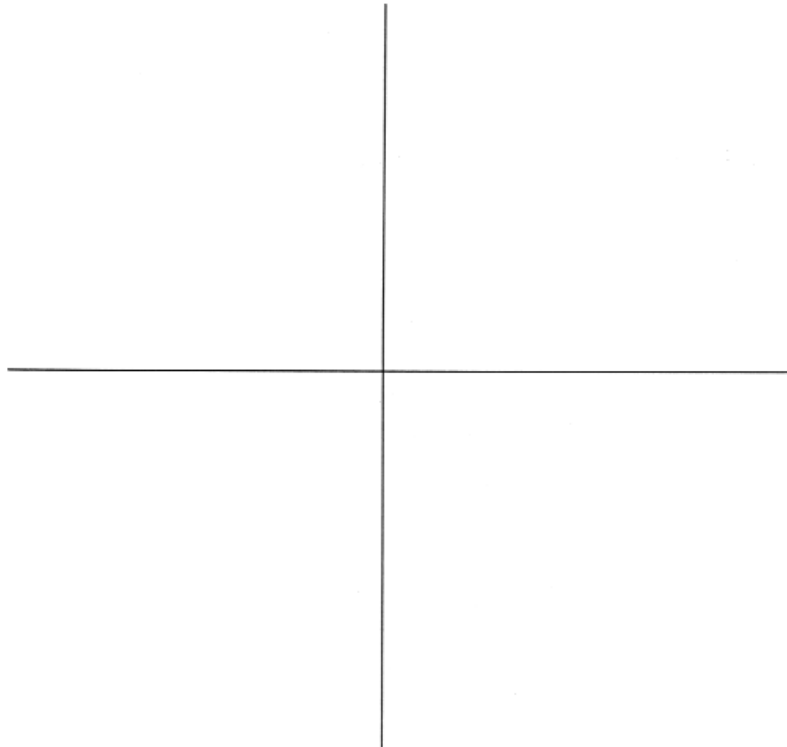


A

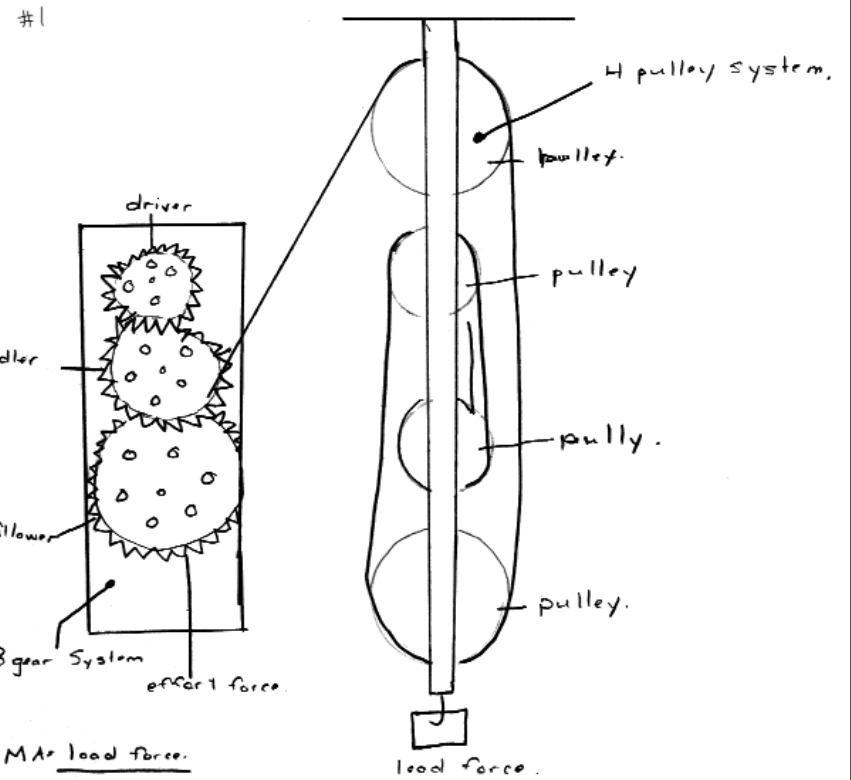
Appendix 6
Making the Plan

1. Restate the Need : Make a mechanism that lifts a 500 g "whale" 10cm high and back down 5 cm .

2. Exploring Ideas: (Use the space below to illustrate your ideas.)

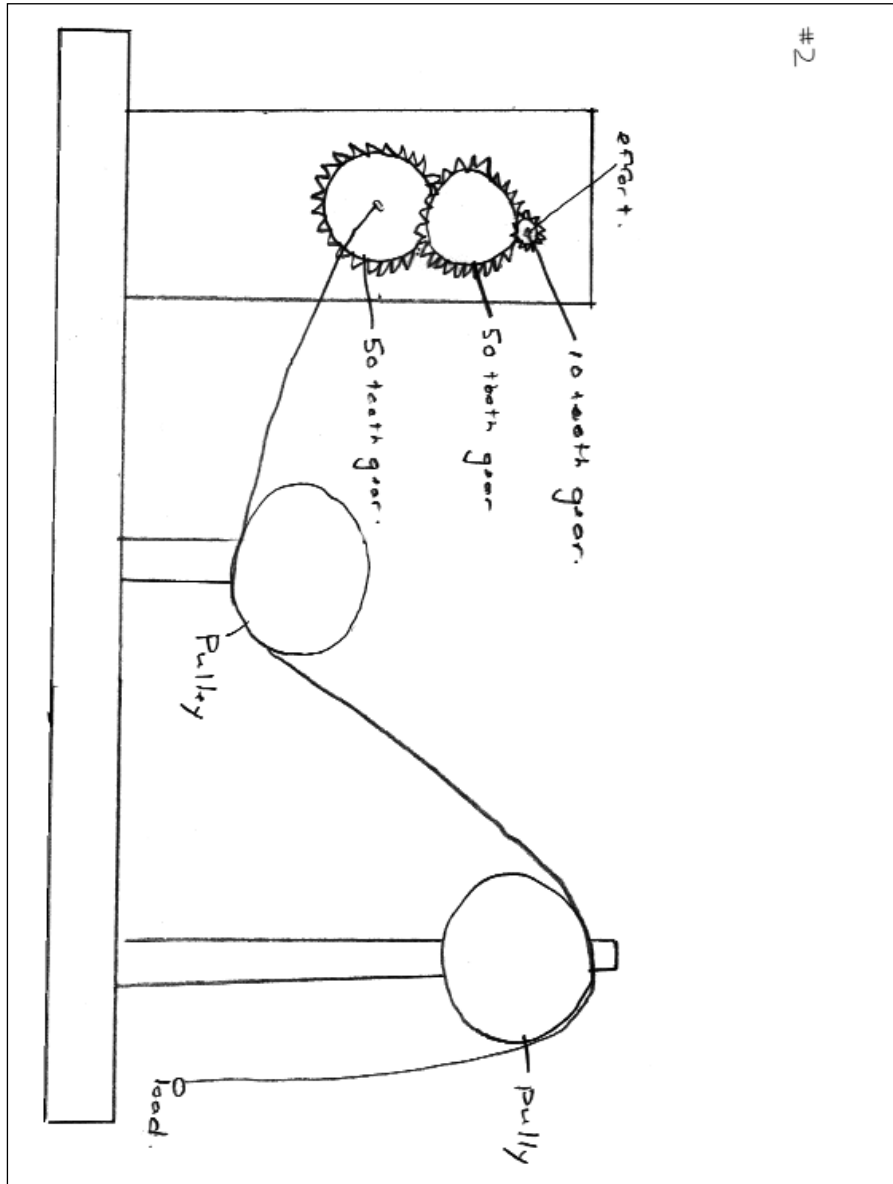


B



Didn't work, pulleys to for a part.

C



D

3. Select your preferred solution and explain why you've made your choice.

I chose plan #2. The four pulley system didn't work out as planned. I then used a 2 pulley system with a 3 gear system. It had a mechanical advantage of 6. It succeeded in all areas.

4. **Design Sketch** (draw a clearly labelled design sketch of your solution on the back of this sheet or on graph paper).

5. **Outline the design process steps** followed in constructing, testing, and revising your solution. These steps should only include the lifting mechanism construction, **not** the supporting structure.

1. Make the wall for the gears. Attach it to base.

Make stand for lower pulley.
Make stand for higher pulley

Collapsad.

Made base

Made pulley system (3 gear) and attached to base.
made pulley (2 pulley) attached to base.

attach dowel rod to follower gear (50)
attach axle to driver (10).

attach string under pulley
glue onto follower rod

calculate MA = 5.

