Day 342 **A Level Maths: B Tier 10-a-day: Model Solutions**

1 Linear inequalities (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Solve $3x + 4 \leq 2x - 9$.

$x \leq -13$

Divide by 1: $x \leq -13$

Answer: $x \leq -13$

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

The vector $\mathbf{a} = \begin{pmatrix} 8 \\ -8 \\ -4 \end{pmatrix}$.

Find $|\mathbf{a}|$ and a unit vector in the direction of $\mathbf{a}$.

$|\mathbf{a}| = \sqrt{8^2 + 8^2 + 4^2} = \sqrt{144} = 12$

Unit vector $= \frac{1}{12}\mathbf{a}$

Answer: $|\mathbf{a}| = 12$, unit vector $\frac{1}{12}\begin{pmatrix} 8 \\ -8 \\ -4 \end{pmatrix}$

3 Simplifying surds (AQA, Edexcel, OCR, MEI, Eduqas)

Simplify $\sqrt{20} + \sqrt{245} + \sqrt{80}$, giving your answer in the form $k\sqrt{5}$.

$\sqrt{20} = 2\sqrt{5}$, $\sqrt{245} = 7\sqrt{5}$, $\sqrt{80} = 4\sqrt{5}$

$2\sqrt{5} + 7\sqrt{5} + 4\sqrt{5} = 13\sqrt{5}$

Answer: $13\sqrt{5}$

4 Smooth inclined plane (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A block slides from rest down a line of greatest slope of a smooth plane inclined at α, where $\sin\alpha = \frac{3}{5}$ to the horizontal.

Take $g = 9.8$ m s^{-2}.

Find its acceleration, and the distance it travels in 2 s.

Along the plane: $mg\sin\alpha = ma$, so $a = 9.8 \times 0.6 = 5.88$

$s = \frac{1}{2}at^2 = \frac{1}{2} \times 5.88 \times 2^2$

Answer: 5.88 m s^{-2}; 11.76 m

5 Solving index equations (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Solve $5^{-3x} = 125^{4x}$.

Write both sides as powers of 5: $5^{-3x} = 5^{3(4x)}$

Equate the indices: $-3x = 12x$

$-15x = 0$

$x = 0$

Answer: $x = 0$

6 Volume of revolution about the x-axis (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The region R is bounded by the curve $y = \sqrt{5}\sqrt{x}$, the x-axis and the lines $x = 0$ and $x = 2$.

R is rotated through 360° about the x-axis. Find the exact volume generated.

$V = \pi\int_0^2 y^2\,dx = \pi\int_0^2 5x\,dx$

$= \pi\left[\frac{5x^2}{2}\right]_0^2$

$= 10\pi$

Answer: 10π

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7 Finding the mean or standard deviation (All boards)

The length X cm of a metal rod is normal with s.d. 3.
Given P(X < 177) = 0.99, find the mean (3 s.f.).

P(X < 177) = 0.99, so z = 2.326

$\frac{177 - \mu}{3} = 2.326$

$\mu = 177 - 2.326 \times 3 = 170$

Answer: $\mu = 170$

8 Exponential growth and decay models (All boards)

A population is modelled by $N = N_0 e^{kt}$, where t is in hours. Initially N = 1000 and after 4 hours N = 2400.
Find (a) k to 3 s.f., (b) when N reaches 5000, to 3 s.f.

$N_0 = 1000$, so $2400 = 1000\, e^{4k}$, $e^{4k} = 2.4$

(a) $k = \frac{1}{4} \ln 2.4 = 0.2189$

(b) $1000\, e^{kt} = 5000$, so $t = \frac{\ln 5}{k} = 7.353$ hours

Answer: (a) k = 0.219 (b) t = 7.35 hours

9 Normal distribution probabilities (All boards)

A journey takes X minutes, normal with mean 170, s.d. 8.
Find, to 3 s.f., the probability a value is
(a) more than 182,
(b) between 182 and 194.

$X \sim N(170, 8^2)$
(a) P(X > 182) = 0.0668
(b) P(182 < X < 194) = 0.9987 − 0.9332 = 0.0655
Answer: (a) 0.0668 (b) 0.0655

10 Braking distance and time (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A car travelling at 20 m s^{-1} brakes and comes to rest with constant deceleration 4 m s^{-2}.
Find (a) the distance travelled while braking, (b) the time taken to stop.

(a) $0 = 20^2 - 2 \times 4 \times s$
$s = 400 \div 8 = 50$
(b) $0 = 20 - 4t$, so $t = 20 \div 4$
Answer: (a) 50 m (b) 5 s