

Open Project STEM Set

E93.1 STEM Lessons

The **Open Projects STEM set** is the ideal classroom solution which will empower students to engage with real-life problem solving, developing critical and engineering design thinking. The set includes a huge library of parts, both structural and mechanical, so that students working in teams can brainstorm, model their ideas and develop solutions trying several iterations. The set can be used as a stand-alone product for open projects or in combination with other **ENGINEO**® robotic solutions for more advanced problems that require coding and electronics. The set comes in a convenient plastic storage tub and has enough parts to build some of the mega models of **ENGINEO**®, such as the motorized London Eye, a 1.5m tall Eiffel tower and an amazing chain reaction machine! The extensive library of parts and interchangeability of **ENGINEO**® system, challenges students of both late Primary and Secondary as it offers unlimited potential of creativity and increasing complexity.



Lesson: Amusement Park

Relation between force and speed

Have you ever thought how the huge and heavy cargos are loaded or removed from ships? Dockside cranes are responsible for this process and are essential for every commerce port. In this experiment you can build a similar type of dockside crane model and learn more about gears and how they are used.

Discover:

- What is a gear and how is it used?
- How does the gear's diameter affects speed and power?

Procedure:

1. Build the **experimental crane model**. For **case 1** make the first gear assembly of **page 2**.

2. Position the experimental crane on a table and lower the load (weight) down to floor level. Then wrap and tie the string around the axle, so it becomes tight. This should be the starting point for every case.

3. Turn the crank and measure how many revolutions are needed until the load reaches the top (green pulley). Write your answer in the next table for case 1. Also, try to feel the amount of force you have to apply in order to lift the load and observe the lifting speed.

4. Repeat the same procedure for **cases 2, 3** and **4**, in which the gears are assembled as in **pages 2** and **3**. Try to keep the same turning pace in each case. Write your findings in the table about the crank's revolutions.

5. Compare the amount of force you used in each case ticking the words **easy**, **medium**, **difficult**, **the most difficult**. Also, compare the lifting speed with the words **slow**, **medium**, **fast** and **the fastest**. Each word should be ticked once.

6. Complete the conclusions in **exercises 2** and **3**.



Engino® experimental crane model

1. Complete the following table according to your measurements and observations. Mark with ✓ the appropriate boxes for **FORCE** and **LIFTING SPEED**.

CASES		1.	2.	3.	4.
Crank's revolutions					
FORCE (difficulty)	easy				
	medium				
	difficult				
	the most difficult				
LIFTING SPEED	slow				
	medium				
	fast				
	the fastest				

2. Look at the "FORCE" row and the "LIFTING SPEED" row of the table and write your conclusions regarding the relationship between the force applied and the elevation speed of the load.

