[mex130] Apsidal angle at very low energies

Use the result of [mex128] to show that for a power-law central force potential $V(r) = -\kappa/r^\alpha$, $0 \leq \alpha < 2$ the apsidal angle of orbits with given angular momentum ℓ approaches an ℓ-independent value at very low energy:

$$\lim_{E \to -\infty} \Delta\vartheta = \frac{\pi}{2 - \alpha}.$$

Hint: Consider first the case $\alpha = 1$.

Solution: