Phy100: More on Energy conservation

1) Mechanical energy (review);

2) Conservation law for isolated systems;

3) Energy model for open systems and work done by external forces.

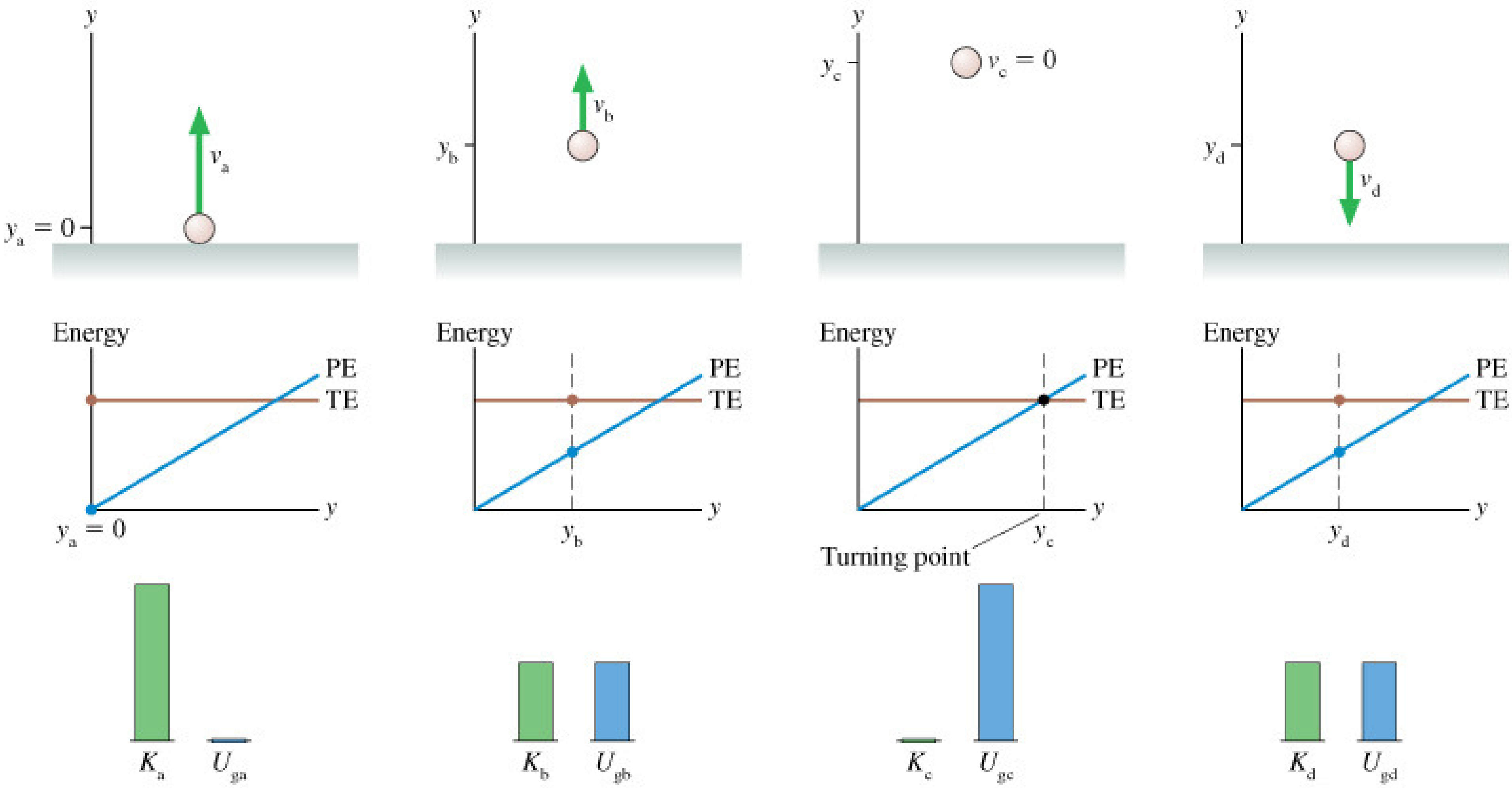
Q2 (from the previous lecture)

A stone is rolling downhill along two different paths, one is twice as long as the other.

At the bottom, the velocity of the stone rolling along the longer path is

1) twice as much as that along the shorter path;
2) one half;
3) the same;
4) None of the above.

A pebble tossed into the air



The particle is projected upward. Energy is entirely kinetic.

The particle has gained potential energy, lost kinetic energy.

The energy is entirely potential at the turning point.

The particle gains kinetic energy and loses potential energy as it falls.

Mechanical energy conservation!?

