H

National Qualifications 2024

X844/76/11

**Applications of Mathematics
Data booklet**

FRIDAY, 3 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 any 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 three documents:

1. Deductions from salaries
2. Dracaena plants and atmospheric carbon dioxide levels
3. Some helpful R commands

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1. **Deductions from salaries**

Scottish income tax bands 2023/24

Band	Taxable income	Scottish tax rate
Personal Allowance	Up to £12,570	0%
Starter rate	£12,570 – £14,732	19%
Basic rate	£14,732 – £25,688	20%
Intermediate rate	£25,688 – £43,662	21%
Higher rate	£43,662 – £125,140	42%
Top rate	Over £125,140	47%

National Insurance Contributions

In the 2023/24 tax year, National Insurance payments varied during the year.

You begin paying National Insurance once you earn more than £1048 a month (this is the amount for the 2023/24 tax year).

For payslips dated between 6 April 2023 and 5 January 2024, you pay 12% of your monthly earnings between £1048 and £4189; 2% of your monthly earnings above £4189.

For payslips dated between 6 January 2024 and 5 April 2024, you pay 10% of your monthly earnings between £1048 and £4189; 2% of your monthly earnings above £4189.

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

2. **Dracaena plants and atmospheric carbon dioxide levels**

Dracaena plants are a type of plant often grown indoors. They make excellent house plants because they tolerate low light and require little water. Dracaena plants have been shown to be effective air filters. They remove formaldehyde, benzene, trichloroethylene, and carbon dioxide from a room's atmosphere.

Carbon dioxide (CO_2) is a natural component of air, but in too large a concentration CO_2 can be harmful to humans. To improve indoor air quality many workplaces and schools take measures to reduce CO_2 concentration levels. Carbon dioxide concentration is measured in parts per million (ppm).

Acceptable CO_2 concentration levels vary from country to country. For example, in the UK, the Health and Safety Executive has a set of standards for acceptable CO_2 concentration levels in indoor spaces:

*   800 ppm or below indicates that an indoor space is likely to have very good indoor air quality.

*   Consistent levels of 1500 ppm or above indicate that an indoor space is likely to have poor indoor air quality.

Where poor indoor air quality is identified, measures should be taken to improve ventilation — this will reduce the CO_2 concentration levels.

3. 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 X

`plot(X,Y,xlab="x-axis label",ylab="y-axis label", main="Scatterplot of Y on X",pch=21,bg="black")` — produces a scatter plot of Y on X with the required title, axis labels, and 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(X)` — produces a boxplot of the numerical variable X

(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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