Day 11 **A Level Maths: C Tier 10-a-day: Model Solutions**

1 Constant acceleration: s = ut + ½at² (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A boat moves in a straight line with constant acceleration 1.5 m s^{-2}. Its initial speed is 7 m s^{-1}. Find the distance travelled in 8 s.

$s = ut + \frac{1}{2}at^2$

$s = 7 \times 8 + \frac{1}{2} \times 1.5 \times 8^2$

Answer: 104 m

2 Integrate (ax + b)^n and related (All boards)

Find $\int (3x + 2)^3 \, dx$.

Reverse the chain rule: raise the power by 1, divide by the new power and by 3
Here a = 3

Answer: $\frac{(3x + 2)^4}{12} + c$

3 Velocity-time graph: acceleration from two stages (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

The graph shows the velocity of a runner.
(a) Find the acceleration in the first 4 s.
(b) Find the deceleration in the last 5 s.
(c) Find the total distance travelled.

(a) $a = \frac{10 - 6}{4}$

(b) $a = \frac{10 - 0}{5}$, a deceleration of 2

(c) area $= \frac{1}{2}(6 + 10) \times 4 + 10 \times 10 + \frac{1}{2} \times 5 \times 10$

Answer: (a) 1 m s^{-2} (b) 2 m s^{-2} (c) 157 m

4 Equation of a circle (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A circle has centre (−3, −3) and passes through the point (−2, −3). Find the equation of the circle.

$r^2 = (-2 - (-3))^2 + (-3 - (-3))^2$
$= 1 + 0 = 1$
Equation: $(x - a)^2 + (y - b)^2 = r^2$

Answer: $(x + 3)^2 + (y + 3)^2 = 1$

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

The discrete random variable X has this distribution.
x: 0, 4, 5, 7
P(X = x): 0.1, 0.2, 0.5, 0.2
Find E(X) and Var(X).

$E(X) = \Sigma xp = 0 \times 0.1 + 4 \times 0.2 + 5 \times 0.5 + 7 \times 0.2 = 4.7$
$E(X^2) = \Sigma x^2 p = 25.5$
$Var(X) = 25.5 - 4.7^2$

Answer: E(X) = 4.7, Var(X) = 3.41

6 Straight line from logarithmic graph (All boards)

Variables x and y satisfy $y = ab^x$. A graph of $\log_{10} y$ against x is a straight line with gradient 0.2 and intercept 0.5. Find a and b to 3 significant figures.

$\log y = \log a + x \log b$
$\log b = 0.2$ so $b = 10^{0.2} = 1.58$
$\log a = 0.5$ so $a = 10^{0.5} = 3.16$

Answer: a = 3.16, b = 1.58

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7 Arithmetic series: sum of terms (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

An arithmetic series has first term 9, last term 78 and 24 terms. Find the sum of the series.

$S_n = \frac{n}{2}(a + l) = \frac{24}{2}(9 + 78)$

$= 1044$

Answer: 1044

8 Normal approximation to the binomial (CIE)

X ~ B(200, 0.5). Use a normal approximation to find P(X ≤ 93), to 3 s.f.

np = 100 and npq = 50, so use Y ~ N(100, 50)

Continuity correction: P(Y < 93.5)

$z = (93.5 - 100) \div \sqrt{50}$

Answer: 0.179

9 The factor theorem and factorising (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

$f(x) = x^3 - 5x^2 - 2x + 24$

(a) Show that $(x - 4)$ is a factor of f(x).

(b) Factorise f(x) completely.

$f(4) = 64 + (-80) + (-8) + 24 = 0$, so $(x - 4)$ is a factor.

$f(x) = (x - 4)(x^2 - x - 6)$

$x^2 - x - 6 = (x + 2)(x - 3)$

Answer: (b) $f(x) = (x + 2)(x - 3)(x - 4)$

10 Estimate with a small angle (AQA, Edexcel, OCR, MEI, Eduqas)

Use a small angle approximation to estimate cos 0.2, where 0.2 is in radians.

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

$\cos 0.2 \approx 1 - \frac{0.2^2}{2} = 0.9800$

Answer: 0.9800