TECHNOLOGY

Systems and Control
(Mechanisms)

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District D15

2009

Grade 9

Learner _____

Teacher _____

CAPABILITY TASK

In this module you are going to design and make a mechanism to help Thabo solve his problem. You will use the knowledge you will obtain about mechanisms in order to comply with the given specifications.

Given Specifications:
- use pulleys
- use gears
- give a mechanical advantage

To help you with your capability task you will complete various activities.

INVESTIGATE

Most manufactured products can be thought of as ***systems***.

A system is a group of ***components*** *connected so that they work together to perform a task.*

The component parts may be ordered steps in a procedure or organizational structure but we need only concern ourselves with physical components each of which has its own contribution to make to the overall operation of a system.
All systems consist of at least three clearly identifiable sections. The ***input*** stage is where energy or information is fed into the system. The ***process*** stage is where energy or information is processed or converted. The ***output*** stage causes something to happen.

The ***energy source*** of the system will determine which type of component is required at each stage. If the energy source is compressed air the components will need to be pneumatic components and these will combine to produce a pneumatic system. If the energy source is electricity the components will need to be electrical or electronic and these will combine to produce an electronic or electrical system. The energy input into a system can be:

Movement - *(mechanical systems),*

Oil/water under pressure - *(hydraulic systems),*

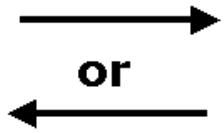
Air under pressure - *(pneumatic systems),*

Electricity - *(electrical or electronic systems).*

MECHANICAL SYSTEMS

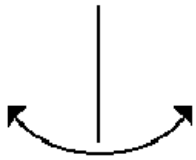
MOVEMENT

There are four basic kinds of motion, or movements:

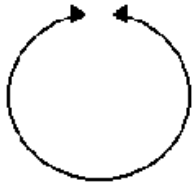


Linear motion
movement in a straight line and in one direction

Reciprocating motion
movement backwards and forwards in a straight line



Oscillating motion
a swinging back and forth



Rotary motion
a circular motion.

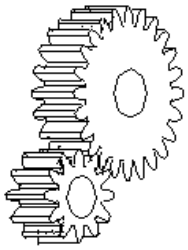
Gears

Gears are wheels with teeth. Gears can be used to slow things down or speed things up, change direction and/or control several things at once. Gears are wheels whose perimeter is made up of evenly sized and spaced teeth. The teeth of one gear mesh with those of an adjoining one and transmit rotary motion between the two gears. The driven gear always rotates in an opposite direction to the driving gear. If both gears have the same number of teeth, they will rotate at the same speed, however if they have different numbers of teeth then the gear with fewer teeth will rotate more quickly. A gear system is a combination of two or more gears working together. Two gears connected together turn in opposite directions; the gear upon which the effort force is being applied is the DRIVER gear and the other gear is the FOLLOWER (driven gear). By placing a gear (IDLER) between the driver and the follower gear, you can make the driver and follower gear turn in the same direction. The smaller driver gear connected to a larger follower gear, results in slower speed, but greater force in the follower gear (gearing down). A larger driver gear, connected to a smaller follower gear results in faster speed, but less force in the follower gear (gearing up).

There are different types of gears: spur gear, bevel gear, worm gear, rack and pinion.

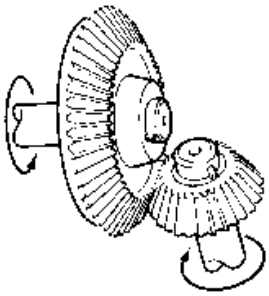
Types of gears

Spur gears

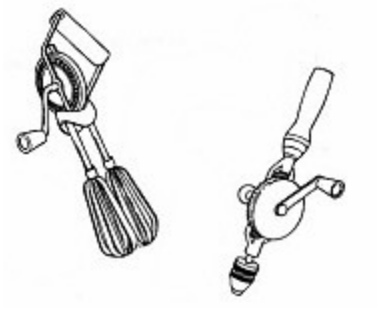


Multiple gears can be connected together to form a gear train. If there are an odd number of gears, the output rotation will be the same direction as the input. If there are an even number, the output will rotate in the opposite direction to the input. Note that for the simple type of gear train shown, the number of teeth on the intermediate gears does not affect the overall velocity ratio which is governed purely by the number of teeth on the first and last cog.

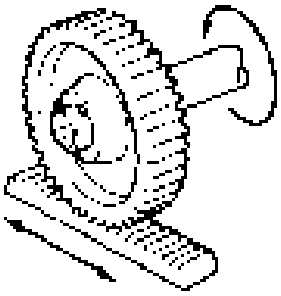
Bevel gears



Bevel gears are used to change rotational movement through an angle of 90°. Bevel gears will provide some mechanical advantage or increase in velocity ratio.



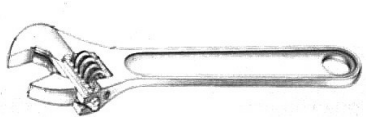
Rack-and-spur gears



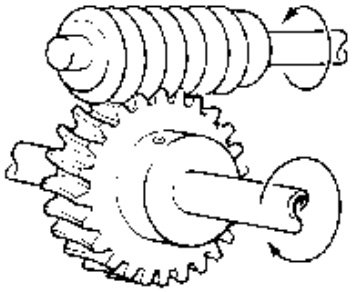
The rack-and-spur gear is used to convert between rotary and linear motion. Often the spur rotates in a fixed position and the rack is free to move - this arrangement is used in the steering mechanism of most cars. Alternatively, the rack may be fixed and the spur rotates moving up and down the rack. This latter arrangement on two-handled cork-pullers.

Rack-and-worm gears

The rack-and-worm gear changes rotational movement into linear movement. In a shifting spanner, the rack-and-worm system is used to adjust the position of the jaw of the spanner —to make the gap wider or narrower. The worm is turned to adjust the position of the spanner. So for each revolution of the worm, the rack advances the distance between two consecutive teeth on the rack.

