Candidate surname | Other names

**Pearson Edexcel
Level 3 Certificate**

Centre Number | Candidate Number

Wednesday 20 May 2020

Morning (Time: 1 hour 40 minutes) | Paper Reference **7MC0/02**

Mathematics in Context
Paper 2: Applications

You must have: Ruler graduated in centimetres and millimetres, pen, HB pencil, eraser, calculator.
Source booklet.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need*.
- **Calculators may be used.**

Information

- The total mark for this paper is 80
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question*.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over

P 6 3 2 9 8 A 0 1 2 4

Pearson

SECTION A

Answer ALL questions. Write your answers in the spaces provided.

SMARTPHONES

1   Refer to the **data source**.

The data for the battery life of smartphones in 2014, from Table 1 in the source booklet, is summarised in the box plot below.
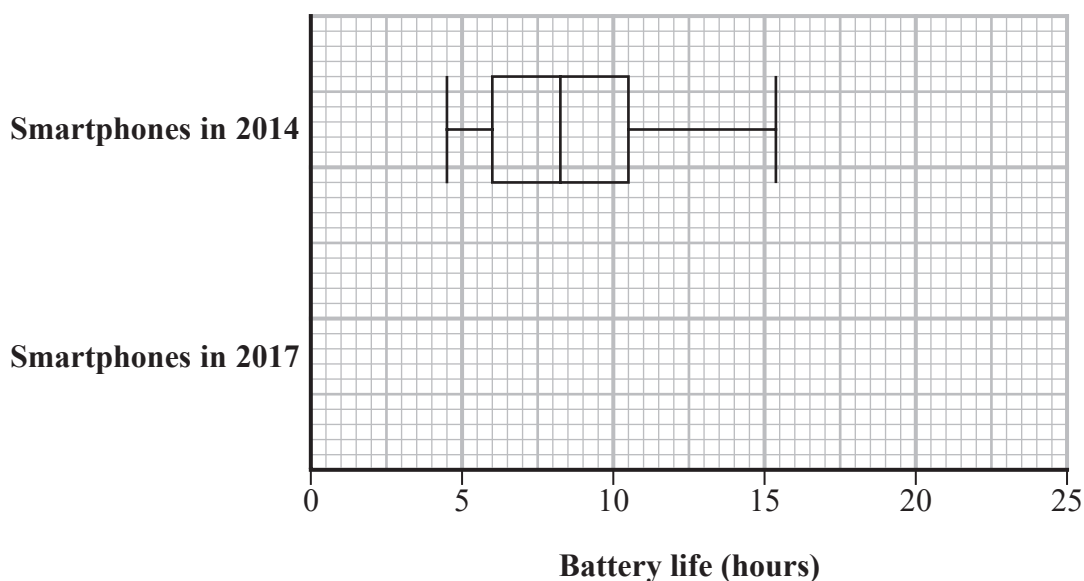
Battery life (hours)

The table below gives the information about smartphones in 2017 from Table 2 in the source booklet.

Model	Battery life (hours) (4G web browsing)
Apple iPhone 6S	11.2
Microsoft Lumia 650	11.4
HTC 10	12.1
LG X Screen	12.3
Apple iPhone 7	13.0
Vodaphone Smart Platinum 7	13.2
Huawei Nova	13.3
LG Leon	14.0
Sony Xperia X Compact	14.4
Motorola Moto X Force	15.1
Samsung Galaxy S6 Edge	15.3
Google Pixel XL	15.6
Apple iPhone SE	16.5
Samsung Galaxy S7 Edge	18.4
Motorola Moto Z Play	23.5

An outlier is defined as any value that is

greater than the upper quartile + (1.5 × interquartile range)

or

less than the lower quartile − (1.5 × interquartile range)

(a) On the grid opposite, draw a box plot to show the information for the battery life of smartphones in 2017.

You must show any outliers on your box plot, along with calculations to identify these outliers.

(6)

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(b) For the given data, compare the battery life, when browsing the web using 4G, of the smartphones in 2014 and the smartphones in 2017.

(2)

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(Total for Question 1 is 8 marks)

2   The data below and the graph opposite show the quarterly sales of new iPhones from quarter 1 (Q1) in 2015 to quarter 2 (Q2) in 2018.

