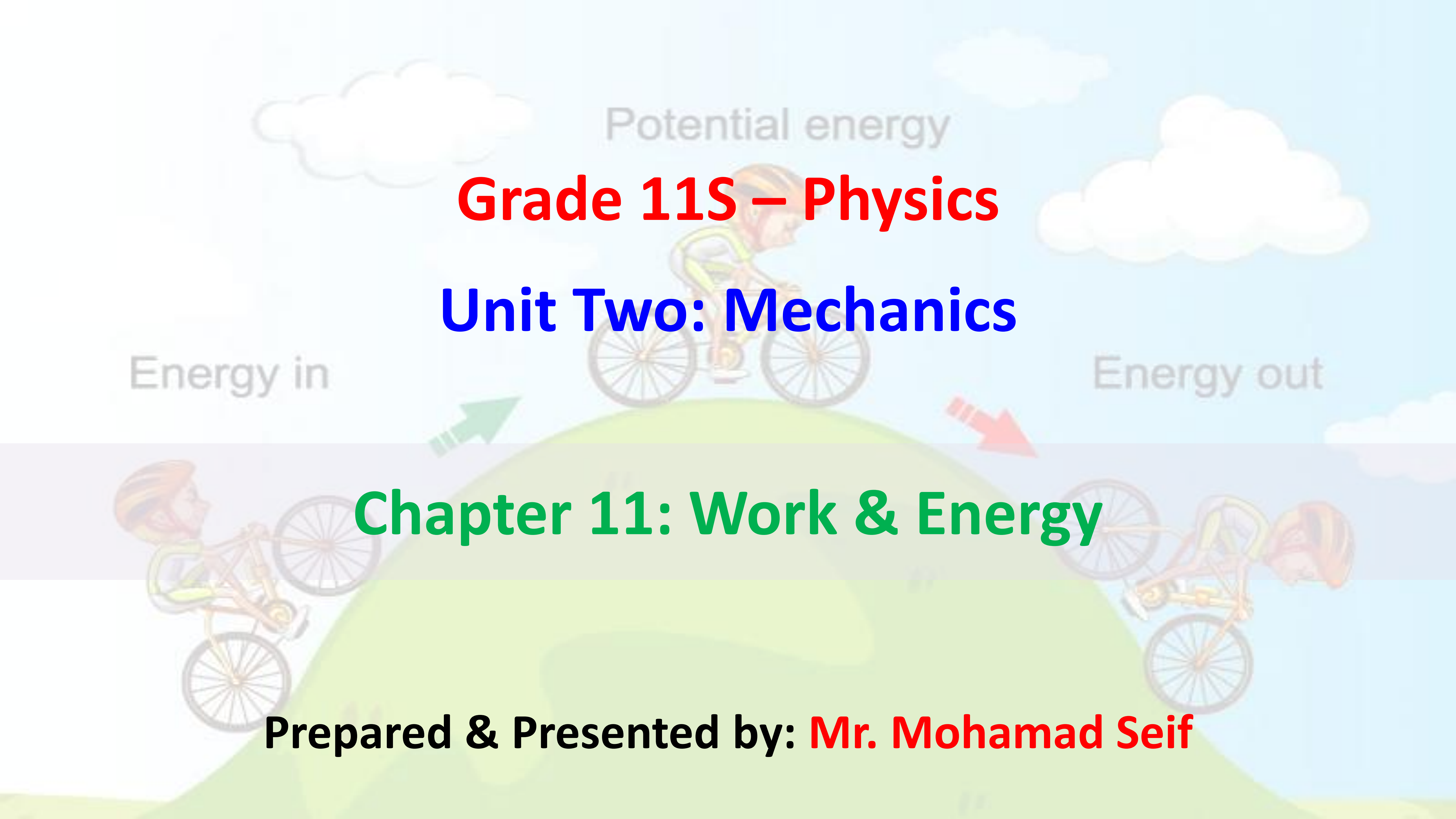


Grade 11S – Physics

Unit Two: Mechanics

Chapter 11: Work & Energy

Prepared & Presented by: Mr. Mohamad Seif

OBJECTIVES

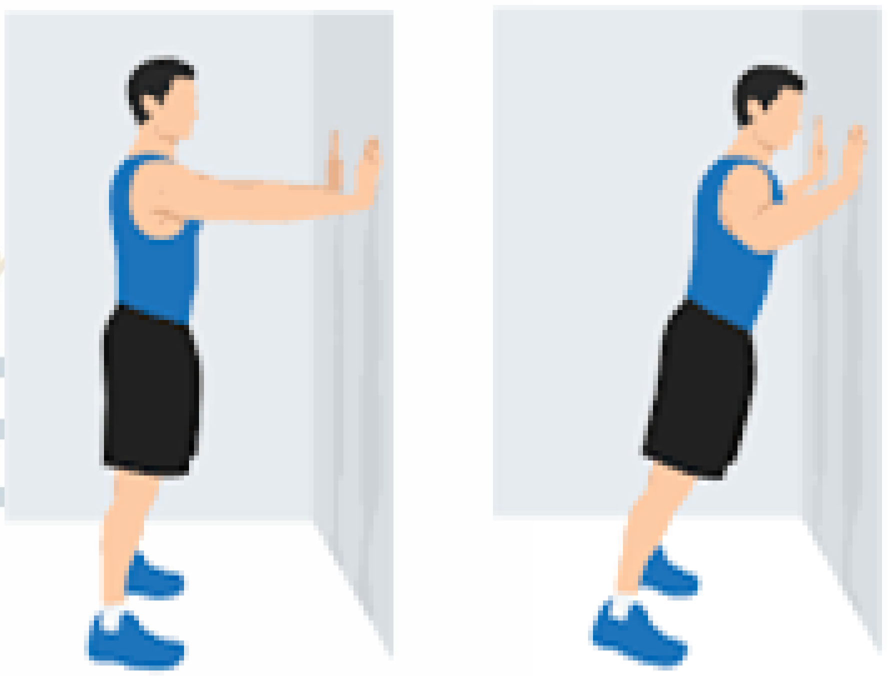
1. Determine the work done by a constant force
2. Determine the work done by weight
3. Determine the mechanical power

Work done by a constant force

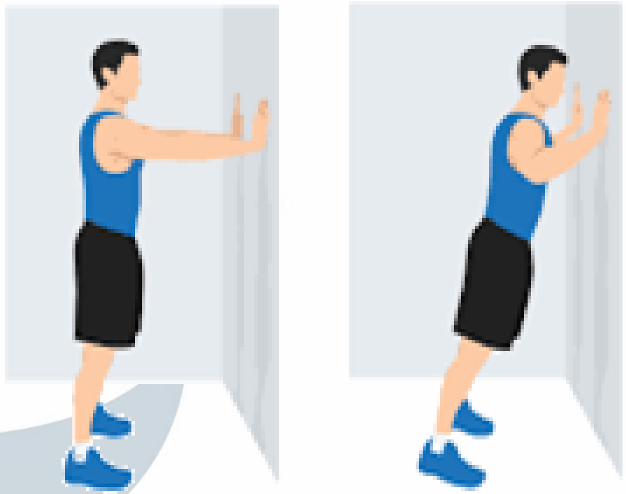
When you push a table, you move it under the action of a force you exert.

If you apply a larger push to a wall,

you might not be able to move it, in spite of the effort you exert!



Work done by a constant force



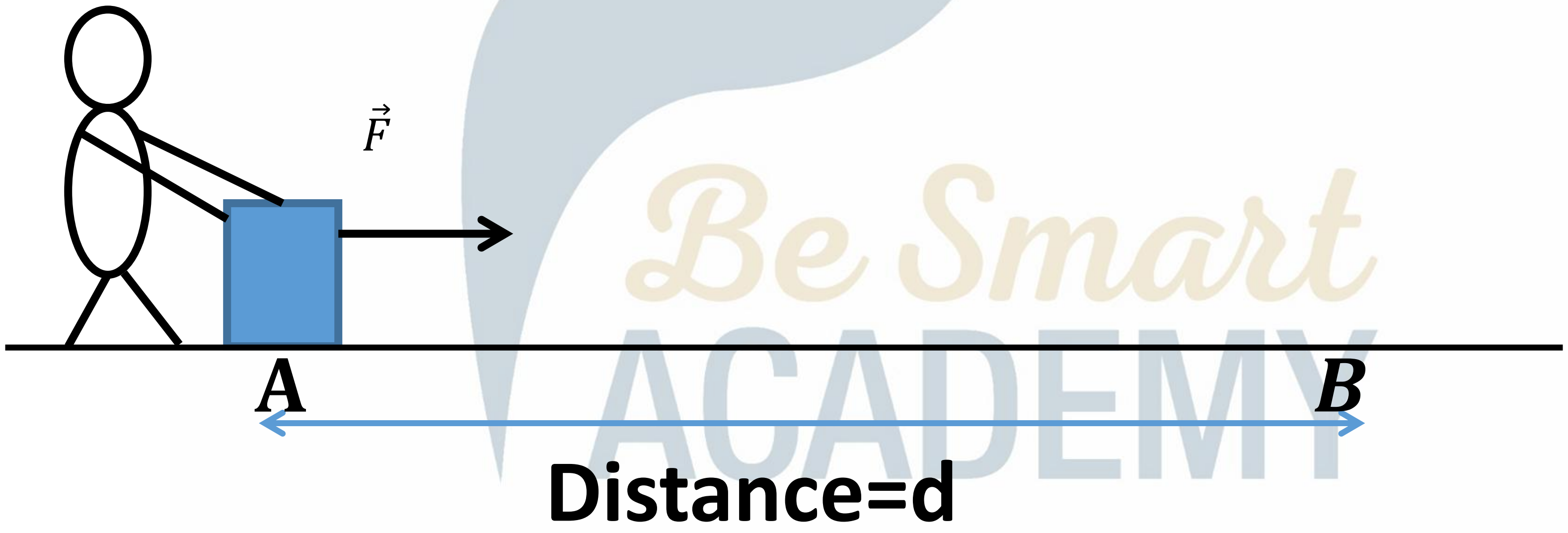
In both cases, you have spent energy, but only in the first case you have accomplished a work.

When force is applied on a object, resulting in the movement of that object, WORK is said to be DONE!

Work done by a constant force

Work is done on an object when a force causes a displacement of that object.

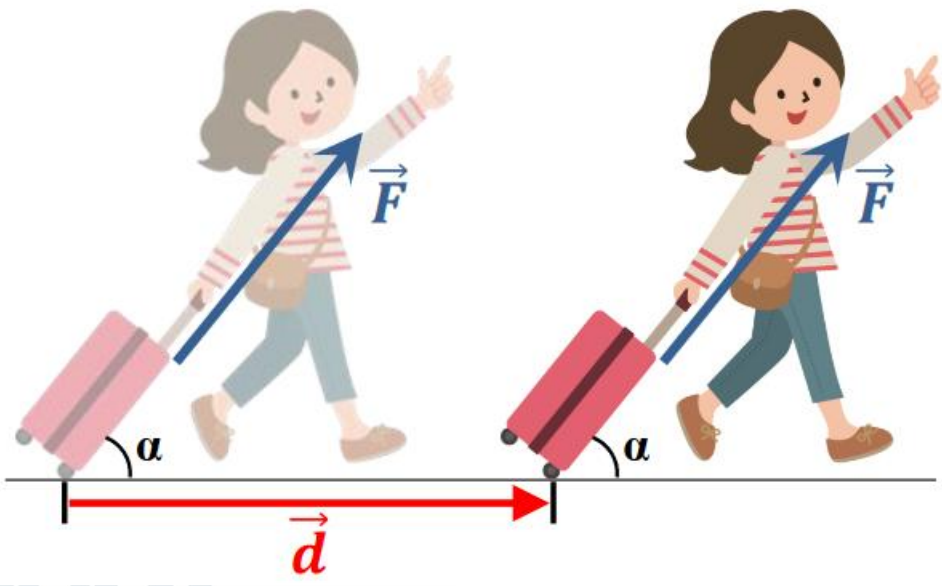
When a force performs work, energy is transferred from one object to another.



Work done by a constant force

The work done on an object by a constant force $\vec{F}$ causing a displacement $\vec{d}$ is:

$$W_{\vec{F}} = \vec{F}.\vec{d} = F \times d \times cos(\alpha)$$



$W_{\vec{F}}$: work done by the force, expressed in Joule J.

F: applied force, expressed in Newton N

d: is the distance covered by the box, expressed in meter m.

α: angle between the force and the displacement, expressed in degree.

Work done by a constant force

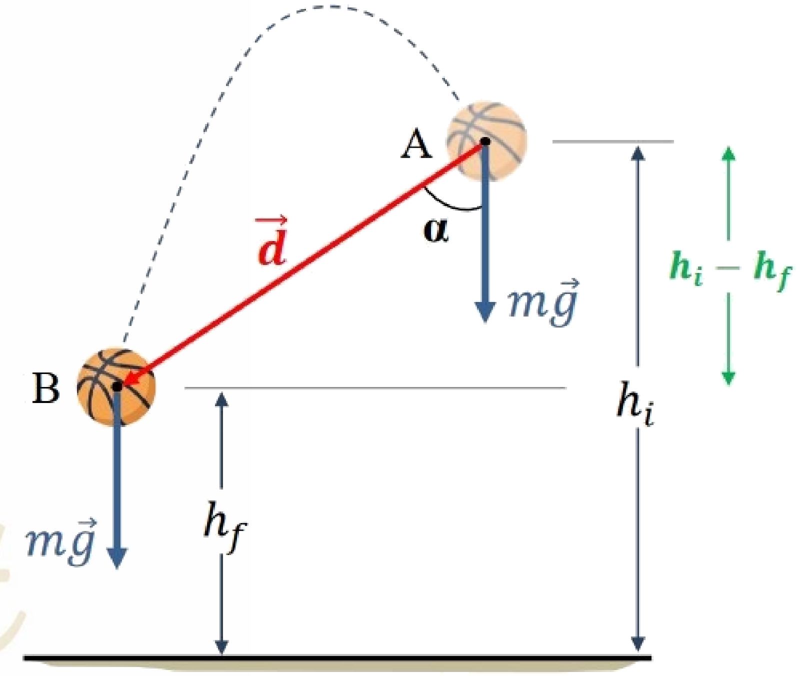
- Work
  - motive
    - If work is positive (W>0)
  - Resistive
    - If work is negative (W<0)

Work done by weight

Suppose you throw a basketball from a point A to a point B.

The initial height of the ball at point A is h_i, and its final height at B is h_f.

The work done by the weight of the ball is:



$$W_{\vec{W}} = mg \times d \times cos(\alpha)$$

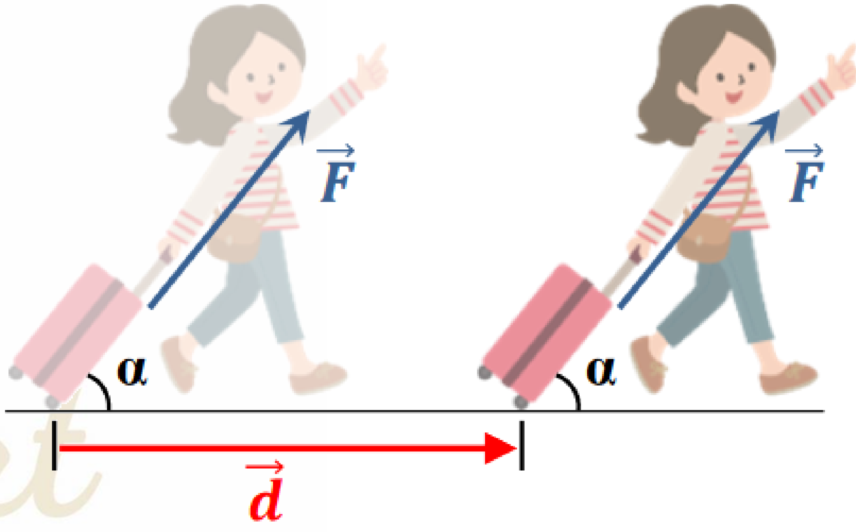
$$cos(\alpha) = \frac{h_i - h_f}{d} \Rightarrow h_i - h_f = dcos(\alpha)$$

$$W_{\vec{W}} = mg(h_i - h_f)$$

Work done by a constant force

Application 1:

The adjacent figure shows a girl that is pulling a suitcase-on-wheels of mass 3Kg on a horizontal track.



The girl exerts a force $\vec{F}$ of magnitude $F = 45N$ on the suitcase at an angle $\alpha = 50^{\circ}$ for a displacement d = 5 m.

The track exerts a friction force $\vec{f}$ of magnitude $f = 20\ N$ on the suitcase.