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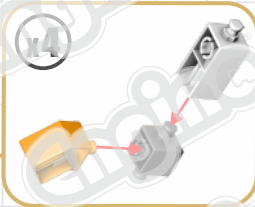
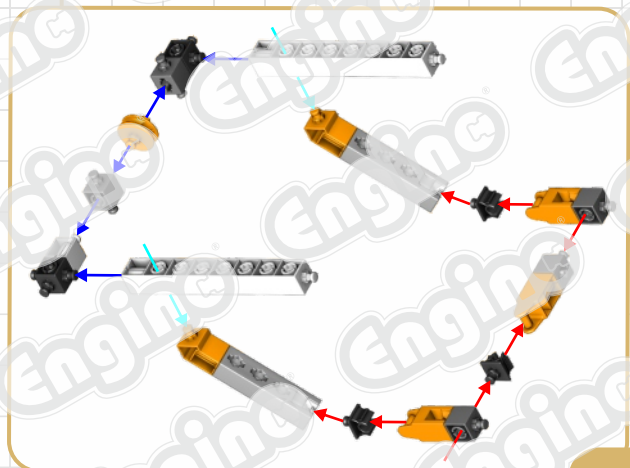
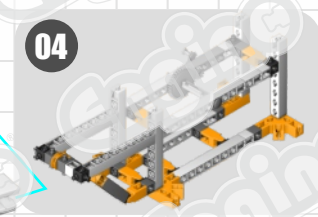
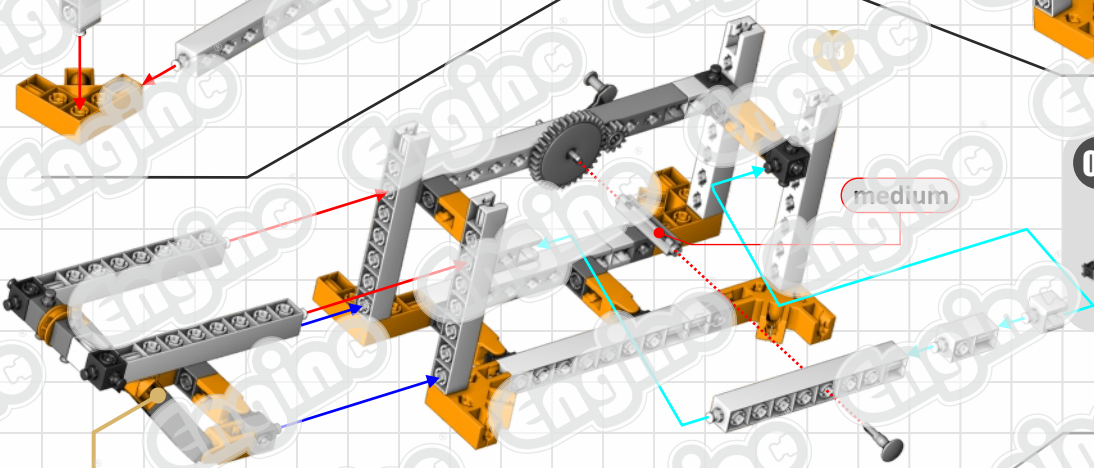
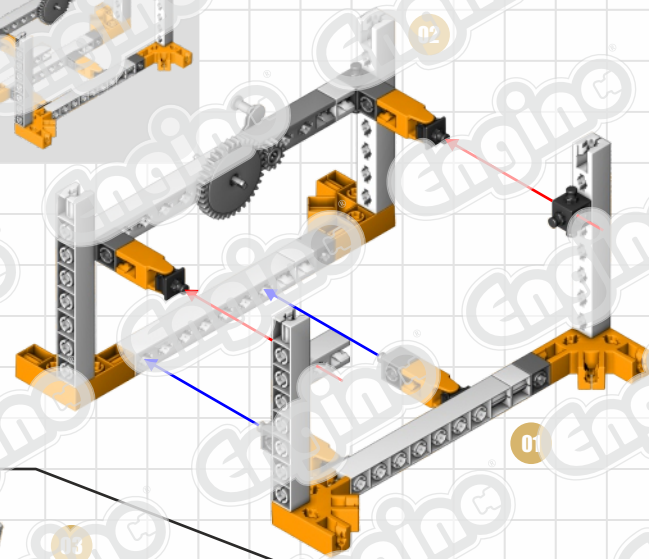
