# Transformations with A, C, and D

**Part I — Basic Structure: Amplitude, Midline, Max/Min, Range**

1. For the function $y = A\sin(x - C) + D$. Describe the effect of, $A$, $C$, and $D$ on the graph of $y = \sin x$. Include amplitude, reflections, phase shifts, vertical shifts, and the midline.

2. For $y = 4\sin x + 3$ determine the midline, the maximum value, the minimum value, how far the graph extends from the midline.

3. Determine the transformations of each parent function in the correct order.

   a) $y = 3\sin\left(x - \frac{\pi}{2}\right) + 1$

   b) $y = 2\cos\left(x - \frac{\pi}{4}\right) + 3$

   c) $y = -4\sin\left(x + \frac{\pi}{3}\right) + 2$

   d) $y = 5\cos\left(x - \frac{\pi}{3}\right) - 2$

   e) $y = -3\cos\left(x + \frac{\pi}{4}\right) + 2$

4. Without graphing $y = -7\sin\left(x - \frac{\pi}{6}\right) + 4$, determine:
   - the maximum value
   - the minimum value
   - the range

**Part II — Phase Shift and Starting Behaviour**

5. For $y = 2\cos\left(x - \frac{\pi}{4}\right) + 3$ determine the starting point, maximum value, minimum value, and midline.

6. Without graphing $y = 5\cos\left(x - \frac{\pi}{3}\right) - 2$, determine:
   - whether the graph begins by increasing or decreasing
   - the maximum value
   - the minimum value
   - the phase shift

**Part III — Mapping Key Points**

7. The parent function $y = \sin x$ has key points: $(0,0), \left(\frac{\pi}{2}, 1\right), (\pi, 0), \left(\frac{3\pi}{2}, -1\right), (2\pi, 0)$. Determine the transformed coordinates of the key points for $y = 2\sin\left(x - \frac{\pi}{2}\right) + 3$.

8. The parent function $y = \cos\ x$ has key points: $(0,1), \left(\frac{\pi}{2}, 0\right), (\pi, -1), \left(\frac{3\pi}{2}, 0\right), (2\pi, 1)$. Determine the transformed coordinates of the key points for $y = -3\cos\ \left(x + \frac{\pi}{4}\right) - 2$.

**Part IV — Graphing Transformed Functions**

9. Determine the five key points for one complete cycle of $y = 3\sin\ \left(x - \frac{\pi}{2}\right) + 1$. Then sketch one complete cycle.

10. Determine the five key points for one complete cycle of $y = -4\sin\ \left(x + \frac{\pi}{3}\right) + 2$. Then sketch one complete cycle.

**Part V — Intercepts and Comparing Graphs**

11. Explain why $y = 2\sin\ x + 5$ has no x-intercepts. Then explain why $y = 5\cos\ x - 1$ does have x-intercepts. Use range, midline, and transformation behavior.

12. Compare $y = 2\sin x + 1$ and $y = 2\sin\left(x + \frac{\pi}{2}\right) + 1$. Describe:
    - what stayed the same
    - what changed

13. Compare the graphs of $y = \cos\left(x + \frac{\pi}{4}\right)$ and $y = -2\cos\ \left(x + \frac{\pi}{4}\right) - 3$. Describe:
    - reflection
    - phase shift
    - vertical shift
    - amplitude change