Day 252 **A Level Maths: C Tier 10-a-day: Model Solutions**

1 Solve a logarithmic equation (one log) (All boards)

Solve $\log_5 (3x + 2) = 3$.

$3x + 2 = 5^3 = 125$
$3x = 123$
$x = 41$
Answer: x = 41

2 Tension in a string supporting a hanging mass (All boards)

A particle of mass 10 kg hangs from a light string and is raised vertically with acceleration 2 m s^{-2}.
Taking g = 9.8 m s^{-2}, find the tension.

$T - mg = ma$
$T = 10 \times 9.8 + 10 \times 2$
Answer: 118 N

3 Transforming a graph with a labelled turning point (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The diagram shows the curve y = f(x). The maximum point is shown. Write down the coordinates of the maximum point on the curve with equation
(a) y = f(x) − 1 (b) y = f(x + 1)

(a) y = f(x) − 1: the maximum point moves to (3, 1).
(b) y = f(x + 1): the maximum point moves to (2, 2).
Answer: (a) (3, 1) (b) (2, 2)

4 Stationary points of a cubic (All boards)

$y = x^3 - 12x$.
Find the coordinates of the stationary points and determine their nature.

$dy/dx = 3x^2 - 12 = 3(x + 2)(x - 2) = 0$
$x = -2$: $y = 16$; $x = 2$: $y = -16$
$d^2y/dx^2 = 6x + 0$: at $x = -2$ it is -12 (maximum), at $x = 2$ it is 12 (minimum)
Answer: (−2, 16) maximum; (2, −16) minimum

5 Venn diagrams (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The Venn diagram shows probabilities for events A and B.
Find P(A | B).

$P(A \mid B) = P(A \cap B) \div P(B)$
$= 0.2 \div (0.2 + 0.25) = 0.2 \div 0.45$
Answer: $\frac{4}{9}$ = 0.444

6 Angle between vectors (scalar product) (CIE)

$\mathbf{a} = -\mathbf{i} + 3\mathbf{j} + \mathbf{k}$ and $\mathbf{b} = 2\mathbf{k}$.
Find the angle between a and b, to 1 decimal place.

$\mathbf{a}.\mathbf{b} = (-1)(0) + (3)(0) + (1)(2) = 2$
$|\mathbf{a}| = \sqrt{11}$, $|\mathbf{b}| = \sqrt{4}$
$\cos\theta = \frac{2}{\sqrt{11} \times \sqrt{4}}$, so $\theta = 72.5°$
Answer: 72.5°

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7 Equation of a transformed curve (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The curve $y = x^2 - 2x$ is translated by the vector $\begin{pmatrix}1\\2\end{pmatrix}$.

Find the equation of the new curve, giving your answer in the form $y = ax^2 + bx + c$.

Replace x by $(x - 1)$ and add 2:
$y = f(x - 1) + 2$
Expand and collect terms.
Answer: $y = x^2 - 4x + 5$

8 Continuous random variable: finding k (CIE)

The continuous random variable X has probability density function $f(x) = kx^3$ for $0 \leq x \leq 2$, and 0 otherwise.
Find the value of k.

$\int$ from 0 to 2 of $k\,x^3\,dx = 1$

$k \times \frac{2^4}{4} = 1$

Answer: $k = \frac{1}{4}$

9 Arithmetic series: sum of terms (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Find the sum of the first 9 terms of the series
$-4 + 3 + 10 + 17 + \ldots$

$a = -4$, $d = 7$, $n = 9$

$S_n = \frac{n}{2}[2a + (n - 1)d] = \frac{9}{2}[2(-4) + 8 \times 7]$

$= 216$

Answer: 216

10 Constant acceleration: $v^2 = u^2 + 2as$ (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A particle moves in a straight line with constant acceleration. Its speed increases from 2 m s^{-1} to 10 m s^{-1} as it travels 19.2 m. Find the acceleration.

$v^2 = u^2 + 2as$

$10^2 = 2^2 + 2 \times a \times 19.2$

$96 = 38.4\,a$

Answer: 2.5 m s^{-2}