1. List and draw, not to scale, the forces acting on the suitcase.

2. Find the work done by each of these forces.

3. Deduce the net work.

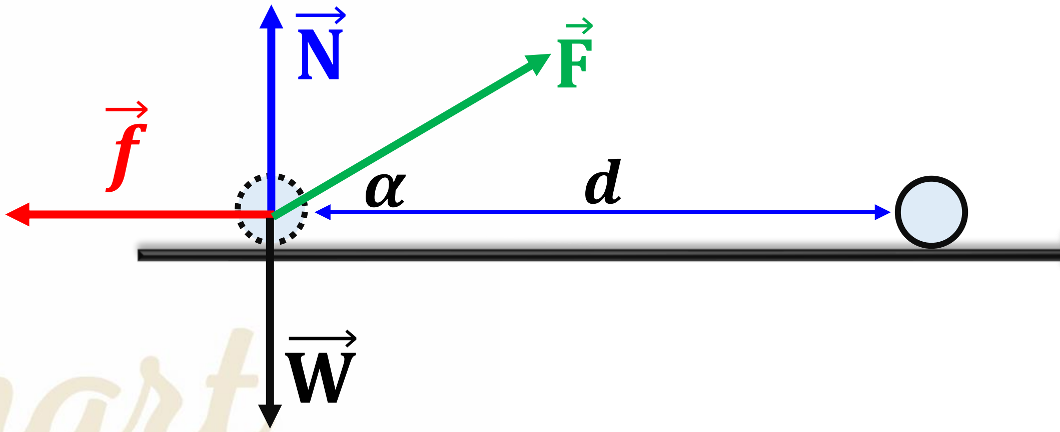
Work done by a constant force

$M = 3kg$; $F = 45N$; $\alpha = 50^{\circ}$; $f = 20N$; $d = 5m$ and $g = 10N/kg$.

1. List and draw, not to scale, the forces acting on the suitcase.

The forces acting on the suitcase are:

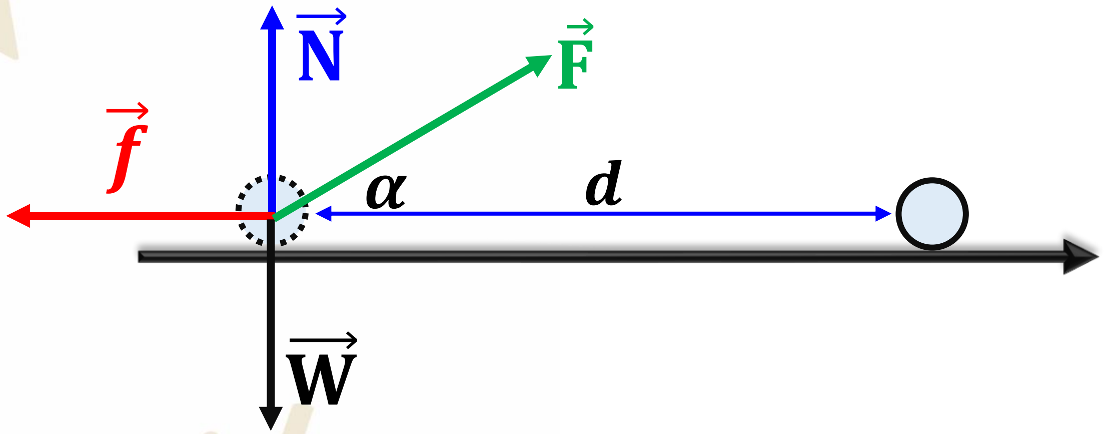
- The pulling force: $\vec{F}$
- The weight of the suitcase: $\vec{W}$
- The Normal reaction of support: $\vec{N}$
- The Friction: $\vec{f}$



Work done by a constant force

$M = 3kg$; $F = 45N$; $\alpha = 50^{\circ}$; $f = 20N$; $d = 5m$ and $g = 10N/kg$.

1. Calculate the work done by each of these forces



Work done by normal force:

$$W_{\vec{N}} = N \times d \times \cos(\vec{N}; \vec{d})$$

$$W_{\vec{N}} = N \times d \times \cos(90)$$

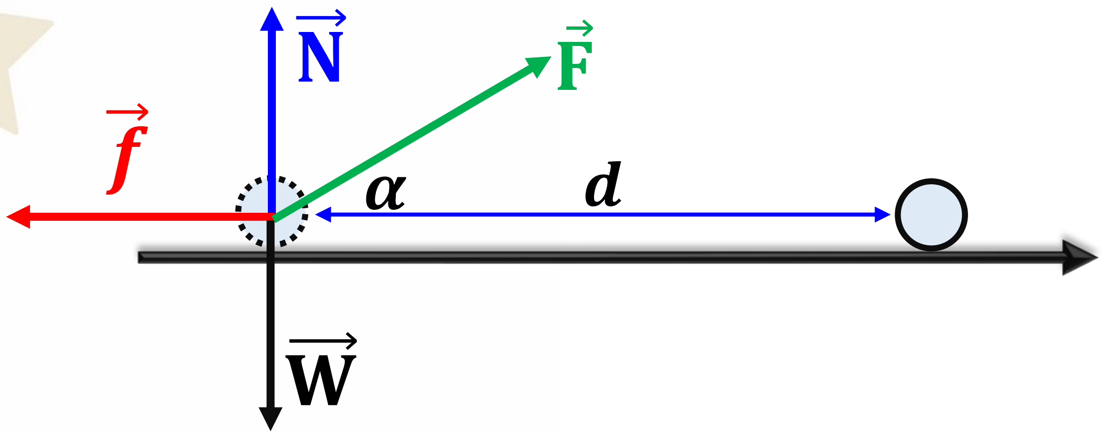
$$W_{\vec{N}} = 0J$$

Note: when the force is ⊥ to distance d, the work is zero

Work done by a constant force

$M = 3kg$; $F = 45N$; $\alpha = 50^{\circ}$; $f = 20N$; $d = 5m$ and $g = 10N/kg$.

Work done by weight :



$$W_{\vec{W}} = mg(h_i - h_f)$$

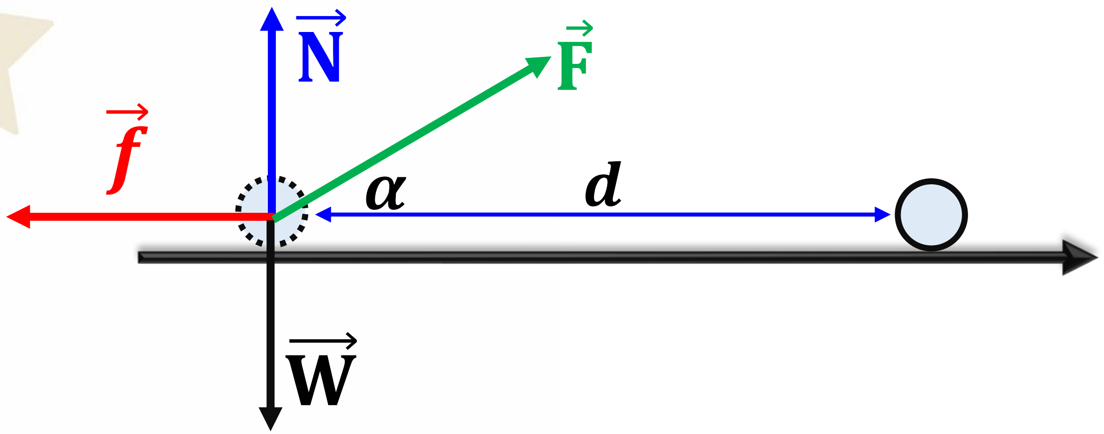
$$W_{\vec{W}} = 3 \times 10(0 - 0)$$

$$W_{\vec{W}} = 0J$$

Work done by a constant force

$M = 3kg$; $F = 45N$; $\alpha = 50^{\circ}$; $\mathrm{f} = 20N$; $\mathrm{d} = 5\mathrm{m}$ and $\mathrm{g} = 10\mathrm{N/kg}$.

Work done by friction force:



$$W_{\vec{f}} = f \times d \times \cos(\vec{f}; d)$$

$$W_{\vec{f}} = f \times d \times \cos(180)$$

$$W_{\vec{f}} = 20 \times 5 \times (-1)$$

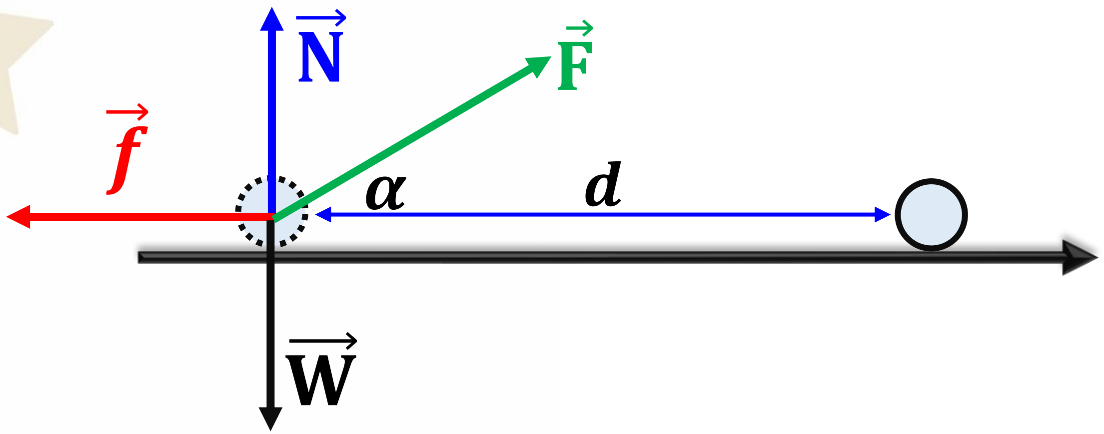
$$W_{\vec{f}} = -100J < 0$$

Resistive work

Work done by a constant force

$M = 3kg$; $F = 45N$; $\alpha = 50^{\circ}$; $f = 20N$; $d = 5m$ and $g = 10N/kg$.

Work done by tractive force:



$$W_{\vec{F}} = F \times d \times cos(\vec{F}; d)$$

$$W_{\vec{F}} = 45 \times 5 \times cos(50)$$

$$W_{\vec{F}} = 145J > 0$$ Motive work

Work done by a constant force

3. Deduce the net work

$$\sum W_{ex} = W_{\vec{W}} + W_{\vec{N}} + W_{\vec{f}} + W_{\vec{F}}$$

$$\sum W_{ex} = 0J + 0J - 100J + 145J$$

$$\sum W_{ex} = 45J$$

Mechanical Power

Suppose you want to lift a box from the ground to the top of a building:

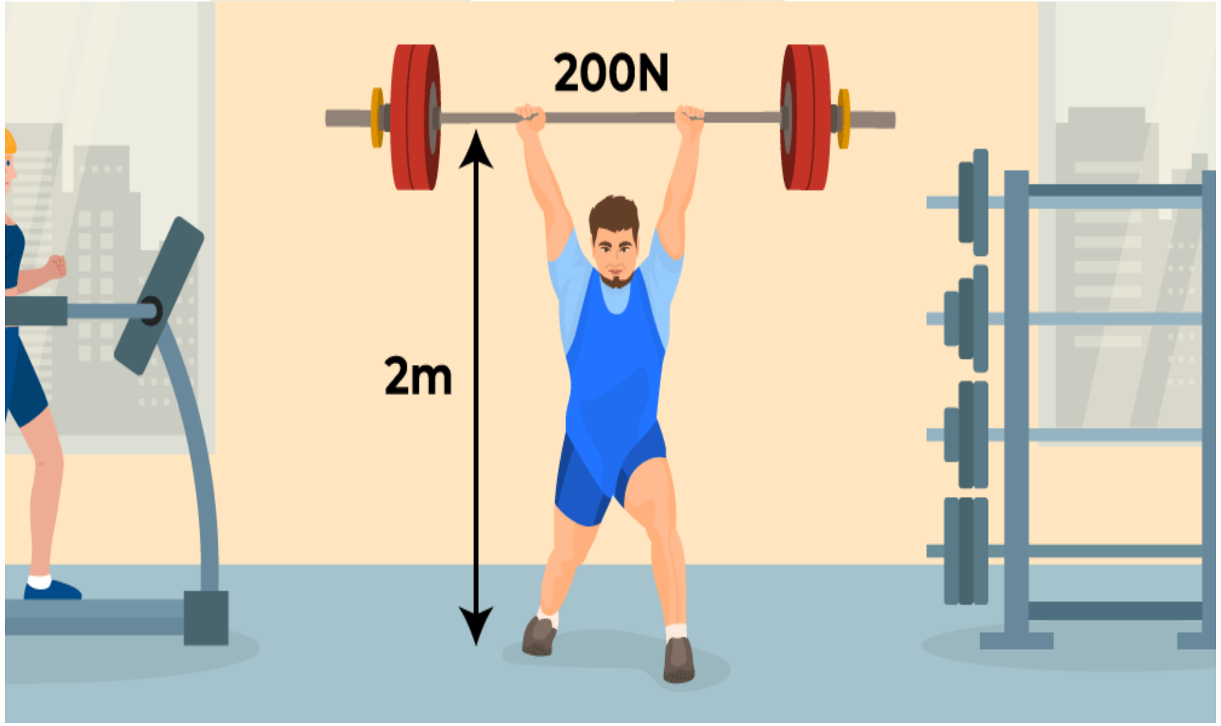
- A winch can lift it in few seconds;
- However, a worker can do the same work in few minutes!

In the two situations, the amount of work done is the same, yet the winch does it more quickly!

Mechanical Power

What is power?

Power is defined as the time rate of doing work.



Power is defined as the time rate at which the energy is transferred.

Mechanical Power

Average Power:

Average power of a force delivering an amount of work W during a time interval Δt is

$$P_{av} = \frac{W}{\Delta t}$$

$$W = \vec{F}.\vec{d} = \vec{F}.\Delta\vec{r} \Rightarrow P_{av} = \frac{\vec{F}.\Delta\vec{r}}{\Delta t}$$

$$P_{av} = \vec{F}.\vec{V}_{av}$$

The SI unit of power Watt [W=J/s]

Mechanical Power

Instantaneous Power:

If the time interval Δt tends to zero, average velocity tends to the instantaneous velocity:

$$\Delta t \rightarrow 0 \quad \Rightarrow \quad \vec{V}_{av} \rightarrow \vec{V}_{in} = \vec{V}$$

$$P_{av} = \vec{F}.\vec{V} = F \times V \times cos(\alpha)$$

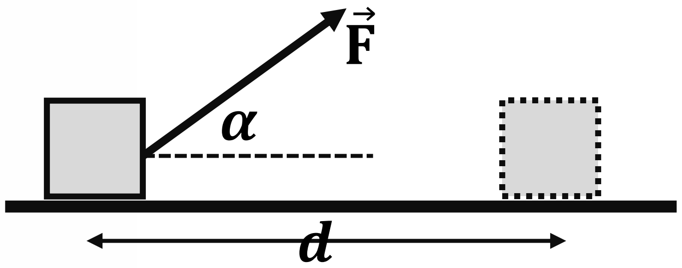
Where α is the angle between $\vec{F}$ and $\vec{V}$

Mechanical Power

Application 2:

A block of mass m = 2 kg covers, under the action of force $\vec{F}$ of magnitude F=20 N making an angle $\alpha = 30^{\circ}$ with horizontal, a distance of 10m horizontally. $g = 10N/kg$

The magnitude of force of friction is f = 5 N.



1. Determine the work done by each force exerted on the block.
2. Calculate the average power developed by each force if the distance is covered during 10 s.

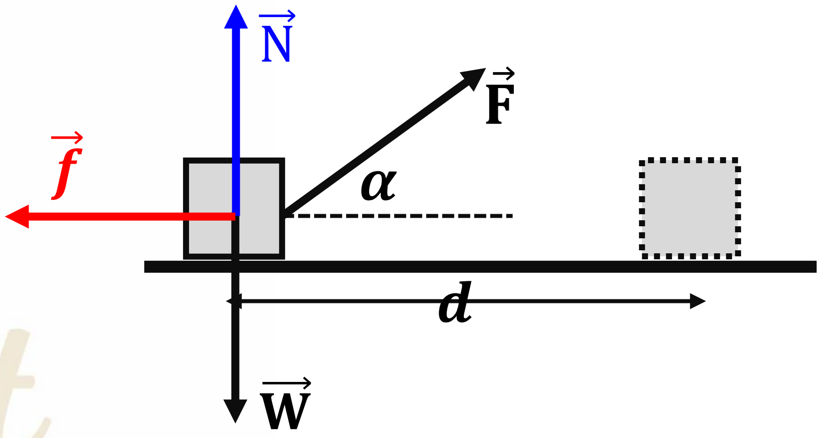
Mechanical Power

m = 2 kg; F=20 N; $\alpha = 30^{\circ}$; f=5N; d=10m; $g = 10N/kg$.