E

Appendix 7 Executing / Evaluating the Plan

Observe and record data that show that your mechanism generates a mechanical advantage (MA) of at least 4. Show how you have applied MA calculations with an explanation. Show evidence verifying your results.

$$MA = \frac{\# \text{ of teeth on follower}}{\# \text{ of teeth on driver}}$$

$$MA = \frac{50}{10} = 5$$

I tried to use the newton scale, but it didn't quite work out because I couldn't figure out how to attach it to the gears. It was very difficult.

F

Appendix 8 Reflection

1. Provide an **evaluation** of the strengths and weaknesses of your mechanism.

a) Strengths: Pulleys are attached, could lift easily 500g, easy to use, pulleys provide easier lift,

b) Weaknesses: base is not sturdy, takes a lot of hands to hold, crank is not easy to turn, falls apart, the follower gear does not stick to the wall.

2. Explain **how** your design could be improved.

- the base could have been sturdier.
- gears could have been put on ground instead of in air.
- create dowel rods small enough to fit in hole without falling out.
- pulley stands could have been sturdier.

Teacher’s Notes

Understanding of Basic Concepts

- The student demonstrates some understanding in applying, calculating, and explaining mechanical advantage (e.g., [P] Executing/Evaluating the Plan: calculates mechanical advantage by applying gear-ratio formulas; experiences technical difficulties in verifying with Newton force meter: “... I couldn’t figure out how to attach [the Newton scale] to the gears.”).

Design Skills

- The student rephrases the problem/need with some clarity (e.g., [P] Making the Plan [1]: focuses on the need to design/construct a mechanism as well as on the goal of lifting a whale, and states some of the design criteria such as load force, height, and distance, but does not mention the required mechanical advantage of 4).
- The student explores potential solutions in a somewhat appropriate way (e.g., [P] Making the Plan [2]: explores two potential ideas in labelled drawings).
- The student selects a solution and provides some explanation for the choice (e.g., [P] Making the Plan [3]: explains that design 2 was chosen because “It had a mechanical advantage of 6.”; elsewhere calculates a mechanical advantage of 5).
- The student creates a somewhat organized and labelled design sketch (e.g., [P] Making the Plan [4]: includes some detail such as driver and follower gears in the first design sketch, and numbers of teeth in the gears in the second sketch).
- The student outlines some steps of the construction plan (e.g., [P] Making the Plan [5]: lists twelve steps, but includes several relating to the supporting structure that was not included as part of the task).
- The student constructs a solution that meets the task criteria to some extent (e.g., [P] Making the Plan [5]: determines a mechanical advantage of 5 using gear ratio, but does not recognize that fixed pulleys do not increase mechanical advantage).

Communication of Required Knowledge

- The student presents the solution with some clarity (e.g., [P] Executing/Evaluating the Plan: makes a correct numerical calculation of MA based on formula for gears but mislabels the written components on which the calculation is based: both gears are identified as “follower”).
- The student demonstrates with some supporting evidence how the solution meets the task criteria (e.g., [V] demonstrates the mechanism’s lifting capacity but needs to use manual force to drive the follower gear).

Relating of Science and Technology to Each Other and to the World Outside the School

- The student provides a somewhat reasonable reflection on the strengths and weaknesses of the model (e.g., [P] Reflection [1a]: notes that pulley system works well: “could lift easily 500g”; [1b]: notes that gear system is unstable and difficult to operate: “takes a lot of hands to hold, crank is not easy to turn ...”).
- The student suggests somewhat appropriate improvements (e.g., [P] Reflection [2]: suggests two improvements to avoid instability: “gears could have been put on ground ...” and “creat dowel rods small enough to fit in hole without falling out”, but does not clearly explain the function of the second improvement).

Comments/Next Steps

- The student should include measurements in the design sketch.
- The student should become more familiar with mechanical advantage calculations.
- The student should use the design process to explore a greater variety of possible solutions.

