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Surname

Other names

Pearson Edexcel
Level 3 Certificate

Centre Number

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Candidate Number

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Mathematics in Context

Paper 2: Applications

Wednesday 25 May 2016 – Morning
Time: 1 hour 40 minutes

Paper Reference

7MC0/02

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

Total Marks

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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.

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SECTION A

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

CARS

- 1 The data below and the graph opposite show the quarterly sales of new cars in the UK between 2012 and 2014.

Quarter	Sales of new cars (thousands)	4-point moving average
2012 Q1	551.0	
2012 Q2	483.8	
2012 Q3	555.0	502.7
2012 Q4	421.0	513.5
2013 Q1	594.2	529.1
2013 Q2	546.3	545.5
2013 Q3	620.3	556.3
2013 Q4	464.3	576.3
2014 Q1	674.4	586.4
2014 Q2	586.6	596.9
2014 Q3	662.1
2014 Q4	515.2	

- (a) Calculate the missing 4-point moving average.

(2)

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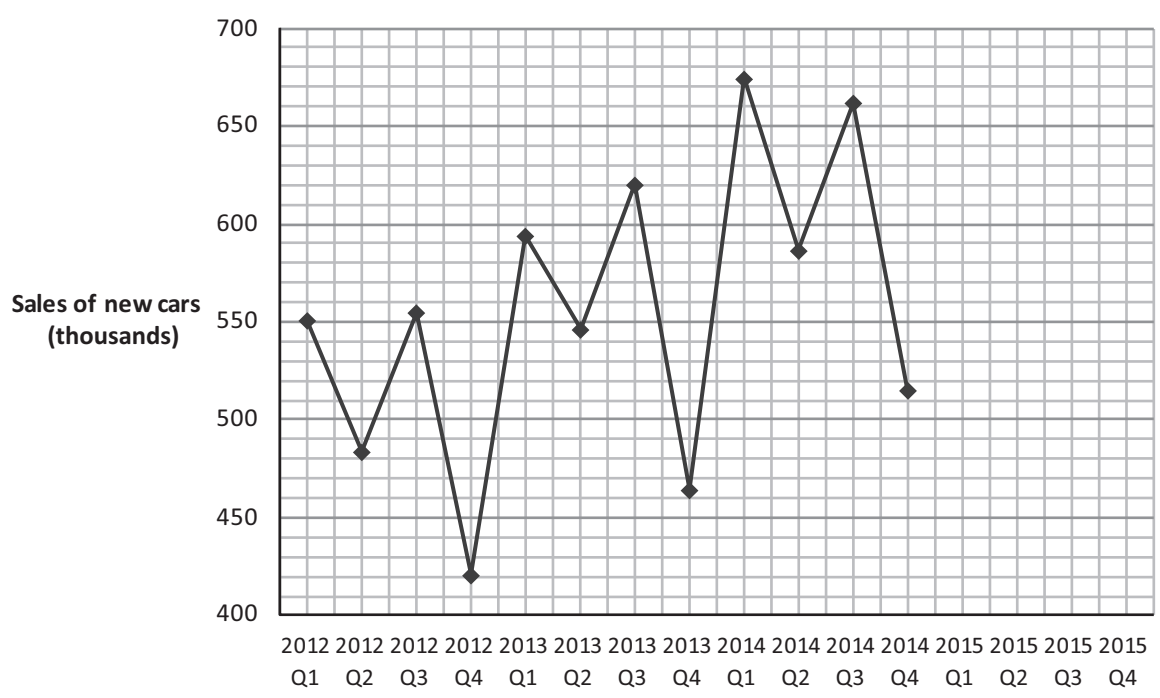


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Sales of new cars in the UK 2012 - 2014



Vehicle Licensing Statistics (<https://www.gov.uk/government/collections/vehicles-statistics>)

- (b) Plot the moving averages on the same grid as the time series using the same scales and axes. (2)
- (c) Use your graph to predict the total sales for the year 2015. (2)

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(Total for Question 1 is 6 marks)



2 A new car is bought for £30 000

Rob estimates that the value will depreciate by 30% each year.

Let n be the number of years after the car was bought.

(a) Find an expression, in terms of n , for the estimated value, in pounds, of the car after n years. Give your expression in the form ak^n where a and k are constants to be found. (2)

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(b) Work out the estimated value of the car after 3 years. (2)

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Renee uses the formula

$$V = 30\,000 - 6000n$$

to estimate the value, £ V , of the car n years after the car was bought.

