Day 176 **A Level Maths: B Tier 10-a-day: Model Solutions**

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

Solve $-3x - 2 \leq 2x - 2$.

$-5x \leq 0$

Divide by -5 (reversing the inequality): $x \geq 0$

Answer: $x \geq 0$

2 Standardising to compare (All boards)

Marks are normal: Maths N(55, 10^2), Physics N(72, 9^2).

Anna scores 50 in Maths and 90 in Physics. Which is her better performance, relatively?

z-score in Maths = $\frac{50 - 55}{10} = -0.500$

z-score in Physics = $\frac{90 - 72}{9} = 2.00$

The higher z-score is in Physics

Answer: Physics

3 Will it move? Limiting friction (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A box of mass 8 kg rests on a rough horizontal floor, with coefficient of friction 0.6. A horizontal force of 38 N is applied to the box.

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

Determine whether the box moves. Find the friction force, or the acceleration if it moves.

$R = 8 \times 9.8 = 78.4$, maximum friction $\mu R = 0.6 \times 78.4 = 47.04$

$38 < 47.04$ so the box stays at rest

Friction balances the applied force: $F = 38$

Answer: Does not move; friction = 38 N

4 Double angle values from a given ratio (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Given that $\tan\theta = -\frac{3}{4}$ and $90° < \theta < 180°$,

find the exact value of $\cos 2\theta$.

Right-angled triangle 3, 4, 5: $\sin\theta = \frac{3}{5}$, $\cos\theta = -\frac{4}{5}$ (θ obtuse)

$\cos 2\theta = \cos^2\theta - \sin^2\theta = \frac{16}{25} - \frac{9}{25} = \frac{7}{25}$

Answer: $\frac{7}{25}$

5 Inverse functions (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

$f(x) = \sqrt{4x + 6}$ for $x \geq -\frac{3}{2}$.

Find $f^{-1}(x)$ and state its domain.

Let $y = \sqrt{4x + 6}$. Then $y^2 = 4x + 6$

$x = \frac{y^2 - 6}{4}$

$f(x) \geq 0$, so the domain of f^{-1} is $x \geq 0$.

Answer: $f^{-1}(x) = \frac{x^2 - 6}{4}$, domain $x \geq 0$

6 Reduction to linear form (logarithms) (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The variables x and y satisfy $y = ax^n$. A graph of ln y against ln x is a straight line with gradient 0.5 that passes through (0, ln 2).

Find the values of a and n.

$\ln y = \ln a + n \ln x$

gradient = $n = 0.5$

intercept $\ln a = \ln 2$, so $a = 2$

Answer: $a = 2$, $n = 0.5$

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7 Triangle formed by two lines and an axis (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Line l_1 has equation $7x - y = -21$ and line l_2 has equation $7x + 9y = 49$.
The lines meet at P. Find the area of the triangle formed by l_1, l_2 and the x-axis.

Solve simultaneously: P = $(-2, 7)$
l_1 meets $y = 0$ at $x = -3$, and l_2 meets $y = 0$ at $x = 7$
Base = 10, height = 7
Area = $\frac{1}{2}$ × base × height = 35
Answer: 35

8 Compound angle formulae (exact values) (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Given that $\sin A = \frac{3}{5}$ and $\cos B = \frac{24}{25}$, where A is obtuse and B is acute,
find the exact value of $\sin(A + B)$.

$\cos A = -\frac{4}{5}$ and $\sin B = \frac{7}{25}$
$\sin(A + B) = \sin A \cos B + \cos A \sin B$
$= \frac{3}{5} \times \frac{24}{25} + (-\frac{4}{5}) \times \frac{7}{25} = \frac{44}{125}$
Answer: $\frac{44}{125}$

9 Jumping to a different journey: two-stage motion (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A coach accelerates uniformly from rest at 1 m s^{-2} for 8 s, then travels at constant speed for 20 s, and finally decelerates uniformly at 1 m s^{-2} to rest.
Find the total distance travelled and the total time of the journey.

Max speed = 1 × 8 = 8
Stage 1: ½ × 8 × 8 = 32; stage 2: 8 × 20 = 160
Stage 3: time = 8 ÷ 1 = 8, distance = ½ × 8 × 8 = 32
Answer: 224 m; 36 s

10 Stratified sampling (AQA, Edexcel, OCR, MEI, Eduqas)

A survey covers 120 urban, 40 suburban and 40 rural households.
A stratified sample of size 25 is taken. Find the number selected from each group.

Total = 120 + 40 + 40 = 200
Sampling fraction = 25/200 = $\frac{1}{8}$
urban: 120 ÷ 8 = 15
suburban: 40 ÷ 8 = 5
rural: 40 ÷ 8 = 5
Answer: urban 15, suburban 5, rural 5