

**Internal Assessment Resource**

**Digital Technologies | Hangarau Matihiko Level 1**

This resource supports assessment against Achievement Standard 91881[[1]](#footnote-1)

**Standard title:** Develop an electronics outcome

**Credits:** 6

**Resource title:** Automated Robotic Vehicle

**Resource reference:** Digital Technologies | Hangarau Matihiko 1.5A Version 2

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| This resource:   * Clarifies the requirements of the achievement standard * Supports good assessment practice * Should be subjected to the school’s usual assessment quality assurance process * Should be modified to make the context relevant to students in their school/kura environment and ensure that submitted evidence is authentic |

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| Date version published by Ministry of Education | November 2019 Version 2  To support internal assessment from 2020 |
| Authenticity of evidence | Teachers/kaiako must manage authenticity for any assessment from a public source, because students may have access to the assessment schedule or student/ākonga exemplar material.  Using this assessment resource without modification may mean that students’ work is not authentic. The teacher may need to change figures, measurements or data sources or set a different context or topic to be investigated or a different text to read or perform. |

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**Teacher/Kaiako guidelines**

The following guidelines are supplied to enable teachers/kaiako to carry out valid and consistent assessment using this internal assessment resource.

Teachers need to be very familiar with the outcome being assessed by the achievement standard. The achievement criteria and the explanatory notes contain information, definitions, and requirements that are crucial when interpreting the standard and assessing students against it.

**Context/Te Horopaki**

This activity requires students to develop a refined robot that can autonomously carry out a task from one of a range of contexts.

Students will need to describe relevant implications that are related to the development of the outcome.

Students will need to show evidence of how they have addressed the relevant implication in the development of their outcome.

For example:

* Navigate a simple maze using a distance sensor and switches.
* Follow a line, such as navigate a black line in a factory to automatically deliver packages, pause for delivery, and return to destination.
* Maintain security of a monitored area, and sound an alarm if it senses an intruder, moving towards the intruder.
* Race a robot on a track (walls or lines) and stop as soon as they are across the finishing line.

Students will develop their understanding of a robot system before being given this assessment. They should know how to build the robot and program a variety of analog and digital inputs (various sensors i.e. infrared reflective sensors, switches, LDR’s) and outputs (i.e. motors, LED indicators). The student may use a given software template to test their robots but must modify, test and debug it for their own outcome.

This assessment task may be modified to integrate the basic iterative processes with another type of digital technology outcome, such as a computer program, digital media, or infrastructure outcome. For example: achievement standard 91883 Develop a computer program. Note: the task requirements will require modification to ensure the program meets the requirements of the programming standard AS91883.

This context can be easily adapted for other electronic environments where there is a combination of hardware and embedded software that performs to specifications.

The teachers should ensure the rigour of the outcome is appropriate for Level 6 of the NZ Curriculum. The specifications need to be agreed to prior to the implementation of interfacing procedures. They may be teacher-given or developed in negotiation with the student.

**Conditions/Ngā Tikanga**

Where a group approach is used, the teacher needs to ensure that there is opportunity for each student to provide evidence for all aspects of the standard.

The 6 credits for the achievement standard indicates that approximately 60 hours needs to be allocated for teaching, learning (in and out of the classroom) and assessment in a programme of study.

Students are required to collect portfolio evidence as they complete the task. This could include annotated photographs, diagrams, short video clips, or code snippets that demonstrate understanding and explain decisions made by the student. If possible, the portfolio should be digital (e.g. Wiki, Website, or other information gathering applications).

**Note:** The intention of the standard is that learners construct an electronics outcome from basic components. **Pre-configured robots that do not have a range of components from which learners can test and choose a range of outcomes are not suitable for this task** (see additional information below).

You may want to give students guidance on appropriate style and format for their evidence portfolio. This achievement standard does not assess format or style.

Conditions of Assessment related to this achievement standard can be found at <http://ncea.tki.org.nz/Resources-for-Internally-Assessed-Achievement-Standards>

**Resource requirements/Ngā Rauemi**

Students may need access to a computer, digital devices, the internet, and/or information from a variety of sources, such as manuals, and/or notes from textbooks, and access to a camera and/or video camera to photograph portfolio evidence. Some students may have cameras on their mobile phones, which can be used to document the process.

Each student will require a microcontroller system that includes simple switches, light and proximity sensors, and is able to control electric motors and a gearing system depending on the activity chosen (teacher-given or negotiated with student).

Following a Maze

1. Scratch-built robot (or an appropriate kit) with motors, distance and touch (switches) sensors
2. A walled maze with a minimum of two bends.

