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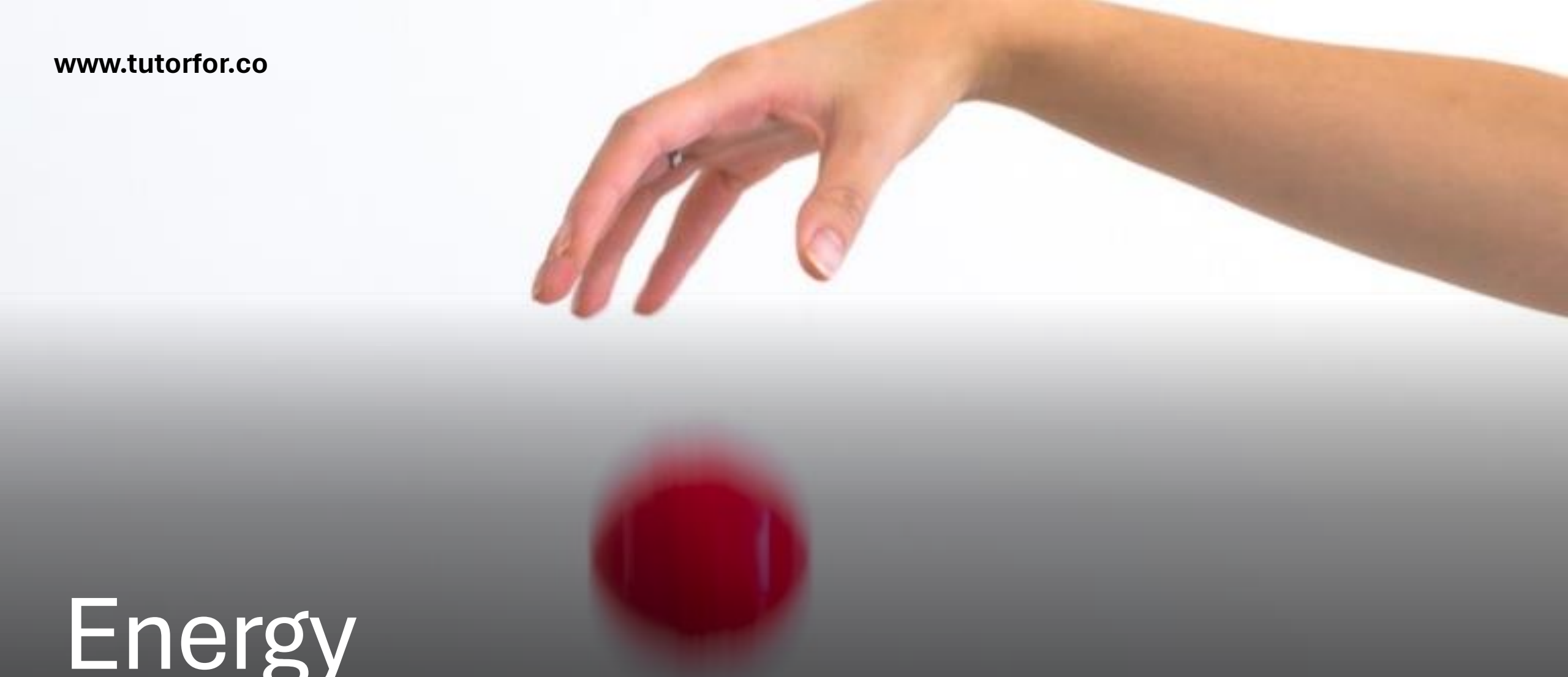