Under what conditions is the Mechanical energy (total of kinetic energy and potential energy) conserved ? (See Paul's demo)

No dissipations say due to frictions or the system is frictionless (See simulations on Friday), or inelastic collisions. Practically, there are always dissipations.

Energy conservation is generally true. However, energy in a particular form (mechanical) is conserved only conditionally.

Bob's Summary of Paul's experiments

1) A ball is released from a given height y; it has potential energy U and no kinetic energy;

2) When the ball approaches the floor, the potential energy is becoming zero (we choose the ground level as our reference point for the potential energy). A tiny but finite amount of mechanical energy is lost due to air frictions during free-fall. Potential energy is mostly transformed into kinetic energy K; however, a small fraction is also transformed into heat H. K=U-H.

3) The ball collides with the floor; the ball is slightly deformed and a substantial part of kinetic energy is transformed into the internal elastic energy related to the deformation, called D; (Paul used a flat ball and this part is big.)

4) The ball bounces back from the floor, but with much less kinetic energy K'=K-D; so a part of mechanical energy is lost during the collision.

5) The deformation energy later is released when the shape of ball is restored.
Energy D is used to do work on the air by pushing molecules away; both the air and ball will be slightly heated during restoring.

6) The ball rises to a maximal height y' which is lower than the initial height y in 1); kinetic energy K' is mostly transformed into the potential energy U'; a small fraction again is lost because of air frictions. U' < K'. Back to 1-4)

Q1

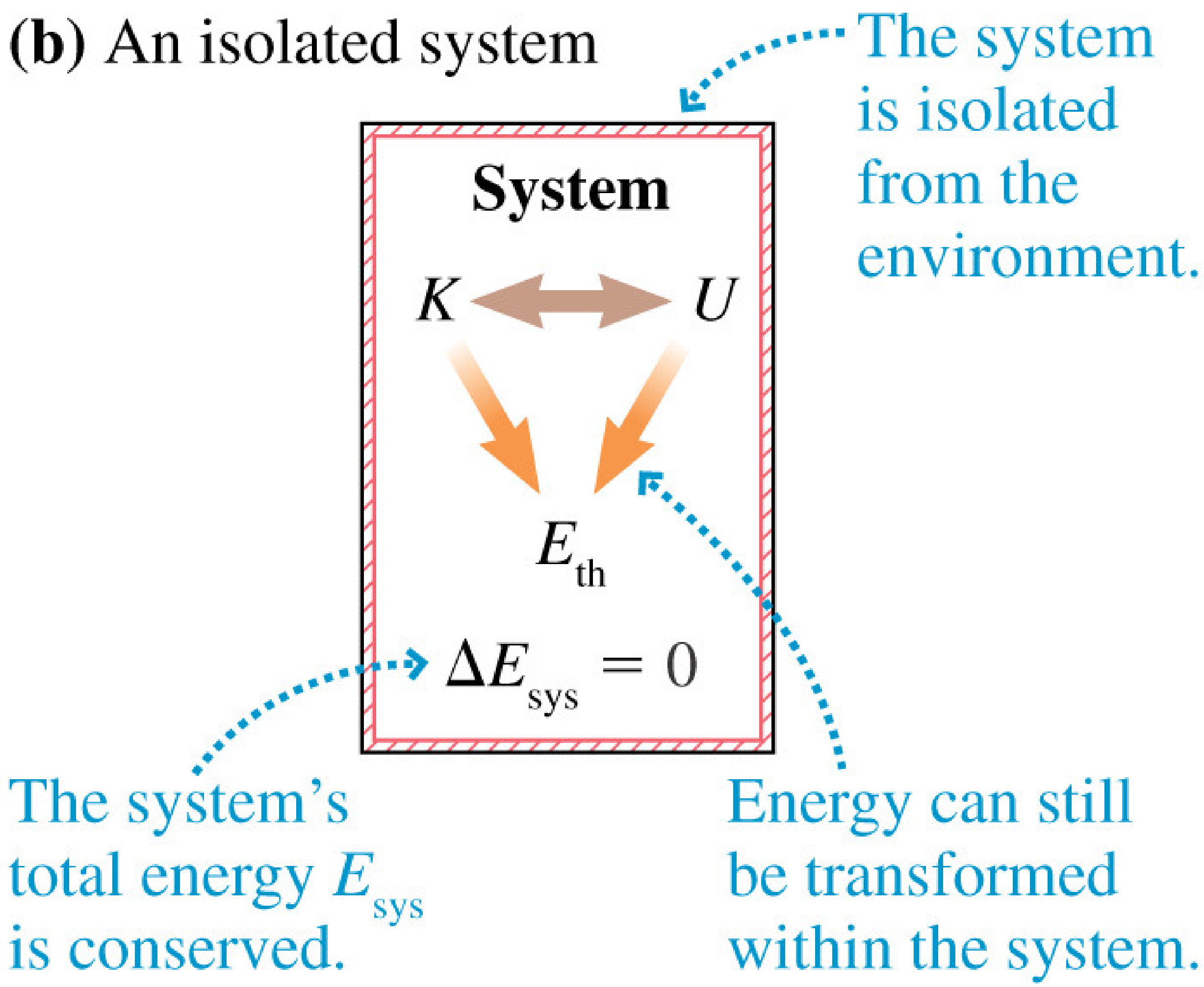
Two marbles, one twice as heavy as the other, are dropped from the roof of a building. The friction force on the heavier one is also TWICE as much as the force acted on the light one. When hitting the ground, the heavier marble has

