



**MATHEMATICS**  
**METHODS**  
**UNIT 3**  
**Section Two:**  
**Calculator-assumed**

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Student Number: In figures

In words

Your name

**Time allowed for this section**

Reading time before commencing work: ten minutes  
Working time for section: one hundred minutes

**Materials required/recommended for this section**

*To be provided by the supervisor*

This Question/Answer Booklet

Formula Sheet (retained from Section One)

*To be provided by the candidate*

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: drawing instruments, templates, notes on two unfolded sheets of A4 paper, and up to three calculators approved for use in the WACE examinations

**Important note to candidates**

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

## Structure of this paper

Section	Number of questions available	Number of questions to be answered	Working time (minutes)	Marks available	Percentage of exam
Section One: Calculator-free	7	7	50	52	35
Section Two: Calculator-assumed	12	12	100	98	65
<b>Total</b>				150	100

## Instructions to candidates

- The rules for the conduct of examinations are detailed in the school handbook. Sitting this examination implies that you agree to abide by these rules.
- Write your answers in this Question/Answer Booklet.
- You must be careful to confine your response to the specific question asked and to follow any instructions that are specified to a particular question.
- Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
  - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
  - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question that you are continuing to answer at the top of the page.
- Show all your working clearly.** Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning. Incorrect answers given without supporting reasoning cannot be allocated any marks. For any question or part question worth more than two marks, valid working or justification is required to receive full marks. If you repeat any question, ensure that you cancel the answer you do not wish to have marked.
- It is recommended that you **do not use pencil**, except in diagrams.
- The Formula Sheet is **not** to be handed in with your Question/Answer Booklet.

## Additional working space

Question number: \_\_\_\_\_

Additional working space

Question number: \_\_\_\_\_

Section Two: Calculator-assumed

65% (98 Marks)

This section has **twelve (12)** questions. Answer **all** questions. Write your answers in the spaces provided.

Working time for this section is 100 minutes.

Question 8 (6 marks)

Water flows into a tank, initially holding 125 L, at a rate given by  $V'(t) = \frac{24t - t^2}{3}$  for  $0 \leq t \leq 24$ , where  $V'(t)$  is measured in litres per hour and  $t$  is in hours.

(a) Determine how much water is in the tank after 24 hours. (3 marks)

(b) Determine the time it takes for the tank to fill to 500 L. (3 marks)

See next page

## Question 9

(8 marks)

The temperature,  $T$  °C, of a bronze casting  $t$  seconds after being removed from an oven was modelled for  $0 \leq t \leq 800$  by  $T = T_0 e^{-0.0034t}$ .

- (a) How long, to the nearest second, did it take for the initial temperature of the casting to halve? (3 marks)
- (b) Determine the initial temperature of the casting, given that it had cooled to 787°C after one minute. (2 marks)
- (c) Can the above rate of change model be used to calculate how long it takes the temperature of the casting to fall below 40°C? Explain your answer. (3 marks)

## Additional working space

Question number: \_\_\_\_\_

Question 19

(9 marks)

Question 10

(8 marks)

The discrete random variable  $X$  has the probability distribution shown in the table.

A pottery produces souvenir coffee mugs, of which it is known that 5% are defective and the rest are good.

$x$	1	2	3	4	5
$P(X = x)$	$b$	$a^2$	$a$	0.14	0.05

(a) Determine the values of  $a$  and  $b$ , if  $E(X) = 2.58$ .

(4 marks)

(b) In a box of 24 mugs, what is the probability that there are at least 4 defectives?

(2 marks)

(c) What is the probability that in 10 boxes, each containing 12 mugs, that either two or three of the boxes contain no defectives?

(2 marks)

(d) The pottery decides to pack  $n$  mugs per box for wholesale clients, so that the chance of there being at least one defective mug in a box is no more than 75%. Find the largest value of  $n$ .

(2 marks)

(b) Determine  $P(X \leq 4 \mid X \geq 4)$ .

(1 mark)

(c) Calculate the values of

(i)  $Var(X)$ .

(2 marks)

(ii)  $Var(10X + 3)$ .

(1 mark)

(iii)  $Var(3 - 2X)$ .

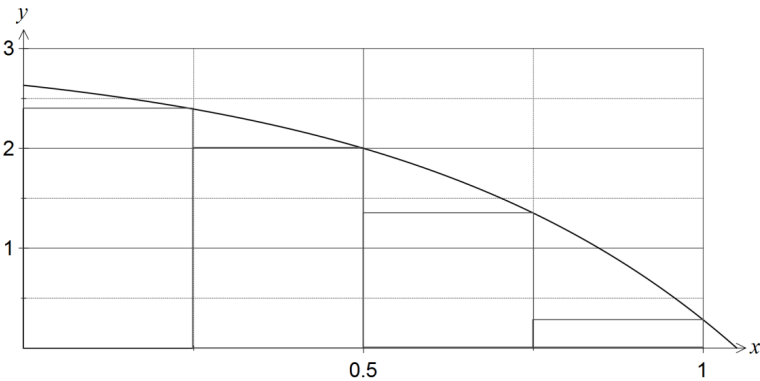
(1 mark)

End of questions

See next page

Question 11 (7 marks)

The graph below shows the function  $f(x) = 3 - e^{2x-1}$ .



An estimate is required for the area under the curve between  $x = 0$  and  $x = 1$ , using the average of inscribed rectangles (shown above) and circumscribed rectangles (not shown).