# Energy

IAS-Physics-Mechanics

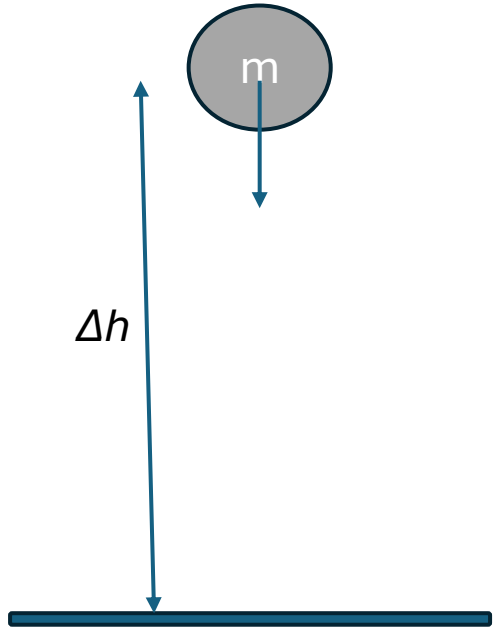
# Gravitational Potential Energy

# Gravitational Potential Energy

Gravitational Potential Energy($E_{grav}$) is the energy an object has by virtue of its position in a gravitational field

**$E_{grav}$ = mass× gravitational field strength× height**

$$E_{grav} = mg\,\Delta h$$

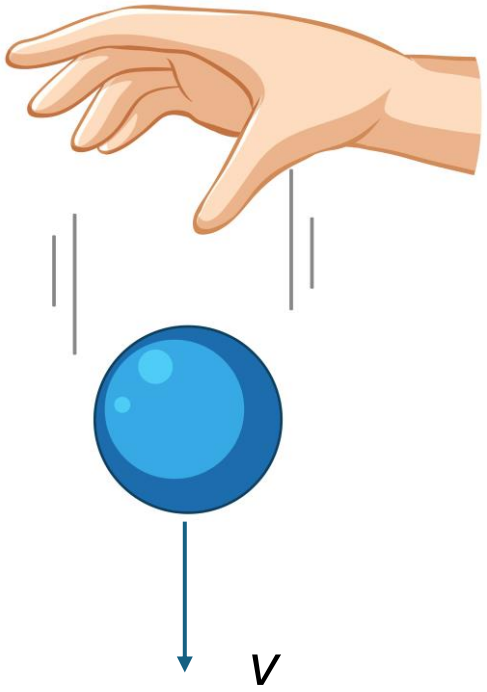


# Kinetic Energy

Kinetic energy ($E_k$) is the energy an object has by virtue of its movement

$$E_k = \frac{1}{2} \times mass \times (speed)^2$$