- (c) Use this formula to find the number of years after which the car will have a value of zero.

(1)

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- (d) Find the annual percentage rate of depreciation in the first year given by this formula.

(2)

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(Total for Question 2 is 7 marks)



Refer to **data source A** in the source booklet for Question 3

- 3 Julie is going to spend around £17000 on a new car. She needs to decide whether she is going to buy a petrol car or a diesel car.

Julie estimates that she will drive approximately 10000 miles per year.

The yearly cost is the total of the standing charges and the running costs.

- (a) Calculate the yearly cost for each type of car. (3)

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- (b) How many miles would Julie need to drive before the yearly cost for the diesel car would be less than the yearly cost for the petrol car? (4)

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(Total for Question 3 is 7 marks)

TOTAL FOR SECTION A IS 20 MARKS



SECTION B

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

TASK 1: DIABETES

4 A screening test for diabetes is a test that is used to identify if a person has the disease.

Screening tests are not completely reliable.

The two-way table shows the possible combinations:

	Has diabetes	Does not have diabetes
Test result is positive	True Positive	False Positive
Test result is negative	False Negative	True Negative

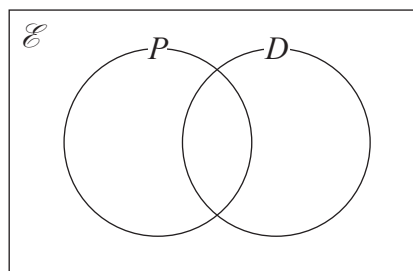
e.g. 'True positive' means that a person who has diabetes gets a positive test result.

The Venn diagram shows the relationship between the sets.

\mathcal{E} = {all people who had a screening test}

P = {people with a positive test result}

D = {people with diabetes}



(i) Give an interpretation in context of $P \cap D$

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(ii) Give an interpretation in context of $P' \cap D$

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(iii) Give an interpretation in context of $(P \cup D)'$

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(Total for Question 4 is 3 marks)



5 A new screening test for diabetes is developed.

400 people have the test.

The table shows information about their results and whether or not they have diabetes.

	Has diabetes	Does not have diabetes	Total
Test result is positive	144	55	199
Test result is negative	36	165	201
Total	180	220	400

One of these 400 people is chosen at random.

(a) Write down the probability that this person gets a positive test result.

(2)

Two measures of the effectiveness of a screening test are its Sensitivity and its Specificity.

$$\text{Sensitivity} = \frac{\text{number of correct positive test results}}{\text{number of people having diabetes}} \times 100$$

$$\text{Specificity} = \frac{\text{number of correct negative test results}}{\text{number of people not having diabetes}} \times 100$$

(b) (i) Show that the Sensitivity for the test is 80%.

(ii) Show that the Specificity for the test is 75%.

(4)



The screening test is now given to a different group of people.
There are 3000 people in this group.

It is estimated that 2% of this group have diabetes.

(c) How many people in this group would be expected to have diabetes?

(2)

(d) Using the Sensitivity and Specificity of the screening test, or otherwise, estimate

(i) the number of people in this group who will be correctly identified as
having diabetes

(ii) the number of people in this group who will be correctly identified as
not having diabetes.

(4)

(Total for Question 5 is 12 marks)



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

The cost of developing the screening test was £1 000 000

The company has three options

- manufacture and distribute the test itself
- go into partnership with a large business and take a royalty
- sell all the rights for £2 500 000

The profit that can be expected depends on the level of sales and is shown below.

	Expected profit (£ thousands)		
	High sales	Medium sales	Low sales
Manufacture itself	8000	4000	-2000
Go into partnership	5000	3000	1000

The table shows the probabilities associated with each level of sales.

	Probability
High sales	0.2
Medium sales	0.5
Low sales	0.3



Which one of the options gives the highest expected profit?
You must show all your working.

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(Total for Question 6 is 5 marks)



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TASK 2: FISH

7 In an attempt to estimate the number of fish in a lake, a sample of fish is caught and marked. There are M fish in the sample.

These fish are released back into the lake.

Later a second sample of T fish is caught.

R is the number of previously marked fish found in this second sample.

The total number of fish, P , in the lake can then be estimated by using the formula

$$P = \frac{MT}{R}$$

Given that $M = 340$, $T = 268$ and $R = 19$

(a) use the formula to work out an estimate for the number of fish in this lake.

(2)

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(b) Write down one assumption for the formula to be valid.

