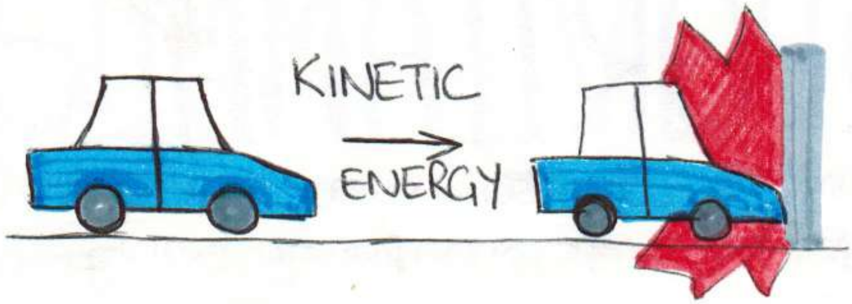
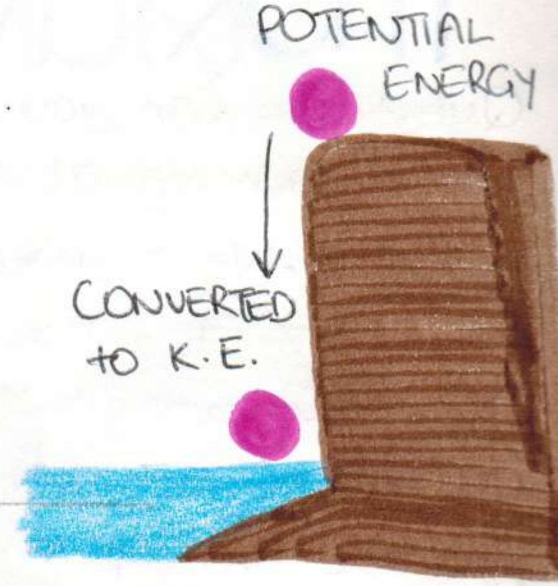
Title





UNIT - 4
ENERGY

SUMMATIVE TASK - INTRO

The amusement park wants you to design a comic strip which will help customers learn about physics concepts.

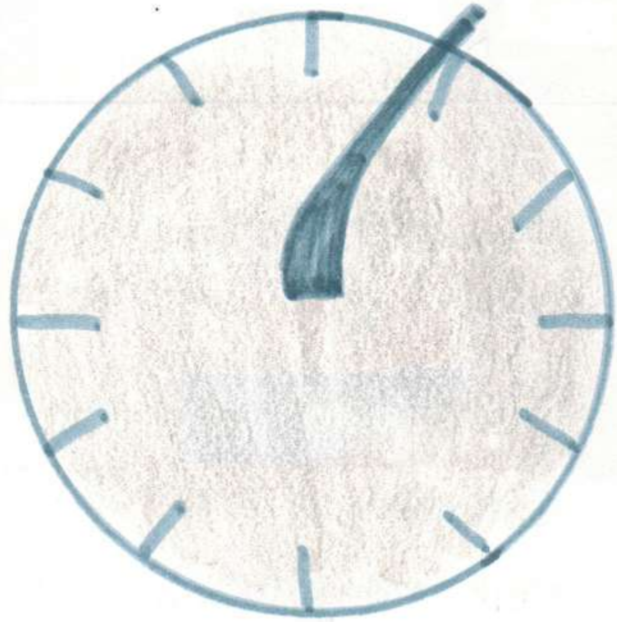
Toc

TABLE OF CONTENTS

EQ How did Clocks work before electricity

ESSENTIAL

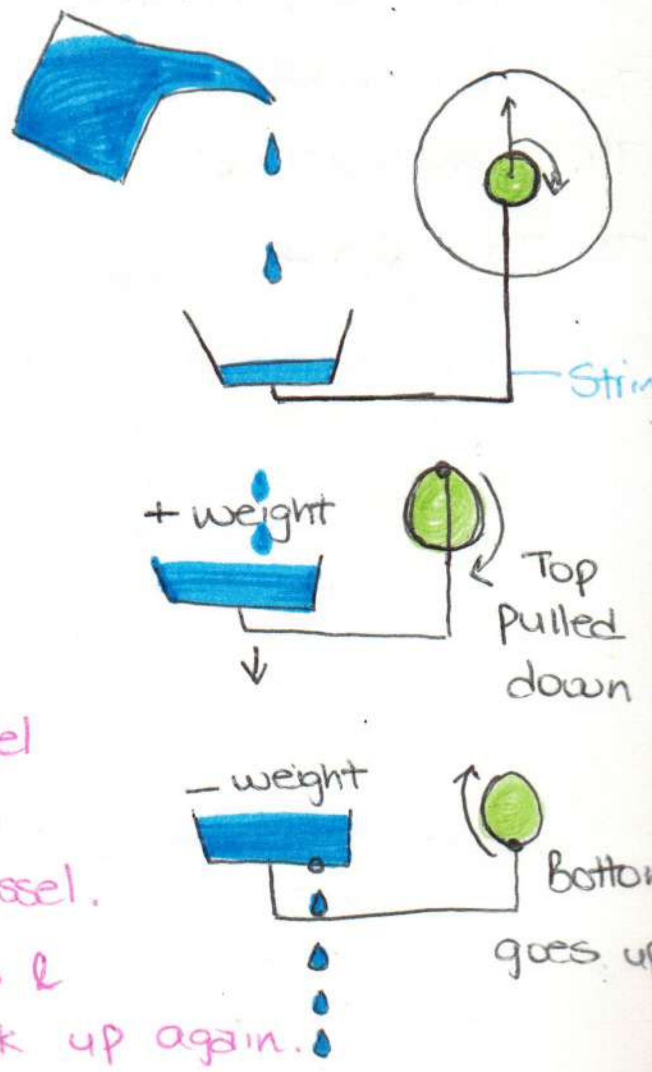
People used Sundials to keep time. The position of Sun changed shadow of pointer on the plate. But this was useful only in the day.



May be people used weights to make the hands of clock move.

Continuous flow of water into a vessel adds weight and this works the hands of clock. With more weight the string pulls down on the hand of clock

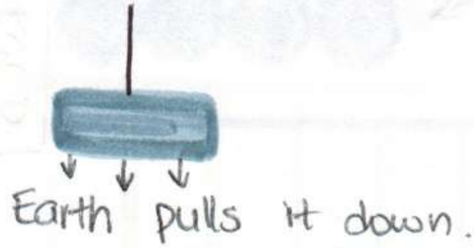
After top travels a whole 180°, the hand is at lowest point. At same time water level reaches a point which trigers a needle & this makes a hole in vessel. With less weight string loosens & hand of clock starts going back up again.



