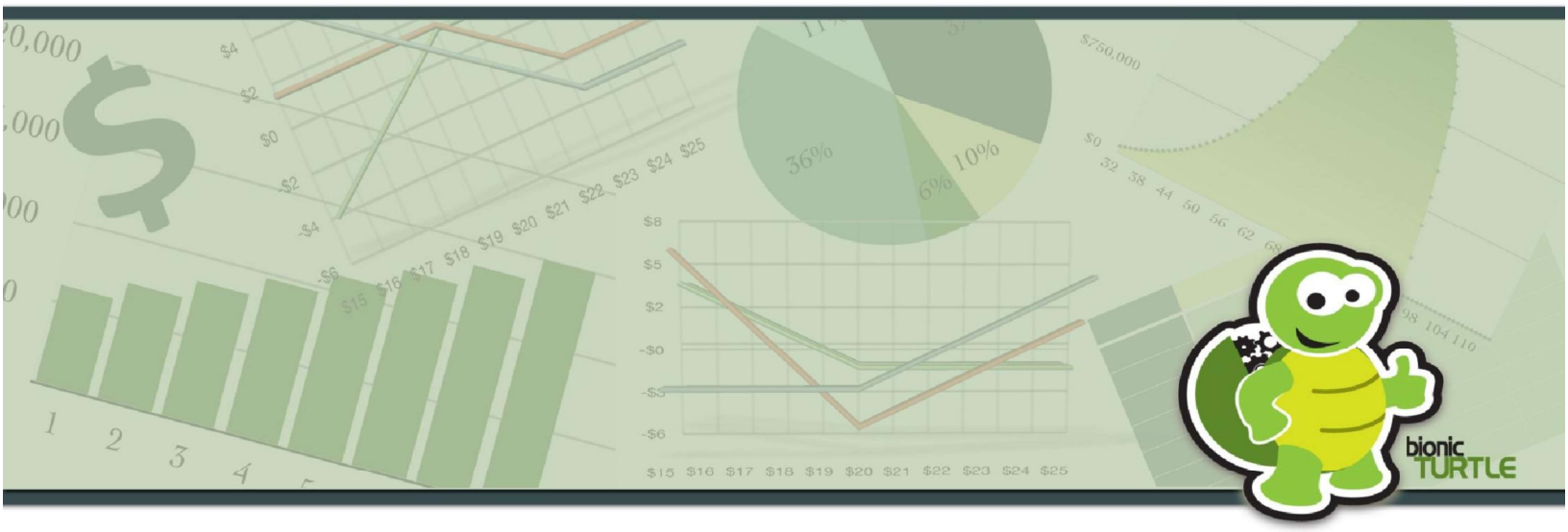

Part 1

Bionic Turtle FRM Full-Length Mock Exam

By David Harper, CFA FRM CIPM
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Candidate Answer Sheet: Mark an X under your answer of choice.

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Question 1: Learning from financial disasters

Case studies that feature financial engineering by way of complex derivatives include Bankers Trust, the Orange County case, and Sachsen Landesbank. In regard to these financial engineering cases, each of the following statements is true **EXCEPT** which is false?

a) Bankers Trust (BT) proposed an overly complex swap to their clients (P&G and Gibson Greetings) but the swaps experienced colossal losses; the clients sued BT, who never recovered from the ensuing reputational damage
b) Orange County's treasurer (Robert Citron) borrowed through the repo market to purchase inverse floating-rate notes--positions that Citron later said he did not understand--but the combination of excessive leverage and embedded interest-rate risk generated losses that ultimately forced Orange County to file for bankruptcy
c) Sachsen Landesbank set up off-balance-sheet vehicles (guaranteed by Sachsen) that held highly-rated U.S. mortgage-backed securities; the operation was highly profitable, but the 2007-08 subprime crisis wiped out Sachsen's capital
d) If the purpose of the position is designated as hedging (rather than speculation) and if the hedge consists only of some combination(s) of forwards, swaps and/or options--which are the primary building blocks--then the firm can avoid problems suffered by the financial engineering case studies because the firm avoids undue sophistication

