Science - Year 5

Forces – Block 5F

May the Forces Be With You

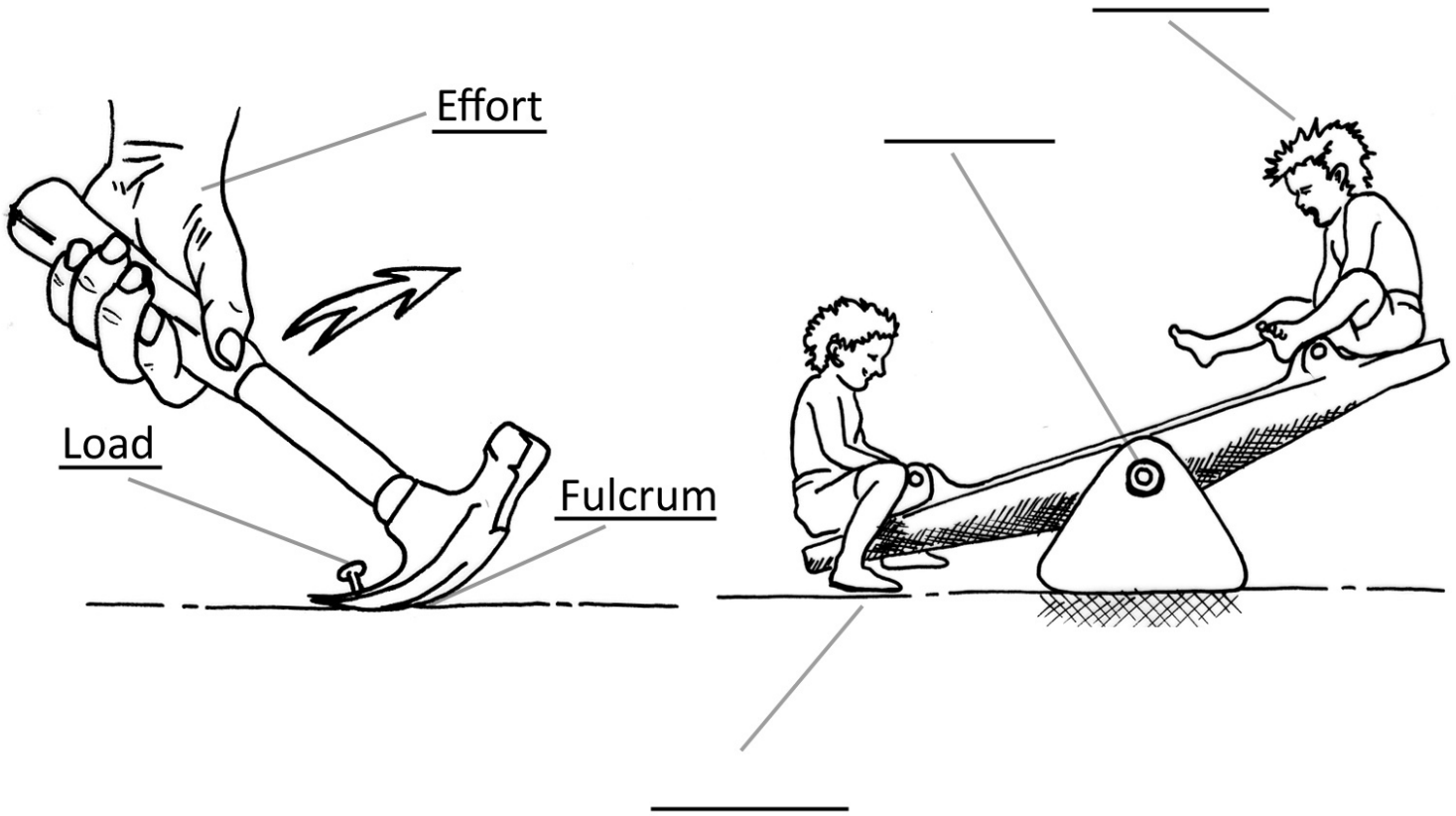
Session 3

Resource pack

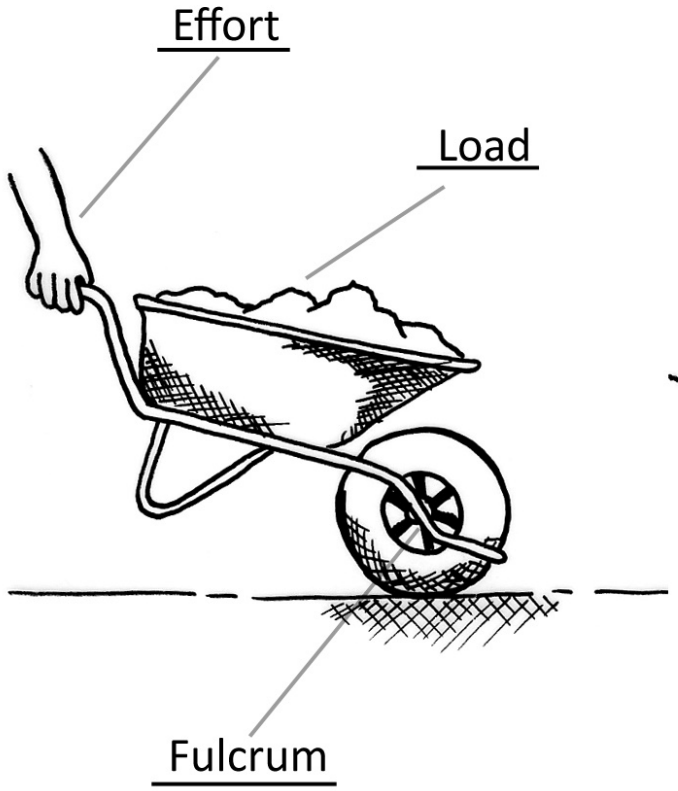
NHM recovery team phone transcript

