| EXAMINATION PAPER 1 | Matching the syllabus written by EDEXCEL Curriculum 2004+ |
|---|---|
| No Calculators | |
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| Time Allowed:-1 hour 30 minutes | |

1. Solve the equation $(4x-2)^2 = 1$ **[3]**

---

2. Calculate a) $\int 4x^3 dx$ b) $\int x^{\frac{1}{2}} - x^{-\frac{1}{2}} dx$ **[4]**

---

3. a) $\sqrt{\frac{4}{3}} = a\sqrt{b}$ where a is rational and b is an integer. Find a and b. **[3]**

   b) Simplify the expression: $(\sqrt{2} + y)(\sqrt{2} - y)$ **[2]**

---

4. $y = 3 - \frac{4}{x}$

   a) Sketch this curve, stating where the curve crosses the $x$-axis. **[3]**

   b) Write down the equation of the 2 asymptotes **[2]**

---

5. A sequence is generated by the relation $x_{n+1} = (x_n)^2 + x_n$.

   a) Given that $x_1 = 1$ find $x_2$, $x_3$ and $x_4$. **[2]**

   b) Justifying your answer explain whether the sequence in a) is arithmetic. **[1]**

   c) i) An arithmetic sequence begins 5, 8, 11,… and is defined by the relationship $x_{n+1} = f(x_n)$ with $x_1 = 5$. Find $f(x_n)$. **[1]**

   ii) Find the sum of the first 62 terms. **[2]**

   iii) Calculate a value for, $x_{n+5} - x_n$. **[1]**

---

6. a) Calculate $\frac{dy}{dx}$ where $y = x^3$. **[1]**

   b) Find the equation of the tangent to the curve when $x = 4$. **[4]**

   c) Calculate $\frac{dy}{dx}$ where $y = -x^{\frac{1}{2}}$. **[1]**

   d) Find the equation of the normal to the curve when $x = 4$. **[5]**

---

7. Two straight lines are $y = 2x - 3$ and $y = Ax + B$ where A and B are constants.

   a) Calculate an expression, in terms of A and B, for the value of $x$ where the two lines cross. **[2]**

   b) Calculate an expression, in terms of A and B, for the value of y where the two lines cross. **[3]**

   c) For the case when the lines cross at $x = 4$; find A in terms of B. **[2]**

   d) If the 2 lines are also perpendicular, then find A and B. **[3]**

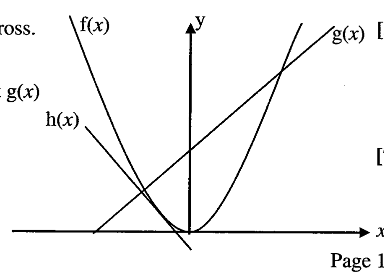
---

8. In the diagram shown, $f(x) = x^2$ and $g(x) = 3x + 4$

   a) Find the co-ordinates where the two lines cross. **[3]**

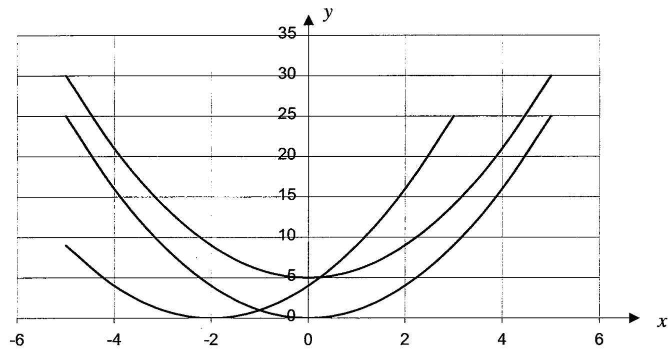
   In the diagram $h(x)$ is the tangent to $f(x)$ such that $g(x)$ and $h(x)$ meet at right-angles.

   b) Find the equation of $h(x)$ **[7]**



Continued… from page 1

9. The function $y = x^2$ and two other quadratics are shown below.
The other two quadratics shown are transformations of $y = x^2$.




a) Write down the equations of the other 2 quadratics. **[2]**

The equation of a curve is $y = f(x)$ where $f(x) = x^2 - 14x + 16$.

b) i) Complete the square for $f(x)$. **[2]**

ii) Hence state the minimum value of $f(x)$ and the value of $x$ that this minimum occurs. **[3]**

The curve $y = x^2 - 14x + 16$ can be transformed to the curve $y = x^2$ by a single translation.

iii) By considering the minimum coordinates of each graph or otherwise state the single translation that maps the curve $y = x^2 - 14x + 16$ to the curve $y = x^2$. **[2]**

10. The straight line $y = x + 2$ intersects the curve $4y + 3x^2 = 7$ **in two places**.

a) Find the coordinates of the two points of intersection. **[4]**

The straight line $y = f(x)$ has gradient 3 and intersects the curve $4y + 3x^2 = 7$ **at one point only**.

b) Find $f(x)$. **[4]**

c) Hence find the coordinates of the point of intersection between $y = f(x)$ and $4y + 3x^2 = 7$. **[3]**

**[75]**

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| Time Allowed:-1 hour 30 minutes | |

1. Solve the inequality $-x^2+x+14>2$ **[3]**

---

2. Calculate a) $\int x^5 dx$ b) $\int \frac{1-2x^2}{x^2} dx$ **[4]**

---

3. Solve the following simultaneous equations, leaving your final answers in surd form:

$$(x+y\sqrt{2})^2 = 27+12\sqrt{2} \text{ and } y = 2x$$ **[5]**

---

4. a) Write $\sqrt{44}$ in the form $a\sqrt{b}$ with $a$ and $b$ integers. **[2]**

b) Simplify i) $\frac{(\sqrt{6}+\sqrt{8})(\sqrt{6}+\sqrt{8})-14}{\sqrt{12}}$ ii) $\frac{(\sqrt{x})^3}{x}$ iii) $\frac{2}{4-\sqrt{3}}$ **[6]**

---

5. A sequence begins 10, 12, 14, 16, 18, .... Let the sum of the first n terms of this sequence be $S_n$.

a) Calculate an expression for the nth term. **[2]**

b) Formulate a quadratic in terms of n for the sum of n terms. **[2]**

A 2nd sequence begins 2, 4, 6, 8, 10, ... Let the sum of the first n terms of this sequence be $T_n$.

c) Find an expression for $S_n - T_n$. **[3]**

---

6. a) Solve the quadratic equation, $-x^2+3x+10=0$ **[2]**

b) Sketch the graph of f(x), where $f(x) = -x^2+3x+10$ **[3]**

c) Calculate $f(x+1)$ and hence sketch the graph of $g(x) = -x^2+x+12$ **[3]**

d) When does the quadratic equation, $-x^2+3x+A=0$ have two distinct real roots? **[3]**

---

7. The three points ABC make a triangle where A(1, 3), B(5, 6) and C(6, 8).

a) Find the length of side AB. **[2]**

b) Find the equation of the straight line through B and C. **[4]**

D is a point on the y-axis such that CD is perpendicular to BC.

