No part of the candidate evidence in this exemplar material may be presented in an external assessment for the purpose of gaining credits towards an NCEA qualification.

91585

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Level 3 Mathematics and Statistics (Statistics), 2016

91585 Apply probability concepts in solving problems

2.00 p.m. Thursday 24 November 2016
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Apply probability concepts in solving problems.	Apply probability concepts, using relational thinking, in solving problems.	Apply probability concepts, using extended abstract thinking, in solving problems.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Show ALL working.

Make sure that you have the Formulae and Tables Booklet L3–STATF.

If you need more room for any answer, use the space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL 18

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QUESTION ONE

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(a) A product demonstrator for a confectionary company approaches shoppers and asks them if they would like to taste the product. Of the last 528 female shoppers approached, 288 tasted the product. Of the last 31 male shoppers approached, 14 tasted the product.

Suppose one of these shoppers approached by the product demonstrator is selected at random.

(i) What is the probability that they tasted the product?

	tasted	didn't taste	total
male	14	17	31
female	288	240	528
total	302	257	559

P(tasted product)

$\frac{302}{559} = 0.54025$ sdp

(ii) How many times as likely is it that a female shopper tasted the product compared to a male shopper?

Support your answer with appropriate statistical statements.

Female tasted $= \frac{6}{11}$ male tasted $\frac{14}{31}$

$\frac{6/11}{14/31} = 1.2078$ udp a female is 1.2 times more likely to taste the product than a male

(iii) The product demonstrator claims that, in general, female shoppers are more likely to taste the product than male shoppers.

Discuss why the product demonstrator should be careful about using this data to make this claim.

There are only a small amount of males. ~~testers~~ compared to females. Also this is just for this confectionary item. If there was a different product up for testing, the results could be different. This is also only applicable for this store. In another store the results could be different.

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(b) At a particular supermarket, 43.4% of shoppers do not have a regular shopping day.

For shoppers who **do not** have a regular shopping day, 28.9% of these shoppers buy most of their groceries for the week on a weekend.

For shoppers who **do** have a regular shopping day, 41.2% of these shoppers buy most of their groceries for the week on a weekend.

(i) Without performing any additional calculations, explain why the events "has a regular shopping day" and "buys most of their groceries for the week on a weekend" are not independent.

$P(A)+P(B) =$

independant is ~~$P(A)+P(B)$~~ $P(A) \times P(B)$ = ~~$P(A \cap B)$~~

~~$P(A)+P(B) = 0.434 + 0.289 = 0.723$~~ ~~$P(A \cap B) =$~~ $P(A)+P(B) = 0.434 + 0.289 = 0.723$

$P(A) \times P(B) = 0.434 \times 0.289 = 0.125426$

$0.723 \neq 0.125426$

so therefore they are not independent

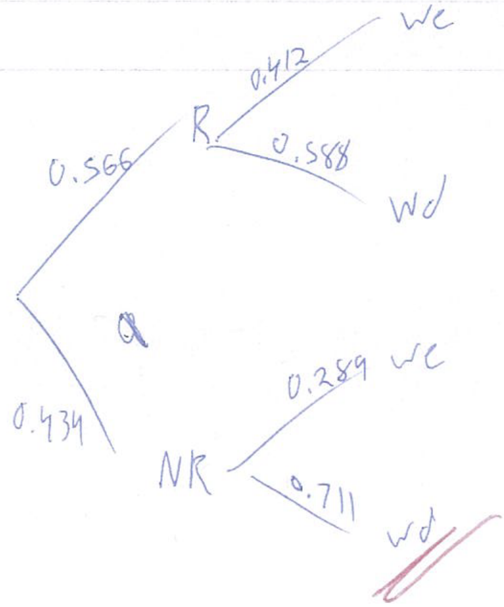
A

(ii) Suppose one of the shoppers at this supermarket is chosen at random.

Calculate the probability that this shopper buys most of their groceries for the week on a weekday.

$(0.566 \times 0.588) + (0.434 \times 0.711) = 0.332808 + 0.308574$

P(shops on weekday) $= 0.641382$



(iii) Suppose three shoppers at this supermarket are chosen at random.

Calculate the probability that all three shoppers have a regular shopping day, and buy most of their groceries for the week on a weekend.

Support your answer with statistical statements and reasoning, including any assumption(s) made.