1. Determine the work done by each force exerted on the block.

$W_{\vec{W}} = 0J$ (weight is ⊥ to distance)

$W_{\vec{N}} = 0J$ (Normal is ⊥ to distance)



$W_{\vec{F}} = F \times d \times cos(\alpha) = 20 \times 10 \times cos(30)$

$$W_{\vec{F}} = 173.2J$$

$W_{\vec{f}} = f \times d \times cos(\alpha) = 5 \times 10 \times cos(180)$

$$W_{\vec{F}} = -50J$$

Mechanical Power

2. Calculate the average power developed by each force if the distance is covered during 10 s.

$$P_{\vec{N}} = \frac{W_{\vec{N}}}{\Delta t} = \frac{0}{10}$$

$$P_{\vec{N}} = 0W$$

$$P_{\vec{W}} = \frac{W_{\vec{W}}}{\Delta t} = \frac{0}{10}$$

$$P_{\vec{W}} = 0W$$

$$P_{\vec{F}} = \frac{W_{\vec{F}}}{\Delta t} = \frac{173.2}{10}$$

$$P_{\vec{F}} = 17.32W$$

$$P_{\vec{f}} = \frac{W_{\vec{f}}}{\Delta t} = \frac{-50}{10}$$

$$P_{\vec{f}} = -5W$$

The End

Grade 11S – Physics

Unit Two: Mechanics

Chapter 11: Work & Energy

Prepared & Presented by: Mr. Mohamad Seif

OBJECTIVES

1. Forms of Energy
2. Determine the Kinetic energy of a particle
3. Apply Work energy theorem.

Energy

What is Energy?

Energy: Is the ability to do work

An object processes energy if it's able to do work.

Energy, as work, is expressed in Joules (J).

Energy

Energy exists in many forms.

Energy can be transferred from one object to another.

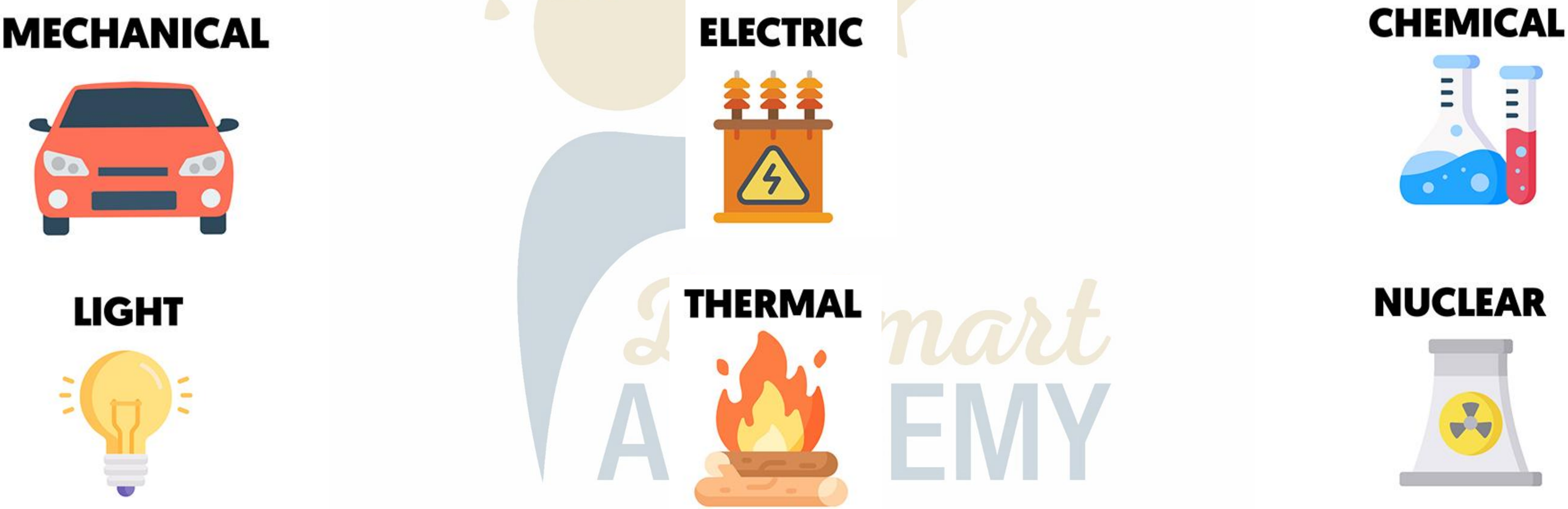
Energy

Energy can be changed from one form to another.

Energy cannot be created or destroyed.

Energy

Forms of energy



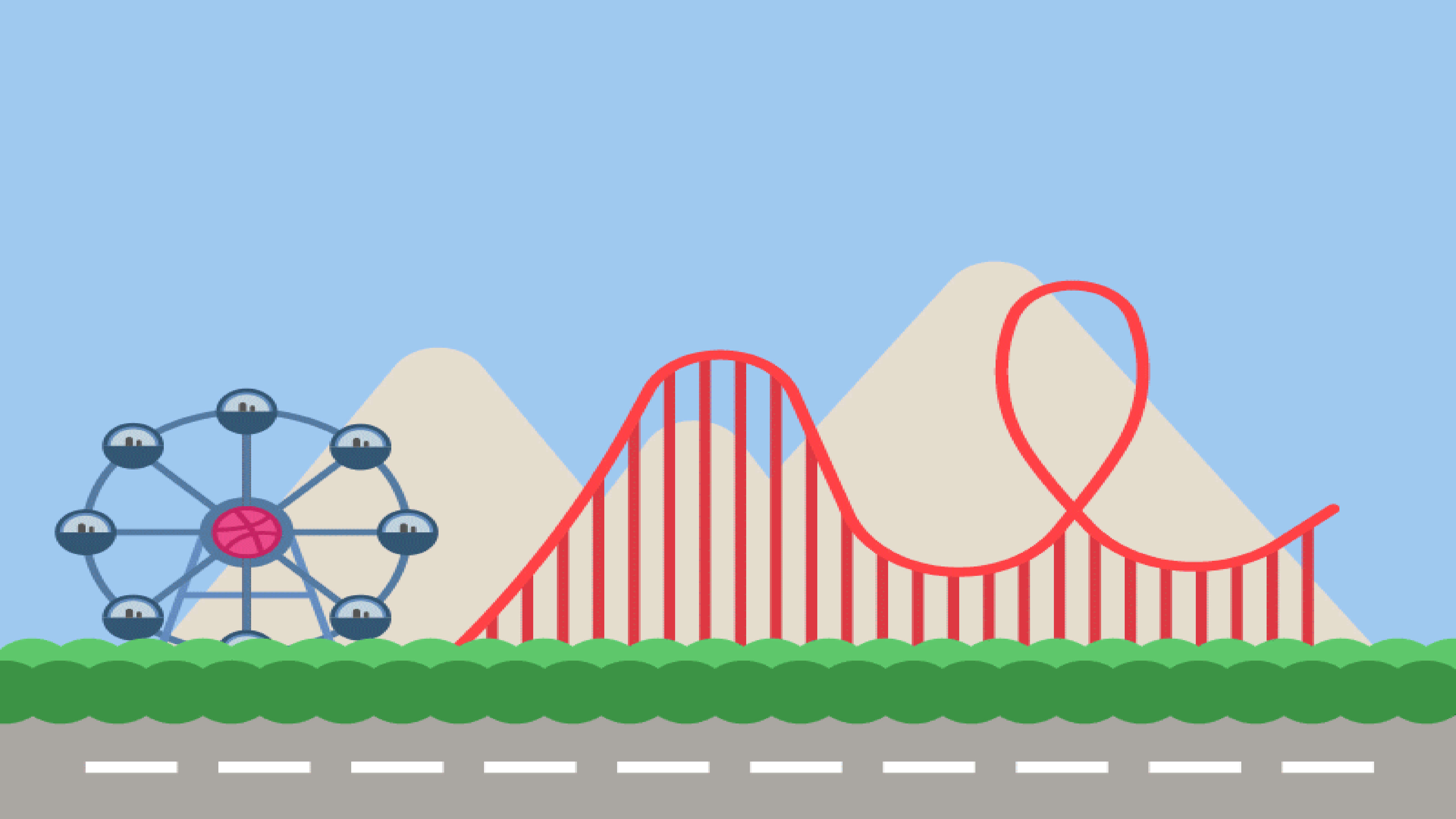
In this lesson we will study mechanical energy

Kinetic Energy (KE)

Kinetic Energy (KE): Energy possessed by a body due to its motion.

Kinetic Energy (KE)

- **Translational motion** → **Kinetic Energy of Translation**
- **Rotational motion** → **Kinetic Energy of Rotation (GS)**



Kinetic Energy (KE)

Kinetic Energy of Translation (KE):

$$KE = \frac{1}{2} m V^2$$

m: mass of the body, expressed in (kg).

V: The velocity of the body, expressed in m/s.

KE: Kinetic energy, expressed in (J).

When an object is at rest (speed v = 0) ➡ $KE = 0J$

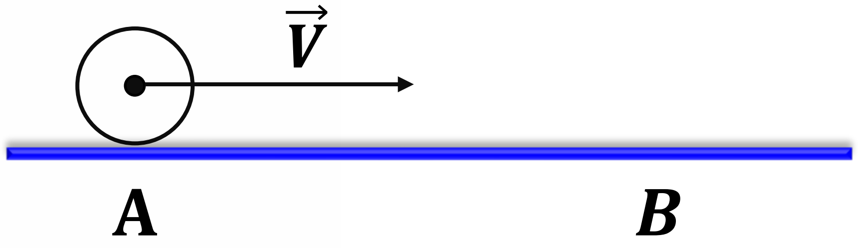
When an object is at motion rest (speed $V \neq 0$ ➡ $KE \neq 0J$

Kinetic Energy (KE)

Application 3:

A ball of mass $m = 2Kg$ starts its motion from rest from A and reaches B with a speed $v = 3m/s$ as shown in the figure.

Calculate the kinetic energy of the ball at A and at B.



$$KE_A = 1/2mV^2$$

$$KE_A = 0.5 \times 2 \times (0)^2$$

$$KE_A = 0J$$

$$KE_B = 1/2mV^2$$

$$KE_B = 0.5 \times 2 \times (3)^2$$

$$KE_B = 9J$$

Theorem of kinetic energy

When external forces do work on an object, its kinetic energy changes from its initial value KE_i to a final value KE_f, the difference between the two values being equal to the sum of works done by these external forces

$$\sum W_{ex} = \Delta KE$$

$$\sum W_{ex} = KE_f - KE_i$$

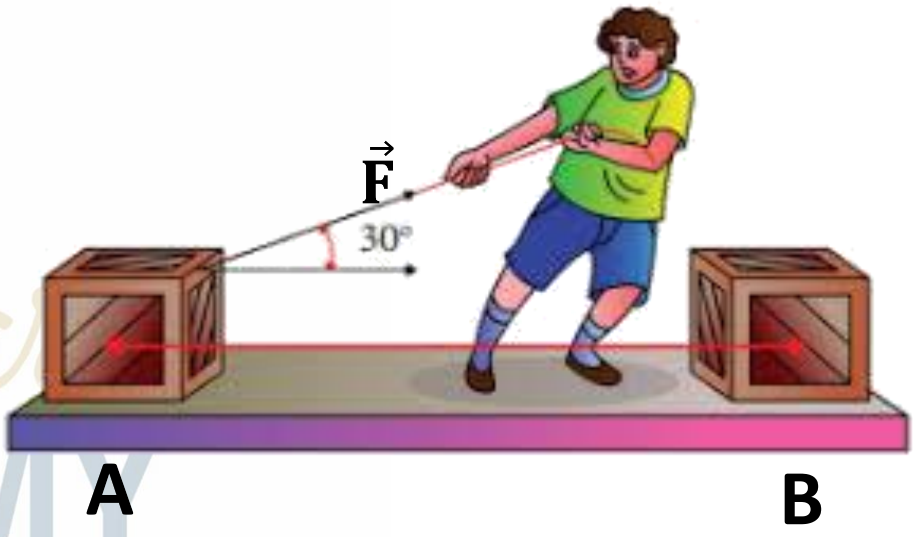
Theorem of kinetic energy

Application 4:

A box of mass 8kg at rest at point A is pulled by a force F of magnitude 16N, and making 30° with the horizontal as shown in the adjacent figure.

During the motion, a constant frictional force of magnitude f_r opposes the motion.

The box reaches point B with a speed of 0.8m/s after covering a distance of 5m.

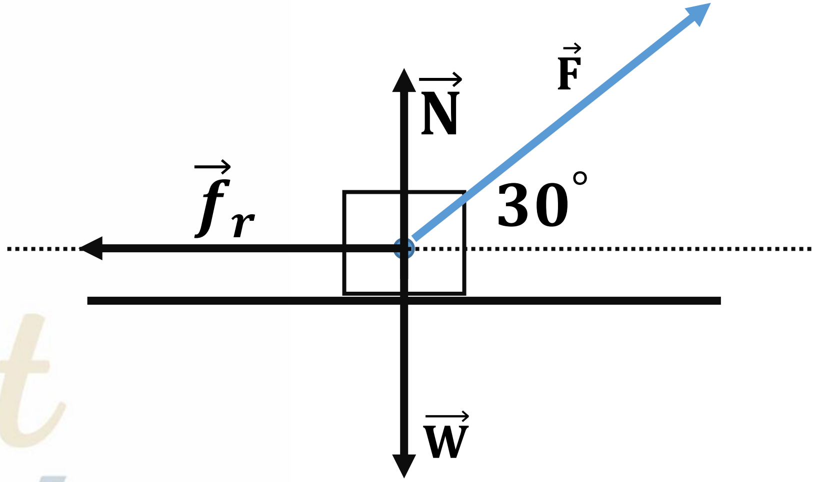


Applying work-energy theorem, determine the magnitude of the force of friction f_r acting on the box.

Theorem of kinetic energy

$V_A = 0$; m=8kg; F=16N; $\alpha = 30^{\circ}$; $V_B = 0.8 m/s$; AB=5m

Applying work-energy theorem, determine the magnitude of the force of friction f_r acting on the box.



The forces acting on the box are:

The pulling force: ($\vec{F}$).

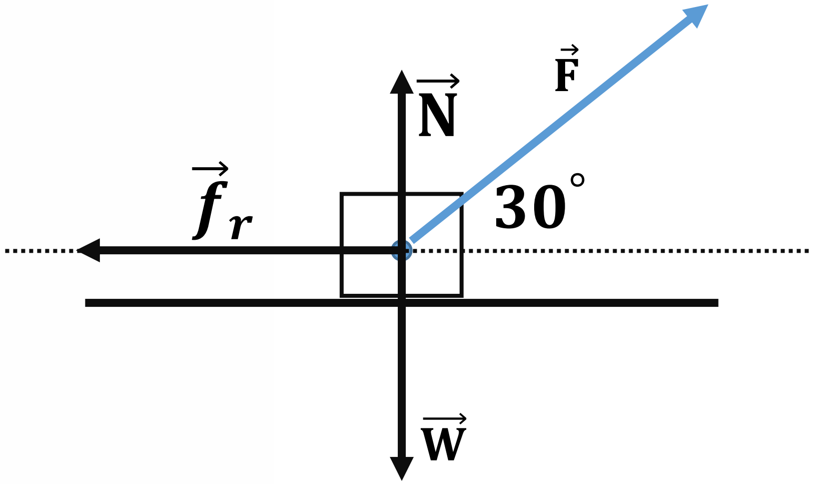
The weight of the box: ($\vec{W}$)

The normal reaction: ($\vec{N}$)

The friction force: ($\vec{f}$)

Theorem of kinetic energy

$V_A = 0$; m=8kg; F=16N; $\alpha = 30^\circ$; $V_B = 0.8m/s$; AB=5m



The work done by normal is:

