Edexcel Maths S2

Topic Questions from Papers

Poisson Distribution

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The random variable X is the number of misprints per page in the first draft of a nove	el.
(a) State two conditions under which a Poisson distribution is a suitable model for X	(2)
The number of misprints per page has a Poisson distribution with mean 2.5. Find probability that	the
(b) a randomly chosen page has no misprints,	(2)
(c) the total number of misprints on 2 randomly chosen pages is more than 7.	(3)
The first chapter contains 20 pages.	
	the
chapter will contain less than 40 misprints.	(7)
	 (a) State two conditions under which a Poisson distribution is a suitable model for X The number of misprints per page has a Poisson distribution with mean 2.5. Find probability that (b) a randomly chosen page has no misprints, (c) the total number of misprints on 2 randomly chosen pages is more than 7.



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Question 3 continued	Olulik



3.	An	estate agent sells properties at a mean rate of 7 per week.	
	(a)	Suggest a suitable model to represent the number of properties sold in a randomly chosen week. Give two reasons to support your model.	
		(3)	
	(b)	Find the probability that in any randomly chosen week the estate agent sells exactly 5 properties.	
		(2)	
	(c)	Using a suitable approximation find the probability that during a 24 week period the estate agent sells more than 181 properties.	
		(6)	



Question 3 continued	Leave blank



	A manufacturer produces large quantities of coloured mugs. It is known from previous records that 6% of the production will be green.				
A r	A random sample of 10 mugs was taken from the production line.				
(a)	Define a suitable distribution to model the number of green mugs in this sample.	(1)			
(b)	Find the probability that there were exactly 3 green mugs in the sample.	(3)			
A r	andom sample of 125 mugs was taken.				
(c)	Find the probability that there were between 10 and 13 (inclusive) green mugs in the sample, using	his			
	(i) a Poisson approximation,	(3)			
	(ii) a Normal approximation.				
		(6)			



Question 5 continued	Leave blank



The random variable J has a Poisson distribution with mean 4.	
(a) Find $P(J \ge 10)$.	(2)
The random variable K has a binomial distribution with parameters $n = 25$, $p = 0.27$	' .
(b) Find $P(K \le 1)$.	(2)
	(3)
(Total 5 ma	ırks)

(a)	State the condition under which the normal distribution may be used as an approximation to the Poisson distribution.
	(1)
(b)	Explain why a continuity correction must be incorporated when using the normal distribution as an approximation to the Poisson distribution. (1)
Sa	company has yachts that can only be hired for a week at a time. All hiring starts on a turday. uring the winter the mean number of yachts hired per week is 5.
(c)	Calculate the probability that fewer than 3 yachts are hired on a particular Saturday
(-,	in winter. (2)
	uring the summer the mean number of yachts hired per week increases to 25. ne company has only 30 yachts for hire.
(d)	Using a suitable approximation find the probability that the demand for yachts cannot be met on a particular Saturday in the summer.
In	the summer there are 16 Saturdays on which a yacht can be hired.
(e)	Estimate the number of Saturdays in the summer that the company will not be able to meet the demand for yachts.
	(2)



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3.	An engineering company manufactures an electronic component. At the end of the manufacturing process, each component is checked to see if it is faulty. Faulty components are detected at a rate of 1.5 per hour.		
	(a) Suggest a suitable model for the number of faulty components detected	per hour. (1)	
	(b) Describe, in the context of this question, two assumptions you have made for this model to be suitable.	de in part (a) (2)	
	(c) Find the probability of 2 faulty components being detected in a 1 hour p		
	(d) Find the probability of at least one faulty component being detected period.	in a 3 hour	
		(3)	



5.		rite down the conditions under which the Poisson distribution may be used as an opproximation to the Binomial distribution. (2)
		centre routes incoming telephone calls to agents who have specialist knowledge all with the call. The probability of the caller being connected to the wrong agent
	(b) Fi	ind the probability that 2 consecutive calls will be connected to the wrong agent. (2)
		ind the probability that more than 1 call in 5 consecutive calls are connected to the rong agent.
	The ca	all centre receives 1000 calls each day.
	(d) Fi	ind the mean and variance of the number of wrongly connected calls. (3)
		se a Poisson approximation to find, to 3 decimal places, the probability that more can 6 calls each day are connected to the wrong agent.



