Problem Set #2 due beginning of class, Tuesday, April 17. Please state the lens you are using and why.

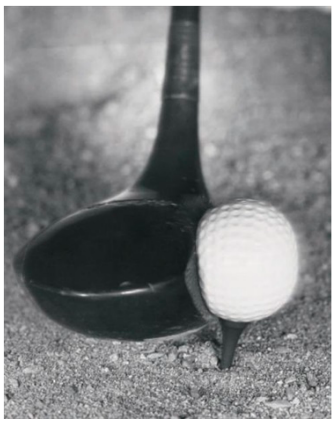
Very important!. Thursday of Week 2, we will do our first of two projects. We will take kinematic movies of an activity. You will provide graphs of your movement as a function of time – position-t, velocity-t, acceleration-t, net force-t, kinetic energy-t, power-t. You will calculate the maximum power you put out. Please plan this activity in a group of 2-4 people. Please read more about the project on the class webpage on our main class website. Please propose an activity/experiment that your group could do. This project is part of your final grade. It will be collected on Thursday of Week 3.

1. My mass is 70 kg, and the mass of my bike is 10 kg. I'm riding my bike at a constant speed of 15 m/s. At 0s, my displacement is x = -10 m. At t = 1s, I apply my breaks and smoothly slow to a stop over a period of two seconds.
   a) What lens do I use to make these graphs?
   b) Please graph my acceleration, velocity, and displacement as a function of time. Label the axes correctly.

   Then please also find:
   c) the force exerted by my breaks;
   d) and the work done by my breaks and
   e) the average power.
   f) Was energy conserved in this process? How?
   g) Was momentum conserved in this process? How?

3. Denny Shute (https://en.wikipedia.org/wiki/Denny_Shute) was a rather tall professional golfer in the 1930s. "Doc" Edgarton (https://en.wikipedia.org/wiki/Harold_Eugene_Edgerton) was a professor of electrical engineering at MIT who pioneered stroboscopic photography, where an ultra-short flash allowed a process to be illuminated on camera film for such a short time to freeze the process in time. His pictures of a bullet through an apple (http://www.bbc.com/future/story/20140722-the-man-who-froze-the-world) for instance made him famous, and when I was a student there in the early 80's his talks would fill the largest lecture halls with no standing room left. Edgerton photographed Denny Shute hitting a golf ball (http://artsalesindex.artinfo.com/auctions/Harold-Edgerton-5230133/Densmore-Shute-Bends-The-Shaft-1938) in the dark with multiple flashes at a frequency of 100 flashes per second.

a) In this photograph of Denny Shute's drive, how can you perceive speed? What lens do you look at this problem through?



b) Where is the golf club moving the fastest? How can you tell? Which lens do you use?
c) Where is the golf club speeding up and slowing down?
d) How does the speed of the golf ball compare to the speed of the golf club?
e) There was no flash at the moment that the club hits a golf ball. Where is the club when the ball is at the last two positions before leaving the screen?
f) Estimate the speed of the golf ball from this picture. Express it in m/s.
g) Roughly estimate the speed of a golf ball from your experiences. Close your eyes and imagine one being hit, or see a video: https://www.youtube.com/watch?v=8W89QnvY4Rg
h) When the club hits the ball, the ball speeds up. Should the speed of the club change as well? How do you know? What lens do you use?
i) From looking at the change in speeds of the ball and club on impact, can you make some statement about their relative masses? Can you estimate the ratio of the mass of the club to the mass of the ball?
j) Please estimate the amount of time that the club is in contact with the ball. You might do this by considering Edgerton's picture, or a careful look at this video at about 30 s: https://www.youtube.com/watch?v=6TA1s1oNpbk
k) Please calculate the average force between the ball and club during the collision.
l) Please calculate the average power provided by the club to the ball during the collision