WORK ENERGY AND POWER

WORK

- Definition: work is the product of the displacement and the component of the force applied parallel to the motion of the object
- $$\mathbf{W = F\ \Delta x\ Cos\ \theta}$$
- W = work measured in joule(J)
- F= force parallel to direction of motion in Newton
- Δx = displacement in meters(only magnitude)
- Cos θ= angle between the applied force and motion of object

Conditions for work done

- 1. there must be an applied force
- 2. the objects displacement must be in the direction of the component of the applied force

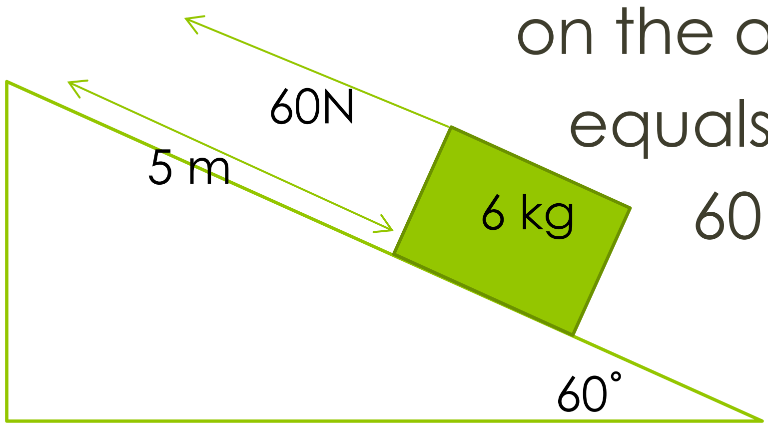
WORK

- POSITIVE WORK: the motion is in the same direction as the applied force. Kinetic energy increases. Velocity increase Cos 0
- NEGATIVE WORK: work done by an opposing force. Decrease in kinetic energy. Velocity decrease Cos 180

CALCULATING WORK DONE

- Calculate the **work** done by the
- 1. applied force
- 2. Friction force
- 3. Nett force

on the object if the friction equals 51N and applied force 60N



WORK/ENERGY THEOREM

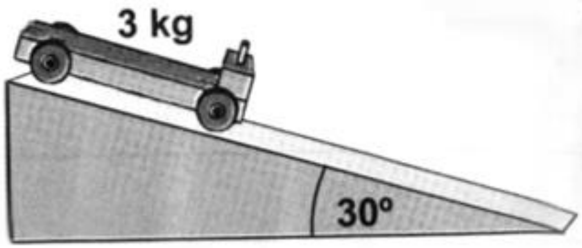
- WORK done increase / decrease the kinetic energy
- **$W_{net} = \Delta E_k$ Work/energy theorem**
- $W_{net} = E_{kf} - E_{ki}$
- **Def: The net work done on an object is equal to the change in kinetic energy of the object.**

A 2 000 kg car moving at 50 $m \cdot s^{-1}$ on a horizontal road is brought to a halt over a distance of 100 m when the brakes are applied.

(1) Calculate the average frictional force applied by the brakes to bring the car to a halt.

(2) If the same car has travelled at twice the velocity, thus 100 $m \cdot s^{-1}$, what will the distance then be? Give an answer without doing a complete calculation.

4. A trolley with a mass of 3 kg slides down an incline. The incline is 1 m in length and forms an angle of 30° to the horizontal, as shown. The trolley begins to move from rest at the top of the incline and undergoes a constant frictional force with a magnitude of 5 N.



4.1 Calculate the magnitude of the net force that is acting on the trolley parallel to the incline.

4.2 Use the work-energy theorem and calculate the sp
of the trolley when it reaches the bottom of the inc

Conservative and non-conservative forces

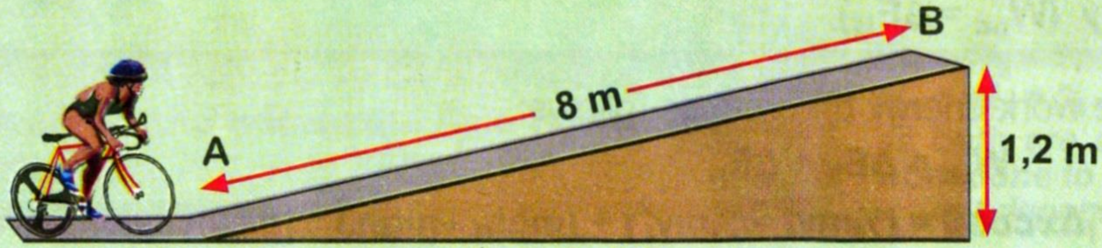
- Conservative: the net work done by the force to move the object that start and end at the same point = 0
- Conservative: work done is determined by starting point and end position
- Non-conservative: the net work done by the force to move the object that starts and end at the same point is not 0.
- Non- conservative: work done depends on the path taken

