Topic: Work Energy Power Date:

Work: It is the product of force and displacment in the direction of force.

$W = F \times s$

* Scalar quantity.
* SI unit Joules (J)

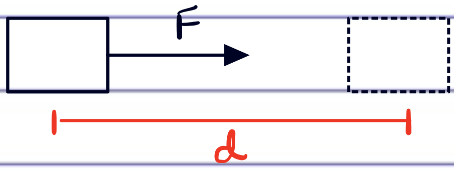
Exams Standard Notation.

Workdone by driving force/Forward force/Engine. $W = F_d \times d$

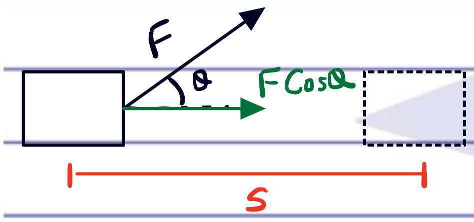
F_d = driving force.

Workdone against Frictional force/resistance/opposing force. $W = F_F \times d$

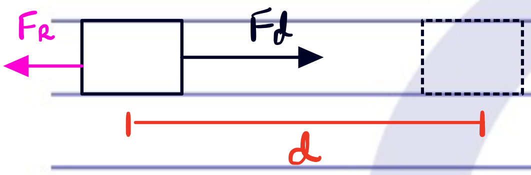
F_F = Frictional force.



$W = F \times d$.

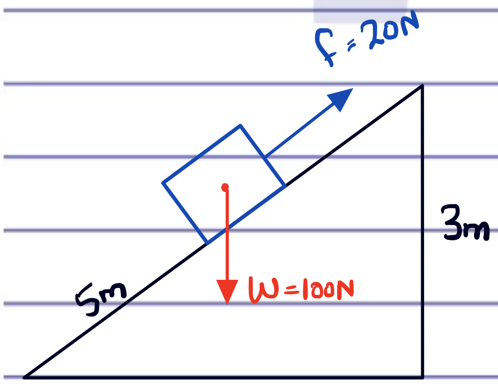


$W = F\cos\theta \times s$



Workdone by Driving Force = $F_d \times S$

Workdone against resistive force = $F_R \times S$



Weight = 100N

Friction = 20N

Workdone by gravity (weight)

$W = 100 \times 3$

$= 300J$

Workdone against friction

$W = 20 \times 5$

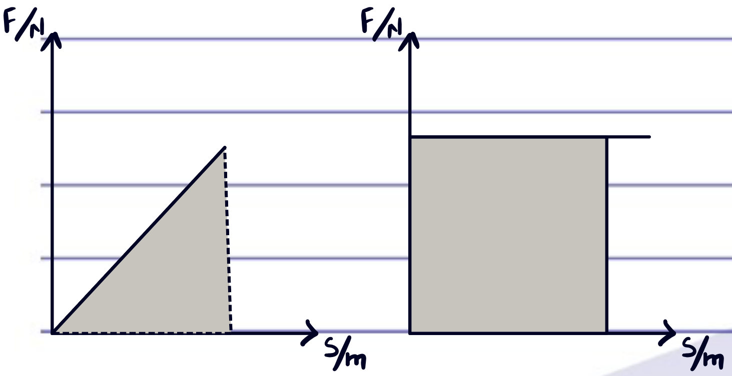
$= 100J$

Workdone by gas:

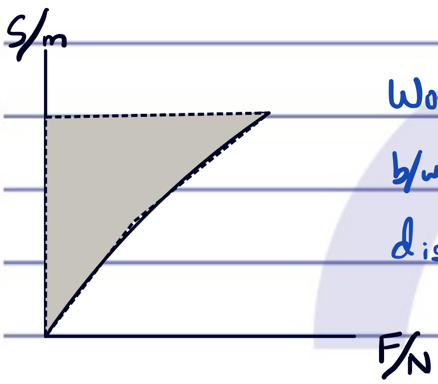
Topic: ______ Date: ______

Force Displacement graphs

* The area under the force displacement graph gives us workdone.