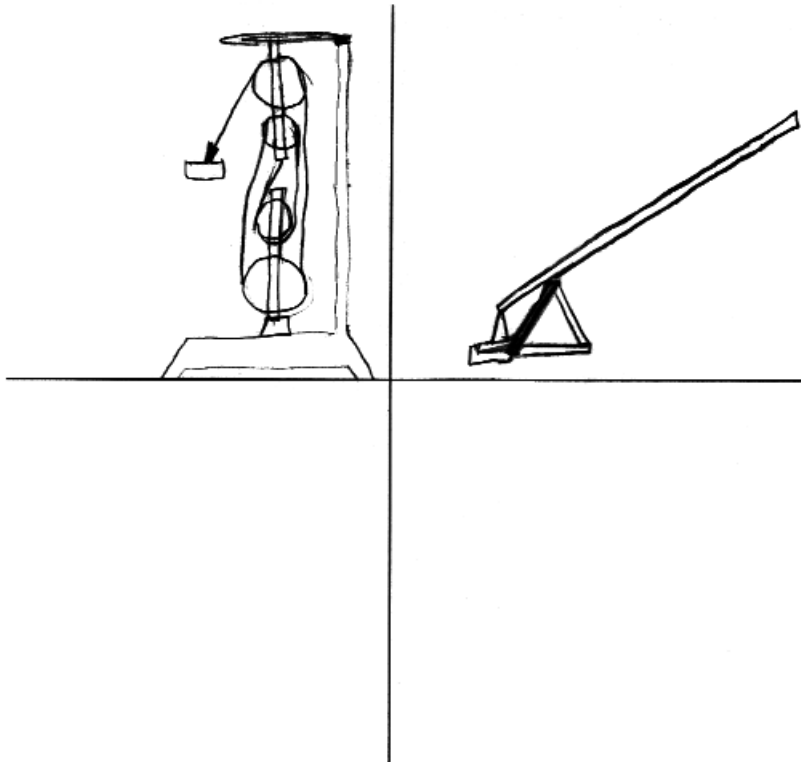
A

**Appendix 6
Making the Plan**

1. Restate the Need

- To lift a whale 10cm and then drop it 5cm
- Have a mechanical advantage of 4.

2. Exploring Ideas: (Use the space below to illustrate your ideas.)



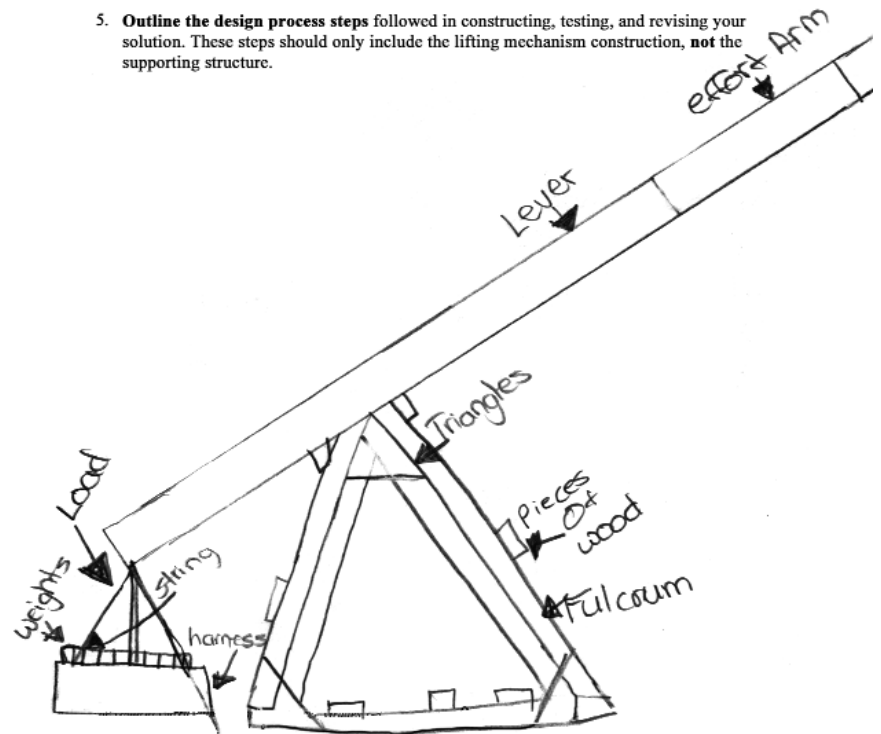
B

3. Select your preferred solution and explain why you've made your choice.

My number 2 design is my preferred because I feel I will have a greater mechanical advantage. I also have triangles supporting everything.

