Day 269 **A Level Maths: C Tier 10-a-day: Model Solutions**

1 Scatter diagrams and correlation (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The scatter diagram shows time on phone and hours of sleep for a group.
Describe the correlation.

The points lie close to a line with negative gradient.
As time on phone increases, hours of sleep tends to decrease.
Answer: strong negative correlation

2 Speed and direction from a velocity vector (AQA, Edexcel, OCR, MEI, Eduqas)

The velocity of a boat is $(-8\mathbf{i} + 15\mathbf{j})$ m s^{-1}, where $\mathbf{i}$ and $\mathbf{j}$ are perpendicular unit vectors.
(a) Find the speed.
(b) Find the acute angle between the direction of motion and the line of $\mathbf{i}$. Give 1 d.p.

(a) speed $= \sqrt{8^2 + 15^2} = \sqrt{289}$

(b) $\tan\theta = \frac{15}{8}$

$\theta = \tan^{-1}(\frac{15}{8})$

Answer: (a) 17 m s^{-1} (b) 61.9°

3 2D vectors: magnitude and direction (All boards)

The vector $\mathbf{p} = -24\mathbf{i} + 7\mathbf{j}$.
Find (a) |p|, (b) the angle p makes with the positive x-axis, measured anticlockwise (1 d.p.).

(a) $|\mathbf{p}| = \sqrt{24^2 + 7^2} = 25$

(b) Acute angle $= \tan^{-1}(\frac{7}{24}) = 16.3°$

p is in the second quadrant, so the angle is 163.7°
Answer: (a) 25 (b) 163.7°

4 Domain and range (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

$f(x) = \frac{1}{x+1} - 2$, $x \neq -1$.
Find the range of f.

$\frac{1}{x+1}$ takes every real value except 0.
Adding -2: f(x) takes every value except -2.
Answer: f(x) takes all real values except -2

5 Solve trig equation in radians (exact) (All boards)

Solve $\tan x = -\sqrt{3}$ for $0 \leq x \leq 2\pi$.
Give your answers in terms of π.

Reference angle: $\frac{\pi}{3}$

tan is negative in the second and fourth quadrants.
$x = \frac{2\pi}{3}, \frac{5\pi}{3}$

Answer: $x = \frac{2\pi}{3}, \frac{5\pi}{3}$

6 Geometric distribution (CIE)

Seeds are planted one at a time until one grows, with probability 0.5 each time. X is the number planted.
Find $P(X \leq 6)$, to 3 s.f.

$P(X \leq 6) = 1 - P(X > 6) = 1 - (\frac{1}{2})^6$

Answer: 0.984

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7 Finding an unknown using the factor theorem (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

$(x + 2)$ is a factor of $x^3 + kx^2 + 6x + 4$.
Find the value of k.

Let $f(x) = x^3 + kx^2 + 6x + 4$. Then $f(-2) = 0$:
$-8 + 4k - 8 = 0$
$4k = 16$
Answer: $k = 4$

8 Resultant force as vectors and acceleration (AQA, Edexcel, OCR, MEI, Eduqas)

Two forces $(-\mathbf{i})$ N and $(4\mathbf{i} - 6\mathbf{j})$ N act on a particle of mass 3 kg. No other horizontal forces act. Find the acceleration of the particle as a vector in terms of $\mathbf{i}$ and $\mathbf{j}$.

Resultant $= (-\mathbf{i}) + (4\mathbf{i} - 6\mathbf{j})$
$= (3\mathbf{i} - 6\mathbf{j})$ N
$F = ma$: $a = \frac{1}{3}(3\mathbf{i} - 6\mathbf{j})$
Answer: $(\mathbf{i} - 2\mathbf{j})$ m s^{-2}

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

Solve $6x + 1 \geq 4x - 7$.

Collect x terms: $2x \geq -8$
Divide by 2: $x \geq -4$
Answer: $x \geq -4$

10 Collinear points using vectors (All boards)

A(−1, 3), B(5, 0) and C(9, −2).
Show that A, B and C are collinear and find AB : BC.

$\overrightarrow{AB} = \begin{pmatrix} 6 \\ -3 \end{pmatrix}$ and $\overrightarrow{BC} = \begin{pmatrix} 4 \\ -2 \end{pmatrix}$
$\overrightarrow{AB} = 3\begin{pmatrix} 2 \\ -1 \end{pmatrix}$ and $\overrightarrow{BC} = 2\begin{pmatrix} 2 \\ -1 \end{pmatrix}$, so AB and BC are parallel with common point B
Hence A, B, C are collinear and AB : BC = 3 : 2
Answer: collinear; AB : BC = 3 : 2