Quarter	Sales of new iPhones (Millions)	4-point moving average
2015 Q1	74.5	
2015 Q2	61.2	
		57.8
2015 Q3	47.5	
		57.9
2015 Q4	48.1	
		55.4
2016 Q1	74.8	
		53.6
2016 Q2	51.2	
		53.0
2016 Q3	40.4	
		53.9
2016 Q4	45.5	
		53.8
2017 Q1	78.3	
		53.9
2017 Q2	50.8	
		54.2
2017 Q3	41.0	
		54.0
2017 Q4	46.7	
		54.3
2018 Q1	77.3	
		54.4
2018 Q2	52.2	
2018 Q3	....	

(a) Calculate the sales of new iPhones for quarter 3 (Q3) in 2018.

(2)

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The quarterly sales of new iPhones are shown on the grid below.
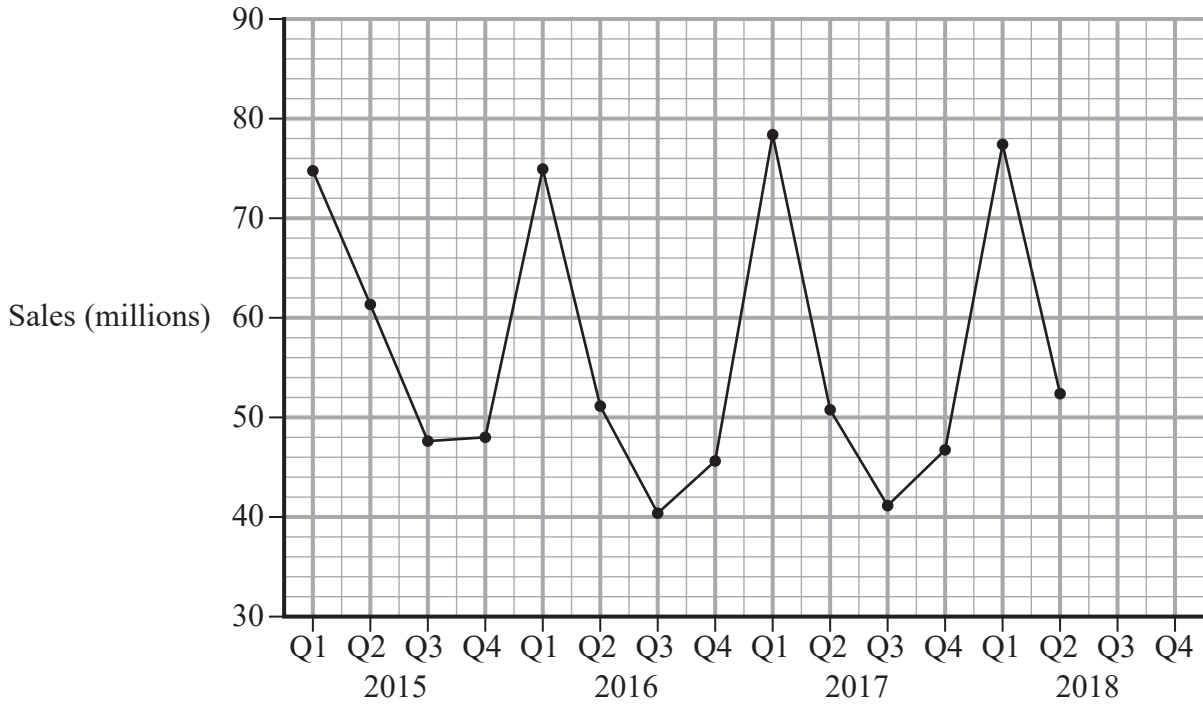
Sales of iPhones 2015 – 2018

https://www.statista.com/statistics/266219/global-smartphone-sales-since-1st-quarter-2009-by-operating-system/

(b) On the grid, plot the moving averages.

(2)

(c) Use your graph to find an estimate for the total sales of new iPhones for 2018.

(2)

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Mabintou gathered data on the quarterly sales of new iPhones for the years 2010 to 2017. Her data is summarised in the table below.

Quarterly sales of new iPhones (S millions)	Frequency
$5 \leqslant S < 20$	7
$20 \leqslant S < 35$	5
$35 \leqslant S < 45$	8
$45 \leqslant S < 55$	8
$55 \leqslant S < 80$	4

(d) (i) Calculate an estimate for the mean quarterly sales of new iPhones for the years 2010 to 2017.

