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**Mathematics**  
**Standard level**  
**Paper 2**

Wednesday 4 November 2020 (morning)

Candidate session number

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1 hour 30 minutes

**Instructions to candidates**

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- A graphic display calculator is required for this paper.
- Section A: answer all questions. Answers must be written within the answer boxes provided.
- Section B: answer all questions in the answer booklet provided. Fill in your session number on the front of the answer booklet, and attach it to this examination paper and your cover sheet using the tag provided.
- Unless otherwise stated in the question, all numerical answers should be given exactly or correct to three significant figures.
- A clean copy of the **mathematics SL formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[90 marks]**.



Please **do not** write on this page.

Answers written on this page  
will not be marked.



Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. In particular, solutions found from a graphic display calculator should be supported by suitable working, for example if graphs are used to find a solution, you should sketch these as part of your answer. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. You are therefore advised to show all working.

### Section A

Answer **all** questions. Answers must be written within the answer boxes provided. Working may be continued below the lines if necessary.

1. [Maximum mark: 6]

Consider the function  $f(x) = x^2 + x + \frac{50}{x}$ ,  $x \neq 0$ .

(a) Find  $f(1)$ . [2]

(b) Solve  $f(x) = 0$ . [2]

The graph of  $f$  has a local minimum at point A.

(c) Find the coordinates of A. [2]

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Do **not** write solutions on this page.

### Section B

Answer **all** questions in the answer booklet provided. Please start each question on a new page.

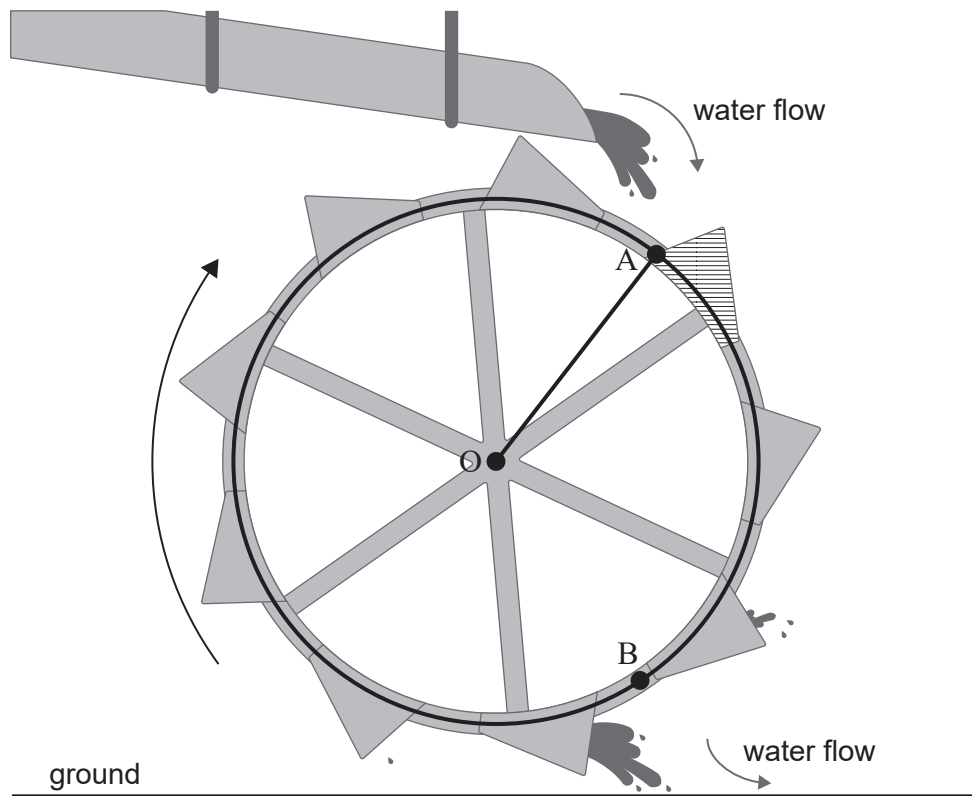
8. [Maximum mark: 14]

The following diagram shows a water wheel with centre  $O$  and radius 10 metres. Water flows into buckets, turning the wheel clockwise at a constant speed.

The height,  $h$  metres, of the top of a bucket above the ground  $t$  seconds after it passes through point  $A$  is modelled by the function

$$h(t) = 13 + 8 \cos\left(\frac{\pi}{18}t\right) - 6 \sin\left(\frac{\pi}{18}t\right), \text{ for } t \geq 0.$$

diagram not to scale



- (a) (i) Find the height of point  $A$  above the ground.
- (ii) Calculate the number of seconds it takes for the water wheel to complete one rotation.
- (iii) Hence find the number of rotations the water wheel makes in one hour. [6]

(This question continues on the following page)



Do **not** write solutions on this page.

**(Question 8 continued)**

A bucket moves around to point B which is at a height of 4.06 metres above the ground. It takes  $k$  seconds for the top of this bucket to go from point A to point B.

(b) Find  $k$ . [3]

The chord  $[AB]$  is 17.0 metres, correct to three significant figures.

(c) Find  $\hat{A}OB$ . [3]

(d) Determine the rate of change of  $h$  when the top of the bucket is at B. [2]



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9. [Maximum mark: 14]

Fiona walks from her house to a bus stop where she gets a bus to school. Her time,  $W$  minutes, to walk to the bus stop is normally distributed with  $W \sim N(12, 3^2)$ .

Fiona always leaves her house at 07:15. The first bus that she can get departs at 07:30.

- (a) Find the probability that it will take Fiona between 15 minutes and 30 minutes to walk to the bus stop. [2]

The length of time,  $B$  minutes, of the bus journey to Fiona’s school is normally distributed with  $B \sim N(50, \sigma^2)$ . The probability that the bus journey takes less than 60 minutes is 0.941.

- (b) Find  $\sigma$ . [3]  
 (c) Find the probability that the bus journey takes less than 45 minutes. [2]

If Fiona misses the first bus, there is a second bus which departs at 07:45. She must arrive at school by 08:30 to be on time. Fiona will not arrive on time if she misses both buses. The variables  $W$  and  $B$  are independent.

- (d) Find the probability that Fiona will arrive on time. [5]

This year, Fiona will go to school on 183 days.

- (e) Calculate the number of days Fiona is expected to arrive on time. [2]

10. [Maximum mark: 16]

Consider a function  $f(x)$ , for  $x \geq 0$ . The derivative of  $f$  is given by  $f'(x) = \frac{6x}{x^2 + 4}$ .

- (a) Show that  $f''(x) = \frac{24 - 6x^2}{(x^2 + 4)^2}$ . [4]

The graph of  $f$  is concave-down when  $x > n$ .

- (b) Find the least value of  $n$ . [2]

- (c) Find  $\int \frac{6x}{x^2 + 4} dx$ . [3]

Let  $R$  be the region enclosed by the graph of  $f$ , the  $x$ -axis and the lines  $x = 1$  and  $x = 3$ . The area of  $R$  is 19.6, correct to three significant figures.

- (d) Find  $f(x)$ . [7]

