Introduction to Quantitative Methods

NQF

Subject Examiner's Report

Unit Title:	**Introduction to Quantitative Methods**
Unit Code:	1.4 IQM (NQF)
Level:	4
Session:	December 2015

Question 1

(a) Without the use of a calculator, find the value of the following showing all steps in your calculations. (Express each answer as a fraction in its simplest form.)

(i) $\left(\frac{1}{4} \div \frac{1}{4}\right) + \left(\frac{6}{8} - \frac{1}{4}\right)$

(ii) $\sqrt{\frac{16}{36}} \div \left(\frac{8}{15} \times \frac{5}{2}\right)$

(iii) $\frac{(-1)\times(-4)}{(-2)\times(1-(-3))}$

(b) The annual salary of an office manager working in Botswana was 76,860.55 Pula in 2014. Express this salary:

(i) In standard form $A \times 10^n$, where $1 \le A < 10$ and n is an integer
(ii) Correct to 2 significant figures
(iii) Correct to 1 decimal place

(c) Convert each of the following numbers from standard form $A \times 10^n$ (where $1 \le A < 10$ and n is an integer) to the normal decimal form:

(i) 37.5×10^{-3}
(ii) 6.56×10^{3}

(d) Express 25% as a:

(i) fraction in its simplest form
(ii) decimal

1. Comments on learners' performance

Part (a) required the application of the four rules of numeracy to fractions, including the use of square roots. While most students performed very well in part (i), a number of students did not understand how to subtract and divide fractions. Part (ii) was answered less well, with many students showing difficulty taking the square root of the fraction and carrying out the arithmetic operations in the correct sequence. In part (iii) students also performed well, although a number of students failed to understand the implication of the brackets and the two minus signs with many students incorrectly multiplying instead of adding the '1' and '3' on the denominator. Common to parts (i) to (iii), a minority of students failed to show all relevant steps in their calculations and/or failed to express each answer as a fraction in its simplest form as stipulated in the question.

Parts (b) to (d) required students to express data in different forms. Compared with previous examination sessions, a number of students showed difficulty expressing the salary in Part (b) in standard form, to 2 significant figures and to 1 decimal place. Students generally answered parts (c) and (d) very well.

2. Mark scheme

(a)

(i) $\left(\frac{1}{4} \div \frac{1}{4}\right) + \left(\frac{6}{8} - \frac{1}{4}\right) = \left(\frac{1}{4} \times \frac{4}{1}\right) + \left(\frac{6}{8} - \frac{2}{8}\right) = \left(\frac{4}{4}\right) + \left(\frac{4}{8}\right) = \left(\frac{8}{8}\right) + \left(\frac{4}{8}\right)$

$= \frac{12}{8} = \frac{3}{2}$ or $1\frac{1}{2}$

(ii) $\sqrt{\frac{16}{36}} \div \left(\frac{8}{15} \times \frac{5}{2}\right) = \frac{4}{6} \div \left(\frac{40}{30}\right) = \frac{4}{6} \times \frac{30}{40} = \frac{120}{240} = \frac{1}{2}$

(iii) $\frac{(-1)\times(-4)}{(-2)\times(1-(-3))} = \frac{4}{(-2)\times 4} = \frac{4}{(-8)} = -\frac{1}{2}$

(b)
(i) 7.686055×10^4
(ii) 77,000
(iii) 76,860.6

(c)
(i) 0.0375
(ii) 6560

(d)

(i) $= \frac{25}{100} \quad = \frac{1}{4}$

(ii) $= \frac{25}{100} \quad = 0.25$

3. Recommendations

Students and tutors are advised to spend a little more time applying the four rules of numeracy without the use of a calculator, focusing in particular on the subtraction and division of fractions, the subtraction of negative numbers and the importance of correctly sequencing arithmetic operations. In addition, students should have more practice approximating data using rounding and significant figures.

Examiner's tips

Do not forget to show all relevant steps in your calculations and when stipulated in the question, always express fractions in their simplest form.