QUESTION

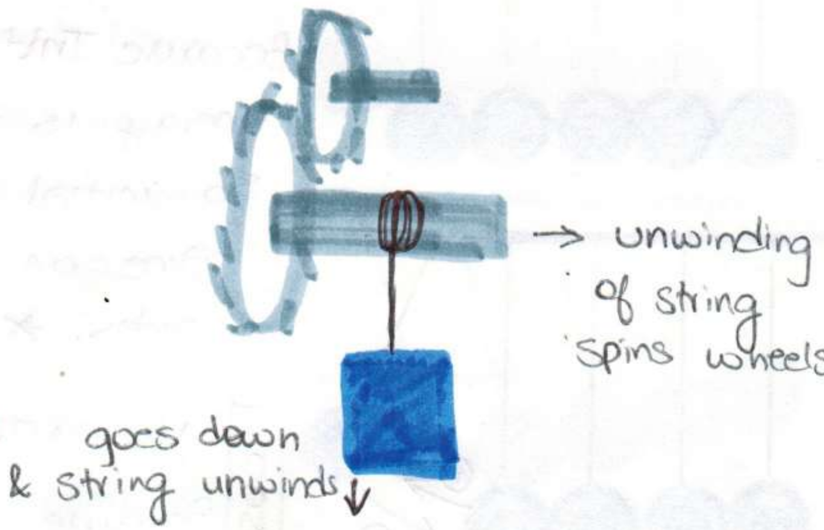
Q- How did clocks work before electricity?

Something that could be used to work the clocks before electricity is GRAVITY.



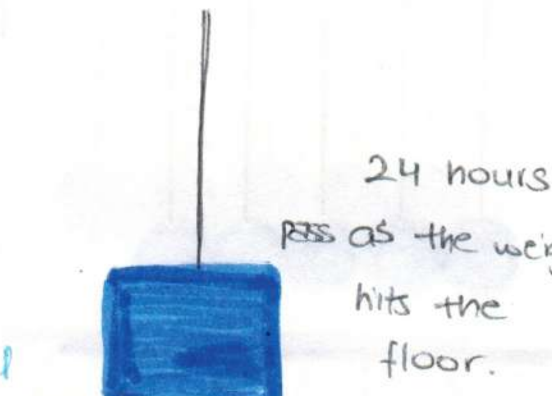
Weights, when at a height, can have a lot of gravitational potential energy.

A weight can now be attached to a wheel of clock, which is connected to other wheels and rotates them to make the clock work.

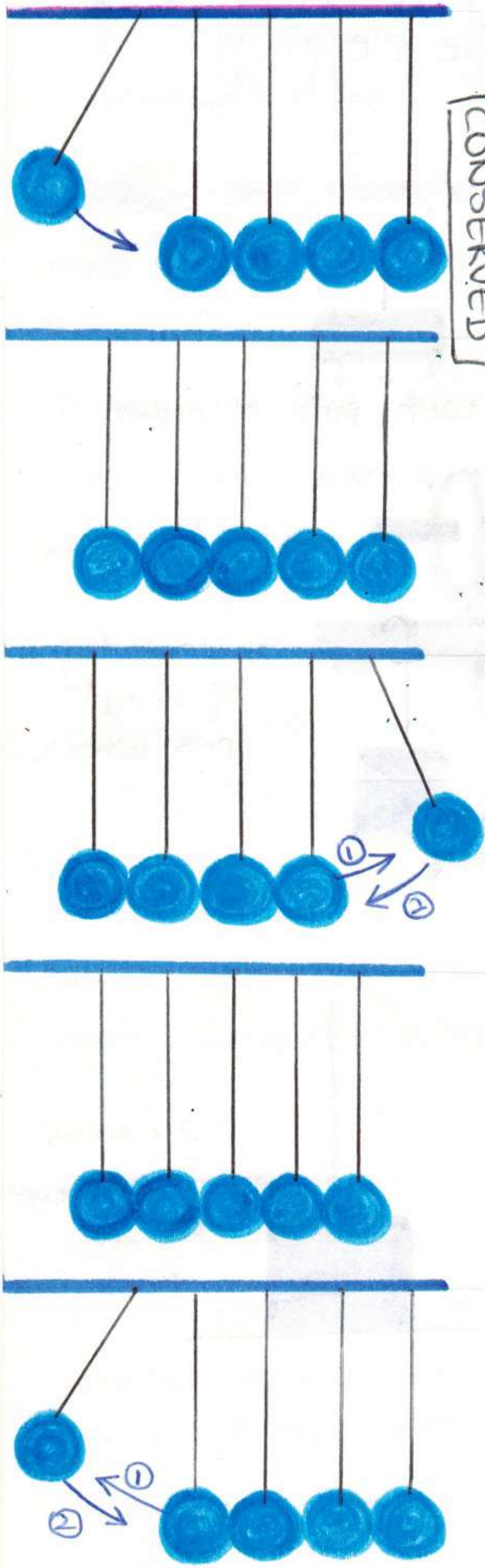


The system should be placed at a height such that the weight hits the floor after about 24 hours.

After that, one can manually wind the string & bring weight to initial height. Another cycle starts.



PERFECTLY ELASTIC COLLISION



CONSERVED

POTENTIAL ENERGY

The energy gained when one ball is lifted to a height

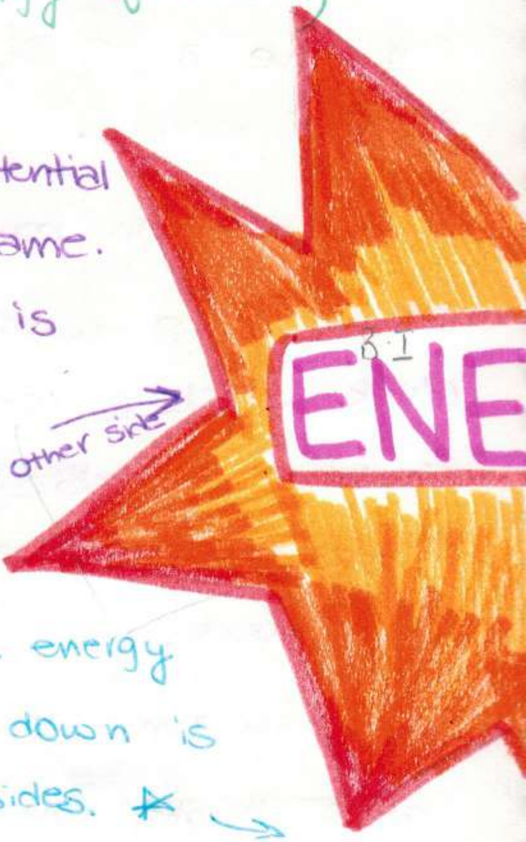
KINETIC ENERGY

The energy gained when the ball comes down. (Energy of motion)

WORK

Because Initial potential energy is the same. So initial force is same on both sides. ★

other side



CONSERVED

MOMENTUM

Because kinetic energy of ball coming down is same on both sides. ★

POWER

Because same amount of work is done on both sides. ★

COLLISION

The first ball comes down and transfers energy to first ball, which in turn transfers it to next ball & so on. The last ball goes up because it can't transfer energy to another ball

PERFECTLY INELASTIC COLLISION

POTENTIAL ENERGY

This gain of energy is same on both sides.

KINETIC ENERGY

~~At~~ first kinetic energy is same on both sides.

WORK

* Because initial force is same on both sides, therefore same amount of work is done.