uestion 5 continued	



3.	(a) State two conditions under which a Poisson distribution is a suitable model statistical work.	to use in
		(2)
	The number of cars passing an observation point in a 10 minute interval is mode. Poisson distribution with mean 1.	elled by a
	(b) Find the probability that in a randomly chosen 60 minute period there will	be
	(i) exactly 4 cars passing the observation point,	
	(ii) at least 5 cars passing the observation point.	(5)
	The number of other vehicles, other than cars, passing the observation point in a cinterval is modelled by a Poisson distribution with mean 12.	60 minute
	(c) Find the probability that exactly 1 vehicle, of any type, passes the observaring a 10 minute period.	tion point
	1	(4)



Question 3 continued	blar



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6.	The probability that a sunflower plant grows over 1.5 metres high is 0.25. A rand sample of 40 sunflower plants is taken and each sunflower plant is measured and its heir recorded.			
	(a)	Find the probability that the number of sunflower plants over 1.5 m high is between 8 and 13 (inclusive) using		
		(i) a Poisson approximation,		
		(ii) a Normal approximation. (10)		
	(b)	Write down which of the approximations used in part (a) is the most accurate estimate of the probability. You must give a reason for your answer.		
		(2)		



Question 6 continued	



•		h cell of a certain animal contains 11000 genes. It is known that each gene has a pability 0.0005 of being damaged.
	A c	ell is chosen at random.
	(a)	Suggest a suitable model for the distribution of the number of damaged genes in the cell. (2)
	(b)	Find the mean and variance of the number of damaged genes in the cell. (2)
	(c)	Using a suitable approximation, find the probability that there are at most 2 damaged genes in the cell. (4)
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Question 4 continued	
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1.	A botanist is studying the distribution of daisies in a field. The field is divided into a number of equal sized squares. The mean number of daisies per square is assumed to be 3. The daisies are distributed randomly throughout the field.
	Find the probability that, in a randomly chosen square there will be
	(a) more than 2 daisies, (3)
	(b) either 5 or 6 daisies. (2)
	The botanist decides to count the number of daisies, x , in each of 80 randomly selected squares within the field. The results are summarised below
	$\sum x = 295 \qquad \qquad \sum x^2 = 1386$
	(c) Calculate the mean and the variance of the number of daisies per square for the 80 squares. Give your answers to 2 decimal places. (3)
	(d) Explain how the answers from part (c) support the choice of a Poisson distribution as a model. (1)
	(e) Using your mean from part (c), estimate the probability that exactly 4 daisies will be found in a randomly selected square. (2)



Question 1 continued	blar



1.	A bag contains a large number of counters of which 15% are coloured red. A random sample of 30 counters is selected and the number of red counters is recorded.
	(a) Find the probability of no more than 6 red counters in this sample. (2)
	A second random sample of 30 counters is selected and the number of red counters is recorded.
	(b) Using a Poisson approximation, estimate the probability that the total number of red counters in the combined sample of size 60 is less than 13. (3)

5.	An administrator makes errors in her typing randomly at a rate of 3 errors every 1000 words.				
	(a) In a document of 2000 words find the probability that the administrator makes 4 or more errors. (3)				
	The administrator is given an 8000 word report to type and she is told that the report will only be accepted if there are 20 or fewer errors.				
	(b) Use a suitable approximation to calculate the probability that the report is accepted. (7)				

Question 5 continued	blan
Question 5 continued	



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8.	A cloth manufacturer knows that faults occur randomly in the production process at a re of 2 every 15 metres.	ate
	(a) Find the probability of exactly 4 faults in a 15 metre length of cloth.	(2)
	(b) Find the probability of more than 10 faults in 60 metres of cloth.	(3)
	A retailer buys a large amount of this cloth and sells it in pieces of length x metres. chooses x so that the probability of no faults in a piece is 0.80	Не
	(c) Write down an equation for x and show that $x = 1.7$ to 2 significant figures.	(4)
	The retailer sells 1200 of these pieces of cloth. He makes a profit of 60p on each pieces of cloth that does not contain a fault but a loss of £1.50 on any pieces that do contain faults.	
	(d) Find the retailer's expected profit.	(4)
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Question 8 continued	