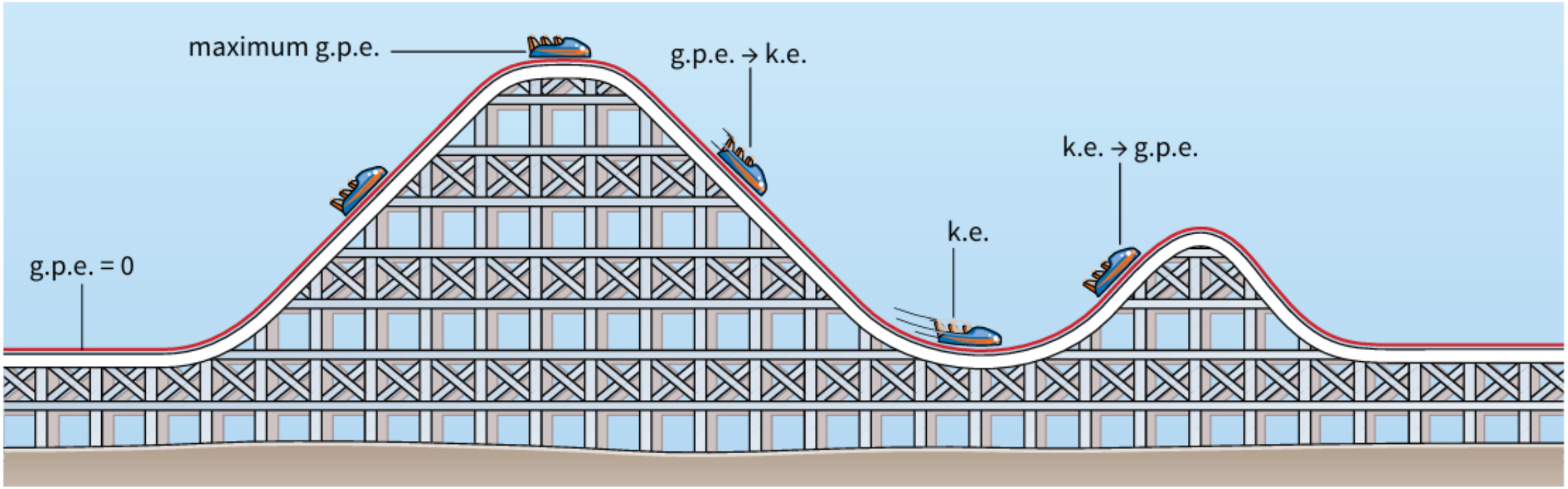
$$E_k = \frac{1}{2} mv^2$$



# The principle of conservation of energy

**Energy cannot be created or destroyed, it can be converted from one form to another and transferred from one place to another.**

# Transfer between Egrav & Ek

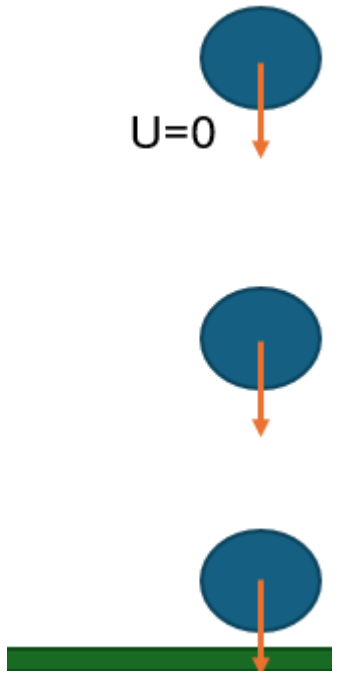


# Transfer between $E_{grav}$ & $E_k$

As objects rise or fall gravitational potential energy can be transferred to kinetic energy and kinetic energy can be transferred to gravitational potential energy.