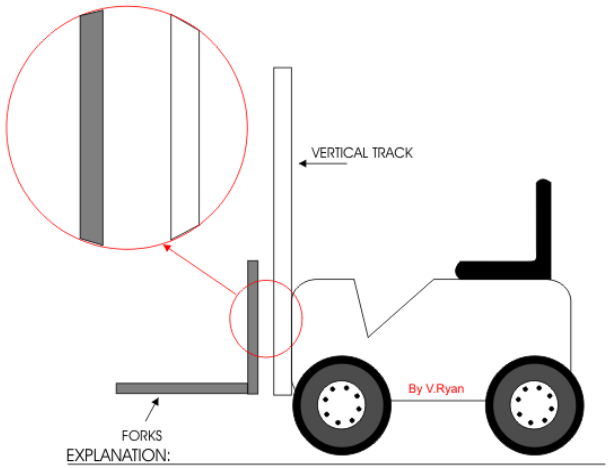


Worm-and-spur gears



A worm-and-spur gear is often used when a large speed reduction is required and not much power is needed. Unlike ordinary gears, the motion is not reversible, a worm can drive a gear to reduce speed but a gear cannot drive a worm to increase it. The velocity ratio of two adjacent cogs can be calculated by dividing the number of teeth on the driven gear by the number of teeth on the driving gear. The velocity ratio of a worm-and-spur gears is easily calculated because the worm has only one tooth. The worm gear is always the drive gear. For example, if the wheel gear has 60 teeth and the worm gear has 1 tooth, then the velocity ratio is 1/60 = 1:60

Activity 1



The diagram below shows a fork lift truck. It is used to lift pallets, complete with their heavy loads. The forks on the front of the truck move up and down the vertical track.

1. In the magnified area, draw the missing mechanism that allows movement of the forks.
2. Explain how the mechanism works

_____

_____

_____

_____

_____

_____

(5)

Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Activity 1	Assignments completed and correct. Obvious effort.	Assignments completed and correct. Some effort.	Assignments completed haphazardly. Hardly any effort.	Assignments incomplete. No effort.	____ 5

Activity 2:

Look at the image on the left of the gears of a wine bottle opener.

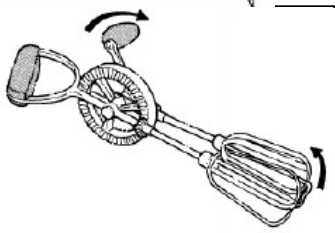
a) What type of gear system is this? _____

b) Is this mechanism a force multiplier or speed multiplier?

_____

c) How does this machine make it easy to uncork the wine bottle?

_____(3)



Look at the eggbeater.

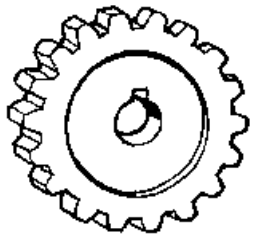
a) Will this type of gearing produce speed or force multiplication. Explain.

_____

_____

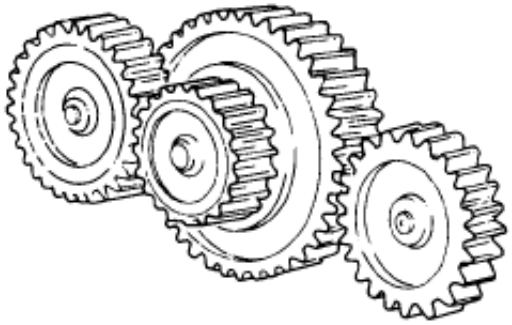
_____(2)

Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Activity 2	Answers were logically planned and well structured and provide in-depth information	Answers planned that provide information to suit the aim of the task	Some answers were given but not all are applicable to the aim of the task	Incomplete or could not answer questions	___ **5**

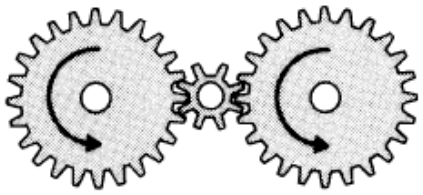


The **spur gear** is the simplest kind of gear. It is a wheel with teeth around its circumference.

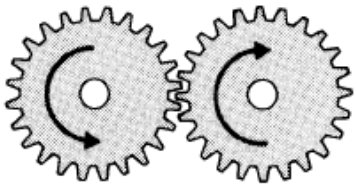
Multiple gears can be connected together to form a gear train.



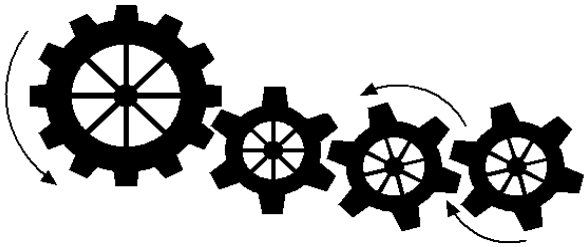
If there are an odd number of gears, the output rotation will be the same direction as the input.



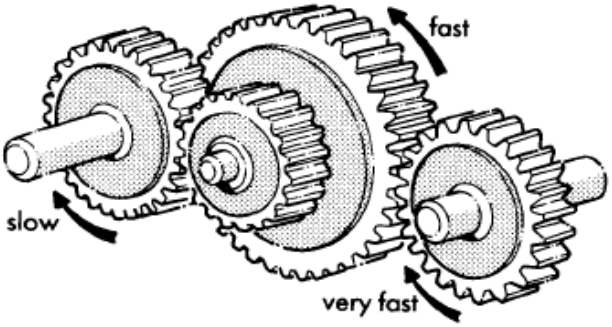
If there is an even number, the output will rotate in the opposite direction to the input.



In a sim**ple gear train the** number of teeth on the idler gears will have no effect on the overall gear ratio or velocity ratio. It is only determined by the teeth on the first and last gear.

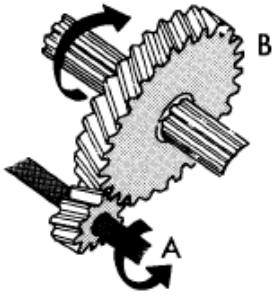


In compound gear trains (when there are more than one gear on an axle) the gear ratio and velocity ratio can be affected by die idler gears.



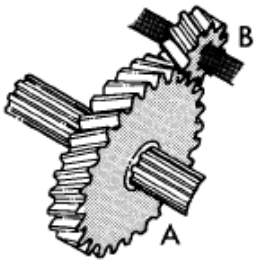
Gearing down

Small driver (A) Large follower (B)
Result: decrease in speed or gearing down.
Gear B turns more slowly than gear A and has greater torque (pulling ability).



Gearing up

Large driver (A) Small follower (B)
Result: increase in speed or gearing up.
Gear B turns much faster than gear A but has less torque (pulling ability).



