Year 5 Design and Technology: Mechanisms – Block D
How can you lift a car onto a roof?

- This block is set in the context of the CUSP Science unit 'Forces'.
- The outline and structure of the block is as follows:

Lesson 1	Lesson 2	Lesson 3
Exploring pulleys and gears and their applications Developing practical skills	Developing designing and problem-solving skills Developing practical skills Evaluating outcomes	Developing designing and problem-solving skills Developing and applying practical skills Evaluating outcomes

At the end of this block, pupils will …	
Know:	**Be able to:**
Types of gears and terminology relating to gears Common uses of pulleys and gears How pulleys and gears can change the direction of movement	Design and make products that use pulleys and gears to lift loads Evaluate the success of their outcomes and recommend improvements

The London Eye (2000)

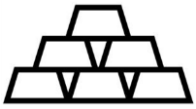
George Washington Gale Ferris Jnr. (1859 – 1896)

In this block, pupils will investigate how pulleys and gears work. They will design and make their own pulleys and gears products, selecting and using 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:
Y5 Mechanisms – Block D

Pupils will be able to:
- give examples of simple mechanisms such as levers and linkages



Prior Learning

- cut and join a range of materials
- identify ways in which to make a structure more stable and rigid

Design or Technology History:

Cranes can lift exceptional loads with little effort using pulleys. It was during the industrial revolution of the eighteenth century that the use of cranes became widespread: this period of history saw significant developments in the use of large-scale industrial machinery to carry out tasks that had previously been done manually.
The Ferris wheel is an example of a machine that uses gear systems. The original Ferris wheel, sometimes referred to as the Chicago Wheel, opened in 1893 and was designed and constructed by an American civil engineer, George Washington Gale Ferris Jnr. The London Eye is an example of a Ferris wheel and is the largest of its kind in Europe.

Links to Literature:

What do pulleys and gears do? by David Glover (teacher resource)
Using pulleys and gears by Greg Pyers (teacher resource)

Materials:

Lesson 1: gears, pulleys, elastic bands, strips of wood / man-made board, nuts and bolts, screws, cardboard, string
Lessons 2 and 3: split pins, scissors, card (cereal boxes), paper, felt tip pens, cardboard (no more than 100cm^2), dowel rods, strips of wood, wire, masking tape and double-sided tape.

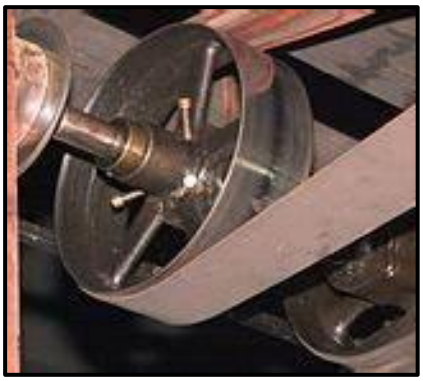
Health and Safety:

This block requires pupils to use glue guns, hand saws and bench hooks, scissors, elastic bands and craft knives which 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.

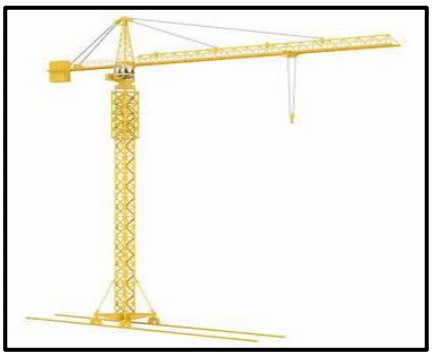
Supporting Information: Y5 Mechanisms – Block D



Supporting Information: Y5 Mechanisms – Block D



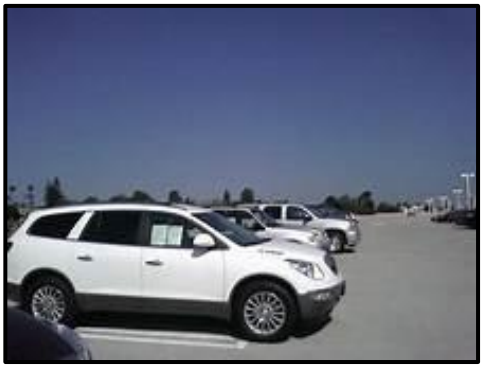









How can you lift a car onto a roof?



