

## Problem 6: Migrating Birds

---

Power ( $P$ ) is the rate at which energy ( $E$ ) is consumed per unit time. Ornithologists have found that the power consumed by a certain pigeon flying at velocity  $v$   $m/s$  is described well by the function  $P(v) = 17v^{-1} + 10^{-3}v^3$   $J/s$ . Assume that the pigeon can store  $5 \times 10^4$   $J$  of usable energy as body fat.

1. Find the velocity that minimizes the power consumption.
2. Show that a pigeon flying at velocity  $v$  and using all of its stored energy can fly a total distance  $D(v) = (5 \times 10^4)v/P(v)$ .
3. Migrating birds are smart enough to fly at the velocity that maximizes distance traveled rather than minimizes power consumption. Show that the velocity  $v_{dmax}$  that maximizes the total distance satisfies  $P'(v) = P(v)/v$ .
4. Find  $v_{dmax}$  and the maximum total distance that the bird can fly.

As always, show your work, fully explain and justify your answer. A solution mainly obtained by computers or calculators will not be accepted.

---

Posting Date 3/20/2021. Submit solutions to Noah Aydin, Mathematics Department, RBH 319 by e-mail or hard-copy by noon on April 2, 2021. An email submission must be a single pdf file. Hard copy submissions must be dropped in the file holder at my office door (Hayes 319) and must include a time stamp.