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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

TUTGATHER
PRACTICE PAPER · NOT AN OFFICIAL HKEAA PAPER

1 hour 5 minutes

This paper must be answered in English

Topic practice: Binomial Distribution

INSTRUCTIONS

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

(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. A biased coin is tossed repeatedly. Each toss is a Bernoulli trial with probability of obtaining a head $p = 0.35$, independent of all other tosses. **(3 marks)**

   (a) State the number of trials and the probability of success if the experiment is modelled by a binomial distribution.

   (b) The coin is tossed 8 times. Write down the probability that exactly 3 heads are obtained, using binomial notation, and evaluate it correct to 3 significant figures.

2. It is known that 12% of the components produced by a machine are defective, independently of one another. A random sample of 15 components is taken. Let X be the number of defective components in the sample. **(3 marks)**

   (a) Name the distribution of X and state its parameters.

   (b) Find the probability that at most 1 component in the sample is defective, correct to 3 significant figures.

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3. Let $X \sim B(40, 0.25)$. **(4 marks)**

(a) Find the mean and the variance of X.

(b) Find the standard deviation of X, correct to 3 significant figures.

(c) A new variable is defined by $Y = 3X - 5$. Find $E(Y)$ and $\text{Var}(Y)$.

4. In a certain game a player throws a fair six-sided die once. The player scores a point if the die shows a 6; otherwise no point is scored. The game is played 10 times, and each throw is independent. **(6 marks)**

(a) Explain why the number of points scored in 10 games can be modelled by a binomial distribution, stating the values of the parameters.

(b) Find the probability that the player scores exactly 2 points.

(c) Find the probability that the player scores at least 1 point, correct to 3 significant figures.

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SECTION A(2) (34 marks)

5. A factory produces light bulbs, and 8% of them are faulty. Faults occur independently. Bulbs are packed in boxes of 20. Let X be the number of faulty bulbs in a randomly chosen box. **(7 marks)**

(a) State the distribution of X.

(b) Find the probability that a box contains exactly 2 faulty bulbs.

(c) Find the probability that a box contains at least 3 faulty bulbs, correct to 3 significant figures.

(d) A box is rejected if it contains 3 or more faulty bulbs. Find the probability that, in a random sample of 5 boxes, exactly 1 box is rejected.

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6. In a multiple-choice test each question has 5 options, exactly one of which is correct. A student answers 30 questions by guessing at random, independently for each question. Let X be the number of correct answers. **(8 marks)**

(a) State the distribution of X and find its mean and variance.

(b) The student's score is $S = 4X - 30$ (4 marks for a correct answer, −1 for a wrong answer). Find $E(S)$ and $\mathrm{Var}(S)$.

(c) Find the probability that the student scores more than 0, correct to 3 significant figures.

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7. A basketball player takes free throws. Each throw is a Bernoulli trial with probability 0.7 of success, independent of all other throws. The player takes throws one at a time until the first success, or until 4 throws have been taken, whichever comes first. Let N be the number of throws taken. **(9 marks)**

(a) Find $P(N = 1)$, $P(N = 2)$ and $P(N = 3)$.

(b) Find $P(N = 4)$.

(c) Show that $E(N) \approx 2.53$.

(d) Given that the player has not succeeded in the first 3 throws, find the probability that the player succeeds on the 4th throw.

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8. In a large population, 30% of people support a certain proposal. A random sample of n people is taken, independently. Let X be the number in the sample who support the proposal, so $X \sim B(n, 0.3)$. **(10 marks)**

(a) Write down $E(X)$ and $\text{Var}(X)$ in terms of n.

(b) Find the smallest value of n such that $E(X) \geq 12$.

(c) For $n = 50$, find $P(X \leq 12)$, correct to 3 significant figures.

(d) For $n = 50$, find the probability that X is within one standard deviation of its mean, i.e. $P(|X - E(X)| \leq \sigma)$ where σ is the standard deviation of X. Give your answer correct to 3 significant figures.

END OF PAPER

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