Calculating mechanical advantage

Gearing up and down

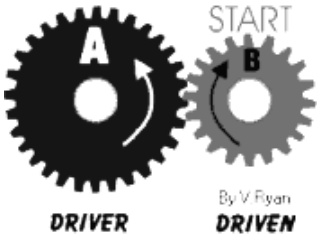
When the driver gear is small and the driven gear is big, the big gear rotates slower—this is called gearing down because the output is slower than the input.
If the driver gear is big and the driven gear is small, the smaller gear rotates faster—this is called gearing up because the output is faster than the input.

Understanding the mechanical advantage in gears

The teeth on any set of gear wheels, that mesh together, are all exactly the same size. If we put these two facts together, we can say that the number of teeth on any individual gear wheel (in a set of meshing gear wheels) is proportional to its diameter.

Formula:

$$\text{Mechanical Advantage} = \frac{\text{number of teeth on driven gear}}{\text{number of teeth on driver gear}} \quad \textbf{OR} \quad \frac{\text{diameter of driven gear}}{\text{diameter of driver gear}}$$



Example:
Gear 'A' has 30 teeth and gear 'B' has 20 teeth. If gear 'A' turns one revolution, how many times will gear 'B' turn ? Which gear revolves the fastest ?

$$\frac{\text{GEAR A} = 30 \text{ TEETH}}{\text{GEAR B} = 20 \text{ TEETH}} = \frac{30}{20} = 1.5 \text{ (GEAR B)}$$

When gear 'A' completes one revolution gear 'B' turns 1.5 revolutions (1½ times)

You should have also found the gear 'B' revolves the fastest. A basic rule of gears is - if a large gear (gear 'A') turns a small gear (gear 'B') the speed increases.
On the other hand, if a small gear turns a large gear the opposite happens and the speed decreases.

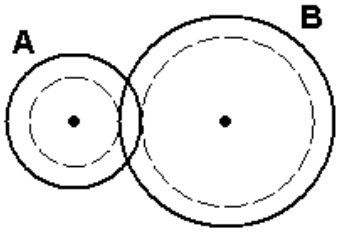
Activity 3:
Look at the image on the left. Gear "B" has 36 teeth and gear "A" has 12.

Calculate the gear ratio of this gear train if "B" is the driver.

_____

_____

_____**(3)**



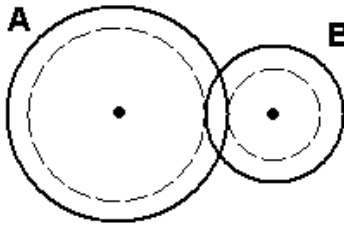
Look at the image on the left. Gear "B" has 12 teeth and gear "A" has 24.

a) Calculate the gear ratio of this gear train if "B" is the driver.

_____

_____

_____**(3)**



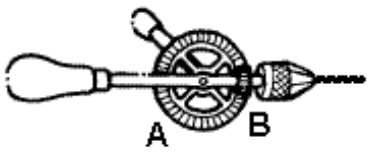
The hand drill on the left uses intermeshing bevel gears. Gear "A" has 80 teeth while gear "B" has 16.

a) Which one is the driver? _____

b) Calculate the gear ratio. _____

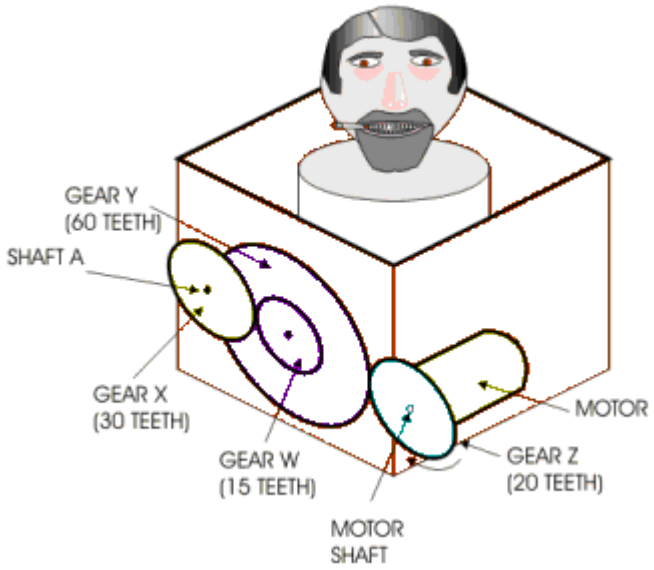
_____

_____**(3)**



Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Activity 3	Answers were logically planned and well structured and provide in-depth information	Answers planned that provide information to suit the aim of the task	Some answers were given but not all are applicable to the aim of the task	Incomplete or could not answer questions	**12**

Activity 4:



a) If the motor turns in a clockwise direction, which direction will gear X turn ?

_____

b) What is the name of the gear arrangement shown in the picture?

_____

c) What is the gear ratio of Gear Y and Gear Z ?

_____

d) Will Gear X spin faster or slower than Gear Z ?

_____

(4)

Assessment					
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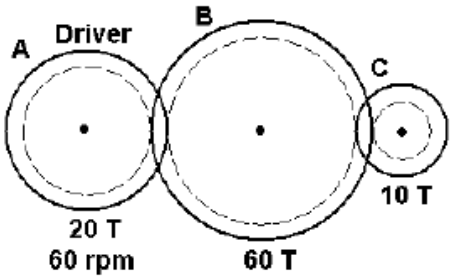
Activity 4	Assignments completed and correct. Obvious effort.	Assignments completed and correct. Some effort.	Assignments completed haphazardly. Hardly any effort.	Assignments incomplete. No effort.	**4**

Gear ratios and simple gear trains

What is the Gear ratio of the Gear Train $_{ABC}$?



$$GR_{ABC} = \frac{\text{Output B}}{\text{Input A}} \times \frac{\text{Output C}}{\text{Input B}}$$

$$= \frac{60\ T}{20\ T} \times \frac{10\ T}{60\ T}$$

$$= \frac{B}{A} \times \frac{C}{B}$$

$$= \frac{60\ T}{20\ T} \times \frac{10\ T}{60\ T}$$

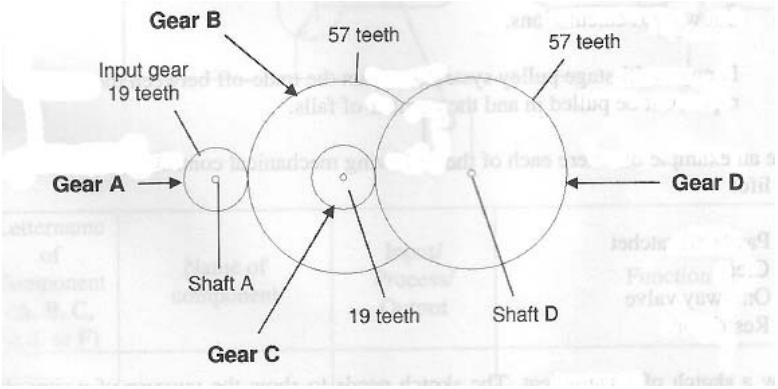
$$GR_{ABC} = \frac{\text{Output C}}{\text{Input A}}$$

$$GR_{ABC} = \frac{10\ T}{20\ T}$$

$$GR_{ABC} = 1 : 2$$

Activity 5:

Study the diagram of a gear system below. Gears A and C each have 19 teeth. Gears B and D each have 57 teeth. Shaft A is the axle through gear A, shaft D is the axle through gear D.



