Unit III Energy Addendum- Particle undergoing uniform acceleration

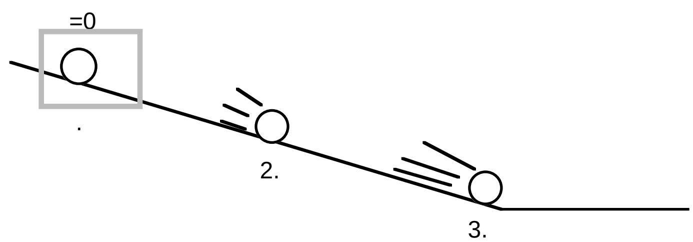
Lab: ball rolling down inclined ramp

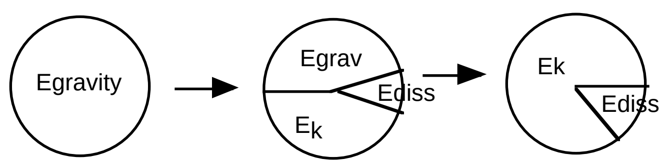
1. Release ball from top of ramp and observe rolling. Explore the energy processes involved:

Leading Questions

- Does the ball have energy at the top of the ramp as I hold it? How do you know?
  (yes-it will roll if released-energy is stored-potential energy)
- Where does that energy come from?
  (gravity)
- What happens to that energy?
  (makes the ball roll-energy of motion, and some is also "lost to " friction)

2. Represent the situation using pie charts, after having defined the **system** =ball + ramp





1. Ball has energy due to gravity to start. (gravitational potential energy)

2. As ball rolls, it gains energy of motion, loses energy of gravity, and some energy is dissipated due to friction.

3. At the bottom, the ball has no more energy due to gravity. The energy is now in the motion of the ball, and some has been dissipated due to friction.

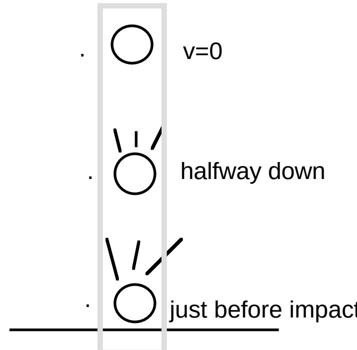
Leading Questions

- What would you physically change about the set-up in order to require larger pie circles to represent the situation?
  (same position- steeper ramp, start ball higher on ramp, more massive ball)
- What would change if the ramp had a rougher surface?
  (greater proportion would be E_{diss})
- How would a rougher surface change the original size of the circles?
  (wouldn't change sizes, because total energy is same. Would just increase the portion that went to E_{diss}.)

UNIT III CONT'D

Lab: freefall lab

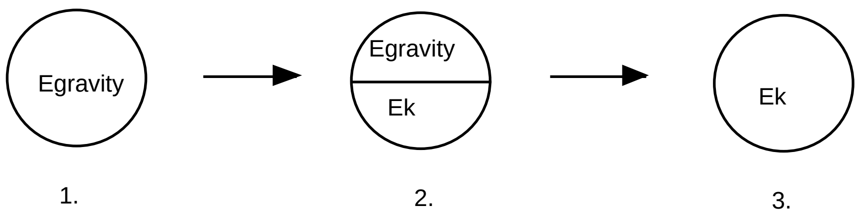
system: ball + Earth



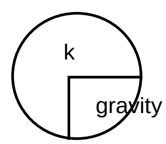
Leading Questions

- Describe the energy of the ball at the top, before it starts to fall.
  (energy due to gravity)
- What happens to the energy as the object falls?
  (energy is transferred to energy of motion)

Corresponding Pie Charts



- Why is there no E_{diss} here?
  (air resistance is minimal - but you could put in a tiny E_{diss} portion)
- What would change if you dropped the ball from a higher point?
  (bigger circles-more energy to start with)
- How would the middle pie look different if the object were 3/4 of the way down instead of 1/2?
  (3/4 would be $E_{kinetic}$, 1/4 $E_{gravity}$):