Question 2

(a) Use a calculator to find the value, correct to 3 decimal places, of:
(i) In(1.5)
(ii) log(2.57)
(iii) $e^{-0.88}$

(b) A multinational food company sells its food products in four geographical markets, namely, Europe, America, Asia and Africa, in the ratio 9:6:5:4. If the value of the company's sales in Africa totalled £15,000, calculate the:
(i) Value of the company's sales in Asia.
(ii) Total value of the company's sales in all its geographical markets.
(iii) Share of the company's sales in America as a percentage of its sales in Europe.

(c) A student purchased an office desk at a 15% discounted price for £106.25.
(i) Calculate the original price of the office desk.
(ii) If the discounted price of the office desk included a tax (VAT) of 20%, calculate the value of the tax that the student paid. (Give your answer correct to 2 decimal places.)

(d) An American agricultural consultant visited Botswana to provide advice on crop production. During the visit, the consultant spent 39,440 Pula. Using the US Dollar (USD) to Botswana Pula (BWP) exchange rate of 1 USD = 9.86 BWP, calculate how much the consultant spent in US Dollars.

1. Comments on learners' performance

This was a relatively popular question. It mainly concerned the application of quantitative methods to business situations and required students to conceptualise business problems using quantitative methods. Part (a) however required students to express data in log and exponential form. Students generally performed well with these expressions, although many did not express their results correct to 3 decimal places as requested in the question.

A number of students experienced difficulty in Parts (b) and (c) conceptualising the mathematical problems using ratios and percentages. Part (d) required students to convert foreign currency, using an exchange rate. Compared to previous examination sessions, students performed very well on this calculation.

2. Mark scheme

(a)
(i) In(1.5) = 0.405
(ii) log(2.57) = 0.410
(iii) $e^{-0.88}$ = 0.415

(b)
(i) (£15,000 ÷ 4) × 5 = £18,750
(ii) (£15,000 ÷ 4) × (9+6+5+4) = £90,000
(iii) (((£15,000 ÷ 4) × 6) ÷ ((£15,000÷ 4) × 9)) × 100 = 66.67%

(c)
(i) Since £106.25 is £85% of the original price, then $\frac{106.25}{85} \times 100$ = £125
(ii) Since the value of tax is £20% of the discounted price, then £106.25 × 0.2 = £21.25

(d) 39,440 ÷ 9.86 = USD 4,000

3. Recommendations

Students and tutors are advised to spend a little more time conceptualising the mathematical problems using ratios and percentages.

Examiner's tips

To find 85% of an original price requires you to divide the actual price by 85 before multiplying by 100.

Question 3

(a) At the end of 2015, a food company purchased new processing equipment costing £275,000. Calculate the value of the equipment at the end of 2020, if it is depreciated using the:
(i) Straight line method, by £25,000 per year.
(ii) Reducing balance method, by 10% per year. (Give your answer to the nearest £.)

(b) An investor deposits £240,000 in a high interest bank account over a ten-year period. Calculate the total interest received after the ten-year period if interest is compounded:
(i) annually at a rate of 8% per annum
(ii) quarterly at a rate of 2% per quarter (Give your answer to the nearest £.)

(c) Calculate the time required for £10,000 to earn £1,350 in interest, if invested in a bank that pays a simple interest rate of 9% per annum.

1. Comments on learners' performance

This question concerned the application of quantitative methods to business situations, notably making use of calculations concerning depreciation and interest. In general, this question was relatively well answered compared with previous examination sessions, with a relatively high number of students attaining good marks.

Part (a) required students to apply both the straight line and reducing balance methods to calculate the value of an asset. There are still a number of students that do not understand how to apply the straight line method correctly, with a level of confusion over whether the calculated value relates to the depreciated asset value or the total level of depreciation. In contrast, students performed better at calculating the value of an asset using the reducing balance method.

Part (b) required students to calculate the total interest earned from an investment at the end of a ten year period, with compound interest applied. While the majority of students performed well, a very common error made by students was to forget to subtract the initial invested sum to calculate just the total value of the interest earned over the period (as specified in the question).

Part (c) required students to rearrange the formula for calculating simple interest in order to solve for the time required for an amount to earn a given level of interest. While there was a marked improvement in the number of students that were able to accurately demonstrate how to rearrange the formula and solve for the time required, compared with previous examination sessions, there were still a number of students that were unable to complete all of the mathematical steps required.

