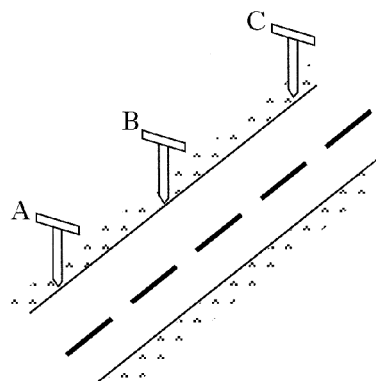**ALL questions should be attempted.**

Marks

1. Find the equation of the straight line which is parallel to the line with equation $2x + 3y = 5$ and which passes through the point $(2, -1)$.   3
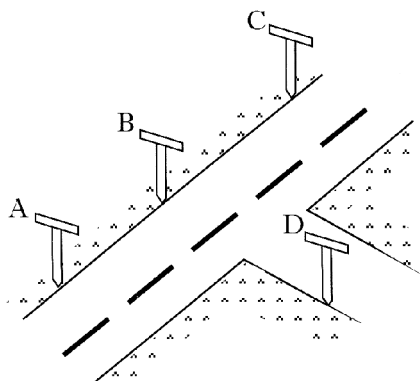
2. For what value of k does the equation $x^2 - 5x + (k + 6) = 0$ have equal roots?   3

3. (a) Roadmakers look along the tops of a set of T-rods to ensure that straight sections of road are being created. Relative to suitable axes the top left corners of the T-rods are the points $A(-8, -10, -2)$, $B(-2, -1, 1)$ and $C(6, 11, 5)$.

   Determine whether or not the section of road ABC has been built in a straight line.   3

   (b) A further T-rod is placed such that D has coordinates $(1, -4, 4)$.

   Show that DB is perpendicular to AB.   3

4. Given $f(x) = x^2 + 2x - 8$, express $f(x)$ in the form $(x + a)^2 - b$.   2
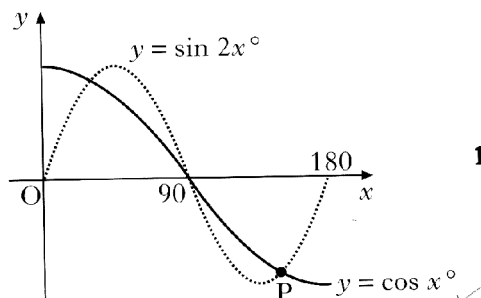
[Turn over

Marks

5. (*a*) Solve the equation $\sin 2x° - \cos x° = 0$ in the interval $0 \leq x \leq 180$.   **4**
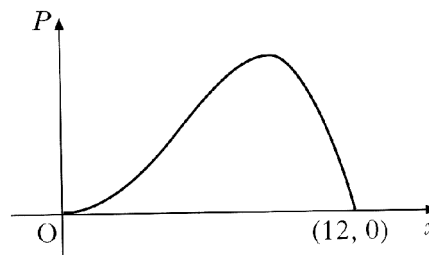
(*b*) The diagram shows parts of two trigonometric graphs, $y = \sin 2x°$ and $y = \cos x°$.

Use your solutions in (*a*) to write down the coordinates of the point P.   **1**

6. A company spends x thousand pounds a year on advertising and this results in a profit of P thousand pounds. A mathematical model, illustrated in the diagram, suggests that P and x are related by $P = 12x^3 - x^4$ for $0 \leq x \leq 12$.

Find the value of x which gives the maximum profit.   **5**

7. Functions $f(x) = \sin x$, $g(x) = \cos x$ and $h(x) = x + \frac{\pi}{4}$ are defined on a suitable set of real numbers.

(*a*) Find expressions for:

   (i) $f(h(x))$;

   (ii) $g(h(x))$.   **2**

(*b*) (i) Show that $f(h(x)) = \frac{1}{\sqrt{2}}\sin x + \frac{1}{\sqrt{2}}\cos x$.

   (ii) Find a similar expression for $g(h(x))$ and hence solve the equation $f(h(x)) - g(h(x)) = 1$ for $0 \leq x \leq 2\pi$.   **5**
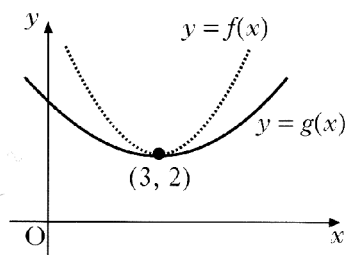
8. Find x if $4 \log_x 6 - 2 \log_x 4 = 1$.   **3**

Marks

9. The diagram shows the graphs of two quadratic functions $y = f(x)$ and $y = g(x)$. Both graphs have a minimum turning point at (3, 2).

   Sketch the graph of $y = f'(x)$ and on the same diagram sketch the graph of $y = g'(x)$.
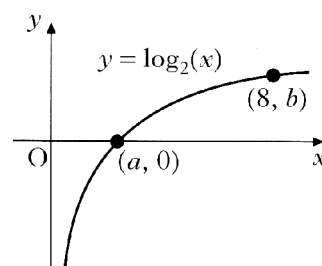
   2

10. The diagram shows a sketch of part of the graph of $y = \log_2(x)$.

    (a) State the values of a and b.

    (b) Sketch the graph of $y = \log_2(x + 1) - 3$.

    1
    3

11. Circle P has equation $x^2 + y^2 - 8x - 10y + 9 = 0$. Circle Q has centre (−2, −1) and radius $2\sqrt{2}$.

    (a) (i) Show that the radius of circle P is $4\sqrt{2}$.

        (ii) Hence show that circles P and Q touch.

    (b) Find the equation of the tangent to circle Q at the point (−4, 1).

    (c) The tangent in (b) intersects circle P in two points. Find the x-coordinates of the points of intersection, expressing your answers in the form $a \pm b\sqrt{3}$.

    4

    3

    3

[END OF QUESTION PAPER]