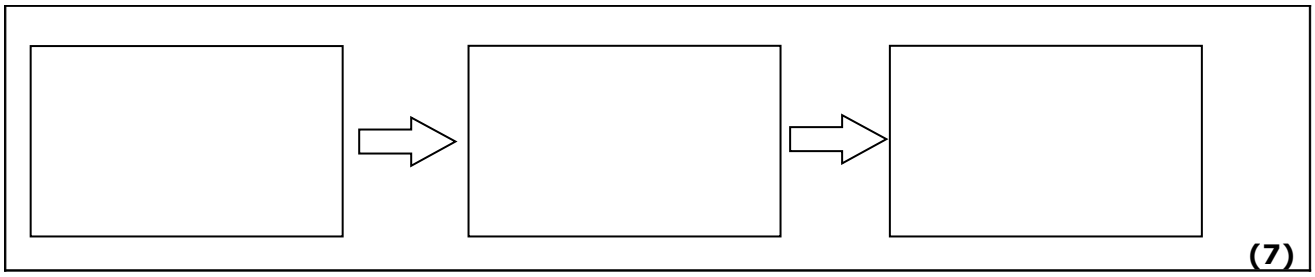
1. Is the gear system simple or compound ? _____
2. What is the gear ratio between the input gear labelled A and the output gear labelled D? Use the following formula: (Show ALL calculations.)

$$\text{Gear ratio} = \frac{\text{Output gear B}}{\text{Input gear A}} \times \frac{\text{Output gear D}}{\text{Input gear C}}$$

_____

_____

3. How much slower will Shaft D turn compared to Shaft A? _____
4. Draw a systems diagram for the simple gear system of Gear A meshing with Gear B.



(7)

Assessment					
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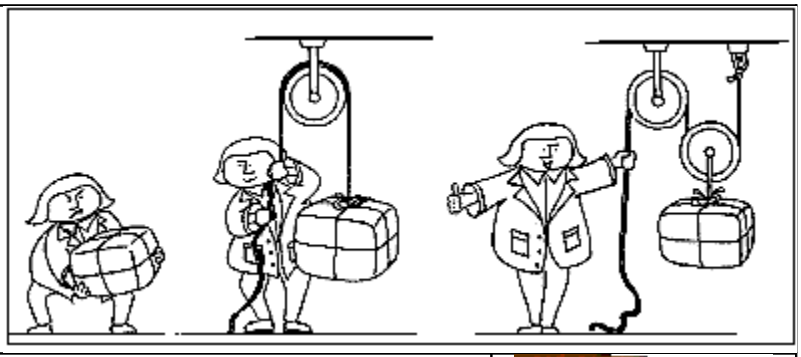
Activity 5	Answers were logically planned and well structured and provide in-depth information	Answers planned that provide information to suit the aim of the task	Some answers were given but not all are applicable to the aim of the task	Incomplete or could not answer questions	**7**

The Pulley

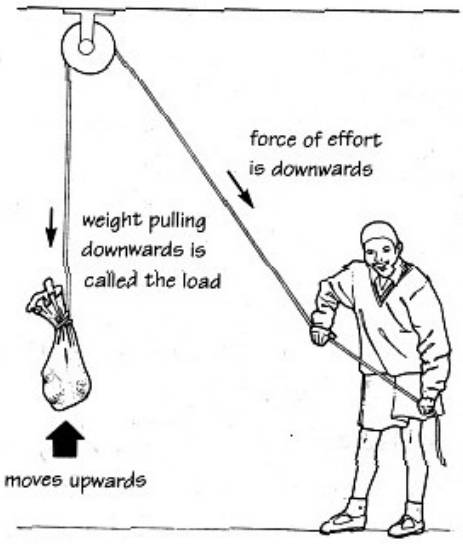
The pulley is a simple machine that consists of a grooved wheel and a rope. Like a lever, it provides a mechanical advantage in lifting a heavy load. There is a direct relationship between the number of ropes that form the pulley and its resulting advantage.

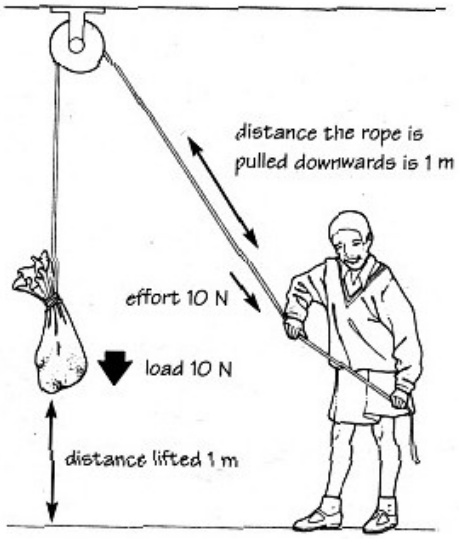


There are two basic types of pulleys. When the grooved wheel is attached to a surface it forms a **fixed pulley**. The main benefit of a fixed pulley is that it changes the direction of the required force. For example, to lift an object from the ground, the effort would be applied downward instead of pulling up on the object. However, a fixed pulley provides no concrete mechanical advantage. The same amount of force is still required, but just may be applied in another direction.

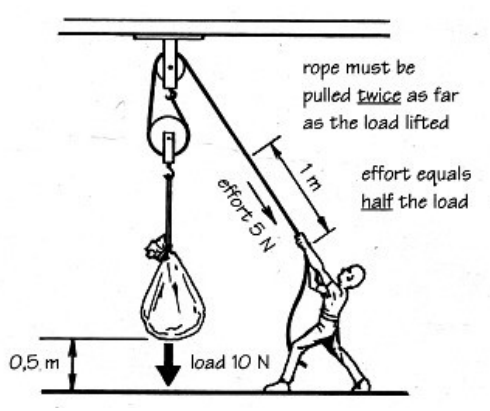
Another type of pulley, called a **movable pulley**, consists of a rope attached to some surface. The wheel directly supports the load, and the effort comes from the same direction as the rope attachment. A movable pulley reduces the effort required to lift a load. Moveable pulleys do provide a mechanical advantage. The effort needed to raise a load is reduced according to the number of ropes supporting the load.

