H

National Qualifications 2023 MODIFIED

X844/76/11

Applications of Mathematics Data booklet

WEDNESDAY, 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 3 documents:

1. Deductions from salaries

2. E10 Petrol

3. Some helpful R commands

1. **Deductions from salaries**

Scottish tax bands 2022/23

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 – £150,000	41%
Top rate	Over £150,000	46%

National Insurance Contributions

In the 2022–23 tax year, National Insurance payments varied during the year.

For payslips dated between 6 April 2022 and 5 July 2022, you began paying National Insurance once you earned more than £823 a month. The National Insurance rate you paid depended on how much you earned: 13.25% of your monthly earnings between £823 and £4189; 3.25% of your monthly earnings above £4189.

For payslips dated between 6 July 2022 and 5 November 2022, you began paying National Insurance once you earned more than £1048 a month. The National Insurance rate you paid depended on how much you earned: 13.25% of your monthly earnings between £1048 and £4189; 3.25% of your monthly earnings above £4189.

For payslips dated between 6 November 2022 and 5 April 2023, you began paying National Insurance once you earned more than £1048 a month. The National Insurance rate you paid depended on how much you earned: 12% 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. E10 Petrol

The following information is taken from the government's website
https://www.gov.uk/guidance/e10-petrol-explained

Petrol in the UK currently contains 5% renewable ethanol (known as E5) or 10% renewable ethanol (known as E10).

Reducing emissions

CO_2 is one of the greenhouse gases that contribute to climate change and the main benefit of E10 petrol is that it reduces overall levels of CO_2-based vehicle emissions.

By blending petrol with up to 10% renewable ethanol, less fossil fuel is needed, helping us reduce carbon emissions and meet climate change targets.

The introduction of E10 petrol in the UK is predicted to cut transport CO_2 emissions by 750 000 tonnes a year — the equivalent of taking 350 000 cars off the road.

Renewable fuel blends, such as E10 petrol, are generally introduced to reduce overall CO_2 emissions. They have little impact on emissions associated with air quality and public health.

The production of renewable ethanol for blending with fossil petrol also results in valuable by-products, including animal feed and stored CO_2.

Fuel economy

Using E10 petrol can slightly reduce fuel economy (the number of miles you are able to drive on a gallon of fuel). You may see a reduction of around 1%, but it is unlikely to be noticeable in everyday driving.

Other factors, such as your driving style or driving with under-inflated tyres or a roof rack, have a much more significant impact on fuel economy than using E10 petrol.

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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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