WORK DONE BY A FORCE

$W_F = |\vec{F}| * |\Delta\vec{S}| * \cos\alpha$

WORK-ENERGY THEOREM (USE WHEN SPEED IS GIVEN/REQURED)

$W_{NET} = K_{FIN} - K_{IN}$

WORK BY GRAVITY $W_G = -mg(y_{fin} - y_{in})$ depends only from initial and final height (*not from the path*)…the weight is a conservative force

This allows to define a function, **GRAVITATIONAL POTENTIAL ENERGY U_G = mgy . ..similar steps for ….*ELASTIC POTENTIAL ENERGY* $U_{el} = (k/2)\,x^2$**

Note: In majority of cases, one fix y = 0 to the earth surface but depending on the problem one may select as Y = 0 to the initial height of the object (y_{in} = 0).

GRAVITATIONAL POTENTIAL ENERGY is defined by the distance of the object form the "source of gravitational force = EARTH for the object close to the earth".

Ug BELONGS ESSENTIALLY to the " *SYSTEM* OBJECT-EARTH " but we often refer it as the POTENTIAL ENERGY of the object.

TOTAL MECHANICAL ENERGY OF THE SYSTEM E = U + K POTENTIAL ENERGY U = Ug + Uel (U_g = mgy ; $U_{el} = kx^2/2$) KINETIC ENERGY $K = m\frac{v^2}{2}$

PROBLEM SOLVING METHODOLOGY

CASE – A (*NO THERMAL ENERGY MENTIONED IN PROBLEM REQUIREMENTS*)

1. *Write all the forces acting on all objects of the problem and identify the conservative forces(weights and elastic forces in mechanics).*
2. *Define the potential function due to each force U_1, U_2,..and the total potential function $U = U_1+U_2+$..*
3. Define "THE SYSTEM"; WRITE CLEARLY System***: EARTH + block _1,+ block_2 +SPRING_1+***…
   In mechanic's problem with objects close to the earth, *the earth is always part of the system*.
4. Draw one diagram showing and CLEARLY noting the *initial and final configurations* of the system. You *do not need to draw the earth* in those diagrams but you must note clearly the **space location where the each potential function U_i is zero (ex. level y = 0 where U_g=0, x=0 where U_{el} = 0)**.
5. Write the ***general form of mechanical energy conservation principle*** $W_{ext} = E_{fin} - E_{in}$ **(*)**
6. *Write clearly the expressions for the initial and final* ***total mechanical energies*** *of the system.* ***Do not forget to include elastic energies if springs participate in the problem.***
7. *Identify and write the* ***external forces****. These are the* ***non conservative*** *forces acting on the system..*
   Remember that the weights are always internal forces because earth is part of the system.
8. *Write the expression for the* ***net work*** *done by* ***external*** *forces* $W_{ext} = \cdots + \cdots + \cdots$.
9. *Substitute the expressions for external work and initial /final energies at the expression (*)*
10. *Solve the found equation for the required unknown.*

CASE – B (*THERMAL ENERGY MENTIONED IN PROBLEM REQUIREMENTS*)

1. The system includes only one of two objects which rub to each other
2. The principle of energy conservation is written $W_{ext} = \Delta E_{mech} + \Delta E_{thermal}$ ***where $\Delta E_{thermal} = \Delta E_{th\text{-}sys} + \Delta E_{th\text{-}obj}$ and W_{ext} does not include friction***
3. The work by friction force goes to increase the thermal energy $\Delta E_{Thermal} = |W_f| = -W_f = -(-f * \Delta x) = f * \Delta x$