# Edexcel (U.K.) Pre 2017

# Questions By Topic

## S2 Chap02 Poisson Distribution

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**5.** A manufacturer produces large quantities of coloured mugs. It is known from previous records that 6% of the production will be green.

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 random sample of 125 mugs was taken.

(c) Find the probability that there were between 10 and 13 (inclusive) green mugs in this sample, using

(i) a Poisson approximation,

**(3)**

(ii) a Normal approximation.

**(6)**

Leave blank

**2.** The random variable $J$ has a Poisson distribution with mean 4.

(a) Find P($J \geqslant 10$).

**(2)**

The random variable $K$ has a binomial distribution with parameters $n = 25$, $p = 0.27$.

(b) Find P($K \leqslant 1$).

**(3)**

**Q2**

**(Total 5 marks)**

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**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)**

Leave blank

**3.** The random variable $X$ is the number of misprints per page in the first draft of a novel.

(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 the probability that

(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.

(d) Using a suitable approximation find, to 2 decimal places, the probability that the chapter will contain less than 40 misprints.

**(7)**

Leave blank

**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)**

Leave blank

**4.** (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)**

A company has yachts that can only be hired for a week at a time. All hiring starts on a Saturday.
During 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)**

During the summer the mean number of yachts hired per week increases to 25.
The 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.

**(6)**

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)**

Leave blank

**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 in part (a) for this model to be suitable.

**(2)**

(c) Find the probability of 2 faulty components being detected in a 1 hour period.

**(2)**

(d) Find the probability of at least one faulty component being detected in a 3 hour period.

**(3)**

Leave blank

**5.** (a) Write down the conditions under which the Poisson distribution may be used as an approximation to the Binomial distribution.

**(2)**

A call centre routes incoming telephone calls to agents who have specialist knowledge to deal with the call. The probability of the caller being connected to the wrong agent is 0.01

(b) Find the probability that 2 consecutive calls will be connected to the wrong agent.

**(2)**

(c) Find the probability that more than 1 call in 5 consecutive calls are connected to the wrong agent.

**(3)**

The call centre receives 1000 calls each day.

(d) Find the mean and variance of the number of wrongly connected calls.

**(3)**

(e) Use a Poisson approximation to find, to 3 decimal places, the probability that more than 6 calls each day are connected to the wrong agent.

**(2)**

Leave blank

**3.** (a) State two conditions under which a Poisson distribution is a suitable model to use in statistical work.

**(2)**

The number of cars passing an observation point in a 10 minute interval is modelled by a Poisson distribution with mean 1.

(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 60 minute interval is modelled by a Poisson distribution with mean 12.

(c) Find the probability that exactly 1 vehicle, of any type, passes the observation point in a 10 minute period.

**(4)**

Leave blank

**6.** The probability that a sunflower plant grows over 1.5 metres high is 0.25. A random sample of 40 sunflower plants is taken and each sunflower plant is measured and its height 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)**

Leave blank

**4.** Each cell of a certain animal contains 11000 genes. It is known that each gene has a probability 0.0005 of being damaged.

A cell 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)**

Leave blank

**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

$$\sum x = 295 \qquad \sum x^2 = 1386$$

(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)**

Leave blank

**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)**

Leave blank

**8.** A cloth manufacturer knows that faults occur randomly in the production process at a rate of 2 every 15 metres.

(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. He chooses $x$ so that the probability of no faults in a piece is 0.80

(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 piece 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)**

Leave blank

**3.** 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)**

Leave blank

**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)**

Leave blank

**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, $X$, 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)**

Leave blank

**5.** Defects occur at random in planks of wood with a constant rate of 0.5 per 10 cm length. Jim buys 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 defects.

**(5)**

(c) Using a suitable approximation, estimate the probability that the total number of defects on Shivani's 6 planks is less than 18.

**(6)**

Leave blank

**3.** The probability of a telesales representative making a sale on a customer call is 0.15

Find the probability that

(a) no sales are made in 10 calls,

**(2)**

(b) more than 3 sales are made in 20 calls.

**(2)**

Representatives are required to achieve a mean of at least 5 sales each day.

(c) Find the least number of calls each day a representative should make to achieve this requirement.

**(2)**

(d) Calculate the least number of calls that need to be made by a representative for the probability of at least 1 sale to exceed 0.95

**(3)**

Leave blank

**4.** 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)**

Leave blank

**4.** The number of houses sold by an estate agent follows a Poisson distribution, with a mean of 2 per week.

(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)**

Leave blank

**1.** (a) Write down the conditions under which the Poisson distribution can be used as an 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)**

Leave blank

**2.** In a village, power cuts occur randomly at a rate of 3 per year.

(a) Find the probability that in any given year there will be

(i) exactly 7 power cuts,

(ii) at least 4 power cuts.

**(5)**

(b) Use a suitable approximation to find the probability that in the next 10 years the number of power cuts will be less than 20

**(6)**

Leave blank

**2.** The number of defects per metre in a roll of cloth has a Poisson distribution with 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)**

Leave blank

**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)**

Leave blank

**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 $P(C \geqslant 3)$

**(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)**

Leave blank

**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($S \geqslant 20$)

**(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)**