2. Mark scheme

(a)

(i)	Initial cost:		= £275,000
	Depreciation:	= £25,000 × 5	= £125,000
	Value of equipment after five years:	= £275,000 – £125,000	= £150,000

(ii) The value of the equipment at the end of each year is 90% of its value at the beginning of the year:

Value at the end of 2015:		= £275,000.00
Value at the end of 2016:	£275,000.00 × 90%	= £247,500.00
Value at the end of 2017:	£247,500.00 × 90%	= £222,750.00
Value at the end of 2018:	£222,750.00 × 90%	= £200,475.00
Value at the end of 2019:	£200,475.00 × 90%	= £180,427.50
Value at the end of 2020:	£180,427.50 × 90%	= £162.384.75

Or by formula:

$275{,}000 \times (1-0.10)^5$	$= 275{,}000 \times 0.9^5$	= £162.384.75
…to the nearest £		= £162.385

(b)

(i) $240{,}000 \times \left(1 + \frac{8.0}{100}\right)^{10} - 240{,}000$ = 518,142.00 – 240,000 = £278,142

(ii) $240{,}000\times\left(1+\dfrac{2.0}{100}\right)^{10\times 4}-240{,}000$ = 529,929.52 – 240,000 = £289,929.52

= £289,930

(c) If $I=P\times i\times t$ then $t=\dfrac{I}{P\times i}$ $\dfrac{1{,}350}{10{,}000\times 0.09}$ = 1.5 years

3. Recommendations

Students and tutors are advised to spend a little more time understanding how to use different formulae for different business applications, notably the use of the simple interest formula to calculate the time required for a given investment to accrue a given level of interest, the use of the compound interest formula, particularly where interest is paid on a quarterly basis, and the use of the straight line method to calculate the depreciated value of an asset.

Examiner's tips

Always try to visualise the mathematical problem being examined. You should be able to tell if your answer is likely to be correct even without knowing what the answer should be.

Question 4

(a) The demand for a product can be represented by the equation $P = 900 – 0.3Q$, where P is the market price of the product (£ per unit) and Q is the quantity (units) demanded in a given period.
(i) From the equation, determine the co-ordinates at which the demand curve would intersect the y-axis if plotted on a graph.
(ii) From the equation, determine the gradient of this demand curve.
(iii) Using the equation, calculate the market price of the product if 500 units were demanded.
(iv) Using the equation, calculate the number of units demanded if the market price of the product was £600 per unit.

(b) Solve the following equations:
(i) $6x – 4 = 3x + 11$
(ii) $\frac{x}{6} + \frac{x}{3} = \frac{12}{6}$
(iii) $x^2 + 3x + 2 = 0$, using factorisation

(c) Simplify the following logarithm equation to a single log term: log (x– 24) + log (x)

1. Comments on learners' performance

This question concerned the use of algebraic methods and logarithms. In general, this question was relatively well answered with a high number of students attaining good grades. Most students performed extremely well evaluating the demand equation and using it to solve business problems.

Part (b) required students to solve three equations. Students performed very well solving the equation in part (i) and solving the quadratic equation using factorisation in part (iii); a few students used the quadratic formulae to solve this equation instead of factorisation as stated in the question. In contrast, they generally performed least well solving the equation where *x* was expressed as a fraction.

Part (c) required students to simplify a logarithm equation to a single log term. Compared to previous examinations, fewer students were able to simplify this logarithm correctly; often unaware of which logarithm rules to use. Nevertheless, a good number of students made a very good attempt at applying the appropriate logarithm rules to simplify the equation to a single log term.