MOMENTUM

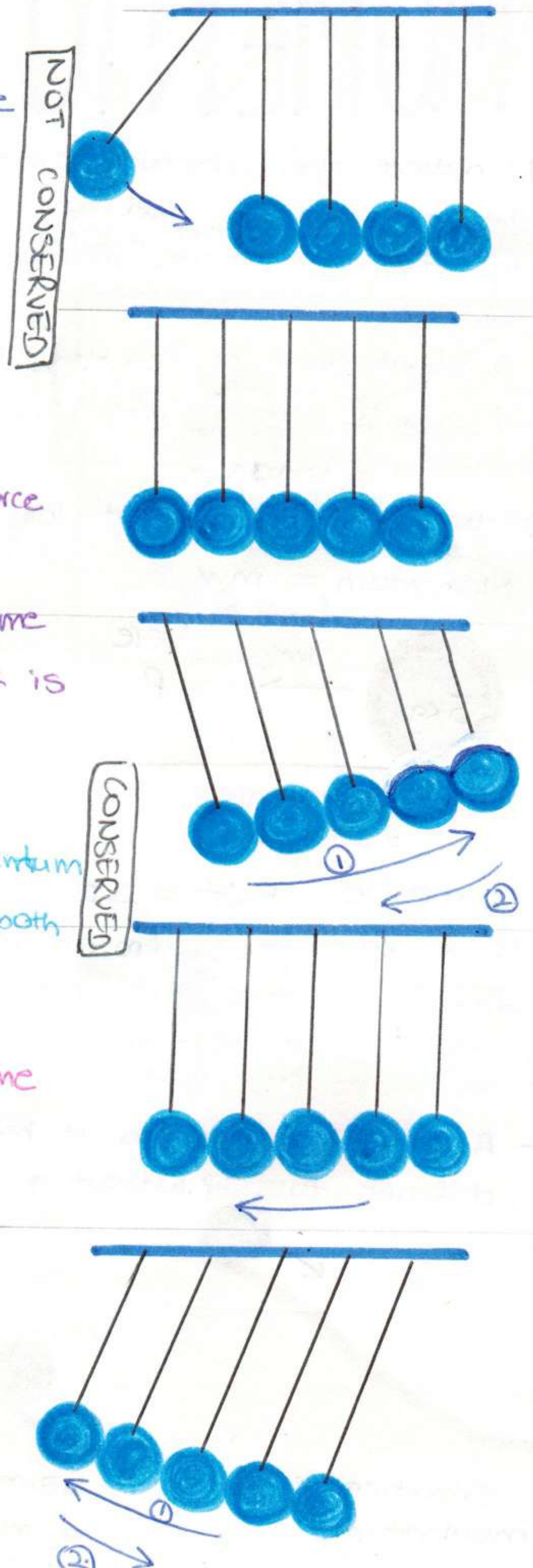
* Therefore, momentum is also same on both sides.

POWER

* And it is done over same amount of time, Power is also same on both sides.

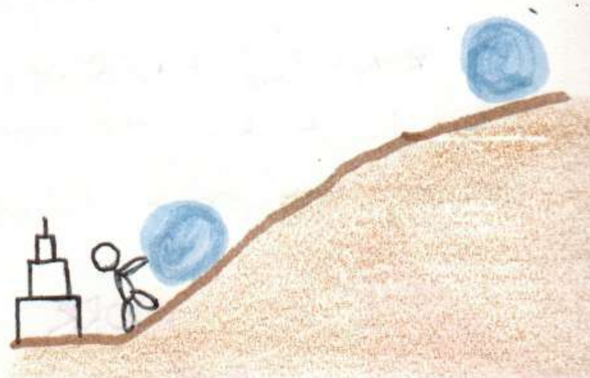
COLLISION

Because when first ball comes down it sticks to other 4, so the energy is now shared by all 5 balls.



MOMENTUM

- I believe the continuous motion of the rock and the RockMan's inability to stop it represents momentum in the video.
- A slight touch of RockMan's feet destroys a part of castle. This seems physically impossible.



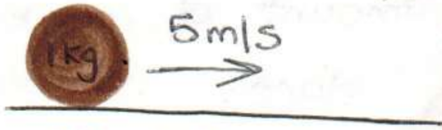
Q- Why did it take that long to stop the rock?

Momentum$_{(P)}$ = m.v

5m/s

More p

$p = 5.5$ kgm/s
$= 25$ kgm/s



5m/s

Less p

$p = 1.5$ kgm/s
$= 5$ kg m/s

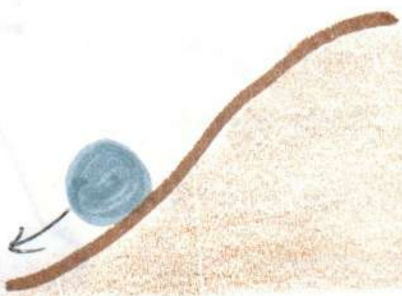
Impulse $F \Delta t = \Delta p$

- If a force acts on an object for long duration of time, it can cause a greater change in momentum.
- So, while pushing a child, longer contact while pushing helps.

Longer contact= more momentum

- A car is heavy, so it has large momentum and is hence difficult to stop without a large, opposite force.

Starting to gain momentum.



Gained large amount of momentum

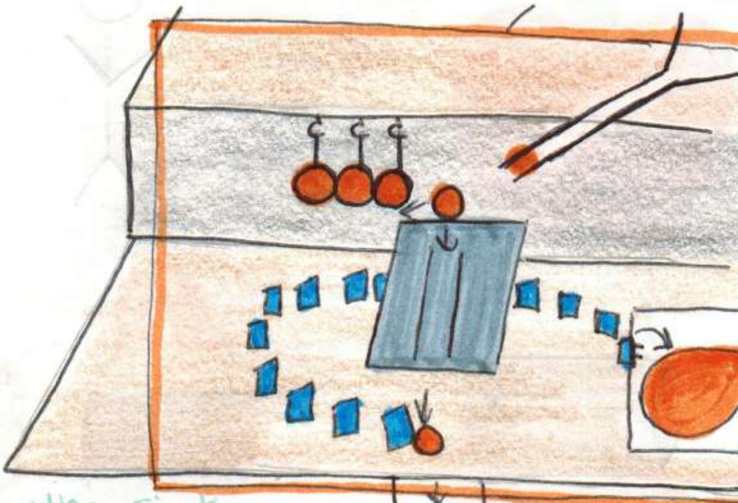
Opposite force makes rock lose momentum.

Rube Goldberg

RUBE GOLDBERG DAY-5

Question - Do the dominoes fall and does last domino pop the balloon when it falls on it?

WE TESTE



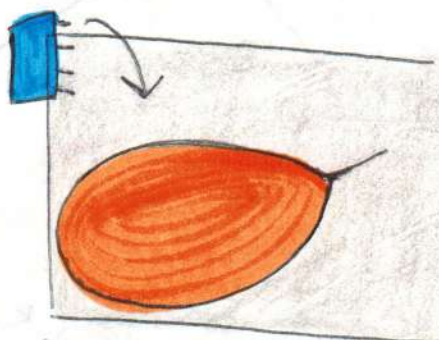
Evidence - • As from last attempts (Day-4) and today, the Newton's cradle works. It worked 19 times out of 20.