(4)

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(ii) Use your answer to part (d)(i) to calculate an estimate for the **total** sales of new iPhones for the year 2018.

(1)

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P 6 3 2 9 8 A 0 6 2 4

(e) Which estimate for the total sales of new iPhones in 2018 is the more reliable, the estimate in part (c) or the estimate in part (d)(ii)?
Give a reason for your answer.

(1)

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(Total for Question 2 is 12 marks)

TOTAL FOR SECTION A IS 20 MARKS

Answer ALL questions. Write your answers in the spaces provided.

TASK 1: GENES

3 A particular disease is a condition that is passed from parents to children.

Each parent passes on one gene linked to the disease to each of his or her children.

Each gene is either normal (N) or faulty (F).

A person always gets this disease when both genes are faulty (**positive** disease status). Otherwise the person does not get the disease (**negative** disease status).

A person is a carrier of this disease if the person has one faulty gene and one normal gene.

Complete the table to show all the possible combinations of the two genes for a person, the corresponding disease status and whether the person is a carrier.

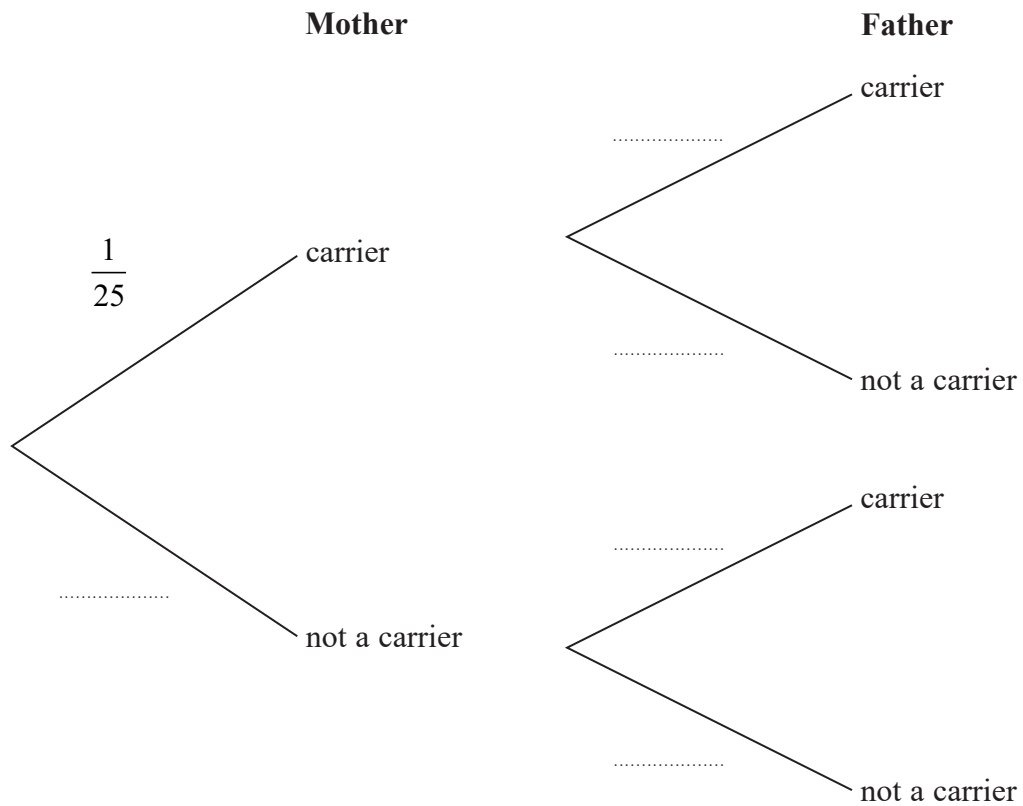| Genes	Disease status	Carrier
FF	positive	

(Total for Question 3 is 2 marks)

4 Research shows that 1 in every 25 people is a carrier of this disease.

(a) Use this information to complete the probability tree diagram.