Using a simple pulley, the effort needed to lift an object is about the same as the weight of the object. If the pulley rotated freely with no friction, then the effort would be equal to the load lifted. The object moves the same distance as the rope moves down. A simple pulley changes the direction of a force. The object is lifted up as the girl pulls the rope down.





These two types of pulleys can be combined to form double pulleys, which have at least two wheels. There are various combinations which can result in a double pulley, some of which will be explored in the student experiment. As the pulley becomes more complex, the total lifting effort decreases.
For example, a system consisting of a fixed pulley and a movable pulley would reduce the workload by a factor of two, because the two pulleys combine to lift the load. A **compound pulley** or **block and tackle** is a system of ropes and pulleys used for lifting heavy loads.



When you use a compound pulley, the effort needed to lift the load is the weight of the object divided by the number of falls. The rope has to be pulled the distance which the object is lifted multiplied by the number of falls.

One Newton (N) is the force exerted by gravity on a mass of 0,1 kg

100 g = 1 Newton

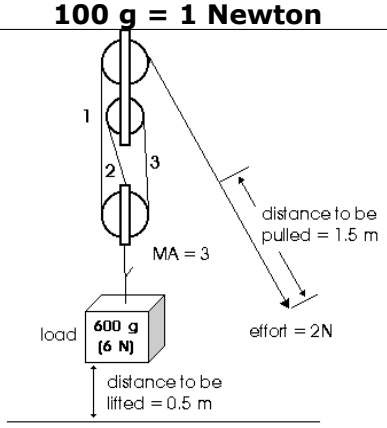
Mechanical advantage

The following are formulas you may need when working with mechanical advantage:

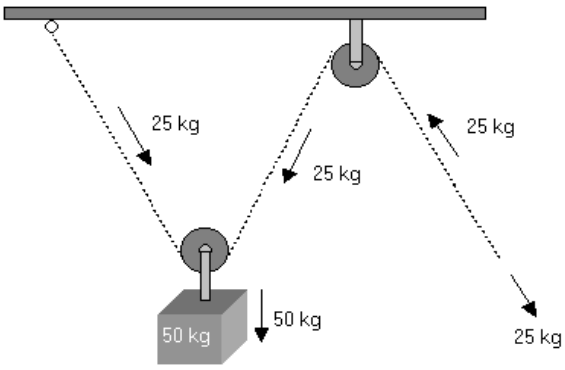
MA = Number of falls supporting the load

$$\textbf{Effort} = \frac{\text{Load}}{\text{Number of falls (MA)}}$$

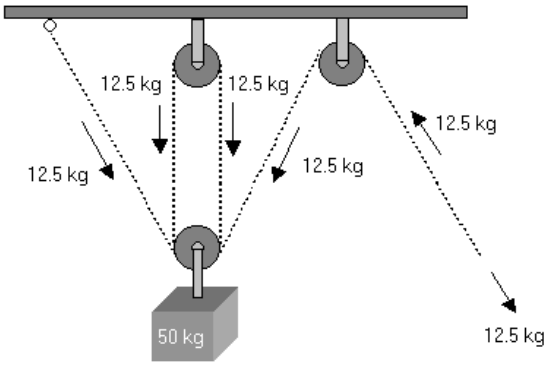
Load = Effort x Number of Falls (MA)



The following figure shows the arrangement after adding a second pulley:



This arrangement actually does change things in an important way. You can see that the weight is now suspended by two ropes rather than one. That means the weight is split equally between the two ropes, so each one holds only half the weight, or 25 kg. That means that if you want to hold the weight suspended in the air, you only have to apply 25 kg of force (the ceiling exerts the other 25 kg of force on the other end of the rope). If you want to lift the weight 40 m higher, then you have to reel in twice as much rope - 80 m of rope must be pulled in. This demonstrates a force-distance tradeoff. The force has been cut in half but the distance the rope must be pulled has doubled.

The following diagram adds a third and fourth pulley to the arrangement:  	In this diagram, the pulley attached to the weight actually consists of two separate pulleys on the same shaft, as shown on the right. This arrangement cuts the force in half and doubles the distance again. To hold the weight in the air you must apply only 12.5 kg of force, but to lift the weight 40 m higher in the air you must now reel in 160 m of rope. A block and tackle can contain as many pulleys as you like, although at some point the amount of friction in the pulley shafts begins to become a significant source of resistance.

Activity 6:

The example on the right shows a pulley system used to lift a 100N load.

Work out the:

1. mechanical advantage _____

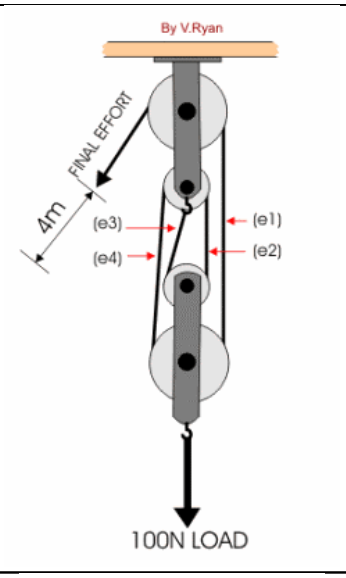
2. What effort is required to lift the 100N load?

_____

3. How far does the load move in compared to the 4m movement of the final effort? _____

_____

(6)



The pulley system on the right is used to lift small loads from aground floor to an upper floor. The load being lifted is 200N.

a. What is the mechanical advantage of this pulley system ?

_____

b. What is the gear ratio of the system ?

_____

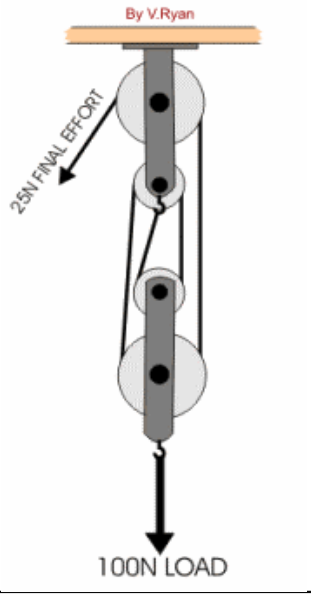
c. What effort is required to lift the load ?

