Day 201 **A Level Maths: C Tier 10-a-day: Model Solutions**

1 Work done and kinetic energy (CIE)

A constant force of 20 N pulls a crate 6 m along rough horizontal ground against a constant frictional force of 12 N. Find (a) the work done by the pulling force, (b) the work done against friction.

(a) Work done = force × distance = 20 × 6
(b) Work done against friction = 12 × 6
Answer: (a) 120 J (b) 72 J

2 Simplifying surds (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

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

$\sqrt{20} = 2\sqrt{5}$ and $\sqrt{80} = 4\sqrt{5}$
Sum = $(2 + 4)\sqrt{5}$
Answer: $6\sqrt{5}$

3 Equilibrium of forces given as vectors (AQA, Edexcel, OCR, MEI, Eduqas)

Three forces $(-2\mathbf{i} + 5\mathbf{j})$ N, $(p\mathbf{i} + q\mathbf{j})$ N and $(-\mathbf{i} - 8\mathbf{j})$ N act on a particle which is in equilibrium. $\mathbf{i}$ and $\mathbf{j}$ are perpendicular unit vectors. Find the values of p and q.

Sum of forces = 0:
i components: $p + (-2) + (-1) = 0$
j components: $q + (5) + (-8) = 0$
Answer: $p = 3$, $q = 3$

4 Tree diagrams (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The tree diagram shows probabilities for events R and L.
Find the probability that exactly one of R and L happens.

Exactly one: (R and L′) or (R′ and L)
$= 0.7 \times 0.9 + 0.3 \times 0.5$
Answer: 0.78

5 Collinear points using vectors (All boards)

A(1, −2), B(13, −6) and C(28, −11).
Show that A, B and C are collinear and find AB : BC.

$\text{AB} = \begin{pmatrix} 12 \\ -4 \end{pmatrix}$ and $\text{BC} = \begin{pmatrix} 15 \\ -5 \end{pmatrix}$

$\text{AB} = 4\begin{pmatrix} 3 \\ -1 \end{pmatrix}$ and $\text{BC} = 5\begin{pmatrix} 3 \\ -1 \end{pmatrix}$, so AB and BC are parallel with common point B

Hence A, B, C are collinear and AB : BC = 4 : 5
Answer: collinear; AB : BC = 4 : 5

6 Solving equations with indices (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Solve $x^{\frac{4}{3}} = 256$.

Raise both sides to the power $\frac{3}{4}$:

$x = 256^{\frac{3}{4}} = (256^{\frac{1}{4}})^3$
$= 4^3 = 64$
Answer: $x = 64$

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7 Identity then solve (sin² to cos) (All boards)

Solve $-4\sin^2 x + 2\cos x + 2 = 0$
for $0° \le x \le 360°$.

Use $\sin^2 x = 1 - \cos^2 x$: $4\cos^2 x + 2\cos x - 2 = 0$

Factorise and solve: $\cos x = \frac{1}{2}$ or $\cos x = -1$

$x = 60°, 180°, 300°$

Answer: $x = 60°, 180°, 300°$

8 Finding a quadratic from its turning point (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The diagram shows a sketch of a quadratic curve.
Find its equation in the form $y = a(x - p)^2 + q$.

The turning point is $(1, -2)$, so $y = a(x - 1)^2 - 2$.
The curve passes through $(0, -1)$:
$-1 = a(-1)^2 - 2$, so $1 = 1\ a$
$a = 1$

Answer: $y = (x - 1)^2 - 2$

9 Selection without replacement (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A bag has 7 red and 7 blue marbles. Two are taken at random without replacement.
Find the probability that they are different colours.

$P(RB) = \frac{7}{14} \times \frac{7}{13}$, $P(BR) = \frac{7}{14} \times \frac{7}{13}$

Add: $\frac{7}{26} + \frac{7}{26}$

Answer: $\frac{7}{13}$

10 Vector geometry with a diagram (OAB) (All boards)

In the diagram, OA = $\mathbf{a}$, OB = $\mathbf{b}$, and P lies on AB with AP : PB = 2 : 3.
Find AB and OP in terms of $\mathbf{a}$ and $\mathbf{b}$.

$\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA} = \mathbf{b} - \mathbf{a}$

$\overrightarrow{AP} = \frac{2}{5}\overrightarrow{AB} = \frac{2}{5}(\mathbf{b} - \mathbf{a})$

$\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP} = \mathbf{a} + \frac{2}{5}(\mathbf{b} - \mathbf{a})$

$= \frac{3}{5}\mathbf{a} + \frac{2}{5}\mathbf{b}$

Answer: $\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$; $\overrightarrow{OP} = \frac{3}{5}\mathbf{a} + \frac{2}{5}\mathbf{b}$