Assignment # 4 <u>due</u> Feb 24 /05

Everyone should have a possible project idea for ther class session on Th Feb 24, and must submit a tentative project title by March 10th. If you have some ideas but are not quite sure talk with Phil, Ken, John, Margo or Boye. Please enter your topic and your e-mail address onto the list put out on the first class (Tuesday) after the midterm break.

P4-1 Swimming in the river

A swimmer takes 5.2 minutes to swim 400 meters downstream in a river. On the return trip it takes her 22.2 minutes to swim back to the starting point. On both laps she applies a steady muscle power of 90 Watt.

a) What is the river velocity v?

b) What is her swimming speed u relative to the water ?

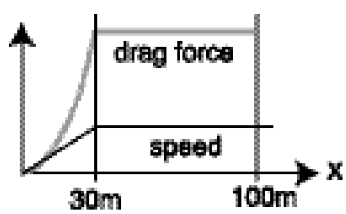
c) What is the drag force F_D?

d) The propulsion force is generated by pushing water rearwards (conservation of momentum). Give reasonable values for the speed u_w [m/s], and the mass flow J[kg/s] that must be ejected rearwards by the swimmer.

4-2 A model of the 100 meter dash

A 75 kg athlete takes T = 11.0 seconds to run 100m. Initially he speeds up at constant acceleration, *a*, until he has reached the distance x_1=30m. Call this time $t=t_1$. Thereafter he maintains constant speed, v_f to the finishing line at x_f= 100m. (no acceleration, all his force is spent to overcome the drag resistance. Assume that it scales as $F_{dr} = Cv^2$ where C= (1/2) $C_D \rho$ A. During the second time interval from t_1 to T, he runs at constant speed

a) What is the time t_1? b) How does the speed increase in the first time interval? What is the final speed v_f ? c) What is the acceleration *a*. d) What force F_m does he apply with his muscles at the very beginning, when the air resistance is still negligible small? e) Assume that in the end, close to the finishing line (where no acceleration takes place) the drag resistance F_d equals the <u>initial</u> muscle force F_m. Find the drag constant C. Then express the muscle force F_m as function of time. f) Calculate the total mechanical energy expenditure E= ?F_m dx. Note that the velocity increases as $v^2-v_o^2=2ax$. If you have trouble with the integration give at least a lower limit for E. g) Give the average mechanical power P, and determine his activity factor b.



P4-3 Locomotion Allometry

(a).. Determine an allometric relation for the average swim velocities shown in the great swim diagram Fig 6.7 (P438 project of M.Y.Yeung 2001), and produce a log-log plot with the propagation velocities U for walking, swimming and flying as function of the body mass. (b) Take the flight velocity of a crane fly, and determine the body weight of a walking, and a swimming animal that moves at the same speed as the crane fly.

(c) Calculate the drag force F_D that a spotted sandpiper has to overcome in flight (remember that the mechanical power $F_D \cdot u$ must be delivered by the metabolism) Take C_D= 0.5. What body parameters do you need to estimate or chose (justify your choice) in order to find F_D? (d) Can you think of reasons why bumble bees and hornets have reported velocites that are significantly above the allometric velocity in the great flight diagram

(e) Why are the velocities of aquatic animals so widely scattered in the great swim diagram, some being nearly a factor 10 above the average allometric swim velocity, and others well below it?

P4-3 Intensities

An object drifting deep under water in the ocean emits blue light (λ= 470 nm) and red light (λ=670nm), and it makes a high pitched sound at f=1000Hz. A diver observes these signals at a distance of 65 meters, and measures the intensities $I_{sound}=4 \cdot 10^{-6}$Watt/m^2, and $I_{blue}=2 \cdot 10^{-3}$Watt/m^2 and $I_{red}=4.2 \cdot 10^{-4}$Watt/m^2 respectively. What are the light intensities [W/m^2] and what is the sound level β at the source?

Reaction times for stopping the clock measured in class Feb 8/05

? t				av	Rob			av
Eye ? t_{eye}	0.247	0.235	0.222	0.233	0.228	0.193	0.198	0.206
Ear /? t_{ear}	0.192	0.175	0.138	0.167	0.168	0.184	0.163	0.172
? t_{eye}/? t_{ear}				1.39				1.20

The ears react faster by at least 20%