Question 2: Common univariate random variables

Let's assume two normal variables: X ~ N(0, 3.0^2) and Y ~ N(4.0, 9.0^2). Let V be a mixture distribution where X has a component weight of 80% and Y has a component weight of 20%. Let W = 0.80*X + 0.20*Y with the assumption that X and Y are independent; that is, this W is the sum of independent, random variables. Which is more likely (the mixture or the convolution) to realize a negative outcome; that is, is Pr(V<0) > Pr(W<0), or on the other hand, is Pr(W<0) > Pr(V<0)?

a) The mixture (V) has a greater probability of a negative outcome; i.e., Pr(V<0) > Pr(W<0)
b) The convolution (W) has a greater probability of a negative outcome; i.e., Pr(W<0) > Pr(V<0)
c) They have the same probability of realizing a negative outcome; i.e., Pr(W<0) = Pr(V<0)
d) It cannot be answered because it depends on correlation in the case of (W)

Question 3: Exchange option, volatility swap, and static option replication

Consider a one-year exchange option to give up 14.0 units of Ethereum (aka, ether or ETH) for one unit of Bitcoin (BTC). The current price of Bitcoin is $4,200.00 BTC and the current price of one unit of ether is $300.00 ETH. The risk-free interest rate is 2.0% per annum with continuous compounding. The per annum volatility of Bitcoin is 50.0% and the volatility of Ethereum is 38.0%. Their correlation, ρ(BTC, ETH) = 0.540. We can price an exchange option with a simple variation on the Black-Scholes-Merton called the Margrabe variation. Using the Margrabe under these assumptions, the price of this BTC-for-ETH exchange option is $723.11. Further, each of the following statements, ceteris paribus, is true **EXCEPT** which is false?

a) Ahigher riskfree rate has no impact on this exchange option's value
b) Ahigher correlation ρ(BTC, ETH) implies a lower exchange option value
c) An increase in Ethereum's (ETH) spot price will increase the exchange option's value
d) An increase in the Bitcoin (BTC) spot price implies an increase in the exchange option's value

Question 4: Quantifying the credit loss distribution

Consider a credit portfolio that contains three positions. The exposure (EAD) of each position is $10.0 million. Further, our model assumes the shape of the loss distribution (aka, the credit risk of each exposure) is identical for each exposure, although their means vary as follows:

- Exposure #1 has a default probability of 2.0% and unexpected loss (UL) of $597,000
- Exposure #2 has a default probability of 4.0% and unexpected loss (UL) of $840,000
- Exposure #3 has a default probability of 6.0% and unexpected loss (UL) of $1,023,500

The pairwise default correlation is 0.40 among each exposure pair, such that the portfolio's unexpected loss is $1,920,250. In regard to Exposure #1, its risk contribution is given by $597,000 * [$597,000 + ($840,000 * 0.40) + ($1,023,500 * 0.40)] / $1,920,250 = $417,348. Because the capital multiplier, CM, is set at 5.50 to reflect a specified confidence level, the economic capital for Exposure #1, EC(#1) = $417,348 * 5.50 = $2,295,415, or about $2.30 million.

Which of the following is **NEAREST**, respectively, to the required economic capital for the second and third exposures, EC(#2) and EC(#3)?

a) $434,000 and $568,000
b) $651,000 and $852,00
c) $3.6 and $4.7 million
d) $5.9 and $7.7 million

Question 5: Anatomy of the Great Financial Crisis 2007-2009

According to GARP, each of the following was a causal factor in the 2007-2009 global financial crisis (GFC) **EXCEPT** which is not a causal factor?

a) Low interest rates
b) The originate-to-distribute (OTD) business model and securitization, especially CDOs
c) An unexpected spike in prepayments due to an acceleration in repeat refinancing
d) Dubious lending practices and risky mortgage loan products (e.g., NINJA) and loan features (e.g., teaser rates)

