INSTITUTE AND FACULTY OF ACTUARIES

Curriculum 2019

SPECIMEN EXAMINATION

Subject SP9 – Enterprise Risk Management Specialist Principles

Time allowed: Three hours and fifteen minutes

INSTRUCTIONS TO THE CANDIDATE

1.   *Enter all the candidate and examination details as requested on the front of your answer booklet.*

2.   *You must not start writing your answers in the booklet until instructed to do so by the supervisor.*

3.   *Mark allocations are shown in brackets.*

4.   *Attempt all three questions, beginning your answer to each question on a new page.*

5.   *Candidates should show calculations where this is appropriate.*

AT THE END OF THE EXAMINATION

Hand in BOTH your answer booklet, with any additional sheets firmly attached, and this question paper.

> *In addition to this paper you should have available the 2002 edition of the Formulae and Tables and your own electronic calculator from the approved list.*

1 Purple Ltd is a global composite insurance company (i.e. it sells both life and general insurance products) with operations in three countries, X, Y and Z.

Each operation calculates its capital requirement using local regulations and submits these to the Group head office in country X, which converts the values to the local currency of country X (the dollar $). The Group function then allocates capital, including the diversification benefit, back to each operation using a proportional allocation method.

(i) Outline the uses of capital allocation to Purple Ltd. [3]

The undiversified capital amounts determined for each risk category, the total diversification benefit and the total (diversified) capital requirement are as follows for the operations in each of the three countries:

Figures in $m	Country X	Country Y	Country Z
Undiversified capital for:			
Interest rate risk	2	12	5
Credit risk	3	14	10
Equity risk	8	8	2
Life insurance risk	6	19	0
General insurance risk	9	0	15
Operational risk	3	6	2
Total undiversified capital	**31**	**59**	**34**
Diversification benefit	(12)	(9)	(4)
Capital requirement	**19**	**50**	**30**

The total capital requirement for Purple Ltd (i.e. at Group level) is $66m.

The proportional method used allocates capital to each of the three operations in proportion to the standalone (diversified) capital requirements determined for the individual country operations.

(ii) Calculate the capital allocated to each of the three operations under this method. [2]

(iii) Discuss the advantages and disadvantages of this capital allocation method. [5]

The Group Chief Finance Officer of Purple Ltd has suggested that scenarios are run in each country to test resilience against future events. He would like each of the three operations to test the two scenarios that would be most appropriate for them given their risk profile.

(iv) Suggest two appropriate scenarios for each of the three operations. [3]

Country Y comprises mainland Hiponia and a large island off the coast of the mainland, Hip Island. Purple Ltd writes business across all of country Y.

Hip Island is currently seeking independence from Hiponia. If this is successful then Hip Island will have its own currency and its own government within three months.

(v)   Assess the possible implications for the risk profile of Purple Ltd if Hip Island gains independence from Hiponia.   [10]

(vi)   Suggest actions that Purple Ltd could take now in order to mitigate the increased or new risks.   [4]

Purple Ltd is considering no longer writing new insurance business in country Y.

(vii)   Propose, with reasons, an appropriate capital allocation method in these circumstances.   [3]
                                                                                    [Total 30]

2   Actuarial Power Limited (AP Ltd) is a new provider of electricity in the country of Actuaria. A large proportion of its electricity will be generated using wind turbines (devices which convert energy from wind into electricity) located together in "wind farms".

AP Ltd is considering building a new wind farm at a site which is in a remote part of the country.

The turbines need an average wind speed of 25 miles per hour to generate sufficient electricity to be profitable over their expected lifetime of 25 years. However, if wind speed exceeds 75 miles per hour, then a safety mechanism prevents the turbines from producing any power.

To test whether the site will be suitable, AP Ltd has been collecting data for the last 200 days. The equipment used to collect the data records both the average wind speed and the maximum wind speed for each of the 200 days. Wind speeds in excess of 75 miles per hour are counted as zero in the calculation of the daily average.

There were 15 days for which the wind speed exceeded 75 miles per hour at some point during that day.

The average wind speed across the whole 200-day period, calculated on the basis described above, was 30 miles per hour.

(i)   Evaluate the suitability of this site for wind power generation, making use of the information above. Your answer should make reference to:

- any shortcomings in the above analysis
- any additional information that would be helpful for the evaluation.

[7]

If the wind speed exceeds 150 miles per hour, it is estimated that the turbines and connected infrastructure would be so badly damaged that they would need to be dismantled and replaced at a very high cost.

During the investigation period, the wind speed on the site of the planned wind farm never exceeded 100 miles per hour.

It is known that the highest wind speed ever recorded in Actuaria is 145 miles per hour. Historical annual maximum wind speeds for Actuaria are available, having been recorded for the past 100 years.

A consultant to AP Ltd has stated that because the maximum speed on the site did not exceed 100 miles per hour during the 200-day investigation period, and has never exceeded 150 miles per hour in the country as a whole, there is no risk of damage to the wind turbines.

(ii)   Comment on the validity of the consultant's statement.   [3]

Another consultant has suggested assessing the risk of damage by using the generalised Pareto distribution to model the likelihood of wind speeds of above 150 miles per hour, using the country level wind data.

(iii)   Describe how this would be done. [4]

(iv)   Discuss the advantages and disadvantages of the suggested approach. [3]

The management of AP Ltd is also investigating two other forms of electricity generation. It is looking at potential sites for a solar farm (which would generate electricity from the sun using solar panels) and a hydroelectric plant (which would generate electricity from water flowing through the turbines).