• The ball toppled dominoes each time.

• The last domino falls into the sink each time. We tested it with a balloon 3 times and it always worked.

Claim - The dominoes tip off and the last domino with a nail pops the balloon.

Reasoning - The dominoes were placed close enough to make sure all of them tipped over.



The last domino has nails on it to burst the balloon.

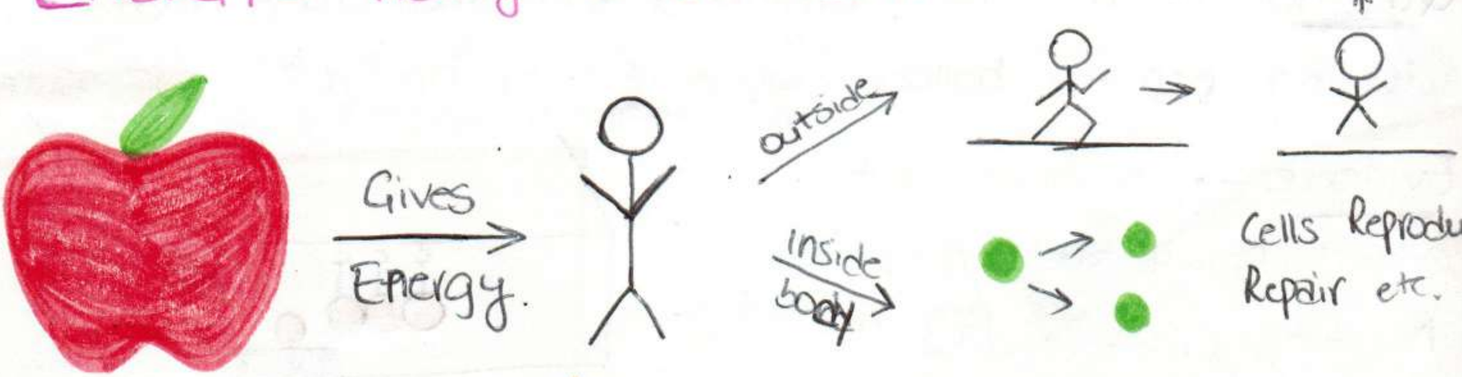
The domino adds mass to the nail as it falls onto a balloon in the sink. It acquires enough energy that when the nail hits the balloon it fails.

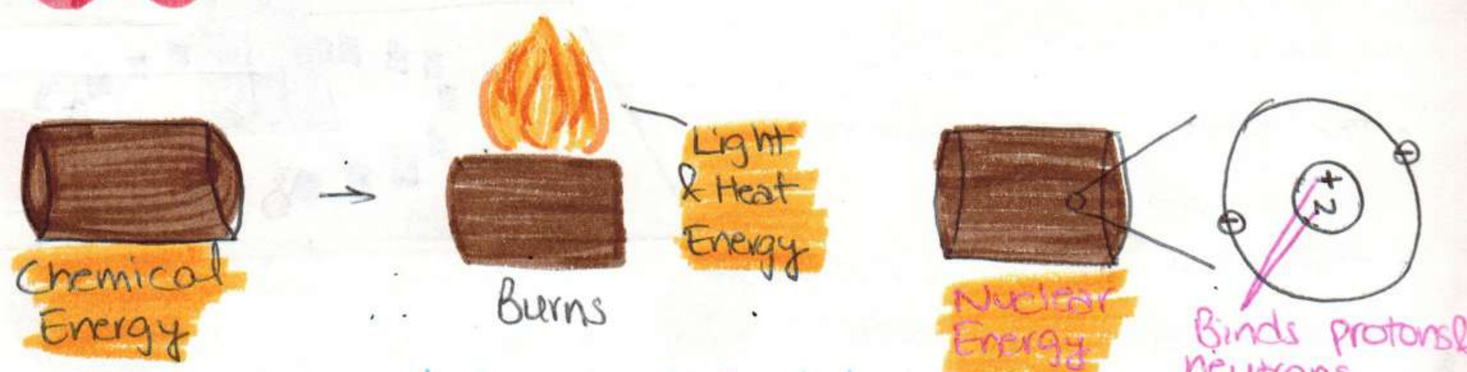
We can add nails on all sides to make sure the balloon pop

Energy

ENERGY

ENERGY - Ability to do work.



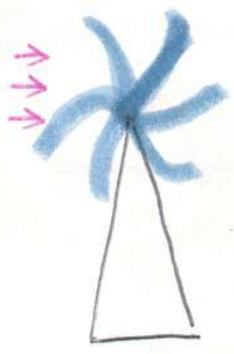


Energy can't be destroyed or created, it can only be transferred.

- Energy
  - Matter
    - P.E
    - K.E.
    - Internal (Molecular)
      - Thermal
        - molecule move — K.E
        - Bounce — P.E
      - Chemical — Holds atoms — P.E
      - Nuclear — Holds Nucleus — P.E.
      - Mass — P.E in nuclei.
  - Light

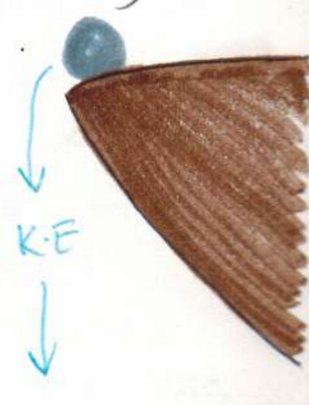
Kinetic Energy (K.E)

Air has motion, so it has Kinetic Energy
↓
Depends on mass & speed



Potential Energy (P.E)

Energy of Position or Shape | Has P.E. which is converted to K.E



Pendulum Lab

PENDULUM LAB

Q → Which variable - Height, length, or weight affects the period of a pendulum the most?

