Year 6 Design and Technology: Mechanisms – Block B
How do pulleys and gears let you see the world?

- The outline and structure of the block is as follows:

Lesson 1	Lesson 2	Lesson 3
Exploring pulleys and their applications Experimenting with different pulley systems	Developing design and problem-solving skills Developing practical skills	Developing design and problem-solving skills Developing practical skills Evaluating outcomes

The London Eye
(completed 2000)

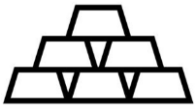
At the end of this block, pupils will …	
Know:	**Be able to:**
Types of pulley systems and gears Common uses of pulleys and gears How pulleys and gears can create simple mechanisms and change direction of movement	Design and make a model Ferris wheel powered by gears Evaluate the success of their outcomes and recommend improvements

In this block, pupils will investigate how pulleys and gears work and design and make their own gears product. Pupils will select and use a variety of modelling materials to create final outcomes.

CUSP Design & Technology Long term sequence	Block A	Block B	Block C	Block D	Block E	Block F
Year 1	Mechanisms	Structures	Food and Nutrition	Understanding Materials	Textiles	Food and Nutrition
Year 2	Textiles	Food and Nutrition	Mechanisms	Understanding Materials	Food and Nutrition	Structures
Year 3	Textiles	Food and Nutrition	Mechanisms	Food and Nutrition	Systems	Structures
Year 4	Food and Nutrition	Mechanisms	Textiles	Structures	Electrical Systems	Food and Nutrition
Year 5	Food and Nutrition	Systems	Textiles	Mechanisms	Structures	Food and Nutrition
Year 6	Food and Nutrition	Mechanisms	Food and Nutrition	Structures	Electrical Systems	Textiles

Point of reference:
Y6 Mechanisms – Block B

Pupils will be able to:
- explain what a gear is and how it works
- identify different types of gears and their applications



Prior Learning

- explore how direction and speed of movement is changed by using a system of gears and / or pulleys
- construct a simple pulley system to lift a load

Design or Technology History:

An elevator or lift is a type of cable-assisted, hydraulic cylinder-assisted, or roller track-assisted machine that vertically transports people or freight between floors, levels or decks of a building, vessel or other structure. The Roman Colosseum, completed in AD 80, had roughly 25 elevators that were used for raising animals up to the floor. In the 17th century, prototypes of elevators were installed in the palace buildings of England and France. Louis XV of France had a so-called 'flying chair' built at the Chateau de Versailles in 1743. In 1823, 'The Ascending Room' was used by tourists to view the London skyline and in 1857 the first ever passenger lift was installed in New York.

Links to Literature:

What Do Pulleys and Gears Do? by David Glover (teacher resource)
Using Pulleys and Gears by Greg Pyers (teacher resource)
Elevators (Engineering Wonders) by Tracy Maurer (teacher resource)
Let's Find Pulleys (Let's Find Simple Machines) by Wiley Blevins

Materials:

Lesson 1: 1m x 1m frames or 1m strips of rigid wood, screw-on hooks, various pulleys (to work with string), string, weights (or bottles of water), Newton meter
Lessons 2 and 3: gears (teaching examples), wooden or plastic gears (range 4cm – 10cm), card (ideally 3 –5mm thick), craft knives, strips of wood or man made board, nuts and bolts, glue guns, scissors, paper, felt tip pens, double-sided tape, masking tape, Blu-Tack®, split pins, scissors, transparent plastic (acetate), lollipop sticks, dowel (4 – 10mm), metal rod, paperclips, wire

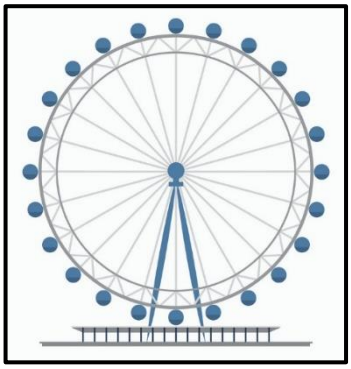
Health and Safety:

This block requires pupils to use glue guns, hand saws and bench hooks, scissors, craft knives and cutting mats to make functioning models that could pose injury. Teachers should ensure that they follow their own school's risk assessments and policies for using the necessary materials and equipment. Pupils should be taught about how to use equipment and materials safely and responsibly as part of these lessons.