(2)

Mother   **Father**

$\dfrac{1}{25}$ carrier

.... carrier

.... not a carrier

.... not a carrier

.... carrier

.... not a carrier

There is a 25% probability that a child of two carriers will have the disease.
In all other cases the probability is 0

(b) Show that, out of 10 000 babies born, 4 babies would be expected to have the disease.

(3)

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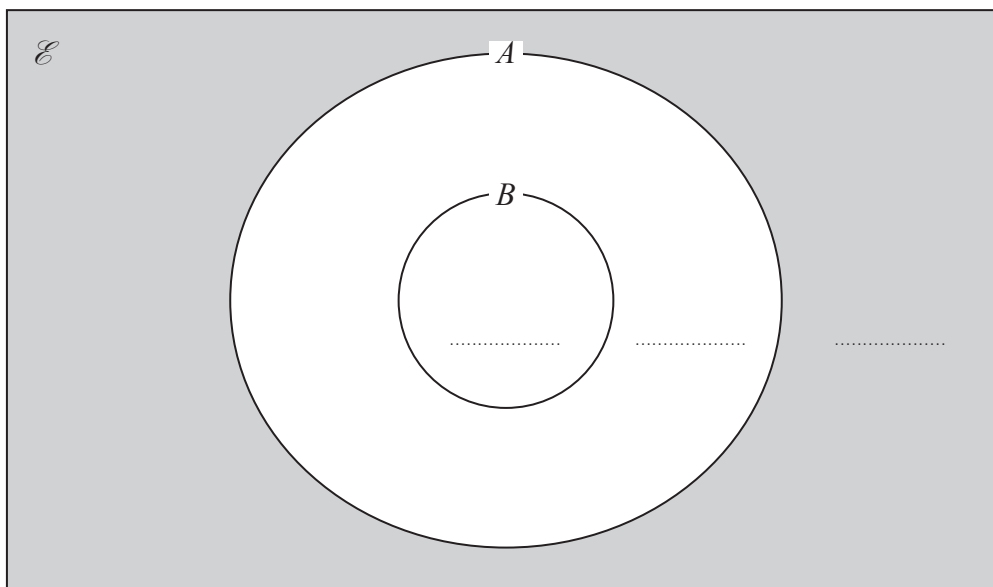
(Total for Question 4 is 5 marks)

5 A doctor tests 1000 people for the presence of the faulty gene.

The Venn diagram shows the relationship between the sets:

$\mathcal{E}$ = {all the people tested by the doctor}
A = {people with at least one faulty gene}
B = {people with the disease}

The doctor finds that, of these 1000 people,
    2 people have the disease
    12 people have the faulty gene.

(a) (i) Complete the Venn diagram for this information.

(2)

   (ii) Explain, in context, why the circle representing set B has been drawn inside the circle representing set A.

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   (iii) Write, using set notation, the set represented by the shaded region.

(1)

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(b) (i) Find P($B|A$)

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(ii) Write down P($A|B$)

(1)

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(Total for Question 5 is 7 marks)

6 A small pharmaceutical company has developed a new screening test for the disease.

The company has two options

* manufacture and distribute the test itself

* go into partnership with a large business and take a royalty

The table below shows the expected profits for the company for each level of sales.

	Expected profit (£ thousands)		
	High sales	**Medium sales**	**Low sales**
Manufacture itself	7000	4000	−3000
Go into partnership	4000	3000	1000

The table below shows the probability of each level of sales.

	Probability
High sales	0.1
Medium sales	0.6
Low sales	0.3

The company has the choice to launch an advertising campaign costing £2 000 000
The company predicts that the campaign will alter the probability of each level of sales, as shown in the table below.

	Probability
High sales	0.2
Medium sales	0.7
Low sales	0.1

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Determine the course of action that will give the greatest expected profit.
You must show all your working.

(Total for Question 6 is 6 marks)

P 6 3 2 9 8 A 0 1 3 2 4

TASK 2: EARTHQUAKES

7 An earthquake occurs when rock underground suddenly breaks.
The epicentre of an earthquake is the place where it is most strongly felt.

An earthquake has occurred in the South West of the United States.
Data has been collected from three seismic monitoring centres located at Eureka, Elko and Las Vegas.