$E_{grav} = E_k$

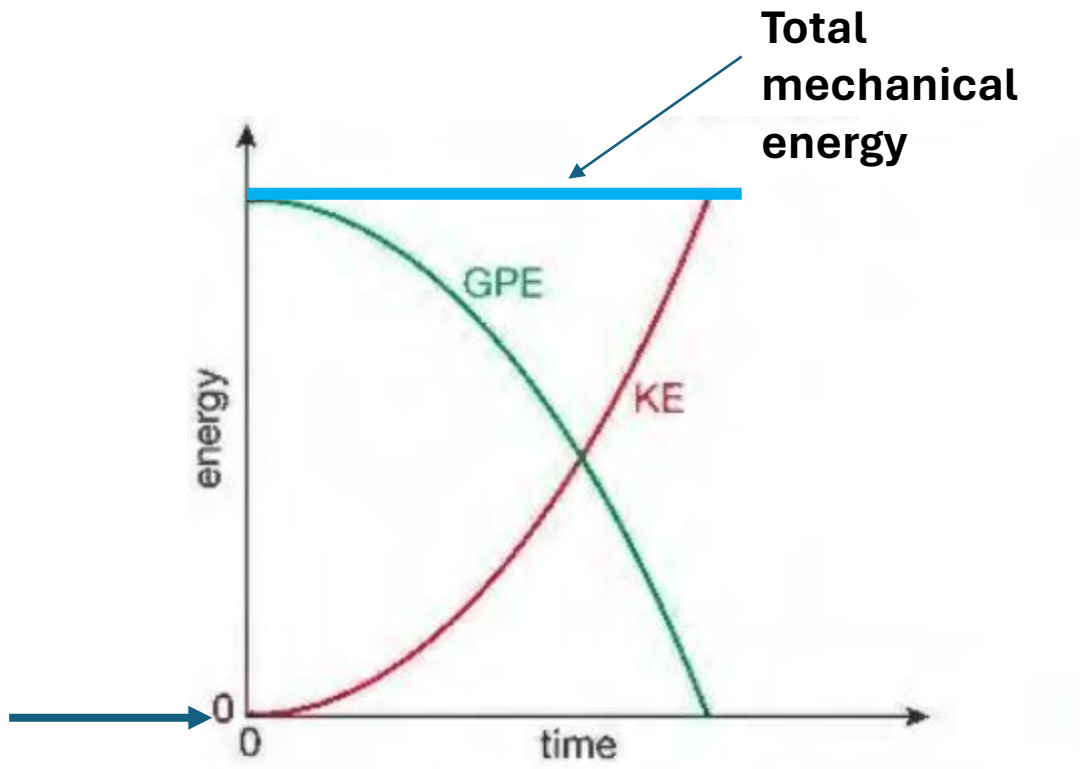
$mg\Delta h = \frac{1}{2}mv^2$




$E_{grav} = mg\Delta h$

$E_k = \frac{1}{2}mv^2$

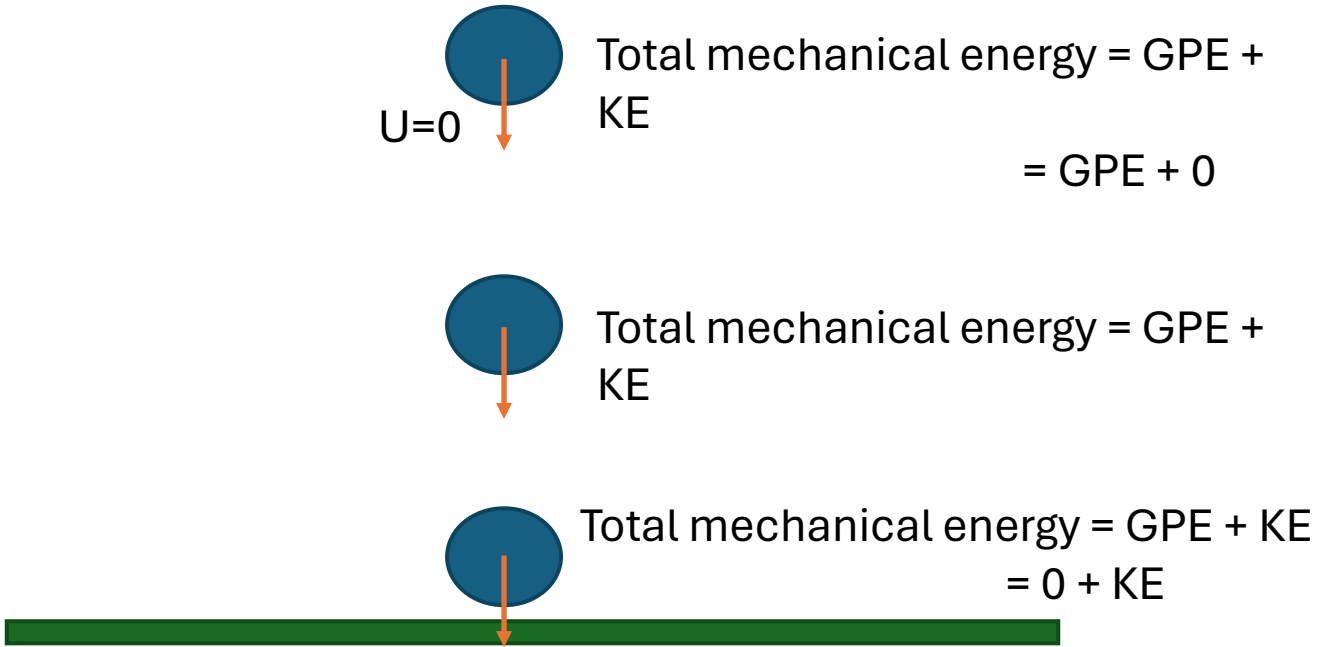
# Energy transfer in a dropped object



# Mechanical energy

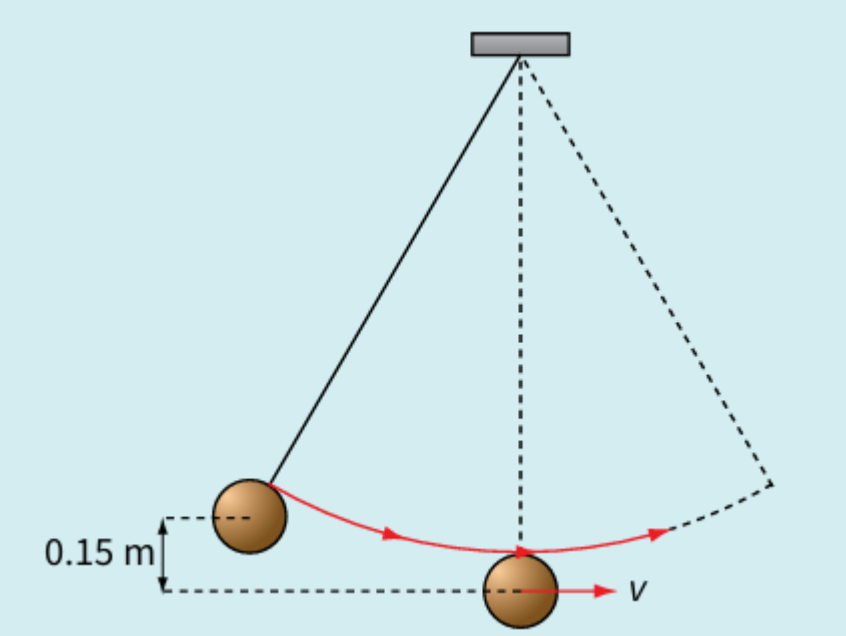
- The sum of the gravitational potential energy and the kinetic energy is called the mechanical energy.

