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Surname	Other names
<b>Pearson Edexcel</b> <b>International GCSE</b>	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">           Centre Number  <div style="border: 1px solid black; width: 30px; height: 30px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 30px; height: 30px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 30px; height: 30px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 30px; height: 30px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 30px; height: 30px; margin: 0 auto;"></div> </div> <div style="text-align: center;">           Candidate Number  <div style="border: 1px solid black; width: 30px; height: 30px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 30px; height: 30px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 30px; height: 30px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 30px; height: 30px; margin: 0 auto;"></div> </div> </div>
<h1 style="margin: 0;">Further Pure Mathematics</h1> <div style="display: flex; justify-content: space-between; align-items: center; margin-top: 10px;"> <div> <h2 style="margin: 0;">Level 2</h2> <h2 style="margin: 0;">Paper 2</h2> </div>  </div>	
Sample assessment material for first teaching September 2017 <b>Time: 2 hours</b>	Paper Reference <b>4PM1/02</b>
<b>Calculators may be used.</b>	Total Marks

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Without sufficient working, correct answers may be awarded no marks.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*
- You must **NOT** write anything on the formulae page.  
Anything you write on the formulae page will gain NO credit.

### Information

- The total mark for this paper is 100.
- 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.
- Check your answers if you have time at the end.

Turn over ►

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## International GCSE in Further Pure Mathematics Formulae sheet

**Mensuration****Surface area of sphere**  $= 4\pi r^2$ **Curved surface area of cone**  $= \pi r \times \text{slant height}$ **Volume of sphere**  $= \frac{4}{3}\pi r^3$ **Series****Arithmetic series**Sum to  $n$  terms,  $S_n = \frac{n}{2}[2a + (n-1)d]$ **Geometric series**Sum to  $n$  terms,  $S_n = \frac{a(1-r^n)}{(1-r)}$ Sum to infinity,  $S_\infty = \frac{a}{1-r} \quad |r| < 1$ **Binomial series** $(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \dots + \frac{n(n-1)\dots(n-r+1)}{r!}x^r + \dots \quad \text{for } |x| < 1, n \in \mathbb{Q}$ **Calculus****Quotient rule (differentiation)**

$$\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right) = \frac{f'(x)g(x) - f(x)g'(x)}{[g(x)]^2}$$

**Trigonometry****Cosine rule**In triangle  $ABC$ :  $a^2 = b^2 + c^2 - 2bc \cos A$ 

$$\tan \theta = \frac{\sin \theta}{\cos \theta}$$

$$\sin(A+B) = \sin A \cos B + \cos A \sin B$$

$$\sin(A-B) = \sin A \cos B - \cos A \sin B$$

$$\cos(A+B) = \cos A \cos B - \sin A \sin B$$

$$\cos(A-B) = \cos A \cos B + \sin A \sin B$$

$$\tan(A+B) = \frac{\tan A + \tan B}{1 - \tan A \tan B}$$

$$\tan(A-B) = \frac{\tan A - \tan B}{1 + \tan A \tan B}$$

**Logarithms**

$$\log_a x = \frac{\log_b x}{\log_b a}$$

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**Answer all ELEVEN questions.**

**Write your answers in the spaces provided.**

**You must write down all the stages in your working.**

- 1** The  $n$ th term of a geometric series is  $3e^{(1-2n)}$

Find the sum to infinity of this series.

Give your answer in the form  $\frac{ae}{e^b - 1}$  where  $a$  and  $b$  are integers to be found.

(5)

**(Total for Question 1 is 5 marks)**

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3  $O$ ,  $A$  and  $B$  are fixed points such that

$$\overrightarrow{OA} = 4\mathbf{i} + 3\mathbf{j} \quad \overrightarrow{OB} = 8\mathbf{i} + p\mathbf{j} \quad \text{and} \quad |\overrightarrow{AB}| = 2\sqrt{13}$$

(a) Find the possible values of  $p$ .