Each seismic monitoring centre measures the arrival times of the Primary shock waves (P-waves) and the Secondary shock waves (S-waves). The distance of the epicentre from the seismic monitoring centre can then be calculated using the following formula

$$D = 9.8(S_t - P_t)$$

where

$S_t - P_t$ is the difference between the arrival times, in seconds, of the P-waves and S-waves
D is the distance in km from the seismic monitoring centre to the epicentre of the earthquake

This diagram shows the information recorded by the seismic monitoring centre at Eureka.
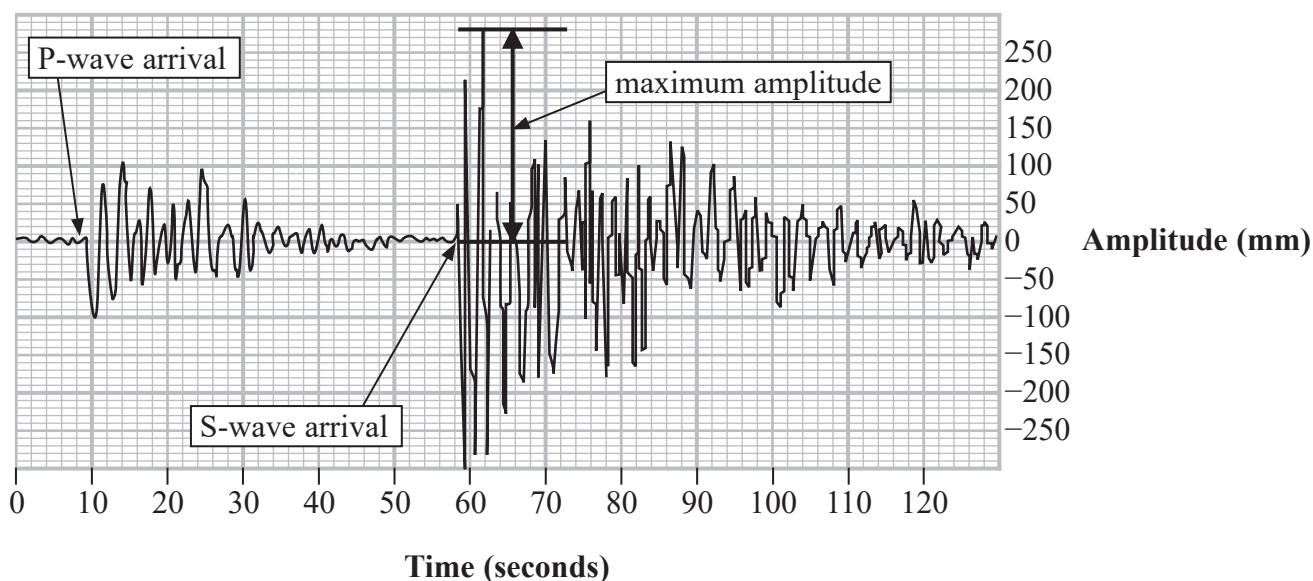
The diagram for Elko is shown below.
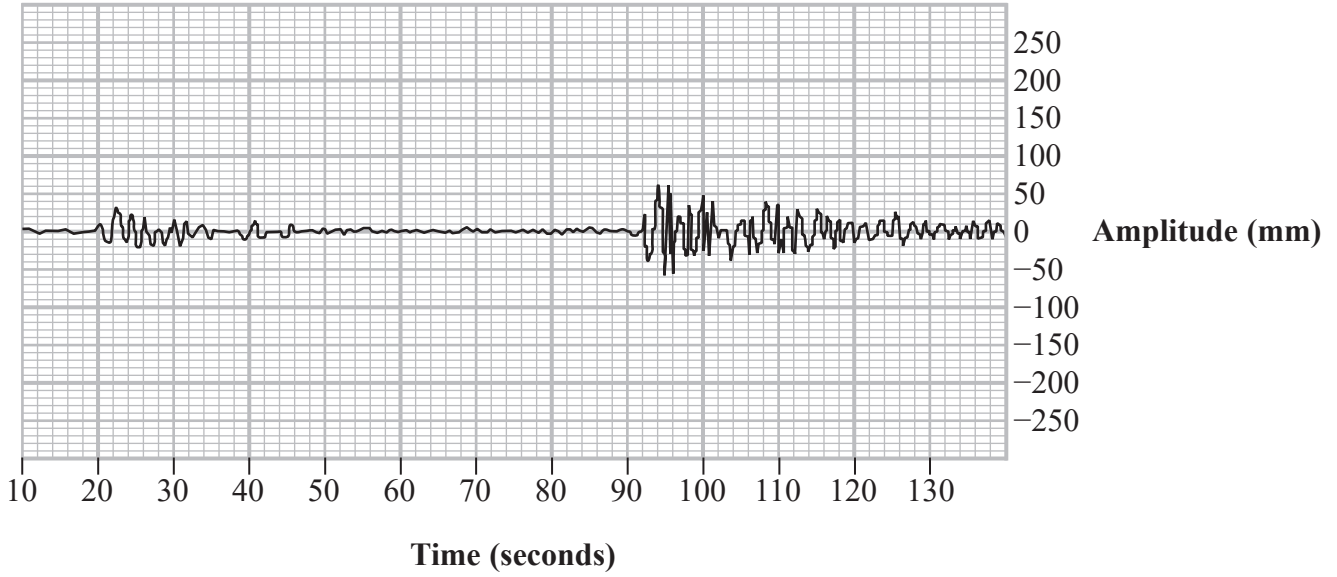
Seismic monitoring centre	Distance from epicentre (km)	Maximum amplitude of S-wave (mm)
Eureka	480	280
Las Vegas	620	100
Elko	....	....

