-16-2015

ENERGY AND WORK

WORK – AN CHANGE IN ENERGY FROM ONE FORM TO ANOTHER
– A FORCE EXERTED THROUGH A DISTANCE
– A SCALAR VALUE

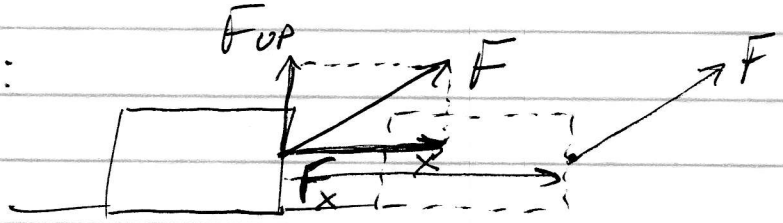
$W = (\text{FORCE IN DIRECTION OF } x) * (\text{DISTANCE } x)$

$W = F \cdot x$

UNITS: $N \cdot m$ OR $\frac{kgm^2}{s^2}$

$1\ J = 1\ \text{JOULE} = 1\ \frac{kg\,m^2}{s^2} = 1\ N \cdot m$

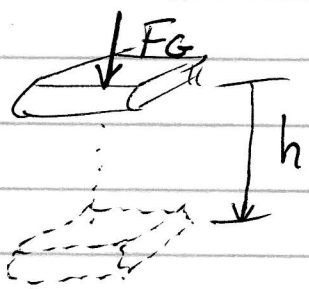
EXAMPLE:



WORK DONE BY $F_{UP} = 0$

$\text{WORK} = F_x \cdot x$

EXAMPLE:

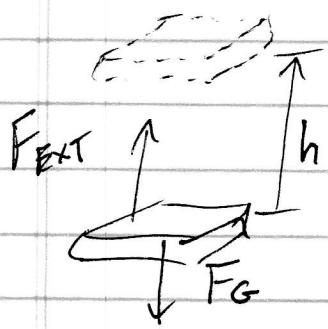


"BY A FORCE"

$W_G = F_G \cdot h = mgh$

F_G IS IN DIRECTION OF MOTION, SO

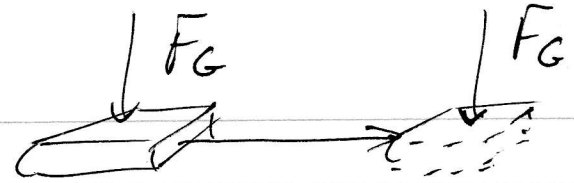
$W_G > 0$



$W_G = -F_G \cdot h$

$= -mgh$

"AGAINST A FORCE"



$W_G = 0$

WORK DOESN'T DEPEND ON THE OBSERVERS FRAME OF REFERENCE { POSITION, VELOCITY }

ENERGY

THE ABILITY TO DO WORK BASED ON AN OBJECTS POSITION AND OR VELOCITY.

UNITS: JOULES SI.
(U.S. POUND-FEET)

OTHER UNITS: erg
KW hours
AMP HOURS
CALORIES
B.T.U.
⋮

TYPES OF ENERGY: MECHANICAL • POTENTIAL (POSITION)
• KINETIC (MOTION)

↑ COMPUTE FROM h, V, r, etc.

DISSIPATIVE • HEAT or THERMAL
FLUID MOTION

(HARDER TO MEASURE)

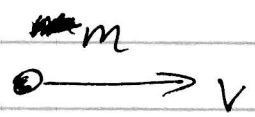
FORMS OF ENERGY

GRAVITATIONAL (MECHANICAL)(POTENTIAL)
SPRING OR ELASTIC (MECHANICAL)(POTENTIAL)
KINETIC (MECHANICAL)(KINETIC)

LIGHT OR ELECTRO-MAGNETIC RADIATION
NUCLEAR
FOOD CALORIES
THERMAL
WIND / WATER / FLUID
ELECTRO-MAGNETIC
CHEMICAL
SOUND WAVES
⋮

KINETIC ENERGY (ENERGY OF MOTION)

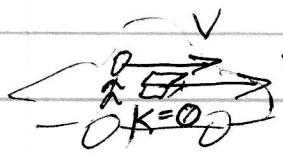
$$K = \frac{1}{2} m v^2$$



$$(kg)\left(\frac{m}{s}\right)^2 = (J)$$

- SCALAR
- ALWAYS NON-NEGATIVE
- DIRECTION IS UNIMPORTANT

VALUE DEPENDS ON OBSERVER



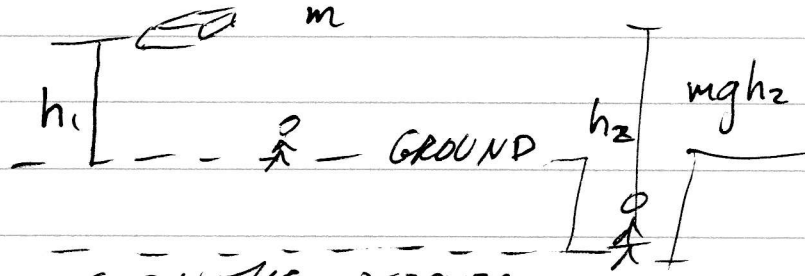
$K = \frac{1}{2} m v^2$

GRAVITATIONAL POTENTIAL ENERGY

$P_G = mgh$

$\left(kg \cdot \frac{m}{s^2} \cdot m\right)$

(J)

