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| Please check the examination details below before entering your candidate information   |  |   |   |
| Candidate surname   |  | Other names   |   |
| <b>Pearson Edexcel</b>  |  | Centre Number   | Candidate Number  |
| <b>Level 3 GCE</b>  |  | <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> | <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> |
| <b>Thursday 14 May 2020</b>   |  |   |   |
| Afternoon   |  | Paper Reference <b>8FM0/21</b>  |   |
| <b>Further Mathematics</b><br><b>Advanced Subsidiary</b><br><b>Further Mathematics options</b><br><b>21: Further Pure Mathematics 1</b><br><b>(Part of options A, B, C and D)</b> |  |   |   |
| <b>You must have:</b><br>Mathematical Formulae and Statistical Tables (Green), calculator   |  |   | Total Marks<br><div style="border: 1px solid black; width: 50px; height: 50px; margin: 0 auto;"></div>  |

**Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.**

### Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear.  
Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.

### Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- The total mark for this part of the examination is 40. There are 5 questions.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*

### Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

**Turn over** ►

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1. The variables  $x$  and  $y$  satisfy the differential equation

$$\frac{d^2y}{dx^2} = 2y^2 - x - 1$$

where  $\frac{dy}{dx} = 3$  and  $y = 0$  at  $x = 0$

Use the approximations

$$\left(\frac{d^2y}{dx^2}\right)_n \approx \frac{(y_{n+1} - 2y_n + y_{n-1}))}{h^2} \quad \text{and} \quad \left(\frac{dy}{dx}\right)_n \approx \frac{(y_{n+1} - y_{n-1}))}{2h}$$

with  $h = 0.1$  to find an estimate for the value of  $y$  at  $x = 0.2$

(7)



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Question 1 continued

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Question 1 continued

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Question 1 continued

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(Total for Question 1 is 7 marks)



2. Use algebra to determine the values of  $x$  for which

$$\frac{x+1}{2x^2+5x-3} > \frac{x}{4x^2-1}$$

(5)



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3. (i) Use the substitution  $t = \tan\left(\frac{x}{2}\right)$  to prove that

$$\cot x + \tan\left(\frac{x}{2}\right) = \operatorname{cosec} x \quad x \neq n\pi, n \in \mathbb{Z} \quad (2)$$

(ii)

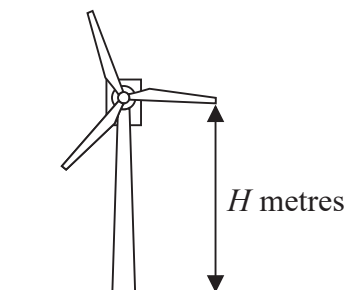


Figure 1

An engineer models the vertical height above the ground of the tip of one blade of a wind turbine, shown in Figure 1. The ground is assumed to be horizontal.

The vertical height of the tip of the blade above the ground,  $H$  metres, at time  $x$  seconds after the wind turbine has reached its constant operating speed, is modelled by the equation

$$H = 90 - 30\cos(120x)^\circ - 40\sin(120x)^\circ \quad (I)$$

- (a) Show that  $H = 60$  when  $x = 0$  (1)

Using the substitution  $t = \tan(60x)^\circ$

- (b) show that equation (I) can be rewritten as

$$H = \frac{120t^2 - 80t + 60}{1 + t^2} \quad (3)$$

- (c) Hence find, according to the model, the value of  $x$  when the tip of the blade is 100 m above the ground for the first time after the wind turbine has reached its constant operating speed. (5)





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Question 3 continued

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Question 3 continued

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Question 3 continued

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(Total for Question 3 is 11 marks)



4.

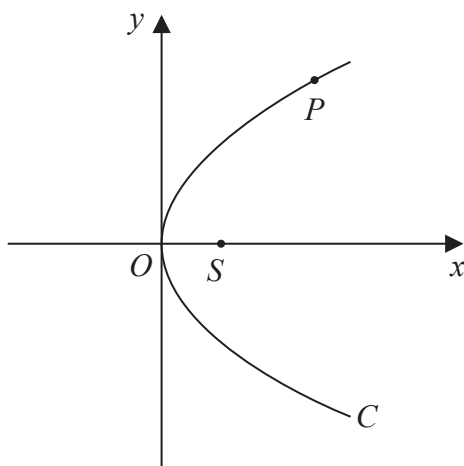
**Figure 2**

Figure 2 shows a sketch of the parabola  $C$  with equation  $y^2 = 4ax$ , where  $a$  is a positive constant. The point  $S$  is the focus of  $C$  and the point  $P(ap^2, 2ap)$  lies on  $C$  where  $p > 0$

(a) Write down the coordinates of  $S$ . (1)

(b) Write down the length of  $SP$  in terms of  $a$  and  $p$ . (1)

The point  $Q(aq^2, 2aq)$ , where  $p \neq q$ , also lies on  $C$ .  
The point  $M$  is the midpoint of  $PQ$ .

Given that  $pq = -1$

(c) prove that, as  $P$  varies, the locus of  $M$  has equation

$$y^2 = 2a(x - a) \quad (5)$$



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Question 4 continued

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Question 4 continued

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Question 4 continued

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(Total for Question 4 is 7 marks)



5.

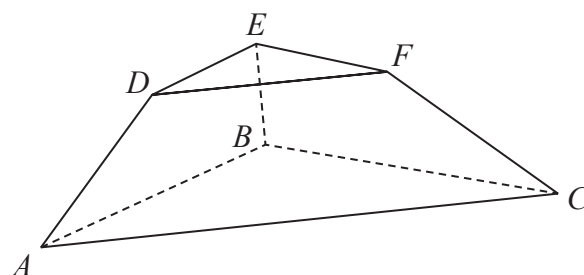


Figure 3

Figure 3 shows a solid display stand with parallel triangular faces  $ABC$  and  $DEF$ . Triangle  $DEF$  is similar to triangle  $ABC$ .

With respect to a fixed origin  $O$ , the points  $A$ ,  $B$  and  $C$  have coordinates  $(3, -3, 1)$ ,  $(-5, 3, 3)$  and  $(1, 7, 5)$  respectively and the points  $D$ ,  $E$  and  $F$  have coordinates  $(2, -1, 8)$ ,  $(-2, 2, 9)$  and  $(1, 4, 10)$  respectively. The units are in centimetres.

- (a) Show that the area of the triangular face  $DEF$  is  $\frac{1}{2}\sqrt{339} \text{ cm}^2$  (3)
- (b) Find, in  $\text{cm}^3$ , the exact volume of the display stand. (7)





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Question 5 continued

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**Question 5 continued**

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Question 5 continued

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**Question 5 continued**

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**(Total for Question 5 is 10 marks)**

**TOTAL FOR FURTHER PURE MATHEMATICS 1 IS 40 MARKS**