c) Find the equation of the straight line that passes through C and D. **[2]**

---

8. Sketch separately the following graphs:

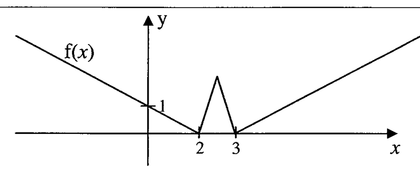
a) $f(x)+1$ **[2]**

b) $f(x+2)$ **[2]**

c) $-f(x)$ **[2]**

d) $f(-x)$ **[2]**

If the *exact values are known*, then write on where each graph crosses the *x and y-axis.*

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9. $f(x) = \frac{x^4}{4} + \frac{1}{x^2}$

a) Find $f'(x)$. **[2]**

b) Find the equation of the tangent to $f(x)$ at the point on the graph where $x = 2$. **[3]**

There are two tangents to the curve $y = \frac{x^4}{4} + \frac{1}{x^2}$ where the gradient is 1.

c) Find the 2 values of the $x$-coordinate where this occurs. **[4]**

---

10. The equation of a curve is $y = f(x)$ where $f(x) = 2x^2 - 12x + 6$.

a) $g(x) = f(2x)$, calculate $g(x)$ and state the relationship between $g(x)$ and $f(x)$. **[3]**

b) Write $f(x)$ in the form $f(x) = a(x+b)^2 + c$ **[3]**

c) Hence or otherwise state the coordinates of the minimum point of the curve $y = f(x)$. **[2]**

d) The curve $y = f(x)$ is reflected in the $x$-axis to produce curve $y = f_2(x)$ and the curve $y = f(x)$ is reflected in the y-axis to produce curve $y = f_3(x)$.
Calculate $f_2(x)$ and $f_3(x)$. **[4]**

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**[75]**

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|---|---|
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| Time Allowed:-1 hour 30 minutes | |

1. Consider the sequence of positive numbers is $u_1, u_2, u_3, u_4, \ldots, u_n$, where $u_n = 1 + 2^n$
   a) Write down the first 5 terms and show that the sequence is not arithmetic. **[2]**
   b) Find an expression for $u_{n+1} - u_n$ in terms of n. **[2]**

---

2. Simplify the following $\dfrac{10}{\sqrt{200}}$ **[3]**

---

3. Solve the inequality: $2x - x^2 > 0$ **[4]**

---

4. Find $a$ and $b$, where $b$ is positive and where $a = \left(\dfrac{27}{64}\right)^{-\frac{2}{3}}$ and $b^4 = 16 \times 4^2$. **[6]**

---

5. Calculate a) $\int \frac{2x^5}{5}\,dx$ b) $\int x(x - x^2)\,dx$ **[4]**

---

6. a) Solve the quadratic equation, $3x^2 + x - 10 = 0$ by completing the square. **[4]**
   b) When does the quadratic equation, $3x^2 + x + A = 0$ have two equal real roots? **[3]**

---

7. A sequence begins; 1000, 996, 992, 988, 984, 980, 976,...,
   a) What kind of sequence is this? **[1]**
   b) Work out an expression for the nth term. **[2]**
   c) Let $u_n$ be the nth term, and find n such that $u_n = 200$. Hence calculate the sum of the terms up to and including the term 200. **[4]**

   Let $s_n$ be the sum of the first n terms.
   d) What is the smallest number of terms needed such that the inequality $s_n < 0$ is satisfied. **[3]**

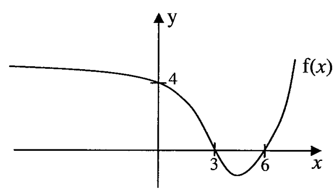
---

8. Two lines are $y = 2x + 3$ and $y = 4x^2 - 1$.
   a) Calculate the exact co-ordinates of where the two lines cross. **[4]**
   b) Calculate the gradient function of each line. **[2]**
   c) Calculate the equation of the tangent to $y = 4x^2 - 1$ when $x = 3$ **[3]**

---

9. Sketch separately the following graphs:
   a) $f(x) + 1$ b) $f(x + 1)$ **[1,2]**
   c) $-f(x)$ d) $-f(-x)$ **[2,2]**

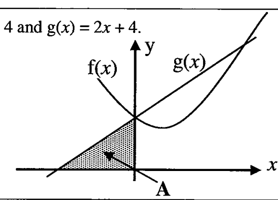
   If the *exact values are known*, then write on where each graph crosses the *x and y-axis*.
   The minimum point of f(x) is (4.3, –1.2).
   e) The curve g(x) is a translation of f(x) such the minimum point of g(x) is (0, –1.2). Find g(x) in terms of f(x). **[2]**




   y = f(x) crosses the y-axis at y = 4 and has a minimum point with coordinates (4.3, –1.2).
   f) Calculate the corresponding y-intercept and coordinates of the minimum point for the curve y = f(3x). **[2]**

---

10. In the diagram shown is a sketch of f(x) and g(x) where $f(x) = x^2 - x + 4$ and $g(x) = 2x + 4$.
    The two lines intersect when $x = 0$ and when $x = 3$.
    a) Find the area **A**. **[2]**
    b) Solve the inequality $x^2 - x + 4 > 2x + 4$ **[2]**
    c) Calculate the equation of the normal to f(x) when $x = 3$. **[6]**
    d) Write f(x) in the form $(x + b)^2 + c$. **[3]**
    e) Without using calculus, and giving a reason, state the minimum value of f(x). **[3]**
    f) State the coordinates of this minimum value. **[1]**

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**[75]**

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|---|---|
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| Time Allowed:-1 hour 30 minutes | |

1. $\sqrt{\frac{2}{5}} = \frac{\sqrt{a}}{5}$ where $a$ is an integer. Find $a$. **[2]**

---

2. Given that $\sum_{1}^{100} r = 5050$, calculate $\sum_{1}^{100} (5+2r)$. **[3]**

---

3. Defining a, n and d, prove that sum of the first n terms of an arithmetic progression is: $^{n}/_{2}[2a+(n-1)d]$ **[4]**

---

4. a) $\sqrt{\frac{1}{3}} = a\sqrt{b}$ where a is rational and b is an integer. Find a and b. **[3]**

   b) Simplify the expression: $(2\sqrt{3} + 2y)(\sqrt{3} - y)$ **[2]**

---

5. Calculate a) $\int \frac{x^5}{6} dx$ b) $\int x(x^{-\frac{1}{2}} - x^{\frac{1}{2}})dx$ **[5]**

---

6. A straight line $L_1$ has equation $y = 2x - 4$. A straight line $L_2$ has equation $2y = 42 - x$.
   a) Sketch these 2 lines, and indicate where they cross the $x$ and y-axes. **[4]**
   b) Prove that lines $L_1$ and $L_2$ are perpendicular. **[1]**
   c) Find the coordinates of where the 2 lines cross. **[3]**
   d) Calculate the area between the 2 lines and the $x$-axis. **[2]**

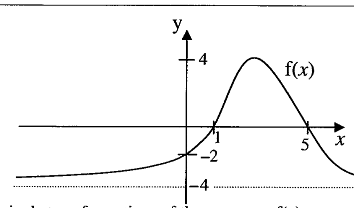
---

7. a) Solve the equation $f(x) = 0$ where $f(x) = (x + 1)(x + 2)(x + 3)$ **[2]**
   b) Calculate the discriminant of the quadratic $x^2 + 6x + 11$. **[2]**
   c) Solve the equation $f(x) - 6 = 0$ where $f(x) = (x + 1)(x + 2)(x + 3)$ **[3]**