- If an object is raised to a certain height and released the total mechanical energy remain constant(conserved) through out its journey(assume no air resistance).

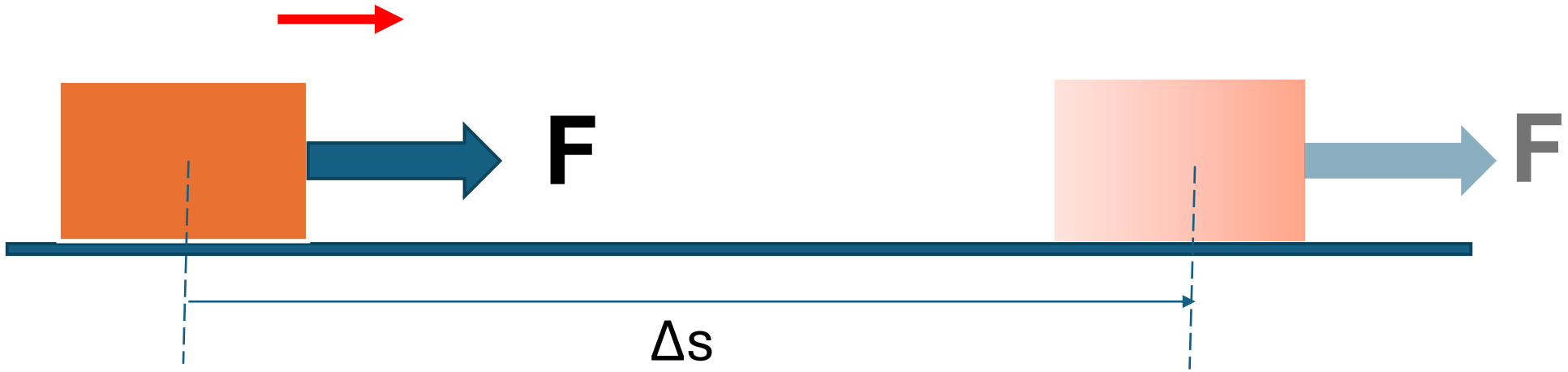


# Concept Learning Questions.

1) A pendulum consists of a brass sphere of mass 5.0 kg hanging from a long string. The sphere is pulled to the side so that it is 0.15 m above its lowest position. It is then released. How fast will it be moving when it passes through the lowest point along its path?