Question 6: Common univariate random variables

A hedge fund's big data algorithm can predict the market's direction on five out of eight days (62.5%). Each day's prediction is either a success (e.g., market goes up and algo predicts up) or a failure (e.g., market goes down but algo predicts up). If we dubiously assume the predictions are independent, the binomial distribution fits a series of daily predictions over, say, a week or a month. Over two months, the probability of each day's predication being successful, p, equals 5/8 or 62.5% and the number of days, n, equals 60. We observe that n*p = 60*62.5% = 37.5 and n*(1-p) = 60*37.5% = 22.5, and both of these values (i.e., 37.5 and 22.5) are greater than 10; this satisfies a conventional test that says we can use the normal to approximate the binomial. For example, if p were only 1.0%, then n*p = 6, but 6 is less than 10, and such a binomial is deemed to be too skewed to be approximated by the normal distribution. But ours passes the test so we will approximate with the normal distribution. If we do rely on the normal distribution to approximate this binomial where p = 5/8 and n = 60, what is the probability that the algo makes a correct prediction on only half the days or worse; i.e., where X is the number of successful predictions and we approximate with the normal distribution, what is the Pr(X <= 30)?

a) 2.2750%
b) 8.3500%
c) 11.090%
d) 14.6667%

Question 7: Option combination strategies

The risk-free rate is 3.0% and the stock price of Discovery Communications (ticker: DISCK) is $20.00. Peter purchases a straddle with six-month European at-the-money options; i.e., S = K = $20.00. If the price of a call option is $2.05, then how much will the stock price need to move in order for him to at least achieve breakeven profit (reminder that profit = final payoff +/- initial premium)?

a) DISCK must move up by at least $2.05
b) DISCK must move down by at least $1.67
c) DISCK must move up or down by at least $3.80
d) DISCK must move up or down by at least $5.75

Question 8: Risk contribution – portfolio's unexpected loss

A credit portfolio contains an adjusted exposure of $30.0 million with a default probability of 4.0%. In regard to loss given default (LGD), the Portfolio Manager estimates an (LGD) of 40.0% with a standard deviation, σ(LGD), of 40.0%. What is the position's unexpected loss (UL)?

a) $2.250 million
b) $3.360 million
c) $5.490 million
d) $7.810 million

Question 9: Learning from financial disasters

Which of the following is **TRUE** about the SWIFT (Society for Worldwide Interbank Financial Telecommunication) case study?

a) The 2015-16 cyber-attack (aka, hack) demonstrated that the SWIFT network was unreliable, and it was subsequently phased out
b) The 2015-16 cyber-attack (aka, hack) successfully exploited vulnerabilities to achieve the theft of about USD 81.0 million
c) The 2015-16 cyber-attack (aka, hack) was an unsuccessful attempt to steal money, and it demonstrated the SWIFT network is essentially impervious to attacks
d) The 2015-16 cyber-attack (aka, hack) was a fictitious news account but the negative press nonetheless shook confidence sufficiently in the network that transactions ground to a halt for several weeks

Question 10: Common univariate random variables

A credit portfolio contains some number of independent credit-sensitive assets with identical default probabilities; as the defaults are i.i.d., we can use the binomial distribution to characterize the number of defaults. We are told the expected number of defaults is 4.0 with a variance of 3.80. Which is nearest to the probability of exactly four defaults; Pr(X = 4 | binomial with mean of 4.0 and variance of 3.80)?

a) Less than 0.01%
b) 10.0%
c) 20.0%
d) 33.3%

Question 11: Properties of stock options

Consider a European call option on a non-dividend-paying stock that has a current price, c = $6.37, if we make the following assumptions:

- S(0) = K = $100.00 and this option has a delta, N(d1) = 0.570
- Volatility, σ = 20.0% and this option has vega = 27.8
- Riskfree rate, Rf = 3.0%
- Time to expiration, T = 0.5 years or six months