---

8. $f(x)$ shown, has a maximum value of 4, and has a horizontal asymptote of $y = -4$ as shown.
   The graph cuts the $x$-axis at 1 and 5 and cuts the y-axis at $-2$.
   Sketch separately the following graphs:
   a) $2f(x)$ **[2]**
   b) $f(x+2)$ **[2]**
   c) $f(-x)$ **[2]**

   *If the exact values are known, then write on where each graph crosses the x and y-axis. In each graph indicate known maximum/minimum values and clearly indicate any asymptotes.*



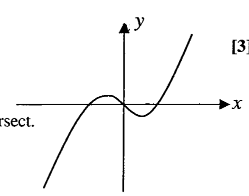

   Two curves $y = g(x)$ and $y = h(x)$ are drawn. Both curves are single transformations of the curve $y = f(x)$.
   One of the new curves has coordinates $(0, -10)$, $(1, 0)$ and $(5, 0)$ and the other has coordinates $(2, 0)$ and $(6, 0)$.
   d) Calculate *g(x) and h(x)* and state the equation of the asymptote in each case. **[6]**

---

9. The curve C has equation $y = f(x)$ with $x \neq 0$ and the point $(a, b)$ lies on the line.
   Given that $f'(x) = x^2 + x^{-2}$
   a) Find $f(x)$ giving your answer in terms of the unknowns $a$ and $b$. **[6]**
   b) Given also that the point $(2a, 2b)$ lies on the line find $b$ in terms on $a$. **[4]**

---

10. In the diagram shown, $f(x) = x^3 - 3x$




a) Solve the equation $f(x) = 0$ **[3]**
   b) Given that $g(x)=\frac{4}{x}$ show that $g(x) = f(x)$ when $x = 2$ or $-2$. **[2]**
   c) i) Sketch $f(x)$ and $g(x)$ using the same pair of axes. **[2]**
      ii) State the coordinates where the graphs of $f(x)$ and $g(x)$ intersect. **[1]**
   d) Find $h(x)$ where $h(x)$ is the normal to $f(x)$ when $x = 3$ **[6]**
   e) Solve the inequality $i(x) < j(x)$ where $i(x) = x + 2$ and $j(x) = x^2$ **[3]**

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**[75]**

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| Time Allowed:-1 hour 30 minutes | |

1. a) Given that $\sum_{1}^{100} r = 5050$ Calculate *a)* $\sum_{5}^{100} r$ *b)* $\sum_{5}^{100} (1+r)$ **[4]**

---

2. a) Express $\sqrt{72}$ in the form $6\sqrt{a}$ where $a$ is an integer. **[1]**
   b) Express $(\sqrt{5}+b)^2 - b^2$ in the form $c + d\sqrt{5}$, where $c$ and $d$ are integers, given that $b$ is an integer. **[3]**

---

3. Solve the following simultaneous equations, leaving your final answers in surd form.
   $(x + y\sqrt{3})^2 = 9$ and $y = x\sqrt{6}$ *Rationalise the denominators in your answers where appropriate.* **[6]**

---

4. Solve the inequalities:
   a) $-2 < 3x + 2 < 2$ **[2]**
   b) $-x^2 + 10 > 0$ **[4]**

---

5. An arithmetic sequence begins 10, 15, 20, 25, …
   a) Find the 100th term of the sequence. **[1]**
   b) Find the sum of the first 100 terms. **[2]**
   A 2nd arithmetic sequence begins 6, $x$, $3x$, ...
   c) Find $x$ and the first four terms of the sequence. **[3]**

---

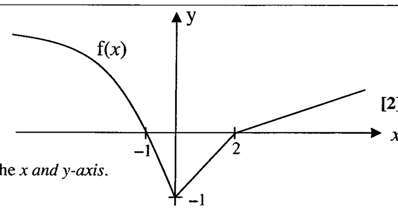
6. Calculate a) $\int x^3 dx$ b) $\int (3x\sqrt{x})dx$ c) $\int \frac{3(x^2-2x)}{x}dx$ **[7]**

---

7. The three points ABC make a triangle where A(1, 3), B(2, 6) and C(3, 8).
   a) Find the equation of the straight line that passes through A and B. **[4]**
   b) Find the equation of the straight line that passes through B and is perpendicular to AC. **[4]**

---

8. Sketch separately the following graphs:
   a) $-f(x)$ **[2]**
   b) $f(-x)$ **[2]**
   c) $5f(x)$ **[2]**
   d) $f\left(\frac{x}{2}\right)$ **[2]**
   In each case write down where each graph crosses the *x and y-axis*.




   The graph is redrawn shifted up by one unit so that the point (–1,0) is now on the origin.
   e) Write down the equation of the new graph in terms of f($x$) **[1]**

---

9. The equation $x^2 + kx + 9 = 0$ has just 1 real solution.
   a) State the possible values of k **[3]**
   The equation $x^2 + jx + 9 = 0$ has 2 real distinct solutions.
   b) State the possible values of $j$. **[3]**
   The equation $ax^2 + bx + c = 0$ has no real roots.
   c) i) What does this mean graphically for a > 0. Draw a graph to aid your explanation. **[2]**
   ii) Adjust your graph and explanation for values of a < 0. **[1]**
   iii) Given a = 2.25, b = 3 c = $\frac{d}{100}$ where d is an integer. Find the smallest possible value of d. **[2]**

---

10. a) Write f($x$) in the form $(x + a)^2 + b$ where $f(x) = x^2 + 3x + 9$ and $x \in \mathbb{R}$ **[3]**
   b) Hence calculate the equation for the line of symmetry for the graph of y = f($x$). **[3]**
   c) What is the maximum value of the function g($x$), where $g(x) = \frac{1}{f(x)}$. **[3]**
   The curve C has equation y = f($x$)
   d) Show that the point (3, 27) lies on the curve. **[1]**
   e) Find the equation of the tangent to the curve C at the point (3, 27). **[4]**

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**[75]**

| Sample Markscheme 1 | Matching the syllabus written by EDEXCEL Curriculum 2004+ |
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1. $(4x-2)^2 = 1 \quad \Rightarrow 4x - 2 = \pm 1$ M1

$\Rightarrow 4x = 2 \pm 1$

So $x = \frac{2 \pm 1}{4} = \frac{3}{4}$ or $\frac{1}{4}$ A1A1(3)

---

2. a) $\int 4x^3 dx = x^4$ **(+ C)** A1

b) $\int x^{\frac{1}{2}} - x^{-\frac{1}{2}} dx = \frac{2}{3}x^{\frac{3}{2}} - 2x^{\frac{1}{2}}$ **+ C** A1A1**B1**

(4)

---

3. a) Multiply by $\frac{\sqrt{3}}{\sqrt{3}}$ M1

Obtain a = $\frac{2}{3}$ A1

b = 3 A1 (3)

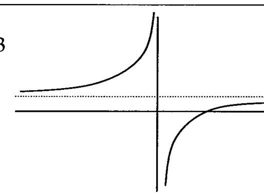
b) Attempt to multiply brackets M1

Cancel to obtain answer $2 - y^2$ A1 (2)