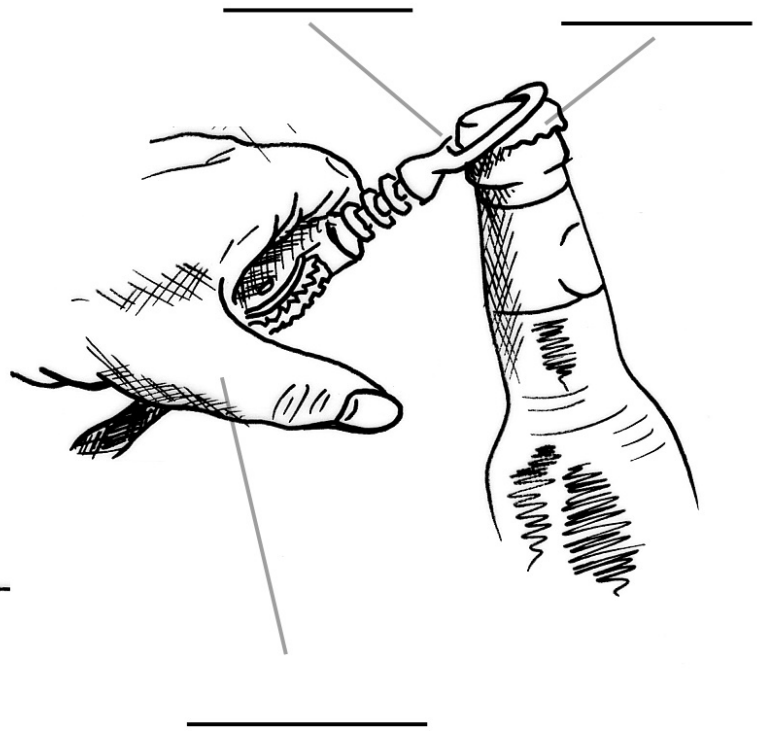
"… big hole… very heavy and bulky… probably about 200kg… 4 metre plank of wood… medium size rock… ground sheet… old oil cans… long rope… advise us on making a lever… how many oil cans for the pulley system…"