Working as a Designer

Design	Make	Evaluate	Apply
The art or process of deciding how something will look or work.	Create something by combining materials or putting parts together.	Form an opinion of the value or quality of something after careful thought.	Use something or make something work in a particular situation.

How can pulleys and gears let you see the world?
Ferris wheel project



Design Brief

Your local town council has decided they want a Ferris wheel that allows people to view the town from a great height in the hope of encouraging more people to visit and appreciate the town. As an aspiring engineer, they have asked you to design this Ferris wheel and you must present a model of your solution at the next town meeting.

Specification

Function:
The design should allow passengers to experience brilliant views of the town. There must be minimal visual obstructions once they reach the top so a 360° view of the town can be fully appreciated. There must be at least four passenger pods / carriages. The model should be driven by gears and powered by hand. There must be a safe way for passengers to get onto the pods.

Size:
The Ferris wheel needs to be at least 500mm tall (50m in real life). The footprint cannot be more than 200mm².

Materials:
Materials will need to be strong and lightweight. You will use modelling materials but think about what materials would be used in real life and include these in your presentation.

Aesthetics:
The design of the wheel and the pods must be attractive and interesting so that people will marvel at its beauty.

Supporting images 1: Y6 Mechanisms – Block B

The ***Bailong Elevator*** is the world's tallest outdoor elevator. Located in Hunan province in China, it takes tourists to the peak of a cliff in the Zhangjiajie National Forest Park, at 326m.	
Salesforce Tower (formerly *Heron Tower*) is a commercial skyscraper in London. It stands at 230m tall, including its 28m mast, making it the second tallest building in the City of London financial district.	
The ***Burj Al Arab*** is a luxury hotel located in the city of Dubai. It is one of the tallest hotels in the world. The shape of the structure is designed to resemble the sail of a ship. It has a helipad near the roof, at a height of 210m above ground.	
The ***Hammetschwand Lift*** in Bürgenstock, Switzerland, is the highest exterior elevator in Europe, standing at 152.8m. It is connected to a rock path that offers a spectacular view of the Bürgenstock plateau and the Swiss Alps, overlooking Lake Lucerne. The elevator can take passengers up the vertical rock face right to the summit within less than a minute.	

Supporting images 2: Y6 Mechanisms – Block B

The ***Sky Tower*** in Auckland, New Zealand, is an observation tower known all over the world, standing at 328m.	
The ***Eiffel Tower*** is the visual icon of Paris, France and stands at 324m tall. At the top of the tower, visitors can get a panoramic view of Paris. To get there, they need to first take a lift from the ground, which runs up the tower legs diagonally to the first floor. From there, another regular elevator runs to the top of the tower.	
The ***Taipei 101*** is one of the most well-known buildings in the world. It is located in Taiwan and has a height of 508m. Two of its elevators lead to the observatory on the 89th floor. The remarkable elevators have an incredible speed of over 1000m per second, almost giving visitors the sensation of travelling in a rocket.	

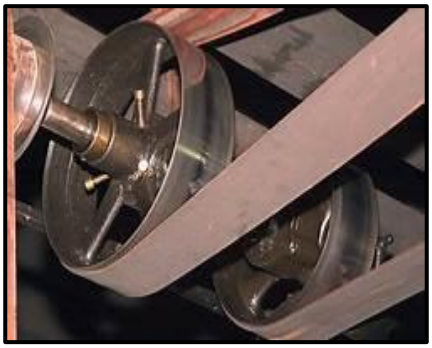
Supporting images 3: Y6 Mechanisms – Block B