Each of the following changes will INCREASE the value of this option, but which factor change will produce the **SMALLEST** change to the option's value?

a) Double the riskfree rate (from 3.0%) to 6.0%
b) Increase the stock price by $5.00 (from $100.00) to $105.00
c) Increase volatility by 10.0% (from 20.0%) to 30.0%
d) Double the time to expiration (from six months) to T = 1.0 year

Question 12: Economic capital relative to credit risk

920.2. Consider a credit portfolio that includes many loans. In order to derive economic capital (EC) for credit risk, we need to quantify four measures: expected losses (EL), unexpected losses, unexpected loss contribution (ULC), and economic capital (EC). In regard to these four measures, each of the following definitions or descriptions is true **EXCEPT** which is inaccurate?

a) Expected losses (EL) can be viewed as payments to an insurance pool, does not itself constitute risk, and is reimbursed through adequate loan pricing
b) Unexpected losses (UL) is the standard deviation of credit losses around the expected loss average
c) Unexpected loss contribution (ULC) is the first partial derivative of the portfolio's unexpected loss (portfolio UL) with respect to the position's weight, w(i)
d) Economic capital (EC) for credit risk is the difference between the expected outcome and the unexpected, negative outcome at a certain confidence level

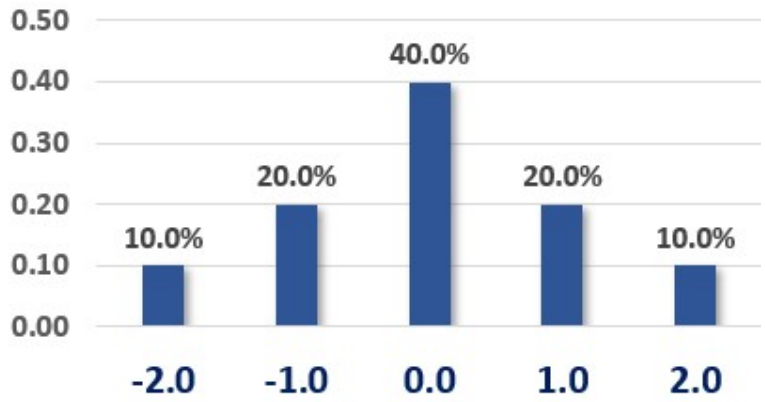
Question 13: GARP Code of Conduct

Barbara is a certified FRM who previously generated income statement and profit projections over a five-year horizon in response to her client's request. Subsequent to the coronavirus outbreak, her client asks Barbara to generate revised financial projections (income statement and balance sheet) and provide the best single point estimate of future revenue, profit, and equity. Barbara utilizes Monte Carlo simulation. Although her client has asked for a single point estimate of these future financial metrics, Barbara perceives that the virus (and the consequential responses) render economic predictions extremely difficult and necessarily laced with great uncertainty. Which of the following is probably her **BEST** approach to the problem?

a) She can comply by simply selecting the most probable future outcome; the Code has generally nothing to say about this technical task
b) She can comply but she should qualify her findings to avoid overstating the accuracy of her projections; for example, she can plot a future distribution
c) She should work hard to generate the most precise estimate possible; for example, "sales will go down by 10.85%" is more useful than "sales will go down by 10%"
d) She should avoid the temptation to offer any revised future estimates in the face of several "unknown unknowns" because some future values cannot be estimated with sufficient accuracy

Question 14: Random variables

Consider the probability mass function (pmf) below. For example, Pr(X = -1.0) = 20.0%.