# Work done(W)

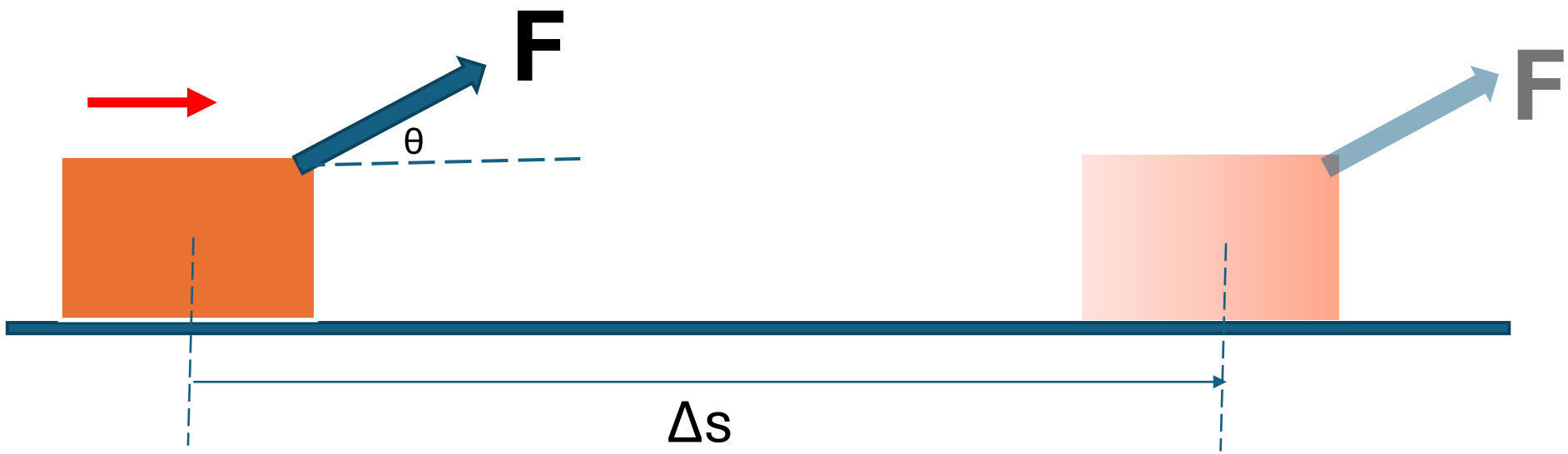



Work done = Force × distance moved in the direction of the force

$$W = F \times \Delta s$$

- ❑ Scalar quantity
- ❑ SI unit is joule(J)