$W_{\vec{N}} = N \times d \times cos(90)$ ➡ $W_{\vec{N}} = 0J$

The work done by weight ($\vec{w}$) is:

$$W_{\vec{w}} = mg(h_A - h_B)$$

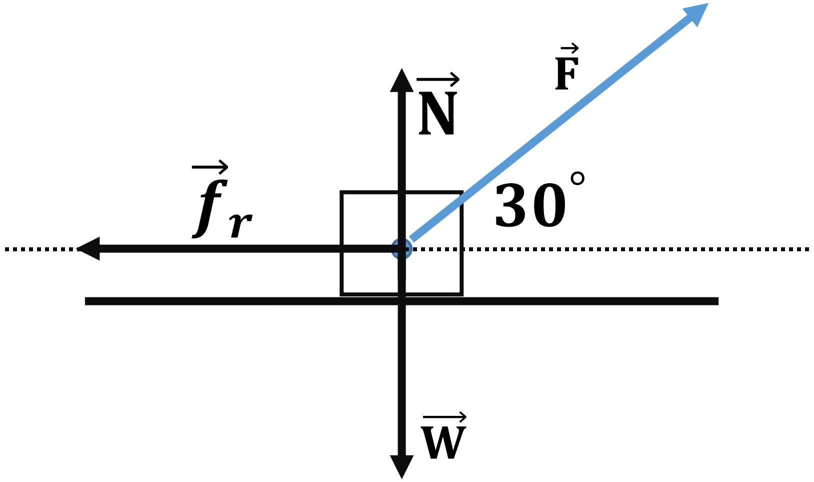
$$W_{\vec{w}} = mg(0 - 0)$$

$$W_{\vec{w}} = 0J$$

Theorem of kinetic energy

$V_A = 0$; m=8kg; F=16N; $\alpha = 30^{\circ}$; $V_B = 0.8m/s$; AB=5m

The work done by force $\overrightarrow{F}$ is:



$$W_{\vec{F}} = F \times d \times cos30^{\circ}$$

$$W_{\vec{F}} = 16 \times 5 \times cos30^{\circ} \Rightarrow W_{\vec{F}} = 69.3J$$

The work done by friction ($\overrightarrow{f}$) is:

$$W_{\vec{f}} = f_r \times d \times cos180^{\circ}$$

$$W_{\vec{f}} = f_r \times 5 \times cos180^{\circ} \Rightarrow W_{\vec{f}} = -5 \times f_r$$

Theorem of kinetic energy

Apply work – energy theorem:

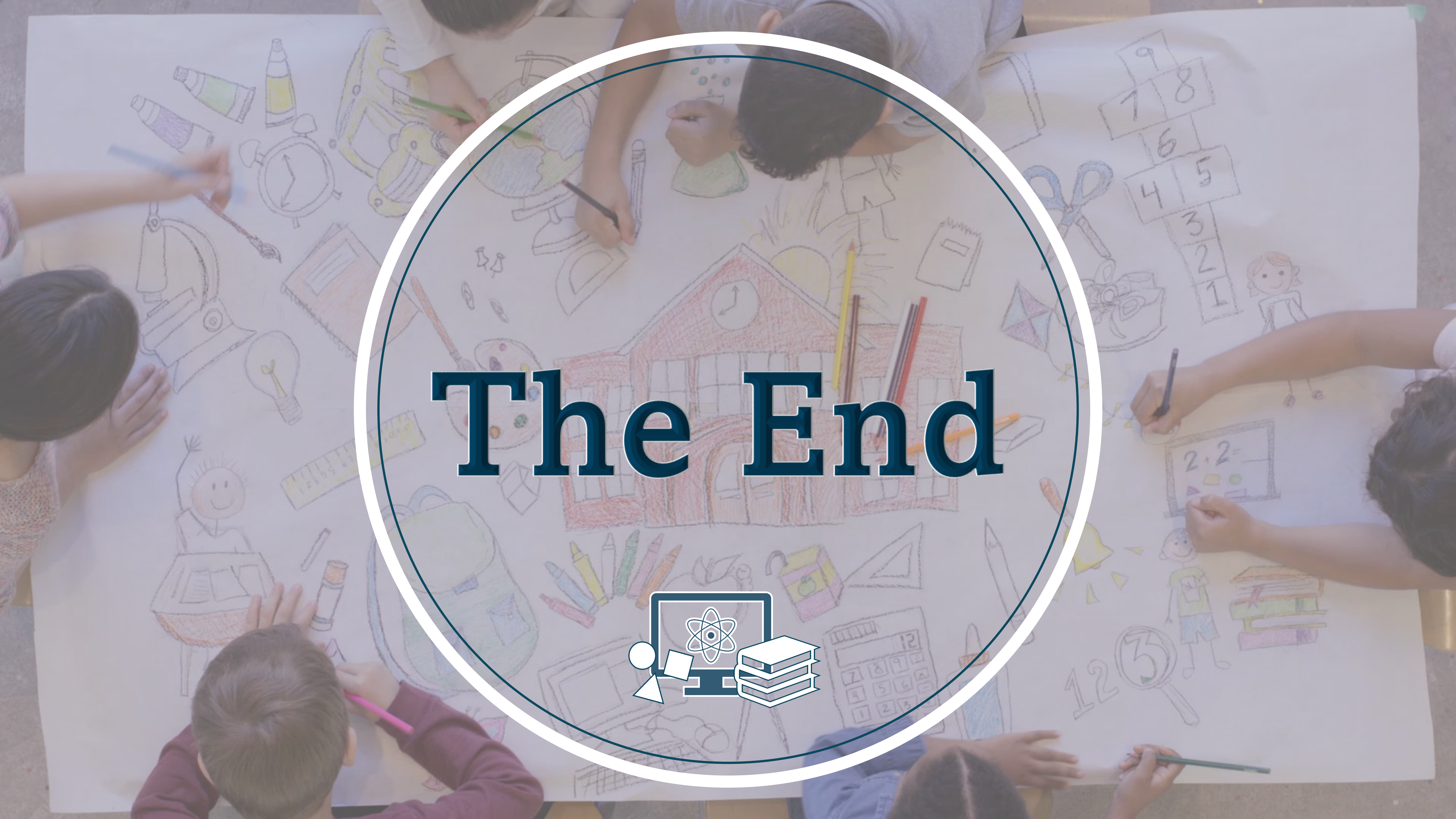
$$\sum W_{\vec{F}} = KE_B - KE_A$$

$$W_{\vec{w}} + W_{\vec{N}} + W_{\vec{F}} + W_{\vec{f_r}} = \frac{1}{2}(8) \times 0.8^2 - 0$$

$$0 + 0 + 69.3 - 5 \times f_r = 2.56$$

$$69.3 - 2.56 = 5 \times f_r \quad \Rightarrow \quad 66.64 = 5 \times f_r$$

$$f_r = 13.34N$$


The End

Grade 11S – Physics

Unit Two: Mechanics

Chapter 11: Work & Energy

Prepared & Presented by: Mr. Mohamad Seif

OBJECTIVES

1. Determine the Gravitational potential energy of a system
2. Determine the Elastic potential energy of a system

Potential Energy (PE)

Potential Energy (PE): is a form of energy stored in the body

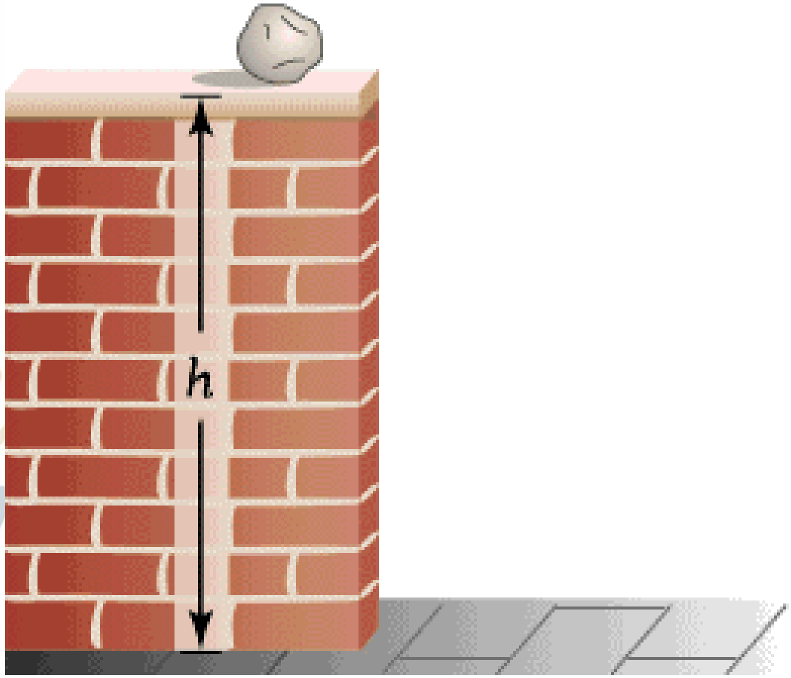
Potential Energy (PE)

- **Gravitational potential energy** ↓
- **Elastic potential energy** ↓

Gravitational Potential Energy (GPE)

Gravitational Potential Energy(GPE) is the energy stored and possessed by an object due to its relative to a given reference

$$PE_g = mgh$$



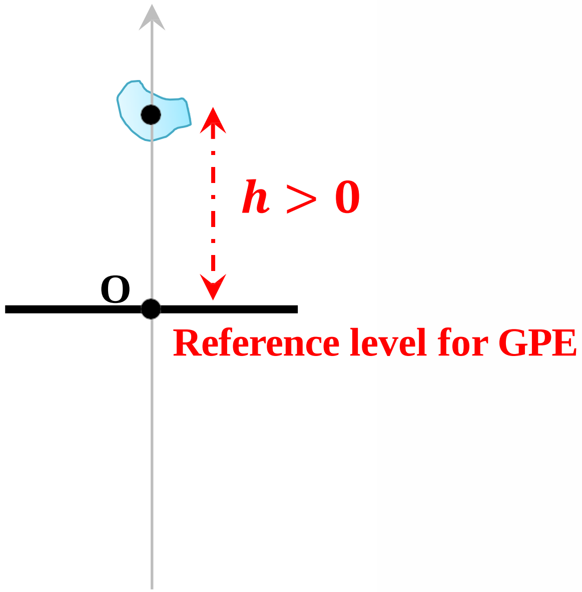
- m: **mass of the body, expressed in kg.**
- g: **gravity, g=10N/kg.**
- h: **height of the body from the reference expressed in m**

Gravitational Potential Energy (GPE)

$$GPE = m\,g\,h$$

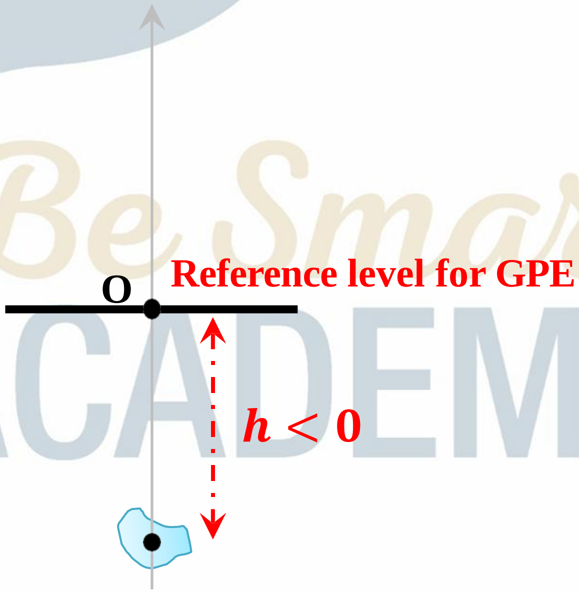
If the object is above the reference level:

$h > 0 \Rightarrow GPE > 0$



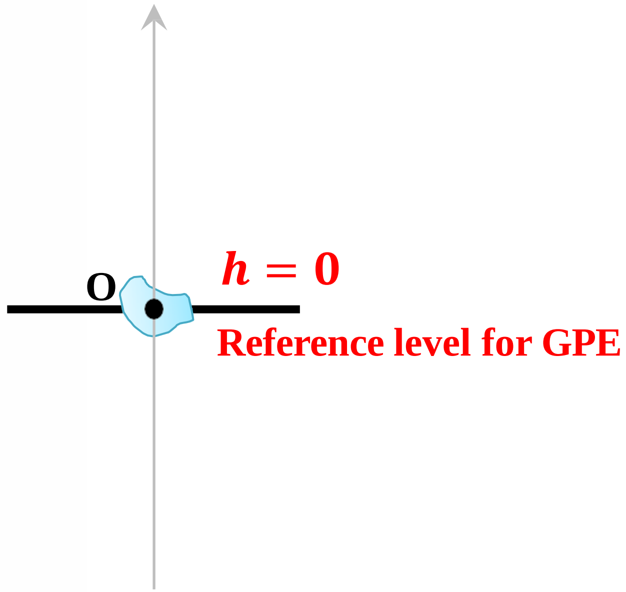
If the object is below the reference level:

$h < 0 \Rightarrow GPE < 0$



If the object is below the reference level:

$h = 0 \Rightarrow GPE = 0$



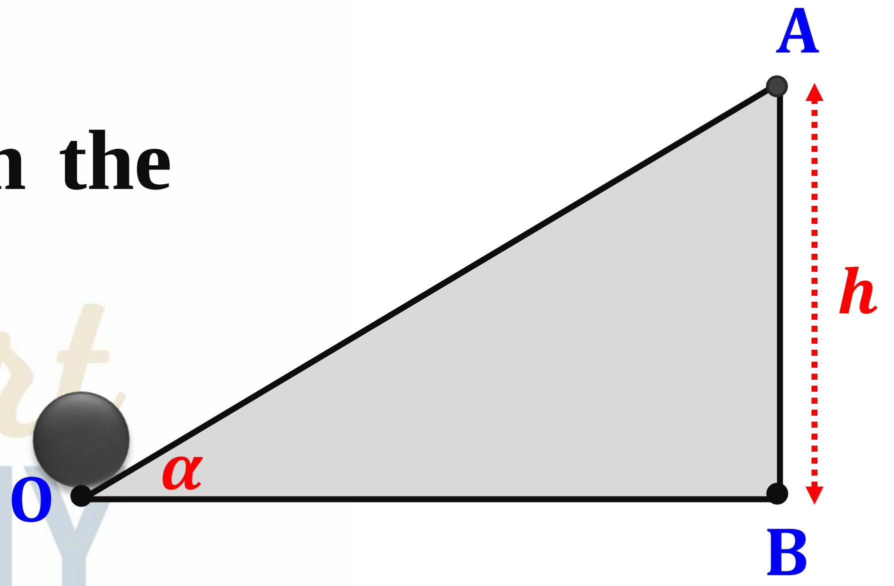
Gravitational Potential Energy (GPE)

Application 5:

A ball (S) of mass $m = 1.2$Kg moves up an inclined plane making an angle $\alpha = 30^{\circ}$ with the horizontal starting from the bottom O.

The ball reaches point A at a height h from the ground, where $OA = 1.5m$

Take the horizontal line passing through B as a reference level for gravitational potential energy. Given g = 10N/kg.



Calculate GPE of the system (ball-earth) at point O and A.

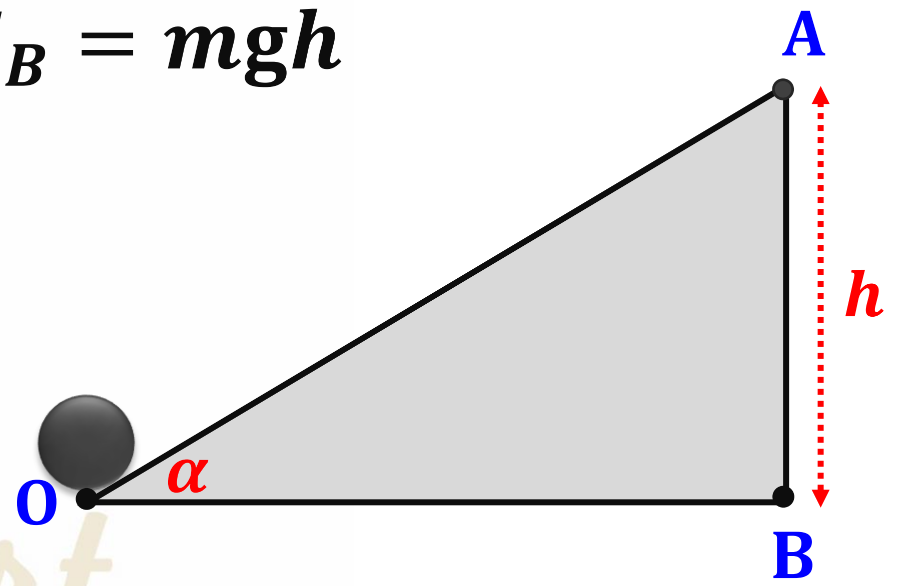
Gravitational Potential Energy (GPE)

$m = 1.2Kg$; OA $= 1.5m$; $\alpha = 30$; g = 10N/kg

The gravitation potential energy is: $GPE_B = mgh$

$$GPE_B = mgh = 1.2 \times 10(0) = 0J$$

$$GPE_A = mgh_A$$



For the triangle AOB: $sin\alpha = \frac{opp}{hyp}$

$$sin\alpha = \frac{h}{OA} \Rightarrow h = OAsin\alpha$$

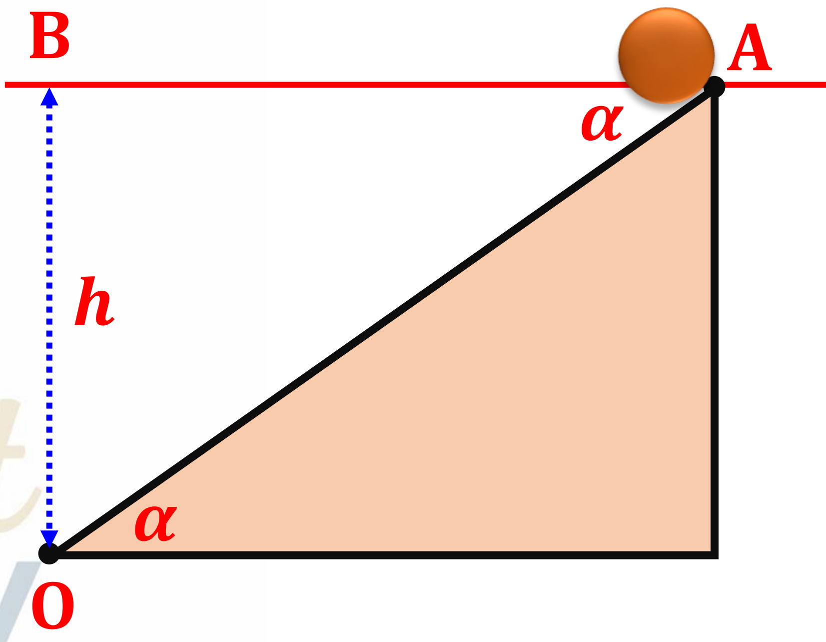
$$GPE = mgh = mgLsin\alpha$$

$$GPE = 1.2 \times 10 \times 1.5 \times sin30 \Rightarrow GPE = 9J$$

Gravitational Potential Energy (GPE)

Application 6:

A ball of mass $m = 2$kg at the top A of an inclined plane making an angle $\alpha = 60^{\circ}$ with the horizontal.



