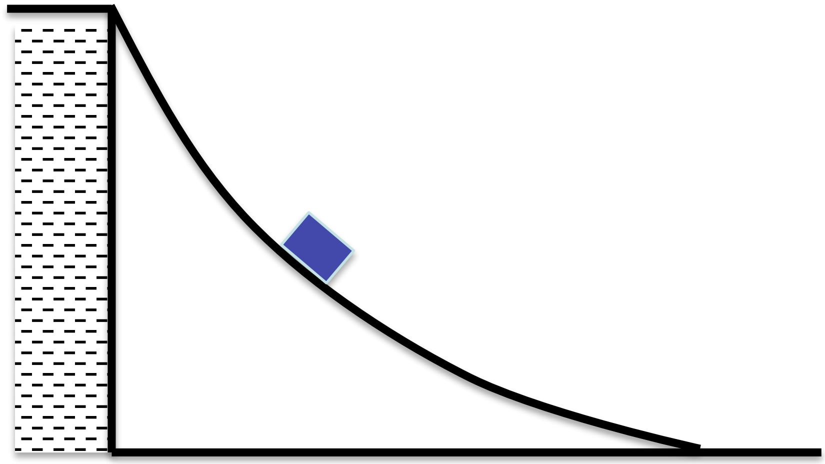
Problem Set #2 due beginning of class, Tuesday, Oct. 4.

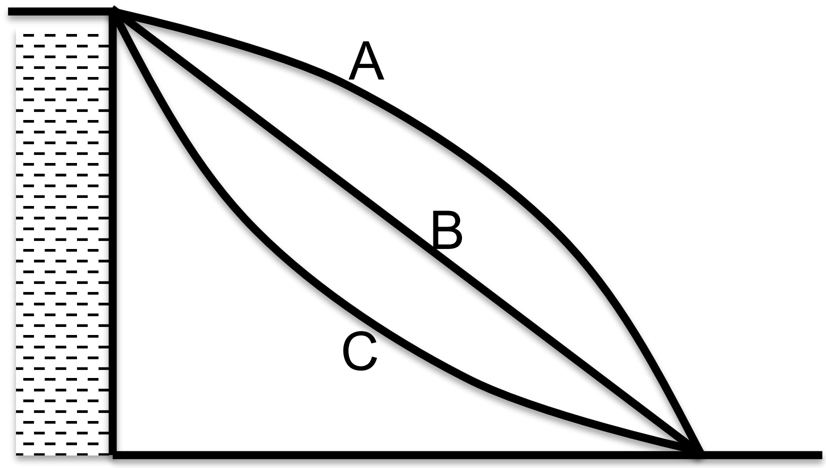
#1 Imagine a 5 kg box sliding down a frictionless curved track at the edge of a 60 m high cliff as shown at right. We would like to know how fast it's going at the bottom. Neglect air friction.

a) Describe using each of the four lenses, what is happening in this process.
b) Which lens is the most helpful to find the final speed of the block at the end?
c) Please find out the speed at the bottom of the track.



Now imagine that there are two other tracks that the box could use as shown at right, bottom.

d) Which track should we use for the fastest final speed, or would all three tracks yield the same final speed? Which lens do you look at this problem through? Please explain your answer.
e) How about if we wanted to know which was going the fastest *half way* down the total length of its path?
f) If three identical frictionless boxes were released at the top of each track, which would get to the bottom first, or would it be the same for all of them? Please explain your answer in terms of which lens you used.



#2. I fling a ball upwards at 20 m/s.