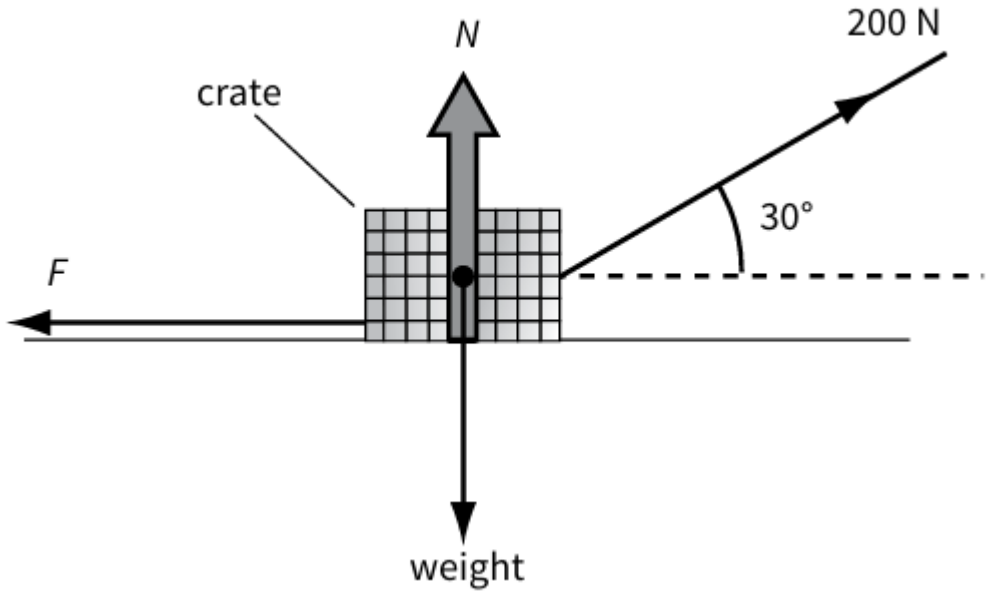
# Work done by forces at an angle




$$W = F\cos\theta \times \Delta s$$

# Concept Learning Questions.

1) A 120 kg crate is dragged along the horizontal ground by a 200 N force acting at an angle of 30° to the horizontal, as shown in the figure. The crate moves along the surface with a constant velocity of 0.5 m/s. The 200 N force is applied for a time of 16 s.



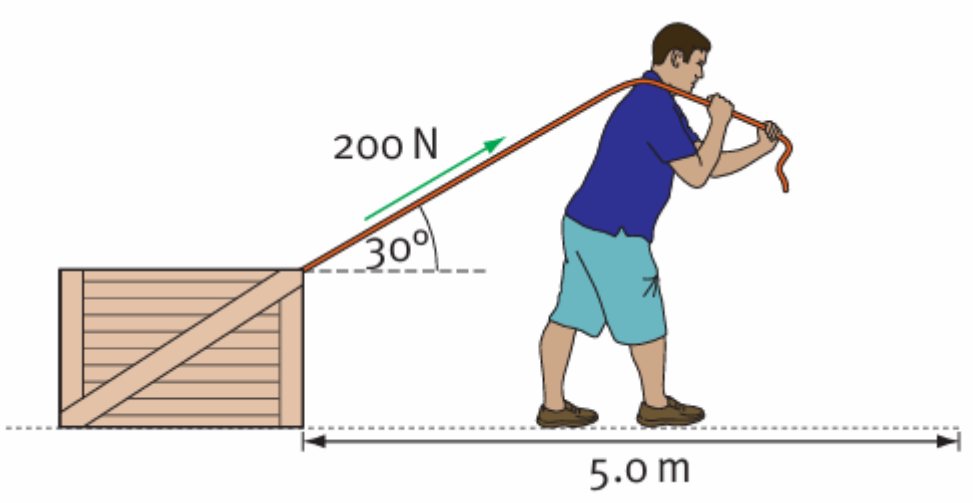

Calculate the work done on the crate by:

i) the 200 N force.

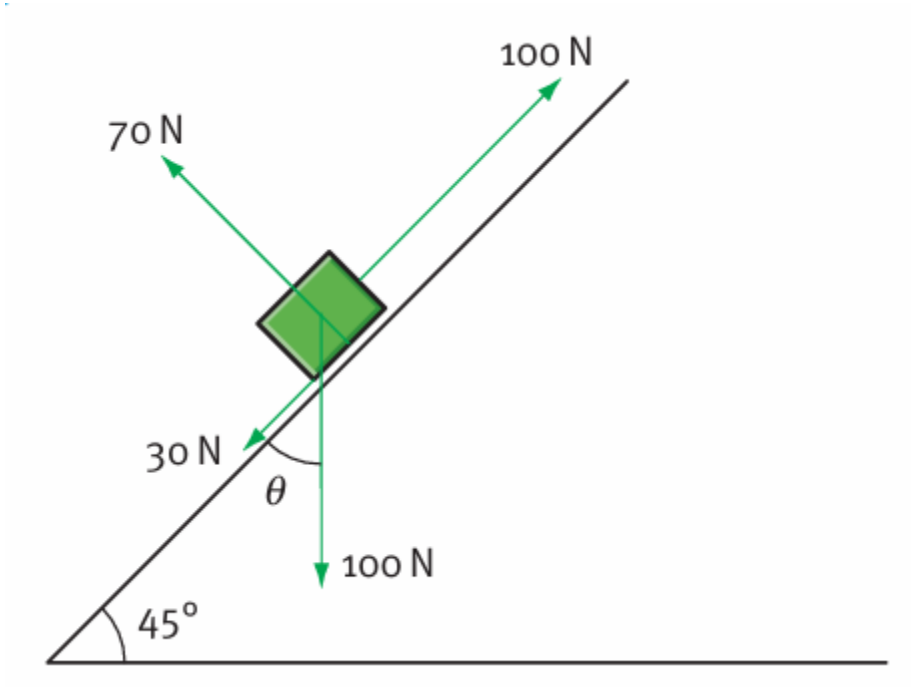
ii) the weight of the crate.