The ball moves down and reaches point O, where $AO = 90cm$.

The horizontal plane passing through A is a reference level for gravitational potential energy. Given g = 10N/kg

Calculate GPE of the system (ball-earth) at point O.

Gravitational Potential Energy (GPE)

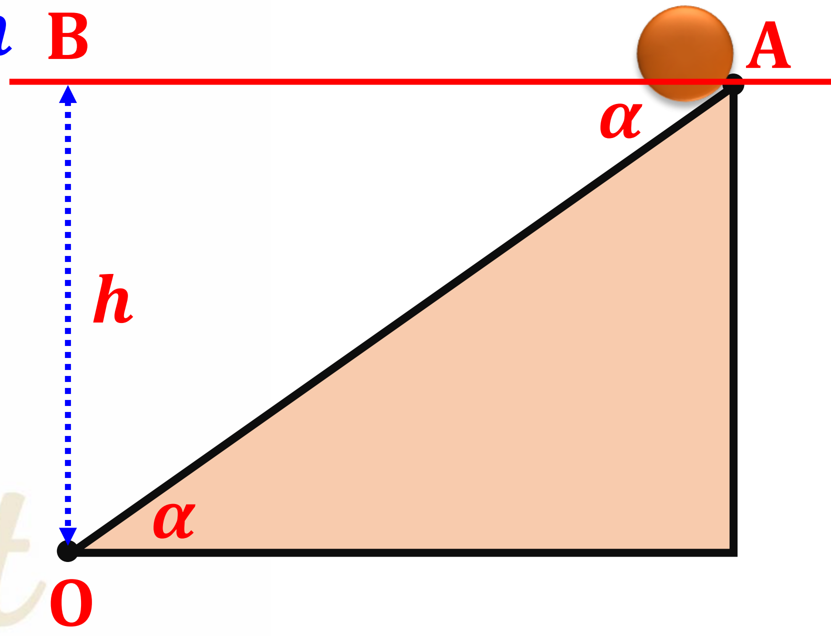
$m = 2Kg$; $AO = 0.9m$; $\alpha = 60^{\circ}$; $g = 10N/kg$

The gravitational potential energy is: $GPE = mgh$

For the triangle AOB: $sin\alpha = \frac{opp}{hyp}$

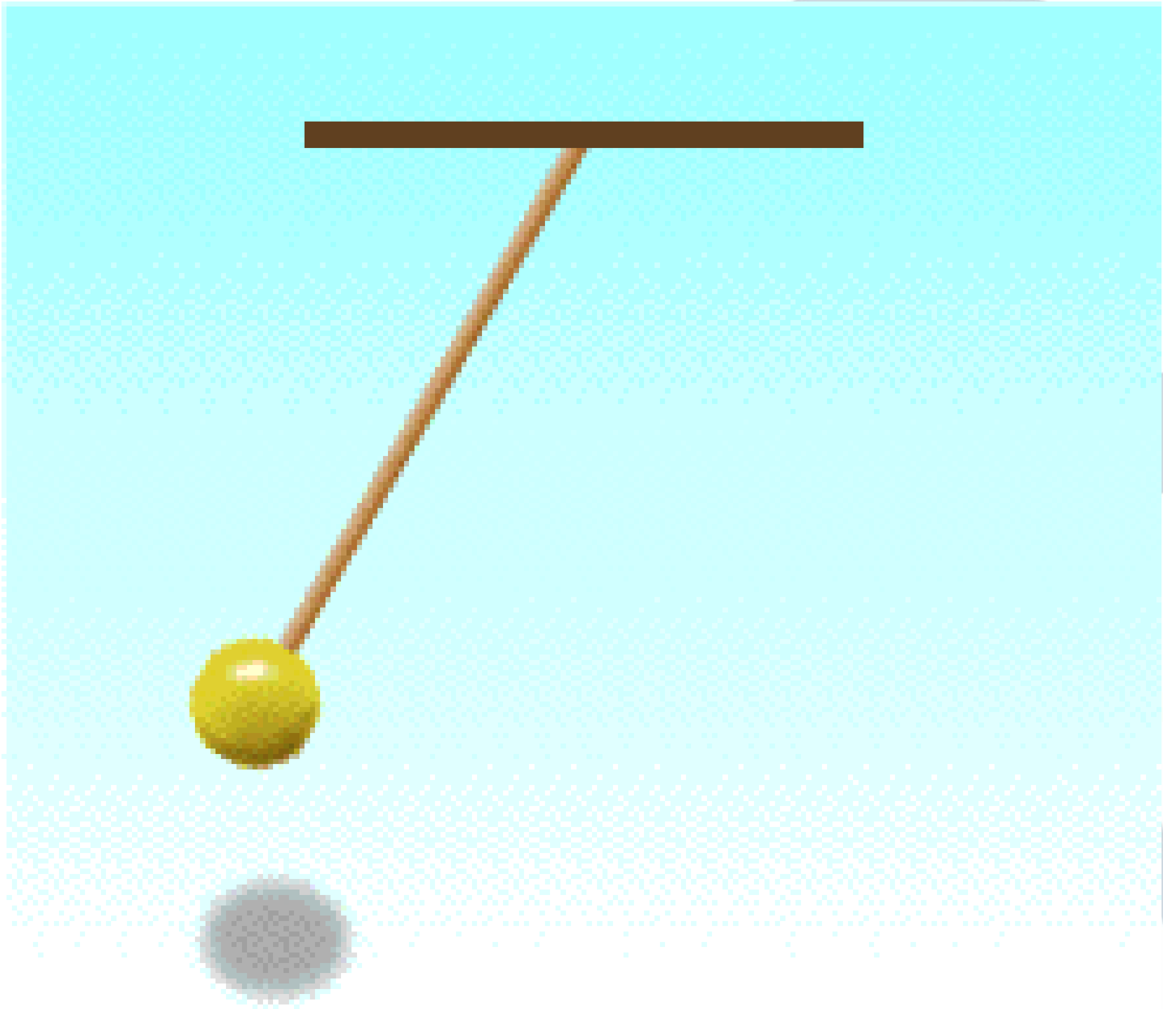
$$sin\alpha = \frac{-h}{AO} \Rightarrow h = -AOsin\alpha$$

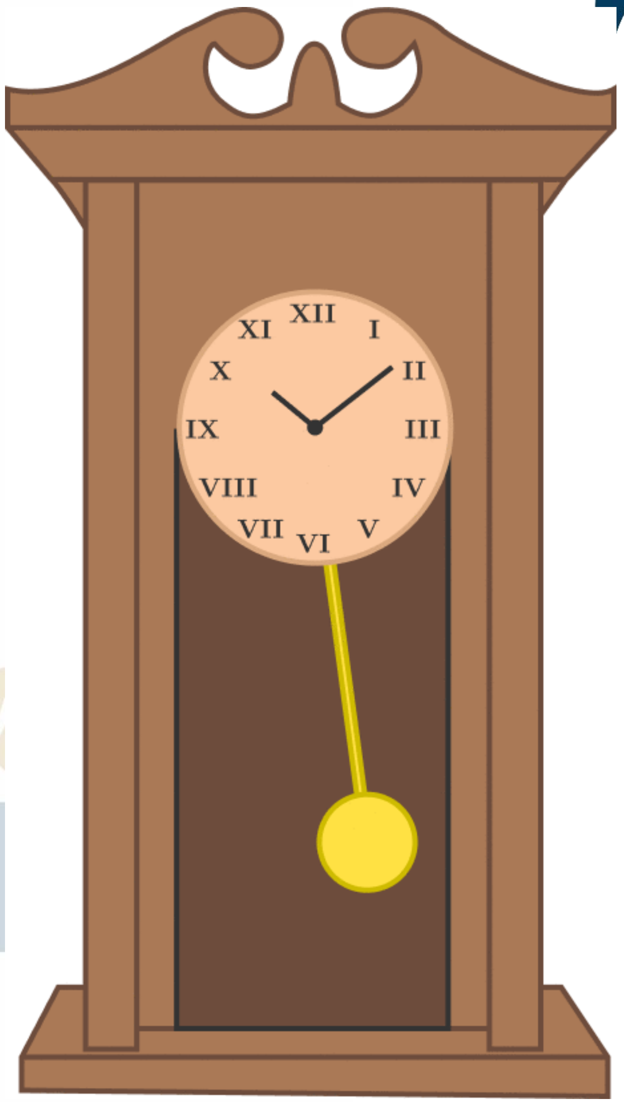
$$GPE = mg(-AOsin\alpha)$$



$$GPE = 2 \times 10 \times (-0.9 \times sin60) \Rightarrow GPE = -15.6J$$

Gravitational Potential Energy/ Pendulum





Gravitational Potential Energy (GPE)/ Pendulum

Gravitational potential energy at point A at a height h above the reference level:

The gravitational potential energy:

$$GPE_A = mgh$$

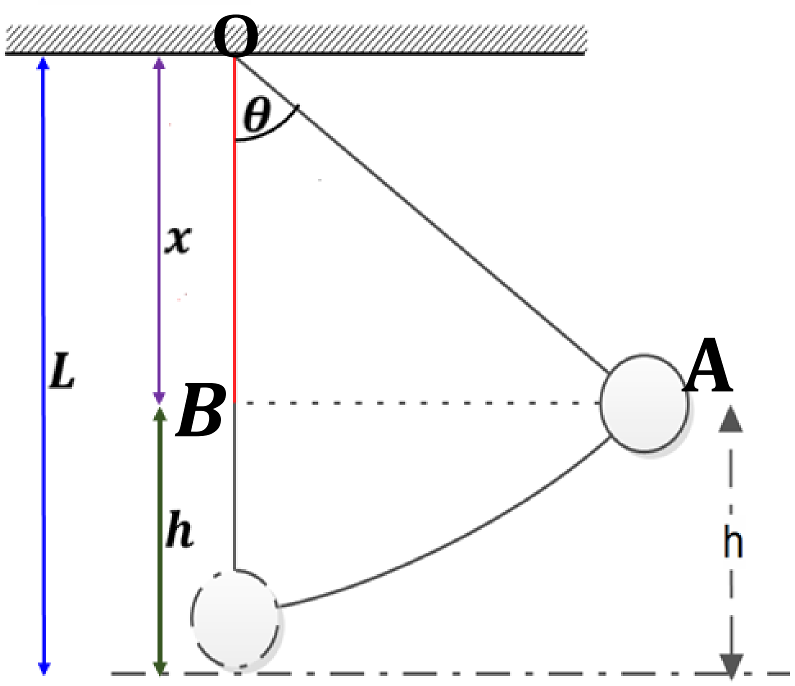
$$L = h + x \rightarrow h = (L - x)$$

For the triangle AOB: $cos\theta = \frac{adj}{hyp} = \frac{x}{L}$

$$x = Lcos\theta$$

$$h = (L - x) = L - Lcos\theta$$

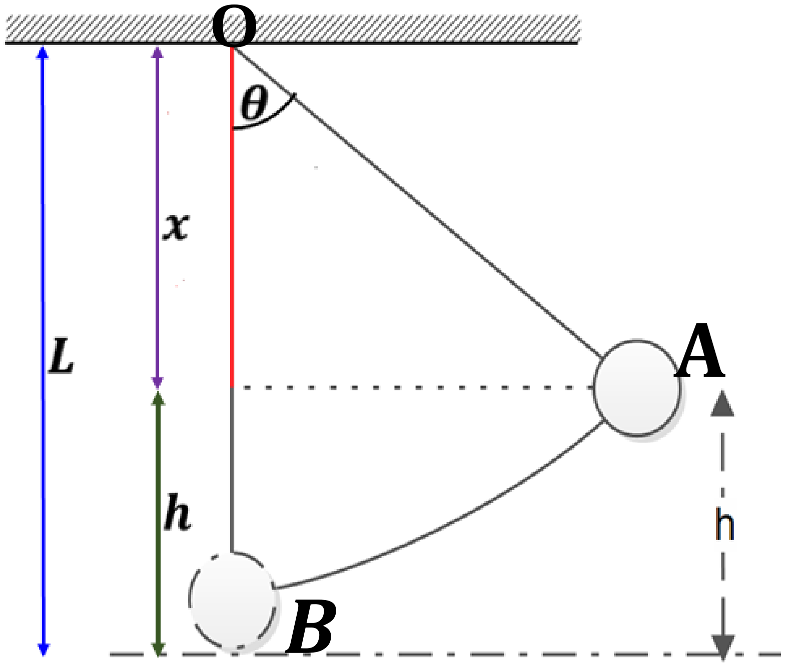
$$h = L(1 - cos\theta)$$



Gravitational Potential Energy (GPE)/ Pendulum

Application 7:

A pendulum is formed of a massless and inextensible string of length $L = 90cm$, having one of its ends O fixed to a support while the other end carries a particle (S) of mass $m = 200\ g$.



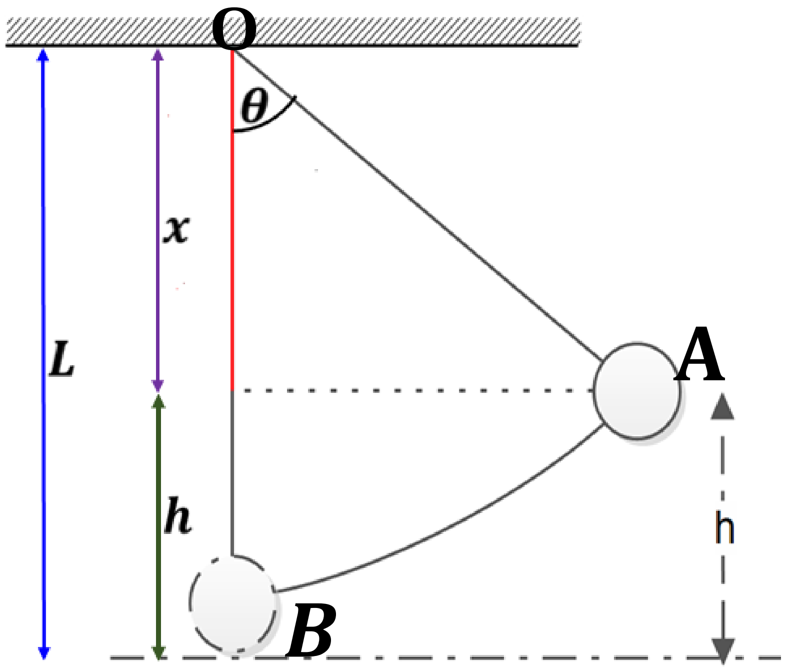
The pendulum is shifted from its equilibrium position to point A making an angle $\theta = 30^{\circ}$.

The horizontal plane passing through B is a reference level for gravitational potential energy. Given $g = 10N/kg$.

Calculate the GPE of the system (pendulum-earth) at point A when it makes an angle $\theta = 30^{\circ}$ with the equilibrium position.