1) as much kinetic energy as the light one;
2) Twice as much as the light one;
3) half as much as the light one;
4) Impossible to determined.

Q2

Two marbles, one twice as heavy as the other, are dropped from the roof of a building. The friction force on the heavier one is the SAME as the force acted on the light one. When hitting the ground, the heavier marble has

1) as much kinetic energy as the light one;
2) Twice as much as the light one;
3) half as much as the light one;
4) Impossible to determined.

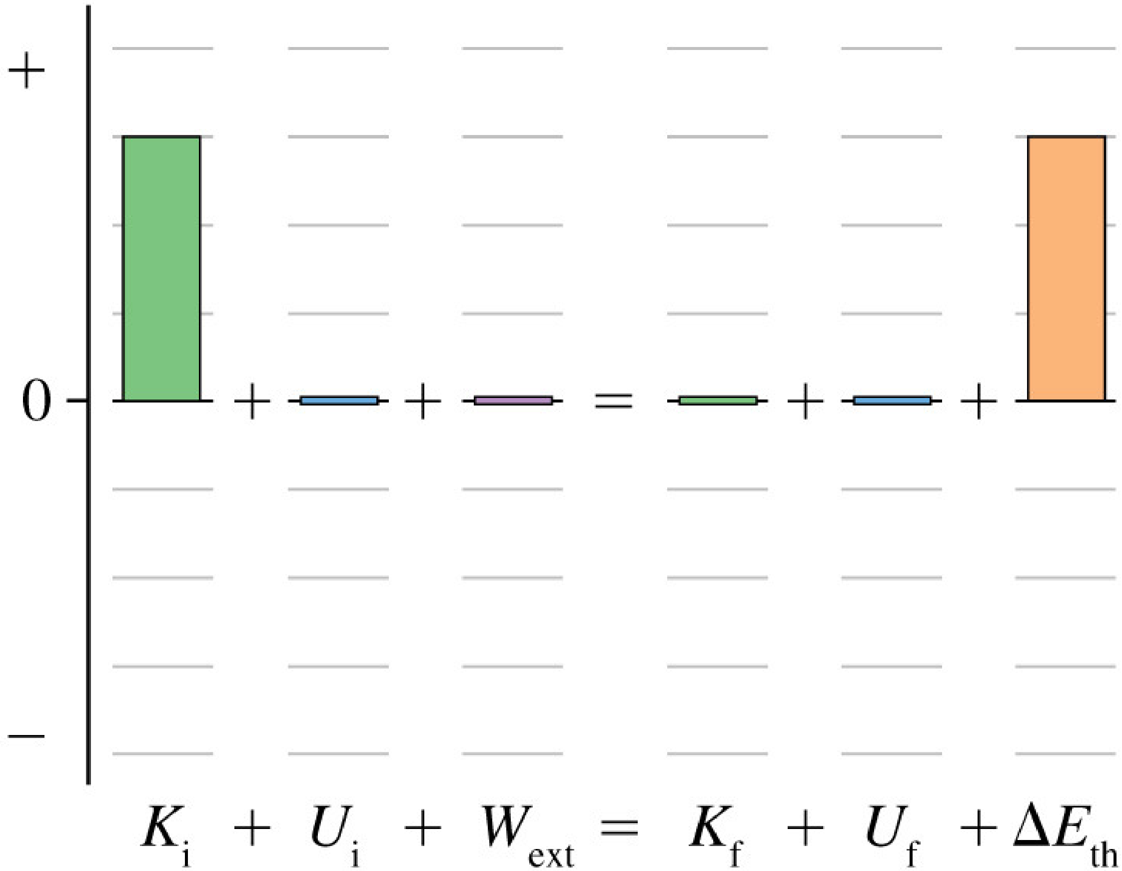


Energy conservation including thermal energy

Esys is conserved for an isolated system

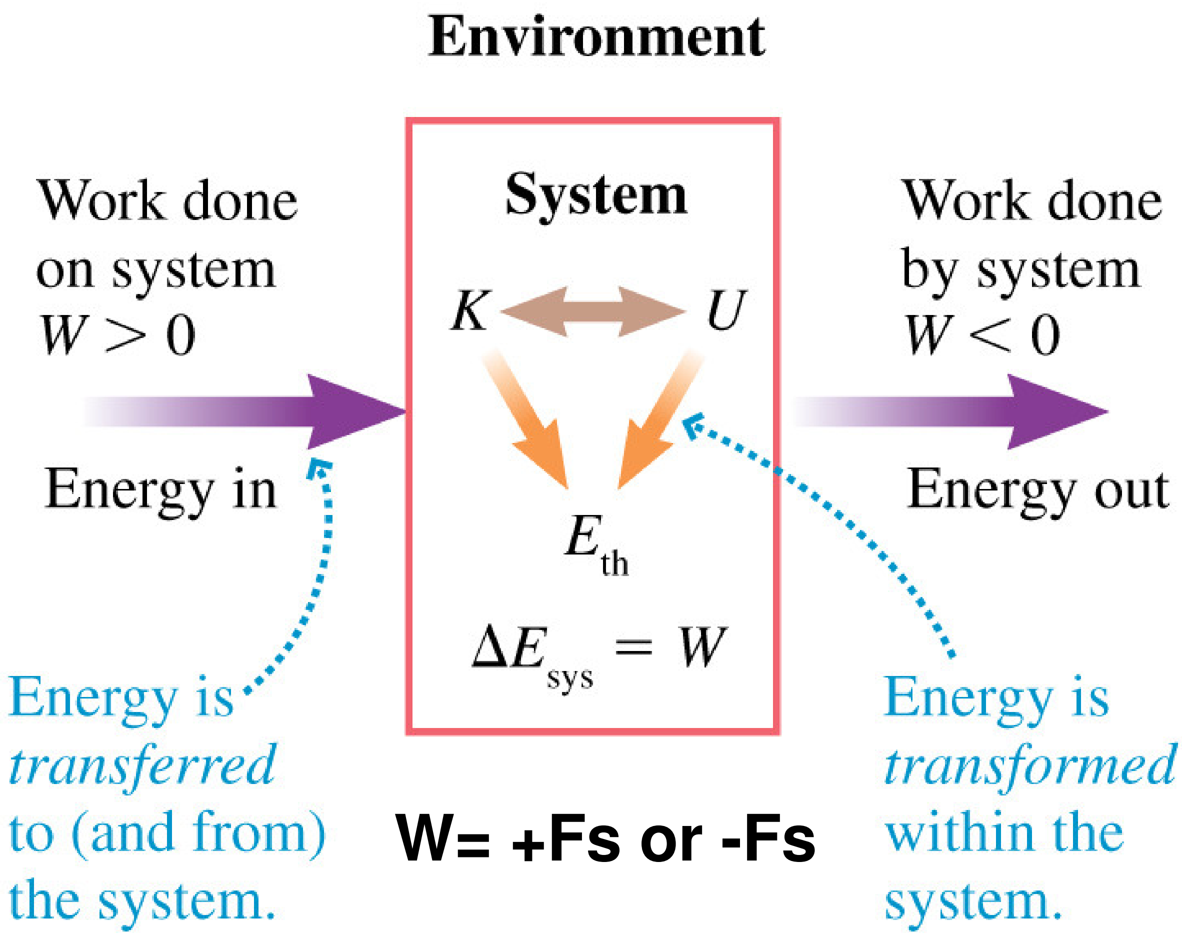
Energy bar chart for a block

sliding across a rough floor until it stops



Energy transfer, work and energy conservation for open systems

Work is an energy transfer due to mechanical forces.



W= +Fs or -Fs

Q3: Work

A block of mass m is pushed on a frictionless surface over a distance s; the exerted force is F. If the mass and distance s are doubled,

1) the final velocity is unchanged;
2) the final kinetic energy is halved;
3) the final velocity is doubled;
4) Not enough information.

Q4: thermal energy

Now suppose there is a small friction force. When both the friction force f and distance s (over which force F is exerted) are doubled, the work done by the friction force or the heat produced before the block comes to a stop is

1) Doubled;
2) Four times as much;
3) Unchanged;
4) Not known because the distance S' over which the object moves before becoming still is not given.

Simulations of energy conservation---

Energy skate park