---

4. a) Curve sketch with asymptote at y = 3 M2

Show that the curve crosses the $x$-axis at $x = 4/3$ A1 (3)



b) Asymptotes are:

$x = 0$ (or y-axis) A1

y = 3 A1 (2)

---

5. a) $x_2 = 1^2 + 1 = 2$

$x_3 = 2^2 + 2 = 6$

$x_4 = 6^2 + 6 = 42$ M1A1(2)

b) $x_2 - x_1 = 2 - 1 = 1$

$x_3 - x_2 = 6 - 2 = 4$

Not common difference so not an Arithmetic progression. A1 (1)

c) i) $f(x_n) = x_n + 3$ A1 (1)

ii) $S_n = \frac{n}{2}(2a + (n-1)d)$

$n = 62$, a = 5 and d = 3

$S_n = \frac{62}{2}(2 \times 5 + (62 - 1) \times 3) = 5983$ M1A1(2)

iii) $x_{n+5} - x_n = 5d = 15$ A1 ft (1)

---

6. a) $\frac{dy}{dx} = 3x^2$. A1 (1)

b) $x = 4$, $y = 4^3 = 64$

| | | | |
|---|---|---|---|
| | | $x = 4$, gradient $= \frac{dy}{dx} = 3x^2 = 3 \times 4^2 = 48$ | M1A1 |
| | | $y = mx + c$ | |
| | | $y = 48x + c$ | |
| | | Substitute in (4, 64) $\rightarrow 64 = 48 \times 4 + c$ | M1 |
| | | Rearranging gives $c = -128$. | |
| | | Therefore $y = 48x - 128$ | A1 (4) |
| | c) | $\frac{dy}{dx} = -\frac{1}{2}x^{-\frac{1}{2}}$ | A1 (1) |
| | d) | $x = 4, y = -2$ | |
| | | $x = 4$, gradient $= \frac{dy}{dx} = -\frac{1}{2}x^{-\frac{1}{2}} = -\frac{1}{2} \times (4)^{-\frac{1}{2}} = -\frac{1}{4}$ | M1A1 |
| | | Gradient of normal = 4 | A1 ft |
| | | Therefore $y = 4x + c$ | |
| | | Substitute in (4, –2) $\rightarrow -2 = 4 \times 4 + c$ | |
| | | Rearranging gives $c = -18$ | M1 |
| | | Therefore $y = 4x - 18$ | A1 (5) |
| 7. | a) | Equate 'y's: $2x - 3 = Ax + B$ | M1 |
| | | Simplify to obtain $x = \frac{B+3}{2-A}$ | A1 (2) |
| | b) | Rearrange to $x = \frac{y+3}{2}$ and $x = \frac{y-B}{A}$ | M1 |
| | | Equate '$x$'s | M1 |
| | | Obtain $y = \frac{3A+2B}{2-A}$ | A1 (3) |
| | c) | Substitute $x = 4$ into result from a) | M1 ft |
| | | Rearrange to obtain $A = \frac{5-B}{4}$ | A1 (2) |
| | d) | $m_1m_2 = -1 \therefore 2A = -1 \; A = -\frac{1}{2}$ | A1 |
| | | Substitute into result from c) and rearrange | M1 ft |
| | | Obtain B = 7 | A1 (3) |
| 8. | a) | Equate f($x$) and g($x$) to give $x^2 = 3x + 4$ | M1 |
| | | Attempt to solve using quadratic formula | |
| | | Obtain $x = -1$ and 4 | A1 |
| | | Substitute $x$ values to obtain y values | |
| | | $\therefore$ coordinates (–1, 1) and (4, 16) | A1 (3) |
| | b) | g($x$) has gradient = 3 | |
| | | Therefore h($x$) has gradient $= -\frac{1}{3}$ | A1 |
| | | Therefore $h(x) = -\frac{1}{3}x + c$ | |
| | | $f'(x) = 2x$ | M1 |
| | | Set $f'(x) = -\frac{1}{3}$. | M1 |
| | | Therefore $2x = -\frac{1}{3}$. | |
| | | Rearranging gives $x = -\frac{1}{6}$ | A1 |
| | | When $x = -\frac{1}{6}$, $f\left(-\frac{1}{6}\right) = \left(-\frac{1}{6}\right)^2 = \frac{1}{36}$ | M1 |

Substitute in $\left(-\frac{1}{6}, \frac{1}{36}\right)$ into $h(x) = -\frac{1}{3}x + c$ M1

$\frac{1}{36} = \frac{1}{3} \times \frac{1}{6} + c$

Rearranging gives $c = -\frac{1}{36}$

Therefore $h(x) = -\frac{x}{3} - \frac{1}{36}$ A1 (7)

---

9. a) $y = x^2 + 5$ A1
$y = (x + 2)^2$ A1 (2)
b) i) $f(x) = (x - 7)^2 - 7^2 + 16$ A1A1(2)
$= (x - 7)^2 - 33$
ii) Minimum value of $f(x)$ occurs at $x = 7$ A1
Minimum value of $f(x)$ is $-33$ A2 (3)
iii) *Translation left 7 units*, **up 33 units** *A1*A1(2)

---

10. a) Substitute $y = x + 2$ into $4y + 3x^2 = 7$ M1
$4(x + 2) + 3x^2 = 7$
Expand brackets and rearrange.
$3x^2 + 4x + 1 = 0$
Solve to find:
$x = -1$ and $-\frac{1}{3}$
Find corresponding values of y from $y = x + 2$ M1
$y = 1$ and $\frac{5}{3}$

Solutions are $(-1, 1)$ and $\left(-\frac{1}{3}, \frac{5}{3}\right)$. A1A1(4)

b) Gradient = 3 $\therefore f(x) = 3x + k$ A1
Substitute $y = x + k$ into $4y + 3x^2 = 7$ M1
$4(3x + k) + 3x^2 = 7$
Expand brackets and rearrange.
$3x^2 + 12x + (4k - 7) = 0$
Crosses axis once $\therefore b^2 - 4ac = 0 \therefore 144 - 48k + 84 = 0$ M1
$\therefore k = \frac{19}{4}$
$\therefore f(x) = 3x + \frac{19}{4}$ A1

c) Substitute $y = f(x)$ into $4y + 3x^2 = 7$
$\therefore 3x^2 + 12x + (4 \times \frac{19}{4} - 7) = 0$ M1
$\therefore 3x^2 + 12x + 12 = 0$
Solve to find $x = -2$ A1
Substitute $y = 3 \times -2 + \frac{19}{4} = -\frac{5}{4}$
$\therefore$ Coordinates are $(-2, -\frac{5}{4})$ A1 (7)

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(75)

| Sample Markscheme 2 | Matching the syllabus written by EDEXCEL Curriculum 2004+ |
|---|---|
| No Calculators | |
|  | Core Mathematics – C1 |

1. Rearrange to get $-x^2 + x + 12 > 0$ or $x^2 - x - 12 < 0$ — M1
Factorise LHS to get $(x + 3)(x - 4)$ — M1
Sketch graph of $y = x^2 - x - 12$
Answer $-3 < x < 4$ — A1 **(3)**

