**Essential Principles of Robotics**

**Description**

This activity is intended to give students an overview of the key principles that are often applied in robotics. Students will work with partners and in groups at an open table to sort words under various headings.

Once the group task has been completed to the best of their knowledge, students will use their prior knowledge to add what they already know about the topic and predict how the principle might be applied in robotics both outside and inside the classroom. The teacher will then reveal what the completed table looks like and briefly discuss the rationale for each word being placed where it is.

Groups will then share what they already know with the class to pool their knowledge of the concepts. The groups will each be assigned to a core robotics principle from the headings that were distributed and conduct additional research for the purpose of teaching other small groups what they’ve learned.

## Lesson Outcomes

Students will review or learn about:

* The basics of classical mechanics:

– Friction, force, torque, speed, rotational speed

* Power transmission using gears, ratios and reductions
* Ohm’s law
* Components of a circuit
* Direct current motors

## Assumptions

Students will:

* Have little background knowledge in classical mechanics, using gears and working with DC motors
* Have some background knowledge of electricity, circuitry and Ohm’s law from Science 9 in the BC curriculum
* Have worked in teams throughout this and other Youth Explore Trades Skills modules
* Know how to effectively perform an internet search to conduct research



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## Key Terminology

**Current**: the measurement of the flow of electric charge.

**DC motor**: short for *direct current motor*. These are used in classroom robotic applications by converting voltage to mechanical power to spin and produce torque.

**Electrical resistance**: impedes the flow of electrons through a circuit. It relates voltage to current.

**Force**: a push or pull upon an object by another object.

**Friction**: heat caused by opposing forces acting on a surface. **OR** a force that resists motion between two surfaces sliding against each other; strength of the force is determined by their textures.

**Power transmission**: the transfer of energy to the place where work is performed.

**Torque**: also known as *moment*. The force of a moving object connected to a single point.

**OR** the measurement of force causing rotation.

**Voltage**: the measurement of electric potential energy.

## Estimated Time

60–90 minutes

## Recommended Number of Students

Up to 30 students

## Facilities

Any classroom with sufficient seating and tables for students to work at will do. A document camera or projector is needed to show students what the completed sort table looks like. A computer lab or set of tablets is needed for the research portion of the activity.

## Materials

Essential Principles of Robotics Notes Organizer Essential Principles of Robotics Sorting Activity

**Resources**

Vex Robotics has an excellent set of resource pages that would work well with this activity. It is recommended that this and the other websites be shared with groups as they begin their research:

<http://curriculum.vexrobotics.com/curriculum>

#### Ohm’s law and circuits:

The Khan Academy has a series of online videos and documents at: https://[www.khanacademy.org/science/physics/circuits-topic/circuits-resistance/v/circuits-part-1](http://www.khanacademy.org/science/physics/circuits-topic/circuits-resistance/v/circuits-part-1)

AllAboutCircuits.com has an online electronics textbook available at: <http://www.allaboutcircuits.com/textbook/>

#### Gear ratios

An interactive gear ratio simulator is available at: <http://geargenerator.com/>

<http://science.howstuffworks.com/transport/engines-equipment/gear-ratio.htm>

An introductory 9-minute video is available at: https://[www.youtube.com/watch?v=D\_i3PJIYtuY](http://www.youtube.com/watch?v=D_i3PJIYtuY)

A series of videos, each about 2–3 minutes long and using VEX gears to demonstrate gear ratios:

https://[www.youtube.com/watch?v=B4j2VPHVm6o](http://www.youtube.com/watch?v=B4j2VPHVm6o) https://[www.youtube.com/watch?v=h1vfR9YvjMA](http://www.youtube.com/watch?v=h1vfR9YvjMA) https://[www.youtube.com/watch?v=-q5FmanzCw4](http://www.youtube.com/watch?v=-q5FmanzCw4)

Torque – a 10-minute video from Khan Academy: https://[www.youtube.com/watch?v=QhuJn8YBtmg](http://www.youtube.com/watch?v=QhuJn8YBtmg)

DC motor torque, speed and current using VEX. Presented by AURA, the Auckland University Robotics Association, a well-known organization in VEX competition at the university level: https://[www.youtube.com/watch?v=STdONYFI2C4](http://www.youtube.com/watch?v=STdONYFI2C4)