Supporting images 4: Y6 Mechanisms – Block B



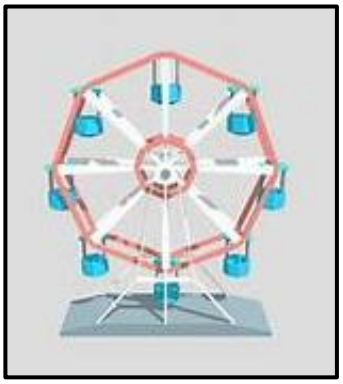


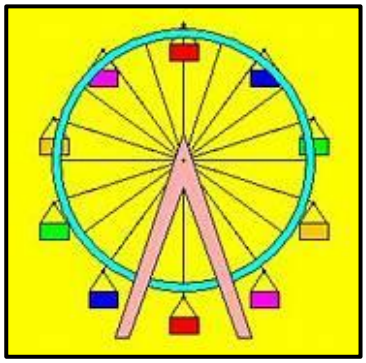







Supporting images 5: Y6 Mechanisms – Block B





Point of explanation:
Y6 Mechanisms – Block B

Core Knowledge	Explanation
pulley	A pulley is a wheel with a grooved rim around it which holds a cord, belt or rope. Pulleys are used to change the speed, direction or magnitude of a force and can be used to raise heavy loads.
movable pulley	This is a simple pulley where the wheel can both move and rotate. In this pulley system, less force is required to lift a load.
fixed pulley	A fixed pulley is one which has a rotating wheel that is attached to a stationary object such as a beam.

Technical Vocabulary	Definition
block and tackle	a lifting mechanism consisting of ropes, a pulley block and a hook
rack and pinion	a device for converting rotary into linear motion and vice versa, in which a gear wheel (the pinion) engages with a flat-toothed bar (the rack)
driver gear	a gear wheel that causes other wheels in a gear train to rotate
driven gear	a gear wheel that moves in the opposite direction to the gear that is driving it

Link to Video: https://vimeo.com/672287832/7607ad0de6

- Explanation and demonstration of taught content
- Lesson by lesson guidance
- Exemplification of techniques and outcomes

Point of delivery:
Y6 Mechanisms – Block B

Revisiting prior learning	Taught content	Point of practice	Point of reflection
1. A pulley is a grooved wheel around which a cord or belt is passed which can be used to lift heavy loads Two connected pulleys will rotate in the same direction, forming a figure of eight - the band attaching them makes them rotate in opposite directions Pulley systems are used to lift heavy loads with little effort Pulleys are used to transfer rotational movement Speed of movement can be changed by altering the size of pulley wheels	Identify different pulley systems such as fixed, movable and compound and explain how they work and their applications Explore and compare the mechanical advantage provided by different pulley systems Explain what a block and tackle is and identify its common uses Make accurate measurements of force using a Newton meter Draw conclusions from results of experimentation	Prepare a 1m x 1m wooden frame for pupils to insert hooks from which they can attach and experiment with pulleys. Alternatively, wooden beams could be used to bridge a gap between tables at least 1m high. Challenge pupils to recall what they learnt about pulleys in Year 5 and use images of pulleys to prompt this discussion. Introduce the Knowledge Note and key vocabulary for this unit. Through discussion, establish that some pulleys are used in belt systems to alter the speed of rotational movement but that the focus of this lesson will be to explore the use of pulley systems for lifting heavy loads. Demonstrate and allow pupils to experiment with fixed, movable and compound pulley systems and in each case, challenge pupils to compare the amount of effort (force) needed to lift a weight such as a bottle filled with water. Pupils could use Newton meters to measure the forces and make a record of their results in their portfolios. Through questioning and discussion, establish that the force required to lift the load with a fixed pulley system is the same as it would be to simply lift the weight without the pulley. Challenge pupils to identify the advantage of using a fixed pulley and explain how this compares with the mechanical advantage provided by the movable and compound systems. Pose the question: which system requires the least amount of effort to lift a load? Pose further questions such as: how does the amount of string that needs to be pulled compare with the height the bottle is lifted? Challenge pupils to explore this question for each of the pulley systems and record their findings. Refer pupils to the key question for this unit: **How do pulleys and gears let you see the world?** Demonstrate a block and tackle and explain that this type of pulley system is commonly used in lifts. Show images of tall buildings and discuss how pulleys have been used to allow people to be transported to great heights. Prompt pupils to make annotated drawings of the different pulley systems they have explored, explaining how they work and the mechanical advantages they provide.	Can name types of pulleys and describe the difference between fixed, movable and compound pulleys Can identify everyday uses of pulleys, such as lifting heavy loads Can make accurate measurements of force and use these results to conclude that compound pulleys require the least amount of effort to lift a load Can make links between the amount of string that needs to be pulled with the height that a weight is lifted Can draw conclusions from experimentation and explain results

Questions for assessment

How do pulleys create mechanical advantage?

