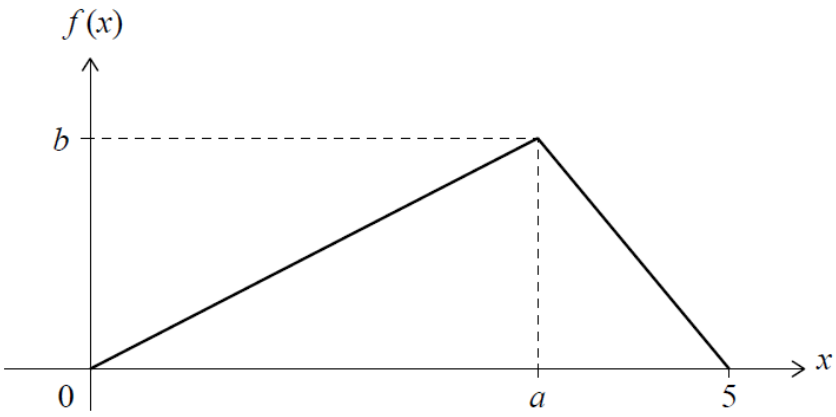
HL / continuous random variable [28 marks]

1. [Maximum mark: 6] 26M.2.AHL.TZ1.7

The continuous random variable X has a probability distribution f defined as

$$f(x) = \begin{cases} \frac{b}{a}x, & 0 \leq x \leq a \\ \frac{b}{a-5}(x-5), & a < x \leq 5 \end{cases}$$ where $0 < a < 5$ and $b \in \mathbb{Q}^+$.

The graph of f is shown in the following diagram.



(a) Show that $b = 0.4$ [2]

It is given that $\mathrm{E}(X) = 3.2$.

(b) Find the value of a. [4]

2. [Maximum mark: 5] 26M.2.AHL.TZ2.6

A continuous random variable X has a probability density function given by

$$f(x) = \begin{cases} \frac{1-\cos 2x}{a} & 0 \leq x \leq \pi \\ 0 & , \text{ otherwise} \end{cases}$$ where $a > 0$.

(a) Find the exact value of a. [2]

(b) Find $\mathrm{Var}\,(X)$. [3]

3. [Maximum mark: 17] 25N.2.AHL.TZ3.11

The lengths, in metres, of jumps in a long jump competition can be modelled by a continuous random variable X with probability density function f defined by:

$$f(x) = \begin{cases} 0, & x < 3 \\ a(x-3)^3 + b(x-3)^2, & 3 \leq x \leq 9 \\ 0, & x > 9 \end{cases}$$

where $a, b \in \mathbb{R}$, $a, b \neq 0$.

(a) Show that $324a + 72b = 1$. [4]

It is given that $f(9) = 0$.

(b.i) Show that $6a + b = 0$. [2]

(b.ii) Determine the value of a and the value of b. [2]

(c) Show that the median of X is less than the mode of X. [5]

Matt has the final jump in the competition. He needs to jump at least $8.52\,\mathrm{m}$ to win the competition.

(d) Given that he jumps over $8\,\mathrm{m}$, use the model to find the probability that he wins the competition. [4]

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