A car dealership has opened a new showroom in the middle of a busy city. There is no forecourt and no space at ground level to display the cars. The company wants the cars to be displayed on the large flat roof of the building which is three storeys high.

Design Brief

Design a machine that will lift the cars using pulleys.

Specification

Function:
Your design must lift a car (toy car approximately 6cm long and 4cm wide) to a height of 25cm. It should incorporate a pulley that is powered by hand.

Size:
Your design cannot be taller than 40cm and its 'footprint' should be no larger than 300cm².

Materials:
You can use modelling materials such as cardboard (no more than 100cm²), dowel rods, strips of wood, wire, masking tape and double-sided tape.

Tools:
You can use basic tools such as a glue gun, saw and drill.

Balance:
Your design must not fall over.

Safety:
A driver could be in the car so the car should be secure when being lifted.

Point of explanation:
Y5 Mechanisms – Block D

Core Knowledge	Explanation
gear	A gear is a toothed wheel that works with others to transfer rotational movement.
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.
mechanism	A mechanism is a system of parts working together in a machine.

Technical Vocabulary	Definition
gear train	a system of gears which transmits movement from one shaft to another
driver gear	a gear wheel that causes other wheels to rotate
idler	a gear for support or guidance instead of power transmission

Link to Video: https://vimeo.com/651110138/86cc9e0fec

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

Point of delivery:
Y5 Mechanisms – Block D

Revisiting prior learning	Taught content	Point of practice	Point of reflection
1. Levers and linkages can change the direction of movement and provide a mechanical advantage Know and use technical vocabulary to describe simple mechanisms and how they work	Explain what a gear is and how it works Identify different types of gears and their applications Explore how the direction and speed of movement is changed by using a system of gears and / or pulleys Introduce and define technical vocabulary related to gears and pulleys Construct a simple pulley system to lift a load Use diagrams, photos and annotations to record information about gears and pulleys	Prepare a simple working example of a spur gear and a two-pulley system to demonstrate to pupils. Introduce the overarching question for this unit: **How can you lift a car onto a roof?** Invite pupils to suggest possible answers to this question. Introduce the Knowledge Note and key vocabulary for the unit. Explain that gears are toothed wheels on a shaft that, when placed together, are used to transfer rotational movement. Show examples of the different types of gear and explain their applications. Demonstrate a simple working example of a *spur* gear which has a large and small gear wheel. Through questioning, demonstration and discussion, teach the concepts of *gear ratio* and how *rotational speed* can be stepped up or down. Define the term *gear train*, identifying the *driver* and *driven* gear. Point out to pupils that longer gear trains may also include *idlers*. Whilst rotating the driver gear in an anti-clockwise direction, challenge pupils to identify the direction of movement of the driven gear. Pupils then create their own gear trains, labelling the *driver gear, driven gear* and *idlers* and using arrows to indicate the direction of rotation for each. Introduce pupils to types of pulley systems and their applications. Demonstrate a simple two-pulley system which has a large and small wheel. Prompt pupils to identify the number of revolutions made by the small wheel for every one revolution of the large. Establish, through questioning, that the direction each wheel rotates is the same. Ask pupils how the direction of each wheel could be changed. Pupils create a two-pulley system and then build on this to create a multi-pulley system. Challenge pupils to label the direction of movement for each pulley and describe the difference in rotational speed of each. Demonstrate how to make a simple well structure, incorporating a pulley system used to lift a load. Pupils could work in pairs or groups to make their own. Pupils use labelled diagrams and photos and annotations to record what they have learnt about gears and pulleys in their portfolios.	Can name different types of gear systems and identify everyday objects that use these mechanisms Can explain that gears and pulleys are used to transfer rotational movement Can explain that a small gear wheel will rotate faster but with less force than a larger gear wheel Can explain that two connected gear wheels will rotate in opposite directions Can explain that two connected pulleys will rotate in the same direction and that forming a figure of eight with the band attaching them will make them rotate in opposite directions Can use appropriate vocabulary verbally and in writing to describe and explain what they have learnt

Questions for assessment

What is a pulley?

What are the two ways pulleys can be used?

How can the direction of rotation be changed in a pulley system?

What is a gear?

What happens if gear wheels are placed too closely together?

How can gears provide a mechanical advantage?

Do idler gears have a purpose?

Do gears placed next to each other always rotate in opposite directions?