What directions do the different pulleys rotate?

How much string is pulled in comparison to the amount the load is lifted?

What products use pulleys to lift a load vertically?

What products use a pulley belt system to work?

What are skyscrapers? **How** do people get to the top of these tall buildings?

What pulley systems are used in lifts?

Point of delivery:
Y6 Mechanisms – Block B

Revisiting prior learning	Taught content	Point of practice	Point of reflection
2. Gears are toothed wheels on a shaft that when placed together are used to transfer rotational movement A small gear wheel will rotate faster but with less force than a larger gear wheel Two connected gear wheels will rotate in opposite directions A driver wheel causes other wheels to rotate An idler gear is used for support or guidance instead of power transmission A gear train is a system of gears which transmits motion from one shaft to another	Name and identify the difference between different types of gears such as spur, worm and bevel Identify the movement involved in a rack and pinion system Apply knowledge of gear trains to design and construct a model Ferris wheel Make decisions about aesthetics, materials to be used and the method of construction Evaluate outcomes and make reasoned suggestions for modifications and improvements	**Ferris Wheel Design and Make Project** This project is designed to run across Lessons 2 and 3. Teachers will need some simple models of gear trains and a rack and pinion for demonstration and explanation purposes. Challenge pupils to explain what they can remember about gears. Through questioning and discussion, revisit and explain some key concepts and technical vocabulary such as: • gear train • idler gears • driver and driven gears • gear ratio. Using a simple gear train, remind pupils that a driver gear causes other gears to rotate and that adjacent gears will rotate in opposite directions. Remind them also that a smaller gear wheel will take less time than a larger gear wheel to make one complete rotation. Show examples of and explain spur, worm and bevel gears. Demonstrate and explain how a rack and pinion system works and prompt pupils to identify the movements involved (rotary and linear). At this point, pupils could complete Vocabulary Task 1. Share and discuss the design brief and revisit the key question for this unit: **How do pulleys and gears let you see the world?** Show and discuss images of Ferris wheels and provide pupils with some contextual information about these mechanisms. Referring closely to the specifications and constraints laid out in the design brief, pupils work in pairs or groups to design their own Ferris wheel, paying close attention to the aesthetics, the shape and design of the wheel, the appearance and stability of the uprights, and how the passenger pods will be attached so that they remain horizontal as the wheel rotates. Pupils will need to make decisions about the materials they plan to use and how the model will be constructed to ensure rigidity and stability. Ensure pupils make detailed, annotated drawings of their designs and encourage them to evaluate and re-think their intentions as they begin to construct the model. Remind pupils that they may need to adjust their original design to overcome building challenges. Take photographs throughout the design and construction process so that pupils have a record of the processes they have completed and changes they have made. Once construction is complete, prompt pupils to evaluate their models. Use questioning and Vocabulary Task 2 to guide pupils in their evaluations.	Can use the correct technical vocabulary to identify types of gears: spur, worm, driver, driven and idler Can recall, from prior learning, how a simple gear train works Can explain how the size of gear wheel used affects the speed in which it makes one complete rotation Can explain how speed of rotation can be stepped up or stepped down Can identify that adjacent gears rotate in opposite directions Can identify the movements involved in a rack and pinion system Can apply knowledge of gears to design and construct a Ferris wheel model Can use simple tools and modelling materials safely and with accuracy Can identify ways in which the aesthetics, stability or functionality of a structure can be improved

Point of delivery:
Y6 Mechanisms – Block B

Questions for assessment

What is a rack and pinion?

What is a gear train?

What direction do adjacent gears rotate?

Does the size of a gear affect how long it takes to make one revolution?

How many gears will your model need? **What** sizes will you select and why?

How will you ensure your model Ferris wheel will be strong enough?