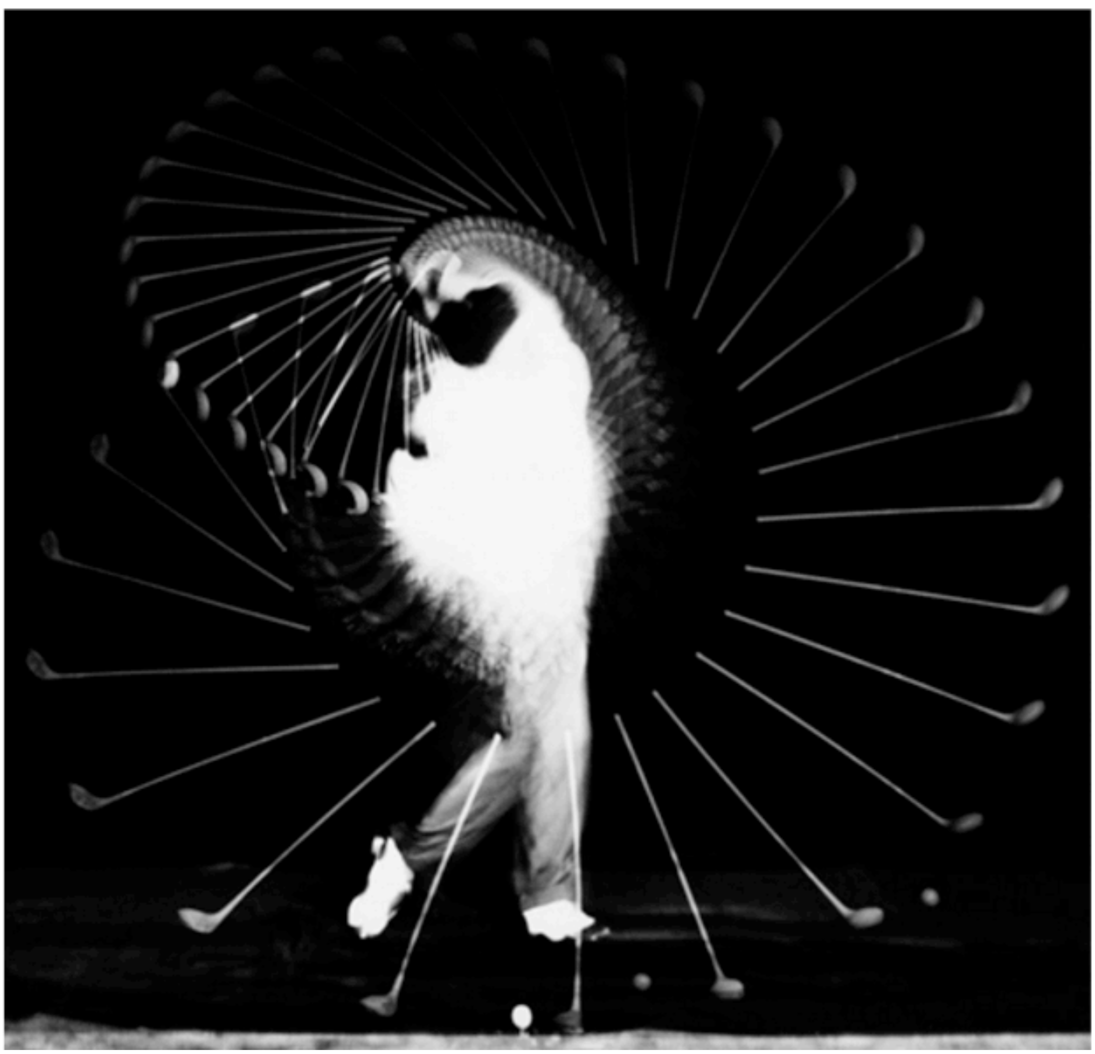
a) How many different ways (lenses) can you think of to find out how high the ball gets? Find the maximum elevation.
b) Find the velocity when the ball is 10 m above the take off point.
c) Make a graph of the ball's velocity versus time.
d) Using the graph above, make a graph of the ball's vertical position versus time.

#3. Two carts have an inelastic collision, approaching each other from opposite directions, both at speeds of 10 m/s. Cart A, moving to the right, has a mass of 1 kg. Cart B has a mass of 2 kg.

a) What is the total kinetic energy of the system?
b) What is the total momentum of the system?
c) What is the final speed of the system?
d) What is the final kinetic energy of the system?
e) How much thermal energy was liberated as heat?
f) If the collision lasted 0.05 seconds, what was the magnitude of the average force between the carts?

#4 Denny Shute was a rather tall professional golfer in the 1930s. "Doc" 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 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 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 does 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 the golf ball. Where is the club when the ball is at the 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.
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.
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



#5 Tracker Assignment, *Please give this "the old college try". If you can't get it to work on your computer (I never got it to work with mine), then please have someone in your group show you how they got it to work on their computer. Otherwise, try doing it with Excel as I do with my motion on the track. Above all, don't let this get you down, it's not worth it.*

Purpose: In this assignment you will familiarize yourself with the Tracker software.

Parts:

You can find the grasshopper file at: https://www.youtube.com/watch?v=EoT_4B-gbRI&src_vid=O-JVepPdZbY&feature=iv&annotation_id=annotation_951640825

1. Watch Smarter Every Day. Download the "Raw Grasshopper Jump Video" file located above. (The link at the end of the Smarter Every Day video is unreliable).
2. Read the Instructions also located adjacent to this document on the Wikispaces website.
3. Repeat the Grasshopper experiment as described in the Smarter Every Day Video using the Tracker Software and come up with the acceleration of this other grasshopper video.
4. Do the best you can by using Tracker, Excel, or any other means to measure the acceleration of the Grasshopper. If you look in the lower left corner of the video, you'll see that the time is given to the *millionth* of a second and that the grasshopper begins the hop around 14 hours, 33 minutes, 26.6 seconds. You will have to make your own scale based on the length of the leg, but this is very doable. Do as good a job as you can.

#6 Cars. a 1000 kg car starts from rest and accelerates with uniform acceleration to 30 m/s in 5 seconds.

a) What was the average power put out by the car's engine? Please put answer in Watts and HP.
b) Is 30 m/s a very high velocity for a car?
c) What was the average force put out by the engine?
d) Then I lock up the wheels providing 10,000 N of force to slow us down, how long are the skid marks?
e) Please make three graphs: *a-t, v-t, x-t.*

#7 Next Tuesday, we will take kinematic movies of an activity. 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 activity on the class webpage at https://sharedcurriculum.wikispaces.com/First+Project+for+Fall+2016