Day 129 **A Level Maths: B Tier 10-a-day: Model Solutions**

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

Solve $-4 < -4x + 3 \leq 7$.

Subtract 3 from each part: $-7 < -4x \leq 4$

Divide each part by -4 (reversing the inequalities): $-1 \leq x < \frac{7}{4}$

Answer: $-1 \leq x < \frac{7}{4}$

2 Position vectors and dividing a line in a ratio (All boards)

A has position vector $\begin{pmatrix} -2 \\ -4 \\ 4 \end{pmatrix}$ and B has position vector $\begin{pmatrix} -17 \\ 11 \\ -1 \end{pmatrix}$.

The point P lies on AB with AP : PB = 2 : 3.

Find the position vector of P.

$\text{AB} = \begin{pmatrix} -15 \\ 15 \\ -5 \end{pmatrix}$

$\text{AP} = \frac{2}{5}\text{AB} = \begin{pmatrix} -6 \\ 6 \\ -2 \end{pmatrix}$

$\text{OP} = \text{OA} + \text{AP} = \begin{pmatrix} -8 \\ 2 \\ 2 \end{pmatrix}$

Answer: $\begin{pmatrix} \mathbf{-8} \\ \mathbf{2} \\ \mathbf{2} \end{pmatrix}$

3 Power, driving force and resistance (CIE)

A car of mass 800 kg moves along a horizontal road. The engine works at a constant rate of 30 kW. The resistance to motion is constant at 400 N.

Find the acceleration when the speed is 10 m s^{-1}.

$P = Fv$: $F = 30000 \div 10 = 3000$ N

$F - R = ma$: $3000 - 400 = 800a$

Answer: 3.25 m s^{-2}

4 Reading a histogram (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The histogram shows the times taken by a group of people to complete a task.

Estimate the number of people who took between 25 and 38 minutes.

Frequency = frequency density × class width.

25 to 35: $4 \times 10 = 40$

35 to 38: $2 \times 3 = 6$

Total = 46

Answer: 46

5 Geometric sequences and series (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A geometric series has second term 8 and fifth term 1.

Find (a) the common ratio, (b) the first term, (c) the sum to infinity.

$ar = 8$ and $ar^4 = 1$, so $r^3 = \frac{1}{8}$

$r = \frac{1}{2}$, and $a = 8 \div \frac{1}{2} = 16$

$S_\infty = \frac{a}{1 - r} = \frac{16}{1 - \frac{1}{2}} = 32$

Answer: (a) $r = \frac{1}{2}$ (b) $a = 16$ (c) 32

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6 Finding the mean or standard deviation (All boards)

The mass X g of a flour bag is normal with s.d. 6.
Given P(X < 511.8) = 0.975, find the mean (3 s.f.).

P(X < 511.8) = 0.975, so z = 1.960

$\frac{511.8 - \mu}{6} = 1.960$

$\mu = 511.8 - 1.960 \times 6 = 500$

Answer: $\mu = 500$

7 Projectile: speed and direction at time t (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A stone is projected horizontally at 176.4 m s^{-1} from a point high above the ground.
Take g = 9.8 m s^{-2}.
Find the speed and the direction of motion 24 s later, to 1 d.p. below the horizontal.

Vertical speed = 9.8 × 24 = 235.2

Speed = $\sqrt{(176.4^2 + 235.2^2)} = 294$

$\tan \alpha = 235.2 \div 176.4$, $\alpha = 53.1°$

Answer: 294 m s^{-1} at 53.1° below horizontal

8 Equations using $\sin^2 x + \cos^2 x = 1$ (All boards)

Solve 4 $\sin^2 x$ + 3 cos x − 4 = 0 for $0 \leq x \leq 360°$,
giving answers to 1 d.p. where necessary.

Use $\sin^2 x = 1 - \cos^2 x$: 3 cos x − 4 $\cos^2 x$ = 0, i.e. 4 $\cos^2 x$ − 3 cos x = 0

(cos x)(4 cos x − 3) = 0, so cos x = 0 or $\frac{3}{4}$

cos x = 0: x = 90.0°, 270.0°

cos x = $\frac{3}{4}$: x = 41.4°, 318.6°

Answer: x = 41.4°, 90.0°, 270.0°, 318.6°

9 Perpendicular bisector (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A is the point (7, 5) and B is the point (3, 7).
Find the perpendicular bisector of AB as ax + by + c = 0, with integer a, b, c.

Midpoint of AB = (5, 6)

Gradient of AB = $\frac{2}{-4} = -\frac{1}{2}$

Perpendicular gradient = 2

y − 6 = 2(x − 5), which gives 2x − y − 4 = 0

Answer: 2x − y − 4 = 0

10 Inequalities with exponents and logs (All boards)

Solve $5^x > 326$, giving your answer to 3 s.f.

Take logs: x ln 5 > ln 326

$x > \frac{\ln 326}{\ln 5} = 3.596$

Answer: x > 3.60