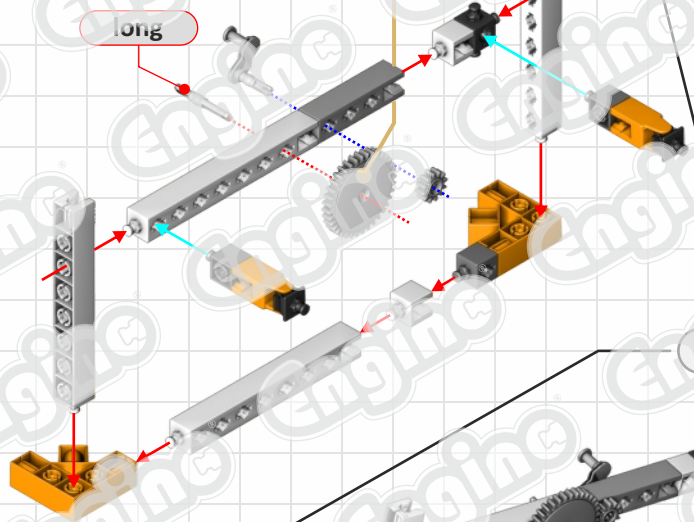
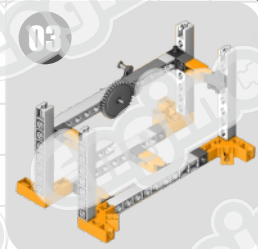
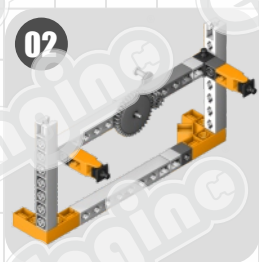
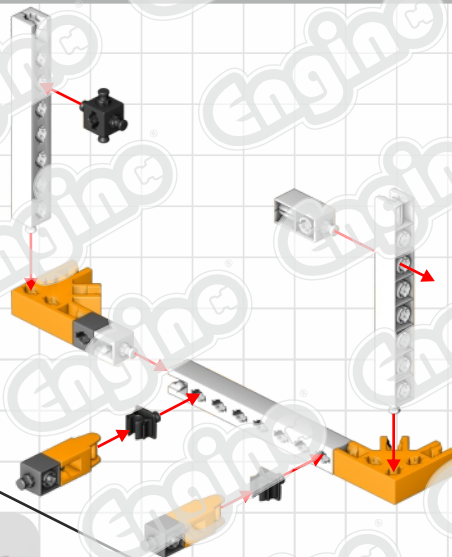
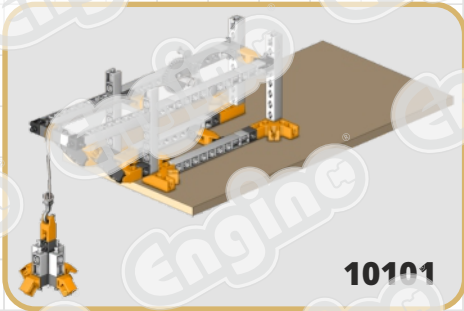