4. Design Sketch (draw a clearly labelled design sketch of your solution on the back of this sheet or on graph paper).

5. Outline the design process steps followed in constructing, testing, and revising your solution. These steps should only include the lifting mechanism construction, not the supporting structure.



C

Steps: First thing I did was draw my plan. Then I started building my fulcrum out of:

- wood
- hot glue
- paper triangles

After this I built my lever (arm) with wood and hot glue. Through this process I stuck the wood together and sawed.

The next thing I did was build my harness. I built it out of wood, glue, tape, string. I had to stick wood together and drill holes for string.

After this procedure I tested it. It worked and it has a mechanical advantage of 5.

D

Appendix 7 Executing / Evaluating the Plan

Observe and record data that show that your mechanism generates a mechanical advantage (MA) of at least 4. Show how you have applied MA calculations with an explanation. Show evidence verifying your results.

My lever is a meter long so that is how I get a mechanical advantage of more than 4 $MA = \frac{LF}{EF} = \frac{10N}{2N} = 5N$. Therefore mechanical advantage is 5N

Appendix 8 Reflection

1. Provide an **evaluation** of the strengths and weaknesses of your mechanism.

a) Strengths:

- It has a long arm to lift 10N.
- Has triangles to hold the fulcrum up and the lever.

b) Weaknesses:

- It is possible the string will break because it is weak.

2. Explain **how** your design could be improved.

- I could use another material instead of string so it could be easier to lift.

Teacher's Notes

Understanding of Basic Concepts

- The student demonstrates some understanding in applying, calculating, and explaining mechanical advantage (e.g., [P] Executing/Evaluating the Plan: cites data from which calculation for mechanical advantage was made – “ $LF = 10N$; $EF = 2N$ ” – and makes correct calculation, but includes other information without explaining its relevance: “My lever is a meter long so that is how I get a mechanical advantage of more than 4”).

Design Skills

- The student rephrases the problem/need with some clarity (e.g., [P] Making the Plan [1]: “To lift a whale 10 cm and then drop it 5 cm” and “Have a mechanical advantage of 4”; leaves out reference to constructing a mechanism to perform the lifting).
- The student explores potential solutions in a somewhat appropriate way (e.g., [P] Making the Plan [2]: provides one moderately clear design sketch and one that is less clear, out of a possible four).
- The student selects a solution and provides some explanation for the choice (e.g., [P] Making the Plan [3]: states reasons but does not explain them clearly: “it will have a greater mechanical advantage. I also have triangles supporting everything.”).
- The student creates a somewhat organized and labelled design sketch (e.g., [P] Making the Plan [4]: provides an enlarged and labelled version of exploratory sketch showing structure and materials, but without measurements).
- The student outlines some steps of the construction plan (e.g., [P] Making the Plan [5]: lists materials and main steps but omits detailed explanations of substeps: “Built my lever [arm] with wood an [and] hot glue. Through this process I stuck the wood together and sawed.”).
- The student constructs a solution that meets the task criteria to some extent (e.g., [V] constructs a lever-based mechanism that lifts the required load; [P] Executing/Evaluating the Plan: correctly calculates MA but explains calculation in relation to the length of the whole lever rather than the ratio between load force and effort force).

Communication of Required Knowledge

- The student presents the solution with some clarity (e.g., [V] presents conclusions but does not support them with specific calculations: “An advantage of this is that because of having a long effort arm my lever has a great mechanical advantage.”).
- The student demonstrates with some supporting evidence how the solution meets the task criteria (e.g., [P] Executing/Evaluating the Plan: states that the mechanism has a mechanical advantage of more than 4 and shows the calculation, but does not explain the process used to determine the elements [load force and effort force] used in the calculation or the construction).

Relating of Science and Technology to Each Other and to the World Outside the School

- The student provides a somewhat reasonable reflection on the strengths and weaknesses of the model (e.g., [P] Reflection [1a]: “... a long arm to lift ...” and “... triangles to hold the fulcrum up ...”; [1b]: “It is possible the string will break because it is weak.”).
- The student suggests somewhat appropriate improvements (e.g., [P] Reflection [2]: suggests an improvement in the materials not the design: “... another material instead of string”).

Comments/Next Steps

- The student needs to review units of measurement and how to use them to calculate mechanical advantage.
- The student should include substeps when describing the construction process and provide a fuller explanation of how this process produced a working lever system.