Point of delivery:
Y5 Mechanisms – Block D

Revisiting prior learning	Taught content	Point of practice	Point of reflection
2. Gears and pulleys are used to transfer rotational movement 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, but forming a figure of eight with the band attaching them will make them rotate in opposite directions 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	Explore different designs of cranes and their everyday applications Cranes use pulley systems to provide a mechanical advantage Identify specific constraints and limitations related to a design brief Make a structure containing a pulley system for a specific purpose Evaluate outcomes, identifying where modifications need to be made and assess whether the requirements and specifications of the brief have been met	Prepare templates or sections of thick cardboard that pupils can use in their constructions. Construct, in advance, an example of a crane for pupils' reference. Recap on the learning from the previous lesson and revisit some of the key vocabulary introduced. Use questioning and discussion to elicit pupils' understanding of gear and pulley systems and their practical applications. Pupils complete Vocabulary Task 1 which challenges them to develop their use of vocabulary relating to movement. Explain that cranes are an example of how pulley systems are used to lift heavy loads with little effort, thus demonstrating a significant mechanical advantage. Show examples of different types of cranes – tower, stacker and bridge – and discuss the differences pupils notice. Refer pupils back to the key question for this unit: **How can you lift a car onto a roof?** Introduce the design and make project for this lesson that directly relates to this question. Organise pupils into small groups and provide each group with a handout detailing the scenario and the design brief. Ensure all pupils understand the specifications and constraints of the brief. Show pupils the example model and images of different cranes and instruct them to make sketches and drawings using these examples to guide them. Provide pupils with a range of modelling materials and basic tools they can use for the construction. Model the appropriate and safe use of tools such as craft knives, hack saws and glue guns. Once groups have completed their mechanical structures, use questioning to support their evaluations and challenge pupils to consider how their construction could be modified and improved. Using photos and annotated drawings, pupils make a record of the construction and evaluation process in their portfolios.	Can describe different types of crane Can explain how a simple pulley system works Can create a design that considers the constraints of a design brief and the purpose of the structure Can apply knowledge of pulleys to build a structure for a specific purpose Can make suggestions about how a structure can be reinforced by adding a triangular frame or side supports Can explain how to change the speed of movement by altering the size of pulley

Questions for assessment

Does your mechanical structure fit within the size constraints of the brief?

How can your structure be made more stable?

How can you stop the cradle from spinning?

How could the speed with which the car is lifted be increased / decreased?

How could multiple cars be lifted?

Is the movement of the pulley system smooth? **How** could this movement be improved?

Point of delivery:
Y5 Mechanisms – Block D

Revisiting prior learning	Taught content	Point of practice	Point of reflection
3. Cranes use pulley systems to provide a mechanical advantage A design brief has specific constraints and limitations Structures can be made more stable by adding triangular supports or frames The speed of movement can be altered by changing the size of a pulley	Explore a range of designs and structures that could fulfil the requirements of the original design brief Explore a range of gear and pulley mechanisms used in structures such as Ferris wheels, windmills, ski lifts and wells and use these as a basis for designs Apply modelling, measuring, joining and cutting skills Evaluate outcomes and identify modifications	Prepare working models of structures based on windmills and Ferris wheels for pupils to refer to and to guide them in their designs. Review the pupils' models made in the previous lesson and discuss the challenges they encountered, the modifications they identified and what they would do differently next time. Refer to the key question for this unit: **How can you lift a car onto a roof?** Remind pupils of the original design specifications and constraints. Explain that pupils are going to make another structure which must incorporate either a pulley system or gear train to lift two or more cars at the same time. Share some images of windmills and Ferris wheels, explaining the mechanisms used and how they work. Show a pre-prepared structure based on the concept of a Ferris wheel and demonstrate how the pulley system steps down the speed of rotation of the main structure. Show a further example of a structure that uses a gear train to control the turning force of extended arms, based upon the mechanisms used in windmills. Alternative mechanisms such as those used in ski lifts and wells could also be shown to pupils to aid them in their design choices. Model the safe use of craft knives, glue guns and saws and demonstrate how to draw a hexagon template from a circle. Divide pupils into small groups and encourage them to make annotated drawings of their design, explaining how it will work and the materials they plan to use. Encourage pupils to test and evaluate their structures throughout the construction process so that modifications and improvements can be made throughout. Prompt pupils to make notes in their portfolios about design changes that were necessary and why. Once complete, pupils share and evaluate the success of their designs and identify further improvements or adjustments. Use questioning and Vocabulary Task 2 to aid pupils with the evaluation process.	Can select, apply and adapt mechanisms to suit a specific design purpose Can use basic tools and materials safely and with control and accuracy Can make decisions about how to construct a model from limited materials and apply skills of cutting, joining and measuring Can give reasons why a specific mechanism has been used and make adaptations to improve its movement Can identify strengths and weaknesses of a design and structure and make reasonable suggestions about modifications

Questions for assessment

What type of structure have you based your design on?