As we can see, this distribution is symmetrical, so we know that its skewness is zero without performing any calculations. We are told the variance is 1.20 (although we can calculate the variance). What is this distribution's kurtosis?

a) Zero
b) 2.50
c) 3.60
d) 4.40

Question 15: Mechanics of options markets

A stock with a volatility of 31.0% is currently trading at $47.00 while the risk-free rate is 3.0%. An investor purchases a European straddle with a strike price of $45.00: a straddle is a call and a put on the same stock with identical strike prices and expiration dates. The straddle expires in nine months (0.75 years). The price of the put is $3.50. Among the following choices, which best summarizes the final stock price required (in nine months, at expiration) in order for the trader to realize at least a positive net **PROFIT** on this trade?

a) Stock to stay inside the interval {$35.00 to $55.00}; i.e., both above $35.00 and below $55.00
b) Stock to stay inside the interval {$37.00 to $57.00}; i.e., both above $37.00 and below $57.00
c) Stock to fall outside the interval {$35.00 to $55.00}; i.e., either below $35.00 or above $55.00
d) Stock to fall outside the interval {$40.00 to $54.00}; i.e., either below $40.00 or above $54.00

Question 16: Internal and external rating systems

Consider the following one-year migration (aka, transition) matrix:

	AAA	AA	A	BBB	BB	B	CCC to C	Default
AAA	91.00	9.00	-	-	-	-	-	-
AA	1.00	84.00	7.00	5.00	3.00	-	-	-
A	0.40	2.00	91.60	3.00	2.00	1.00	-	-
BBB	-	0.60	2.00	88.50	5.00	3.00	0.90	-
BB	-	0.40	1.00	3.00	79.60	10.00	4.00	2.00
B	-	-	0.80	3.00	9.00	67.20	9.00	11.00
CCC - C	-	-	-	2.00	10.00	15.00	58.00	15.00

When is the soonest that an obligation rated AAA (the highest rating) can default?

a) During the first year (i.e., by the end of the first year) with a margin probability of 2.0%
b) During the second year (i.e., between the end of the first and second year) with a joint probability of 0.1879% (or 0.001879 or 1.879e-3)
c) During the third year (i.e., between the end of the second and third year) with an unconditional probability of 0.00540% (or 0.0000540 or 5.40e-5)
d) During the fourth year (i.e., between the end of the third and fourth year) with a conditional probability of 2.00%

Question 17: Learning from financial disasters

Arguably the U.S. savings and loan (S&L) crisis in the 1980s had multiple causes, but among the following which is the **BEST** summary explanation of the S&L crisis?

a) S&Ls engaged in a practice called "riding the yield curve" but this was one of the central bank's monetary policy tools and was not meant to be performed by private banks
b) The Fed's restrictive monetary policy led to a dramatic increase in short-term interest rates which wiped out bank's interest rate spread due to their asset-liability mismatch
c) The Fed's expansionary monetary policy led to a dramatic decrease in short-term interest rates which wiped out bank's interest rate spread due to their asset-liability mismatch
d) New regulations introduced in the early 1980s hindered the ability of the savings and loan (S&L) industry to lend and/offer new loan products that could help it grow out of its problems

Question 18: Random variables

A discrete random variable is characterized by the probability mass function (pmf) as given by f(x) = x*a, and its domain is the set of integers {6, 7, 8., 9, and 10}. What is the variable's expected value?

a) 6.67
b) 8.00
c) 8.25
d) 9.33

Question 19: Using the swap rate to bootstrap the forward rate and basic interest rate swap valuation

Suppose that the 6-month, 12-month, 18-month, and 24-month overnight indexed swap (OIS) zero rates with continuous compounding are 2.00%, 2.40%, 3.00%, and 3.60%, respectively. Suppose further that the six-month LIBOR rate is 2.60% with semiannual compounding. The forward LIBOR rate for the period between 6 and 12 months is 3.00% with semiannual compounding. The forward LIBOR rate for the period between 12 and 18 months is 3.60% with semiannual compounding. (Please Note: this question is inspired by Hull's Example 7.2 in 10th Edition).[1]

Finally and importantly, assume the two-year swap rate is 4.00%. Conditional on the realization of the LIBOR forward rates, the future cash flow in six months is, therefore (2.60% - 4.00%)/2 *$100.0 = -$0.70 and its prese 0.020*0.50) = -$0.693; that is, we are using the (discounting purposes.