(3)

Given that  $p > 0$

(b) find a unit vector parallel to  $\overrightarrow{AB}$

(2)

(Total for Question 3 is 5 marks)

4

$$f(x) = 2x^3 + px^2 + qx + 12 \quad p, q \in \mathbb{Z}$$

Given that  $(x + 3)$  is a factor of  $f(x)$  and that when  $f'(x)$  is divided by  $(x + 3)$  the remainder is 37

(a) show that  $p = 1$  and find the value of  $q$  (6)

(b) hence factorise  $f(x)$  completely (2)

(c) show that the equation  $f(x) = 0$  has only one real root. (2)

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**Question 4 continued**

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**(Total for Question 4 is 10 marks)**

5 (a) Show that  $\cos(A - B) - \cos(A + B) = 2 \sin A \sin B$  (2)

(b) Hence express  $2 \sin 5x \sin 3x$  in the form  $\cos mx - \cos nx$  where  $m$  and  $n$  are integers, giving the value of  $m$  and the value of  $n$ , (1)

(c) (i) Find  $\int 4 \sin 5\theta \sin 3\theta \, d\theta$

(ii) Hence evaluate  $\int_0^{\frac{\pi}{6}} 4 \sin 5\theta \sin 3\theta \, d\theta$ , giving your answer in the form  $\frac{a\sqrt{b}}{c}$  where  $a$ ,  $b$  and  $c$  are integers. (4)

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**Question 5 continued**

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**(Total for Question 5 is 7 marks)**

6 Solve the equation  $\log_2 x + 6\log_x 2 = 7$

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**Question 6 continued**

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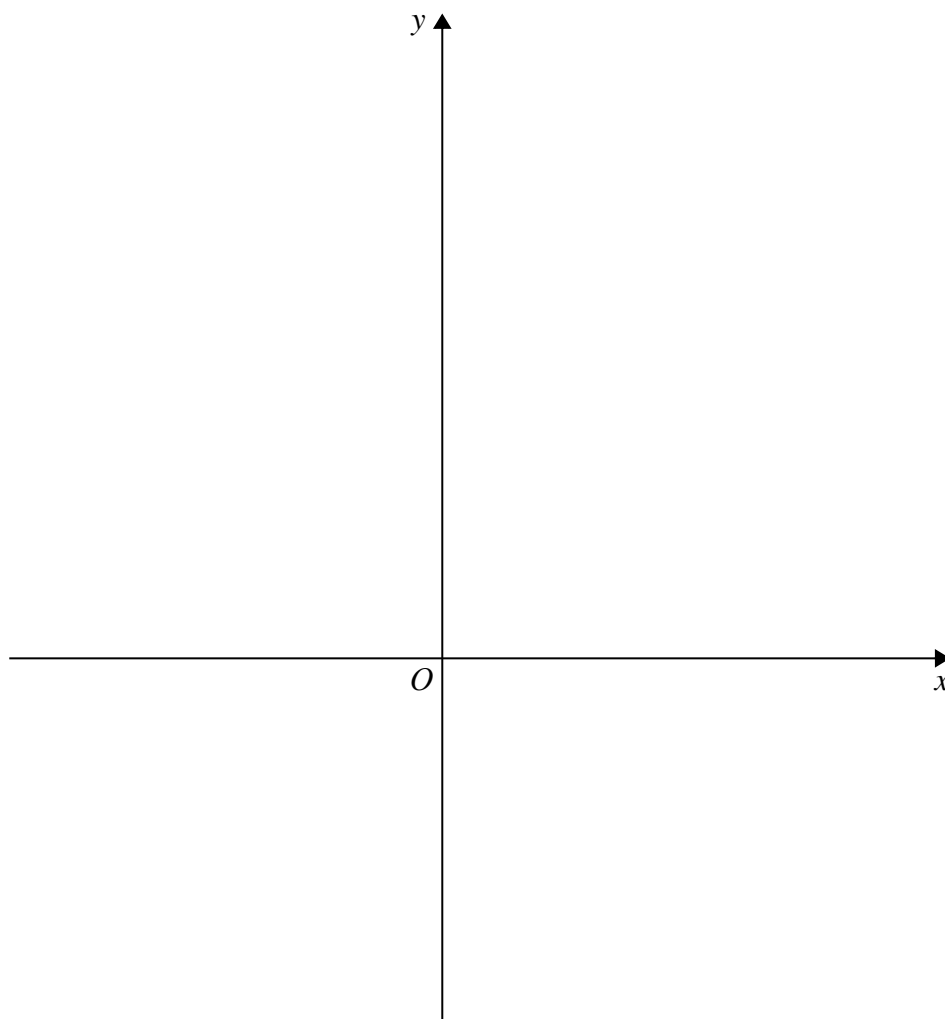
**(Total for Question 6 is 7 marks)**

