Sample assessment task	
Year level	7
Learning area	Technologies
Subject	Design and Technologies: Engineering principles and systems
Title of task	Motion, mechanisms and motors
Task details	
Description of task	Students are required to study and understand the fundamentals of motion, force and energy. Students learn a design process and construct a simple electromechanical or mechanical device using components and materials available in a studio or workshop.
Type of assessment	Formative
Purpose of assessment	Develop students' understandings of the use of motion, force and energy to manipulate and control electromechanical and mechanical systems
Assessment strategy	A design folio development
Evidence to be collected	• Series of worksheets and design folio • Completed product and evaluation sheet
Suggested time	One term, approximately 9 weeks
Content description	
Content from the Western Australian Curriculum	***Knowledge and understanding*** **Technologies and society** Competing factors, including social, ethical and sustainability considerations, in the development of technologies Ways in which products, services and environments evolve locally, regionally and globally **Engineering principles and systems** The use of motion, force and energy to manipulate and control electromechanical and mechanical systems ***Processes and production skills*** **Investigating and defining** Define and break down a given task, identifying the purpose Consider components/resources to develop solutions, identifying constraints **Designing** Design, develop, review and communicate design ideas, plans and processes within a given context, using a range of techniques, appropriate technical terms and technology Follow a plan designed to solve a problem, using a sequence of steps **Producing and implementing** Safely make solutions using a range of components, equipment and techniques **Evaluating** Independently apply given contextual criteria to evaluate design processes and solutions **Collaborating and managing** Work independently, and collaboratively when required, to plan, develop and communicate ideas and information, using management processes

Task preparation	
Prior learning	Students have an understanding of a simple design process, have ICT capabilities and fundamental hand skills of production using materials.
Assessment differentiation	Teachers should differentiate their teaching and assessment to meet the specific learning needs of their students, based on their level of readiness to learn and their need to be challenged. Where appropriate, teachers may either scaffold or extend the scope of the assessment tasks.
Assessment task	
Assessment conditions	Individually complete worksheets and a design folio and the construction of the product and evaluation sheet.
Resources	• Theory worksheets • Design task template for folio • Relevant theory and skill demonstrations • Selection of available materials, components, tools and equipment

Instructions for teacher

Part one: knowledge worksheet

1. Introduction to the use of motion, force and energy to manipulate and control electromechanical and mechanical systems
2. Below are worksheets that require students to research specific fundamental motion, mechanisms and changes of force.

With teacher supervision and guidance, students can investigate given websites to find correct responses to the worksheet questions.

In addition, instruct students to research, using available research tools, and collect images of machines that represent the types of motion and mechanisms.

Students complete a series of investigation and presentation tasks to gain knowledge and understanding of the Engineering fundamental principles of the types of motion, and the mechanisms that direction and change movement.

Using the worksheets, students develop an understanding of:

- types of motion
- types of levers
- linkages
- pulleys and belts
- gears
- chain and sprocket
- crank and slider.

Students are required to seek definitions of terms, view associated mechanisms that exhibit these types of motion, and select appropriate images that relate to the methods of movement and motion.

This knowledge will be applied to designing and producing a mechanical device

Online resources

Scootle http://www.scootle.edu.au

Design and Technology; all contexts and years (UK sites)

http://www.design-technology.info/home.htm

http://www.design-technology.org/

http://www.notesandsketches.co.uk/Index.html

Design and Technology; all contexts and years (AUS sites)

https://www.scorpiotechnology.com.au/

Part two: design and produce a mechanical device

Students will design, construct and test a simple mechanical device.

1. Provide or have students prepare a design folio; start with discussing and writing a design brief.
2. In the worksheet is a page for a mind map. Brainstorming or mind mapping are simple methods for the collection and sorting out of thoughts.