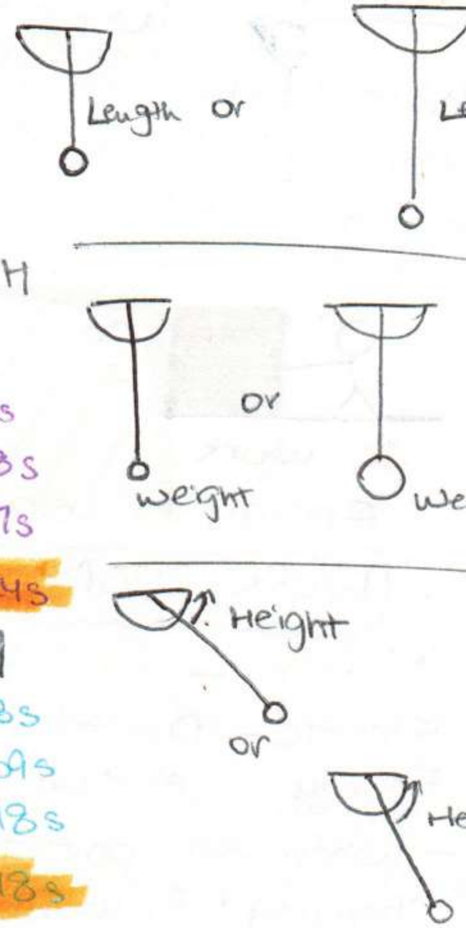
Evidence →

CONTROL →

L	W	H
41cm	Light	30°

$T_1 = 1.368s$ $T_2 = 1.390s$, $T_3 = 1.386s$

$T_A = 1.374 s$



Only change L

$\boxed{L = 30\ cm}$

$T_1 = 1.115s$

$T_2 = 1.118s$

$T_3 = 1.128s$

$T_A = 1.120s$

$\boxed{L = 60\ cm}$

$T_1 = 1.612s$

$T_2 = 1.603s$

$T_3 = 1.630s$

$T_A = 1.615s$

Only change W

$\boxed{W = Heavy}$

$T_1 = 1.428s$

$T_2 = 1.400$

$T_3 = 1.412s$

$T_A = 1.410s$

$\boxed{W = Light + Heavy}$

$T_1 = 1.409s$

$T_2 = 1.400s$

$T_3 = 1.409s$

$T_A = 1.406s$

Only change H

$\boxed{H = 45°}$

$T_1 = 1.306s$

$T_2 = 1.328s$

$T_3 = 1.337s$

$T_A = 1.324s$

$\boxed{H = 60°}$

$T_1 = 1.328s$

$T_2 = 1.309s$

$T_3 = 1.318s$

$T_A = 1.318s$

Claim - Changing length of String affects the time period of a pendulum more as compared to changes in W & H.

Reasoning - • A change in weight or Height of pendulum did not cause a large change in period of the pendulum as compared to control.

• A change in Length of String → caused the time period to increase or decreased with increase or decrease in Length of string, respectively. This change was very large.

• So changing length of the string of pendulum affects its period by a lot.

WORK, ENERGY, POWER

WORK

Work = Force x Displacement $\left(N.m \text{ or } \frac{kg\,m^2}{s^2}\right)$

Work is done only when a Force (m x a) is present, that is, there is a mass being accelerated and this causes the object to move.

Energy is used in both cases

(WORK ALWAYS REQUIRES ENERGY)

W = 4.0N . 3 m
= 12 Nm or Joules

ENERGY – Ability to do work. Units – Joules

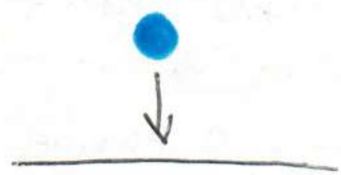
Kinetic Energy – Due to motion $\left(\frac{1}{2}mv^2\right)$

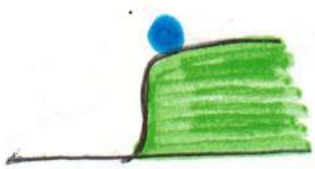
- when an object has changing K.E. work is being done

Potential Energy – Due to position (mgh)

- when P.E of an object changes to K.E, work is done

← work is done →





→ Ball has energy but no work is done

(* Energy can be present with no work being done.)

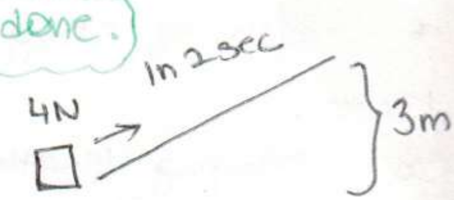
POWER

(It is the speed at which work is done.)

$P = \frac{W}{t} = \frac{F.d}{t}$

Units – Joule/s
= Watt

1 horsepower = 746 watts



W = 12J

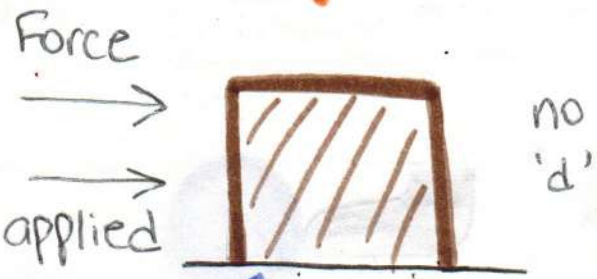
$P = \frac{12J}{2s} = 6\,J/s$
= 6 watt

WORK, ENERGY, POWER

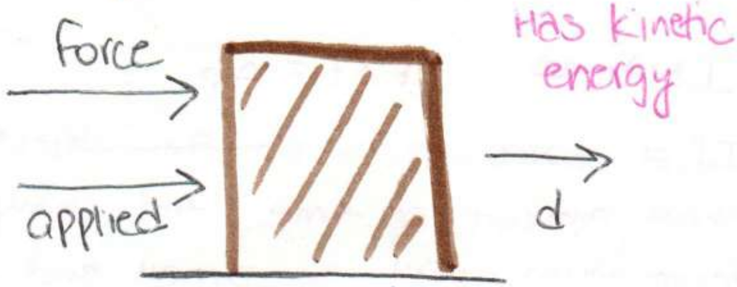
Measured in units of Joules

ENERGY

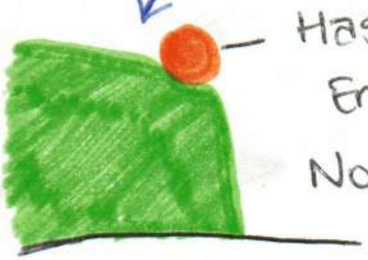
Ability to do work
- Can be Kinetic or potential



No Work



Work is done



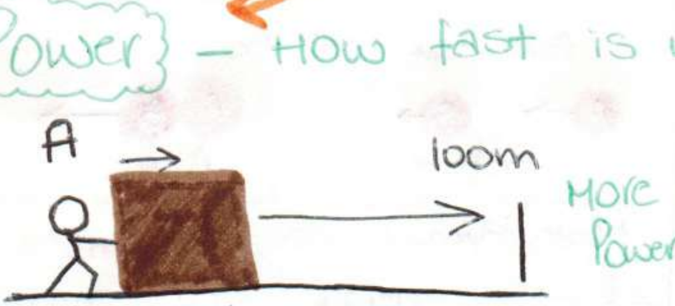
Has Potential Energy
No 'd'

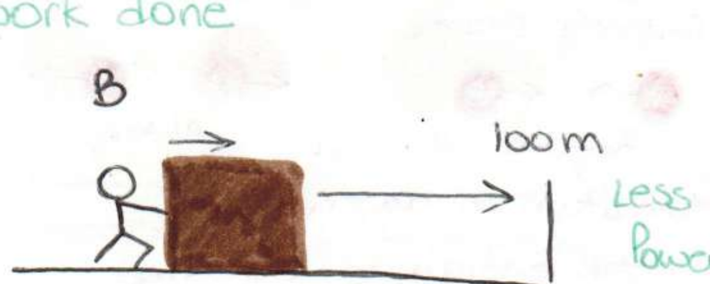
in a free fall gravity accelerates an object & it gains K.E. work is d

work = Force x displacement

Kinetic Energy has to be involved for work to be done. Faster use of Energy means less time to complete work

Power - How fast is work done





- Both 'A' & 'B' use same amount of total energy.
- Both do same amount of work, but A does it faster & hence has more power

MOMENTUM & COLLISIONS

MOMENTUM (p) = m.v

More p — Less p

* Momentum is always conserved.