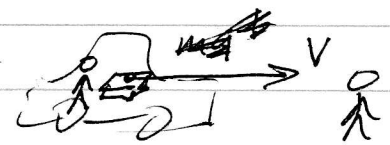


DEPENDS ON THE OBSERVER

P_G IS NOT INTRINSIC TO BOOK,
IT IS DUE BOOK-EARTH SYSTEM

WORK = CHANGE IN ENERGY IS SAME
FOR ALL OBSERVERS

BOOK IN CAR -



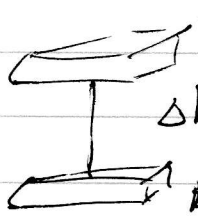
TO V=0

ΔK = CHANGE IN KINETIC ENERGY
$= 0 - \frac{1}{2}mV^2$

BOTH AGREE ON V CHANGE
SO BOTH AGREE ON ΔK

WORK = ΔK

BOOK IN GRAVITY FIELD



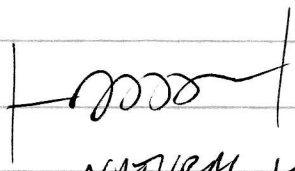
$P_{TOP} = mgh_{TOP}$

$P_{BOTTOM} = mgh_{BOTTOM}$

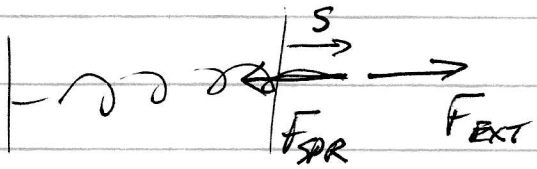
$\Delta P = mg\Delta h$

$= WORK$

ELASTIC ENERGY



$$W_{SPR} = -F_{SPR}^{k \cdot s} \cdot s$$

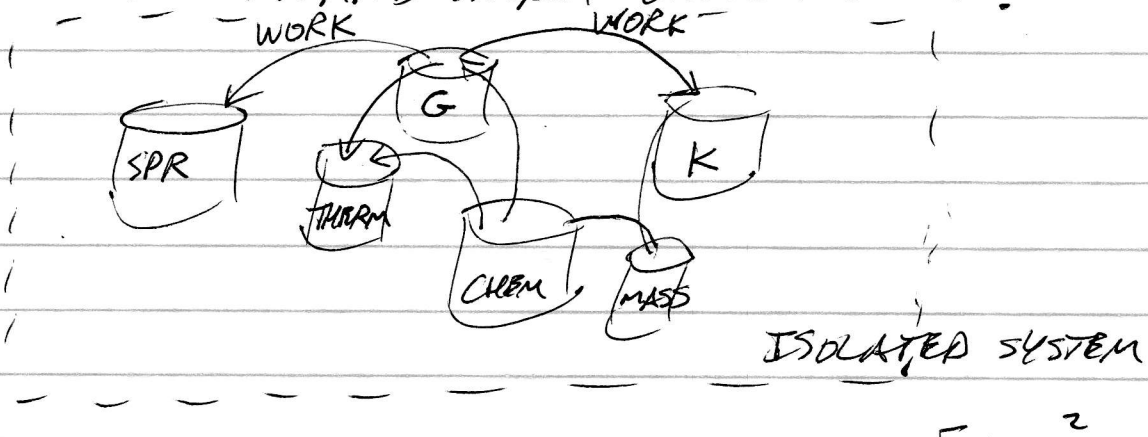


$$\boxed{P_{SPR} = \frac{1}{2} k s^2}$$

$$\left(\frac{N}{m}\right)(m)^2 = (N \cdot m) = (J)$$

P_{SPR} IS 0 OR POSITIVE

HOW DOES WORK AND ENERGY CAUSE MOTION?



TOTAL ENERGY = CONSTANT

$E = mc^2$

IN AN ISOLATED SYSTEM, TOTAL ENERGY IS CONSTANT.

CONSERVATION OF ENERGY

SOMETIMES MECHANICAL ENERGY IS CONSERVED

(ONLY HAVE CONSERVATIVE FORCES: GRAVITY, ELASTIC, ELECTRIC)

(NO DISSIPATIVE FORCES: FRICTION, DRAG)

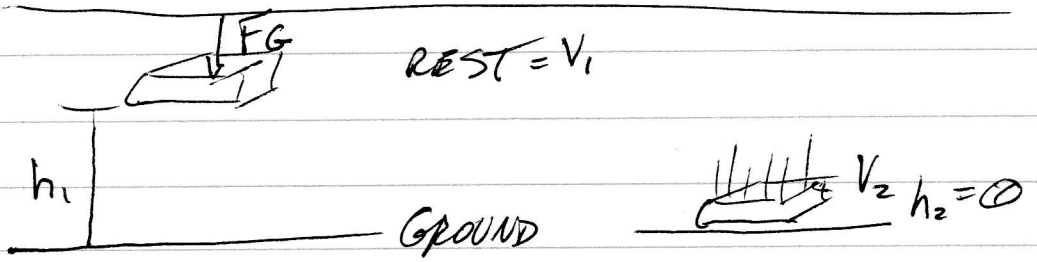
PRINCIPLE OF WORK AND ENERGY (KINETIC)

$$\boxed{W_{NET} = \Delta K} \quad \text{OR} \quad K_2 - K_1 = W_{NET} \quad \text{OR} \quad K_2 = K_1 + W_{NET}$$

MOTION

FORCES ACTING THRU DISTANCE

APPLY THE LAW OF CONSERVATION OF ENERGY



HOW FAST IS IT MOVING BEFORE IT HITS?

START

$$P_{G_1} + \cancel{K_1}^{0} = \cancel{P_{G_2}}^{0} + K_2$$

(IGNORE AIR RESISTANCE)

$$mgh_1 = \tfrac{1}{2}mV_2^2 \qquad V_2 = \sqrt{2gh_2}$$

DOESN'T DEPEND ON MASS

(SAME ANSWER AS USING NEWTON'S LAW)