(a) Complete the table.

(3)

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The distance of the epicentre of an earthquake from a seismic monitoring centre is related to the maximum amplitude of the S-wave measured at the seismic monitoring centre.

Seismic monitoring centre	Distance from epicentre (km)	Maximum amplitude of S-wave (mm)
Eureka	480	280

Let a mm be the maximum amplitude of the S-wave at a distance, d km, from the epicentre of the earthquake that occurred in the South West of the United States. The following model is proposed to link a and d.

$$a = 0.0036d^2 - 5.2d + c \quad \text{where } c \text{ is a constant.}$$

(b) (i) Use the data for Eureka to calculate the value of c.

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(ii) According to the model, what is the maximum amplitude of the S-wave at the epicentre of the earthquake?

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An alternative model is proposed to link a and d.

$$a = 3 \times 10^{13} \times d^{-4.12}$$

(iii) Explain why this model cannot be used to find the maximum amplitude of the S-wave at the epicentre of the earthquake.

(1)

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(Total for Question 7 is 7 marks)

8 In September 2011 there was an earthquake of magnitude 6.8 in Sikkim, India.

There was damage to houses in this area.

The table below shows the type of damage, the proposed actions to repair the houses and the number of houses affected.

Damage	Action	Number of houses affected
Grade 1	Retrofit with wood members	1111
Grade 2	Retrofit with wood members Repair cracks to walls	9749

The table below shows the cost of each action.

Action	Cost in dollars
Retrofit with wood members	540
Repair cracks to walls	8.50 per metre length of wall

Assuming that the average total length of the walls needing repairs to cracks in each house is 20 metres, calculate an estimate for the total cost of **all** repairs.

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(Total for Question 8 is 3 marks)

9 An earthquake of magnitude 7.4 on the Richter Scale occurred in Christchurch, New Zealand, on 4 September 2010.

The energy released by an earthquake can be calculated using the formula

$$E = 10^{4.8 + 1.5M}$$

where

E is the energy in joules

M is the magnitude of the earthquake on the Richter Scale

(a) Calculate the energy released by this earthquake.
Give your answer in standard form correct to 2 significant figures.

(2)

The energy released by one of the nuclear bombs used in World War Two was 63 terajoules.
1 terajoule = 10^{12} joules

A newspaper headline in September 2010 referring to the earthquake in Christchurch claimed,

"The energy released by the earthquake was equivalent to more than 100 World War Two nuclear bombs."

(b) Assess the validity of this claim.

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(Total for Question 9 is 5 marks)

10 The table shows the average number of earthquakes per year of magnitude 5 and above on the Richter Scale for the years 2008 to 2017 inclusive.

Magnitude (M)	Average number per year
8+	1
$7 \leqslant M < 8$	15
$6 \leqslant M < 7$	138
$5 \leqslant M < 6$	1700
Total	1854

(a) Calculate the probability that an earthquake will be of magnitude 6 or greater given that it is of magnitude 5 or greater.