How could you ensure the model is well balanced and stable? Would your Ferris wheel be able to withstand high winds?

How could the aesthetics of the design be improved?

Does the wheel spin smoothly? **How** could this motion be improved?

Which is the driver gear? **Which** is the driven? **What** direction does each gear revolve?

How could the design be adapted to accommodate more passengers?

How could the rotational speed be stepped up or stepped down?

Oracy and Vocabulary:
Y6 Mechanisms – Block B

Task 1: You have been learning about gears and how different sizes of gears will rotate at different speeds. Order these adjectives according to their speed.

brisk	fleeting	rapid	leisurely	measured	sluggish	stagnant

Exploration: say say

When I am riding my bike uphill, I change to a low gear.
Can you explain why I do this?

Task 2:
Use these questions and sentence starters to evaluate your Ferris wheel model.

What difficulties did you face during construction and how did you solve these problems? Did you have to modify your design?	• We had difficulties with … • These problems were caused by … • We had to make some changes to the design by … • We solved the problem by …
Which part of your structure is most successful and why?	• The most successful part of our structure is … • What makes this so successful is …
Which aspect of your model is most in need of improvements? How would you make those improvements?	• The part that is the least successful is … • This needs improving because … • One way of improving this would be to …
Has your design fulfilled the brief? What would you do differently next time?	• Our design has / has not fulfilled the brief because … • Next time we could / should / would …

Vocabulary: Y6 Mechanisms – Block B

OWN-it — Analyse

Change the noun *revolution* to a verb.

Write the root of the word *motionless*.

Change the adjective *linear* to a noun.

KNOW-it — Define

Write a definition of a *pinion*.

Tick true or false for this statement.

A *movable pulley* is more effective than a *fixed pulley* for lifting loads with less effort.

true | false

Explain the term *linear motion*.

LINK-it — Connect

The root of the word *rotation* is *rota*, which comes from the Latin for wheel.
Write three more words that contain the root *rota*.

Write three synonyms of the word *fixed*.

Write three words associated with the word *movable*.

USE-it — Use in context

Use the following words correctly in a sentence.

gear opposite driver

Write a brief description of a *block and tackle*.

Tick the box if the word *rotation* has been used correctly.

He discovered the *rotation* of the Earth on its axis and found this causes day and night.

Knowledge Note:
Y6 Mechanisms – Block B

Year 6: Mechanisms
How do pulleys and gears let you see the world?

Core content:

Investigate how pulleys and gears work.
Design and make a gears product.
Select and use a variety of modelling materials.

Technical vocabulary:

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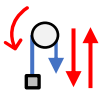
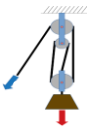
Movable pulley – a simple pulley where the wheel can both move and rotate.



Fixed pulley – a fixed pulley is one which has a rotating wheel that is attached to a stationery object such as a beam.

Block and tackle – a lifting mechanism consisting of ropes, a pulley block and a hook.



Rack and pinion – a device for converting rotary into linear motion and vice versa.

Driver gear – a gear wheel that causes other wheels in a gear train to rotate.

Driven gear – a gear wheel that moves in the opposite direction to the gear that is driving it.

Connections:

The London Eye
(completed 2000)

Year 6: Mechanisms
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Connections:

The London Eye
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Exemplification: Y6 Mechanisms – Block B
How do pulleys and gears let you see the world?

Challenge pupils to identify different products that use pulleys that they may have come across in real life

Which products use pulleys to lift a load vertically?

Which products use a pulley-belt system to work?