_____

d. If the system moves the load 5 metes upwards, how far must the effort move ? _____

_____

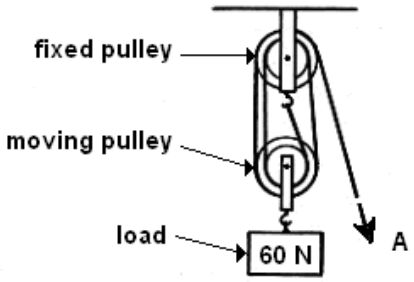
(6)



Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Activity 6	Assignments completed and correct. Obvious effort.	Assignments completed and correct. Some effort.	Assignments completed haphazardly. Hardly any effort.	Assignments incomplete. No effort.	**12**

Activity 7:

In the diagram below, the moving pulley is attached to a load of 60N. The number of times the rope supports the load is called the number of falls.



a) Determine the distance the rope must be pulled in at A to lift the 60N load up by 5m.
Use the following formula: (Show ALL calculations.)

Distance rope must be pulled in = height load is lifted x the number of falls

_____

_____

_____

_____

b) In any multi-stage pulley system, explain the trade-off between the distance the rope must be pulled in and the number of falls.

_____

_____

_____

_____

(8)

Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Activity 7	Answers were logically planned and well structured and provide in-depth information	Answers planned that provide information to suit the aim of the task	Some answers were given but not all are applicable to the aim of the task	Incomplete or could not answer questions	**8**

Activity 8:

Look at the examples in Figure 9. Count the number of falls in each case.
Work out an equation to calculate the **effort** needed to lift a known load, if the number of falls is known.

Figure 9 (A)

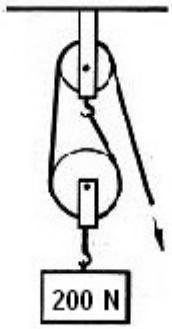


Figure 9 (B)

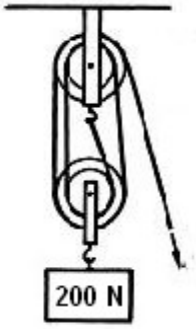


Figure 9 (C)

_____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

(6)

Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Activity 8	Answers were logically planned and well structured and provide in-depth information	Answers planned that provide information to suit the aim of the task	Some answers were given but not all are applicable to the aim of the task	Incomplete or could not answer questions	___ **6**

DESIGN

Design Brief Date:_____

_____

_____

_____

_____

_____

Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Design Brief	Formulation of problem solving is clear and comprehensible.	Formulation of problem solving is reasonably clear	Formulation of problem solving is vague	Formulation of problem solving is incomplete and not relevant	___ **5**

Specifications Date:_____

_____

_____

_____

_____

_____

_____

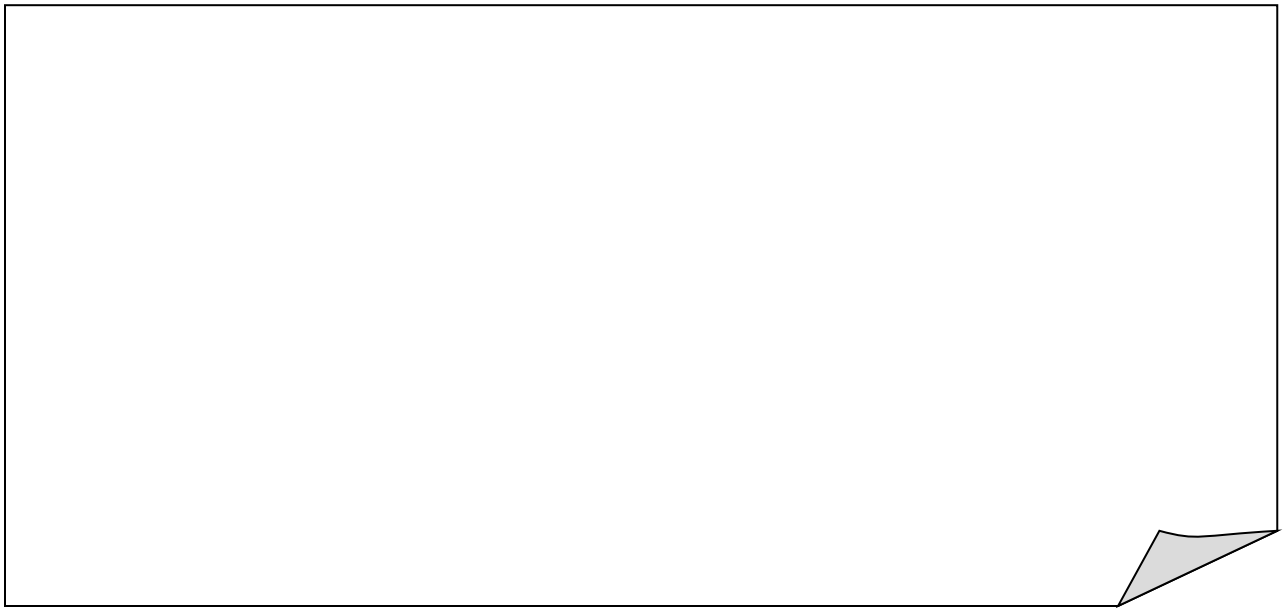
_____

_____

Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Specifications	List of specifications complete and relevant.	Specifications complete	A few specifications were given	Specifications incomplete	___ **5**

Possible ideas **Date:_____**

Draw freehand 3-D representations of 3 possible solutions for the problem and briefly give pros and cons for each idea.

