Day 121 **A Level Maths: C Tier 10-a-day: Model Solutions**

1 Rationalising the denominator (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Rationalise the denominator of $\frac{1}{3-\sqrt{2}}$.

Write your answer in the form $p + q\sqrt{2}$.

Multiply top and bottom by $3 + \sqrt{2}$:

$$\frac{1(3+\sqrt{2})}{(3)^2-(\sqrt{2})^2} = \frac{1(3+\sqrt{2})}{7}$$

Answer: $\mathbf{\frac{3}{7} + \frac{1}{7}\sqrt{2}}$

2 3D vectors: distance, magnitude and midpoint (All boards)

$\text{OA} = \begin{pmatrix} 2 \\ -3 \\ -3 \end{pmatrix}$ and $\text{OB} = \begin{pmatrix} 11 \\ -5 \\ 3 \end{pmatrix}$.

Find AB and |AB|, and a unit vector in the direction of AB.

$$\text{AB} = \text{OB} - \text{OA} = \begin{pmatrix} 9 \\ -2 \\ 6 \end{pmatrix}$$

$|\text{AB}| = \sqrt{9^2 + 2^2 + 6^2} = 11$

Unit vector $= \frac{1}{11}$ AB

Answer: $\mathbf{AB = \begin{pmatrix} 9 \\ -2 \\ 6 \end{pmatrix}}$**, |AB| = 11, unit vector** $\mathbf{\frac{1}{11}\begin{pmatrix} 9 \\ -2 \\ 6 \end{pmatrix}}$

3 Evaluating fractional and negative indices (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Evaluate $8^{\frac{2}{3}}$.

$8^{\frac{2}{3}} = (8^{\frac{1}{3}})^2$

$8^{\frac{1}{3}} = 2$

$(2)^2 = 4$

Answer: 4

4 Counting: arrangements and selections (CIE)

In how many ways can a team of 2 be chosen from 7 students?

${}^7C_2 = \frac{7\times6}{2\times1}$

Answer: 21

5 Factorised trig equation (All boards)

Solve $\cos x(\cos x + 1) = 0$ for $0° \le x \le 360°$.

Either $\cos x = 0$ or $\cos x + 1 = 0$

$\cos x = 0$: $x = 90°, 270°$

$\cos x = -1$: $x = 180°$

Answer: x = 90°, 180°, 270°

6 Horizontal projection from a cliff (AQA, Edexcel, OCR, MEI)

A ball is thrown horizontally at 10 m s^{-1} from the top of a vertical cliff of height 44.1 m above the sea. Take g = 9.8 m s^{-2}. Find (a) the time taken to reach the sea, (b) the horizontal distance of the landing point from the cliff.

(a) Vertically: $u = 0$, $s = 44.1$, $a = 9.8$

$44.1 = \frac{1}{2} \times 9.8 \times t^2$, so $t^2 = 9$

(b) Horizontal distance = speed × time = 10 × 3

Answer: (a) 3 s (b) 30 m

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7 Binomial: cumulative probabilities (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

X ~ B(8, 0.6). Find P(X > 6), giving your answer to 3 s.f.

$P(X > 6) = 1 - P(X \leq 6)$

$P(X \leq 6) = 0.8936$

Answer: 0.106

8 Partial fractions (Edexcel, OCR, MEI, CIE, AQA, Eduqas)

Express $\frac{-9x + 13}{(x - 5)(x + 3)}$ in partial fractions.

Write $\frac{-9x + 13}{(x - 5)(x + 3)} = \frac{A}{(x - 5)} + \frac{B}{(x + 3)}$

$-9x + 13 = A(x + 3) + B(x - 5)$

$x = 5$: $-32 = A(8)$ so $A = -4$

$x = -3$: $40 = B(-8)$ so $B = -5$

Answer: $\mathbf{\frac{-4}{(x - 5)} + \frac{-5}{(x + 3)}}$

9 Constant acceleration: finding the initial speed (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A particle moving in a straight line with constant acceleration 3 m s^{-2} travels 260 m in 10 s.
Find its initial speed.

$s = ut + \frac{1}{2}at^2$

$260 = 10\,u + \frac{1}{2} \times 3 \times 10^2$

$10\,u = 110$

Answer: 11 m s^{-1}

10 Area between a line and a curve (All boards)

The curve $y = 4x - x^2$ and the line $y = 2x$ meet at the origin and at P.
Find the area enclosed between them.

$4x - x^2 = 2x$ gives $2x - x^2 = 0$, so $x = 0$ or $x = 2$

Area $= \int_0^2 (2x - x^2)\,dx = \left[\frac{2x^2}{2} - \frac{x^3}{3}\right]$ from 0 to 2

$= \frac{2^3}{2} - \frac{2^3}{3} = \frac{4}{3}$

Answer: $\mathbf{\frac{4}{3}}$