   Instruct students to create their own mind map about simple mechanical devices, group them by types of motion, noting input actions and output results. Use computer software or pencil and paper.
3. Investigate the available input, transition and output components.
   Design limitations

   Input components, choose from:
   - low voltage electric motors
   - cranks
   - springs
   - rubber bands
   - pneumatics

   Processing or transition components, choice of:
   - axles and shafts
   - levers and linkages
   - pulleys and belts
   - gears
   - sprockets and chains
   - crank and sliders
   - cams

   Output components, choose from;
   - wheels, various materials
   - axles and shafts
   - belts and tracks
   - blades, fan or propellers or paddles
   - low voltage DC generator

   Power supply – batteries or low voltage power transformer
   Technical knowledge and understanding of ratios of the input and output forces of components of devices
   Materials for a stand or housing the device formed from;
   - pieces of clear or coloured acrylic plastic
   - light metals or timber
   - other materials considered suitable for parts of the model

   The housing may be painted, or decorated with signage or logos
   Available specialist tools, materials and equipment
   Teacher directed and demonstrated;
   - identifying components parts, and construction/assembly of any electronic components
   - general and specialist workshop tools such as plastics bandsaw, drill, buffing machine, heat strip bender

   Methods of making a stand or housing
   - marking, cutting and shaping, and finishing
4. Discuss with the class the types of mechanical devices that could be design-built.
5. Direct students in the writing of a statement of intent, based on the design problem.

6. Teach the applications of the fundamentals of the following:
    - motion – input, process or transition and output
    - ratios
    - safety awareness in the workshop.
7. Teach students some simple sketching techniques to get them to design, sketch and write notes on ideas and possible solutions:
    - sketches and notes should show a sequence of developing ideas and concepts
    - add measurements to the sketches
    - finish with a detailed sketch that could be used to build the solution
    - list of colours, additional materials and printed logos to add to the housing or stand
    - working drawings may be created, depending on the complexity of the solution.
8. Teacher should demonstrate some fundamental building skills:
    - students should observe, discuss and list the steps required to build the solution.
9. Students carefully follow their planned steps of production to collaboratively and safely use tools and equipment in the workshop to produce and test their solution.
10. Complete the assembly of the device to the housing or stand.
11. Students photograph their finished solution.
12. Evaluation: students write a 50 word reflection about how the device worked out and satisfied the design problem. Focus on the finished, working product. Explain how it works, and discuss its success as well as the areas that could be improved or changed (teacher may provide focus questions on a worksheet).

Name: _____ Group: _____

Worksheet task description:

Read, research and answer the questions on the following worksheets. Seek definitions of terms, view associated mechanisms that exhibit these types of motion, and select appropriate images that relate to the methods of movement and motion.

Types of Motion

*All mechanisms involve **motion** of some kind.*
*Motion can be an input into a mechanism or an output from it. There are **four** types of motion.*

linear motion	***reciprocating motion***	***rotary motion***	***oscillating motion***

- *Place the four types of motion with the correct definition.*
- *Then find and include an image that represents that type of motion.*

_____is movement in a straight line in one direction.
e.g. car on a freeway, aircraft flying through the sky.

_____is movement forwards and backwards in a straight line.
e.g. movement of a piston in a petrol engine or a sewing machine needle.

_____is movement in a circle in one direction.
e.g. CD spinning in a CD player or a tumble clothes dryer.

_____is movement forwards and backwards in an arc.
e.g. A child on a playground swing or a pendulum clock.

Types of levers

Levers were probably the first kind of mechanism to be used; moving rocks or prising open shells. Many simple mechanisms used today are levers: crowbar, fork, wheelbarrow, bicycle brakes, tweezers, door handles and electrical switches.

Find a definition of lever.

_____

_____

_____

What forms of motion do levers perform? _____

Three classifications of levers are determined by the arrangement of the effort, fulcrum and load.

Class 1: Load, Fulcrum and Effort

Class 2: Fulcrum, Load and Effort

Class 3: Fulcrum, Effort and Load

For each type of lever, find two images that represent each type.

Class 1: Load, Fulcrum and Effort

Class 2: Fulcrum, Load and Effort

Class 3: Fulcrum, Effort and Load

Linkages

Linkages are levers coupled to transmit motion and force in a desired way.

- **Parallel linkages** move while the opposite sides stay parallel.
- **Treadle linkages** can change rotary motion into oscillating motion.
- **Toggle clamps** use an over-centre locking linkage to fix quickly and hold firmly.

Find two examples of:

Parallel linkages

Treadle linkages

Toggle Clamps

Pulleys and Belts

Rotary motion produced by electric motors or engines must be controlled and, in most cases, the revolutions are transmitted through shafts or axles. These shafts can have pulleys attached.
Pairs of pulleys are grooved wheels linked by a belt.
The **driver pulley** is on the motor shaft and a **driven pulley** is on an output shaft.
Speed changes are made by using different sized pulleys.
Stepped cone pulleys are common on machinery that needs a quick change of output speeds. Belts connect and rotate with the different sized pulley wheels.

