

CCMMWC
STEM Learning Activity
Catapult 投石器 in Battle of Guandu(官渡之戰) – Energy Converter

Name : _____() Class : S_____ Date : _____ Score : _____

Learning objectives

Science	Mathematics	Technology
➤ Apply law of energy conservation in making catapult	➤ Find out the relationship between tension of rubber string and the size of potential energy	➤ Make use of Scratch for simulation of the experiments

Background

The **Battle of Guandu** was fought between the warlords [Cao Cao](#) and [Yuan Shao](#) in 200 CE in the late [Eastern Han dynasty](#). The military conflict between Cao Cao and Yuan Shao had become apparent by 196 CE. Yuan Shao held control of the lands north of the [Yellow River](#), namely the Hebei region, while Cao Cao controlled most of the lands south of the Yellow River. Cao Cao's decisive victory against Yuan Shao's numerically superior forces marked the turning point in their war.

Yuan Shao led an army of 100000 to attack Cao Cao's team on a highland with many arrows. He took an advantage over CaoCao. However, CaoCao invented catapult to fight back to lengthen the battle time. A catapult will create loud sound during a battle,so it is named “霹靂車” in Chinese It allowed CaoCao's army to discover the storing supplies of Yuan Shao's team and burned his grain carts. Finally CaoCao defeated Yuan Shao.

Pre-lesson preparation

Law of conservation of energy states that: (1 mark)

energy is conserved, will change from one form to alternative form, the amount of energy

_____ .

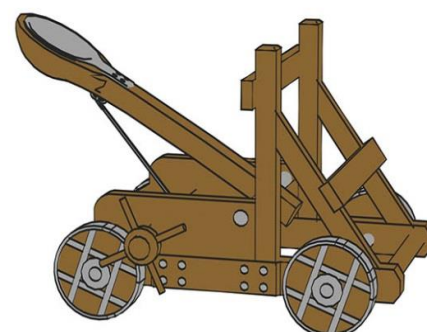
Below is the diagram for a catapult. Write down the energy conversion. (2 marks)

Catapult stores _____ → _____ of the rock

State the energy conversion when a rock flies and falls down(4 marks)

_____ → _____

→ _____ + _____



Making your own catapult

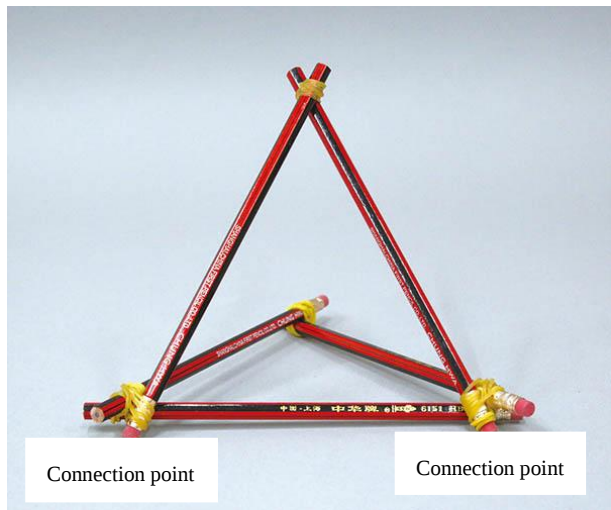
Materials for a group in 4 :

Pencil	12
Rubber bands	15(Long)+3(Short)
A plastic lid	1

Procedures :



1. Form a triangle with three pencils and connect them with rubber bands. This is the base of the catapult.



2. Connect the two junctions of the triangle. Gently pull the top triangle backward and connect them with rubber bands.



3. Fix two more pencils as a support (shown above)



4. Punch three holes on the plastic lid and tie three rubber bands on the holes



5. Tie the three rubber bands in the middle of the pencil framework. You can start shooting now.

6. If you want to further strengthen or modify your catapult, you can utilize the materials left.

You can learn how to make the catapult
By scanning the QR code on the right side.