P(R × Wc) = 0.566 × 0.412 = 0.233192

0.233192 × 0.233192 × 0.233192

~~P(Regular at weekend) = 0.0~~

probability that all 3 will shop regually on a weekend is 0.01268 5dp

ASSESSOR'S USE ONLY

M6

ASSESSOR'S USE ONLY

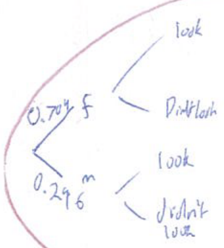
QUESTION TWO

A market research company employs five different "observers" to watch how shoppers at a supermarket interact with products displayed on a particular shelf of an aisle of a supermarket. Each observer records the gender of the shopper, the shopper's estimated age band (e.g. 20 – 29 years), and whether the shopper stops to look at the products on this shelf.

(a) In the most recent study of shoppers at this supermarket, the market research company found that 42.1% of the shoppers observed stopped to look at the products displayed on this shelf. The company also found that 70.4% of the shoppers observed were female.

(i) One of the observers has used this information to predict that 17.1% of shoppers will be male and will not stop to look at products displayed on this shelf.

Show how the observer made this prediction, including stating any assumption(s) that were made.



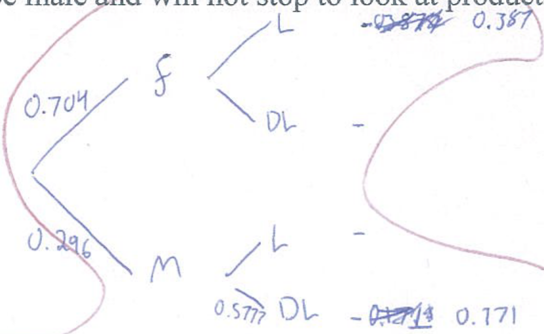
P(Male) = 1 − 0.704 = 0.296

P(look at shelf) = 1 − 0.421 = 0.579

0.296 × 0.579 = 0.171 3dp or 17.1%

(ii) It is also known that 38.7% of shoppers in the most recent study were female and stopped to look at the products displayed on this shelf.

Use this information to predict how many shoppers out of every 300 shoppers at the supermarket will be male and will not stop to look at products displayed on this shelf.



$\frac{0.171}{0.296} = 0.5777$ 4dp

0.5777 × 300 = 173.3108 or 173 males

out of 300 shoppers 173 will be males that did not stop to look at the products displayed

(b) Every 10th shopper observed in the recent study took a survey. One of the questions in this survey asked the shopper to select their actual age band. The market research company compared each shopper's estimated age band with their actual age band, and, based on these comparisons, calculated that each observer has an 86% accuracy rate for estimating the shopper's age band.

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(i) Give ONE reason why this "accuracy" rate is only an estimate for the true probability that an "observer" will record each shopper's actual age band correctly.

The experimental probability is what comes up in a test, the theoretical probability is what people expect to occur. Due to external factors the true probability can never been known as we can not predict exactly how accurate someone will guess. We can only know the probability and the experimental

(ii) One of the observers has recorded the correct age band for 30 of the 42 shoppers they observed.

Discuss how carrying out a simulation would help the market research company consider whether this observer has a lower than 86% accuracy rate.

You do not need to design the simulation.

$\frac{30}{42} = \frac{5}{7} = 0.714286$ accuracy rating

~~eh~~ 71.4% is lower than 86% so this observer has an accuracy rating lower than 86%. This simulation will give a general accuracy rating.

(c) Each observer also records whether each shopper has young children with them, buys any products on this shelf, and how long the shopper spends at the supermarket.

Of the 435 shoppers observed in the most recent study:

- 60 shoppers had young children with them, bought products on this shelf, and spent more than 30 minutes at the supermarket
- 86 shoppers had young children with them, and bought products on this shelf
- 62 shoppers bought products on this shelf, and spent more than 30 minutes at the supermarket
- 129 shoppers bought products on this shelf

