**Day 360** **A Level Maths: B Tier 10-a-day: Model Solutions**

## 1 Linear inequalities (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Solve $-x + 10 \leq x - 4$.

$-2x \leq -14$

Divide by $-2$ (reversing the inequality): $x \geq 7$

**Answer: $x \geq 7$**

## 2 Sector and arc in terms of π (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A sector of a circle has radius 15 cm and angle 210°.

Find, in terms of π, the arc length and the area of the sector.

$\theta = 210° = \frac{7\pi}{6}$ radians

Arc length $= r\theta = \frac{35\pi}{2}$ cm

Area $= \frac{1}{2}r^2\theta = \frac{525\pi}{4}$ cm$^2$

**Answer: arc $\frac{35\pi}{2}$ cm, area $\frac{525\pi}{4}$ cm$^2$**

## 3 Binomial expansion (positive integer power) (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

In the binomial expansion of $(1 + kx)^n$, where n is a positive integer, the coefficient of x is $-24$ and the coefficient of $x^2$ is 252.

Find the values of n and k.

$nk = -24$, so $k = \frac{-24}{n}$

$\frac{n(n-1)}{2}k^2 = 252$, so $\frac{n(n-1)}{2} \times \frac{576}{n^2} = 252$

$\frac{(n-1) \times 576}{2n} = 252$, so $576(n - 1) = 504n$

$n = 8$, and $k = -3$

**Answer: $n = 8$, $k = -3$**

## 4 Product rule (All boards)

Given that $y = (2x - 1) \ln x$,

find $\frac{dy}{dx}$, and its value when $x = 1$.

Product rule with $u = 2x - 1$, $v = \ln x$

$u' = 2$, $v' = \frac{1}{x}$

$\frac{dy}{dx} = u'v + uv' = 2 \ln x + \frac{2x - 1}{x}$

When $x = 1$: $\frac{dy}{dx} = 1$

**Answer: $\frac{dy}{dx} = 2 \ln x + \frac{2x - 1}{x}$; value 1**

## 5 Expectation and variance of aX + b (AQA, OCR, MEI, Eduqas, CIE)

The random variable X has $E(X) = 4$ and $Var(X) = 2$.

Find (a) $E(-3X + 3)$,

(b) $Var(-3X + 3)$, (c) $E(X^2)$.

(a) $E(aX + b) = aE(X) + b = (-3) \times 4 + 3 = -9$

(b) $Var(aX + b) = a^2Var(X) = 9 \times 2 = 18$

(c) $Var(X) = E(X^2) - [E(X)]^2$, so $E(X^2) = 2 + 16 = 18$

**Answer: (a) $-9$ (b) 18 (c) 18**

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## 6 Partial fractions and integration (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

(a) Write $\frac{-x-7}{(x+4)(x+5)}$ in partial fractions.

(b) Hence evaluate $\int_0^4 \frac{-x-7}{(x+4)(x+5)}\,dx$,
giving the answer as a single logarithm.

(a) $\frac{-x-7}{(x+4)(x+5)} \equiv \frac{A}{x+4} + \frac{B}{x+5}$, so $-x-7 \equiv A(x+5) + B(x+4)$
$x = -4$: $A = -3$; $x = -5$: $B = 2$

(b) $\int_0^4 \left(\frac{-3}{x+4} + \frac{2}{x+5}\right) dx = [-3\ln(x+4) + 2\ln(x+5)]_0^4$
$= -3\ln\frac{8}{4} + 2\ln\frac{9}{5} = \ln\left(\frac{81}{200}\right)$

**Answer: (a) $A = -3$, $B = 2$ (b) $\ln\left(\frac{81}{200}\right)$**

## 7 Modulus equations (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

Solve $|x-4| = |-3x-6|$.

Either $x - 4 = -3x - 6$ or $x - 4 = -(-3x - 6)$

$x - 4 = -3x - 6$ gives $x = -\frac{1}{2}$

$x - 4 = -(-3x - 6)$ gives $x = -5$

**Answer: $x = -5$ and $x = -\frac{1}{2}$**

## 8 Lift: weighing scales reading (AQA, Edexcel, OCR, MEI, Eduqas, CIE)

A woman of mass 60 kg stands on weighing scales in a lift. The lift decelerates at 1.5 m s$^{-2}$ while moving upwards.
Take g = 9.8 m s$^{-2}$.
Find the force exerted on the woman by the scales.

The acceleration is downwards, magnitude 1.5
Taking up as positive: $R - 60 \times 9.8 = -60 \times 1.5$
$R = 60(9.8 - 1.5)$
**Answer: 498 N**

## 9 Finding mean and standard deviation from two probabilities (All boards)

The masses (kg) of parcels are normally distributed.
P(X < 18) = 0.1587 and P(X > 48) = 0.0668.
Find the mean and standard deviation (3 s.f.).

$z_1 = -0.9998$ and $z_2 = 1.500$
$18 = \mu + (-0.9998)\sigma$ and $48 = \mu + 1.500\sigma$
Subtract: $30 = 2.500\,\sigma$, so $\sigma = 12.0$
$\mu = 18 - (-0.9998)(12.00) = 30.0$
**Answer: $\mu = 30.0$, $\sigma = 12.0$**

## 10 Velocity parallel to a direction (AQA, Edexcel, OCR, MEI, Eduqas)

A particle moves so that at time t s its velocity is $\mathbf{v} = (3t^2 + 3)\mathbf{i} + (3t - 3)\mathbf{j}$ m s$^{-1}$.
Find the time when the particle is moving in the direction of $\mathbf{i}$, and its speed then.

Parallel to $\mathbf{i}$: $\mathbf{j}$ component = 0
$3t - 3 = 0$, so $t = 1$
$\mathbf{v} = (3 \times 1^2 + 3)\mathbf{i} = 6\mathbf{i}$
**Answer: t = 1 s, speed 6 m s$^{-1}$**