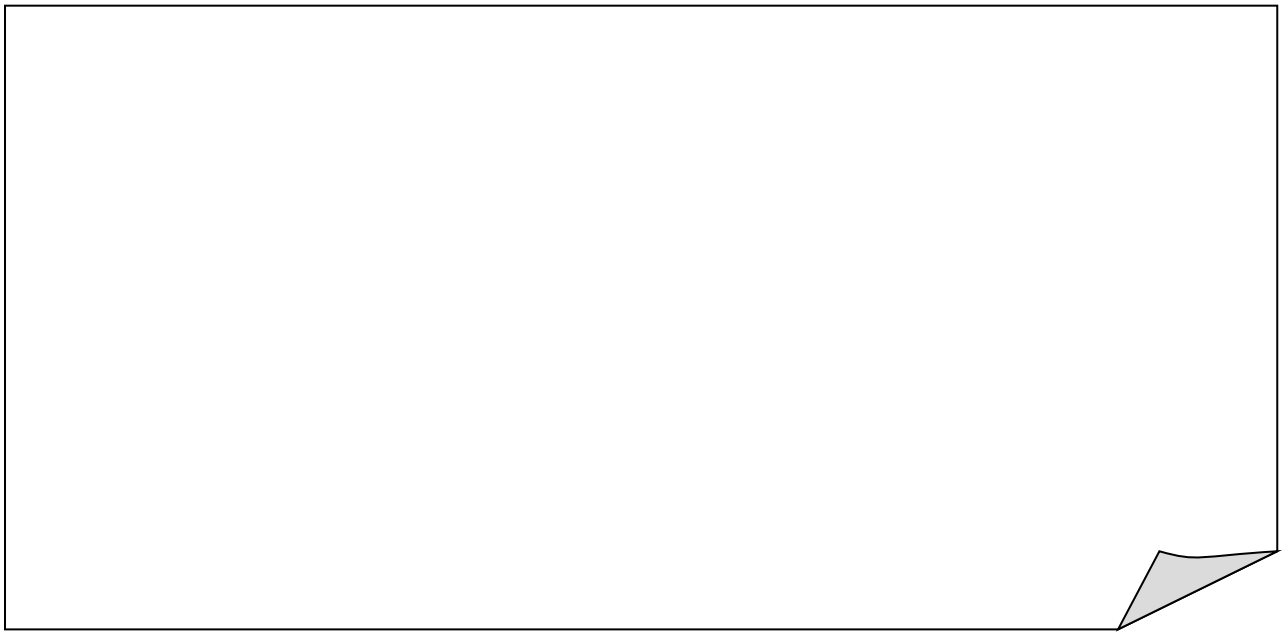


Pros and Cons: _____

_____

_____

_____



Pros and Cons: _____

_____

_____

_____

Pros and Cons: _____

_____

_____

Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Possible ideas	Ideas very neatly drawn, labels added. All pros and cons mentioned. Chosen idea very well motivated.	Ideas reasonably neatly drawn, labels added. Pros and cons mentioned. Chosen idea motivated.	Ideas not neatly drawn labels added. Few pros and cons mentioned. Chosen idea not clearly motivated.	Incomprehensible drawings of ideas. Pros and cons incomplete. Weak motivation of chosen idea.	___ 10

Final Design Date: _____

Give final information regarding your product and make the required drawings.