How rigid and stable is your structure? **How** could the stability be increased?

Why have you chosen a particular mechanism?

How can the speed of the rotation be stepped down?

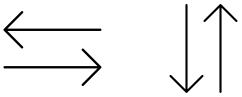
How can the rotational movement be made smoother?

What alternative materials could you have used?

Oracy and Vocabulary:
Y5 Mechanisms – Block D

Task 1: Sort these adjectives and verbs according to the type of movement they refer to.

revolve
rotation
zigzag
pivot
gyrate
vertical
circular
horizontal
swivel
linear
angular



Order these words according to their strength of meaning.

revolve spin turn whirl

Exploration:

say say

- When does a turn become a spin?
- How can you change the direction of movement of a pulley?
- Do small gears always turn faster than large gears?

Task 2: Present your group's model to the class. Use these prompts to help you structure your presentation. Make sure everyone in your group gets the opportunity to speak.

say say

What type of mechanism did you base your design on and why?	• Our design is based on … • It uses a _____ mechanism. • We chose this design because …
What difficulties did you face during construction and how did you solve these problems?	• We had difficulties with … • These problems were caused by … • We solved the problem by …
Which part of your structure is most effective and why?	• The most effective 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: Y5 Mechanisms – Block D

OWN-it — Analyse

Write the root of *revolution*.

_____

Change this verb to an adjective.

rotate

_____

Tick the correct word class for the word *movement*.

- ❑ noun
- ❑ verb
- ❑ adverb

KNOW-it — Define

Explain what a *gear train* is.

_____

_____

Tick the correct definitions of the word *pulley*.

- ❑ a device used to lift loads
- ❑ a mechanism used to change the direction of movement
- ❑ a device that reinforces structures

Write a definition of the term *driver gear*. Use no more than five words.

LINK-it — Connect

The term *idler* is derived from the word *idle*.

What does *idle* mean? Write a definition.

Write two words associated with the word *mechanism*.

Write a synonym and an antonym of the word *movement*.

synonym	antonym

USE-it — Use in context

Identify and **record** two practical uses of *pulleys*.

1. _____
2. _____

Explain what *pulleys* and *gears* have in common.

Tick the sentence if the word *mechanism* has been used correctly. Then, write your own sentence using this word.

- ❑ The *mechanism* for locking the washing machine door is childproof.

Knowledge Note:
Y5 Mechanisms – Block D

Year 5: Mechanisms
How can you lift a car onto a roof?

Core content:

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

Technical vocabulary:

Gear – a toothed wheel that works with others to transfer rotational movement.

Pulley – 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.

Mechanism – a system of parts working together in a machine.

Gear train – a system of gears which transmits motion from one shaft to another.

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

Idler – a gear used for support or guidance instead of power transmission.

Connections:

George Washington
Gale Ferris Jnr. (1859 – 1896)
American civil engineer

The London Eye

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Exemplification: Y5 Mechanisms – Block D
How can you lift a car onto a roof?

Challenge pupils to identify different products that use pulleys

Pose questions to pupils:

