Please check the examination details be	low before ente	ering your candidate information
Candidate surname		Other names
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<b>Time</b> 2 hours	Paper reference	4PM1/02
Further Pure Mat	hema	ntics
Calculators may be used.		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,  $S_{\infty} = \frac{a}{1-r} |r| < 1$ 

### **Binomial series**

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \dots + \frac{n(n-1)\dots(n-r+1)}{r!}x^r + \dots$$
 for  $|x| < 1, n \in \mathbb{Q}$ 

#### Calculus

## **Quotient rule (differentiation)**

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

## **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

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



# Answer all ELEVEN questions.

# Write your answers in the spaces provided.

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

1 Find the set of values of k for which the equation

$$2kx^2 + 5kx + 5k - 3 = 0$$
 where  $k \neq 0$ 

has real roots.	
	(4)

(Total for Question 1 is 4 marks)



2	A particle $P$ moves along the $x$ -axis. At time $t$ seconds, the displacement, $x$ metres,
	of P from the origin O is given by

$$x = t^4 - 13.5t + 12$$

(a) Find the velocity, in m/s, of P when t = 3

**(2)** 

(b) Find the value of t for which P is instantaneously at rest.

(2)

(c) Find the acceleration, in  $m/s^2$ , of P when t = 2

(2)




<b>3</b> O, A and B are fixed points such that
--

$$\overrightarrow{OA} = (p\mathbf{i} - 4\mathbf{j})$$

$$\overrightarrow{OA} = (p\mathbf{i} - 4\mathbf{j})$$
  $\overrightarrow{OB} = \mathbf{i} + (2p+1)\mathbf{j}$ 

Given that  $\sqrt{2} \left| \overrightarrow{OA} \right| = \left| \overrightarrow{OB} \right|$  and p > 0

(a) find the value of p

(4)

Using this value of p

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

**(5)** 






 $C_1$   $C_2$   $C_2$   $C_2$   $C_3$   $C_4$   $C_5$   $C_6$   $C_7$   $C_8$   $C_8$   $C_9$   $C_9$ 

Diagram **NOT** accurately drawn

**(7)** 

Figure 1

Figure 1 shows two circles,  $C_1$  and  $C_2$ , each with a radius of 6 cm.

The centre of  $C_1$  is  $O_1$  such that  $O_1$  lies on  $C_2$ 

The centre of  $C_2$  is  $O_2$  such that  $O_2$  lies on  $C_1$ 

The circles intersect at the points A and B and enclose the region R, shown shaded in Figure 1

The area of region R is  $P \text{ cm}^2$ 

Find the exact value of P, giving your answer in the form  $a\pi - b\sqrt{c}$  where a, b and c are integers.



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Question 4 continued



5	The roots of the quadratic equation	$2x^2 + (6+2p)x + 2p = 0$	are $\alpha$ and $\beta$
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- (a) Write down an expression in terms of p for
  - (i)  $\alpha + \beta$
- (ii) *αβ*

(2)

(b) Show that  $(\alpha - \beta)^2 = 9 + 2p + p^2$ 

**(4)** 

Given that  $(\alpha - \beta) = 3$ 

(c) find the possible values of p

(3)





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Question 5 continued	





6	(a)	Using a	formula	from	page 2,	show that	$\cos 2A =$	$1 - 2\sin^2 A$
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(2)

The finite region R is bounded by the curve with equation  $y = 3 + 2\sin x$ , the x-axis, the y-axis and the line with equation  $x = \frac{\pi}{4}$ 

The region R is rotated through  $360^{\circ}$  about the x-axis.

(b) Use calculus to find the volume of the solid generated. Give your answer to the nearest integer.

**(6)** 




(i) (a) Using a formula from page 2, show that

$$\tan 2\theta = \frac{2\tan\theta}{1-\tan^2\theta}$$

**(2)** 

Given that  $\tan 2\alpha = 1$ 

(b) show that  $\tan \alpha = a \pm \sqrt{b}$  where a and b are integers whose values need to be found.

(3)

(ii) (a) Using formulae from page 2, show that  $\cos(x-30)^{\circ} = \sin(x+30)^{\circ}$  can be written as  $\tan x^{\circ} = 1$ 

**(4)** 

(b) Hence, or otherwise, solve

$$\cos(2y-30)^{\circ} = \sin(2y+30)^{\circ}$$
 for  $-90 < y \le 90$ 

**(2)** 





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Question 7 continued		





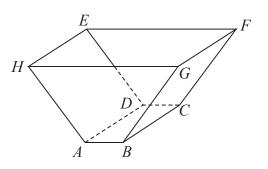


Diagram **NOT** accurately drawn

Figure 2

Figure 2 shows a waste paper basket in the shape of a right prism with 5 faces and a cross section that is a trapezium. The top, *EFGH*, of the waste paper basket is open.

The base of the prism ABCD is a rectangle with

$$AB = DC = 2x \text{ cm}$$
 and  $AD = BC = h \text{ cm}$ 

The cross sections HGBA and EFCD are such that

$$EF = HG = 8x \text{ cm}$$
 and  $AH = BG = CF = DE = 5x \text{ cm}$ 

The top, EFGH, of the waste paper basket is such that

$$EH = FG = h \text{ cm}$$

The volume of the waste paper basket is 2250 cm<sup>3</sup>

The total surface area of the 5 faces of the waste paper basket is Scm<sup>2</sup>

(a) Show that 
$$S = 40x^2 + \frac{1350}{x}$$

**(5)** 

Given that x can vary,

(b) use calculus, to find, to 3 significant figures, the value of x for which S is a minimum.

Justify that this value of x gives a minimum value of S

(5)

(c) Find, to 3 significant figures, the minimum value of S

(2)



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9 The straight line  $L_1$  passes through the point A with coordinates (4, 7) and has gradient m, where m < 0

Another straight line  $L_2$  is perpendicular to  $L_1$  and passes through the point B with coordinates (4, k) where  $k \neq 7$ 

The lines  $L_1$  and  $L_2$  intersect at the point  ${\cal C}$ .

Given that the y coordinate of C is Y

(a) show that 
$$Y = \frac{7 + m^2 k}{m^2 + 1}$$

**(7)** 

Given that the triangle ABC is isosceles,

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Question 9 continued	





10 Solve the equation							
$\log_4 x + \log_{16} x + \log_2 x = 10.5$							
Show your working clearly.	(=)						
	(5)						





## **11** A curve *C* has equation

$$y = \frac{(2a-1)x+1}{ax-6}$$
 where a is a constant and  $x \neq \frac{6}{a}$ 

(a) Find  $\frac{dy}{dx}$ 

(3)

The curve crosses the y-axis at the point A.

The normal to C at the point A is the line l with equation 66y - 72x + 11 = 0

Show that

(b) (i) a = 3

(4)

(ii) the equation of C is  $y = \frac{5x+1}{3x-6}$  where  $x \neq 2$ 

(1)

(c) Using the axes on the opposite page, sketch C, showing clearly the asymptotes with their equations and the coordinates of the points where C crosses the coordinate axes.

**(5)** 

The line l meets C again at the point D.

(d) Find the x coordinate of D.

Give your answer as an improper fraction.

**(4)** 

Question 11 continued				
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Question 11 continued	





Question 11 continued		
	(Total for Question 11 is 17 marks)	
	TOTAL FOR PAPER IS 100 MARKS	

