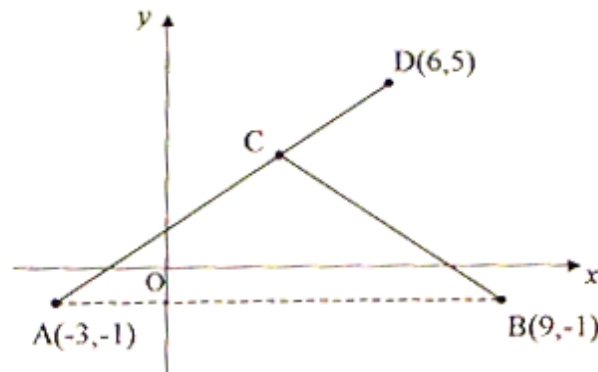


**All questions should be attempted**

1. The diagram shows a line joining the points  $A(-3,-1)$  and  $D(6,5)$ .  
 B has coordinates  $(9,-1)$  and C is a point on AD.



- |     |  |   |
|-----|--|---|
| (a) | Find the equation of the line AD.  | 2 |
| (b) | Hence establish the coordinates of C given that triangle ABC is isosceles          | 3 |
| (c) | Calculate the size of angle BCD, giving your answer correct to the nearest degree. | 3 |

2. A lead shot is discharged from a gun at a clay pigeon.  
 The height,  $h$  feet, of the shot after  $t$  seconds is given by the function

$$h(t) = 288t - 48t^2$$



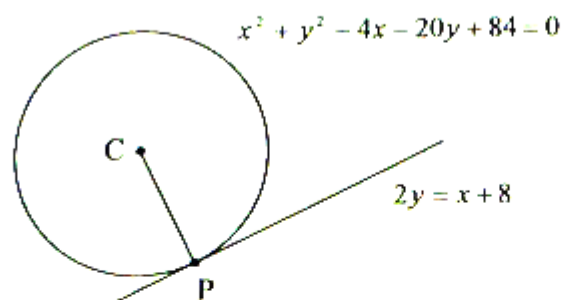
- |     |  |   |
|-----|--|---|
| (a) | What is the maximum height the shot can reach ?  | 4 |
| (b) | For the shot to actually break the clay pigeon it must strike the pigeon at a speed greater than <u>or</u> equal to 48 feet per second.<br>The speed, $s$ , of the shot after $t$ seconds can be found from $s = h'(t)$ , where $0 < t \leq 3$ .<br>Will the shot break the clay pigeon after a flight of 2.7 seconds ? Explain. | 2 |
| (c) | Calculate the maximum <b>height</b> the shot can reach <b>and</b> still break the clay pigeon.   | 3 |

3. Solve algebraically the equation

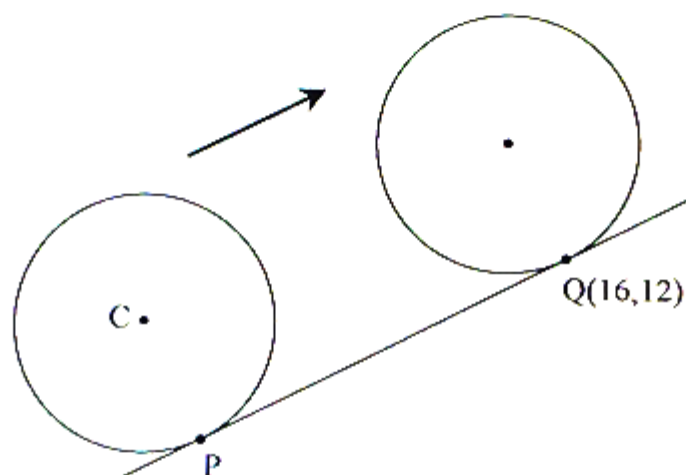
$$9 \sin x^\circ + 4 = 2 \cos 2x^\circ \quad \text{where } 0 \leq x < 360$$

6

4. A circle, centre C, has as its equation  $x^2 + y^2 - 4x - 20y + 84 = 0$ .  
It touches the line with equation  $2y = x + 8$  at point P, as shown.



