H

National Qualifications 2022 MODIFIED

X844/76/11

Applications of Mathematics Data booklet

WEDNESDAY, 4 MAY

9:00 AM – 11:05 AM

Pre-release material

This booklet will be issued to centres in advance of the date of examination.

Candidates will be issued with a clean copy of this booklet. Copies will be issued at the start of the examination session and collected at the end of the session. Candidates must not take their own copies of this booklet into the examination.

Centres should ensure that candidates are familiarised with the contexts and information contained in this booklet in preparation for the examination.

Some examination questions will be based on this material.

This booklet contains a set of five documents:

1. Dogs and fleas
2. Strength and conditioning
3. Deductions from salaries
4. Mountain gorillas
5. Some helpful R commands

1. Dogs and fleas

The UK is a nation of dog-lovers with 1 in 4 adults owning a dog. Owning a dog is a big commitment and it is important that dog owners meet the needs of their dogs and register them with a vet. One thing that dog owners need to be aware of is fleas.

Fleas are a blood-sucking parasite that are found in shaded areas near long grass and bushes. Fleas are found throughout the year and are believed to be more common in the warmer months. They are thought to be more common in rural areas. A dog is said to have a flea infestation when the number of fleas exceeds 20.

Study 1:

To investigate the seasonal variation of flea infestations in dogs, a student vet, on placement in a veterinary clinic in Edinburgh city centre, gathers data on the number of dogs requiring treatment for flea infestations. From appointment records, the number of treatments for flea infestations in dogs over a one-year period were recorded.

Study 2:

To investigate whether flea infestations are more common in rural areas than urban areas, a second study was designed by the student vet. In the study, a sample of dogs was inspected for flea infestations over a 3-month period at the Edinburgh clinic, and a similar sample of dogs was inspected for flea infestations at a rural veterinary clinic.

2. Strength and conditioning

Strength and conditioning is an important part of overall health and fitness. A strength and conditioning coach uses a variety of different exercises to improve overall health and fitness.

Some of the exercises that a coach may use are:

- Back squat: a lower-body weight training exercise in which the trainee performs a squat using added weight. The back squat weight is usually recorded in kilograms.

- Bench press: an upper-body weight training exercise in which the trainee presses a weight upwards while lying on a weight training bench. The bench press weight is usually recorded in kilograms.

- Plank: a physical exercise designed to strengthen the abdominal muscles, in which the trainee performs a press-up and holds the raised position for a set period of time. Plank hold time is usually recorded in seconds.

One measurement of overall strength and condition is a person's vertical jump height. This is the height of a jump straight up into the air from a standing position. Vertical jump height is usually recorded in centimetres.

3. Deductions from salaries

Scottish tax bands 2021/22

Band	Taxable income	Scottish tax rate
Personal Allowance	Up to £12,570	0%
Starter rate	£12,570 – £14,667	19%
Basic rate	£14,667 – £25,296	20%
Intermediate rate	£25,296 – £43,662	21%
Higher rate	£43,662 – £150,000	41%
Top rate	Over £150,000	46%

National Insurance contributions

You begin paying National Insurance once you earn more than £184 a week (this is the amount for the 2021–22 tax year). The National Insurance rate you pay depends on how much you earn: 12% of your weekly earnings between £184 and £967; 2% of your weekly earnings above £967.

National Insurance is calculated on a person's salary before deductions such as pension contributions.

4. Mountain gorillas

Deforestation is happening on a massive scale throughout the world and many animals are experiencing habitat loss. Conservation teams have been campaigning against deforestation in a bid to increase wildlife populations.

One success story is the mountain gorilla. More than half of the world's mountain gorillas live in the Virunga Mountains, a range of extinct volcanoes that border the Democratic Republic of Congo, Rwanda and Uganda.

A study in 2008 showed there were only 680 mountain gorillas in the Virunga Mountains. A further study in 2020 showed that due to conservation efforts, including clamping down on illegal logging, the population of mountain gorillas had increased.

Mountain gorillas are considered adults when they are 10 years old and will live for an average of 35 years.

Mountain gorillas survive on a **mainly** vegetarian diet consisting of bamboo shoots, fruit, and berries. Given the opportunity, mountain gorillas will also eat ants and termites, but their diet will remain mostly vegetarian.

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5. Some helpful R commands

To read in data from an Excel csv file called *excel_data.csv* to R Studio and name it *mydata*, first use the drop down menus in R Studio **Session > Set Working Directory > Choose Directory** to indicate the location of *excel_data.csv* on your computer. The following code will then read the data in to R Studio:

```
mydata<-read.csv("excel_data.csv")
```

`attach(mydata)` — this adds the variable names

At the end of the analysis remember to use `detach(mydata)` to disassociate the variable names.

(a) Graphics

`hist(X,col="yellow",main="Histogram of X (units)")` — this produces a histogram of the variable named 'X'

`plot(X,Y,xlab="x-axis label",ylab="y-axis label", main="Scatterplot of Y on X",pch=21,bg="black")` — produces a scatterplot of X vs Y with black dots

`pie(table(X), main="Title")` — this gives a simple pie chart of the categories in variable X with the specified title

`barplot(table(X), main="title", xlab="x-axis label",col="orange")` — this gives a bar chart of the categories in the variable X with the required title, axis labels and colour

`boxplot(Y)` — produces a boxplot of the numerical variable Y

(b) Descriptive Statistics

`mean(X)` — computes the mean of X

`sd(X)` — computes the standard deviation of X

`summary(X)` — computes the mean, median, minimum, maximum, and upper and lower quartiles

`table(X)` — computes the number of observations in each level of the categorical variable X

`prop.table(table(X))` — returns the proportion of observations in each level of the categorical variable X

`prop.table(table(X))*100` — returns the percentage of observations in each level of the categorical variable X

`table(X,Y)` — produces a cross-tabulation between the two categorical variables X and Y

(c) Correlation and Regression

`cor.test(X,Y)` — computes the correlation between X and Y and performs a test of the null hypothesis of zero correlation

`lm(Y~X)` — fits a linear regression line to the data (`lm` command stands for linear model)

`abline(lm(Y~X))` — produces a scatterplot with the least squares linear regression line superimposed on the data

`summary(lm(Y~X))` — displays the coefficient of determination (r-squared)

`predict(lm(Y ~ X), newdata=data.frame(X=C),interval = "pred")` — computes the predicted value of Y when X=C along with a 95% prediction interval

(d) Hypothesis Testing

`t.test(X,Y)` — performs a two sample t-test between X and Y

`t.test(X,Y,paired=TRUE)` — performs a paired t-test between X and Y

`prop.test(x = c(a, b), n = c(n1, n2))` — performs a 2-sample test for equality of proportions with continuity correction

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