7 The curve  $C$  with equation

$$y = \frac{ax - 5}{x - b}$$

where  $a$  and  $b$  are integers, crosses the  $x$ -axis at the point  $(2.5, 0)$ . The asymptote to  $C$  which is parallel to the  $y$ -axis has equation  $x = 1$

- (a) (i) Show that  $a = 2$  (3)
- (ii) Find the value of  $b$ . (1)
- (b) Find the coordinates of the point where  $C$  crosses the  $y$ -axis. (1)
- (c) Find the equation of the asymptote to  $C$  which is parallel to the  $x$ -axis. (1)
- (d) Using the axes below, sketch the curve  $C$  showing clearly the asymptotes and the coordinates of the points where  $C$  crosses the coordinate axes. (3)



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**Question 7 continued**

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**(Total for Question 7 is 8 marks)**

- 8 (a) Expand  $\frac{3}{\sqrt{1-2x}}$  in ascending powers of  $x$  up to and including the term in  $x^3$  and simplifying each term as far as possible. (4)
- (b) Write down the range of values of  $x$  for which this expansion is valid. (1)
- (c) Show that  $\frac{3}{\sqrt{0.9}} = \sqrt{10}$  (1)
- (d) Express  $\frac{1}{\sqrt{10}-3}$  in the form  $a\sqrt{10} + b$ , where  $a$  and  $b$  are integers. (2)
- (e) Hence, using your expansion with a suitable value for  $x$ , obtain an approximation to 5 decimal places of  $\frac{1}{\sqrt{10}-3}$  (3)

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**Question 8 continued**

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**(Total for Question 8 is 11 marks)**

$$f(x) = 7 + 4x - 2x^2$$

Given that  $f(x)$  can be written in the form  $P(x + Q)^2 + R$  where  $P$ ,  $Q$  and  $R$  are constants,

- (a) find the value of  $P$ , the value of  $Q$  and the value of  $R$ . (3)
- (b) hence write down
- (i) the maximum value of  $f(x)$ ,
  - (ii) the value of  $x$  for which this maximum occurs.

The curve  $C$  has equation  $y = 7 + 4x - 2x^2$

The line  $l$  with equation  $y = 4 - x$  intersects  $C$  at two points.

- (c) Find the  $x$  coordinates of these two points. (3)

The finite region bounded by the curve  $C$  and the line  $l$  is rotated  $360^\circ$  about the  $x$ -axis.

- (d) Use algebraic integration to find, to 3 significant figures, the volume of the solid generated.



**Question 9 continued**

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**Question 9 continued**

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**Question 9 continued**

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**(Total for Question 9 is 13 marks)**