Par	$100.00
2-year swap rate	4.00%

Period	OIS Zero rates (CC)	Forward LIBOR (s.a.)	Cash Flow FV	Cash Flow PV
0.50	2.00%	2.600%	($0.700)	($0.693)
1.00	2.40%	3.000%	($0.500)	($0.488)
1.50	3.00%	3.600%	($0.200)	($0.191)
2.00	3.60%	???		

Which is **nearest** to an estimate for the forward l F(1.5, 2.0)?

a) 3.880%
b) 4.503%
c) 5.747%
d) 6.950%

Question 20: Internal versus external credit ratings

918.3. In regard to through-the-cycle (TTC) versus at-the-point (aka, point in time, PIT) approaches to credit ratings, each of the following statements is true **EXCEPT** which is false?

a) Agency (i.e., external) credit ratings tend to be through-the-cycle (TTC)
b) Through-the-cycle (TTC) is conditional, while at-the-point (PIT) is unconditional
c) Credit spreads are at-the-point (PIT) and PIT measures incorporate more information
d) During crisis periods, PIT approaches imply higher expected and unexpected loss (EL & UL) such that PIT tends to be pro-cyclical

[1] John C. Hull, Options, Futures, and Other Derivatives, 10th Edition (New York: Pearson Prentice Hall, 2017)

Question 21: Enterprise Risk Management (ERM)

Alice, Bert, Chris, Don, Eva, and Fred are individual investors. Each of them exhibits a particular behavioral bias.

- Alice (A) invested in the stock Cloudera (CLDR) and bad news (aka, new information) renders her original thesis obsolete but she is reluctant to sell today because an exit implies the realization of a -30.0% loss on the position and she much prefers to sell after her position experiences a double-digit gain
- Bert (B) can buy a new smartphone for $79.00 but he cannot resist a sale and prefers to pay $100.00 because it represents a 50.0% discount from the retail (MSRP) price
- Chris (C) attends an investment conference but he avoids the seminar focusing on recession risks because he is overweight homebuilders and he worries the topic will make him anxious with worry
- Don (D), who enjoys food shopping, tends to be price-conscious (e.g., he seeks bargains) when he pays cash at Sprouts or Trader Joes, but when he uses his Amazon credit card at Whole Foods he doesn't worry about the cost because he doesn't look at the statement for several days or weeks
- Eva (E) purchased Facebook (FB) at $160.00 because his firm's price target was $200.00, and he decides to ignore new information until the price reaches this level
- Fred (F) was previously a patient buy-and-hold investor who purchased high-conviction stocks and only checked his portfolio once a week, but last year he signed up for a subscription to Seeking Alpha and since that time his buy/sell transactions have quintupled because he's reading news about his portfolio holdings every day

Which of the following correctly matches the individual investor to his or her behavioral bias?

a) A= Home bias, B = Mental accounting, C = Ostrich effect, D = Herding, E = Groupthink, F = Framing
b) A= Loss aversion, B = Framing, C = Ostrich effect, D = Mental accounting, E = Anchoring, F = Feedback effects
c) A= Groupthink, B = Herding, C = Home bias, D = Framing, E = Loss aversion, F = Ostrich effect
d) A = Mental accounting, B = Home bias, C = Loss aversion, D = Groupthink, E = Feedback effects, F = Herding

Question 22: Probabilities and Bayes rule

The probability graph below illustrates event A (the yellow re
rectangle). The unconditional probability of event A is 50.0%
probability of event B is 44.0%; i.e., Pr(A) =
50.0% and Pr(B) = 44.0%. Their overlap is graphed by the g
B) = 27.0%. The orange rectangle conditions on the event C
event C, there is a 50.0% probability that event A occurs, Pr

Which of the following is **TRUE** about, respectively, the unc
relationship between events A and B?

a) Aand B are unconditionally dependent but conditiona
b) Aand B are unconditionally dependent and also con
c) Aand B are unconditionally independent but conditionally (on event C) dependent
d) Aand B are unconditionally independent and also conditionally (on event C) independent

Question 23: Eurodollar futures contracts

Below are given three-month Eurodollar Futures quotes for contracts with maturities of, respectively, 300, 393, and 486 days; for example, 94.50 is the Eurodollar Futures quote for a contract that matures in 300 days and settlement will be based on the then-prevailing three-month LIBOR.