Gravitational Potential Energy (GPE)/ Pendulum

$m = 0.2kg$; $L = 0.9m$; $\theta = 30$; $g = 10N/kg$.



$$GPE_A = mgh$$

$$GPE_A = mgL(1 - cos\theta)$$

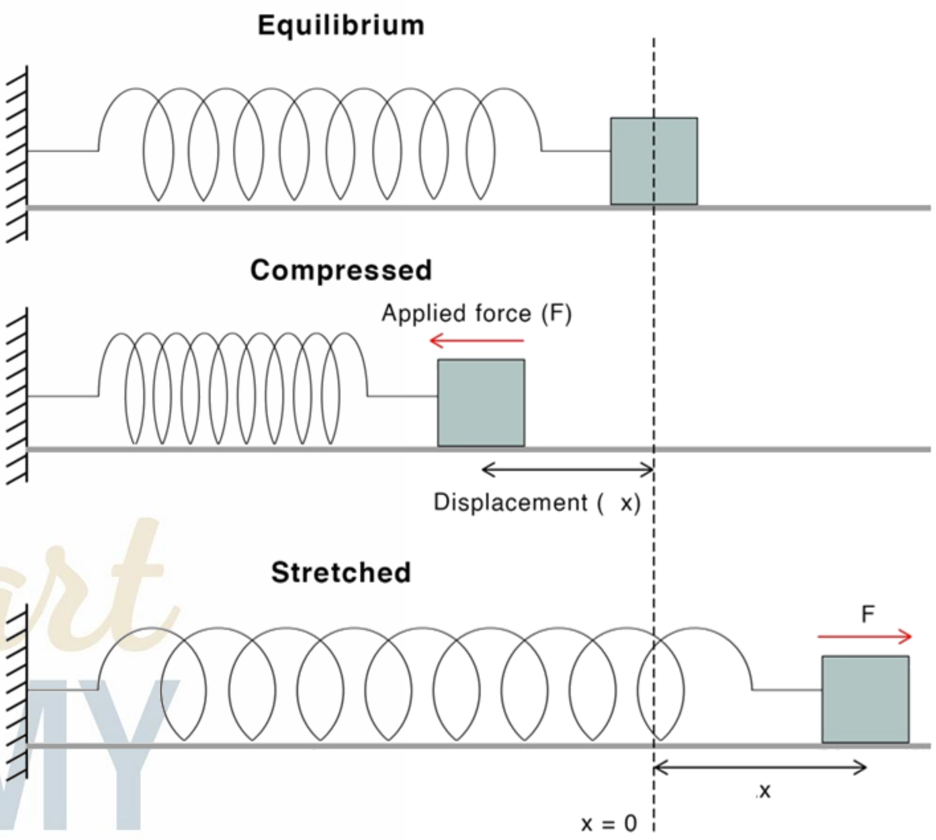
$$GPE_A = 0.2 \times 10 \times 0.9(1 - cos30)$$

$$PE_g = 0.24J$$

Elastic Potential Energy (EPE)

It is the energy stored as a result of deformation of an elastic object, such as a spring.

The energy is stored in the spring when it is compressed or stretched.



$$EPE = \frac{1}{2}kx^2$$

EPE**: elastic potential energy, expressed in J.**

K: spring constant (stiffness) expressed in N/m.

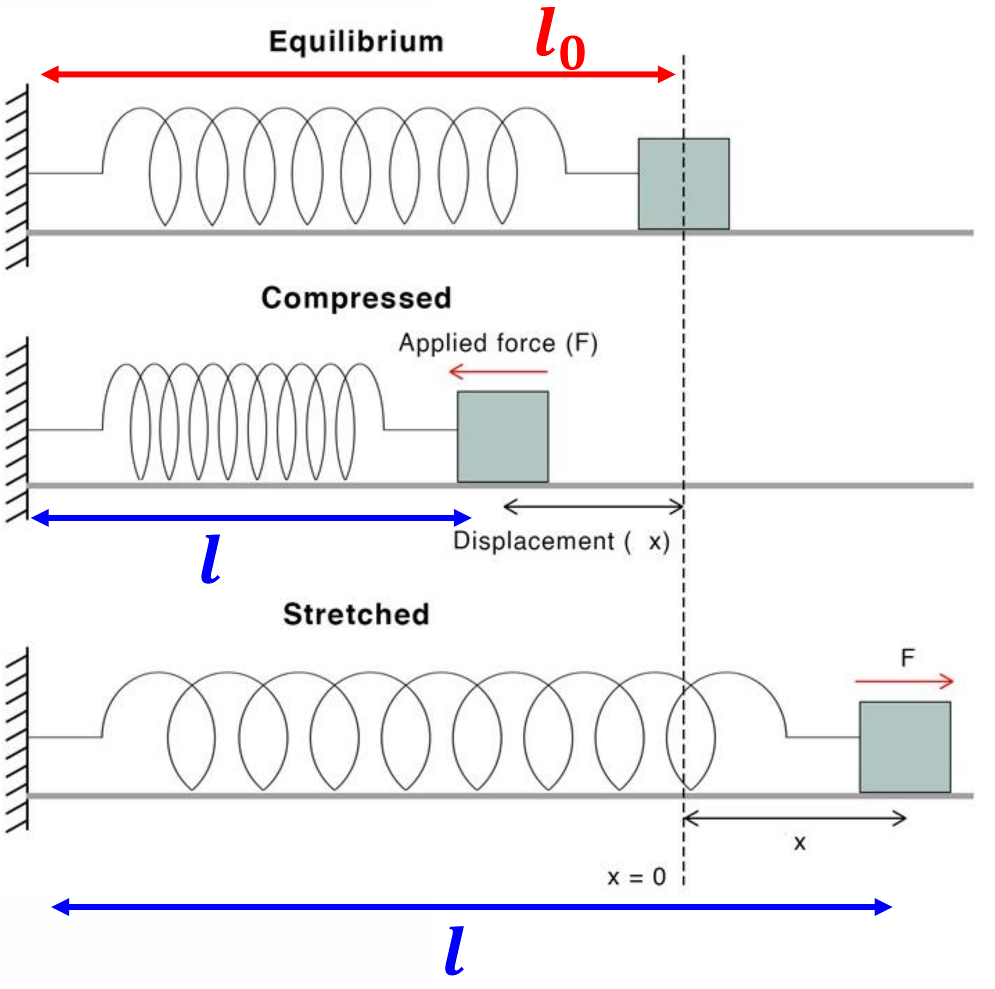
x**: The compression or elongation of the spring, expressed in m.**

Elastic Potential Energy (EPE)

$$EPE = \frac{1}{2}kx^2$$

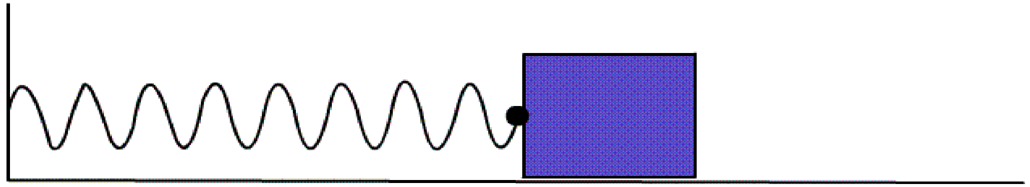
l_0: initial length

$$x = \begin{cases} l - l_0 \ (elongation \\ l_0 - l \ (compression) \end{cases}$$



Elastic Potential Energy (EPE)

$$EPE = \frac{1}{2}kx^2$$



Horizontal spring

Vertical spring

Elastic Potential Energy (EPE)

When the spring is elongated to maximum

x is maximum then EPE is maximum

$V = 0$ then KE is zero

x is minimum then EPE is minimum

$V = 0$ then KE is zero

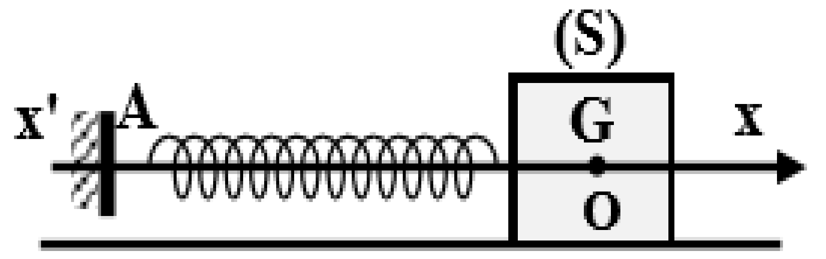
Elastic Potential Energy (EPE)

Application 8:

Consider a solid (S) of mass $m = 500g$ is connected to a spring (R) of free length $l_0 = 25cm$.

The stiffens of the spring is $k = 20N/m$.

The spring is elongated by a distance x and become has a length $l = 35cm$.



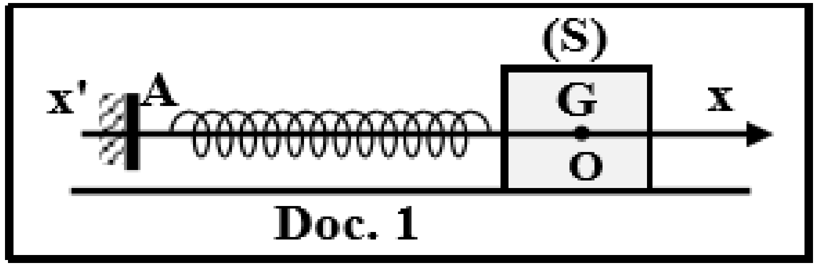
Doc. 1

1. Calculate the variation in length Δl.
2. Calculate the elastic potential energy stored in the spring when it is elongated by $x = \Delta L$

Elastic Potential Energy (EPE)

$m = 500\text{g}$; $l_0 = 25cm$; $k = 20N/m$; $l = 35cm$.

1. Calculate the variation in length Δl.



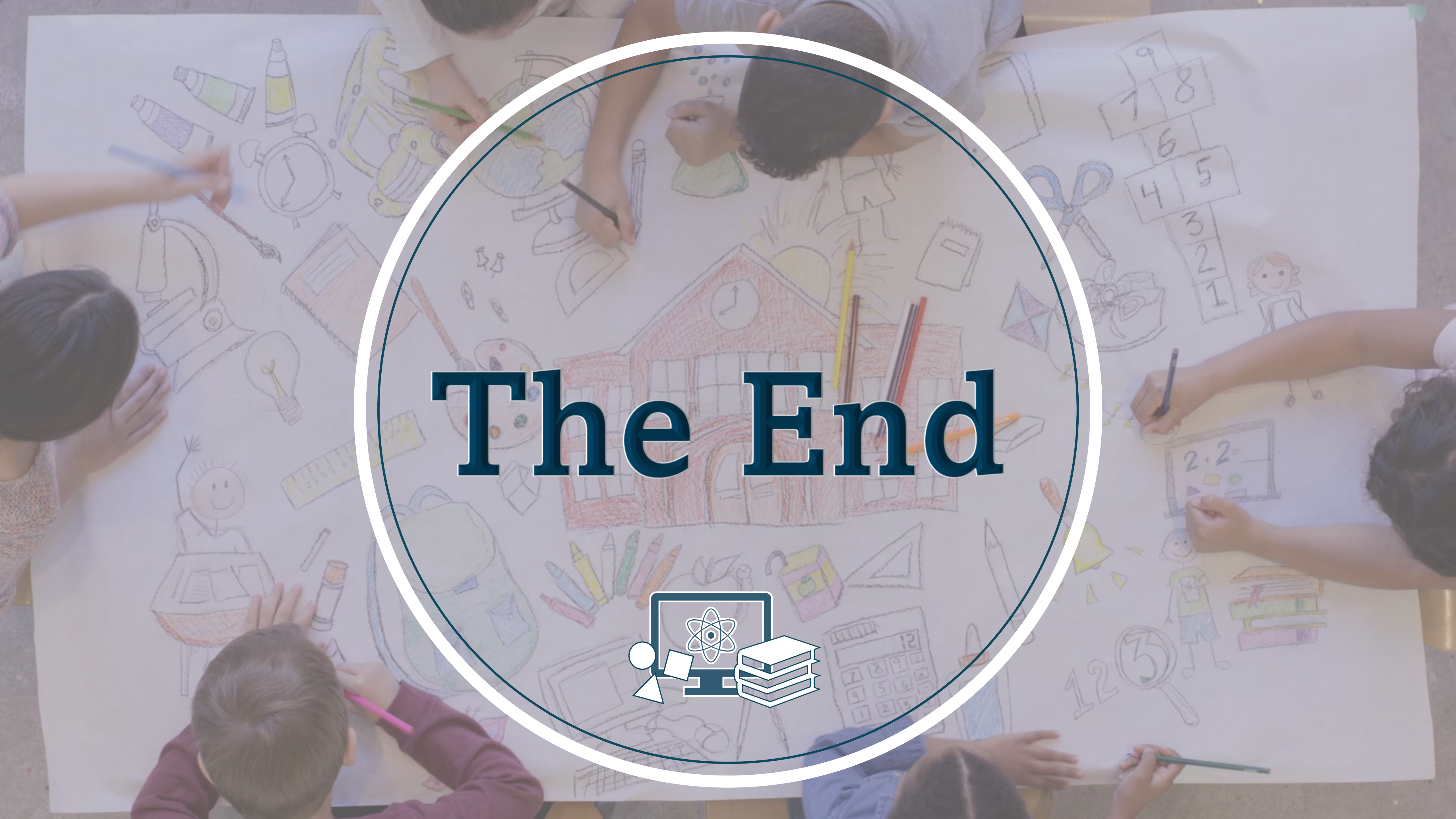
$$x = \Delta L = l - l_0$$

$x = 35 - 25$ ➡ $x = 10cm = 0.1m$

2. Calculate the elastic potential energy stored in the spring when it is elongated by $x = \Delta L$

$\text{EPE} = 1/2\text{kx}^2$ ➡ $\text{EPE} = 0.5 \times (20) \times (0.1)^2$

$$\text{EPE} = 0.1\text{J}$$


The End

Grade 11S – Physics

Unit Two: Mechanics

Chapter 11: Work & Energy

Prepared & Presented by: Mr. Mohamad Seif

OBJECTIVES

Be Smart ACADEMY

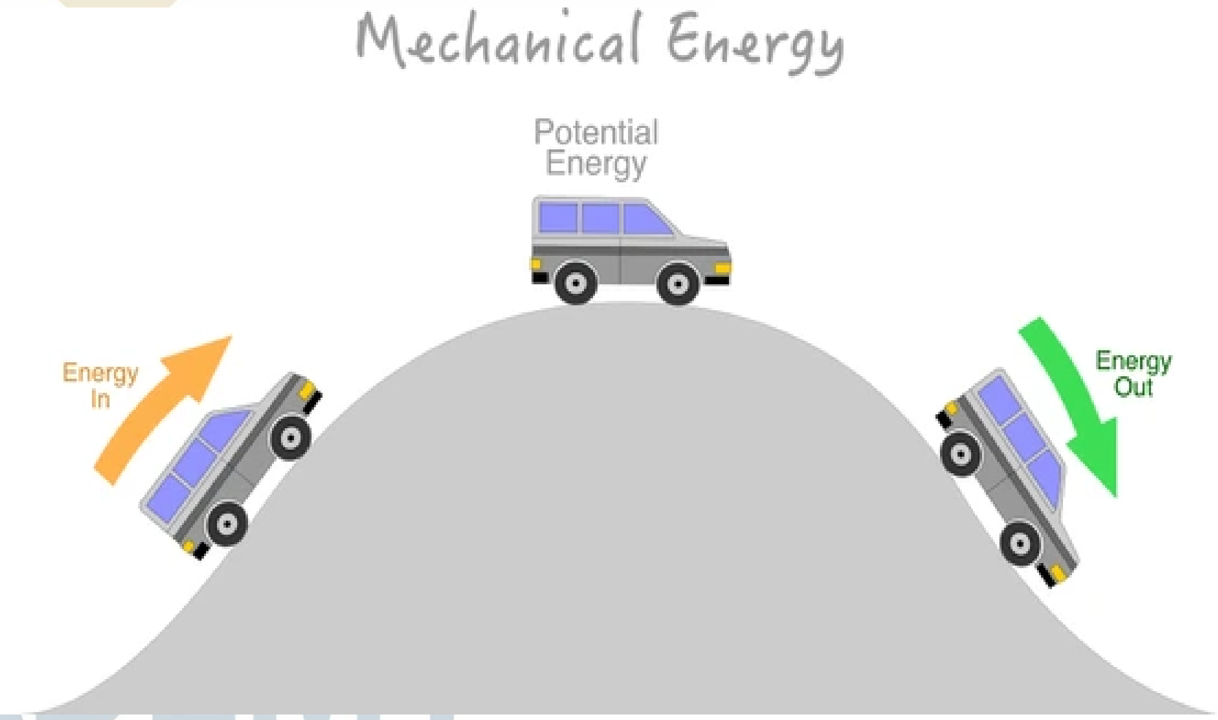
1	Determine the Mechanical energy of a system
2	Apply the law of conservation of mechanical energy
3	Apply the law of non -conservation of mechanical energy

Mechanical Energy (ME)

Mechanical Energy of a system at a certain point is:

The sum of kinetic energy and potential energy of a system at that point, expressed in J

$$ME = KE + PE_g + PE_e$$



Mechanical Energy: ME = KE + PE

Kinetic (KE) (motion)

- **Translation**
  ($KE_{tran} = 1/2mV^2$)
- **Rotation <u>(GS)</u>**
  ($KE_{rot} = 1/2I\theta'^2$)

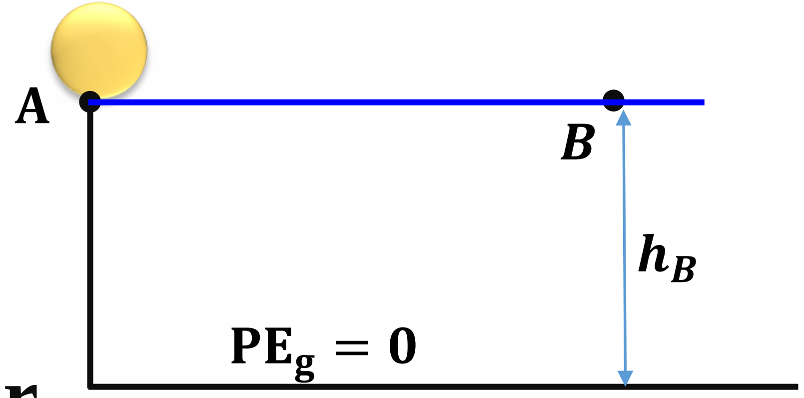
Potential (PE) (position)

- **Gravitational**
  ($GPE = mgh$)
- **Elastic**
  ($EPE = 1/2\mathrm{k}x^2$)

Mechanical Energy (ME)

Application 9:

A particle (S) of mass of $m = 1.25Kg$ starts its motion from rest from A.