$p = 1000 \times 10$ kgm/s
$= 10000$ kgm/s

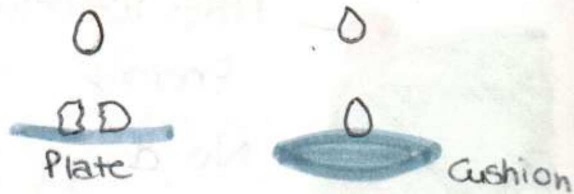
$p = 500 \times 10$ kgm/s
$p = 5000$ kg m/s

IMPULSE $F\Delta t = \Delta p$

If a force acts on an object for a short amount of time, the change in momentum will be small and vice-versa.

* Strong force in small time can be as effective as weak force over a long time period.

* Longer time interval at impact reduces force.



CONSERVATION OF MOMENTUM

$$P_{Ai} + P_{Bi} = P_{Af} + P_{Bf}$$

B gained equal & opposite amount of P lost by A.

COLLISIONS

Perfectly Elastic

- Momentum is conserved
- Kinetic energy is conserved

(what one object loses, the other object gains)

Perfectly Inelastic

Momentum is conserved

- Kinetic energy is not conserved

(Energy is lost as sound and deformation of objects)

MOMENTUM & COLLISION

MOMENTUM

How strong is the object's motion

Depends on mass & velocity

More p   Less p

COLLISIONS ARE NOTHING BUT CHANGE IN MOMENTU OF TWO OBJECTS WHEN THEY PHYSICALLY INTERACT

IMPULSE $\Delta P = F\Delta t$

Change in momentum depends on force of 2 objects and the time for which they interact

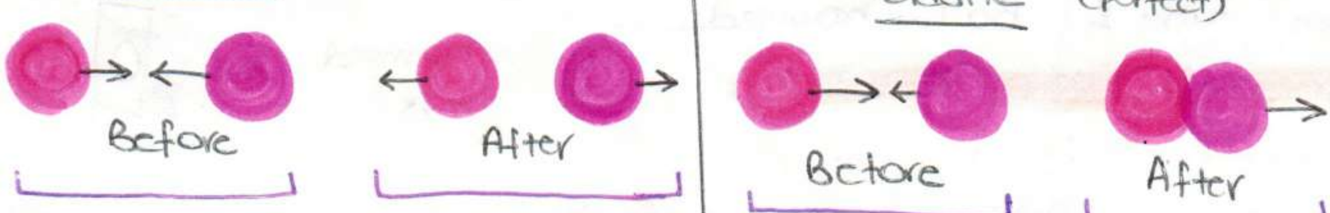
COLLISIONS

Physical interaction between objects that causes change in their individual momentums.

— Of 2 types

<u>inelastic</u> (perfect)

<u>Elastic</u> (Perfect)



$\text{Momentum}_{I_1} = \text{Momentum}_{F_1}$

$\text{Momentum}_{I_2} = \text{Momentum}_{F_2}$

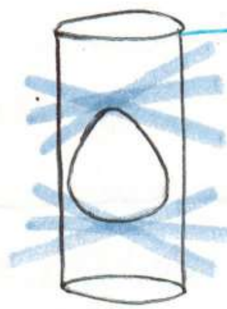
Momentum is conserved in both cases.

EGG LAUNCHER D-3

Q – Do structures I & III bounce off of the wall when thrown with a golf ball in each?

Evidence – we built structures I & III.

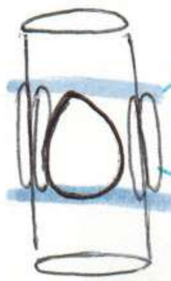
STRUCTURE I



1 Sheet

Made holes in tube & inserted Straw like folded paper.

STRUCTURE III



Paper folded like straw

Tubes made out of paper.


= Half Sheet of paper = o

Top View


when launched, the structure bounced back off of the wall.

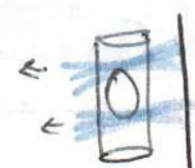
when launched, the structure bounced a negligible amount.

Claim – Structure I bounced off the wall, while Structure III did not.

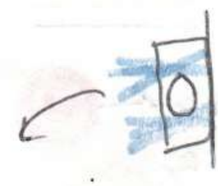
Reasoning – STRUCTURE I

- The structure hit the wall side-on. This led to straws coming out of the main tube & ball bounced.
- Egg would have cracked.

Straws Came out

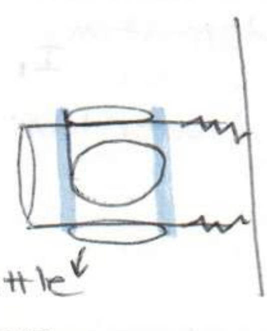


bounced back



STRUCTURE II

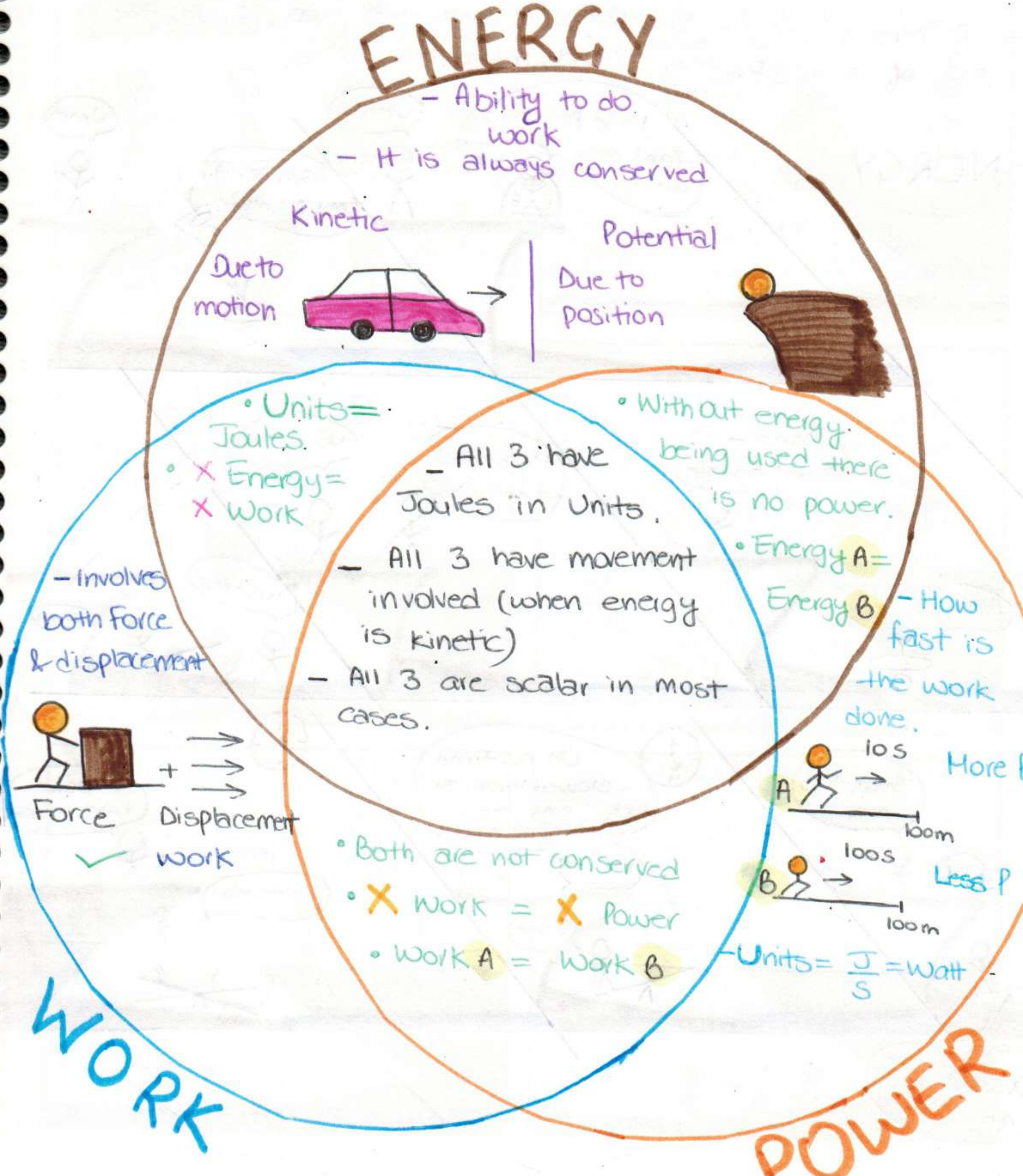
- The structure hit the wall with the top side.
- The top crumbled and the wall put some force on ball.
- Egg may or may not have cracked.