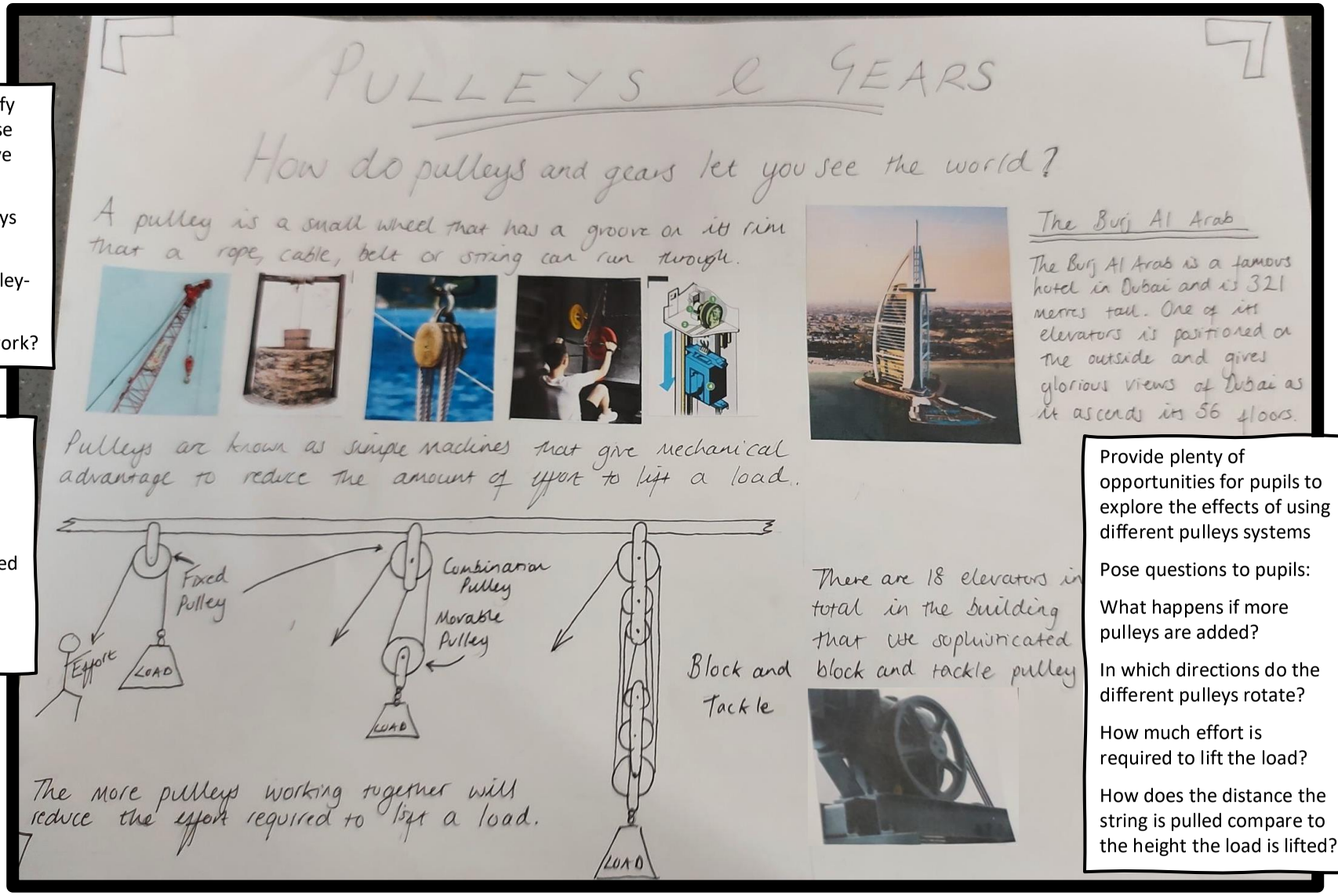
How do these products work?

Pose questions to aid discussion on pulleys:

How do pulleys convert rotary movement?

Why are pulleys considered to be simple machines?

How do pulleys create mechanical advantage?



Provide plenty of opportunities for pupils to explore the effects of using different pulleys systems

Pose questions to pupils:

What happens if more pulleys are added?

In which directions do the different pulleys rotate?

How much effort is required to lift the load?

How does the distance the string is pulled compare to the height the load is lifted?