Conservative forces F_c non wastefull/ internal forces	Non- conservative forces F_{nc} wastefull/ external forces
Gravitational force Electrical power Elastic resillience	Frictional force Air resistance Tension in a rope Motor propulsion Push or pull forces

Mechanical energy and non-conservative forces

- Wnc = $\Delta E_k + \Delta E_p$
- $= (E_{kf} – E_{ki}) + (E_{pf} - E_{pi})$
- WORK ENERGY THEOREM: work done by non-conservative forces acting on an object is equal to the objects change in mechanical energy(**frictional force**)
- $W_{nc} = \Delta\ E_M$

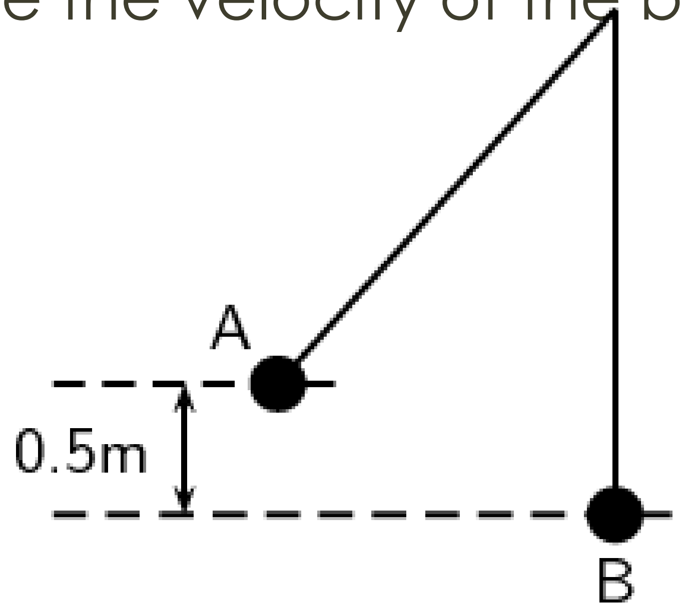
Thabita, a cyclist, free-wheels (without pedaling) at a constant speed of 10 $m \cdot s^{-1}$ on a horizontal level road. She reaches the bottom of a ramp (incline position A) with a height of 1.2 m and a length of 8 m, as shown in the figure. While she free-wheels up the ramp, she experiences a frictional force of 18 N. The total mass of Thabita and her bicycle is 55 kg.



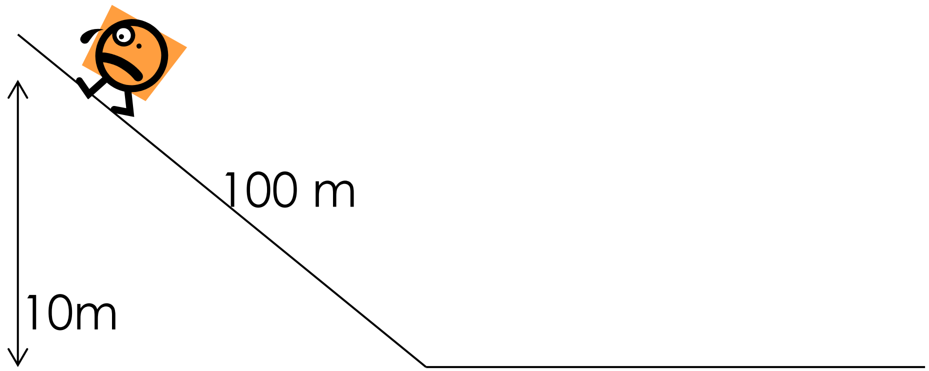
Law of conservation of mechanical energy

- Energy cannot be created or destroyed. Energy can only be converted from 1 form to another. Total energy of the isolated system is always conserved.
- If conservative forces are present = mechanical energy is conserved

- Example 2
- A 2 kg metal ball is suspended from a rope as a pendulum. If it is released from point A and swings down to the point B (the bottom of its arc):
- calculate the velocity of the ball at point B.



- Example 3
- A mountain climber who is climbing a mountain in the Drakensberg during winter, by mistake drops her water bottle which then slides 100 m down the side of a steep icy slope to a point which is 10 m lower than the climber's position. The mass of the climber is 60 kg and her water bottle has a mass of 500 g .



- If the bottle starts from rest, how fast is it travelling by the time it reaches the bottom of the slope? (Neglect friction.)

POWER

- Power is the rate of doing work.
- $Power = \frac{work}{time}$
- $\boldsymbol{P = \frac{W}{\Delta t}}$
- Power is measured in Watt or Joule per second.
- 1 W = 1 $J.s^{-1}$
- AND second possible formula for constant velocity..........**P = F v**

  ....unit W or $N.m.s^{-1}$