---

2. a) $\int x^5 dx = \frac{x^6}{6}$ (+ **C**) — A1

b) $\int \frac{1-2x^2}{x^2} dx = \int (x^{-2} - 2) dx$ — M1
$= -x^{-1} - 2x + \mathbf{C}$ — A1**A1**(4)

---

3. Substitute $y = 2x$ to give $(x + 2x\sqrt{2})^2 = 27 + 12\sqrt{2}$ — M1
Take out factor of $x^2$ and simplify to give $x^2(9 + 4\sqrt{2}) = 27 + 12\sqrt{2}$ — M1
Obtain answer $x = \sqrt{3}$ or $-\sqrt{3}$ — A1 either
Substitute $x$ value in $y = 2x$ to obtain $y = 2\sqrt{3}$ or $y = -2\sqrt{3}$ — A1
Paired solutions so, $x = \sqrt{3}$ and $y = 2\sqrt{3}$ or $x = -\sqrt{3}$ and $y = -2\sqrt{3}$ — A1 both & paired (5)

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4. a) $\sqrt{44} = \sqrt{4 \times 11} = 2\sqrt{11}$ — A1A1(2)

b) i) $\frac{6 + 2\sqrt{6}\sqrt{8} + 8 - 14}{\sqrt{12}}$ — M1

$= \frac{2\sqrt{48}}{\sqrt{12}} = 2\sqrt{4} = 4$ — A1

ii) $\frac{(\sqrt{x})^3}{x} = \frac{x^{\frac{1}{2}\times 3}}{x}$ — M1

$= x^{\frac{3}{2}-1} = x^{\frac{1}{2}}$ — A1

iii) $\frac{2}{4-\sqrt{3}} \times \frac{4+\sqrt{3}}{4+\sqrt{3}}$ — M1

$= \frac{2(4+\sqrt{3})}{16-3} = \frac{8+2\sqrt{3}}{13}$ — A1 (6)

---

5. a) Use formula $u_n = a + (n - 1)d$ — M1
Substitute $a = 10$, $d = 2$
$u_n = 10 + 2(n - 1)$
$= 2n + 8$ — A1 (2)

b) Use formula $S_n = \frac{1}{2}n(2a + (n - 1)d)$ — M1
Substituting $a = 10$, $d = 2$
$S_n = \frac{1}{2}n(20 + 2(n - 1))$
$S_n = n^2 + 9n$ — A1 (2)

c) Use $S_n = \frac{1}{2}n(2a + (n - 1)d)$ with $d = 2$, $a = 10$ (for 1st sequence)
and $a = 2$ (for 2nd sequence)
$S_n = n^2 + 9n$ — M1
$T_n = n^2 + n$ — M1
$S_n - T_n = 8n$ — A1 (3)

| | | | |
|---|---|---|---|
| 6. | a) | Factorise to $(x+2)(x-5)$ or use quadratic formula<br>Obtain solutions $x=-2$, $x=5$ | M1<br>A1 (2) |
| | b) | n-shape curve<br>$x$-intercepts $=-2, 5$<br>y-intercept = 10 | A1<br>A1<br>A1 (3) |
| | c) | Attempt to substitute $(x+1)$ for $x$ i.e. $-(x+1)^2+3(x+1)+10$<br>Simplify to obtain answer $f(x+1)=-x^2+x+12$<br>$g(x)$ drawn shifted 1 unit to the left (cuts $x$-axis at $-3$ and 4) | M1<br>A1<br>A1 (3) |
| | d) | Use $\sqrt{b^2-4ac}$<br>Substitute coefficients to obtain $\sqrt{9+4A}$<br>i.e. $-x^2+3x+A=0$ has two distinct roots when $\sqrt{9+4A}>0$ $\therefore$ when $A>-\frac{9}{4}$. | M1<br>M1<br>A1 (3) |
| 7. | a) | Use Pythagoras theorem<br>$AB=\sqrt{4^2+3^2}=\sqrt{25}=5$ | M1<br>A1 (2) |
| | b) | Gradient $=\frac{\Delta y}{\Delta x}=\frac{8-6}{6-5}=2$<br>Therefore $y=2x+c$<br>Substitute in (5, 6)<br>Therefore $y=6=2\times 5+c$<br>Rearranging gives $c=-4$<br>Therefore $y=2x-4$ | M1A1<br><br>M1<br><br><br>A1 (4) |
| | c) | $m_1m_2=-1$ $2m_2=-1$ $\therefore$ $m_2=-\frac{1}{2}$<br>$y=-\frac{1}{2}x+c$<br>Substitute (6, 8) to find $c=11$ and hence $y=-\frac{1}{2}x+11$ | M1<br><br>A1 (2) |
| 8. | a) | Translated in y direction by +1 unit, crosses y-axis at $y=2$ | M1A1(2) |
| | b) | Translated in $x$ direction by $-2$ units, touches origin (0,0) and $x$-axis at $x=1$ | M1A1(2) |
| | c) | Reflected in $x$-axis, crosses y-axis at $y=-1$ and touches $x$-axis at $x=2$ and $x=3$ | M1A1(2) |
| | d) | Reflected in y-axis, crosses y-axis at $y=1$ and touches $x$-axis at $x=-3$ and $x=-2$ | M1A1(2) |
| 9. | a) | $f'(x)=x^3-2x^{-3}$ | A1A1(2) |
| | b) | $f'(2)=8-\frac{1}{4}=\frac{31}{4}$<br>Therefore $y=\frac{31}{4}x+c$<br>When $x=2$, $y=4+\frac{1}{4}=\frac{17}{4}$<br>Substitute in $\left(2,\frac{17}{4}\right)\rightarrow\frac{17}{4}=\frac{31}{4}\times 2+c$<br>Rearranging gives $c=\frac{17}{4}-\frac{62}{4}=-\frac{45}{4}$<br>Therefore $y=\frac{31}{4}x-\frac{45}{4}$. | M1<br><br><br>M1<br><br>A1 (3) |

| | | | |
|---|---|---|---|
| | c) | $x^3 - \frac{2}{x^3} = 1$ | M1 |
| | | Therefore $x^6 - 2 = x^3$ | |
| | | Therefore $x^6 - x^3 - 2 = 0$ | |
| | | $(x^3 - 2)(x^3 + 1) = 0$ | M1 |
| | | Therefore $x^3 = 2$ or $x^3 = -1$ | |
| | | Therefore $x = \sqrt[3]{2}$ or $x = -1$ | A1A1(4) |
| 10. | a) | $g(x) = 2 \times (2x)^2 - 12 \times (2x) + 6$ | M1 |
| | | $= 8x^2 - 24x + 6$ | A1 |
| | | $f(x)$ is a stretch in the horizontal scale factor $\times 0.5$ of $g(x)$ | A1(3) |
| | b) | $f(x) = 2(x^2 - 6x + 3)$ | M1 |
| | | $= 2[(x-3)^2 - 3^2 + 3] = 2(x-3)^2 - 12$ | A1A1(3) |
| | c) | Minimum point is $(3, -12)$ | A1A1(2) |
| | d) | $f_2(x) = -f(x)$ | M1 |
| | | $= -2x^2 + 12x - 6$ | A1 |
| | | $f_3(x) = f(-x)$ | M1 |
| | | $= 2x^2 + 12x + 6$ | A1 (4) |