- (a) Complete the table below, rounding values to two decimal places. (2 marks)

$x$	0	0.25	0.5	0.75	1
$f(x)$			2.00		

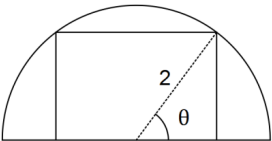
- (b) Use the right-rectangles shown to calculate an under-estimate for the area. (2 marks)

- (c) Use four left-rectangles to calculate an over-estimate for the area. (2 marks)

- (d) Use your over- and under- estimates to calculate an estimate for the area under the curve between  $x = 0$  and  $x = 1$ . (1 mark)

Question 18 (8 marks)

A rectangle is inscribed in a semicircle of radius 2 metres, as shown in the diagram.



- (a) Show that the perimeter of the rectangle is given by  $4 \sin \theta + 8 \cos \theta$ . (3 marks)

- (b) Use calculus methods to determine the maximum perimeter of the rectangle, and state the dimensions of the rectangle to achieve this maximum. (5 marks)

Question 17

(9 marks)

In the mailroom of a large company it is known that 20% of incoming letters contain a cheque. Let  $X$  be the number of randomly chosen letters that are opened until a cheque is discovered.

- (a) Complete the table below for the values of  $x = 1, 2, 3$  and  $4$ .

(2 marks)

$x$	1	2	3	4
$P(X = x)$				

- (b) Determine a rule for  $P(X = x)$  for any integer value of  $x$  greater than 0.

(2 marks)

- (c) Calculate

(i)  $P(X = 10)$ .

(1 mark)

(ii)  $P(3 \leq X \leq 6)$ .

(2 marks)

(iii) the smallest value of  $k$ , so that  $P(X = k) < 0.001$ .

(2 marks)

See next page

- (b)

Determine an equation for the displacement of the body at time  $t$ .

(2 marks)

- (c)

Calculate the change in displacement of the body during the sixth second.

(3 marks)

See next page

Question 12

(8 marks)

A small body travels in a straight line with acceleration given by  $a = 2e^{-0.1t}$  ms<sup>-2</sup>.

The body had an initial displacement of 250 metres relative to a fixed point  $O$ , at which time its

velocity was 10 ms<sup>-1</sup>.

- (a)

Determine the velocity of the body after one second, rounded to three significant figures.

(3 marks)

Question 13 (7 marks)

A cubical six-sided dice is known to be biased. It is thrown 3 times and the total number of sixes is noted. This experiment is then repeated 200 times, with the results shown in this table.

Number of sixes	0	1	2	3
Frequency	67	93	33	7

(a) What is the mean number of sixes per experiment? (2 marks)

(b) Name a suitable discrete probability distribution to model the number of sixes obtained in one experiment. (1 mark)

(c) What is the probability of obtaining a six when this dice is thrown? (2 marks)

(d) Use the distribution from (b) to calculate the expected number of times that no sixes would occur in 200 experiments and comment on how well your answer agrees with the experimental result above. (2 marks)

(c) Determine the acceleration of the body when  $t > 0$  and it has a velocity of 27 cm/s. (5 marks)



Question 14

(9 marks)

A closed cylindrical can of radius  $r$  cm has a volume of  $250\pi$  cm<sup>3</sup>.

- (a)
- Show that the total surface area,  $A$  cm<sup>2</sup>, of this can is given by  $A = \frac{500\pi}{r} + 2\pi r^2$ .
- (3 marks)

Question 16

(10 marks)

The displacement, in centimetres, of a small body from a fixed point  $O$  after  $t$  seconds is given by  $x(t)$ , where  $x(t) = (t - a)(2t^2 - 5t + 2)$ , where  $a$  is a constant.

- (a)
- Show that the body is at  $O$  when  $t = \frac{7}{2}$ .
- (1 mark)

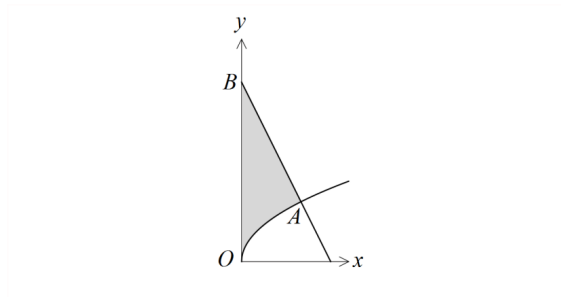
- (b)
- Given that the body has a velocity of 3 cm/s when  $t = 1$ , determine the value of the constant  $a$ .
- (4 marks)

- (b)
- Use derivatives to determine the minimum possible surface area of the can, justifying that it is a minimum, and state the radius and height required to achieve this minimum area.
- (6 marks)

## Question 15

(9 marks)

The diagram below shows the graph of the function  $y = \sqrt{x}$  and the straight line  $AB$  that is perpendicular to the curve at  $A$ , where  $x = 4$ .



- (a) Determine the equation of  $AB$ . (3 marks)

- (b) Determine the shaded area in the diagram, enclosed by the curve  $y = \sqrt{x}$ , the straight line  $AB$  and the  $y$ -axis. (3 marks)

- (c) Determine the area enclosed by the curve  $y = \sqrt{x}$ , the straight line  $AB$  and the  $x$ -axis. (3 marks)