What forms of motion do pulleys and belts perform? _____

Find examples of: stepped cone pulley sets, and different combinations of pulleys.

Gears

Gears are wheels with evenly spaced teeth cut into the circumference. Gear teeth are designed to interlock or mesh; the teeth need to be the same size and pitch. A gear train will transfer rotary motion to another gear; however, this will cause the driven gear to rotate in the opposite direction.

What forms of motion do gears perform? _____

Find examples of spur gears, idler gear and compound gears.

Other types of gears can be arranged to change the direction of rotation.

Find examples of bevel gears, worm and wheel gears, crown and spur, rack and pinion.

Chain and Sprocket

A chain and sprocket mechanism has several advantages over pulley systems; there is no possibility of slippage, while the distance between driver and driven can be greater.
The sprockets are toothed wheels. The chain, usually made up from multiple links and pins, runs over the teeth.

What forms of motion do chain and sprocket perform? _____

Find examples of chain and sprocket assemblies.

Crank and Slider

The crankshaft and slider (e.g. in a car engine, connecting rod attached to the piston in the cylinder) mechanism is designed to change reciprocating motion into rotary motion. However, the mechanism can be used where powered rotary motion can be changed into reciprocating motion. Older forms of a crank can be found in other simpler mechanisms.

Find examples of crank and slider mechanisms

All mechanisms are designed to create some type of mechanical advantage. This mechanical advantage (MA) is usually calculated by the ratio between the input force and the resultant output force through the components of the mechanical device.

Simple calculations can use the following formulas to find the difference between the original speed (input) and the final speed (output). Note: the symbol Ø is diameter, and n^{o} is the number of.

- pulley belt ratio = $\frac{\text{Ø follower pulley}}{\text{Ø driver pulley}}$ = input revolutions:1 output revolution

- chain and sprocket ratio = $\frac{\text{n}^{o}\text{ teeth follower gear}}{\text{n}^{o}\text{ teeth driver gear}}$ = input revolutions:1 output revolution

- gear ratio = $\frac{\text{n}^{o}\text{ teeth follower gear}}{\text{n}^{o}\text{ teeth driver gear}}$ = input revolutions:1 output revolution
  - pinion gear
  - idler gear
- for rack and pinion, calculate the distance moved = $\frac{\text{n}^{o}\text{ teeth pinion} \times \text{n}^{o}\text{ revolutions}}{\text{n}^{o}\text{ teeth per metre of rack}}$

Name: _____ Group: _____

Design Brief:
In this section, write down your design problem.

_____

_____

_____

_____

Create a mind map showing simple mechanical devices. Group them by types of motion, noting input actions and output results. You may use computer software or pencil and paper.

Mind Mapping

Statement of intent

Write a clear description of the project you are going to design and make.

Write and describe each of the following:

- why – situation
- what – is it expected to do
- where – location
- who – you, family or other
- and when – time of day, or occasion.

Make statements that are clear, with full sentences, and that are detailed in their meaning.

Include the likely components you think are needed for this device to function.

Think about ideas and sketch some concepts **drawing space for ideas and concepts**

Additional notes on ideas, colours and logos for device

Drawing template for ideas and concepts **Write notes around and about your ideas (annotations)**

Drawing template for developing ideas and concepts Write annotations around your drawings

Drawing template for consolidating ideas and concepts **Don’t forget important annotations**

Notes from Teacher Production skills demonstration

Take notes on materials, components, cutting and shaping tools and machines, assembly of components, and finishing procedures, testing, forces and powering up.

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Planning production

List the tools and equipment, and the steps of the process you need to follow to produce your design.

Tools/equipment	Process

My completed working device (photographs) and evaluation

Evaluation: Write a 50 word reflection about how you think your device worked out. Focus on the finished, working product. Explain how it works, and discuss its success as well as the areas that could be improved or changed.

