Day 352 **A Tier 10-a-day: Model Solutions**

1 Median and interquartile range

Here are the masses, in kg, of 7 parcels.
37 33 54 8 41 44 23
(a) Work out the median.
(b) Work out the interquartile range.

Put in order: 8, 23, 33, 37, 41, 44, 54
(a) The middle value is number 4, so the median is 37
(b) Lower half: 8, 23, 33, so LQ = 23
Upper half: 41, 44, 54, so UQ = 44
IQR = 44 − 23 = 21
Answer: (a) 37 (b) 21

2 Area of parallelograms and kites

The diagram shows a rhombus.
The diagonals are 8 cm and 10 cm and cross at right angles.
Work out the area of the rhombus.
The diagram is not drawn accurately.

Area = $\frac{1}{2}$ × (diagonal 1) × (diagonal 2)

= $\frac{1}{2}$ × 8 × 10

= 40

Answer: 40 cm^2

3 Independent events

The probability that Tara wins a game is 0.2.
The probability that Isla wins a game is 0.9.
The two events are independent.
Work out the probability that at least one of them will win a game.

P(neither) = 0.8 × 0.1 = 0.08
P(at least one) = 1 − 0.08 = 0.92
Answer: 0.92

4 Quadratic inequalities

Solve $x^2 \geq 36$

$x^2 = 36$ at $x = \pm 6$
The curve $y = x^2$ is above 36 outside the roots
$x \leq -6$ or $x \geq 6$
Answer: $x \leq -6$ or $x \geq 6$

5 Income tax

No tax is paid on the first £12,000 of income. Tax of 20% is paid on the next £30,000. Tax of 35% is paid on all income above £42,000. (Calculator)
Femi earns £53,000 a year.
Work out the income tax paid.

Next £30,000 at 20%: £30,000 × 0.2 = £6,000
Above £42,000: £53,000 − £42,000 = £11,000, taxed at 35%: £11,000 × 0.35 = £3,850
Total tax = £6,000 + £3,850 = £9,850
Answer: £9,850

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6 Algebraic rearrangement and change of sign

(a) Show that the equation $x^3 + 4x - 28 = 0$ can be rearranged to give $x = \sqrt[3]{28 - 4x}$
(b) Show that the equation has a solution between x = 2 and x = 3

(a) Add 28 and subtract 4x from both sides: $x^3 = 28 - 4x$
Take the cube root of both sides: $x = \sqrt[3]{28 - 4x}$
(b) Let $f(x) = x^3 + 4x - 28$
f(2) = −12
f(3) = 11
There is a change of sign (negative to positive) and f is continuous, so there is a solution between x = 2 and x = 3
Answer: Shown: f(2) = −12, f(3) = 11 (change of sign)

7 Stem and leaf diagrams

The stem and leaf diagram shows the ages of 15 people.
Key: 1 | 2 represents 12 years
(a) Work out the median age.
(b) Work out the interquartile range.

(a) 15 values, so the median is the 8th value
Counting along the leaves gives 33
(b) LQ is the middle of the lower 7 values = 17
UQ is the middle of the upper 7 values = 38
IQR = 38 − 17 = 21
Answer: (a) 33 years (b) 21 years

8 Reverse compound change

The value of an investment grows by 20% each year. (Calculator)
After 2 years it is worth £43,200.
Work out its value at the start.

Yearly multiplier = 1.2
Overall multiplier = $1.2^2 = 1.44$
Original value = £43,200 ÷ 1.44 = £30,000
Answer: £30,000

9 Quadratic sequences

Here are the first five terms of a quadratic sequence.
7, 12, 15, 16, 15
(a) Find an expression for the nth term.
(b) Work out the 8th term.

First differences: 5, 3, 1
Second differences: −2, −2, so a = −2 ÷ 2 = −1
Subtract $-n^2$ from each term (−1, −4, −9, −16): 8, 16, 24, 32
This is linear: 8n
nth term = $-n^2 + 8n$
(b) Substitute n = 8: $-1 \times 8^2 + 8 \times 8 = 0$
Answer: (a) $-n^2 + 8n$ (b) 0

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10 Bearings with the cosine rule

Boat P sails 12 km from a harbour on a bearing of 185°.
Boat Q sails 20 km from the same harbour on a bearing of 305°. (Calculator)
Work out the distance between the two boats.
Give your answer to 3 significant figures.

The angle between the two paths = $|185° - 305°| = 120°$

$d^2 = 12^2 + 20^2 - 2 \times 12 \times 20 \times \cos 120°$

$d^2 = 784.00$

$d = 28.0$

Answer: 28.0 km