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| Sample Markscheme 3 | Matching the syllabus written by EDEXCEL Curriculum 2004+ |
|---|---|
| No Calculators | |
|  | Core Mathematics – C1 |

1\. a) $u_1 = 1 + 2^1 = 3$, $u_2 = 5$, $u_3 = 9$, $u_4 = 17$, $u_5 = 33$ A1
Show non constant difference (e.g. $u_2 - u_1 \neq u_3 - u_2$) $\therefore$ sequence not arithmetic A1 (2)

b) Deduce $u_{n+1} = 1 + 2^{n+1}$ M1
$\therefore u_{n+1} - u_n = 1 + 2^{n+1} - (1 + 2^n)$
Factorise to give $2^n(2^1 - 1) = 2^n$ A1 (2)

---

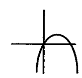
2\. $\dfrac{10}{\sqrt{200}} = \dfrac{10}{10\sqrt{2}}$ M1

$= \dfrac{1}{\sqrt{2}} \times \dfrac{\sqrt{2}}{\sqrt{2}}$ M1

$= \dfrac{\sqrt{2}}{2}$ A1 (3)

---

3\. $x(2 - x) > 0$ M1



*(by considering graph or otherwise, may be implied)* M1

$0 < x < 2$ A1A1(4)

---

4\. $a = \left(\dfrac{27}{64}\right)^{-\frac{2}{3}} = \left(\dfrac{64}{27}\right)^{\frac{2}{3}}$ M1

$= \left(\sqrt[3]{\dfrac{64}{27}}\right)^2$ M1

$= \left(\dfrac{4}{3}\right)^2 = \dfrac{16}{9}$ A1 (3)

$b = \left(16 \times 4^2\right)^{\frac{1}{4}}$ M1

$= \left(4^2 \times 4^2\right)^{\frac{1}{4}}$ M1

$= \left(4^4\right)^{\frac{1}{4}} = 4$ A1 (3)

---

5\. a) $\int \frac{2x^5}{5} dx = \dfrac{x^6}{15} + c$ A1 (1)

b) $\int x(x - x^2)dx = \int (x^2 - x^3)\,dx$ M1

$= \dfrac{x^3}{3} - \dfrac{x^4}{4} + c$ A1A1(3)

---

6\. a) $3x^2 + x = 10$

Divide by 3 to give $x^2 + \dfrac{x}{3} = \dfrac{10}{3}$ M1

$\left(x + \dfrac{1}{6}\right)^2 - \dfrac{1}{36} = \dfrac{10}{3}$ M1

| | | | |
|---|---|---|---|
| | | $x+\frac{1}{6}=\sqrt{\frac{121}{36}}=\pm\frac{11}{6}$ | M1 either |
| | | $\therefore x=\frac{5}{3}$ or $-2$ | A1 both (4) |
| | b) | Use $b^2-4ac$ | M1 |
| | | Substitute coefficients to obtain $1-12A$ | M1 |
| | | i.e. $-x^2+3x+A=0$ has two equal roots when $1-12A=0$ $\therefore$ when $A=\frac{1}{12}$ | A1 (3) |
| 7. | a) | Arithmetic | A1 (1) |
| | b) | Use formula $u_n=a+(n-1)d$ | M1 |
| | | Substitute $a=1000$, $d=-4$ | |
| | | $u_n=1000-4(n-1)$ | |
| | | $=1004-4n$ | A1 (2) |
| | c) | Substitute $u_n=200$, into result from b) | M1 ft |
| | | Obtain $n=201$ (i.e. 200 is the 201st term) | A1 |
| | | Use formula $S_n=\frac{1}{2}n(2a+(n-1)d)$ | M1 |
| | | Substitute $n=201$, $a=1000$, $d=-4$ | |
| | | i.e. $S_n=\frac{1}{2}\times 201\times(2\times 1000+200\times -4)$ | |
| | | $\therefore$ $S_n=120600$ | A1 (4) |
| | d) | $S_n=0$ when $2a=-(n-1)d$ | M1 |
| | | Substitute $a=1000$, $d=-4$ | |
| | | i.e. $2\times 1000=4(n-1)$ | |
| | | $2000=4n-4$ | |
| | | $\therefore$ $n=501$ and hence $S_{501}=0$ | M1 |
| | | $\therefore$ Smallest number of terms for $S_n<0$ is 502 | A1 (3) |
| 8. | a) | Equate 'y's: $2x+3=4x^2-1$ | M1 |
| | | Simplify to quadratic $4x^2-2x-4=0$ and use quadratic formula | M1 |
| | | Obtain $x=\frac{2\pm\sqrt{68}}{8}$ or $x=\frac{1\pm\sqrt{17}}{4}$. | A1 |
| | | Substitute $x$ values into either line equation to give y values $\frac{7\pm\sqrt{17}}{2}$ | |
| | | and hence coordinates $(\frac{1+\sqrt{17}}{4},\frac{7+\sqrt{17}}{2})$ and $(\frac{1-\sqrt{17}}{4},\frac{7-\sqrt{17}}{2})$ | A1 (4) |
| | b) | For $y=2x+3$, $\frac{dy}{dx}=2$ | A1 |
| | | For $y=4x^2-1$, $\frac{dy}{dx}=8x$ | A1 (2) |
| | c) | Substitute $x=3$ into $\frac{dy}{dx}=8x$ to find gradient of tangent i.e. $y=24x+c$ | M1 |
| | | Substitute $x=3$ into $y=4x^2-1$ to find $y=35$ at this point | M1 |
| | | Substitute (3, 35) to find $c=-37$ and hence equation $y=24x-37$ | A1 (3) |
| 9. | a) | $f(x)$ translated on the y-axis by +1, crosses axes at $y=5$ | *A1* (1) |
| | b) | $f(x)$ translated on the $x$-axis by $-1$, crosses axes at $x=2$ and $x=5$ | M1*A1*(2) |
| | c) | $f(x)$ mirrored in the $x$-axis, crosses axes at $x=3$, $x=6$, $y=-4$ | M1*A1*(2) |
| | d) | Reflect $f(x)$ in y-axis and in $x$-axis, crosses axes at $x=-3$, $x=-6$, $y=-4$ | M1*A1*(2) |
| | e) | $g(x)=f(x+4.3)$ | A2 (2) |
| | f) | y-intercept = 4 | A1 |

$(4.3, -1.2 \times 3) = (4.3, -3.6)$ *A1* (2)

---

10. a) Substitute $x = 0$ into either line equation to give coordinates of intersection (0, 4) M1
or substitute y = 0 to show $g(x)$ cuts $x$-axis at (–2, 0).

