2027-TG-MATH-M1
PAPER

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TUTGATHER PRACTICE PAPER

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2027

MATHEMATICS Extended Part Module M1
PAPER

Question-Answer Book

Candidate Number

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PRACTICE PAPER · NOT AN OFFICIAL HKEAA PAPER

1 hour 5 minutes

This paper must be answered in English

Topic practice: Poisson Distribution

INSTRUCTIONS

(1) This paper consists of THREE sections, A(1), A(2) and B.

(2) Attempt ALL questions in this paper. Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins.

(3) Unless otherwise specified, all working must be clearly shown.

(4) Unless otherwise specified, numerical answers should be either exact or correct to 3 significant figures.

(5) The diagrams in this paper are not necessarily drawn to scale.

(6) Calculators and mathematical drawing instruments may be used.

(7) The marks for each question are shown in brackets.

(8) No extra time will be given after the 'Time is up' announcement.

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SECTION A(1) (16 marks)

1. The number of typing errors on a page typed by a clerk follows a Poisson distribution with mean 2.4. Find the probability that a randomly chosen page contains exactly 3 typing errors. **(3 marks)**

2. The number of emails arriving at a server in a one-minute interval follows a Poisson distribution with variance 5.76. Find the mean number of emails arriving in a 15-second interval, and state the standard deviation of the number of emails arriving in a 2-minute interval. **(3 marks)**

3. In a large shipment of components, 2% are defective. A random sample of 150 components is taken. Using a Poisson approximation to the binomial distribution, estimate the probability that the sample contains at most 1 defective component. State one condition under which the approximation is valid. **(4 marks)**

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4. The number of customers entering a small shop in a 10-minute period follows a Poisson distribution with mean 3. Assume that the numbers of customers in disjoint time periods are independent. **(6 marks)**

(a) Find the probability that exactly 2 customers enter in a given 10-minute period.

(b) Find the probability that at least 1 customer enters in a given 5-minute period.

(c) Find the probability that exactly 2 customers enter in a 10-minute period and exactly 1 customer enters in the next 5-minute period.

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SECTION A(2) (24 marks)

5. The number of accidents occurring at a road junction in a week follows a Poisson distribution with mean λ. It is known that the probability of exactly 2 accidents in a week equals the probability of exactly 3 accidents in a week. **(7 marks)**

(a) Find λ.

(b) Hence find the probability that there are at most 2 accidents in a two-week period.

(c) Find the variance of the number of accidents in a 3-day period (take 1 week = 7 days).

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6. A factory produces light bulbs, and each bulb is defective with probability 0.015, independently of other bulbs. A box contains 200 bulbs. **(8 marks)**

(a) Using a Poisson approximation, estimate the probability that a box contains no defective bulbs.

(b) Using the same approximation, estimate the probability that a box contains at least 2 defective bulbs.

(c) A quality inspector checks 5 boxes. Stating any assumption you make, estimate the probability that exactly 2 of these 5 boxes each contain at least 2 defective bulbs.

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7. Calls arrive at a helpline at random, and the number of calls in any time interval of length t minutes follows a Poisson distribution with mean $0.8t$. Assume calls arrive independently of one another. **(9 marks)**

(a) Find the probability that exactly 4 calls arrive in a 5-minute interval.

(b) Find the probability that at least 1 call arrives in a 2-minute interval.

(c) Given that exactly 4 calls arrive in a 5-minute interval, find the probability that exactly 1 of them arrives in the first 2 minutes.

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SECTION B (10 marks)

8. The number of vehicles passing a checkpoint in a 1-minute interval follows a Poisson distribution with mean μ. The numbers of vehicles in disjoint intervals are independent. It is given that the probability of at least 1 vehicle passing in a 1-minute interval is 0.7. **(10 marks)**

(a) Show that $\mu = -\ln 0.3$ and find μ correct to 4 decimal places.

(b) Find the probability that exactly 2 vehicles pass in a 2-minute interval.

(c) Find the probability that exactly 2 vehicles pass in a 2-minute interval, given that at least 1 vehicle passes in that interval.

(d) A student claims: "Since the mean number of vehicles in 2 minutes is 2μ, the variance of the number of vehicles in 2 minutes is also 2μ, so the standard deviation is $\sqrt{2\mu}$." Explain, with justification, whether this claim is correct.

END OF PAPER

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