## ADVANCED GCE

MATHEMATICS
Probability \& Statistics 2

Candidates answer on the Answer Booklet
OCR Supplied Materials:

- 8 page Answer Booklet
- List of Formulae (MF1)

Other Materials Required:
None

## Wednesday 17 June 2009

Morning
Duration: 1 hour 30 minutes


## INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer all the questions.
- Do not write in the bar codes.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.
- You are permitted to use a graphical calculator in this paper.


## INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You are reminded of the need for clear presentation in your answers.
- The total number of marks for this paper is 72.
- This document consists of 4 pages. Any blank pages are indicated.

1 The random variable $H$ has the distribution $\mathrm{N}\left(\mu, \sigma^{2}\right)$. It is given that $\mathrm{P}(H<105.0)=0.2420$ and $\mathrm{P}(H>110.0)=0.6915$. Find the values of $\mu$ and $\sigma$, giving your answers to a suitable degree of accuracy.

2 The random variable $D$ has the distribution $\operatorname{Po}(20)$. Using an appropriate approximation, which should be justified, calculate $\mathrm{P}(D \geqslant 25)$.

3 An electronics company is developing a new sound system. The company claims that $60 \%$ of potential buyers think that the system would be good value for money. In a random sample of 12 potential buyers, 4 thought that it would be good value for money. Test, at the $5 \%$ significance level, whether the proportion claimed by the company is too high.

4 A survey is to be carried out to draw conclusions about the proportion $p$ of residents of a town who support the building of a new supermarket. It is proposed to carry out the survey by interviewing a large number of people in the high street of the town, which attracts a large number of tourists.
(i) Give two different reasons why this proposed method is inappropriate.
(ii) Suggest a good method of carrying out the survey.
(iii) State two statistical properties of your survey method that would enable reliable conclusions about $p$ to be drawn.

5 In a large region of derelict land, bricks are found scattered in the earth.
(i) State two conditions needed for the number of bricks per cubic metre to be modelled by a Poisson distribution.

Assume now that the number of bricks in 1 cubic metre of earth can be modelled by the distribution Po(3).
(ii) Find the probability that the number of bricks in 4 cubic metres of earth is between 8 and 14 inclusive.
(iii) Find the size of the largest volume of earth for which the probability that no bricks are found is at least 0.4.

6 The continuous random variable $R$ has the distribution $\mathrm{N}\left(\mu, \sigma^{2}\right)$. The results of 100 observations of $R$ are summarised by

$$
\Sigma r=3360.0, \quad \Sigma r^{2}=115782.84
$$

(i) Calculate an unbiased estimate of $\mu$ and an unbiased estimate of $\sigma^{2}$.
(ii) The mean of 9 observations of $R$ is denoted by $\bar{R}$. Calculate an estimate of $\mathrm{P}(\bar{R}>32.0)$.
(iii) Explain whether you need to use the Central Limit Theorem in your answer to part (ii).
$7 \quad$ The continuous random variable $X$ has probability density function given by

$$
\mathrm{f}(x)= \begin{cases}\frac{2}{9} x(3-x) & 0 \leqslant x \leqslant 3 \\ 0 & \text { otherwise }\end{cases}
$$

(i) Find the variance of $X$.
(ii) Show that the probability that a single observation of $X$ lies between 0.0 and 0.5 is $\frac{2}{27}$.
(iii) 108 observations of $X$ are obtained. Using a suitable approximation, find the probability that at least 10 of the observations lie between 0.0 and 0.5 .
(iv) The mean of 108 observations of $X$ is denoted by $\bar{X}$. Write down the approximate distribution of $\bar{X}$, giving the value(s) of any parameter(s).

8 In a large company the time taken for an employee to carry out a certain task is a normally distributed random variable with mean 78.0 s and unknown variance. A new training scheme is introduced and after its introduction the times taken by a random sample of 120 employees are recorded. The mean time for the sample is 76.4 s and an unbiased estimate of the population variance is $68.9 \mathrm{~s}^{2}$.
(i) Test, at the $1 \%$ significance level, whether the mean time taken for the task has changed.
(ii) It is required to redesign the test so that the probability of making a Type I error is less than 0.01 when the sample mean is 77.0 s . Calculate an estimate of the smallest sample size needed, and explain why your answer is only an estimate.

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