Types of lever

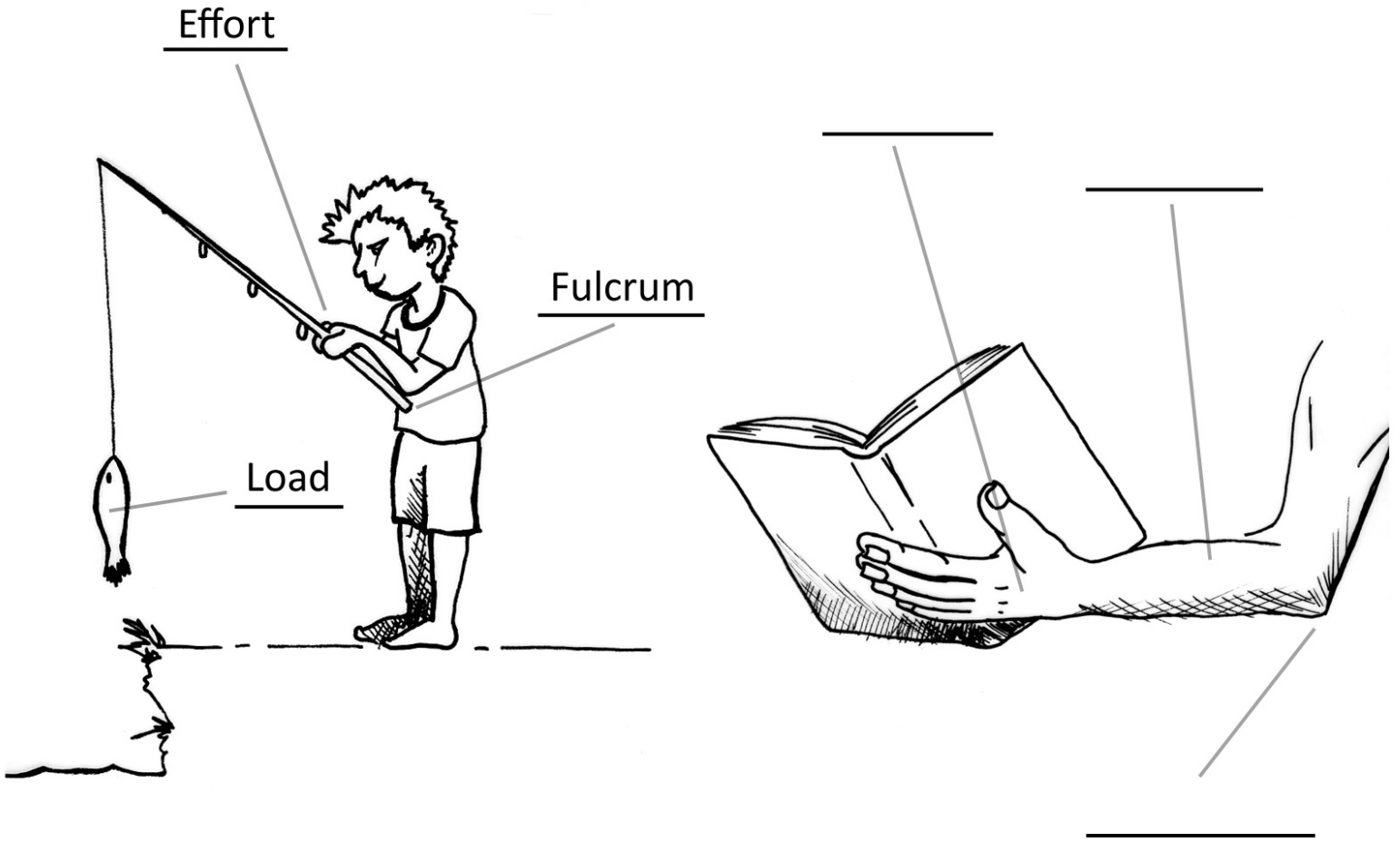


Other examples are: pliers, crowbar, scissors, rowing a boat





Other examples are: nut crackers, nail clippers



Other examples are: sugar tongs, pair of tweezers

Lever investigation guidance

You will need to identify where the best position is for the fulcrum in a simple lever. Identify those things that will need to stay constant while you take measurements and make observations for your main variable. Plan methodically to ensure your testing is fair, logical and the results are not unreliable.

Lever remit:

- The lever needs to enable two 70kg people to lift a 200kg meteorite

Equipment:

- Table top seesaws (already prepped for lesson)
- Movable fulcrum
- Modelling clay
- Force meter

Possible variables to investigate

What are you investigating? Can you come up with an enquiry question for your investigation?

Measuring and recording your results

What will you need to measure in order to know where the fulcrum needs to be?

What will you use to measure with?

How will you record your results? Think about what will help you to see the best outcome for the remote team.

Your findings

What have you found out?
Can you make any conclusive observations?
Can you make any recommendations?
Record your recommendations in the form of a diagram, showing where forces are acting and the positioning of the fulcrum

Improvements

How could you have made your investigation more accurate?
Is there any other way that you could have investigated?

Investigation mathematics

How can you scale your lever, weight and input force to the equipment and force sizes of the recovery team?

	Weight in newtons (N) of meteorite	Length of plank	Input energy in N
In house testing			
In field reality	2000N	4m	140N

Sample results tables (blank and complete) for lever investigation

LEVER INVESTIGATION	Enquiry question/s:							
Variables we kept the same:					Variable changed:			
Distance of fulcrum from load:								
Can the load be lifted?								
Does **load x distance of load to fulcrum = effort x distance of effort to fulcrum**								
Overall recommendations								
Scientific rationale								
Possible improvements to our investigation								
What else could we have investigated?								

