FREE SAMPLE: THE FIRST QUESTION

Question One (9 marks)

(a) Simplify $(4x^2y^{-6})^{(3/2)} \div (2y^{-1})$, giving your answer with positive indices only (x and y are positive).

[3 marks]

(b) Write $y = x^2 + 4x$ in the form $y = a(x - p)^2 + q$.

Hence state the coordinates of the turning point, and find the values of k for which the equation $x^2 + 4x = k$ has no real solutions.

[3 marks]

(c) A car is bought for $40,000. Its value falls by 15% of its value at the start of each year.

Form an equation, and solve it, to find after how many whole years the car is first worth less than 50% of its original price.

[3 marks]

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THE WORKED ANSWER TO THAT QUESTION

Question 1 (9 marks) [Expressions, indices and surds]

(a) Simplify $(4x^2y^{-6})^{(3/2)} \div (2y^{-1})$, giving your answer with positive indices only (x and y are positive).

(a) Answer: $4x^3/y^8$

- Evidence level: Merit (apply the laws of indices, including fractional indices).
- Apply the index $\frac{3}{2}$ to each factor in the bracket: $4^{(\frac{3}{2})} \times x^{(3)} \times y^{(-9)}$.
- $4^{(\frac{3}{2})} = 8$, so the bracket becomes $8x^3/y^9$.
- Divide by $2y^{-1}$: subtract the indices of x and y, and divide the numbers.
- Write with positive indices: $4x^3/y^8$.

> **KEY TAKEAWAY**
> Fractional indices: (a^m)^(p/q) means take the q-th root and raise to the power p; treat the number and each letter separately, then subtract indices when dividing.

(b) Write $y = x^2 + 4x$ in the form $y = a(x - p)^2 + q$. Hence state the coordinates of the turning point, and find the values of k for which the equation $x^2 + 4x = k$ has no real solutions.

(b) Answer: $y = (x + 2)^2 - 4$; turning point $(-2, -4)$; $k < -4$

- Evidence level: Merit (complete the square, then link the turning point to the number of solutions).
- Halve the x coefficient ($4 \div 2 = 2$) and square it.
- $y = (x + 2)^2 - 4$.
- The turning point is $(-2, -4)$, a minimum.
- $x^2 + 4x = k$ has no real solution when the horizontal line $y = k$ does not touch the curve: $k < -4$.

> **KEY TAKEAWAY**
> Completing the square gives the turning point (p, q) directly; a horizontal line y = k misses the parabola when k is beyond the minimum (or maximum) value.

(c) A car is bought for $40,000. Its value falls by 15% of its value at the start of each year. Form an equation, and solve it, to find after how many whole years the car is first worth less than 50% of its original price.

(c) Answer: 5 years

- Evidence level: Merit (model exponential decay and solve with logarithms).
- After n years the value is $V = 40{,}000 \times 0.85^n$.
- We need $V < 40{,}000 \times 0.5$, so $0.85^n < 0.5$.
- Take logs: $n \times \log(0.85) < \log(0.5)$. Dividing by $\log(0.85)$, which is NEGATIVE, reverses the inequality: $n > 4.27$.
- The first whole number of years is $n = 5$.

> **KEY TAKEAWAY**
> Exponential decay uses a multiplier below 1; dividing by a negative logarithm reverses the inequality sign.

LOS: Expressions, indices and surds (91261)

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