2. Mark scheme

(a)
(i) (0, 900)
(ii) –0.3
(iii) $P = 900 – (0.3 \times 500)$ $P = 900 – (150)$ $P = £750$
(iv) $600 = 900 – 0.3Q$ $0.3Q = 900 – 600$ $Q = \frac{900-600}{0.3}$ $Q = 1{,}000$ units

(b)
(i) $6x – 4 = 3x + 11$ $6x – 3x = 11 + 4$ $3x = 15$ $x = 5$
(ii) $\frac{x}{6} + \frac{x}{3} = \frac{12}{6}$ $\therefore \frac{x}{6} + \frac{2x}{6} = \frac{12}{6}$ $\frac{3x}{6} = \frac{12}{6}$ $x = \frac{12}{6} \times \frac{6}{3}$

$x = \frac{72}{18}$ $x = 4$

(iii) $x^2 + 3x + 2 = 0$, using factorisation gives: $(x + 2)(x + 1) = 0$
$\therefore$ either: $x + 2 = 0$ or $x + 1 = 0$
so: $x = –2$ or $x = −1$

(c) Using the rule: $\log (p \times q) = \log p + \log q$
$\log (x − 24) + \log (x)$ $= \log (x (x − 24))$ $= \log (x^2 − 24x)$

3. Recommendations

Students and tutors are advised to spend a little more time rearranging equations to solve for x, where x is expressed as a fraction, as well as simplifying logarithm expressions to a single log term, with a particular focus on choice and application of the appropriate logarithm rules.

Examiner's tips

If a question states that you should solve a quadratic equation using factorisation, then do not instead use the quadratic formula as this will likely mean that you will not be able to attain full marks.

Question 5

(a) Explain the difference between 'quantitative data' and 'qualitative data', giving an example of each.

(b) List two examples of 'continuous data'.

(c) A survey was carried out to determine the type of transport used by 360 students to get to college on a particular day. A total of 90 students had used a car. All other students surveyed reported that they had used public transport to get to work, of which a third had used the train and two-thirds had used the bus.
(i) Tabulate this survey data to show the number of students that had used each type of transport to get to college.
(ii) Draw a fully-labelled bar chart to show the number of students that had used each type of transport. (Use the graph paper at the front of your answer book.)
(iii) Sketch a fully-labelled pie chart to show the proportion of students that had used each type of transport. (Use the graph paper at the front of your answer book.)

1. Comments on learners' performance

This question required students to distinguish between different types of data and to conceptualise a business problem through the tabulation of data and the construction and use of graphs.

Part (a) required students to differentiate between quantitative and qualitative data, with examples. In the main this part was well attempted with good definitions of the two terms presented. However, despite being able to define the two terms accurately, relatively few students were able to explicitly explain the 'difference' between the two terms. In contrast, Part (b) was answered less well, with many students unable to provide correct examples of continuous data.

In Part (c), although many students showed difficulty presenting the survey data correctly in a table, the majority of students were able to accurately plot a fully-labelled bar chart and draw a fully-labelled pie chart. Consistent with previous examination sessions, students typically lost marks for failing to include a title and axes labels.

2. Mark scheme

(a) Quantitative data is generally referred to as information about 'quantities', for which observations are measurable and numerical in nature. Such data is easy to analyse statistically. In contrast, qualitative data is generally referred to as information about 'qualities', for which observations can't actually be measured and are non-numeric in nature.

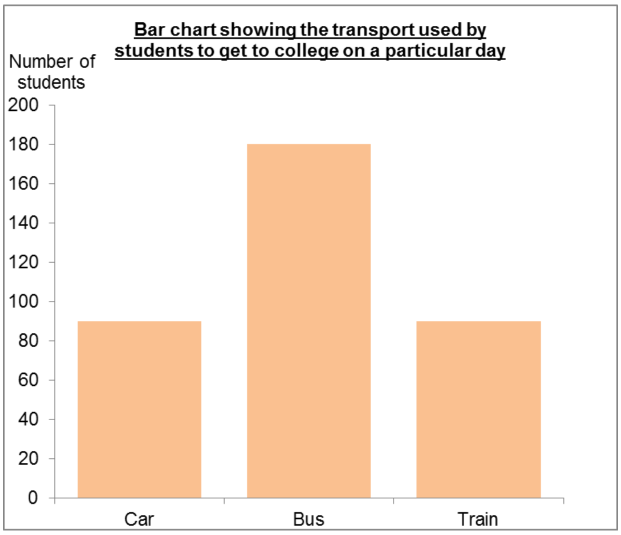
An example of quantitative data could include the number of cars produced by a car manufacturing plant each day. An example of qualitative data could include the different colours of cars produced by a car manufacturing plant each day.