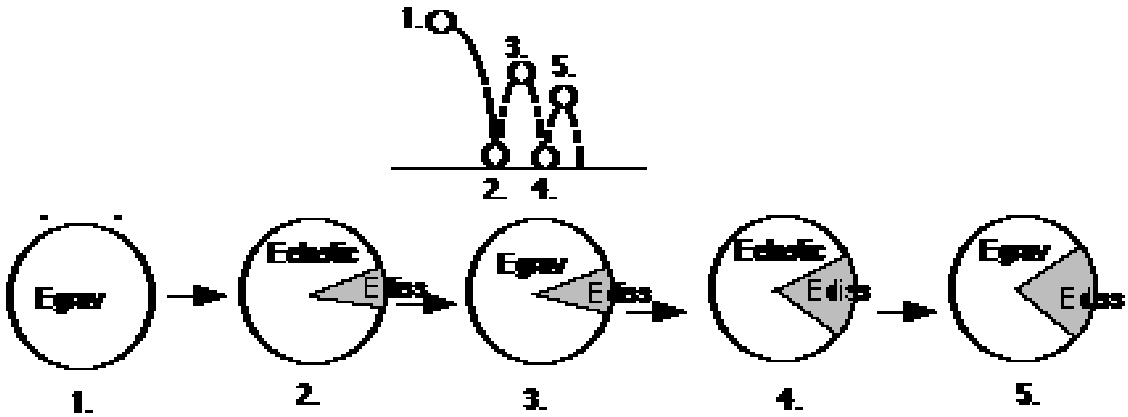


Analysis

1. Note that the Earth has been included in the system here. This is so that the energy of gravity can be considered an internal energy. If the Earth were NOT included, the Earth would be exerting a force on the object, which would cause the transfer of energy via an external force (work). This is a more complex analysis, better saved for later labs.

UNIT III CONT'D

2. An extension question-what happens when the object hits the ground?(stage 4) (assuming it doesn't bounce).What would the pie look like?
   The entire circle would be Ediss - the energy of motion would be "lost" (dissipated) in the collision to the internal energy of the object and the Earth.
3. What if it DID bounce? Another good extension question - what would the energy analysis of a bouncing superball look like?



system = ball and floor
With each bounce, the original gravitational energy becomes stored in the elastic potential energy of the rubber ball as it hits the floor. Some of that elastic energy is dissipated to the internal energy of the ball and the floor. This dissipated energy can no longer be used, so there is less energy available to go back to gravitational potential energy, and thus the ball does not go as high. This dissipated energy is shown shaded in, to represent the unuseable nature of E_{diss}.

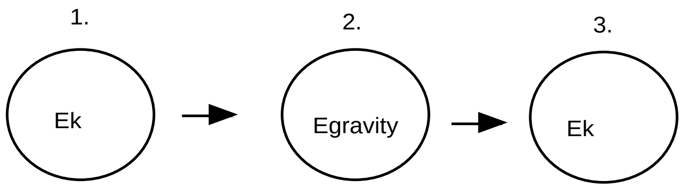
If the analysis were taken to the point where the ball stopped bouncing completely, the final pie chart would be a shaded-in circle of E_{diss}.
To be more detailed, one could represent the energies at intermediate stages to address the kinetic energy changes as well.

KINEMATICS/ENERGY DEPLOYMENT IDEAS

Energy analysis could be included in the kinematics deployments in order to make the whole unit more cohesive.

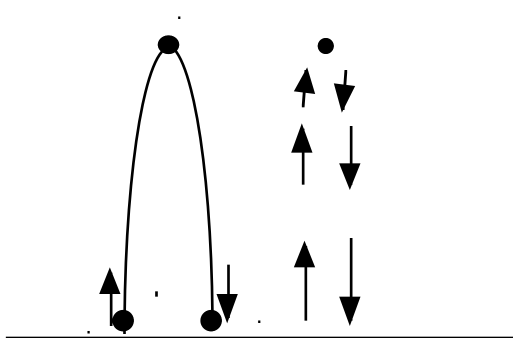
For example: Given a particular motion map, generate a situation that it could be representing, and draw the corresponding pie charts. Or given the pie charts, generate the corresponding motion maps.

<u>Example 1:</u>



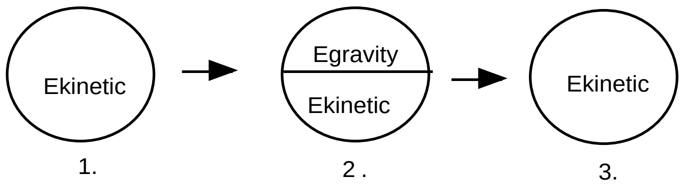
Possible situation:
throw a ball up, and it falls back down

Draw the corresponding pictorial representation, identifying the points shown by each pie chart. Draw the corresponding motion map.



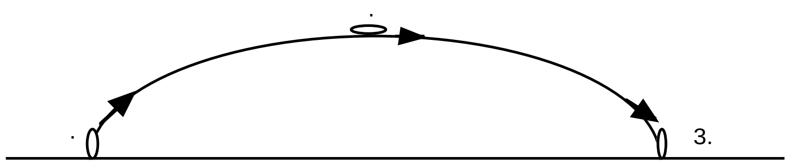
DEPLOYMENTS, CONT'D

Example 2:



Possible situation:
projectile motion - throwing a football, launching missile, etc.

Draw the corresponding pictorial representation, identifying the points shown by each pie chart. Draw the corresponding motion map.



Example 3

Do a pictorial representation and system designation, motion map and pie charts for a block sliding to a stop on a table: