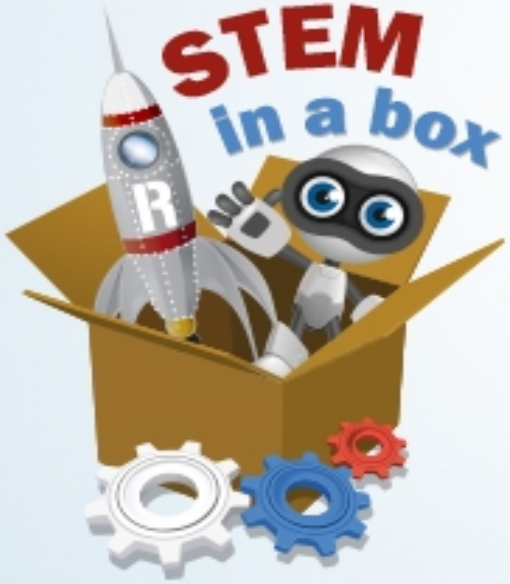

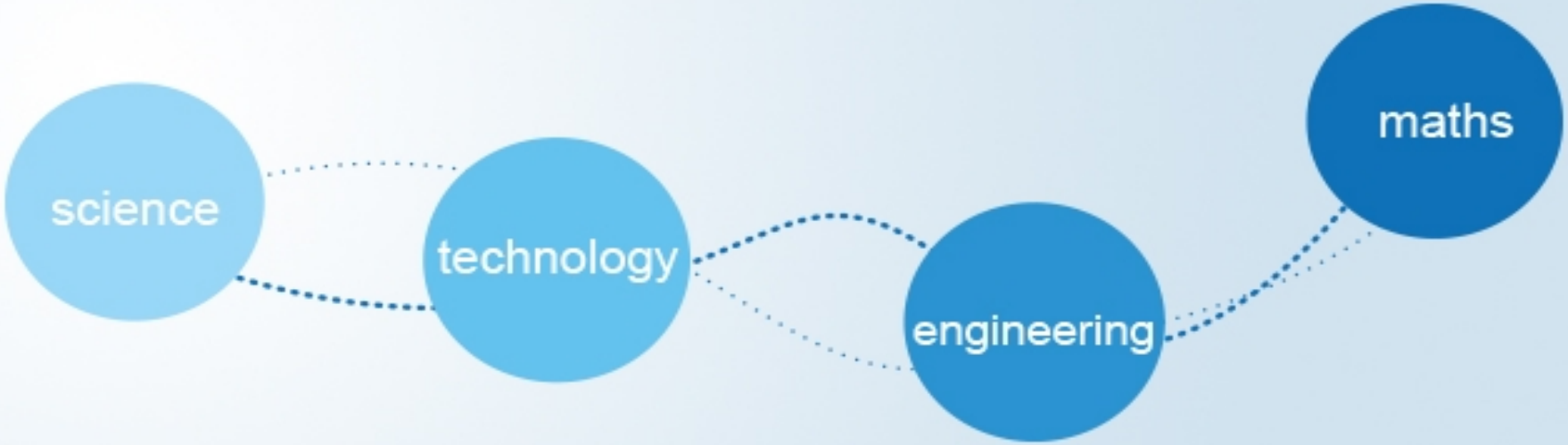

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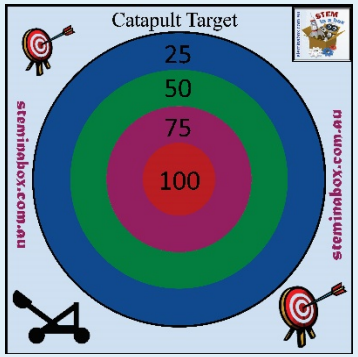
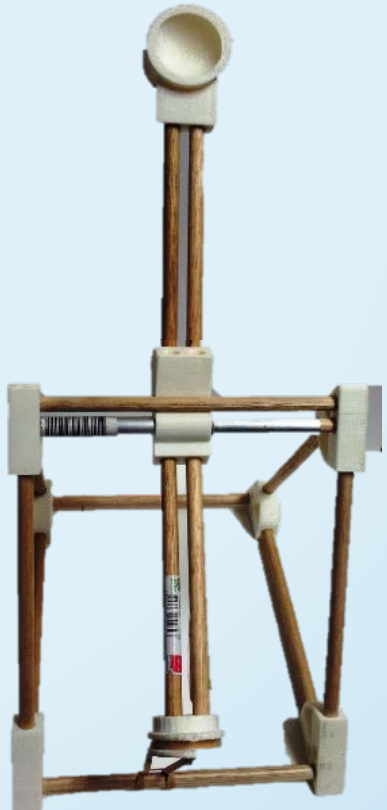
Catapult Kit