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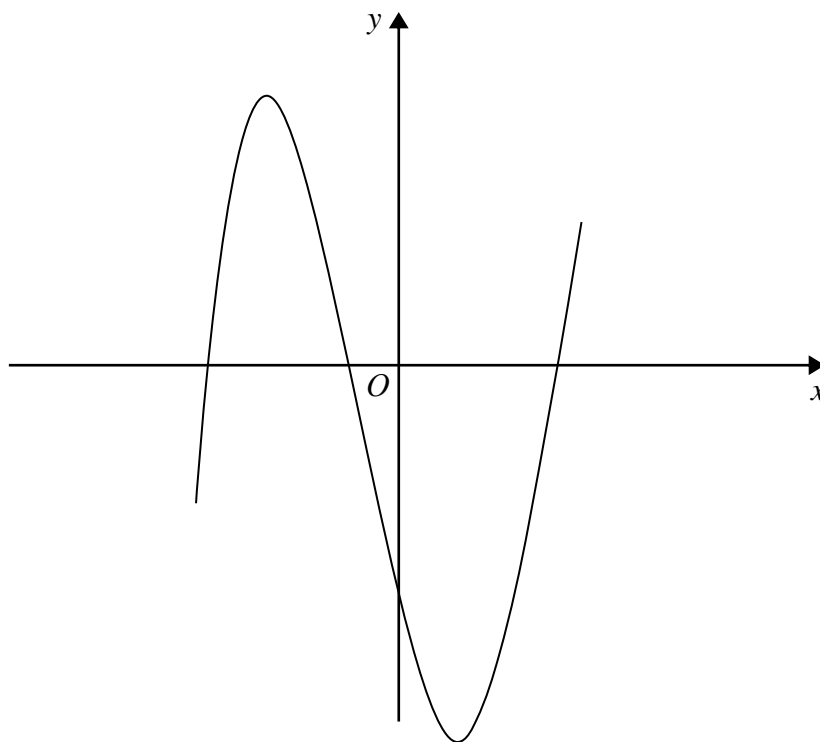
**Figure 1**

Figure 1 shows the curve  $M$  with equation  $y = x^3 - 13x - 12$

The point  $P$ , with  $x$  coordinate  $-2$ , lies on  $M$  and line  $l_1$  is the tangent to  $M$  at the point  $P$ .

- (a) Find an equation for  $l_1$  (5)

The point  $Q$  lies on  $M$  and the line  $l_2$  is the tangent to  $M$  at the point  $Q$ .

Given that  $l_1$  and  $l_2$  are parallel,

- (b) find an equation for  $l_2$  (4)

The normal to  $M$  at  $P$  meets  $l_2$  at the point  $R$ .

- (c) Find the coordinates of  $R$ . (4)

- (d) Find the exact length of the line  $PR$ . (2)

The tangent and normal at  $P$  and the tangent and normal at  $Q$  form a rectangle.

- (e) Find the exact area of this rectangle. (3)

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**Question 10 continued**

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**(Total for Question 10 is 18 marks)**

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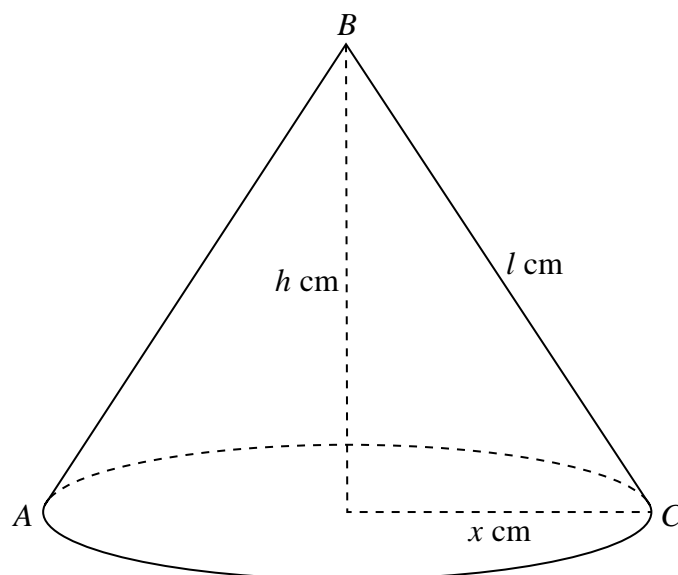
Diagram **NOT**  
accurately drawn**Figure 2**

Figure 2 shows a right circular cone with a base radius of  $x$  cm. The slant height of the cone is  $l$  cm and the height of the cone is  $h$  cm. The vertex of the cone is  $B$  and the points  $A$  and  $C$ , on the base of the cone, are such that  $AC$  is a diameter of the base.

The cone is increasing in size in such a way that the size of the angle  $ABC$  is constant at  $60^\circ$  and the **total** surface area of the cone is increasing at a constant rate of  $10 \text{ cm}^2/\text{s}$ .

Find the exact rate of increase of the volume of the cone when  $x = 6$

(11)

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**Question 11 continued**

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**(Total for Question 11 is 11 marks)**

**TOTAL FOR PAPER IS 100 MARKS**

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