2016 F=ma Exam: Problem 4

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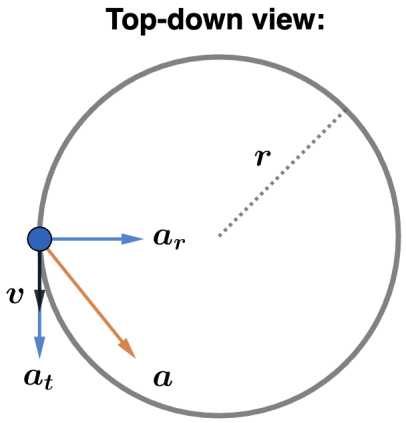

Looking top-down at the bead sliding down the helix, we see that it has a tangential acceleration a_t determined by the pitch of the helix and a radial acceleration $a_r = v^2/r$. The total acceleration is

$$a = \sqrt{a_t^2 + a_r^2}$$

Since $v = a_t t$, we have

$$a(t) = \sqrt{a_t^2 + \left(\frac{a_t^2 t^2}{r}\right)^2} = a_t \sqrt{1 + \frac{a_t^2 t^4}{r^2}}$$

To determine the graph of $a(t)$, we look at small and larges times. For $t \to 0$,

$$a \to a_t = \text{const.}$$

For $t \to \infty$,

$$a \to \frac{a_t^2 t^2}{r} \propto t^2$$

Thus, the answer is $\boxed{\text{D}}$.