Dr Oliver Mathematics
Extended Mathematics Certificate
Sample Assessment Materials: Non-Calculator
1 hour 15 minutes

The total number of marks available is 60.
You must write down all the stages in your working.

1.
$$\mathrm{f}(x) = 4x + 6.$$

(a) Find $\mathrm{f}(-3)$. (1)

(b) Find an equation for the line perpendicular to (2)
$$y = 4x + 6$$
that passes through the point $(0, -8)$.

Point A with coordinates $(a, 10)$ and point B with coordinates $(3, b)$ both lie on
$$y = 4x + 6.$$

(c) Find the length of AB. (3)
Give you answer in the form $c\sqrt{d}$, where c and d are integers.

2. (a) Simplify (1)
$$\sqrt{18}.$$

(b) Simplify (2)
$$\sqrt{8} + \sqrt{18} - 3.$$

$$\frac{\sqrt{2} + 6}{\sqrt{8} + \sqrt{18} - 3}.$$

(c) Hence write in the form (4)
$$\frac{a\sqrt{b} + c}{d},$$
where a, b, c, and d are integers.

3. Here are the first few rows of Pascal's Triangle.

				1						
			1		1					
		1		2		1				
	1		3		3		1			
1		4		6		4		1		
	5		10		10		5		1	

(a) Using this information, expand (2)

$$(e + f)^3.$$

Given that

$$(e + f)^4 = e^4 + 4e^3f + 6e^2f^2 + 4ef^3 + f^4,$$

(b) (i) work out (2)

$$7^4 + 12 \times 7^3 + 6 \times 7^2 \times 3^2 + 28 \times 3^3 + 3^4.$$

(ii) expand and simplify (3)

$$(2e + f)^4.$$

4. (a) (i) Simplify (1)

$$81^{\frac{3}{4}}.$$

(ii) Write (1)

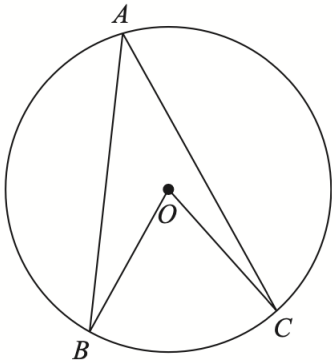
$$\frac{1}{9^2}$$

in the form 3^n.

$$27^{-\frac{2}{3}} \times 3^{2y+1} \times \frac{1}{9^2} \times 81^{\frac{3}{4}} = 27.$$

(b) Find the value of y. (4)

5. The diagram shows a circle, centre O. (4)
A, B, and C are points on the circumference of the circle.



Prove that the angle subtended by the arc at the centre is twice the angle subtended at the circumference.

6. The point Q with coordinates $(-2, 0)$ is on the curve $\mathrm{f}(x)$.

The transformation

$$\mathrm{f}(x + a) + b$$

of the curve $\mathrm{f}(x)$ moves the point P from $(0, 0)$ to $(3, 4)$.

(a) Write down the coordinates of Q after the transformation (1)

$$\mathrm{f}(x + a) + b.$$

(b) Work out the value of a and the value of b. (2)

The transformation

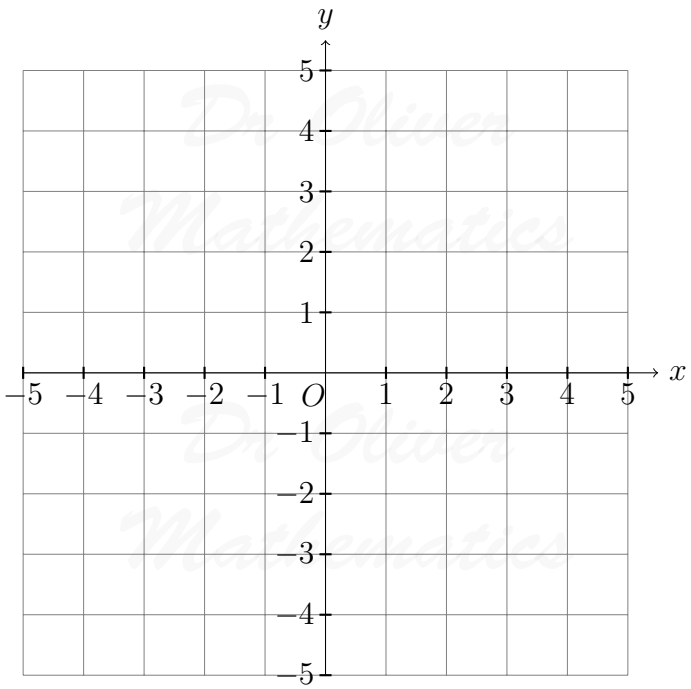
$$k\,\mathrm{g}(dx) + 1$$

of the curve $\mathrm{g}(x)$ moves the point R, from $(-3, 2)$ to $(-6, 7)$.

(c) Work out the value of d and the value of k. (3)

7. A circle **C** has centre $(0, -3)$ and circumference 4π.

(a) Sketch the graph of **C**. (2)



The line **L** has equation

$$2x - y = 5.$$

(b) Find, algebraically, the coordinates of the points of intersection of **C** and **L**. (5)

8. Alex is standing on a tower and throws a ball to Chris who is standing on the ground.

The motion of the ball is modelled by the equation

$$s = -5t^2 + 20t + 7,$$

where s is the height of the ball above the ground, in metres, and t is the time, in seconds, from when Alex throws the ball.

(a) Write down the initial height of the ball? (1)

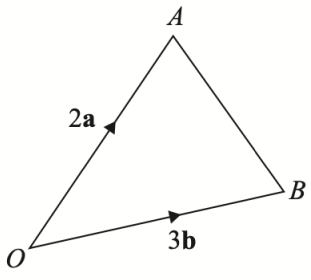
(b) Explain why the model is not valid when $t = 5$. (1)

(c) Work out the maximum height the ball reaches. (3)

Chris catches the ball when it is 2 metres above the ground.

(d) Work out the total amount of time the ball is in flight. (4)
Give your answer in the form $a + \sqrt{b}$, where a and b are integers.

9. Here is a picture. (8)



- $\overrightarrow{OA} = 2\mathbf{a}$.
- $\overrightarrow{OB} = 3\mathbf{b}$.
- C is a point such that $\overrightarrow{AC} = \frac{5}{3}\overrightarrow{AB}$.
- D is a point such that $\overrightarrow{AD} = x\mathbf{a} + y\mathbf{b}$ and $\overrightarrow{CD} = -\frac{2}{3}x\mathbf{a} + \frac{13}{33}y\mathbf{b}$.

Find the ratio $OB : BD$.
Give your ratio in its simplest form.