(b) Continuous data may take any value between two stated limits. For example, height and weight data are continuous as they are both measurable.

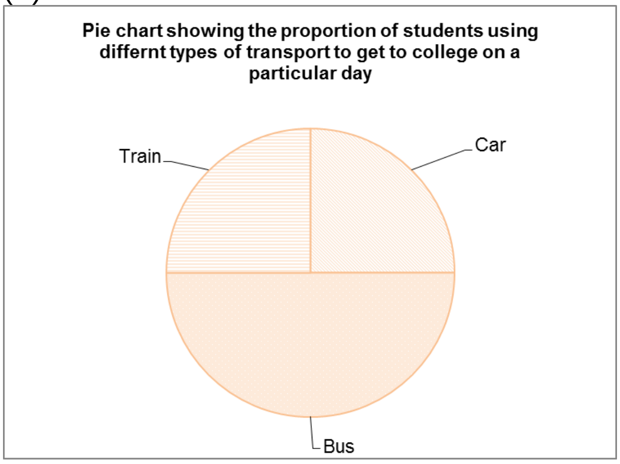
(c) (i) **Number of students using different types of transport to get to college on a given day**

Type of transport	Number of students
Car	90
Train	90
Bus	180
Total	360

(ii)



(iii)



3. Recommendations

Students and tutors are advised to spend a little more time conceptualising business problems through the tabulation of data as well as applying the general rules and principles of graphical construction. In addition, students should gain a better understanding of examples of continuous data.

Examiner's tips

Always apply the general rules and principles of graphical construction: appropriate scaling; inclusion of axes labels (with units) and a title; accuracy of presentation; and a legend if necessary.

Question 6

(a) The following data shows the number of telephone calls received by a travel agent over a fourteen day period:

14 12 12 25 10 15 22 5 8 11 12 6 17 27

Using this data, calculate the:
(i) Mode number of phone calls
(ii) Median number of phone calls
(iii) Mean number of phone calls
(iv) Range of the data on daily phone calls
(v) Standard deviation of the data on daily phone calls
(vi) Co-efficient of variation of the data on daily phone calls

(b) The following table shows the number of times 500 customers shopped in a food retail store in a particular month:

Number of monthly shopping visits	Number of customers
1	27
2	11
3	20
4	68
5	83
6	75
7	64
8	82
9	50
10	20
	500

Using this information, calculate the:
(i) Mean number of shopping visits during the month
(ii) Standard deviation of the monthly shopping visit data

1. Comments on learners' performance

This question concerned the application of statistical methods. Part (a) required students to calculate named measures of location and dispersion of an ungrouped dataset. While students were generally able to accurately calculate the mode, mean and range, many students still demonstrated difficulty in calculating the median and standard deviation; common errors included failing to order the dataset before identifying the middle values when computing the median and a general lack of understanding of how to calculate $\sum x^2$ or $\sum(x-\bar{x})^2$ when calculating the standard deviation.

Part (b) required students to calculate the mean and standard deviation of a grouped dataset. Consistent with previous years, students generally performed less well calculating the summary statistics of the grouped dataset.

2. Mark scheme

(a)

(i) Mode $= 12$

(ii) Median $= (12 + 12) \div 2 = 12$

(iii) Mean $= \frac{196}{14} = 14$

(iv) Range $= 27 - 5 = 22$

(v) Standard deviation $= \sqrt{\frac{3326}{14} - \left(\frac{196}{14}\right)^2} = 6.45$

(vi) Co-efficient of variation $= \frac{6.45}{14}$ $= 0.46$

(b)

Loan amount (£'000) (*x*)	**Number of customers (*f*)**	***fx***	**$(x - \bar{x})$**	**$(x - \bar{x})^2$**	**$f(x - \bar{x})^2$**
1	27	27	-5.0	25.0	675
2	11	22	-4.0	16.0	176
3	20	60	-3.0	9.0	180
4	68	272	-2.0	4.0	272
5	83	415	-1.0	1.0	83
6	75	450	0.0	0.0	0
7	64	448	1.0	1.0	64
8	82	656	2.0	4.0	328
9	50	450	3.0	9.0	450
10	20	200	4.0	16.0	320
	500	3,000			2,548

(i) Mean $= \frac{3000}{500}$ $= 6$

(ii) Standard deviation $= \sqrt{\frac{2548}{500}}$ $= 2.26$

3. Recommendations

Students and tutors are advised to spend a little more time calculating the mean and standard deviation of both ungrouped and grouped data, and in particular how to calculate $\sum x^2$ or $\sum (x - \bar{x})^2$ when calculating the standard deviation of ungrouped data and $\sum fx$ and $\sum f(x - \bar{x})^2$ when calculating the mean and standard deviation of grouped data.