Hence area of triangle $= \frac{1}{2} \times 2 \times 4 = 4$ units$^2$ A1 (2)

b) $x^2 - 3x > 0$
$x(x - 3) > 0$ M1
Either $x < 0$ or $x > 3$ A1 (2)

c) $f'(x) = 2x - 1$ A1
$f'(3) = 6 - 1 = 5$ M1A1

$y = -\frac{x}{5} + c$ M1

When $x = 3$, $f(x) = 9 - 3 + 4 = 10$

Substitute in (3, 10) $\rightarrow 10 = -\frac{3}{5} + c$ M1

Rearranging gives $c = \frac{53}{5}$

Therefore $y = -\frac{x}{5} + \frac{53}{5}$ A1 (6)

d) Completing the square, $f(x) = \left(x - \frac{1}{2}\right)^2 - \left(-\frac{1}{2}\right)^2 + 4$ i.e. $b = -\frac{1}{2}$ A1M1

$c = \frac{15}{4}$ A1 (3)

e) Since $(x + b)^2$ is always positive, the minimum value occurs when $x = -b$ M1
And hence $(x + b)^2 = 0$ M1

$\therefore$ minimum value $= c = \frac{15}{4}$ A1 (3)

f) The minimum occurs at (–b, c)

Minimum occurs at $\left(\frac{1}{2}, \frac{15}{4}\right)$ A1 (1)

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| Sample Markscheme 4 | Matching the syllabus written by EDEXCEL Curriculum 2004+ |
|---|---|
| No Calculators | |
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1. $\sqrt{\frac{2}{5}} \times \frac{\sqrt{5}}{\sqrt{5}} = \frac{\sqrt{10}}{5}$ M1

a = 10 A1 (2)

---

2. $\sum_{1}^{100}(5+2r) = \sum_{1}^{100}5 + 2\sum_{1}^{100}r$ M1

$= 500 + 2 \times 5050$ A1

$= 500 + 10100$

$= 10600$ A1 (3)

---

3. Define: a = first term, d = common difference, $n^{th}$ term is last term of summation M1

Correct proof A3 (4)

---

4. a) Multiply by $\frac{\sqrt{3}}{\sqrt{3}}$ M1

Obtain $a = \frac{1}{3}$ A1

$b = 3$ A1 (3)

b) Attempt to multiply brackets M1

Cancel to obtain answer $6 - 2y^2$ A1 (2)

---

5. a) $\int \frac{x^5}{6}dx = \frac{x^6}{36}$ (+ **C**) A1 (1)

b) $\int x(x^{-\frac{1}{2}} - x^{\frac{1}{2}})dx = \int x^{\frac{1}{2}} - x^{\frac{3}{2}}\,dx$ M1

$= \frac{2}{3}x^{\frac{3}{2}} - \frac{2}{5}x^{\frac{5}{2}} + \mathbf{C}$ A1A1**A1** (4)

---

6. a) Correct sketch showing:

$L_1$ crosses $x$-axis at 2 and y-axis at –4 A1A1

$L_2$ crosses $x$-axis at 42 and y-axis at 21 A1A1(4)

b) $m_1m_2 = -1$ $m_1 = 2$ and $m_2 = -\frac{1}{2}$, $2 \times -\frac{1}{2} = -1$ ∴ Perpendicular A1 (1)

c) Equate 'y's: $2x - 4 = 21 - \frac{x}{2}$ M1

Rearrange to find $x = 10$ A1

Substitute $x = 10$ into either line equation to find y = 16

and hence coordinates (10, 16) A1 (3)

d) Use Area = $\frac{1}{2}$ × base × height

where base length is $x$-axis 42 – 2 = 40 and height = 16 M1

∴ Area = $\frac{1}{2} \times 40 \times 16 = 320$ units$^2$ A1 (2)

---

7. a) $(x + 1) = 0$, $(x + 2) = 0$ or $(x + 3) = 0$ M1

Hence $x = -1, -2, -3$ A1 (2)

b) Substitute a = 1, b = 6, c = 11 into $b^2 - 4ac$ M1

Obtain result $-8$ A1 (2)

c) Multiply out $f(x) = (x + 1)(x + 2)(x + 3)$

$= (x + 1)(x^2 + 5x + 6)$

$= x^3 + 6x^2 + 11x + 6$ M1

$\therefore f(x) - 6 = x^3 + 6x^2 + 11x$

$\therefore f(x) - 6 = x(x^2 + 6x + 11)$ M1

Since $x^2 + 6x + 11 = 0$ has no real solutions, $x = 0$ A1 (3)

---

8. a) Stretch $\times 2$ along the y-axis. Min/max values + asymptotes = A1

Maximum at y = 8. cuts/touches axis' shown = A1

Cuts $x$-axis at 1 and 5.

Cuts y-axis at y = –4

Asymptote at y = –8 (2)

b) Shift 2 units to the left. Min/max values + asymptotes = A1

Maximum at y = 4 cuts/touches axis' shown = A1

Cuts $x$-axis at –1 and 3.

Not known where graph cuts y-axis

Asymptote at y = –4 (2)

c) Reflect in the y-axis. Min/max values + asymptotes = A1

Maximum at y = 4. cuts/touches axis' shown = A1

Cuts $x$-axis at –1 and –5.

Cuts y-axis at y = –2

Asymptote at y = –4 (2)

d) $g(x) = 5f(x)$ M1A1

Asymptote: y = –20 A1

$h(x) = f(x - 1)$ M1A1

Asymptote: y = –4 A1 (6)

---

9. a) $f(x) = \int x^2 + x^{-2}\,dx$ M1

$= \frac{x^3}{3} - x^{-1} + c$ A1A1B1

Substitute in (a, b) $\rightarrow$ b = $\frac{a^3}{3} - a^{-1} + c$ M1

Therefore c = b + $a^{-1} - \frac{a^3}{3}$ A1 (6)

b) Substitute in (2a, 2b) $\rightarrow$ 2b = $\frac{(2a)^3}{3} - (2a)^{-1} + b + a^{-1} - \frac{a^3}{3}$ M1M1

Therefore b = $\frac{7a^3}{3} + \frac{1}{2a}$ A2 (4)

---

10. a) $x^3 - 3x = 0 \therefore x(x^2 - 3) = 0$ M1

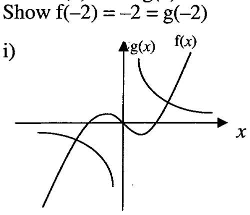
Hence $x = 0$ or $x^2 - 3 = 0$ A1 for x=0

Obtain $x = \pm\sqrt{3}$ A1 (3)

b) Show f(2) = 2 = g(2) A1

Show f(–2) = –2 = g(–2) A1 (2)

c) i) M1A1(2)



ii) Substitute $x$=2 into either f($x$) or g($x$) and obtain coordinates (2,2) and (–2,–2) A1 (1)

d) $f'(x) = 3x^2 - 3$ A1A1

$f'(3) = 3 \times 3^2 - 3 = 24$ M1

$f(3) = 3^3 - 3 \times 3 = 18$

Gradient of normal = $-\dfrac{1}{24}$ M1

Therefore h($x$) = $-\dfrac{x}{24} + \text{c}$

Substitute in (3, 18) $\rightarrow$ 18 = $-\dfrac{3}{24} + \text{c}$ M1

Rearrange to give c = $18\dfrac{3}{24}$ or $18\dfrac{1}{8}$

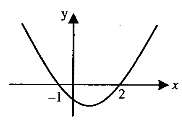
Therefore h($x$) = $-\dfrac{x}{24} + 18\dfrac{3}{24}$ A1 (6)

e) $i(x) < j(x) \therefore j(x) - i(x) < 0$ M1

$\therefore x^2 - x - 2 < 0$

$\therefore (x-2)(x+1) < 0$ A1

$\therefore x < -1$ or $x > 2$ A1 (3)