Delivery or Security Bot

1. Scratch-built robot (or an appropriate kit) with motors and infrared reflective sensors to allow robot to travel from A-to-B to deliver packages, pause at destination and return (the robot not required to collect or deliver package itself)
2. Sensors to allow robot's return when at A or B
3. Line (could be made with black electric tape) from A to B (not a straight line)

Racing Bot

1. Scratch-built robot (or an appropriate kit) with motors and infrared reflective sensors to allow robot to travel from A-to-B
2. A laned track

Developing an electronics outcome involves using appropriate resources and techniques, selecting, testing, and debugging of the hardware and embedded software that allow different devices to work together to meet the given specifications.

**Additional information/He Kōrero Atu**

As part of the teaching and learning programme, ensure that students understand the interfaces, functions and components of the systems used. For example:

* a circuit as a complete path
* voltage as an energy path
* current as rate of flow of charge
* distribution of voltage and current through a circuit (series and parallel circuits)
* conduction (limited to the macroscopic behaviour of conductors, insulators, and semiconductors)
* circuit subsystems
* symbolic conventions and schematics
* hardware (for example components and combinations of components)
* embedded systems as software subject to hardware constraints.

For this assessment, appropriate robot kits are constructed from basic components and subsystems where a certain amount of electronics knowledge is demonstrated to complete the task. Students must be able to make decisions on voltage required (choose appropriate battery), current flow (limitations of microcontroller port outputs) **and a justified choice of components to complete the task.** In some cases they will have to use soldering techniques to solder the motor wires and inline switches.

Students may also require:

* an electronic breadboard
* soldering irons to construct robots from scratch
* electronic circuit simulation software, for example:

[www.falstad.com/circuit/](http://www.falstad.com/circuit/)

[www.yenka.com](http://www.yenka.com/)

<https://circuits.io/>

* an embedded programming language

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**Student/Ākonga instructions**

**Introduction/Kupu Arataki**

This assessment activity requires you to develop a refined robot that can accurately navigate a given maze.

You are going to be assessed on the quality of the robot that you have developed.

This is an individual assessment task. You have 8 weeks to complete it.

Teacher note: Insert context, due dates and timeframes

**Task/Hei Mahi**

You are going to make an automated robotic vehicle using basic electronic components and a microcontroller. The robot must perform to the specifications outlined in the task.

Identify and describe the relevant implications that are the most important for your outcome.

You should identify the implication, say what it means and what this might mean for your outcome. For example, you could:

* Describe what ethics is. Describe the ethical issues that relate to your outcome. What might you need to include in your outcome to ensure this is addressed?
* Describe what aesthetics is. Describe the aesthetic elements that relate to your outcome. What might you need to include in your outcome to ensure this is addressed?
* Describe what usability and functionality are. What does this mean in relation to your outcome? What might you need to include in your outcome to ensure this is addressed?

You will need to consider addressing these implications during the design, development and testing of your outcome.

**You must:**

* choose appropriate component types and values for the robotic vehicle
* modify, test and debug a functional model of the robotic vehicle
* use data sheets or calculations to assist in choosing appropriate component types and values for the robot
* write well-structured, clearly annotated, and readily understandable software.

As part of developing your outcome you will need to describe the interfaces and functions of the components of the systems used, explain the behaviour and function of the electronics outcome and justify your choice of the components and systems you have used.

Examples of concepts that you can refer to when demonstrating this requirement are:

* a circuit as a complete path
* voltage as an energy path
* current as rate of flow of charge
* distribution of voltage and current through a circuit (series and parallel circuits)
* conduction (limited to the macroscopic behaviour of conductors, insulators, and semiconductors)
* circuit subsystems
* symbolic conventions and schematics
* hardware (for example components and combinations of components)
* embedded systems as software subject to hardware constraints.

As you complete the task, gather evidence to include in a portfolio. This will be handed in with your completed robotic vehicle. Check with your teacher the length of the portfolio.

**Specifications**

Your specifications must be agreed with your teacher prior to construction.

Specifications for the automated robotic vehicle include:

sensors and a method to:

* + avoid wall collisions (if walls are used), or
  + detecting the line or path (black and white) marked on a given field, and calibrated to maintain its progress inside paths (if lines are used)
* a circuit that allows the robot to autonomously navigate a given maze, and a start/stop switch (with an associated delay sub-systems) to manually begin the task.

The system will be a microcontroller-based circuit, and may use the following components:

* microcontroller, for example PICAXE, Raspberry Pi, Arduino or MicroBBC, or other suitable system
* sensors i.e. light sensors, colour sensors, ultrasonic (proximity) sensors, touch sensors, side-switches to avoid collisions, potentiometer to control motor speed
* LEDs or a buzzer as indicators
* at least two motors turning wheels
* a suitable motor controller depending on the robot chassis. This could be an available subsystem or built from scratch.