Examiner's tips

Familiarise yourself with the differences in the formulae for calculating the mean and standard deviation of both grouped and ungrouped data, which is contained at the end of the examination paper.

Question 7

(a) Explain, using an example, what is meant by the term 'equally likely outcome'.

(b) An architect hopes to win two contracts in 2016, which are to be awarded independently of each other. The architect predicts that her chances of being awarded contract A is 30% and contract B is 15%. Contract A will generate an income of £40,000 and contract B will generate an income of £20,000. Using this information, calculate the 'expected monetary value' of the revenue to the consulting company from both contracts A and B.

(c) A drinks company produces 5,000 bottles of apple juice per day, with each bottle containing 1 litre of juice. On a given day, 200 bottles were found to contain the wrong volume of juice, of which 50 bottles contained less than 1 litre.

(i) If one bottle is randomly selected from the daily production of 5,000 bottles, calculate:

- The probability that it will contain less than 1 litre of juice.
- The probability that it will contain more than 1 litre of juice.

(ii) If two bottles are randomly selected from the daily production of 5,000 bottles, calculate:

- The probability that both bottles will each contain exactly 1 litre of juice.
- The probability that both bottles will each contain less than 1 litre of juice

1. Comments on learners' performance

This question concerned the application of the laws of probability. As in previous examinations, this is one of the least popular questions on the exam paper. In Part (a) many students showed difficulty providing an explanation of what is meant by the term 'equally likely outcome' with examples.

Part (b) required the calculation of the expected monetary value. In contrast to previous examination sessions, this question was answered well with most students demonstrating an excellent understanding of how to calculate expected values. Of those students that failed to calculate the expected value correctly, many showed an understanding of how to calculate expected values of a single outcome but failed to sum the expected sales values from each outcome as required.

Part (c) required students to calculate various probabilities. Students generally made a good attempt at determining the probabilities in part (i), although consistent with previous examinations students tended to show more difficulty calculating probabilities in part (ii) which required the use of the multiplication rule.

2. Mark scheme

(a) An equally likely outcome is one in which any one outcome of an event is no more likely to occur than any other. For example, the possible outcomes of tossing a coin are either 'heads' or 'tails'. As long as the coin is unbiased, then we would not expect 'heads' to occur any more than 'tails' when tossing the coin. In practice, equally likely outcomes are not common.

(b) EMV = (40,000 x 0.3) + (20,000 x 0.15) = £15,000

(c)

(i) P (bottle < 1 litre) $= \frac{50}{5{,}000} = \frac{1}{100}$ or 0.01 or 1%

P (bottle > 1 litre) $= \frac{150}{5{,}000} = \frac{3}{100}$ or 0.03 or 3%

(ii) P (both bottles = 1 litre) $= \frac{4{,}800}{5{,}000} \times \frac{4{,}799}{4{,}999} = \frac{23{,}035{,}200}{24{,}995{,}000}$ or 0.92 or 92%

P (both bottles < 1 litre) $= \frac{50}{5{,}000} \times \frac{49}{4{,}999} = \frac{2{,}450}{24{,}995{,}000}$ or 0.000098 or 0.0098%

3. Recommendations

Students and tutors are advised to spend a little more time conceptualising business problems and applying the various laws of probability to determine probabilities and expected outcomes. In addition, students should gain a better understanding of the term 'equally likely outcome' in the context of probability theory.

Examiner's tips

Remember to sum the expected values of each outcome when calculating the expected value of multiple outcomes.

Question 8

The weight of a bag of rice produced is found to be normally distributed with a mean weight of 1,000 grams and a standard deviation of 120 grams.