(1)

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(Total for Question 7 is 3 marks)



8 A different lake is stocked with an initial population of 4000 fish.

The fish have

a birth rate of 70 per thousand fish per year
and a death rate of 20 per thousand fish per year

The population after $n + 1$ years is modelled by $u_{n+1} = u_n(1 + b - d)$

where b = birth rate

d = death rate

u_n = population after n years

Given that $u_0 = 4000$

(a) work out u_1

(2)

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(b) After how many years will the population first exceed 5000 fish?

(3)

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(c) What does the model predict in the long term?

(1)

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(d) In practice what is likely to happen and why?

(2)

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Each year, 700 fish are caught and removed from the lake.

The birth rate and the death rate remain unchanged.

$$P_n = 14\,000 - 10\,000 \times 1.05^n$$

where P_n = population after n years

(e) Work out P_6 and P_7

Interpret your answers.

(5)

(Total for Question 8 is 13 marks)



9 In Lake Ximena, 10 fish with an infectious disease are accidentally introduced to the population.

Each fish remains infectious for one week and during this time will infect 3 previously uninfected fish.

Each newly infected fish will, in turn, remain infectious for one week and also infect 3 previously uninfected fish.

Calculate the total number of fish that will have been infected 4 weeks after the introduction of the infected fish.

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(Total for Question 9 is 4 marks)



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TASK 3: CEREAL

A company makes two varieties of breakfast cereal: Standard and Deluxe.

It takes 3 seconds of production time and 8 grams of fibre to make each packet of Standard cereal.

It takes 6 seconds of production time and 20 grams of fibre to make each packet of Deluxe cereal.

There are 13 hours of production time available each day.

There are 150kg of fibre available each day.

Let x be the number of packets of Standard cereal made each day.

Let y be the number of packets of Deluxe cereal made each day.

10 (a) Show that $x + 2y \leq 15\,600$ and $2x + 5y \leq 37\,500$ (3)

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The total number of packets of cereal made each day cannot exceed 12 000.

The company makes at least 2500 packets of Standard cereal and 1500 packets of Deluxe cereal each day.

(b) Write down three inequalities to represent this information. (3)

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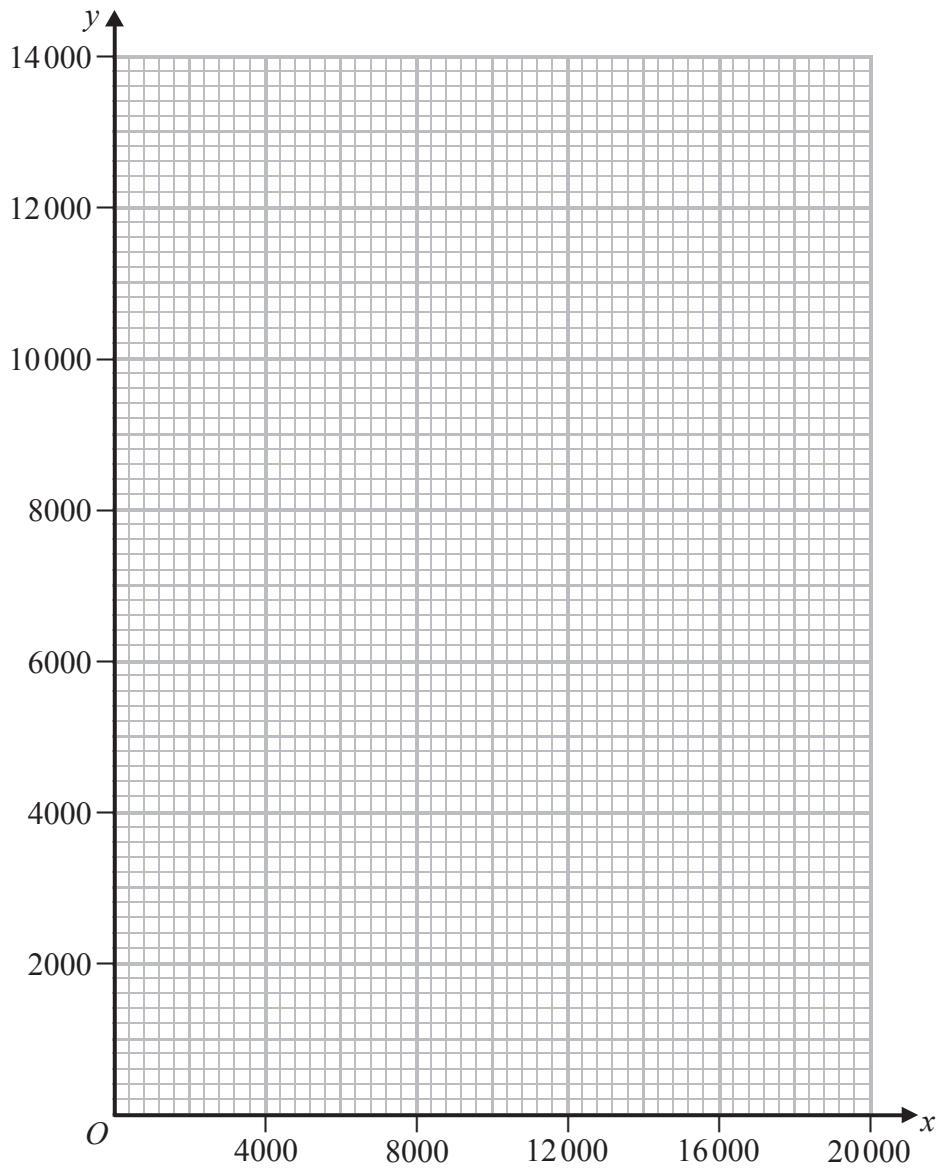
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(c) Illustrate your inequalities from parts (a) and (b) on the grid.
Label the feasible region, R .