Very little bounce

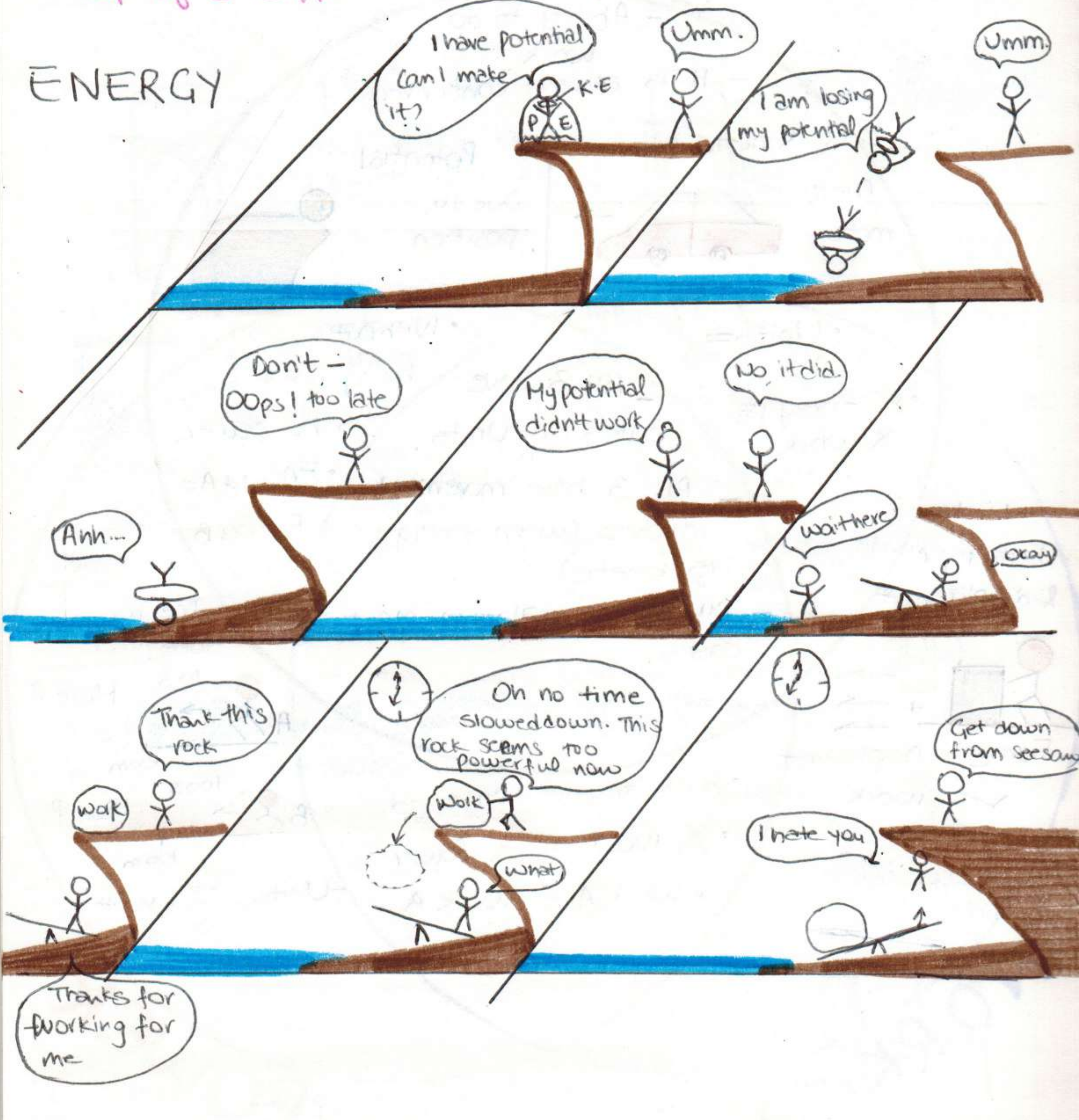
Q what to change in SI & how good is Structure II ?