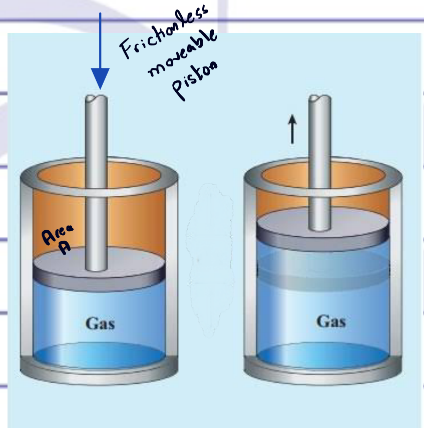
Displacment Force graph.



Workdone is are b/w graph and displacment axis

Formula For calculating workdone in case of gases.

The diagram below shows a container filled with a gas. the gas pressure is denoted by P, a Piston is positioned as shown the area of Piston is denoted by A and we apply a force downwards F, So the Piston moves through a small distance of Δx In this case since the gas gets compressed, we say "work is done on the gas."



$WD = F \times S$

As $P = \frac{F}{A}$

$P \times A = F$

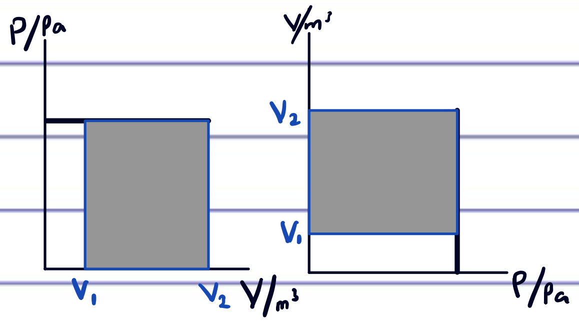
$WD = PA \times \Delta s$

$\therefore A \times \Delta s$

$= \Delta V$

$WD = P\Delta V$

$WD = P(V_2 - V_1)$



Area under the P-V graph = Workdone by gas.

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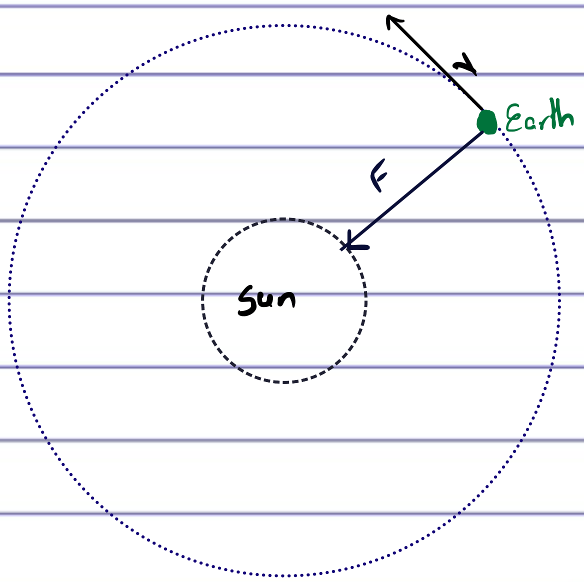
iv)



When something is moving in a circle about a point (for eg planetary motion)

There is no displacement in the direction of the force hence no work is done.

Infinite freefall ∃ A2

Reliable Energy Source: Energy resource that we can rely upon at any time.

Efficiency = $\frac{\text{Useful Energy output}}{\text{Total Energy input}} \times 100$

OR

Efficiency = $\frac{\text{Useful Power output}}{\text{Total power input}} \times 100$

Energy:

Ability of a body to do work.

* SI unit = (Joules)
* Scalar quantity. (No direction involved)

Types of Energy.

1) Mechanical Energy.
   a) Kinetic Energy
   b) Potential Energy (Gravitational)
2) Heat Energy
3) Chemical Energy
4) Elastic (Strain) Energy
5) Electrostatic Energy
6) Nuclear Energy
7) Internal Energy

Sources of Energy

1.) Non Renewable Resources.

→ Consumption rate of these resources is much higher compare to regeneration rate

Coal, oil, natural gas, Nuclear.

