Day 207 **A Level Maths: C Tier 10-a-day: Model Solutions**

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

Write $\sqrt{45}$ in the form $p\sqrt{q}$, where q is an integer as small as possible.

$\sqrt{45} = \sqrt{9 \times 5} = \sqrt{9} \times \sqrt{5}$

$= 3\sqrt{5}$

Answer: $3\sqrt{5}$

2 Vertical motion under gravity: thrown upwards (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A rock is thrown vertically upwards with speed 19.6 m s^{-1}. Take g = 9.8 m s^{-2}.

(a) Find the time taken to reach its greatest height.

(b) Find the greatest height reached.

(a) $v = u + at$: $0 = 19.6 - 9.8t$, so $t = 2$

(b) $v^2 = u^2 + 2as$: $0 = 19.6^2 - 2 \times 9.8 \times s$

$s = \frac{384.16}{19.6}$

Answer: (a) 2 s (b) 19.6 m

3 Transforming a point on a graph (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The point P(5, −5) lies on the curve y = f(x).

Write down the coordinates of the image of P on

(a) $y = f(x - 3)$ (b) $y = 4f(x)$

(a) $y = f(x - 3)$ adds 3 to x, so P maps to (8, −5).

(b) $y = 4f(x)$ multiplies y by 4, so P maps to (5, −20).

Answer: (a) (8, −5) (b) (5, −20)

4 Integrating acceleration to find velocity (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A particle moves in a straight line. Its acceleration at time t seconds is $(4t + 3)$ m s^{-2}.

When t = 0 its velocity is 3 m s^{-1}.

Find its velocity when t = 2.

$v = \int a\,dt = 2t^2 + 3t + c$

$t = 0$, $v = 3$ gives $c = 3$

When t = 2: $v = 8 + 6 + 3$

Answer: 17 m s^{-1}

5 Small angle approximations (AQA, Edexcel, OCR, MEI, Eduqas)

θ is small and measured in radians.

Use the small angle approximations to find an approximation for $1 - \cos 6\theta$.

Use $\cos 6\theta \approx 1 - \frac{6^2\theta^2}{2}$

So $1 - \cos 6\theta \approx 18\theta^2$

Answer: $18\theta^2$

6 Hypothesis test for a normal mean (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A population is $N(\mu, 6^2)$. H_0: $\mu = 30$, H_1: $\mu < 30$.

A sample of 16 has mean $\bar{x} = 25.2$.

Test at the 5% level. Critical value: $z = -1.645$.

$z = (\bar{x} - \mu) \div (\sigma \div \sqrt{n}) = (25.2 - 30) \div (6 \div 4)$

$z = -3.20$

-3.20 is inside the critical region, so reject H_0

Answer: $z = -3.20$; reject H_0

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7 Straight line from logarithmic graph (All boards)

Variables x and y satisfy $y = ax^n$. A graph of $\log_{10} y$ against $\log_{10} x$ is a straight line with gradient 2 and intercept 1.1. Find n and a, giving a to 3 significant figures.

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

Gradient $n = 2$

$\log a = 1.1$ so $a = 10^{1.1} = 12.6$

Answer: n = 2, a = 12.6

8 Discrete random variable: E(X) and Var(X) (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The discrete random variable X has this distribution.

x: 0, 1, 5, 6

P(X = x): 0.2, 0.1, 0.4, 0.3

Find E(X) and Var(X).

$E(X) = \Sigma xp = 0\times0.2 + 1\times0.1 + 5\times0.4 + 6\times0.3 = 3.9$

$E(X^2) = \Sigma x^2 p = 20.9$

$\text{Var}(X) = 20.9 - 3.9^2$

Answer: E(X) = 3.9, Var(X) = 5.69

9 Modulus graphs (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Sketch $y = |2x + 2|$. Write down the coordinates of the vertex and of the point where the graph meets the y-axis.

The vertex is on the x-axis where $2x + 2 = 0$: $x = -1$

$x = 0$: $y = |2| = 2$

Answer: Vertex (−1, 0) ; y-axis (0, 2)

10 Vector equation of a line (3D) (CIE)

A line has equation $\mathbf{r} = \begin{pmatrix}4\\2\\2\end{pmatrix} + t\begin{pmatrix}1\\1\\2\end{pmatrix}$.

Find the coordinates of the point on the line where t = 2.

$$\mathbf{r} = \begin{pmatrix}4\\2\\2\end{pmatrix} + 2\begin{pmatrix}1\\1\\2\end{pmatrix}$$

$$= \begin{pmatrix}6\\4\\6\end{pmatrix}$$

Answer: (6, 4, 6)