Experiment

Materials for a group of 4 :

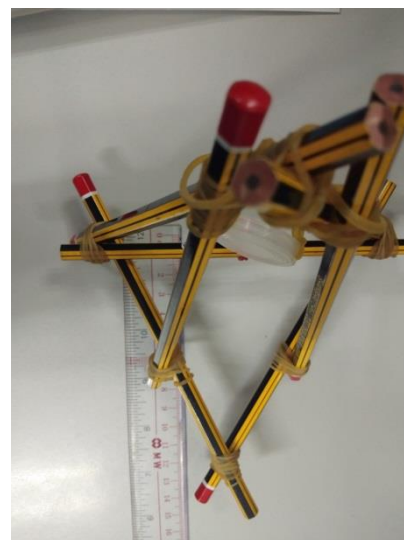
ruler	1
load (serve as a rock)	1

Apparatus required for each class :

Meter rule	1
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Steps :

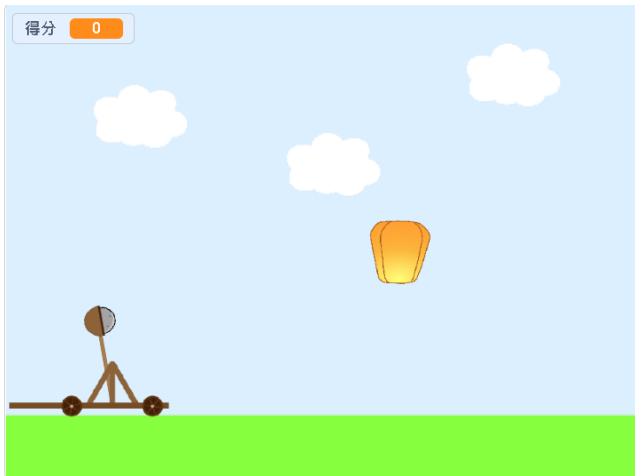
1. Place the catapult on the reference point and put the load (e.g. a 10 cent coin / an eraser) onto the bucket (i.e. the lid)
2. Place the meter rule under the bucket (as a reference point). The lid is at the 0 cm of the meter rule as shown in the above photo.
3. Pull the bucket 4 cm backward (with the aid of a meter rule), release the load.
4. Measure the distance between the load and reference point with the aid of a meter rule. Repeat



step 3 twice to obtain a total of three data, then calculate the average value.

- Groups of the whole class can have trials of 4 cm, 6cm, 8cm and 10 cm.

Before the competition, you can try the online *scratch* simulation to have more practice. You can click the below link: <https://scratch.mit.edu/projects/255761137/> OR scan the provided QR code.



Data processing :

The distance of the lid pulled backward	The distance between the load released and the catapult			
	1st	2nd	3rd	<u>Average</u>
4cm				
6cm				
8cm				
10cm				

Conclusion

The _____ the bucket to be pulled backward is , the _____ the load can be released from the reference point.

Discussion

Science Part:

- With the aid of the Law of Conservation of energy, explain the result.

Chinese History Part:

2. 雖然投石器能幫助曹操軍投出大石，但他還遇到不少其他難題，試替他想想以下難題的解決辦法！

(a) 若你們的投石器製作成實物大小，其重量使它並不能隨意移動，可以怎麼辦？

(b) 在你的投石器中，如何改良才能將更多勢能儲存其中？單純以人手操作，是否可以將如此多的能量儲起？

3. (與中國歷史相關)曹操與袁紹，除了因為曹操軍改良了投石器之外，還有甚麼因素使曹操能獲得勝利？(如果曹操軍不積極解決上述問題，他能成功擊敗袁紹嗎？可上網尋找一下袁紹怎樣的性格致使他失敗！)

Competition

1. Each class sends 3 representatives to take part in the competition. Each class only has one chance and comes out class by class.
2. Place several water bottles away from the catapult location by 1m, 2m and 3m respectively.
3. Within 2 minutes, each class has total 6 throws to knock down the bottles.
4. Knocking down bottles at 1m, 2m and 3 m can score 2 marks, 5 marks and 10 marks respectively.
5. The class who obtains the highest score will be the winner.