Date: ______ Day: ______

Formula Sheet

Unit no:- 04 Work & Energy

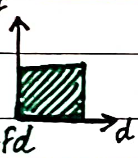
Work:- The dot product of force & displacement. $W = F.d\cos\theta$

Scalar quantity, SI unit (Nm = J), Dimension $[ML^2T^{-2}]$

Dependence:- Magnitude of force * Magnitude of displacement * Angle b/w force & displacement.

Work done by a constant force

$W = Fd\cos\theta$



Work done by variable force

$W_T = \sum_{i=1}^{i=n} F_i \Delta d_i \cos\theta_i$

▸ **Centripetal force don't perform work**

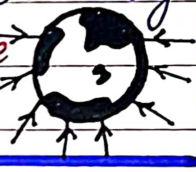
Proof Because the force is always perpendicular to instantaneous displacement

$W = Fd\cos 90^\circ$

$W = Fd(0) \rightarrow 0$

Gravitational field:- The space around earth in which its gravitational force acts on a body.

Gravitational field strength = $\frac{\text{Gravitational force}}{\text{mass}}$



$= W/m = mg/m = 9.8\,Nkg^{-1}$

Earth gravitational field is a **CONSERVATIVE FIELD**

* Cause it is independent of path followed * And work done in a close path is always zero.

Power:- Rate of doing work

$P = W/t$ (Scalar quantity, SI unit (Watt = Js^{-1}), Dimension $[ML^2T^{-3}]$) (Average Power) $P_{av} = W_{av}/t$

(Instantaneous power) $P_{ins} = \lim_{\Delta t \to 0} \frac{\Delta W}{\Delta t}$

$1kwh = 1000W \times 3600$
$= 10^3 W \times 3.6 \times 10^3$
$= 3.6 \times 10^6 J$

$1\,kWh = 3.6\,MJ$

▸ **Kilowatt hour**

The amount of workdone by a body whose power is 1 kilowatt in 1 hour. ▸ Commerical unit of electricial energy 1 KWh = 1 unit

Energy:- Capacity of a body to do work.

K.E (motion) — $\cdot \frac{1}{2}mv^2$

P.E (Height/Position) — $\cdot mgh$

ABSOLUTE P.E:-

$U = -\frac{GMm}{r}$

$U = -\frac{GMm}{R}$ (at surface of earth)

Work & Energy principle:- Workdone on the body equals change in its K.E.

$Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ (law of conservation of mass)

Whenever work is done on body. It increase its energy.

Interconversion of energy

Loss in P.E = Gain in K.E

$mg = \frac{1}{2}mv^2 + fh$

Imp points

$\theta < 90^\circ$ (work +ive)

$\theta > 90^\circ$ (work -ive)

$\theta = 90^\circ$ (work 0)

Example of variable force ▸ Force exerted by spring increases with the amount of stretch (x) $F = kx$

Conservative field

The field in which work done is independent of path followe

E.g:- Gravitational & Electric field.

Cases

K.E ∝ m (if v const)

$K.E \propto P^2$ (if m const)

$K.E \propto v^2$ (if m const)

$K.E \propto \frac{1}{m}$ (if P const)

W (+ive) Along dir. of force.

W (-ive) against dir. of force.

(Point)

cgs unit of work is erg

$1J = 10^7 erg$

Work has same dimension as that of torque ☺

If P is momentum and E energy of mass m then

$E = \frac{P^2}{2m}$, $P = \sqrt{2mE}$

Proof

$P = \vec{F}.\vec{v}$

$P = W/t$

$P = F.d/t$

$(\because v = d/t)$

$P = \vec{F}.\vec{v}$

$1hp = 746\,W$

W +ve

ΔK.E = +ive

P.E = less

ΔP.E = -ive

W = 0

ΔK.E = 0

K.E = constt

P.E = constt

W = -ve

ΔK.E = -ive

P.E = more

ΔP.E = +ive

Escape velocity

$V = \sqrt{2gR}$

$V = \sqrt{\frac{2GMe}{Re}}$