Trigger questions

- *Did your design satisfy the design brief and statement of intent? If not, what changes did you make and why?*
- *Did your design turn out as you planned it would? Explain why or why not? (Consider your sketch and comment on the size, shape, colour, added materials etc.)*

- *Did your design work mechanically as planned? Explain why or why not?*
- *Did your production process use the tools and equipment listed? If not, what changes did you make and why?*

Sample marking key

Description	Marks
Technologies and Society	
Demonstrates an extensive understanding of the competing factors and different devices in engineering technologies (e.g. the mind map and the variety of notes and images).	5
Demonstrates a high level of understanding of the competing factors and different devices in engineering technologies (e.g. the mind map and the variety of images).	4
Demonstrates a satisfactory level of understanding of the factors and different devices in engineering technologies (e.g. the mind map and the variety of images).	3
Has a limited understanding of the different devices, and requires guidance to arrange and present them on a mind map.	2
Has difficulty selecting different devices, and requires assistance to select images to complete the mind map.	1
Subtotal	**5**
Description	**Marks**
Engineering principles and specialisations	
Expresses a clear understanding of the operation of the mechanisms. Comprehensively acknowledges the principles behind the operations of a range of mechanical devices and how they function.	5
Explains the operation of a selection of mechanical devices and clearly describes their function.	4
Appropriately explains the operation of mechanical devices to complete a task. Provides a simple explanation of function.	3
Demonstrates limited understanding of the operation and function of some mechanical devices.	2
Requires assistance to understand how a mechanical device works.	1
Subtotal	**5**
Description	**Marks**
Investigating and defining	
Demonstrates thought and insight into the researching of devices for an intended purpose. Considers a wide range of components/resources to develop solutions, describing likely constraints.	5
Applies learned research skills to present relevant devices for an intended purpose. Considers available components/resources to develop solutions, identifying constraints.	4
Demonstrates effective research skills. Presents relevant information on a suitable range of components/resources to develop solutions.	3
Demonstrates developing research skills. Presents limited information on common components/resources, may not be relevant in developing solutions.	2
Demonstrates limited accuracy in the research. Presents incomplete information on a limited range of components/resources/devices.	1
Subtotal	**5**

Description	Marks
Designing	
Demonstrates a well-developed understanding of design process, using a range of appropriate technical terms to explain plans, drawings and design choices. Provides accurately drawn and labelled design for a device. Selects a variety of appropriate components and materials to make a device and justifies materials selected to match their use.	5
Applies understanding of the design process and demonstrates a high level of competence when choosing components and materials, which is reflected in the drawing of the device, while using suitable technical terms to explain choices. Drawings reflect accurate detail for the proposed design.	4
Demonstrate developing understanding of the design process, through labelled, satisfactory drawings of their intended device. Uses some technical terms to explain choices.	3
Demonstrates limited level of understanding of the design process, with limited notes and few steps in the design process completed. Requires assistance to correct inaccuracies in drawn design.	2
Shows little accuracy in the steps of the design process. Notes are incomplete and lack any detail. Demonstrates limited skills in drawing and does not communicate ideas clearly.	1
Subtotal	**5**
Description	**Marks**
Producing and implementing	
Selects materials appropriate to the construction of the device and accurately plans and follows the procedure. Explains safety considerations clearly. Confidently and safely uses a range of components, equipment and techniques to complete a product, explaining any alterations made.	5
Selects construction materials and tools for the making of the device and follows a planned procedure. Safely uses a range of components, equipment and techniques to complete a product, explaining any alterations made.	4
Demonstrates safe processes using a range of components, equipment and techniques to complete a product, explaining the processes. Identifies changes made.	3
Requires assistance to produce an end product that may not match the design. Attempts to give basic reasons for changes.	2
Finishes with an end product that does not match the design and provides no relevant explanation as to why.	1
Subtotal	**5**
Description	**Marks**
Collaborating and managing	
Demonstrates consistent management skills and processes. Works independently and co-operatively to develop ideas and plan production. Works collaboratively when required to assist others to produce designed devices.	5
Demonstrates developing management skills. Works co-operatively to develop ideas and plan production. Works collaboratively when required to produce designed device.	4
Works co-operatively to develop ideas and plan production. Works collaboratively when required to produce designed device.	3
Works co-operatively to produce designed device.	2

Demonstrates little collaboration, and requires assistance to work towards an end product.	1
Subtotal	**5**
Description	**Marks**
Evaluating	
Comprehensively acknowledges that the initial design needs to match the end outcome and accurately explains any alterations made, justifying why they were made.	5
Understands that the device must match the design any can clarify and changes made and give reasons for the changes.	4
Follows design accurately and understands the end program should match the initial design. Lists basic changes made.	3
End product may not match design. Attempts to give basic reasons for changes.	2
End product does not match the design and no explanation is given for why, or the explanation is not relevant to the task.	1
Subtotal	**5**
Total	**35**