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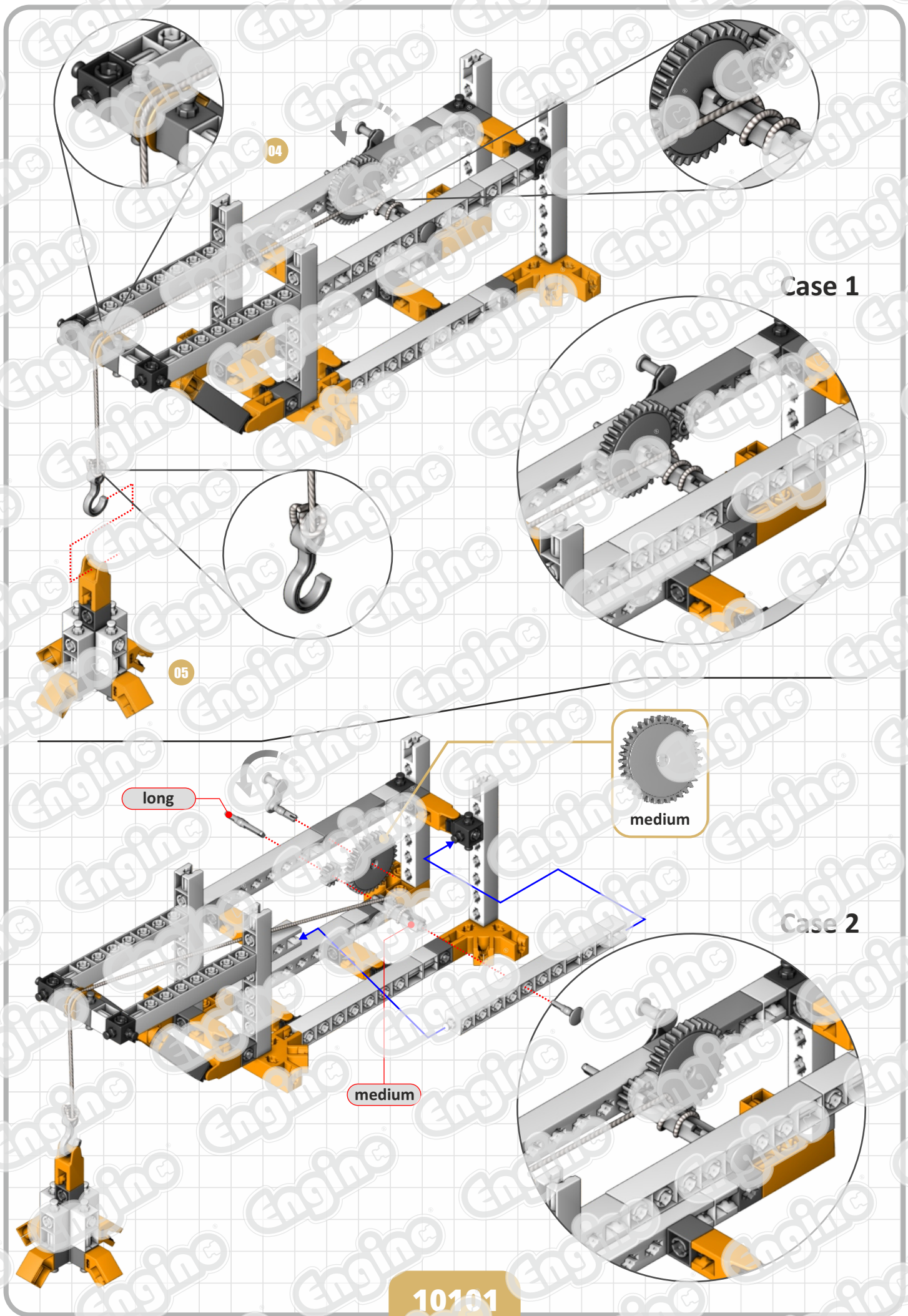
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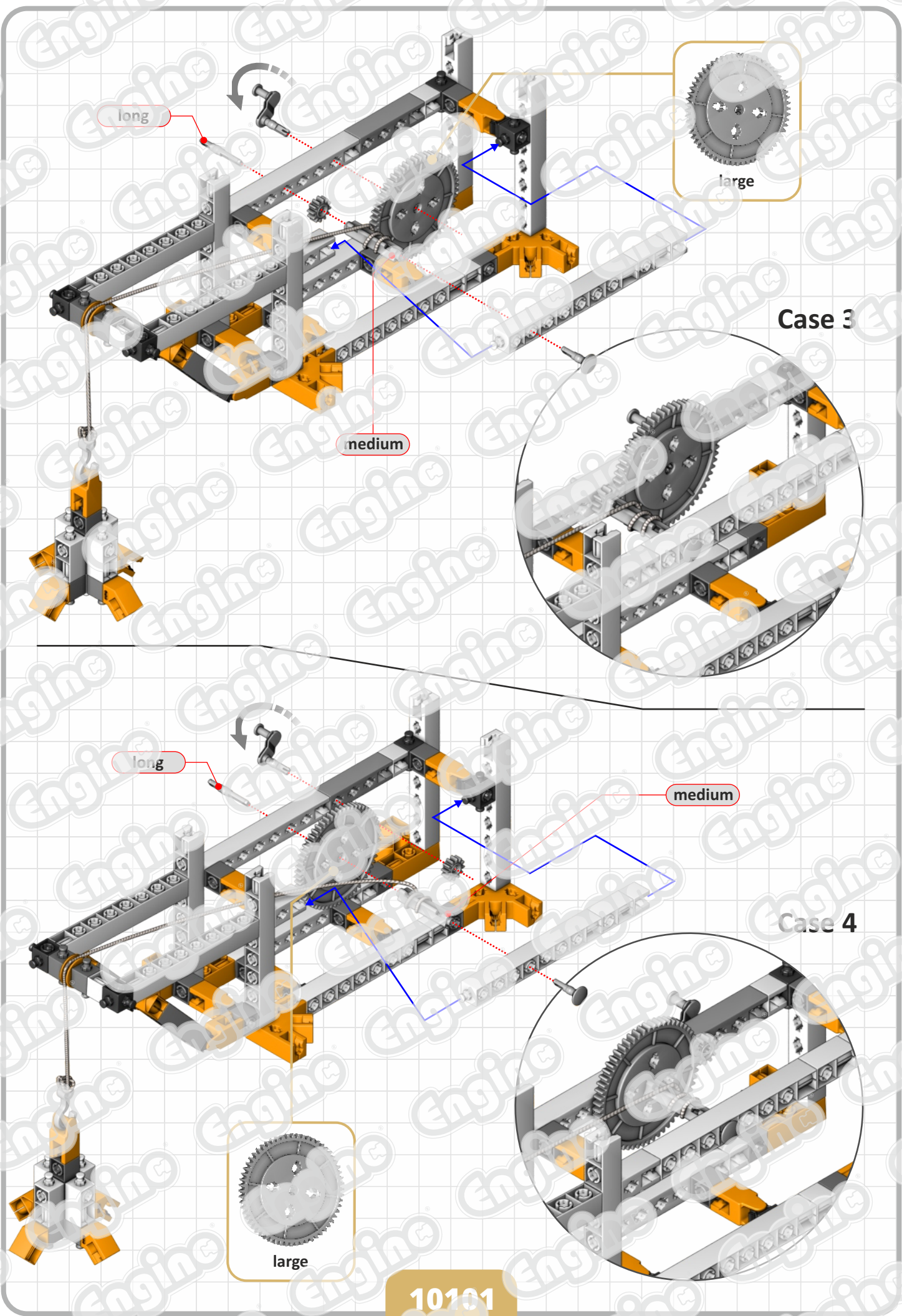
3. Complete the conclusion below using the words in the box.