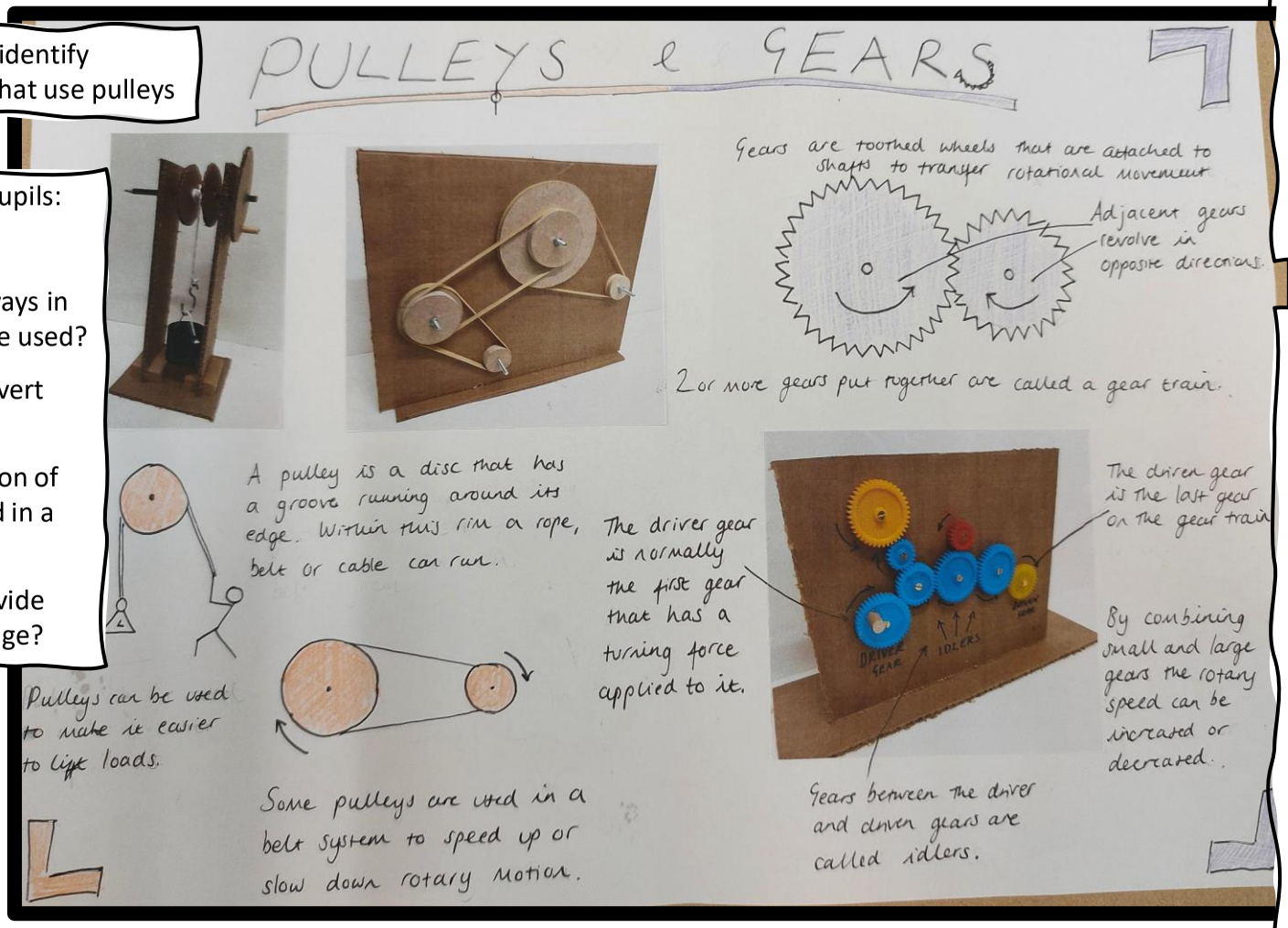
What is a pulley?

What are the two ways in which pulleys can be used?

How do pulleys convert rotary movement?

How can the direction of rotation be changed in a pulley-belt system?

How do pulleys provide mechanical advantage?



Ask pupils to identify different products that use gears that they may have come across in real life

Pose questions to pupils:

How do these products work?

How does a Ferris wheel work?

Provide plenty of opportunities for pupils to explore the effect of using bigger gears and smaller gears together

Pose questions to pupils:

What is a gear?

What are the three types of gears?

What are multiple gears together called?

What is the difference between a driver gear and a driven gear?

How can gears provide mechanical advantage?

How do gears transfer rotary motion?