A suitable platform for this work can be an electronic breadboard and/or other robot chassis. Many of these robot chassis are available with geared DC motors. You may also need fixed or variable resistors, diodes and capacitors.

After the hardware has been selected:

* Attach inputs or outputs to microcontroller and modify embedded programs that test each microcontroller input and output to ensure they function as expected.
* Integrate embedded software programs to develop the robot to meet specifications.
* The embedded software program needs to be well structured, readily understandable, and clearly annotated. The program may be based upon commonly available program stubs, sketches, examples etc., but needs to be modified appropriately to meet the context. This means your program should:
* be clearly set out and correctly indented
* include comments that explain exactly what the program is doing at each step
* use labels so that it is easy to read and understand the program.

**Completing the task**

As you perform the task, make notes and gather evidence for inclusion in your portfolio. For example:

* Show your use of appropriate resources and techniques used in developing your robot.
* Document the testing and iterative improvement you have made to your robot throughout the development and testing process. For example:
* trialling and selecting the best type and value of components
* trialling and selecting the best arrangement of components
* adjusting hardware input and/or output parameters
* adjusting software parameters
* using a multimeter to measure and report voltage and/or current levels at indicated points.
* Include diagrams, annotated photographs, written descriptions or video evidence to show your understanding of the interfaces and functions of the components you have selected for your system. This evidence should explain the behaviour and function of the outcome and show reasons (justify) for your choice of components and systems. For example:
* explain your choice of basic components to build your circuit, for example resistor to limit current and/or transistor to amplify current
* explain any calculations and/or research, for example manufacturer data sheets, that you used to determine the best components for your circuit
* describe how your circuit behaves in terms of the basic concepts, for example, a voltage divider, or the effect of a low battery
* explain the operation, function, and calculation of the electronic components you used in your circuit.
* Show evidence of your iterative testing procedures. This would generally include evidence of improvement through repeated cycles of trialling and
* Undertake testing procedures to debug and diagnose the electronic system to ensure fitness for purpose.

Examples may include:

* trialling and improving sub circuits and components
* trialling and improving embedded software for functionality and usability
* trialling and improving circuit layout
* trialling and improving circuit design and function
* trialling and improving the reliability of the circuit

Provide evidence of how you addressed the relevant implications that you identified and described in the process of developing the outcome. For example:

* How have you addressed ethical or intellectual property issues?
* How have you ensured that your outcome is usable and functional for your end users?

**In your portfolio, you must include:**

* circuit diagrams
* layouts
* embedded software programs for each step of the task.
* evidence of iterative improvement of the outcome.

**You may also want to include:**

* annotated diagrams and photographs, or videos
* journal entries with tables that describe your trialling and testing of circuits
* your responses to teacher questions
* interview notes from a scheduled teacher consultation.
* a short video showing the electronics outcome working

**Resources**

**Useful websites:**

<http://www.arduino.cc/en/>

[www.electronics-tutorials.com/basics/basic-electronics.htm](http://www.electronics-tutorials.com/basics/basic-electronics.htm)

<http://williamson-labs.com/>

**Assessment schedule/Mahere Aromatawai: Digital Technologies | Hangarau Matihiko 91881 –** **Automated Robotic Vehicle**