LEVER INVESTIGATION	Enquiry question/s: *At which point between the load and the effort exerted does the fulcrum need to be to lift the load?*							
Variables we kept the same: *component parts, the input force being exerted, weight and mass of load*					Variable changed: *Position of the fulcrum*			
Distance of fulcrum from load:	*40cm*	*35cm*	*30cm*	*29cm*	*28cm*	*27cm*	*26cm*	
Can the load be lifted?	*No*	*No*	*Nearly*	*Nearly*	*Nearly*	*Lifting slightly*	*Yes*	
Does **load x distance of load to fulcrum = effort x distance of effort to fulcrum**	*No*	*No*	*No*	*No*	*No*	*No*	*Just about!*	
Overall recommendations	*Place the fulcrum at 26cm from the load*							
Scientific rationale	*We used a plank of 40cm and a weight of 200N. We needed to position the fulcrum 2.6cm from the load in order for 14N of effort to lift the load:* *2.6 x 200 = 27.4 x 14 (just about!)*							
Possible improvements to our investigation *We needed to 'attach' the load better to lift it.* *Our fulcrum could have been better for balancing the plank.*								
What else could we have investigated? *Moving the effort position.* *Increasing the effort.*								

Pulley investigation

Encourage chn to make both types of pulley then text them out with a range of weights to see which can lift heavier weights easier.

Instructions for making a fixed pulley

You will need:

Knitting needle or length of dowelling
Cotton reel
Length of string
Small container/bucket to hold load
2 hooks
Length of 10mm wood
Load, e.g. marbles, wooden bricks

Method:

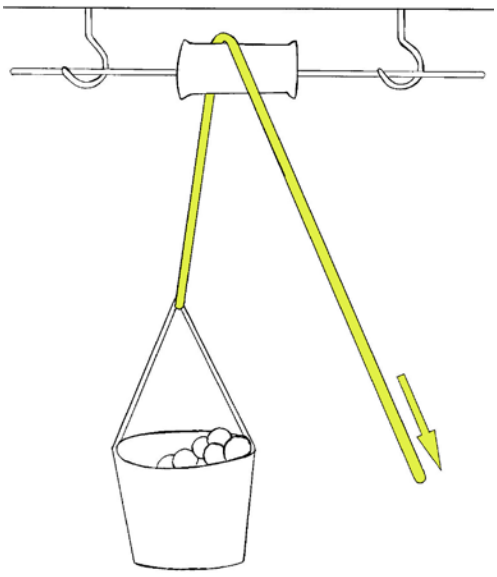
1. Fix hooks into length of wood and place wood across a gap between two tables

2. Push dowelling or knitting needle through the cotton reel and place onto hooks

3. Place load in container and lift

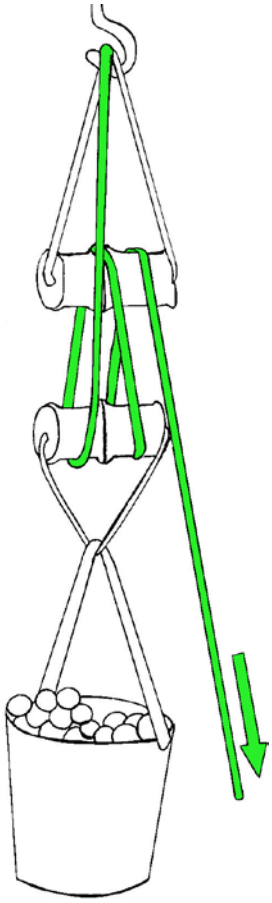
3. Tie the string to handle of container and run over the cotton reel

4. Pull on string to lift the load



Instructions for making a block and tackle pulley

You will need:
4 cotton reels
1 hook
Length of 10mm wood
Length of string
Scissors
Small container/bucket to hold load
Load, e.g. marbles, wooden bricks
Force meter



Method:
1. Fix hook into length of wood and place wood across gap between two tables

2. Tape two cotton reels together and thread string through them, knotting them in place. Tie to the hook (block)

3. Place the load in container and lift

4. Tape together two more cotton reels and thread string through them, knotting them in place. Tie to container (tackle)

5. Tie a third piece of string to the hook and wrap it round the cotton reels as shown in the diagram

6. Pull the string to lift the load

7. Compare the force needed with that in point 3, using a force meter.

Discuss with chn whether it was easier or harder to lift the load using the pulleys. Which is better for lifting loads – the fixed pulley or the block and tackle? Which pulley system do they think they would like to recommend to the recovery team and why? What do they think would happen if you added more cotton reels? Try this out and see if it changes their recommendations.