Topic: ____________ Date: ____________

Renewable Energy Resources:

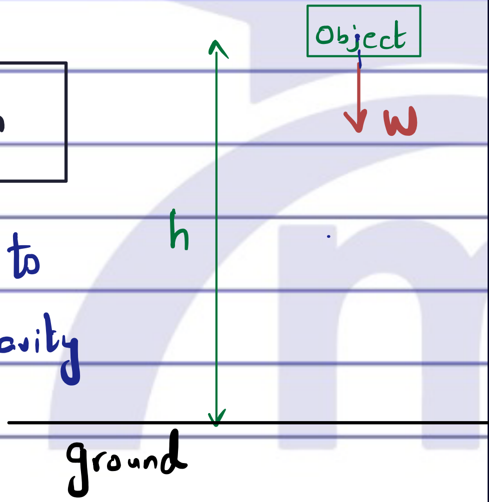
→ Resources Regenerate at an incredibly fast rate so consumption doesnot effect their reserves.

- Solar
- Tidal
- Geothermal
- Biogas
- Wind

Gravitational Potential Energy:

Energy stored in a body due to its position in the gravitational field.

$$GPE = m g \Delta h$$

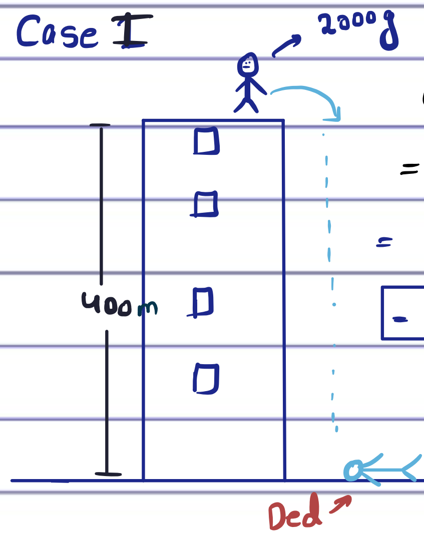


* It is due to the pull of gravity on the object in the field

$$GPE = m g \Delta h$$

- m → mass
- g → gravity (9.8)
- Δh → Change in height

Case I



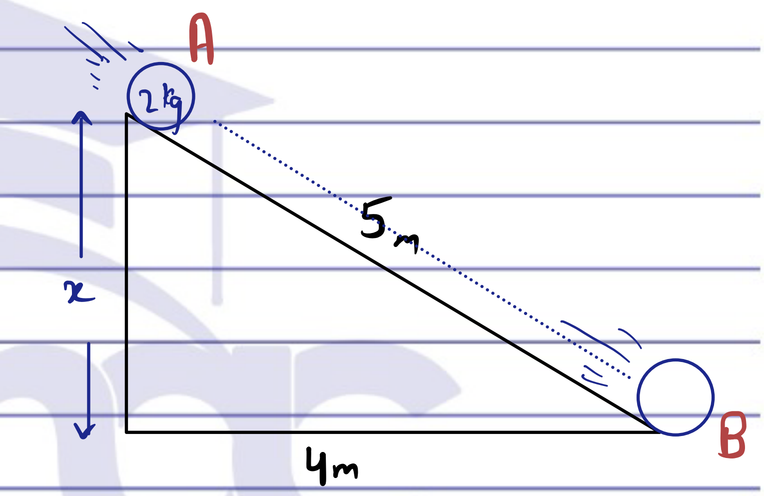
Change in GPE

$= m g h$

$= 2 \times 9.81 \times 400$

[-]

Case II



Find change in GPE from point A to B.

$GPE = m g \Delta h$

$= 2 \times 9.81 \times x$

For x:

$H^2 = P^2 + B^2$

$5^2 = 4^2 + x^2$

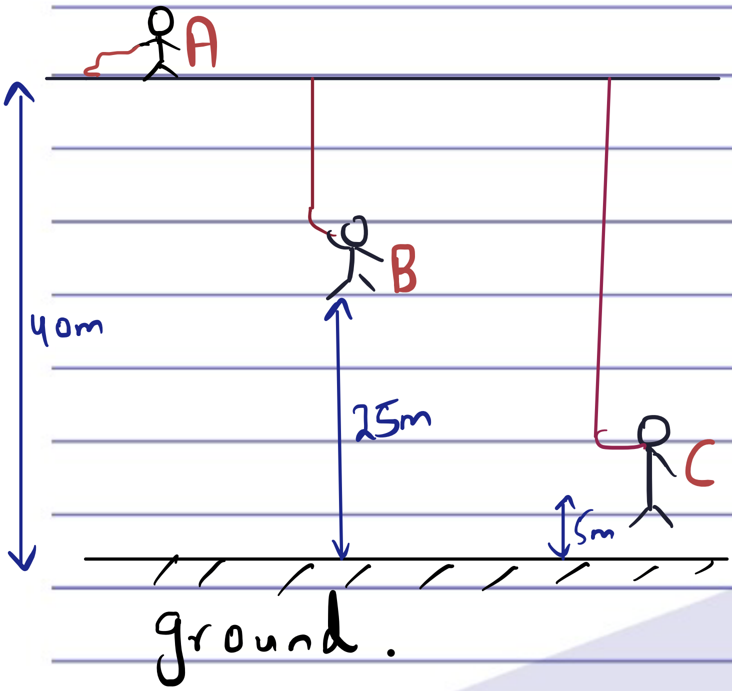
$x = 3$

$= 2 \times 9.8 \times 3$

$= 58.8 \, J$

Topic: ______ Date: ______

Case no III



A person of mass 10kg jumped from a roof carrying a rope

a) Find decrease in GPE from point A to B

$E_p = mg(h_f - h_i)$

$= (10)(9.8)(40 - 25)$

$=$

b) Find total change in GPE from A to C

$E_p = mg\Delta h$

$= mg(h_f - h_i)$

$(10)(9.8)(40 - 5)$

Kinetic Energy:

Energy stored in an object because of its motion.

$$E_K = \frac{1}{2} m v^2$$

E_K → Kinetic Energy; m → mass; v^2 → $(\text{Speed})^2$

$E_K \propto m$

m	E
2m	2E
3m	3E
5m	5E

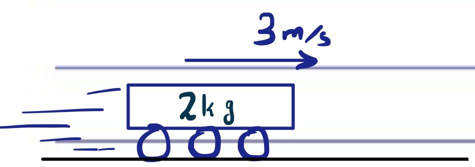
$E_K \propto v^2$

v	E
v	E
2v	4E
3v	9E
v/3	E/9

mass	speed	KE
2m	3v	$E \times 2 \times 3^2 = 18E$
3m	$\frac{1}{2}v$	$E \times 3 \times \left(\frac{1}{2}\right)^2 = \frac{3}{4}E$
4m	2v	$E \times 4 \times 2^2 = 16E$