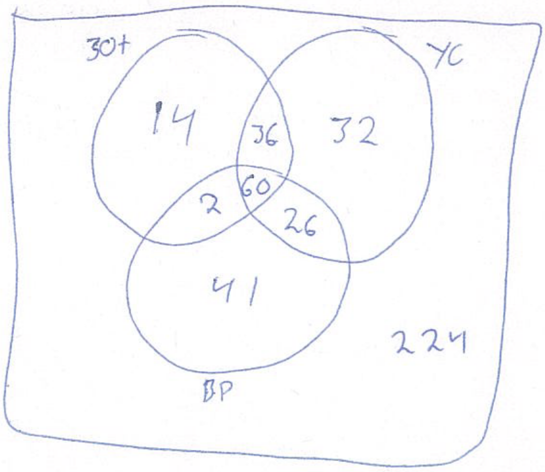
- 32 shoppers had young children with them, but did not buy any products from this shelf, and did not spend more than 30 minutes at the supermarket
- 154 shoppers had young children with them
- 14 shoppers spent more than 30 minutes at the supermarket, but did not have young children with them, and did not buy products on this shelf.

A shopper from this study is selected at random.

Calculate the probability that the shopper did not have young children with them, did not buy any products on this shelf, and did not spend more than 30 minutes at the supermarket.

Support your answer with appropriate statistical statements or diagrams.

ASSESSOR'S USE ONLY



30+ = over 30 min
YC = Young children
BP = Buy product

P(No children, No products, less than 30 min) $= \frac{224}{435}$

$P = 0.5149$

E7

QUESTION THREE

ASSESSOR'S USE ONLY

(a) A certain supermarket has self-service checkout machines. Customers scan each item and then place the item into a shopping bag, which is then weighed by the machine. The machine then uses this weight to check that the item scanned is the same item that was placed in the shopping bag.

If the weight of the product stored on the machine (obtained from the barcode scanned) does not match the weight of the item measured by the machine, the machine flashes a red light; otherwise the machine flashes a green light. The self-service checkout machine does not always flash the correct coloured light.

In cases where the item scanned actually is the same item placed in the shopping bag, the machine will incorrectly flash a red light 3% of the time. In cases where the item scanned is not the same as the item placed in the shopping bag, the machine will correctly flash a red light 98% of the time.

(i) Give ONE possible reason why the self-service checkout machine does not have a 100% accuracy rate when using item weights to check whether the correct item has been placed into the shopping bag.

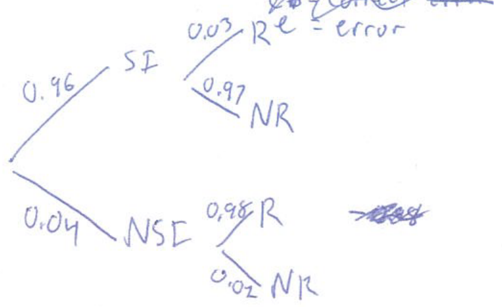
Due to variations in weight, a product could have a set weight between 200g - 500g but this scanned item may be an outlier of 170g and therefore the red light will flash incorrectly as the weight is outside the variables

(ii) At this supermarket, it is estimated that in 4% of the scans, the item scanned is not the same as the item placed in the shopping bag.

Suppose that an item is scanned and the machine flashes a red light.

Estimate the probability that the item scanned is not the same as the item placed in the shopping bag.

R = Red
e = error



P(flashes red) = 0.0392 + 0.0288 = 0.068

P(not same item) = R × NSI = 0.0392

P(NSI if flashes red) = $\frac{0.0392}{0.068}$ = $\frac{49}{85}$ = 0.57647

M5

Excellence exemplar 2016

Subject:	Statistics	Standard:	91585	Total score:	18

Q	Grade score	Annotation
1	**M6**	The calculation of the relative risk was completed and interpreted with a minor error. Should have stated “it was 1.2 times as likely”, rather than “it was 1.2 times more likely”. This candidate could not explain that the two events were not independent because the two probabilities were not the same. The calculation from a tree diagram constructed by the candidate was done accurately. The candidate failed to get an E7 or E8 in part b iii because they didn’t go on to explain about either the assumption of independent shopper habits or the assumption that the sample size was sufficiently large so as not to alter the probability.
2	**E7**	Candidate correctly modelled the information using a 3-event Venn diagram and then used it to calculate the required probability. Hence gaining the E7. The candidate failed to show an understanding of how a simulation could provide evidence for the market research company to make a decision if the observer has a lower than 88% accuracy rate.
3	**M5**	The fact that this question was a conditional probability situation was recognised by the candidate and processed accordingly. They also recognised that any product will have a variety of weights, and it could fall outside the machine’s tolerance level.