

# INTRODUCING YOUR CHILD TO STEM

## VOCABULARY TO KNOW

### MOMENT OF INERTIA

The amount of force of an object rotating around an axis.

### KINETIC ENERGY

The energy of motion.

## CALCULATION SOLUTIONS REAL END GAME

$$\text{Moment of inertia} = \frac{1}{2} \cdot (22.7 \text{ kg}) \cdot (0.208 \text{ m})^2 = 0.491 \text{ kg m}^2$$

$$\text{Kinetic energy} = \frac{1}{2} \cdot (0.491 \text{ kg m}^2) \cdot \left( \frac{30,000 \text{ deg/sec} \cdot \pi}{180} \right)^2 = 67,305.22 \text{ J}$$

$$\text{Potential Throwing Height} = \frac{24843.71 \text{ joules}}{100 \text{ kg} \cdot 9.8 \text{ m/s}^2} = 25.35 \text{ meters}$$

## CALCULATION TABLE REAL END GAME

WEAPON MASS (kg)	WEAPON RADIUS (m)	MOMENT OF INERTIA (kg m <sup>2</sup> )	ROTATIONAL SPEED (deg/sec)	ENERGY (joules)
22.7 kg	0.208 m	0.491 kg m <sup>2</sup>	30,000 deg/sec	67,305.22 J

## CALCULATION SOLUTIONS VEX BATTLEBOTS END GAME

$$\text{Moment of inertia} = \frac{1}{2} \cdot (0.02 \text{ kg}) \cdot (0.0445 \text{ m})^2 = 0.0000198 \text{ kg m}^2$$

$$\text{Kinetic energy} = \frac{1}{2} \cdot (0.0000198 \text{ kg m}^2) \cdot \left( \frac{360 \text{ deg/sec} \cdot \pi}{180} \right)^2 = 0.000391 \text{ J}$$

## CALCULATION TABLE VEX BATTLEBOTS END GAME

WEAPON MASS (kg)	WEAPON RADIUS (m)	MOMENT OF INERTIA (kg m <sup>2</sup> )	ROTATIONAL SPEED (deg/sec)	ENERGY (joules)
.020 kg	0.0445 m	0.000198 kg m <sup>2</sup>	360 deg/sec	0.000391 J

## EXTENSION ACTIVITIES

What will have a greater effect on the amount of energy - increasing the radius of the cylinder or increasing the mass of the cylinder?

Solution: Increasing the radius has a greater effect on energy.

What happens to the energy when you double the speed of the cylinder (rpm)?

Solution: Doubling the speed of the cylinder will quadruple (multiply by 4) the energy.

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.

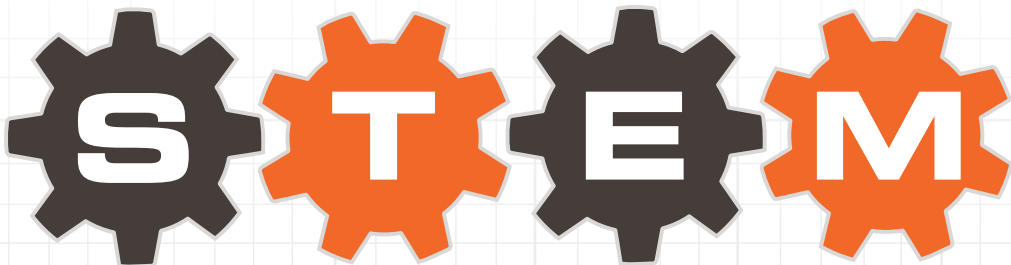
Activities involving the VEX® BATTLEBOTS® construction toys helps individuals learn more about **math, physics, and engineering** by engaging in activities that are useful and enjoyable while providing them hands-on experiences in those key areas.

This activity with the VEX® BATTLEBOTS® End Game provides a fun and interesting way for students to learn about **physics, math, and kinetic energy**.

## EXTEND YOUR LEARNING

You can explore additional engaging hands-on activities with VEX/HEXBUG toys here: <https://www.vex.com/help/buid-instructions>

# STEM STANDARDS ADDRESSED



## ✓ HS-PS2-4

Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects

## ✓ HS-ETS1-1

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants

## ✓ HE-ETS1-2

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering

## ✓ HS-PS3-3

Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy

## ✓ MS-PS2-4

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects

## ✓ ISTE1.1A

Students articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes

## ✓ 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 while pursuing answers and solutions

## ✓ ISTE4.4C

Students develop, test and refine prototypes as part of a cyclical design process

## ✓ ISTE4.4D

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

## ✓ ISTE7.7C

Students contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal

## ✓ ETS1.A

Defining and delimiting engineering problems

## ✓ ETS1.B

Developing possible solutions

## ✓ ETS1.C

Optimizing the design solution

## ✓ CCSS.MATH.PRACTICE.MP1

Make sense of problems and persevere in solving them

## ✓ CCSS.MATH.PRACTICE.MP4

Model with mathematics

## ✓ CCSS.MATH.PRACTICE.MP7

Look for and make use of structure

## ✓ CCSS.MATH.CONTENT.HSG.SRT.C.7

Explain the relationship between the sine and cosine of complementary angles

## ✓ CCSS.MATH.CONTENT.HSN.VM.A.3

Solve problems involving velocity and other quantities that can be represented by vectors

## STANDARDS REFERENCED

### MATH

Common Core State 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>