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| **Evidence/Judgements for Achievement/Paetae** | **Evidence/Judgements for Achievement with Merit/Kaiaka** | **Evidence/Judgements for Achievement with Excellence/Kairangi** |
| The student has developed an electronics outcome which involves:  ● using appropriate resources and techniques when developing a functional combination of hardware and software that performs to specifications  **For example (partial evidence)**  Student has developed a functional electronics outcome (or robot) that meets specifications. Each interface works, and the student is able to demonstrate a working robot. This includes includes at least two inputs and two outputs  They demonstrate individual programs to test the ports that may be sample programs that they have modified for their robot. They also have final code that shows correct operation for the robot but may not work reliably.  ● modifying and debugging embedded software ● undertaking testing procedures to debug and diagnose the electronic system ● describing the interfaces and functions of components and systems used  The student has described the interfaces and function of the main components and systems used within their outcome.  The student has evidence of modifying and debugging the software. They also have final code that allows for the robot to function but it may not work reliably.  The student has evidence of testing and debugging the input and output interfaces on expected analogue/digital inputs and outputs  **For example (partial evidence)**  **“***I have used a motor controller to provide more current to the motors than the Arduino can deliver”. They showed a diagram of the interface between the Arduino and the motor controller. “The motor controller I used can control the direction of the motors as well as the speed.”*  The student drew a completed circuit schematic with all the correct symbols and conventions. Using this, the student is able to describe the voltage and current flow requirements through the various subsystems.*“In electronics, we talk about a circuit as a complete path. This means that electrons flow from a battery through the components and back to the battery again. Sometimes there are breaks and shorts in the path due to incorrect wiring. See my circuit diagram and photograph with notes showing a completed circuit without short circuits or disconnections.”*  ● describing relevant implications.  **For example (partial evidence):**  *future-proofing -  is the process of making sure that the outcome will continue to be made available for future use based upon software and hardware*  *Functionality  - that the outcome works as expected.*  *The examples above are indicative samples only.* | The student has developed an informed electronics outcome which involves:  ● modifying, debugging and commenting software so that the program is logical and readily understandable  **For example (partial evidence)**  ● undertaking testing procedures to debug and diagnose the electronic system to improve the reliability  *“I used a distance sensor to measure the distance to the maze wall. The distance sensor is an ultrasonic sensor which means that it measure how long the signal takes to return. I desk checked the calculations using a variety of ruler measurement points to make sure that the correct values were being reported on and had to make changes to my setup of the robot as it would not measure walls less that 5 cm away.*  *I also tested each wire to make sure that the power and signal would function properly, I found that one of the wires was damaged from when I developed and initially tested the robot as it fell on the floor during testing.”*  *“I realised I needed to boost the current to the motors as the motors draw at least 100mA but the Arduino output port can only deliver 40mA. I decided to use a motor controller that is able to make my robot go backwards and forwards and I can control the speed.”*  The student demonstrates a robot that meets all the specifications reliably. They are able to write their own software using examples. The code is well documented and easy to understand. They use a more structured testing approach.  ● explaining the behaviour and function of the electronics outcome  **For example (partial evidence)**  “*I have used a LED as an indicator to show that my robot is on. I calculated the resistor value required using Ohm’s law. The resistor is required to limit the current through the LED to about 10 mA otherwise it will blow.”*  ● addressing relevant implications.  **For example (partial evidence):**  *future proofing - The student used only open source code when getting ideas for their embedded software program and have kept attribution within the code as comments.*  *functionality - The student related their choice of each component to its importance for the functionality of the outcome.*  *The examples above are indicative samples only.* | The student has developed a refined electronics outcome which involves:  ● undertaking testing procedures to debug and diagnose the electronic system to ensure it is fit for purpose  The student demonstrates a robot that meets the specifications and is fit for purpose. The robot is well constructed.  **For example (partial evidence)**  “*I have decided to try various heights for my IR sensor because the differentiation between black and white was not reliable. Sometimes depending on outside light the robot loses the line around the corners. I found that instead of 10mm off the surface, 5mm height worked much better. My robot can navigate the line now more reliably around the circuit.”*  Students have provided evidence of improvement through a repeated cycle of trialling and testing during the design, development and testing process.  for example: trialling and improving sub circuits and components   * trialling and improving embedded software for functionality and usability * trialling and improving circuit layout * trialling and improving circuit design and function * trialling and testing the reliability of the circuit * iterative improvement throughout the development and testing process * justifying the choice of components and systems used in the development of the electronics outcome   Testing procedures and documentation shows the student has improved the robot iteratively to provide a better outcome.  The student is able to justify their choices for components/subsystems.  **For example (partial evidence)**  “*I calculated the resistor value for my LED on my microcontroller to be … using Ohm’s law in this way (see my calculation and explanation). I wanted the LED to be bright enough for the light to be seen at a distance on a bright day. I chose the capacity of the battery for my project to be … based upon my calculations of the current demands of my circuit with … LEDs, motor … Here are my calculations …”*  *“I tested my motor and found that it could not be run directly by my microcontroller. So I used a transistor in the circuit between the microcontroller and the relay because the microcontroller is limited to providing X current and my motor requires Y current. The transistor for my motor amplifies the current as a microcontroller cannot drive a motor directly.*  *The microcontroller has … which can be used along with some code to control the function of the circuit. It does this by … I found some errors in the code on testing which I fixed by …*  *I researched three transistors… Their specifications are… I chose... as the specification for my relay is… and then I knew that my chosen transistor would not overheat/explode/cease to function. The effect of swapping the transistor in the circuit is … “*    *The examples above are indicative samples only.* |

Final grades will be decided using professional judgement based on a holistic examination of the evidence provided against the criteria in the Achievement Standard.

1. This achievement standard is derived from both *The New Zealand Curriculum* and *Te* *Marautanga o Aotearoa.* [↑](#footnote-ref-1)