Which is **nearest** to the implied 393-day zero rate expressed per annum with continuous compounding?

a) 3.601%
b) 4.380%
c) 5.538%
d) 6.026%

Days	Zero Rate (Continous Compounding)	Eurodollar Futures Quote (ACT/360, Quarterly Compounding)
300	3.00%	94.500
393	???	95.620
486		95.480

Question 24: External credit rating scales

Quotecan Corporation has issued a bond with the following features, characteristics and/or qualities: Quotecan's interest coverage ratio (i.e., earnings before interest and taxes, EBIT, divided by interest expense) is within reasonable limits such that, at least in the near term, investors have adequate protection and should expect their interest and principal payments on the bond. On the one hand, the bond is better than junk. On the other hand, the bond carries more credit risk than bonds issued by the highest-rated corporations like, for example, Microsoft (MSFT), Apple (AAPL), Exxon Mobil (XOM), Johnson & Johnson (JNJ), Walmart (WMT). To be more specific, Quotecan's capacity to repay may be impaired if adverse economic conditions materialize, or if circumstances suddenly change. While these obligations are not speculative in their entirety, they do contain just a few speculative elements which may render the protective elements unreliable over a longer time horizon.

Based on these facts, which credit rating is most likely assigned to Quotecan's bond offering?

a) A-1 or P-1
b) AA or Aa
c) Bor B
d) BBB or Baa

Question 25: Enterprise Risk Management (ERM)

GARP explains that "perhaps the biggest argument for ERM is that an enterprise-level perspective is the best way to prioritize risks and optimize risk management."[2] Each of the following is one of the four key reasons that enterprise risk might demand the practice of (or, the art and science of) enterprise risk management, ERM, **EXCEPT** which is NOT one of the four key reasons?

a) Identify hidden and/or dangerous concentrations including (for example) geographical, industry, product, or among suppliers
b) Vertical vision recognizes potential threats to the whole enterprise ideally in their early stages to reduce the leverage effect of time
c) Portfolio thinking permits the business units to specify a more accurate distribution that incorporates the allocation of corporate overhead
d) Thinking beyond silos acknowledges diversification among risk types and a better understanding of how interactions might worsen enterprise threats

[2] 2020 FRM Part I: Foundations of Risk Management, 10th Edition. Pearson Learning Solutions, 10/2019

Question 26: Conditionally independent events

Yesterday a web page hosted by Acme received tens of thousands of page views, but some were views by malicious bots. Acme utilizes two software applications to detect these malicious "bot-views." It uploads the same data file from yesterday to both applications. The first application detects 200 bot-views and the second application detects 300 bot-views. Among these, only 40 bot-views were detected by both applications. All bot-views are equally likely to be located, but clearly, both applications only identify a minority of the bot-views (otherwise there would be a much higher number of identified bot-views common to both applications). Further, the identification of a bot-view by one application is independent of its identification by the other application. How many malicious bot-views did the web page experience on this day?

a) 300
b) 460
c) 540
d) 1,500

Question 27: US Treasury bonds

The counterparty with the short position in a Treasury bond futures contract has decided to deliver and is trying to decide between the four bonds displayed below; e.g. the quoted price of bond #4 is $129.41 and its conversion factor (CF) is 1.290.

Futures settlement price	$99.00

Four bonds eligible for delivery		
Bond	Quoted Price	CF
#1	$75.26	0.7600
#2	$36.18	0.3600
#3	$110.51	1.1000
#4	$129.41	1.2900

If the future contract's settlement price is $99.00, then which bond is cheapest to deliver (CTD)?

a) Bond #1
b) Bond #2
c) Bond #3
d) Bond #4