decrease, smaller, driver gear, driven gear, force, increase

To increase speed the has to be bigger than the, while to speed the driver gear has to be than the driven gear. However, what you gain in speed you lose in and vice versa.







Lesson: Amusement Park

Gear ratio

The gearbox is any combination or assembly of gears and can be found in a variety of devices: from the smallest wrist watch to the biggest train! In this experiment we will learn all about this ingenious assembly, which allows us to control the speed of any machine.

Discover:

- What is a gearbox?
- What is gear ratio and how is it calculated?

Procedure:

1. Build the base of the **gearbox**. For **case 1** make the first assembly of **page 1**.

2. In the experiment we need to measure how many revolutions the **output shaft** makes when the **input crank** rotates. Two people are needed for this: one should turn the crank slowly with the appropriate number of revolutions (as stated in the table) and the other should measure the output revolutions. The green part connected at the shaft of the output gear will help you measure the revolutions with more ease.

3. For **case 1**, revolve the input crank **1 time** (1 full circle). While measuring revolutions, feel the amount of force you apply.

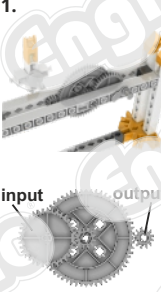
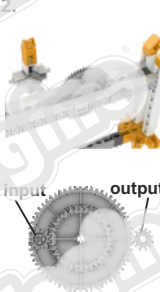
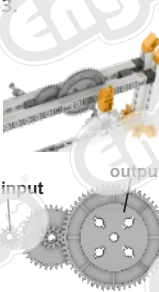
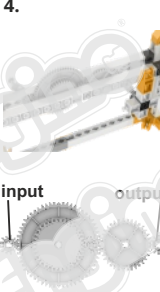
4. Repeat the same for the remaining cases. For **case 2**, make the second gear assembly of **page 1** and turn the crank **3 times**. For **case 3** make the third assembly in **page 2** and turn the input crank **15 times**. Finally, for **case 4** make the fourth assembly in **page 2** and turn the input crank **5 times**.

5. In the last row divide the INPUT by the OUTPUT revolutions and write it as a simple ratio. Then, answer **question 2**.

6. Measure the number of teeth of each gear: large, medium and small. Then, look carefully at the gear assembly of case 1. There are two pairs: 1) a medium gear connected with a small one and 2) a big gear connected with a small gear. Keep this in mind for **exercise 3**.

7. Calculate the gear ratios for all cases. Note that in case 4 there is one compound gear system meshing with the last two gears.

1. Complete the following table according to your measurements and observations. After you take all measurements, complete the FORCE row with the words: **easy**, **medium**, **difficult** and **most difficult**. Also, fill in the last row with a simplified ratio of input revolutions to output revolutions.

CASES	1.	2.	3.	4.
				
INPUT	1	3	15	5
OUTPUT				
FORCE				
INPUT OUTPUT				

2. Why the gear ratio (input revolutions to output revolutions) is different in each case? What about Torque?

3. Make the following calculations concerning the gear assembly of case 1 and compare your result with the input/output ratio you found in the table above. What is the connection between the number of teeth ratio and speed ratio?

$$\begin{aligned}
 \text{gear pair 1} &= \frac{\text{teeth of small gear}}{\text{teeth of medium gear}} = \frac{\boxed{}}{\boxed{}} \\
 \text{gear pair 2} &= \frac{\text{teeth of small gear}}{\text{teeth of large gear}} = \frac{\boxed{}}{\boxed{}}
 \end{aligned}
 \quad \left. \begin{array}{l} \\ \end{array} \right\} \text{gear pair 1} \times \text{gear pair 2} = \frac{\boxed{}}{\boxed{}} \times \frac{\boxed{}}{\boxed{}} = \frac{\boxed{}}{\boxed{}}$$



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