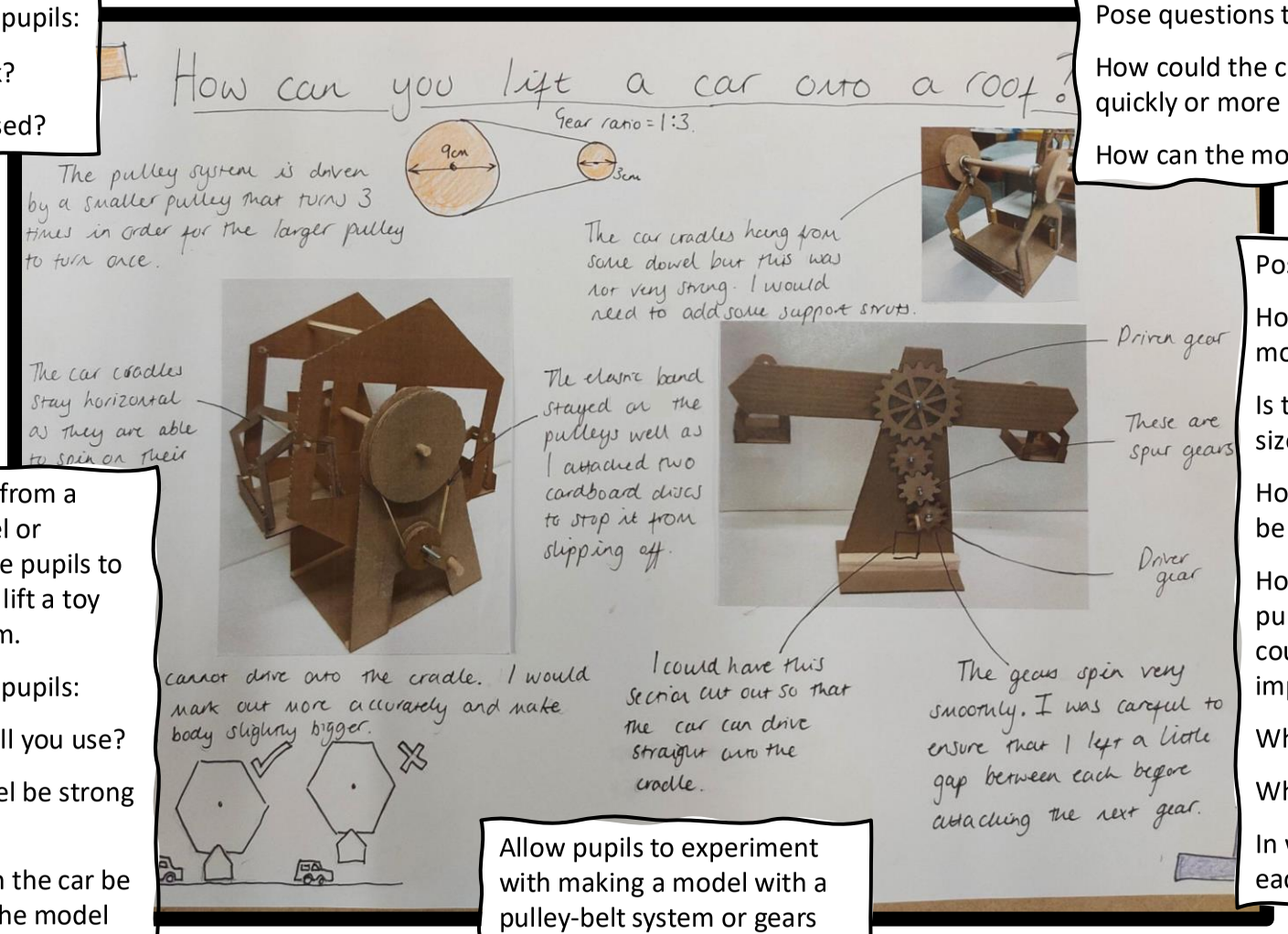
Exemplification: Y5 Mechanisms – Block D
How can you lift a car onto a roof?

Examine cranes, Ferris wheels and windmills

Pose questions to pupils:

How do they work?

Where are they used?



Pupils evaluate the success of their model

Pose questions to pupils:

How could the car be lifted more quickly or more slowly?

How can the model be made stronger?

Pose further questions:

How can the car be moved more securely?

Is the model within the size limitations?

How could the balance be improved?

How well do the gears or pulleys revolve? How could this movement be improved?

Which is the driver gear?

Which is the driven gear?

In which direction does each gear revolve?

Taking inspiration from a crane, Ferris wheel or windmill, challenge pupils to design a model to lift a toy car onto a platform.

Pose questions to pupils:

What materials will you use?

How will the model be strong enough?

How smoothly can the car be transferred from the model to the roof?

Will the model be well balanced?

Allow pupils to experiment with making a model with a pulley-belt system or gears