The particle reaches point B, 3.1m above the ground with a speed of 2.5m/s.

Take the ground as reference level for gravitational potential energy. Given g = 10N /kg .

1)Calculate the mechanical energy of the system[(S)-earth] at point A.

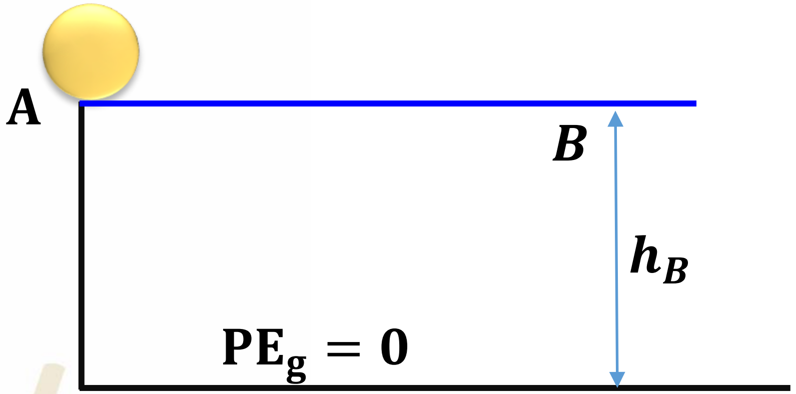
2) Calculate the mechanical energy of the system[(S)-earth] at point B

Mechanical Energy (ME)

$m = 1.25kg$; $h_A = h_B = 3.1m$; $V_B = 2.5m/s$; g=10N/kg.

1)Calculate the mechanical energy of the system[(S)-earth] at point A.

$$\mathrm{ME}_A = \mathrm{KE}_A + (\mathrm{GPE})_A$$



$$ME_A = \frac{1}{2}mV_A^2 + mgh_A$$

$$ME_A = 0.5 \times 1.25 \times (0)^2 + 1.25 \times 10 \times 3.1$$

$$ME_A = 0 + 38.75$$

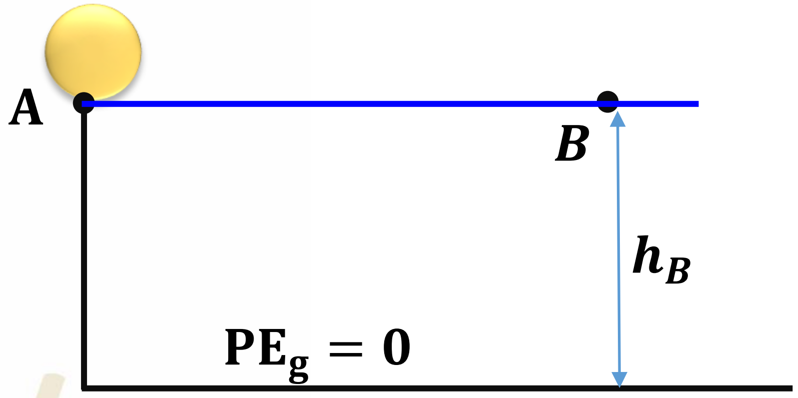
$$\mathrm{ME} = 38.75\mathrm{J}$$

Mechanical Energy (ME)

$m = 1.25kg$; $h_A = h_B = 3.1m$; $V_B = 2.5m/s$; g=10N/kg.

2) Calculate the mechanical energy of the system[(S)-earth] at point B.

$$\mathrm{ME}_B = \mathrm{KE}_B + (\mathrm{GPE})_B$$



$$ME_B = \frac{1}{2}mV_B^2 + mgh_B$$

$$ME_B = 0.5 \times 1.25 \times (2.5)^2 + 1.25 \times 10 \times 3.1$$

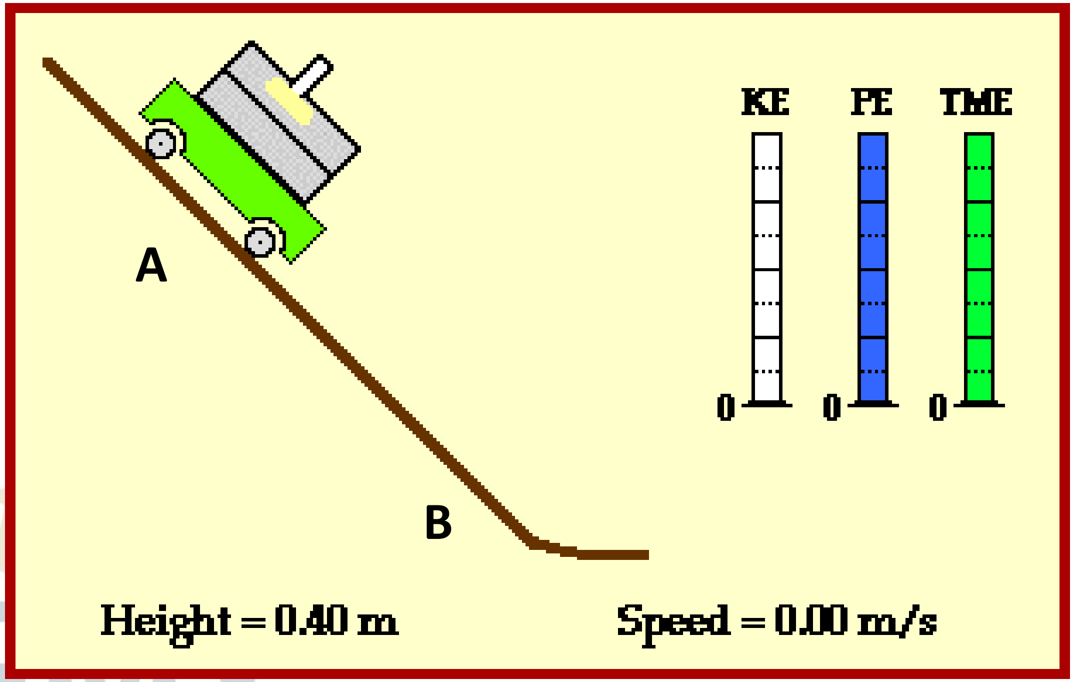
$$ME_A = 3.9 + 38.75$$

$$\mathrm{ME} = 42.65\mathrm{J}$$

Conservation of Mechanical Energy

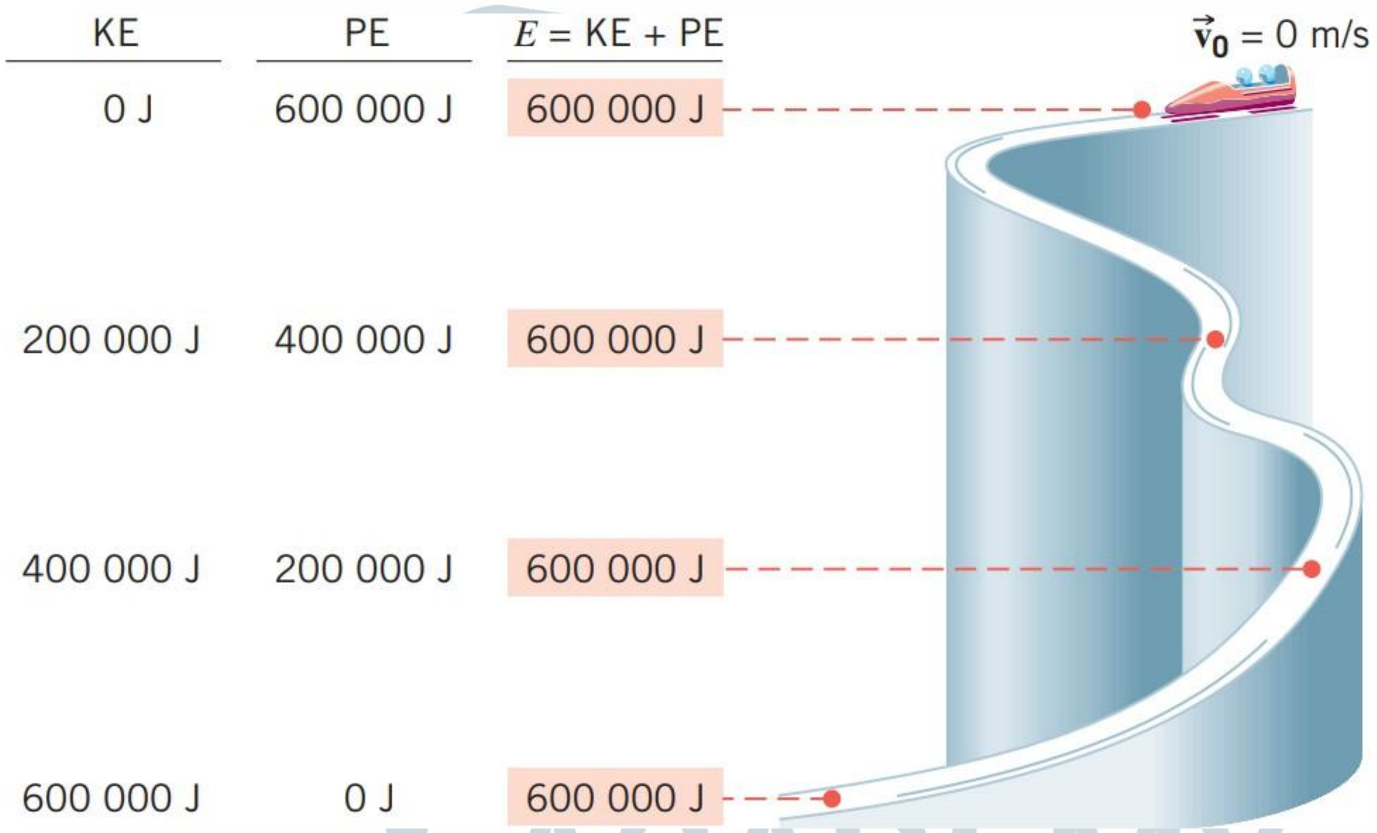
The Mechanical energy of an object is conserved (remains constant) if the object is not submitted to any non- conservative force):

The non-conservative forces (friction, air resistance, braking force, traction forces, damping force…) are zero or neglected. (ex: $f_r = 0$).



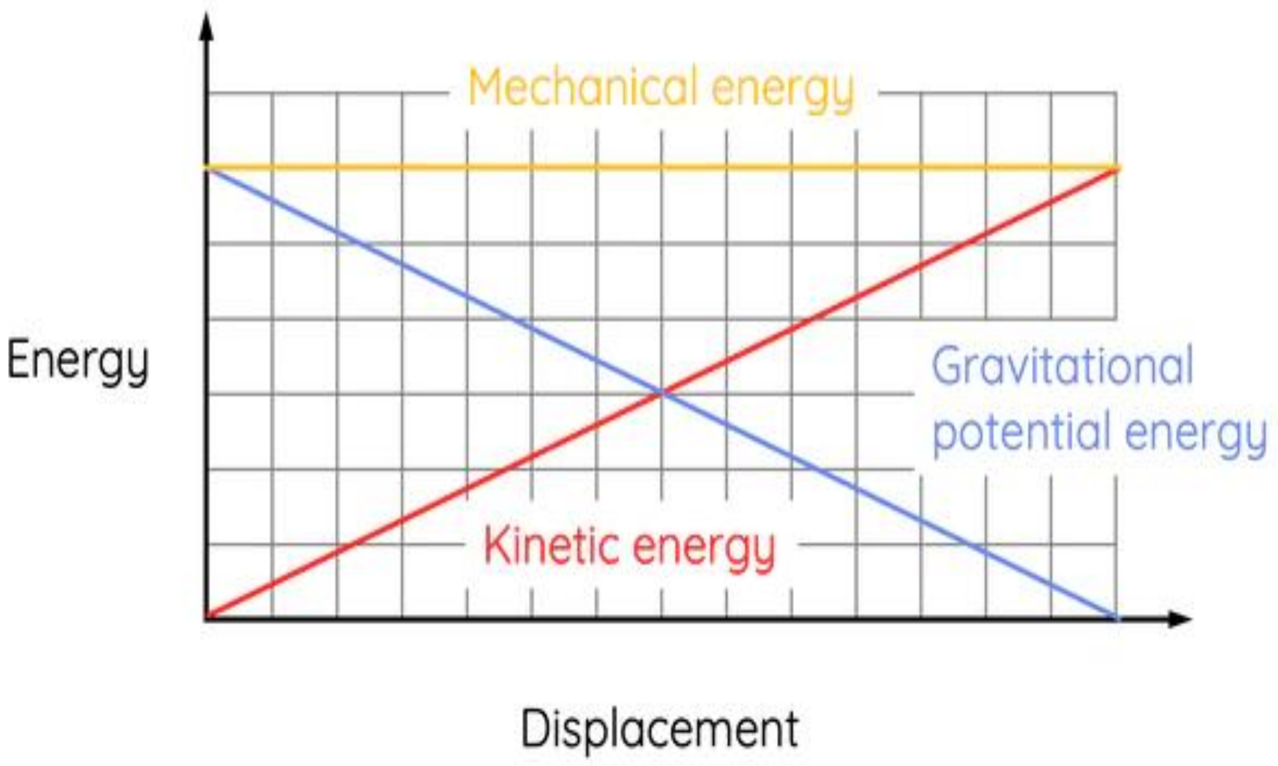
$$ME_A = ME_B$$

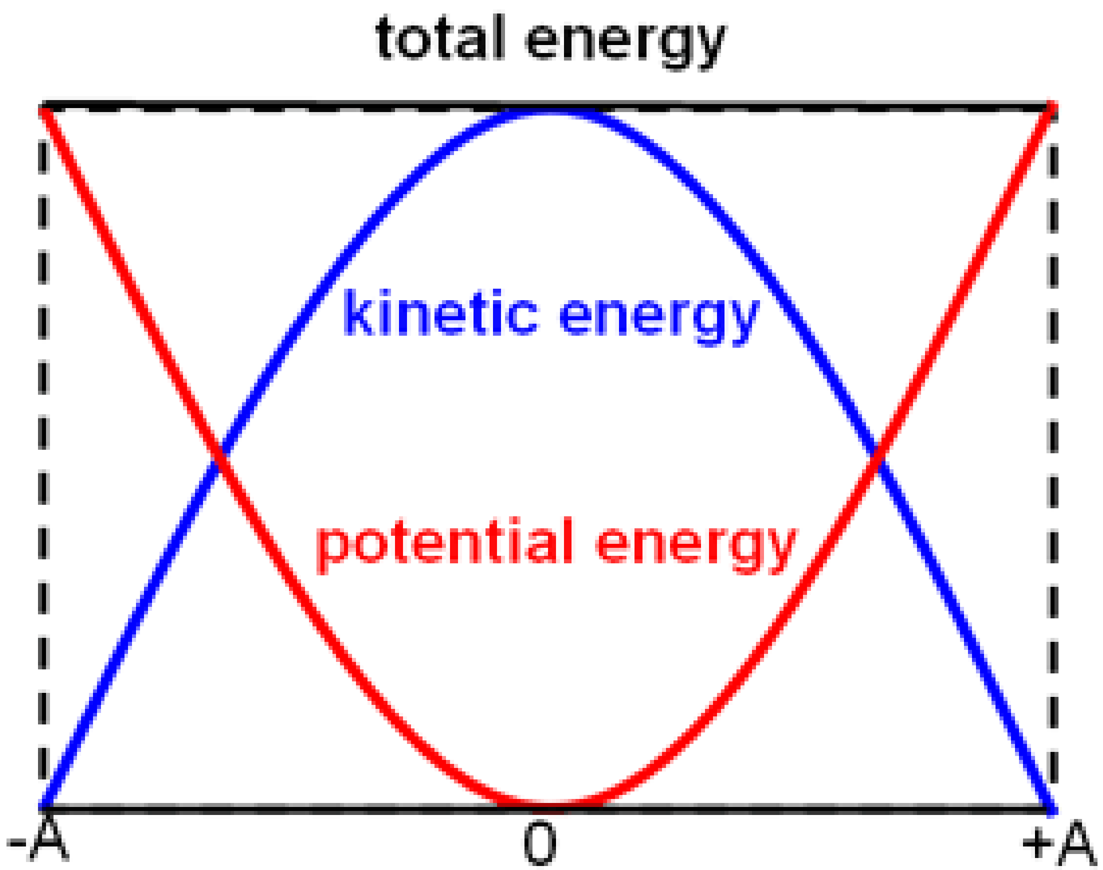
Conservation of Mechanical Energy



Ignoring friction and air resistance, a car run illustrates how kinetic energy and potential energy are interconverted, while the mechanical energy remains constant.