A robot is programmed to build cars on a production line. The robot breaks down at random at a rate of once every 20 hours.
(a) Find the probability that it will work continuously for 5 hours without a breakdown. (3)
Find the probability that, in an 8 hour period,
(b) the robot will break down at least once, (3)
(c) there are exactly 2 breakdowns. (2)
In a particular 8 hour period, the robot broke down twice.
(d) Write down the probability that the robot will break down in the following 8 hour period. Give a reason for your answer.
(2)



Question 3 continued	blar



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5.	A café serves breakfast every morning. Customers arrive for breakfast at random at a rate of 1 every 6 minutes.
	Find the probability that
	(a) fewer than 9 customers arrive for breakfast on a Monday morning between 10 am and 11 am. (3)
	The café serves breakfast every day between 8 am and 12 noon.
	(b) Using a suitable approximation, estimate the probability that more than 50 customers arrive for breakfast next Tuesday. (6)



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6.	Cars arrive at a motorway toll booth at an average rate of 150 per hour.	
	(a) Suggest a suitable distribution to model the number of cars arriving at the toll booth, <i>X</i> , per minute.	
	(2)	
	(b) State clearly any assumptions you have made by suggesting this model. (2)	
	Using your model,	
	(c) find the probability that in any given minute	
	(i) no cars arrive,	
	(ii) more than 3 cars arrive. (3)	
	(d) In any given 4 minute period, find m such that $P(X > m) = 0.0487$ (3)	
	(e) Using a suitable approximation find the probability that fewer than 15 cars arrive in any given 10 minute period.	
	(6)	

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Question 6 continued	
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Defects occur at random in planks of wood with a constant rate of 0.5 per 10 cm len Jim buys a plank of length 100 cm.	gth.
Jim ouys a plank of length 100 cm.	
(a) Find the probability that Jim's plank contains at most 3 defects.	
	(2)
Shivani buys 6 planks each of length 100 cm.	
(b) Find the probability that fewer than 2 of Shivani's planks contain at most 3 defec	ets. (5)
(c) Using a suitable approximation, estimate the probability that the total number defects on Shivani's 6 planks is less than 18.	r of
defects on Shivain's 6 planks is less than 16.	(6)
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Question 5 continued	





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1.	A website receives hits at a rate of 300 per hour.	
	(a) State a distribution that is suitable to model the number of hits obtained during a 1 minute interval.	
	(1)	
	(b) State two reasons for your answer to part (a). (2)	
	Find the probability of	
	(c) 10 hits in a given minute, (3)	
	(d) at least 15 hits in 2 minutes. (3)	
	The website will go down if there are more than 70 hits in 10 minutes.	
	(e) Using a suitable approximation, find the probability that the website will go down in a particular 10 minute interval.	
	(7)	



Question 4 continued	Leave blank



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4.	The number of houses sold by an estate agent follows a Poisson distribution, with a mean of 2 per week.	Olank
	(a) Find the probability that in the next 4 weeks the estate agent sells,	
	(i) exactly 3 houses,	
	(ii) more than 5 houses. (5)	
	The estate agent monitors sales in periods of 4 weeks.	
	(b) Find the probability that in the next twelve of these 4 week periods there are exactly nine periods in which more than 5 houses are sold. (3)	
	The estate agent will receive a bonus if he sells more than 25 houses in the next 10 weeks.	
	(c) Use a suitable approximation to estimate the probability that the estate agent receives a bonus.	
	(6)	