Classroom Scientific Investigations

Catapult Kit – Overview

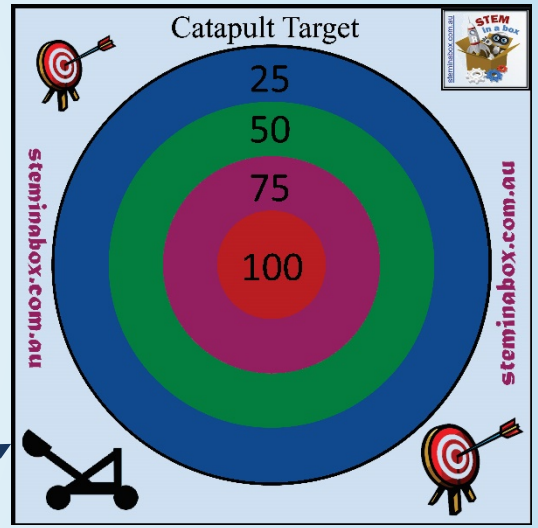
- 4 Complete Catapults
- 4 Separate Investigations
- Tough Vinyl Target
- Quick configuration between experiments
- Exemplars, instructions & student worksheets





Catapult Scientific Investigations

- **Effect of Throw Arm Length on Projectile Displacement**
- **Effect of Launch Angle on Projectile Displacement**
- **Effect of Launch Power on Projectile Displacement**
- **Optimal Catapult Configuration for Desired Projectile Displacement & Accuracy**

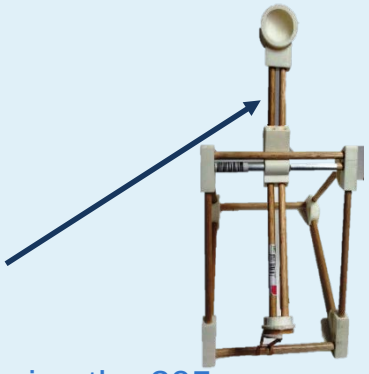


Exemplar: Effect of Throw Arm Length on Projectile Displacement

Aim: To determine the influence of Throw Arm length on projectile displacement.

Hypothesis: A greater Throw Arm increases displacement

Method: Using a “fair test method” alter the Throw Arm length and record resultant horizontal projectile displacement .



Results: The greatest projectile displacement was produced using the 205mm Throw Arm (Table 1 & Fig. 1)

Table 1. Effect of Throw Arm Length on Projectile Displacement

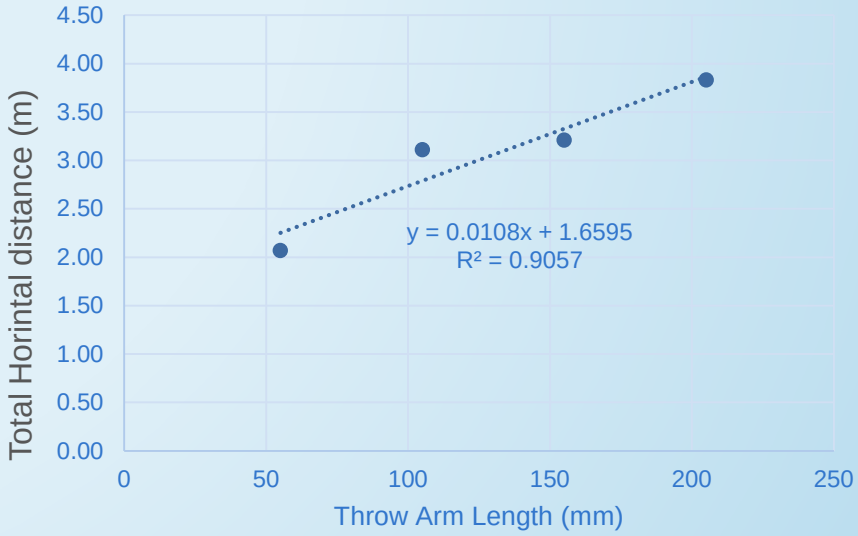
Throw Arm Length (mm)	Total Horizontal Distance (m)			
	Trial 1	Trial 2	Trial 3	Av
55	2.08	1.97	2.17	2.07
105	3.13	3.18	3.03	3.11
155	3.20	3.25	3.19	3.21
205	3.80	3.78	3.92	3.83
Controlled Variables: Launch angle, launch power, wind conditions				