- (a) Find **algebraically** the coordinates of P. 4  
(b) The circle is rolled up the line until Q(16,12) becomes the new point of tangency.



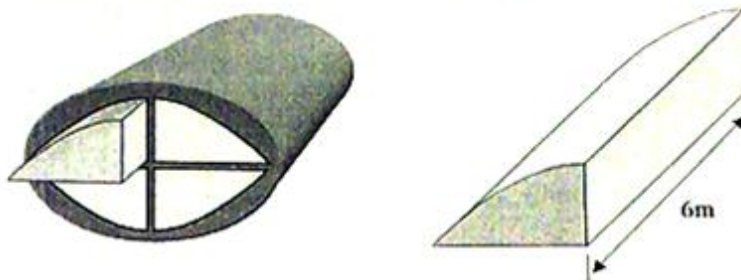
Establish the equation of the circle in this new position.

5

5. A sequence is defined by the recurrence relation  $U_{n+1} = aU_n + b$ , where  $a$  and  $b$  are constants.

- (a) Given that  $U_0 = a - 2$  and  $b = 1$ , show clearly that  $U_1 = a^2 - 2a + 1$ . 2  
(b) Hence find an expression for  $U_2$  in terms of  $a$ . 2  
(c) Given now that  $U_2 = 37$ , form an equation and solve it to find  $a$ .  
Explain why there is only one possible answer for  $a$ . 4

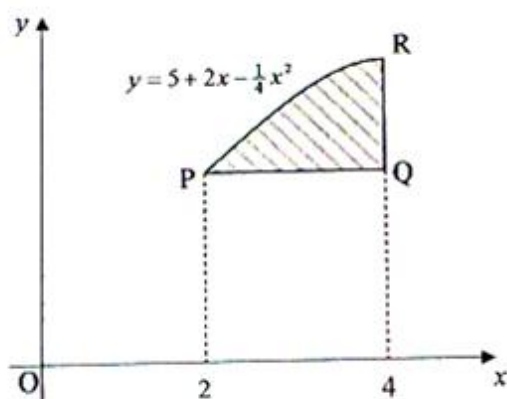
6. A titanium rod from a nuclear reactor is a solid prism which slots into an elliptical chamber along with three other identical rods. It has a cross-sectional shape made up of two straight lines and a curved edge.



Each rod has a depth of 6 metres.

The cross section of a rod is shown geometrically in the coordinate diagram below where the **units are in metres**. The diagram is not drawn to scale.

The curved section is part of the graph of the curve with equation  $y = 5 + 2x - \frac{1}{4}x^2$ . PQ is horizontal and QR is vertical.



- (a) Calculate the shaded area in square metres. 7
- (b) Hence calculate the **total volume** of titanium contained in **all four rods**. 2
7. The angle  $\theta$  is such that  $\tan \theta = \frac{2}{\sqrt{2}}$  where  $0 < \theta < \frac{\pi}{2}$ .
- (a) Find the exact values of  $\sin \theta$  and  $\cos \theta$ . 3
- (b) Hence show clearly that the exact value of  $\sin(\theta + \frac{\pi}{3})$  can be expressed as

$$\sin(\theta + \frac{\pi}{3}) = \frac{1}{6}(\sqrt{6} + 3).$$

5

8. Three functions are defined on suitable domains as

$$f(x) = x - 1, \quad g(x) = 3x^2 - 3 \quad \text{and} \quad h(x) = x^3 - 6x.$$

(a) Given that  $y = g(f(x)) - h(x)$ , find a formula for  $y$  in its simplest form. 3

(b) Hence find the coordinates of the maximum turning point of the graph of  $y = g(f(x)) - h(x)$ , **justifying your answer**. 4

9. An equation is given as  $ax(x - 1) = c(x - 1)$ , where  $a \neq 0$ ,  $c \neq 0$ , and  $a$  and  $c$  are constants.

(a) Show clearly that this equation can be written in the form

$$ax^2 - (a + c)x + c = 0. \quad \text{2}$$

(b) What condition needs to be met for this quadratic equation to have equal roots? 4

[ END OF QUESTION PAPER ]