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Question 4 continued	



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1.	(a) Write down the conditions under which the Poisson distribution can be used as an	0
	approximation to the binomial distribution.	
	(2)	
	The probability of any one letter being delivered to the wrong house is 0.01	
	On a randomly selected day Peter delivers 1000 letters.	
	(b) Using a Poisson approximation, find the probability that Peter delivers at least 4 letters to the wrong house.	
	Give your answer to 4 decimal places.	
	(3)	
		1

2. I	n a village, power cuts occur randomly at a rate of 3 per year.	
(a	a) Find the probability that in any given year there will be	
	(i) exactly 7 power cuts,	
	(ii) at least 4 power cuts.	
		(5)
(1	b) Use a suitable approximation to find the probability that in the next 10 years number of power cuts will be less than 20	the
	number of power cuts will be less than 20	(6)



Question 2 continued	Le
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5.	In a village shop the customers must join a queue to pay. The number of customers joining the queue in a 10 minute interval is modelled by a Poisson distribution with mean 3
	Find the probability that
	(a) exactly 4 customers join the queue in the next 10 minutes, (2)
	(b) more than 10 customers join the queue in the next 20 minutes. (3)
	When a customer reaches the front of the queue the customer pays the assistant. The time each customer takes paying the assistant, T minutes, has a continuous uniform distribution over the interval $[0, 5]$. The random variable T is independent of the number of people joining the queue.
	(c) Find $P(T > 3.5)$ (1)
	In a random sample of 5 customers, the random variable C represents the number of customers who took more than 3.5 minutes paying the assistant.
	(d) Find $P(C \ge 3)$ (3)
	Bethan has just reached the front of the queue and starts paying the assistant.
	(e) Find the probability that in the next 4 minutes Bethan finishes paying the assistant and no other customers join the queue.
	(4)



Question 5 continued	Leave blank

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- 7. As part of a selection procedure for a company, applicants have to answer all 20 questions of a multiple choice test. If an applicant chooses answers at random the probability of choosing a correct answer is 0.2 and the number of correct answers is represented by the random variable *X*.
 - (a) Suggest a suitable distribution for X.

(2)

Each applicant gains 4 points for each correct answer but loses 1 point for each incorrect answer. The random variable *S* represents the final score, in points, for an applicant who chooses answers to this test at random.

(b) Show that S = 5X - 20

(2)

(c) Find E(S) and Var(S).

(4)

An applicant who achieves a score of at least 20 points is invited to take part in the final stage of the selection process.

(d) Find $P(S \ge 20)$

(4)

Cameron is taking the final stage of the selection process which is a multiple choice test consisting of 100 questions. He has been preparing for this test and believes that his chance of answering each question correctly is 0.4

(e) Using a suitable approximation, estimate the probability that Cameron answers more than half of the questions correctly.

(5)



Question 7 continued	Leave blank
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2. The number of defects per metre in a roll of cloth has a Poisson distribution mean 0.25					
	Find the probability that				
	(a) a randomly chosen metre of cloth has 1 defect, (2)				
	(b) the total number of defects in a randomly chosen 6 metre length of cloth is more than 2				
	(3)				
	A tailor buys 300 metres of cloth.				
	(c) Using a suitable approximation find the probability that the tailor's cloth will contain less than 90 defects. (5)				

Question 2 continued		blank
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	(Total 10 marks)	



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7.	A telesales operator is selling a magazine. Each day he chooses a number of people to telephone. The probability that each person he telephones buys the magazine is 0.1
	(a) Suggest a suitable distribution to model the number of people who buy the magazine from the telesales operator each day. (1)
	(b) On Monday, the telesales operator telephones 10 people. Find the probability that he sells at least 4 magazines. (3)
	(c) Calculate the least number of people he needs to telephone on Tuesday, so that the probability of selling at least 1 magazine, on that day, is greater than 0.95 (3)
	A call centre also sells the magazine. The probability that a telephone call made by the call centre sells a magazine is 0.05 The call centre telephones 100 people every hour.
	(d) Using a suitable approximation, find the probability that more than 10 people telephoned by the call centre buy a magazine in a randomly chosen hour. (3)



Question 7 continued		blank
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	(Total 10 marks)	
	TOTAL FOR PAPER: 75 MARKS	
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