## Procedure

* 1. Prior to the lesson, the teacher should print off the sorted grid and cut them up so the headings and words are randomized.
  2. Have students pair up and give each pair an unsorted stack of headings and words. Ask them to do their best to determine which words go under the headings.
  3. Have them write any words or sketch symbols from what they might already know about the heading/topic/words.
  4. Once the class seems to have stalled in their sorting, pair each group with another group of two and have them compare their grids, sharing their rationale for the groupings.
  5. Have the groups of four discuss their prior knowledge they wrote in step three, and fill in the final box for each heading by predicting the possible applications and connections to the world of robotics.
  6. After a few minutes, put groups of four together so that they are in eights. They should briefly share their sorted words, background knowledge and connections.
  7. The teacher should show the arranged sorted grid and briefly discuss the rationale for each word in its heading, as well as how it connects to the world of robotics.
  8. Assign a “heading and associated words” to the groups of four, and have them conduct research on the topic for the purpose of presenting to their classmates in a method determined by the teacher.
  9. Prior to breaking to do their research, decide on the method of presentation (group to group, whole class, rapid fire, etc.), and communicate that to the groups.
  10. Tell the groups that they have 30–60 minutes to gather important information, visuals, videos, diagrams, examples and sample robotics problems they might encounter.
  11. Distribute the notes organizer for students to organize their notes during presentations.
  12. Have the groups present in the desired format.
  13. Once complete, students can revisit their sorted grids and decide which words can go in multiple columns based on what they’ve learned.

## Assessment

The evaluation of this lesson is based on the learning outcomes outlined above.

Prior to teachers using the evaluation grid it is recommended that students perform some form of peer-assessment and self-assessment.

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|  | **Outcome To Be Assessed** | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
| **Outcome 1** | **Classical mechanics** | | | | | | | |
| **1.1** | Demonstrates an understanding of classical mechanics. |  |  |  |  |  |  |  |
| **Outcome 2** | **Power transmission** | | | | | | | |
| **2.1** | Demonstrates an understanding of power transmission involving gears. |  |  |  |  |  |  |  |
| **Outcome 3** | **Ohm’s law and circuitry** | | | | | | | |
| **3.1** | Demonstrates an understanding of Ohm’s Law and the components of a circuit. |  |  |  |  |  |  |  |
| **Outcome 4** | **DC motors** | | | | | | | |
| **4.1** | Demonstrates an understanding of DC motors. |  |  |  |  |  |  |  |
| **Outcome 5** | **Teamwork** | | | | | | | |
| **5.1** | Division of work. |  |  |  |  |  |  |  |
| **5.2** | Effort of each team member. |  |  |  |  |  |  |  |
| **Outcome 6** | **Understanding Key Terminology** | | | | | | | |
| **6.1** | Demonstrate the use of Key Terminology. |  |  |  |  |  |  |  |
| **6.2** | Apply terminology appropriately. |  |  |  |  |  |  |  |

### Total Points:

|  |  |  |
| --- | --- | --- |
| 6 | Completed successfully at the exceptional level | Exemplary |
| 5 | Completed successfully at higher than the expected level | Accomplished |
| 4 | Completed successfully to the expected level | Emerging |
| 3 | Attempted successfully at the minimum level | Developing |
| 2 | Attempted - Unsuccessful - Close to Successful | Beginning |
| 1 | Attempted - Unsuccessful | Basic |
| 0 | Not Attempted | N/A |

**Comments:**

**Essential Principles of Robotics Notes Organizer**

Name:

Use this worksheet to organize your thoughts for your presentation to the class about your topic. You may need these notes for future reference as you complete the Electronics and Robotics module.

Add the three headings of the principles that you did NOT research. Use this worksheet to capture your notes as your peers present their work.

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**Electronics and Robotics Essential Principles of Robotics**

# Essential Principles of Robotics Sorting Activity

|  |  |  |  |
| --- | --- | --- | --- |
| **Classical mechanics** | **Power transmission – gears, ratios and reductions** | **Ohm’s law and components of a circuit** | **DC motors** |
| Speed | Teeth | Current | Mechanical output |
| Velocity | Newton-metre | Voltage | Electromagnetic field |
| Acceleration | Torque | Load | Wire coils |
| Force | Shaft | Power | Load torque |
| Torque | Input speed | Battery | Current draw |
| Isaac Newton | Pitch | Switch | Stall |
| Rotational speed | Diameter | Conductor | Electrical energy à  mechanical |