Discussion: The Experimental results indicated that as the Throw Arm length was increased the projectile displacement in the horizontal direction also increased. The increase in distance was in direct proportion to increased Throw Arm length as indicated by the upward sloping straight line in Fig 1. This is a strong positive linear relationship with a correlation coefficient of 0.91 which means that 91% of the variation in displacement is explained by Throw Arm length. The linear regression analysis indicates that for every extra 1mm of Throw Arm length the displacement increases by 0.018m or 1.8cm.

This result is likely due to the greater throw arm length increasing the launch velocity. Further testing should be conducted to determine the optimal Throw Arm length which could be larger than the 205mm tested in this experiment.

Conclusion: Experimental results clearly showed that increased Throw Arm length launches the projectile further which confirms the original hypothesis that a greater Throw Arm increases displacement.

Fig 1. Effect of Throw Arm Length on Projectile Displacement

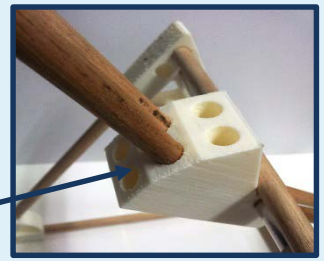


Exemplar: Effect of Launch Angle on Projectile Displacement

Aim: To determine the influence of launch angle on projectile displacement.

Hypothesis: A greater launch angle increases horizontal displacement

Method: Using a "fair test method" alter the launch angle and record resultant horizontal projectile displacement .



Results: The greatest projectile displacement was produced with a launch angle of 45^0 (Table 2 & Fig. 2).

Table 2. Effect of Launch Angle on Projectile Displacement

Launch Angle (Degrees from Horizontal)	Total Horizontal Distance (m)			
	Trial 1	Trial 2	Trial 3	Av
22.50	2.15	2.12	2.23	2.17
45.00	2.25	2.46	2.37	2.36
67.50	1.17	1.23	1.15	1.18

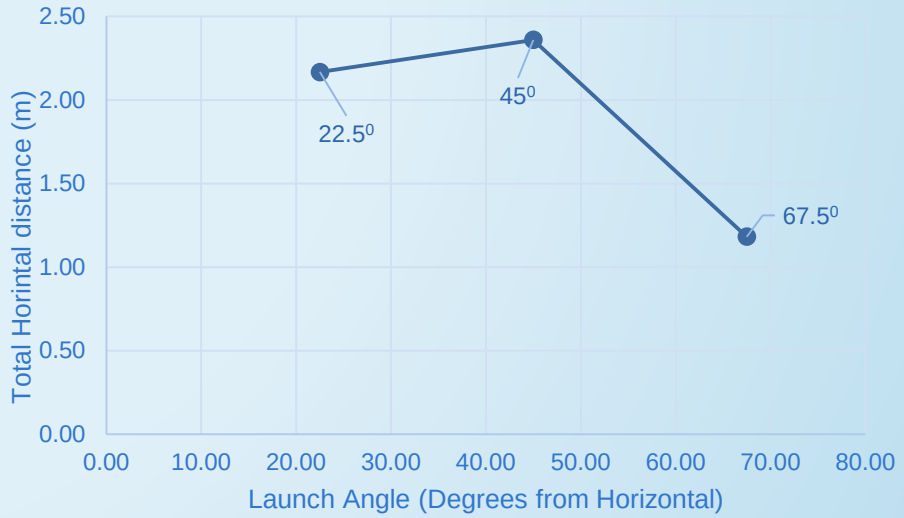
Controlled Variables: Throw arm length, launch power, wind conditions

Discussion: Projectile vertical displace was not recorded however the 22.5^0 angle of launch went the highest with the 67.5^0 launch not going very high and hitting the ground with lots of horizontal velocity. An effective trade off between vertical displacement and horizontal displacement was a 45^0 launch angle which produced the greatest horizontal displacement.