(2)

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It is assumed that the distribution of earthquakes per year of magnitude 5 and above on the Richter Scale will remain constant over each of the next 10 years.

(b) Show that in the next 10 years there is more than a 50% chance of at least one earthquake being of magnitude 6 or greater given that it is of magnitude 5 or greater.

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(Total for Question 10 is 5 marks)

TASK 3: ANIMAL FEED

11 A company manufactures packets of feed for animals.
Two of the ingredients used are bonemeal and grain.

Bonemeal contains 40 g of protein, 20 g of fat and 20 g of carbohydrate per 100 g.

Grain contains 10 g of protein, 15 g of fat and 60 g of carbohydrate per 100 g.

Each packet of feed must contain at least 180 g of protein, 120 g of fat and 180 g of carbohydrate.

Let x be the number of grams of bonemeal used in each packet.
Let y be the number of grams of grain used in each packet.

(a) In addition to $x \geqslant 0$ and $y \geqslant 0$ show that this gives the following inequalities

(4)

$$4x + y \geqslant 1800$$
$$4x + 3y \geqslant 2400$$
$$x + 3y \geqslant 900$$

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There is a maximum of 600 g of bonemeal and 1 kg of grain available for the manufacture of each packet.

(b) Write down **two** further inequalities to represent this information.

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(c) Represent the inequalities from parts (a) and (b) on the grid.
Label the feasible region **R**.

(5)
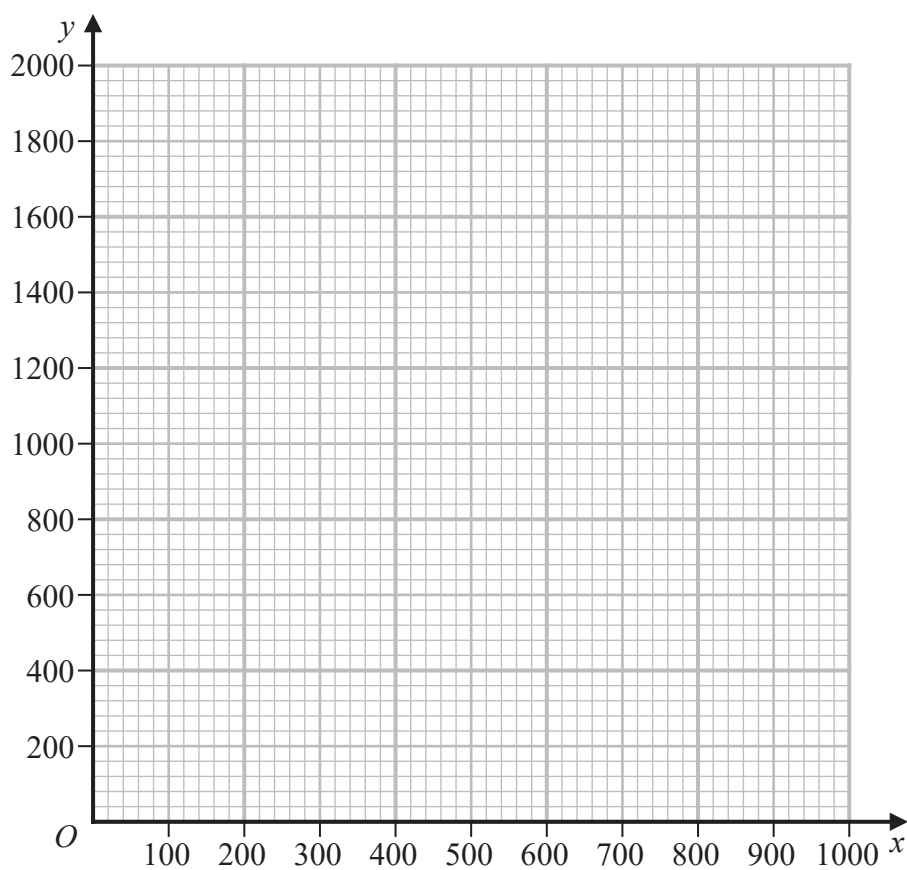
Bonemeal costs 0.3p per gram and grain costs 0.1p per gram.

The manufacturer wants to minimise the cost of bonemeal and grain, C pence, used in each packet of animal feed.