(5)



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The company has two options to increase its profits.

- Option 1 Increase the production time available each day.
- Option 2 Increase the amount of fibre available each day.

(f) Explain fully why Option 1 will increase profits and Option 2 will not.

(2)

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(Total for Question 10 is 20 marks)

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



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Source booklet

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Formulae sheet

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

$$\text{Mean of a frequency distribution} = \frac{\sum fx}{\sum f}$$

$$\text{Mean of a grouped frequency distribution} = \frac{\sum fx}{\sum f}, \text{ where } x \text{ is the mid-interval value}$$

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

$$\text{Standard deviation (set of numbers)} = \sqrt{\left[\frac{\sum x^2}{n} - \left(\frac{\sum x}{n} \right)^2 \right]}$$

or

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

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

$$\text{Standard deviation (discrete frequency distribution)} = \sqrt{\left[\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f} \right)^2 \right]}$$

or

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

$$\text{Spearman's rank correlation coefficient} = 1 - \frac{6 \sum d^2}{n(n^2 - 1)}$$

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 $b = \frac{S_{xy}}{S_{xx}}$

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

$$u_n = ar^{n-1}$$

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

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

There will be no credit for anything you write in this source booklet.

SECTION A: CARS

Yearly Costs: Petrol Car

	Purchase price of the car when new:				
	Up to £13 000	£13 000 to £18 000	£18 000 to £25 000	£25 000 to £32 000	Over £32 000
Standing charges per year, £					
VED (Road Tax)	110	145	180	283	609
Insurance	360	409	481	571	762
Cost of capital	203	251	355	494	877
Depreciation	1190	2156	2611	3672	6974
Breakdown cover	50	50	50	50	50
Standing charges total:	1913	3011	3678	5070	9271

Running costs, pence per mile					
Petrol *	10.84	13.12	14.55	16.22	18.04
Tyres	1.37	1.57	1.94	2.32	3.35
Service labour costs	2.1	2.07	2.09	2.04	2.34
Replacement parts	2.24	2.39	2.25	2.73	3.34
Parking and tolls	2	2	2	2	2
Running costs total:	18.56	21.14	22.83	25.31	29.06

* NB: Petrol at 129 pence per litre

Yearly Costs: Diesel Car

	Purchase price of the car when new:				
	Up to £16 000	£16 000 to £22 000	£22 000 to £26 000	£26 000 to £36 000	Over £36 000
Standing charges per year, £					
VED (Road Tax)	30	110	180	180	361
Insurance	424	499	511	601	771
Cost of capital	245	325	429	541	823
Depreciation	1705	2426	2618	3373	5197
Breakdown cover	50	50	50	50	50
Standing charges total:	2454	3411	3788	4745	7203

Running costs, pence per mile					
Diesel Fuel *	9.28	10.2	12.65	12.88	16.79
Tyres	1.15	1.49	2.06	2.02	2.87
Service labour costs	2.1	2.14	2.29	2.24	2.76
Replacement parts	2.73	2.43	2.53	2.99	3.44
Parking and tolls	2	2	2	2	2
Running costs total:	17.26	18.25	21.54	22.14	27.85

* NB Diesel Fuel at: 137 pence per litre

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