Key science questions for pulley investigation (differentiated)

HA

- What does the pulley/lever do to the amount of force needed to lift or move something?
- What should remain constant each time you test the lever? *(the component parts, the input force being exerted, weight and mass of load)* How can you make sure these stay the same/constant each time? Why is this important?
- What are you going to investigate? *(how moving the fulcrum increases or decreases the force needed to lift the load)*

MA

- What does the pulley/lever do to the amount of force needed to lift or move something?
- What do you not need to change each time you test the lever? *(the component parts, the input force being exerted, weight and mass of load)* How can you make sure this stays the same/constant each time? How might the results be affected if these things change, even by just a small amount, each time?
- What are you going to investigate? *(how moving the fulcrum increases or decreases the force needed to lift the load)*

LA

- Does the pulley/lever make it easier or hard to lift or move something? Does it make the force you use have a bigger or smaller impact?
- Why do you need to make sure that the component parts, the input force being exerted, weight and mass of load don't changing during your testing? How might the results be affected if these things change, even by just a small amount, each time?
- What are you going to try and find out? *(how moving the fulcrum increases or decreases the force needed to lift the load)*

Sample results table (blank and complete) for pulley investigation

PULLEY INVESTIGATION	Enquiry question/s:							
Variables we kept the same:					Variable/s changed:			
Pulley system	**Max weight lifted**							
Fixed pulley								
Block & tackle pulley								

Block & tackle extension	Number of cotton reels			
	4	6	8	10
Weight lifted				
Overall recommendations				
Scientific rationale				
Possible improvements to our investigation				
What else could we have investigated?				

PULLEY INVESTIGATION	Enquiry question/s: *Which pulley makes moving the load easier?* *How many cotton reels makes the dog pulley system lift 200N?*

Variables we kept the same: *Effort force*	Variable/s changed: *Type of pulley system* *Number of cotton reels* *Weight*

Pulley system	**Max weight lifted**							
Fixed pulley	2kg	3kg	4kg	5kg	6kg(X)	5.5kg	5.6kg	5.7kg (X)
Block & tackle pulley	5kg	7kg	9kg	10kg (X)	9.5kg	9.8kg	9.9kg (X)	9.85kg (X)

Block & tackle extension	Number of cotton reels			
	4	6	8	10
Weight lifted	9.8kg	14.2kg	19kg	23.6kg
Overall recommendations	*We would recommend the block and tackle style of pulley system, using multiple oil cans.*			
Scientific rationale	*The use of more oil cans spreads the load more, making it easier to lift the weight.*			

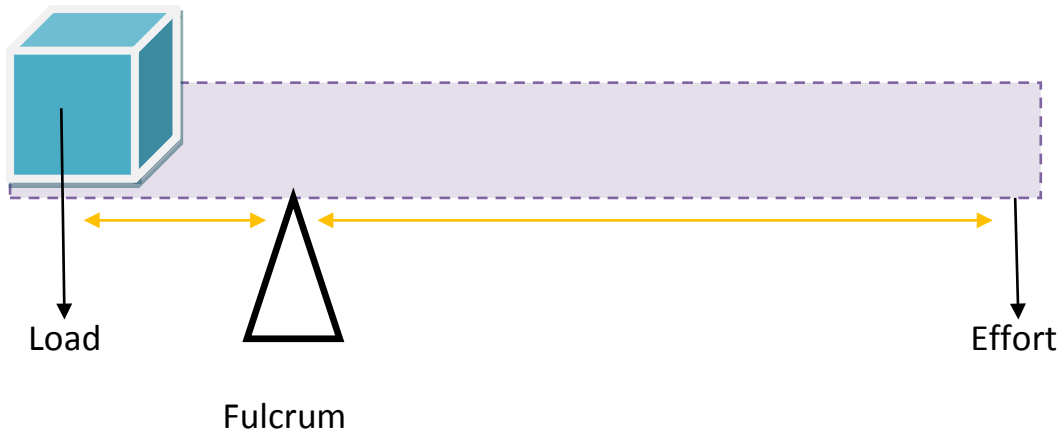
Possible improvements to our investigation

We could have taken more care with our pulley design to ensure it didn't keep getting caught.

What else could we have investigated?

The amount of force needed for a set weight using various numbers of cotton reels

Calculating the position of the fulcrum



load x distance of load to fulcrum = effort x distance of effort to fulcrum