Topic: ____________ Date: ____________

Case # 1

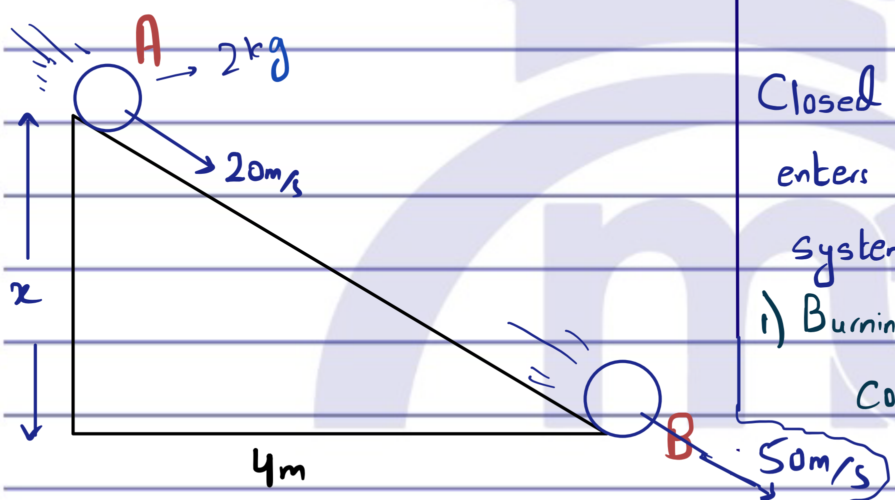


$$E_k = \frac{1}{2}mv^2$$

$$= \frac{1}{2}(2)(3)^2$$

$$= 9\ J$$

Case # 2



Calculate change in KE

$$E_k = \frac{1}{2}m(\Delta v)^2$$

$$= \frac{1}{2}m(v^2 - u^2)$$

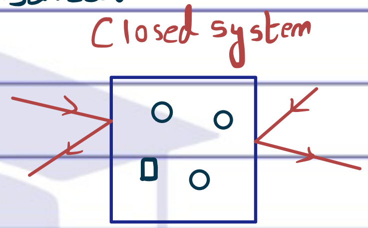
v = final velocity
u = initial velocity.

$$= \frac{1}{2}(2)(50^2 - 20^2)$$

Law of Conservation of Energy:

Energy can neither be created nor it can be destroyed but can be converted from one form to another.

* Total Energy of a closed system is conserved.

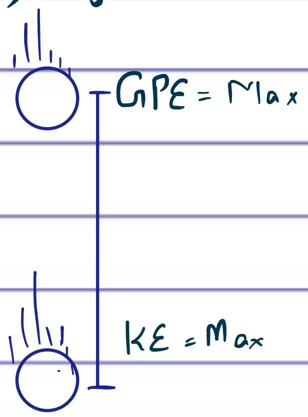


Closed system means no energy enters or leaves a specific system.

1) Burning of coal, wood or any combustion.

Chemical Energy $\longrightarrow$ light + Heat.

2) Object in freefall (Without Air Resistance)



$$E_k = E_p$$

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

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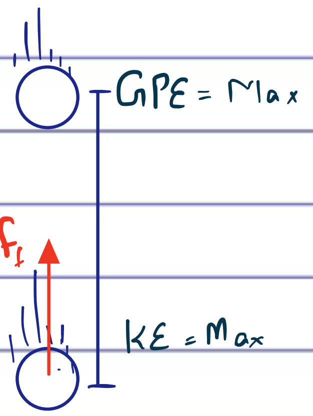
Topic: ______ Date: ______

3) Object falling with Air Resistance.



$$mgh = \frac{1}{2}m(v^2 - u^2) + (f_r \times s)$$

Power : Rate of change of workdone

OR

Rate of change of Energy.

Anything wrt time

$$P = \frac{WD}{t}$$

Power, Workdone, time

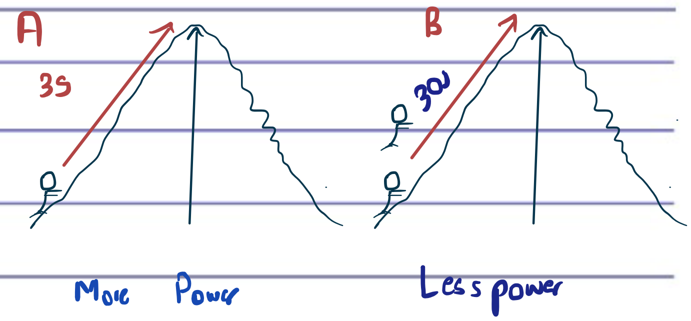
$$P = \frac{E}{t}$$

Power, Energy, time

SI unit (watt) W

1 Watt is 1 Joules Per second

$W = J/s$



$$\downarrow P \propto \frac{1}{t\uparrow}$$

$$P = \frac{\text{Workdone}}{\text{time}} \Rightarrow P = \frac{F \times s}{t}$$

$$\therefore \frac{s}{t} = v$$

$$P = F \times v$$

Force, velocity.

$$P = \frac{E}{t}$$

If $E = mgh$

$$P = \frac{mgh}{t}$$

$$P = \dot{m}gh$$

$\dot{m}$ = mass flowrate.

Example : Pumping water to a height.

$$P = \frac{mgh}{t}$$ → speed.

$$P = mgv$$

If $E = \frac{1}{2}mv^2$

$$P = \frac{mv^2}{2t}$$

$$P = \frac{1}{2}\dot{m}v^2$$

Example : liquid flowing Horizontally.

" $\dot{m} = \rho A v$ "

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