The solar panels will be profitable only if there is sufficient sunlight. However, very sunny weather can make these solar panels extremely profitable – much more so than the potential maximum profitability of the wind turbines.

The profit generated by hydroelectric power is very reliable and predictable. However, the expected profit is low when compared with the other forms of electricity generation.

AP Ltd has to decide how much to invest in each of the three sources of electricity generation: wind, solar and hydroelectric. It has a finite amount of capital available for this purpose.

A method using the Euler principle has been suggested as being the best approach to take for the capital allocation, with the risk measure being defined as the standard deviation of profitability.

(v)   Describe how this methodology would be applied to determine the optimal allocation of capital to invest in each of these three forms of electricity generation. [3]

(vi)   Discuss whether the choice of the standard deviation-based Euler approach is appropriate. [3]

In order to manage the risks within AP Ltd, it has been suggested that ISO 31000 is adopted.

(vii)   Draw a diagram to illustrate the risk management process under ISO 31000. [3]

(viii)   State the main risk management principles in ISO 31000. [4]
[Total 30]

3 (i) Define the term "credit rating". [2]

A flower grower is interested in growing the largest flowers possible for a particular type of plant. This type of plant produces a single flower.

The flower grower gives each of his plants one of the following four ratings:

- Plants rated A have the largest possible flower.
- Plants rated B have a medium-sized flower.
- Plants rated C have a small flower.
- Plants rated D are plants that have died.

Each flower first takes the form of a bud which, as soon as it opens, is rated C.

The size of a flower for this particular plant then varies over time, increasing from the time at which the bud opens. It takes six months from the time at which the bud first opens to the time at which the flower is typically at its largest.

The flower grower has grown one batch of these plants each year over the last twenty years. He has kept data on his plants in two formats over this period. He now wishes to use this data, at the point at which the buds first open on this year's batch of plants, to estimate the proportion of these plants that will produce A-rated flowers six months later.

"Format one" involves measuring the diameter of each flower at the end of each of the six months following the point at which the bud first opens. Each month, this measurement is used to rate each plant as either A, B, C or D for that stage in its life. This information is then used to calculate the transition probabilities between the ratings, i.e. the proportion of plants for which the rating stays the same and the proportions that change to each of the other possible ratings each month. These transition probabilities are assumed to be constant over time, and so can be averaged over the six-month observation periods. The information is used to calculate a matrix of these one-month transition probabilities, averaged across those determined over the last twenty years.

(ii) Describe how this matrix could be used, when the buds first open on this year's batch of plants, to estimate the proportion of these plants that will produce A-rated flowers six months later. [3]

"Format two" also involves measuring the diameter of each flower in each of the six months following the opening of the bud. However, for this format the information recorded is the proportion by which the flower has grown each month. The average monthly rate of growth of the flower diameter and the standard deviation of that growth rate are then recorded for each plant. These growth rates are assumed to be constant over time, and so can be averaged over the six-month observation periods. The average of these growth rate averages and the average of the standard deviations are then determined across all the observed plants and over the twenty year period. The output under this format is therefore a single averaged monthly growth rate and a single averaged standard deviation of monthly growth rates.

It can be assumed that an A-rated flower is one which is at least as large as a specified diameter.

(iii)   Propose a method that could be used under "Format two" to estimate the proportion of plants that will produce A-rated flowers six months after the buds open. Your answer should include an outline of how the method would be applied. [3]

Flowers are a scarce commodity in this particular country. Because of this, flower sellers (i.e. those who sell flowers on a retail basis to the general public) order their flowers from flower growers six months in advance in order to guarantee their supply.

Flower sellers are required to pay the flower growers at the time of order, i.e. six months before receiving them. In order to avoid tying up capital, flower sellers use short-term funding to cover this cost. This is in the form of bank loans, which are renegotiated on an annual basis. The interest rate charged by a bank depends on its view of the riskiness of the borrower.

Once flowers are received by the flower sellers, the flower sellers are free to set their own prices for onward sale to the general public. Generally speaking, the lower the price charged, the more quickly the flowers are sold.

However, the level of demand is not constant from year to year. This can mean that in some years it takes much longer to sell the flowers at a given profit margin. There is the opportunity to sell the flowers immediately to a flower-pressing factory, whose demand is unlimited. However, the prices paid by the flower-pressing factory can be significantly lower than the prices paid by the flower sellers to the flower growers.

(iv)   Compare the nature of the exposures of the banks and the flower sellers to the risks relating to the flower sellers' profits. [5]

(v)   State two definitions of liquidity risk. [2]

A particular flower seller has two employees and operates from a rented shop.

(vi)   Explain how liquidity risk may affect the flower seller. [7]

(vii)   Describe an approach by which the level of liquidity risk for this flower seller could be modelled. [8]

(viii)   Suggest ways in which the flower seller's liquidity risk could be reduced. [4]

The flower seller's friend has been talking about how the company he works for has just spent a long time implementing and embedding an enterprise risk management framework. The flower seller responds that she does not need to do that as she has only two employees in addition to herself.

(ix)   Comment on this response. [6]

[Total 40]

END OF PAPER

Note: This specimen paper is derived from the September 2016 ST9 examination paper. In order to maintain compliance with CERA syllabus requirements there have been no significant changes.