Conservation of Mechanical Energy





Conservative & Non-conservative Forces

Conservative forces

Forces that conserve the mechanical energy of the system (keep it constant)

Examples: weight, spring force…

Non - conservative forces

Forces that change the mechanical energy of the system.

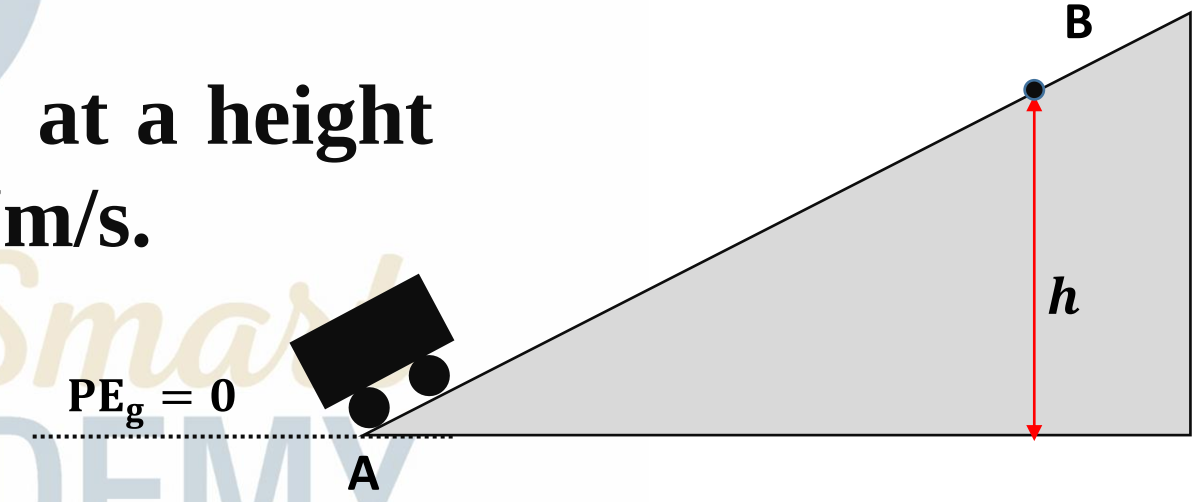
Examples: friction, air resistance, traction force …

Conservation of Mechanical Energy

Application 10:

A car considered as a particle of mass 500kg starts with a speed of 20m/s from the bottom A of an inclined plane making an angle $\alpha = 30^{\circ}$ with the horizontal.

The car cuts 35.1m reaches point B at a height h above the ground with a speed of 7m/s.



1. Calculate the mechanical energy of the system[car-earth] at point A.

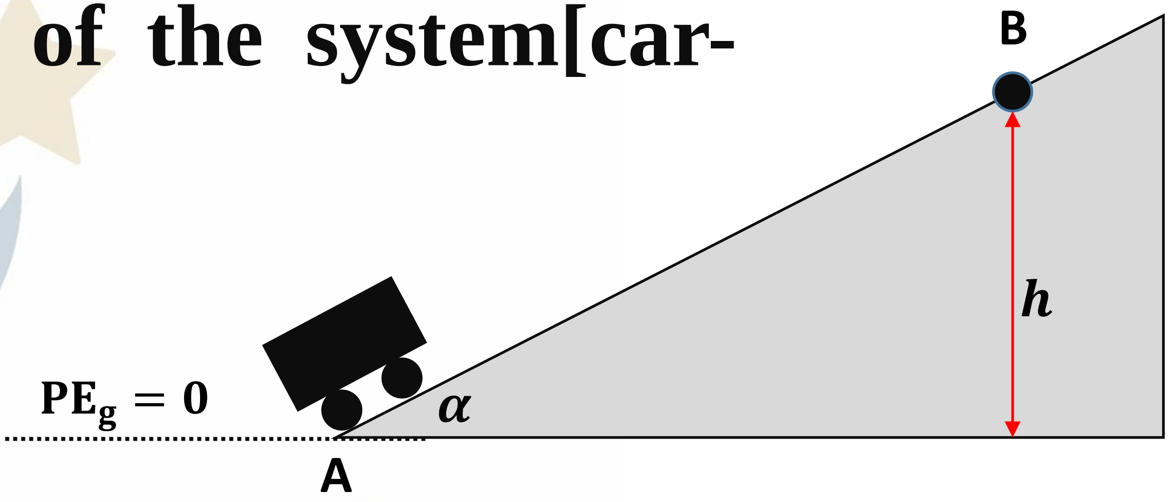
2. Calculate the mechanical energy of the system[car-earth] at point B.

3. Compare the mechanical energy at A and B, then deduce

Conservation of Mechanical Energy

$m = 500kg$; $V_A = 20m/s$; $\alpha = 30^{\circ}$; $AB = 35.1m$; $V_B = 7m/s$

1.Calculate the mechanical energy of the system[car-earth] at point A.



$$ME_A = KE_A + PE_A$$

$$ME_A = \frac{1}{2}mV_A^2 + mgh_A$$

$$ME_A = \frac{1}{2} \times 500 \times (20)^2 + 0$$

$$ME_A = 100,000J$$

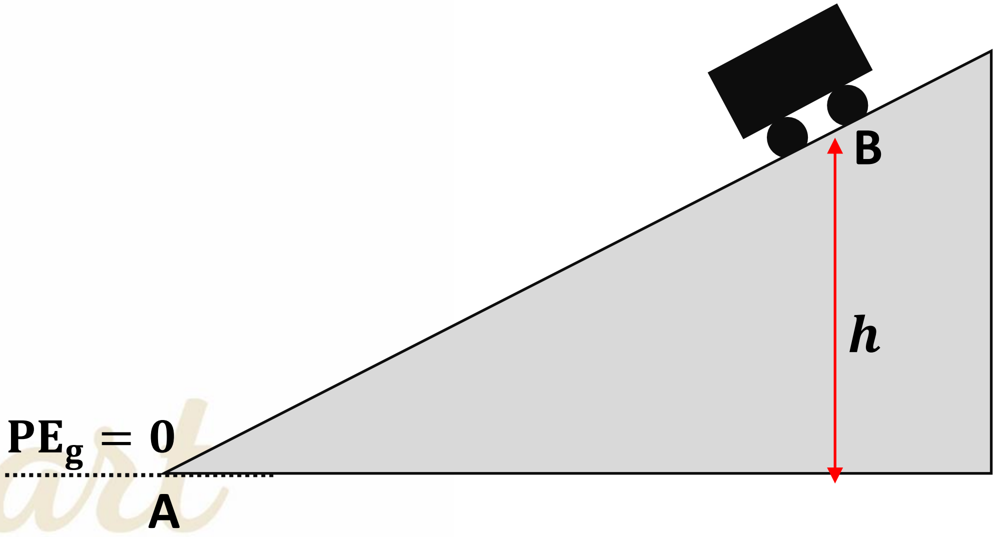
Conservation of Mechanical Energy

$m = 500kg$; $V_A = 20m/s$; $\alpha = 30^{\circ}$; $AB = 35.1m$; $V_B = 7m/s$

2.Calculate the mechanical energy of the system[car-earth] at point B.

$$ME_B = KE_B + PE_B$$

$$ME_B = \frac{1}{2}mV_B^2 + mgh_B$$



$$sin\alpha = \frac{h}{AB}$$

$$h = AB.sin\alpha$$

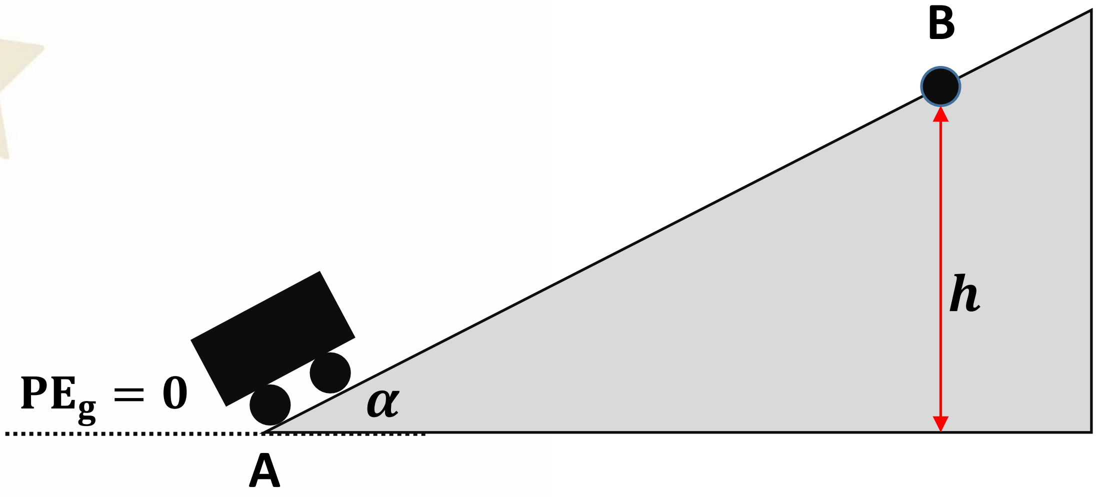
$$ME_B = 1/2mV_B^2 + mgAB.sin\alpha$$

$$ME_B = 0.5 \times 500 \times (7)^2 + 500(10).(35.1).sin30$$

$$ME_B = 100,000J$$

Conservation of Mechanical Energy

3.Compare the mechanical energy at A and B, then deduce.



$$ME_A = ME_B = 100,000J$$

Then the mechanical energy is conserved.

The frictional forces are neglected ($f_r = 0$).

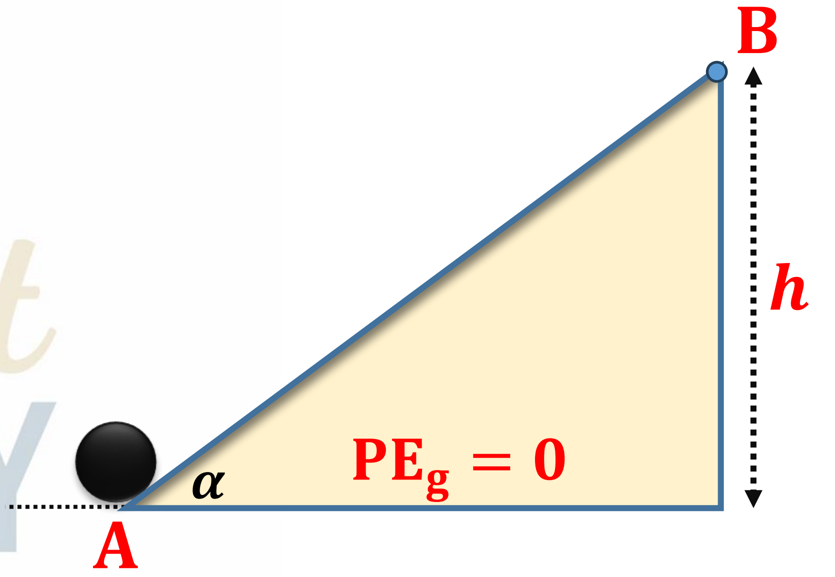
Non – conservation of Mechanical Energy

A particle moves from point A to point B. If the non-conservative forces acting on the body is not neglected, then:

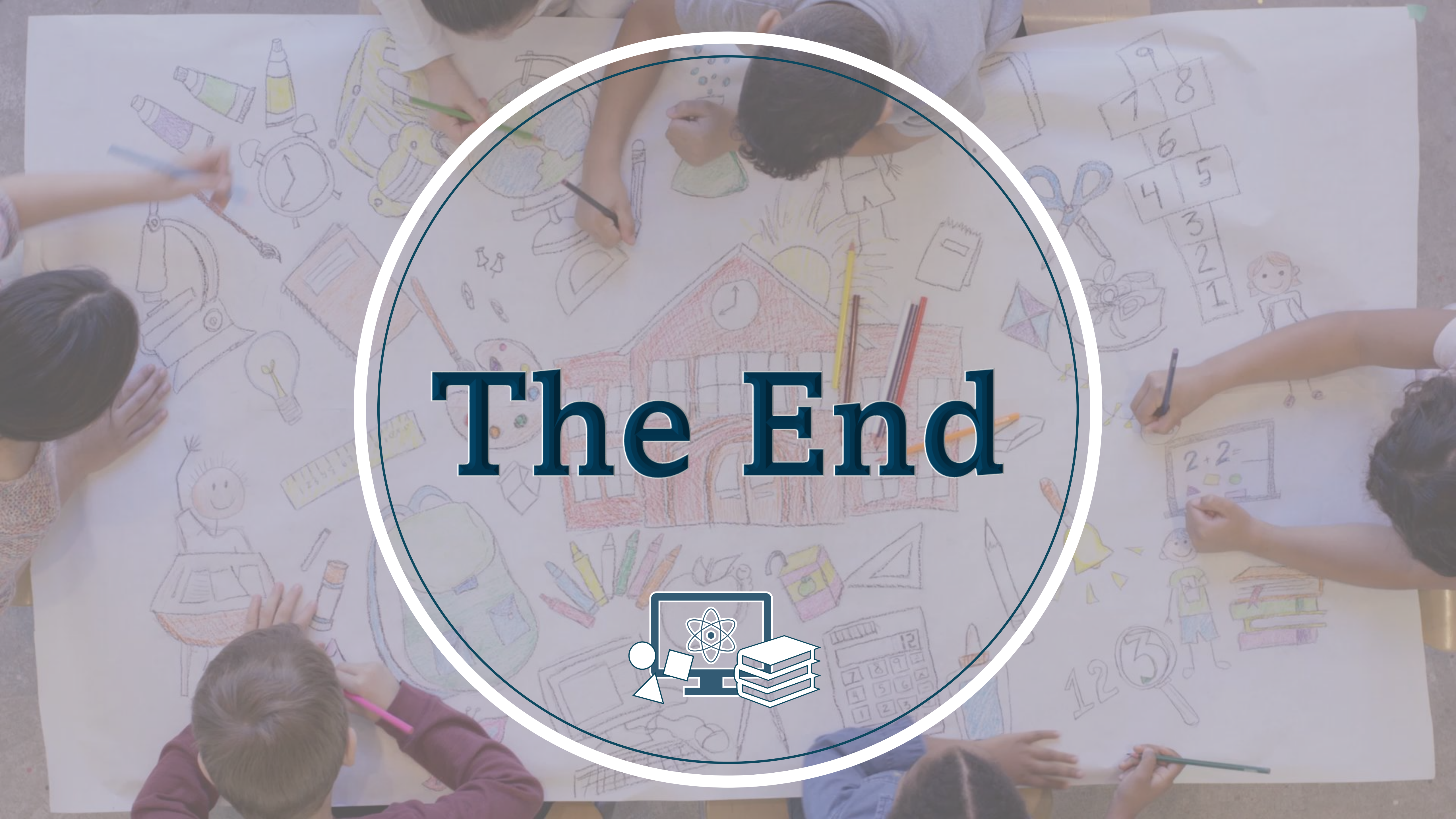
The mechanical energy of the system[body-earth] is NOT conserved. $(f_r \neq 0)$

$$ME_A \neq ME_B$$

The variation of mechanical energy between these two points equal to sum of work done by these forces.



$$\Delta M.E = \sum W_{non-cons}. \Rightarrow ME_f - ME_i = \sum W_{non-cons}.$$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