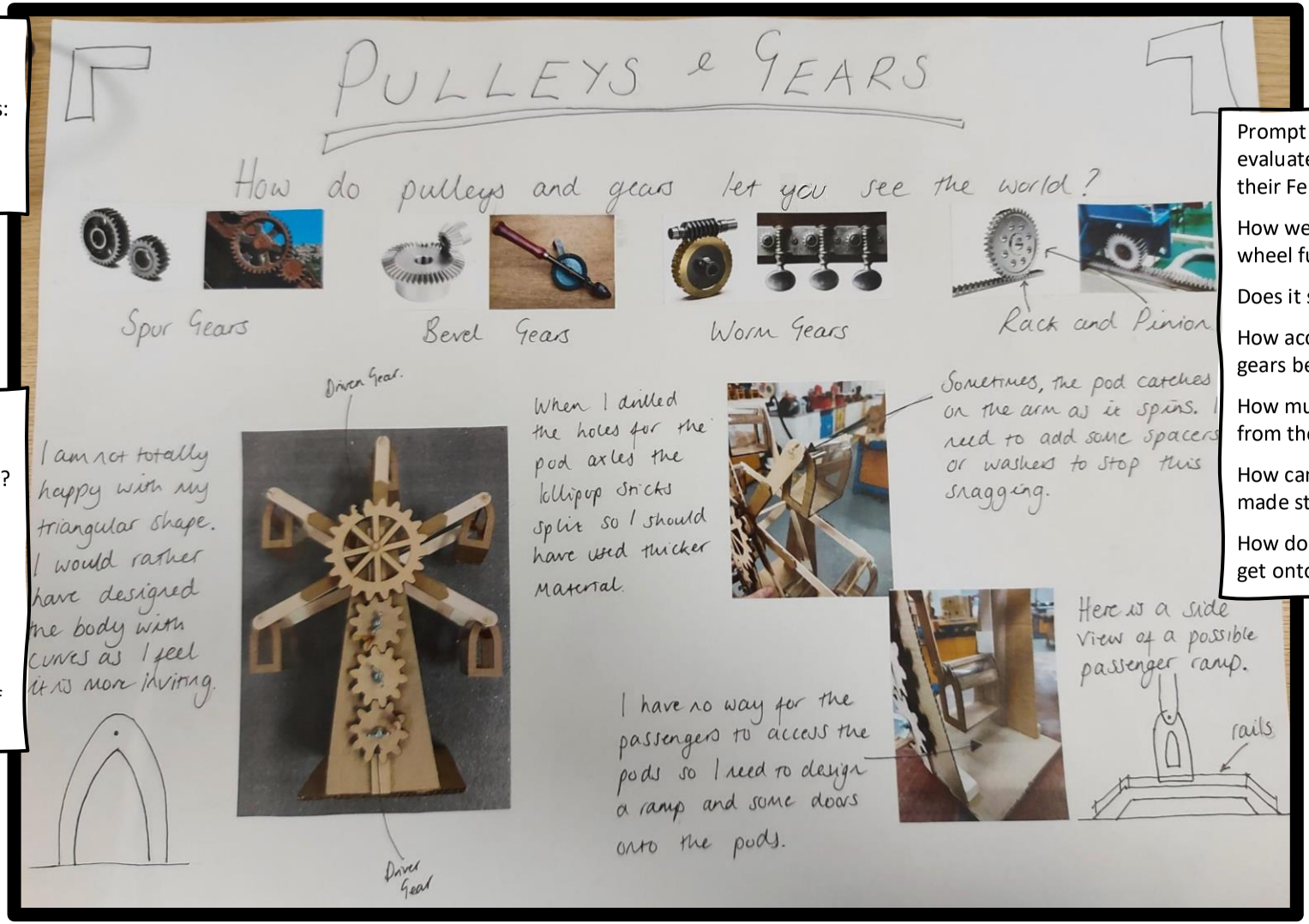
Exemplification: Y6 Mechanisms – Block B
How do pulleys and gears let you see the world?

Examine some real-life products that use gears

Pose questions to pupils:

How do they work?

Where are they used?



At the design stage pose questions such as:

What materials will you use?

How will the pods attach?

Will the model be well balanced?

Could it withstand high winds?

How could the aesthetics of the design be improved?

Prompt pupils to evaluate the success of their Ferris wheel

How well does the Ferris wheel function?

Does it spin smoothly?

How accurately have the gears been attached?

How much is the view from the top obscured?

How can the model be made stronger?

How do the passengers get onto the pods?