(d) Write down the objective function, C, in terms of x and y.

(1)

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(e) Find the exact coordinates of the point giving the minimum value of C. You must make your method clear.

(4)

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Each packet of feed weighs 800 g.
Once the bonemeal and grain have been added, the remainder of the packet is made up of fibre that costs 50p per kg.

(f) Calculate the minimum cost of all the ingredients needed for each packet of feed.

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(Total for Question 11 is 20 marks)

TOTAL FOR SECTION B IS 60 MARKS
TOTAL FOR PAPER IS 80 MARKS

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Pearson Edexcel Level 3 Certificate

Wednesday 20 May 2020

Morning (Time: 1 hour 40 minutes) | Paper Reference **7MC0/02**

Mathematics in Context

Paper 2: Applications

Source booklet
Do not return this source booklet with the question paper.

Turn over ▶

P63298A

Pearson

Formulae sheet

There will be no credit for anything you write on this formulae sheet.

Mean of a frequency distribution

$$= \frac{\sum fx}{\sum f}$$

Mean of a grouped frequency distribution

$$= \frac{\sum fx}{\sum f}, \text{ where } x \text{ is the mid-interval value}$$

Variance

$$= \frac{\sum (x - \bar{x})^2}{n}$$

Standard deviation (set of numbers)

$$\sqrt{\left[\frac{\sum x^2}{n} - \left(\frac{\sum x}{n} \right)^2 \right]}$$

or

$$\sqrt{\left[\frac{\sum (x - \bar{x})^2}{n} \right]}$$

where $\bar{x}$ is the mean of the set of values

Standard deviation

(discrete frequency distribution)

$$\sqrt{\left[\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f} \right)^2 \right]}$$

or

$$\sqrt{\left[\frac{\sum f(x - \bar{x})^2}{\sum f} \right]}$$

Spearman's rank correlation coefficient

$$1 - \frac{6 \sum d^2}{n(n^2 - 1)}$$

The product moment correlation coefficient is

$$r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}} = \frac{\sum x_i y_i - \frac{(\sum x_i)(\sum y_i)}{n}}{\sqrt{\left(\sum x_i^2 - \frac{(\sum x_i)^2}{n}\right)\left(\sum y_i^2 - \frac{(\sum y_i)^2}{n}\right)}}$$

The regression coefficient of y on x is $b = \dfrac{S_{xy}}{S_{xx}}$

Least squares regression line of y on x is $y = a + bx$ where $a = \bar{y} - b\bar{x}$

Arithmetic series

$u_n = a + (n - 1)d$

$S_n = \frac{1}{2}n(a + l) = \frac{1}{2}n[2a + (n - 1)d]$

Geometric series

$u_n = ar^{n-1}$

$S_n = \dfrac{a(1 - r^n)}{1 - r}$

$S_\infty = \dfrac{a}{1 - r}$ for $|r| < 1$

SECTION A: SMARTPHONES

Table 1: Battery performance comparisons of smartphones in 2014

Model	Battery life (hours) (4G web browsing)
Samsung Galaxy S4	4.5
HTC One mini	4.8
Google Nexus 4	5.0
Nokia Lumia 930	6.0
HTC One M7	6.8
Google Nexus 5	6.9
Motorola Moto X	7.5
Apple iPhone 5	8.2
Apple iPhone 5S	8.6
LG G3	8.8
Huawei Honor 6	10.1
Samsung Galaxy S5	10.5
HTC One M8	10.6
Apple iPhone 6 Plus	11.2
Huawei Ascend Mate 2	15.4

Table 2: Battery performance comparisons of smartphones in 2017

Model	Battery life (hours) (4G web browsing)
Apple iPhone 6S	11.2
Microsoft Lumia 650	11.4
HTC 10	12.1
LG X Screen	12.3
Apple iPhone 7	13.0
Vodaphone Smart Platinum 7	13.2
Huawei Nova	13.3
LG Leon	14.0
Sony Xperia X Compact	14.4
Motorola Moto X Force	15.1
Samsung Galaxy S6 Edge	15.3
Google Pixel XL	15.6
Apple iPhone SE	16.5
Samsung Galaxy S7 Edge	18.4
Motorola Moto Z Play	23.5

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