ENERGY VENN DIAGRAM

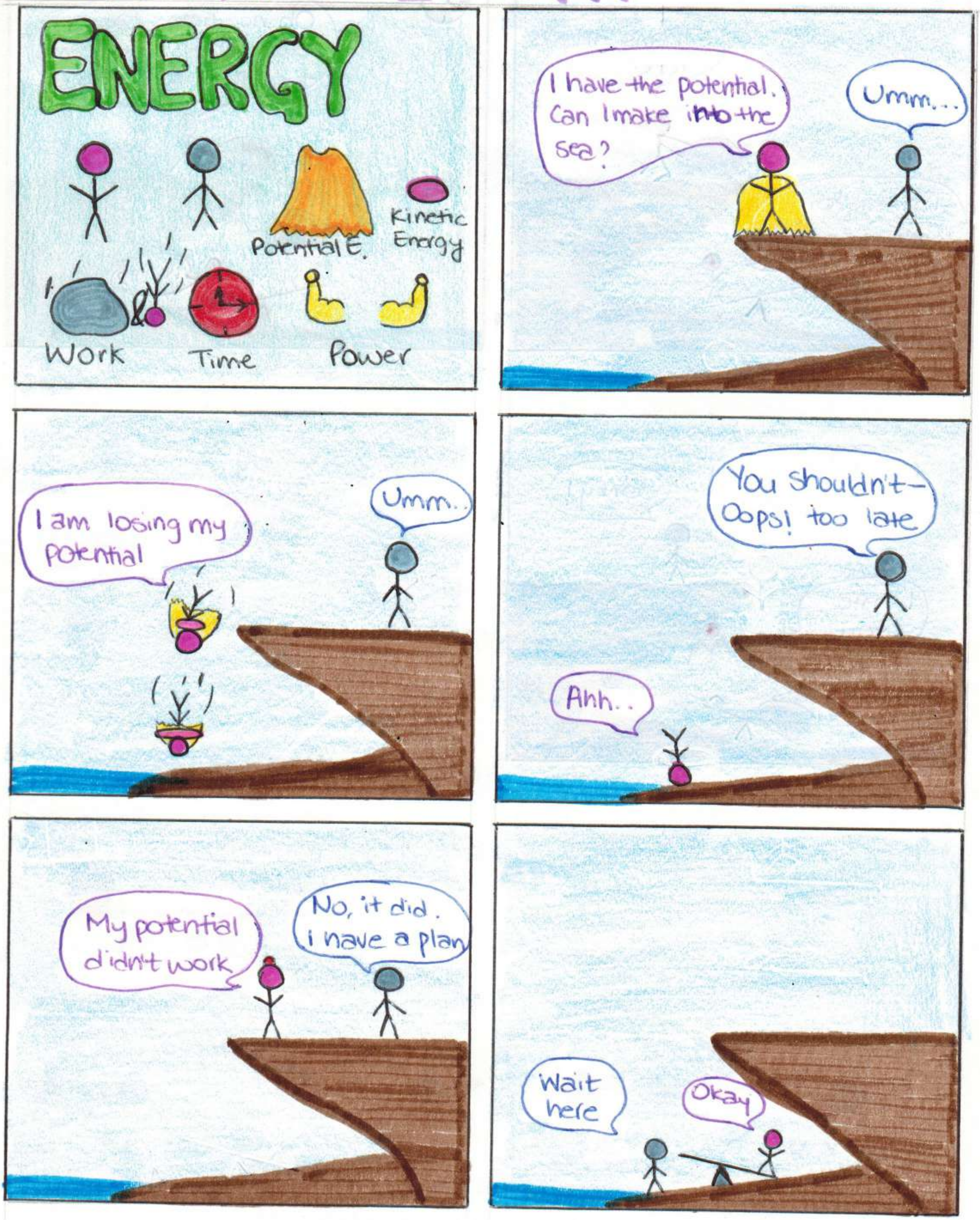


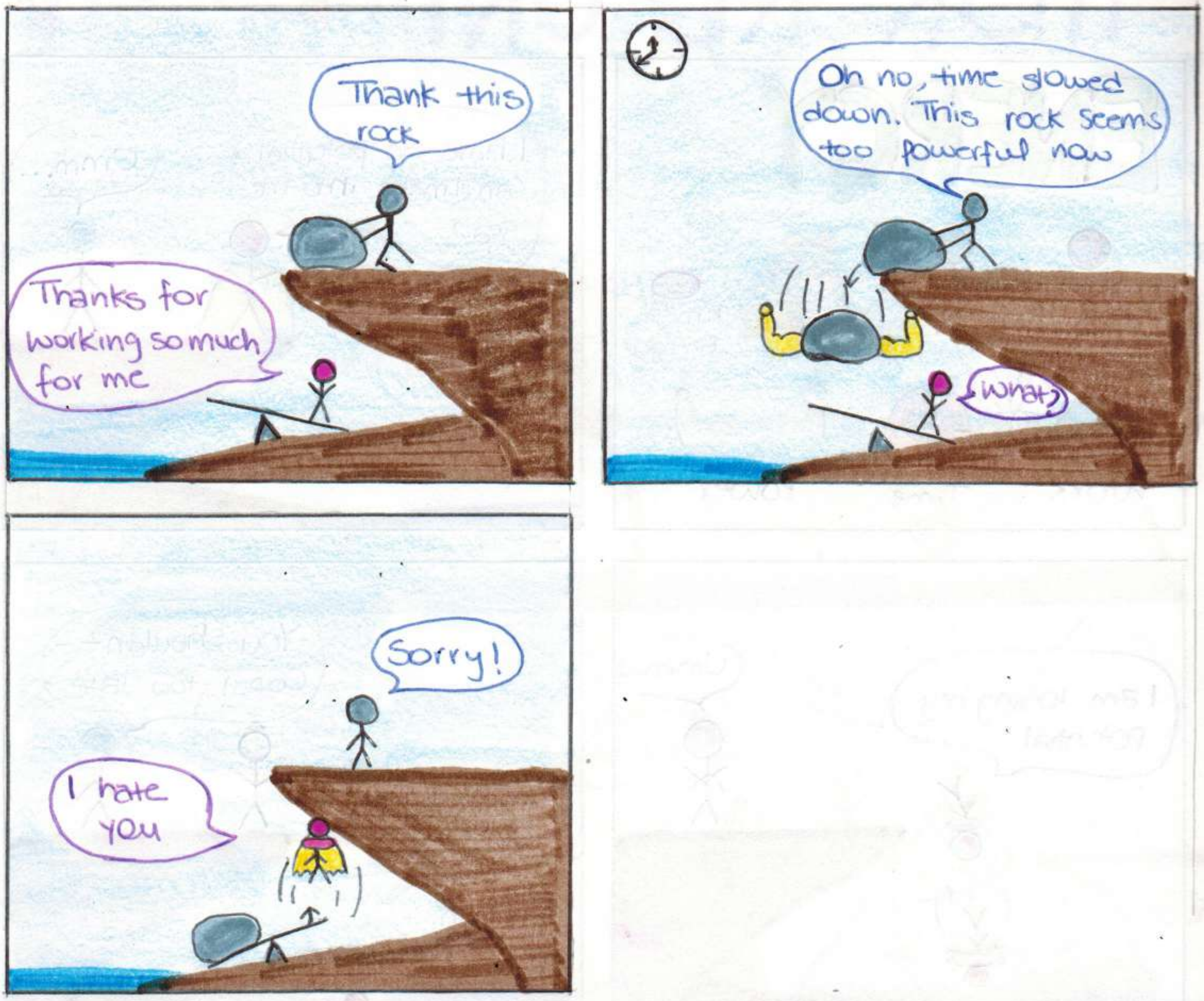
SUMMATIVE TASK

- Main focus → Energy.
- A person wants to make it into the sea from the top of a cliff. His friend helps him do so.



TASK REPORT


ENERGY
Potential E.
Kinetic Energy
Work
Time
Power
I have the potential. Can I make into the sea?
Umm...
I am losing my potential
Umm..
You shouldn't- Oops! too late
Ahh..
My potential didn't work
No, it did. i have a plan
Wait here
Okay


Thanks for working so much for me
Thank this rock
Oh no, time slowed down. This rock seems too powerful now
What?
Sorry!
I hate you