iii) the normal contact force N.

2) A man pulls a box along horizontal ground using a rope. Th e force provided by the rope is 200 N, at an angle of 30° to the horizontal. Calculate the work done if the box moves 5.0 m along the ground.



3) The following figure shows the forces acting on a box which is being pushed up a slope. Calculate the work done by each force if the box moves 0.50 m up the slope.



# Power(P)

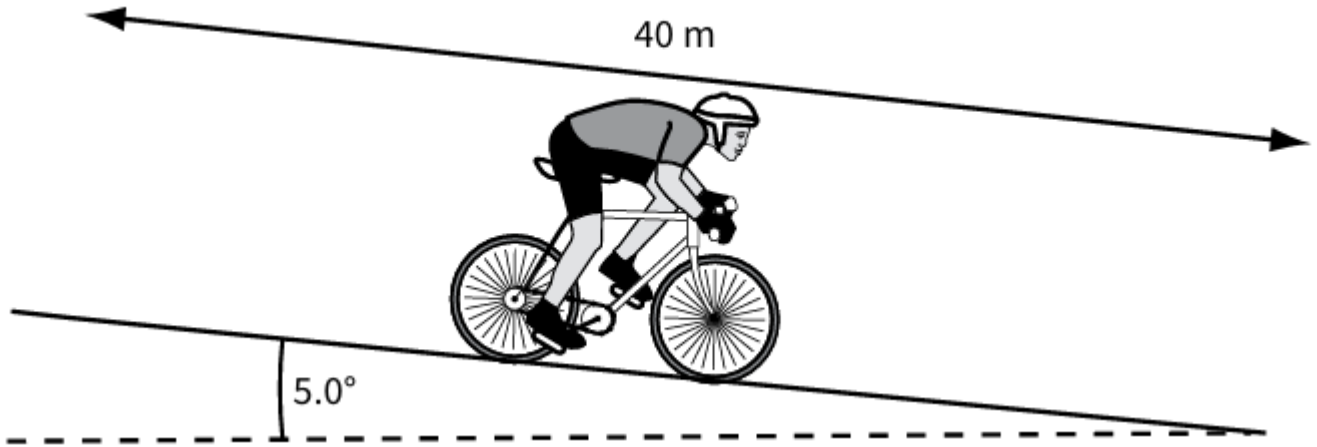
- Power is the rate of energy transfer.

$$\text{Power} = \frac{Energy}{Time} \quad \text{or} \quad \text{Power} = \frac{Work\ done}{time}$$

- The SI unit is watt(W)
- It is a scalar quantity.

# Concept Learning Questions

1) A cyclist pedals a long slope which is at 5.0° to the horizontal. The cyclist starts from rest at the top of the slope and reaches a speed of 12 m/s. aft er a time of 67 s, having travelled 40 m down the slope. The total mass of the cyclist and bicycle is 90 kg.




a Calculate:
i) the loss in gravitational potential energy as he travels down the slope.
ii) the increase in kinetic energy as he travels down the slope.

b i ) Use your answers to a to determine the useful power output of the cyclist.
ii) Suggest one reason why the actual power output of the cyclist is larger than your value in i.

# Efficiency

The efficiency of an energy conversion system is defined as:

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy output}} \times 100\%$$