

INTRODUCING YOUR CHILD TO STEM

Science, Technology, Engineering, and Mathematics (STEM) education provides young adults with the opportunity to participate in many themed, **hands-on activities**, including those with connections to sports, history, and other subjects.

Activities involving the Robotic Arm construction toys by Hexbug help individuals learn more about **physics** and **engineering** by engaging in activities that are useful and enjoyable while providing them hands-on experiences in those key areas.

This activity with the Robotic Arm provides a fun and interesting way to introduce students to engineering concerns involved in designs and the calculation of compound gear ratios. Issues are raised related to the robotic arms' structures (forms), their functions (targeted tasks), and their mechanical power. Students will observe the relation between input and output forces and calculate a compound gear ratio.

VOCABULARY TO KNOW

COMPOUND GEAR RATIO

The combined gear ratio that results from having two or more gear combinations that share a common shaft(s) or axle(s).

END EFFECTOR

The tool at the end of the robotic arm.

FORCE

A push or pull exerted on an object.

MECHANICAL ADVANTAGE

In this context, added torque (mechanical power) within an output gear due to the gear ratio.

ROBOTIC ARM

The most common manufacturing robot designed for heavy, repetitive work.

GENERAL SOLUTIONS

MOVEMENT	INPUT	OUTPUT	USES GEARS?	USES SHAFTS?
MOVING THE CLAW ARM FORWARD/BACKWARD	ROTATIONAL FORCE TO TURN KNOB	MOVING FORCE	YES	YES
MOVING THE CLAW ARM UP/DOWN	ROTATIONAL FORCE TO TURN KNOB	LIFTING FORCE	YES	YES
OPENING/CLOSING THE CLAW	ROTATIONAL FORCE TO TURN KNOB	GRIPPING FORCE	YES	YES

GEAR RATIO

$$\frac{\text{Driven (output) Gear}}{\text{Driving (input) Gear}} = \frac{60 \text{ Teeth}}{12 \text{ Teeth}} = \frac{5}{1} \text{ or } 5:1$$

EXTEND YOUR LEARNING

DISCUSS

The design of a robot like this Robotic Arm depends on what it is going to be used to do. What other designs can you think of?

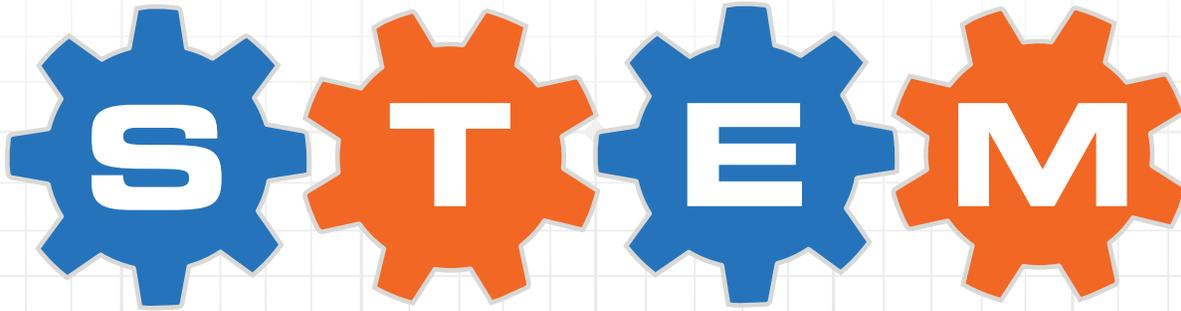
APPLY

What other gear sizes could be used to make the compound gear ratio more efficient?

EXPLORE

You can explore additional VEX Hexbug builds and investigations here:
<https://www.hexbug.com/vex>

STEM STANDARDS ADDRESSED



MS-ESS1-1

Patterns can be used to identify cause and effect relationships.

3-PS2-1

Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

3-PS2-2

Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

MS-PS2-2

Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

ISTE1.1D

Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.

ISTE3.3D

Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories, and pursuing answers and solutions.

ISTE4.4D

Students exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems.

3-5-ETS1-1

Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

MS-PS3-2

Develop a model to describe unobservable mechanisms.

MS-ETS1-4

Develop a model to generate data to test ideas about designed systems, including those representing inputs and output.

CCSS.MATH.PRACTICE.MP1

Make sense of problems and persevere in solving them.

CCSS.MATH.PRACTICE.MP3

Construct viable arguments and critique the reasoning of others.

CCSS.MATH.PRACTICE.MP7

Look for and make use of structure.

CCSS.MATH.CONTENT.6.R.PA.1

Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

CCSS.MATH.CONTENT.6.R.PA.3

Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

CCSS.MATH.CONTENT.3.NF.A.3B

Recognize and generate simple equivalent fractions.

STANDARDS REFERENCED

MATH

Common Core Standards for Math
<http://www.corestandards.org/math/>

SCIENCE & ENGINEERING

Next Generation Science Standards
<http://www.nextgenscience.org/>

TECHNOLOGY

International Society for Technology in Education
<http://www.iste.org/standards/>