The relationship between launch angle and horizontal displacement is not in direct proportion which is why Fig 2 shows a non-linear line. Reducing the launch angle by 22.5^0 from 45^0 reduced displacement by 8% but increasing launch by the same amount decreased displacement by half.

Conclusion: Results indicated that horizontal displacement is greatest with a launch angle of 45^0 which does not support the original hypothesis. Rather observations showed that vertical displacement (height) increases as launch angle decreases.

Fig 2. **Effect of Launch Angle on Projectile Displacement**



Exemplar: Effect of Launch Power on Projectile Displacement

Aim: To determine the influence of launch power on projectile displacement.

Hypothesis: Increasing launch power increases horizontal displacement

Method: Using a “fair test method” alter the launch power and record resultant horizontal projectile displacement .

Results: The greatest projectile displacement was produced with the maximum launch power using three parallel rubber bands (Table 3 & Fig. 3).

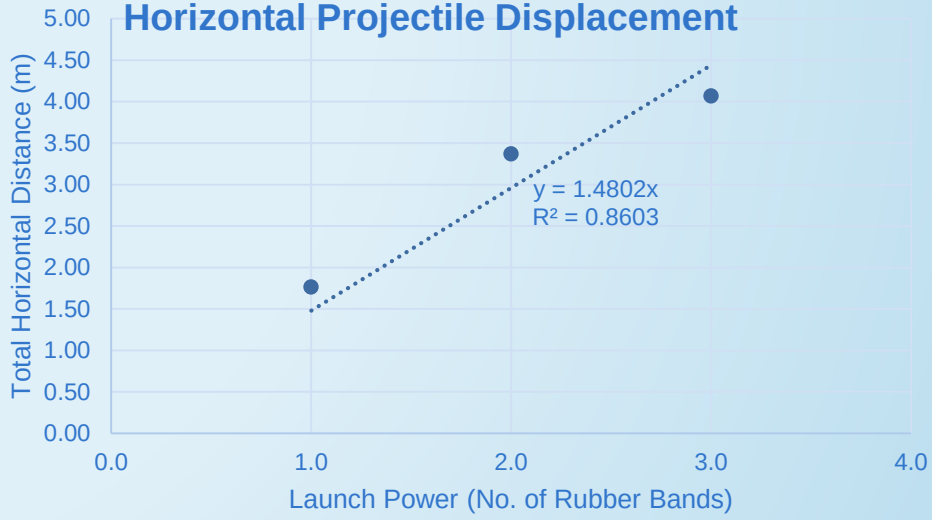
Table 3. Effect of Launch Power on Projectile Displacement

Launch Power (No. of Rubber Bands)	Total Horizontal Distance (m)			
	Trial 1	Trial 2	Trial 3	Av
1	1.73	1.86	1.71	1.77
2	3.38	3.29	3.45	3.37
3	4.07	3.99	4.15	4.07

Controlled Variables: Launch angle, throw arm length, wind conditions

Discussion: The power of the catapult is derived from the stored elastic potential energy in the stretched rubber bands. Each rubber band when stretched by the same amount would have the same energy so it follows that displacement would increase in proportion with the number of rubber bands (total launch power). This is verified by the straight line (linear) relationship in Fig 3. Furthermore, regression analysis indicates a strong relationship (correlation coefficient = 0.86) and that for every extra rubber band the horizontal displacement increases by 1.48m. However, the dowel throw arm was straining with 3 rubber bands and would probably break with 4 bands so 3 rubber bands might be the optimum for this catapult design.

Fig 3. Effect of Launch Power on Horizontal Projectile Displacement



Conclusion: The initial hypothesis that increased launch power increases horizontal displacement is confirmed by these fair test results with the caveat that greater launch power (>3 rubber bands) will likely cause a structural failure in the catapult throw arm and result in no displacement.

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