Day 237 **A Level Maths: C Tier 10-a-day: Model Solutions**

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

Solve $x^2 + x - 20 \geq 0$.

Solve $x^2 + x - 20 = 0$: $(x + 5)(x - 4) = 0$
Critical values $x = -5$ and $x = 4$.
The graph is a ∪-shaped parabola, so take the regions outside the roots.
Answer: $x \leq -5$ or $x \geq 4$

2 Conditional probability: two-way tables (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Of 70 people, 35 are women. 20 of the women and 24 of the men walk to work.
One person is chosen at random.
Given that the person walks to work, find the probability they are a woman.

44 people walk to work in total: 20 + 24
P = 20 ÷ 44
Answer: $\frac{5}{11}$

3 Iteration $x_{n+1} = g(x_n)$ (All boards)

$x_{n+1} = \sqrt{2x_n + 5}$, with $x_0 = 3$.
Find x_1, x_2 and x_3 to 3 decimal places.

$x_1 = 3.3166$
$x_2 = 3.4108$
$x_3 = 3.4382$
Answer: $x_1 = 3.317$, $x_2 = 3.411$, $x_3 = 3.438$

4 Velocity at time t with constant acceleration (vectors) (AQA, Edexcel, OCR, MEI, Eduqas)

A particle has initial velocity $(-\mathbf{i} - 4\mathbf{j})$ m s^{-1} and constant acceleration $(-2\mathbf{i} + \mathbf{j})$ m s^{-2}.
Find its velocity after 3 s.

$v = u + at$
$v = (-\mathbf{i} - 4\mathbf{j}) + 3(-2\mathbf{i} + \mathbf{j})$
$= (-\mathbf{i} - 4\mathbf{j}) + (-6\mathbf{i} + 3\mathbf{j})$
Answer: $(-7\mathbf{i} - \mathbf{j})$ m s^{-1}

5 Rearrange and iterate (All boards)

(a) Show that $x^2 - x - 4 = 0$ can be rearranged to $x = 1 + \frac{4}{x}$.
(b) Use x_{n+1} = this formula with $x_0 = 2$ to find x_1, x_2 to 3 d.p.

(a) Divide $x^2 - x = 4$ by x: $x - 1 = \frac{4}{x}$, so $x = 1 + \frac{4}{x}$
(b) $x_1 = 3.0000$, $x_2 = 2.3333$
Answer: (a) shown (b) $x_1 = 3.000$, $x_2 = 2.333$

6 Starting from rest: find the time (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A car starts from rest and moves in a straight line with constant acceleration 1 m s^{-2}.
It travels 2 m. Find the time taken.

$s = ut + \frac{1}{2}at^2$ with $u = 0$
$2 = \frac{1}{2} \times 1 \times t^2$
$t^2 = 4$
Answer: 2 s

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7 Collinear points using vectors (All boards)

A(2, 3), B(8, 9) and C(12, k).
Given that A, B and C are collinear, find k.

$\text{AB} = \begin{pmatrix} 6 \\ 6 \end{pmatrix}$, $\text{AC} = \begin{pmatrix} 10 \\ k - 3 \end{pmatrix}$

AC = $\frac{5}{3}$ AB, so $10 = \frac{5}{3} \times 6$, giving the multiple $\frac{5}{3}$

$k - 3 = \frac{5}{3} \times 6$, so $k = 13$

Answer: k = 13

8 Composite functions (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

$f(x) = 3x - 2$ and $g(x) = x^2 - 3$.
Find (a) fg(x), (b) gf(x).

$fg(x) = f(x^2 - 3) = 3x^2 - 11$

$gf(x) = (3x - 2)^2 - 3 = 9x^2 - 12x + 1$

Answer: (a) $3x^2 - 11$ (b) $9x^2 - 12x + 1$

9 Grouped data: estimated median (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The table shows grouped data.
Class: $10 \leq x < 20$; $20 \leq x < 30$; $30 \leq x < 40$; $40 \leq x < 50$
Frequency: 4, 8, 13, 7
Estimate the median, to 3 s.f.

n = 32, so the median is the 16 th value, in class $30 \leq x < 40$
Cumulative frequency before this class = 12

Median $\approx 30 + \frac{(16 - 12)}{13} \times 10$

Answer: 33.1

10 Linear and quadratic simultaneous equations (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Solve the simultaneous equations:
$y = x^2 - 3$, $y = x - 3$.

$x^2 - 3 = x - 3$

$x^2 - x = 0$

$(x - 1)(x + 0) = 0$

Use $y = x - 3$ to find each y.

Answer: x = 0, y = −3 and x = 1, y = −2