(a) Calculate the probability that the weight of a bag of rice selected at random is:
(i) Less than 940 grams
(ii) More than 1,186 grams
(iii) Between 1,120 grams and 1,186 grams
(iv) Between 910 grams and 1,186 grams

(b) Sketch separate standard normal distribution curves for (a)(iii) and (a)(iv), and represent each probability as an area under the standard normal distribution.

(c) If 425 bags of rice were selected at random, calculate how many bags would weigh more than 1,124 grams. (Give your answer rounded up to the nearest bag of rice.)

1. Comments on learners' performance

This question concerned the application of the laws of probability. As in previous examinations, this is one of the least popular questions on the exam paper. Part (a) required students to determine probabilities using the normal distribution making use of tables. Students generally answered this part of the question very well. However, as in previous examination sessions students generally performed better when calculating probabilities to one side of the normal distribution (parts (i) and (ii)) compared to the calculation of a probability within a specific range (parts (iii) and (iv)). As in previous examination sessions, when drawing the standard normal distribution curves in part (b), many students show some confusion of where within the normal distribution their calculated probabilities lay relative to the range specified. There was a marked improvement this examination session in the number of students that were able to use their calculated probability in part (c) to solve for the number of bags of rice that would weigh more than a specified weight.

2. Mark scheme

(a)

(i) $P(X < 940) = P(Z < \frac{940-1000}{120}) = P(Z < -0.5) = 0.3085$ or 30.85%

(ii) $P(X > 1{,}186) = P(Z > \frac{1186-1000}{120}) = P(Z > 1.55) = 0.0606$ or 6.06%

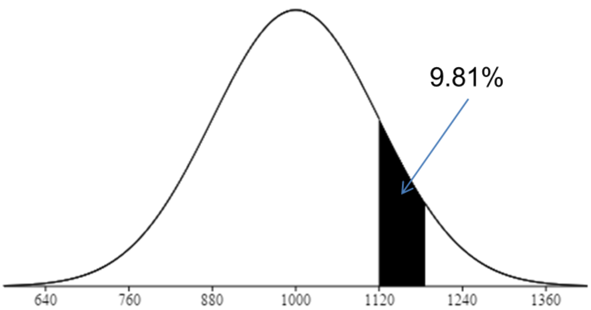
(iii) $P(1{,}120 < X < 1{,}186) = P(\frac{1120-1000}{120} < Z < \frac{1186-1000}{120}) = P(1.00 < Z < 1.55)$

$= 0.1587 - 0.0606 = 0.0981$ or 9.81%

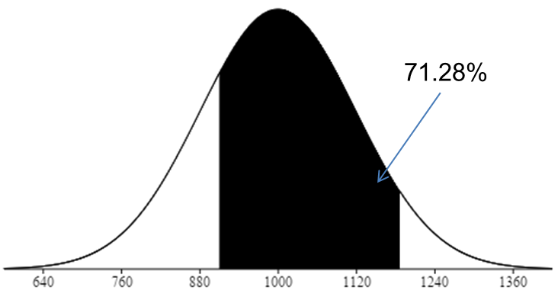
(iv) $P(910 < X < 1{,}186) = P(\frac{910-1000}{120} < Z < \frac{1186-1000}{120}) = P(-0.75 < Z < 1.55)$

$= 1 - (0.2266 + 0.0606) = 0.7128$ or 71.28%

(b)
(i) $P(1{,}120 < X < 1{,}186)$



(ii) $P(910 < X < 1{,}186)$



(c) 425 x 0.0606 = 25.755 = 26 bags of rice

3. Recommendations

Students and tutors are advised to spend a little more time interpreting and using z-values to calculate and represent normal probabilities as areas under the standard normal distribution curve.

Examiner's tips

Always read the question carefully and present your final answer in the form specified; this question requires the answer to be 'rounded up' to the nearest bag of rice.

Conclusions

Information for next sitting / Issues found / Difficult questions or topics

There are no specific issues to raise or information to note. The standard of scripts appears to be relatively similar to that of previous sessions with students achieving marks across the entire range. While students have made significant improvements in a number of areas, students continue to exhibit problems with the application and interpretation of quantitative methods to specific business situations as well as the application of the laws of probability.