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| Sample Markscheme 5 | Matching the syllabus written by EDEXCEL Curriculum 2004+ |
|---|---|
| No Calculators | |
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1\. a) $\sum_{5}^{100} r = \sum_{1}^{100} r - \sum_{1}^{4} r$ M1

$= 5050 - (1 + 2 + 3 + 4)$

$= 5040$ A1 (2)

b) $\sum_{5}^{100}(1+r) = \sum_{5}^{100} 1 + \sum_{5}^{100} r$ M1

$= 96 + 5040$

$= 5136$ A1 (2)

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2\. a) $\sqrt{72} = \sqrt{2 \times 36} = 6\sqrt{2}$ A1 (1)

b) $(\sqrt{5} + b)^2 - b^2$

$= 5 + 2\sqrt{5}b + b^2 - b^2$ A1A1

$= 5 + 2b\sqrt{5}$

$\therefore c = 5,\ d = 2b$ A1 (3)

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3\. Substitute $y = x\sqrt{6}$ into $(x + y\sqrt{3})^2 = 9$ to obtain $(x + x\sqrt{18})^2 = 9$ M1

Square root both sides: $x + x\sqrt{18} = \pm 3$ M1

Factorise and divide to give $x = \frac{\pm 3}{1+\sqrt{18}} = \frac{\pm 3}{1+3\sqrt{2}}$ M1

Multiply positive answer by $\frac{1-3\sqrt{2}}{1-3\sqrt{2}}$ to give $\frac{3-9\sqrt{2}}{1-18} = \frac{9\sqrt{2}-3}{17}$ M1A1

And hence negative answer $\frac{3-9\sqrt{2}}{17}$ A1 (6)

$y = \frac{18\sqrt{3}-3\sqrt{6}}{17}$ or $\frac{3\sqrt{6}-18\sqrt{3}}{17}$

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4\. a) $-2 < 3x + 2 < 2$

$-4 < 3x < 0$ M1

$\therefore -\frac{4}{3} < x < 0$ A1 (2)

b) $-x^2 + 10 > 0$

$10 > x^2 \therefore x^2 < 10$ M1

Using graph or other method M1

$-\sqrt{10} < x < \sqrt{10}$ A1A1(4)

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5\. a) $n^{th}$ term $= a + (n - 1)d$

$100^{th}$ term $= 10 + (100 - 1) \times 5$

$= 10 + 500 - 5$

$= 505$ A1 (1)

b) $S_n = \frac{n}{2}(2a + (n - 1)d)$

$S_{100} = \frac{100}{2}(2 \times 10 + (100 - 1) \times 5)$

$= 50(20 + 500 - 5)$ M1

$= 50 \times 515$

$= 25750$ A1 (2)

c) $x - 6 = 3x - 3$ M1
$x - 6 = 2x$
$x = -6$ A1
6, –6, –18, –30 A1 (3)

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6. a) $\int x^3\,dx = \frac{x^4}{4} + c$ A1 (1)

b) $\int (3x\sqrt{x})\,dx = \int 3x^{\frac{3}{2}}\,dx$ M1

$= 3 \times \frac{2}{5}x^{\frac{5}{2}} + c$

$= \frac{6}{5}x^{\frac{5}{2}} + c$ A1 (2)

c) $\int \frac{3(x^2 - 2x)}{x}\,dx \quad = \int 3x - 6\,dx$ M1

$= 3\frac{x^2}{2} - 6x + c$ A1A1B1

(4)

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7. a) Gradient $= \frac{\Delta y}{\Delta x} = \frac{6-3}{2-1} = \frac{3}{1} = 3$ M1A1

Therefore $y = 3x + c$

Substitute in $(1, 3) \rightarrow 3 = 3 + c$, therefore $c = 0$ M1

Therefore $y = 3x$ A1 (4)

b) $m_1 = \frac{8-3}{3-1} = \frac{5}{2}$ M1

$m_1m_2 = -1$, $\frac{5}{2}m_2 = -1$. $\therefore$ $m_2 = -\frac{2}{5}$ M1

$y = -\frac{2}{5}x + c$

Substitute (2, 6) to find c = 6.8 and hence $y = -\frac{2}{5}x + \mathbf{6.8}$ A1**A1**(4)

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8. a) Reflection in the $x$-axis. **Cuts $x$-axis at –1 and 2, cuts y-axis at 1**. A1**A1**(2)

b) Reflect in y-axis. **Cuts $x$-axis at –2 and 1 cuts y-axis at –1.** A1**A1(2)**

c) Stretch ×5 along the y-axis. **Cuts $x$-axis at –1 and 2, cuts y-axis at –5**. A1**A1**(2)

d) Stretch ×2 along the $x$-axis. **Cuts $x$-axis at** –**2 and 4, cuts y-axis at –1.** A1**A1**(2)

e) $f(x) + 1$ A1 (1)

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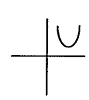
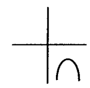
9. a) $D = b^2 - 4ac$
$= k^2 - 4 \times 1 \times 9$
$= k^2 - 36$
1 solution $D = 0$ M1
Therefore $k = 6$ or $-6$ A1A1(3)

b) $D > 0$ M1
$D = j^2 - 4 \times 1 \times 9 > 0$
Therefore $j^2 > 36$
Therefore $j < -6$ or $j > 6$ A1A1(3)

c) i) It means a u-shaped graph is totally above the $x$-axis.  A1A1(2)

ii) It means an n-shaped graph is totally below the $x$-axis.  A1 (1)

iii) $D < 0$ M1

$D = 3^2 - 4 \times 2.25 \times \frac{d}{100} < 0$

$9 - \frac{9d}{100} < 0$

Therefore $9 < \frac{9d}{100} \Rightarrow 100 < d$.

Therefore smallest possible value of d is 101. A1 (2)

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10. a) $f(x) = \left(x + \frac{3}{2}\right)^2 - \frac{9}{4} + 9 = \left(x + \frac{3}{2}\right)^2 + \frac{27}{4}$ M1A1A1(3)

b) Minimum value of curve occurs when $\left(x + \frac{3}{2}\right)^2 = 0 \Rightarrow x + \frac{3}{2} = 0$ M1

Hence line of symmetry is $x = -\frac{3}{2}$ A2 (3)

c) $g(x) = \dfrac{1}{\left(x + \frac{3}{2}\right)^2 + \frac{27}{4}}$

Maximum g($x$) occurs when $\left(x + \frac{3}{2}\right)^2 = 0$ and hence maximum g($x$) is $\frac{4}{27}$. M1A2(3)

d) $f(3) = 3^2 + 3 \times 3 + 9$
$= 9 + 9 + 9 = 27$ A1 (1)

e) $f'(x) = 2x + 3$ M1

$f'(3) = 2 \times 3 + 3 = 9$ M1

Therefore $y = 9x + c$

Substitute in (3, 27) $\rightarrow 27 = 9 \times 3 + c$ M1

Therefore $c = 0$

Therefore $y = 9x$ A1 (4)

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(75)