_____

_____

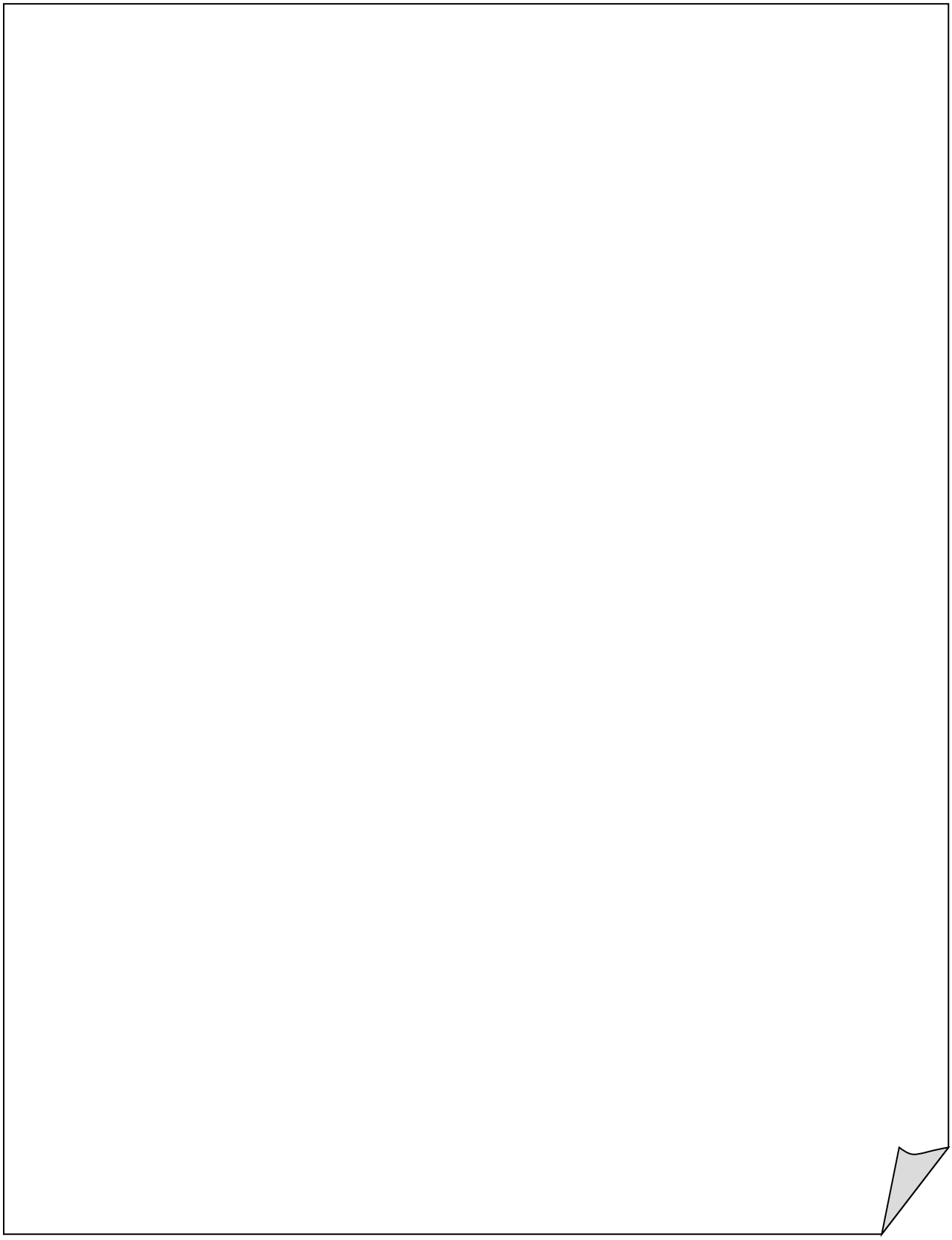
_____

_____

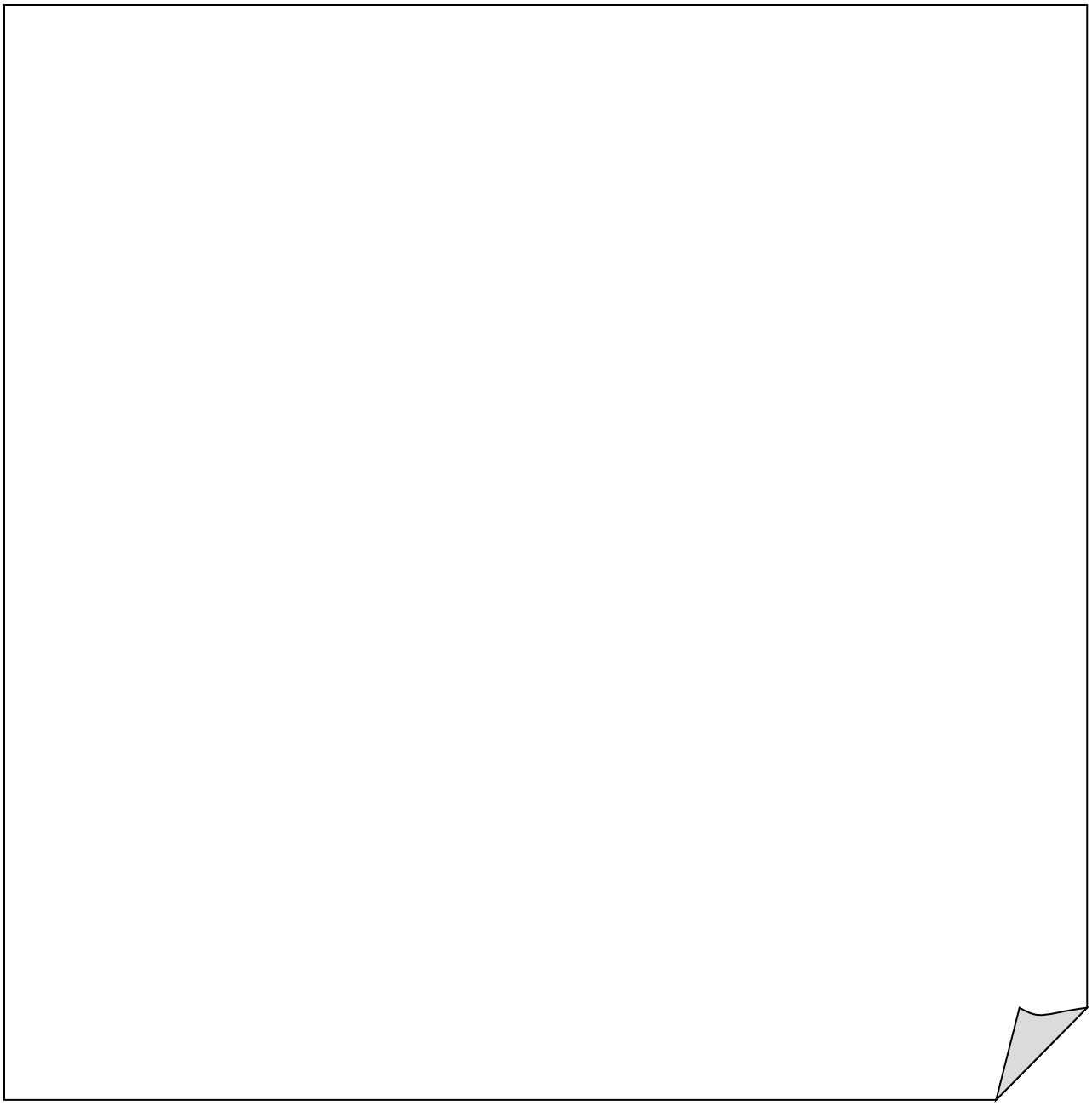
_____

_____

Make a first angle orthographic drawing of your product and indicate dimensions.



Draw 3-D representations of your product. Make use of exploded drawings and labeling to explain your idea in detail.



Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Final design	Working drawing and 3-D drawing is done and labeled.	Parts of the working drawing and 3-D drawing have been omitted.	Working drawing and 3-D drawing are incomplete.	Working drawing and 3-D drawing are neat and is labeled.	___ 10

MAKE

Flow diagram Date:_____

Draw a flow diagram to show your work method, time, tools equipment and materials.

Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)** / **Level 5 (Substantially mastered)**	**Level 4 (Adequately mastered)** / **Level 3 (Moderately mastered)**	**Level 2 (Elementary mastered)** / **Level 1 (Not mastered)**	**Mark**
Flow diagram	List of tools and materials is detailed Flow diagram is logical and comprehensible.	List of tools and materials is complete Flow diagram is logical and but a bit sketchy.	List of tools and materials is not quite complete Flow diagram is not logical or comprehensible.	List of tools and materials is incomplete Flow diagram is incomprehensible.	$\frac{\quad}{10}$

Project **Date:_____**

Paste a picture of your project here:

Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)**	**Level 4 (Adequately mastered)**	**Level 2 (Elementary mastered)**	**Mark**
		Level 5 (Substantially mastered)	**Level 3 (Moderately mastered)**	**Level 1 (Not mastered)**	
Project	The project is strong, can withstand forces, will have an increased lifespan. Documents will be kept neat and dry. The size is at least 350 x 250 x 60 mm. Was made of recycled paper/cardboard.	The project is reasonably strong, can withstand forces, will have an increased lifespan. Documents will be kept neat. The size is at least 350 x 250 x 60 mm. Was made of recycled paper/cardboard.	The project is not very strong, can withstand forces to a certain extent, will not have an increased lifespan. Documents will be kept neat. The size is not at least 350 x 250 x 60 mm. Was not made of recycled paper/cardboard.	The project was not done or is incomplete. The measurements does not comply to the specifications. Documents can not be kept neatly in the folder.	**____ 35**

EVALUATION

Evaluation **Date**_____

Weak vs Strong points

_____

_____

_____

_____

_____

_____

_____

Possible changes and modifications

_____

_____

_____

_____

_____

_____

_____

Assessment					
Aspect	**Level 7 (Mastered excellently)**	**Level 6 (Meritoriously mastered)**	**Level 4 (Adequately mastered)**	**Level 2 (Elementary mastered)**	**Mark**
		Level 5 (Substantially mastered)	**Level 3 (Moderately mastered)**	**Level 1 (Not mastered)**	
Evaluation	Relevant evaluation criteria. Useful ideas to improve product.	Reasonable evaluation criteria and ideas to improve product.	Evaluation criteria unclear. Ideas to improve product irrelevant.	No evaluation criteria. Ideas to improve product incomplete.	___ **10**