كل ما يحتاجه الطالب في جميع الصفوف من أوراق عمل واختبارات ومذكرات، يجده هنا في الروابط التالية لأفضل مواقع تعليمي إماراتي 100 %

تطبيق المناهج الإماراتية | الاجتماعيات | الرياضيات

الصفحة الرسمية على التلغرام | الاسلامية | العلوم

الصفحة الرسمية على الفيسبوك | الانجليزية

التربية الاخلاقية لجميع الصفوف | اللغة العربية

التربية الرياضية

مجموعات التلغرام.	مجموعات الفيسبوك	قنوات تلغرام	قنوات الفيسبوك
الصف الأول	الصف الأول	الصف الأول	الصف الأول
الصف الثاني	الصف الثاني	الصف الثاني	الصف الثاني
الصف الثالث	الصف الثالث	الصف الثالث	الصف الثالث
الصف الرابع	الصف الرابع	الصف الرابع	الصف الرابع
الصف الخامس	الصف الخامس	الصف الخامس	الصف الخامس
الصف السادس	الصف السادس	الصف السادس	الصف السادس
الصف السابع	الصف السابع	الصف السابع	الصف السابع
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Creative Design and Innovation

G12 General Teacher's Guide

CREATIVE DESIGN
INNOVATION

Term 2 2018-19

Volume 01

Table of Content:

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Introduction:

This Teacher's Guide aims to provide the teachers of Creative Design and Innovation with a set of teacher support materials. This includes the Instructional Planner (IP), the Lesson Plans (LPs) and Answer Keys.

The Instructional Planner aims to provide teachers with the scope and sequence during the term. Teachers will be able to have a detailed idea of when to teach each section of the book and accordingly organise their work during the entire term in advance. The Instructional Planner also highlights the material that will not be assessed throughout the term (self-study). This IP can be found on LMS, where some very important resources are attached to each week and need to be downloaded by the teacher.

Note that the IP is divided into weeks containing three periods, the same applies to Lesson Plans. These may be organised as double and single or all single periods depending on school timetables. Assessment weeks will be confirmed by ADU throughout the term and the current distribution of weeks might need to be slightly tweaked by the teacher accordingly.

The Lesson Plans provide a model teaching strategy for Creative Design and Innovation teachers. It highlights the core points that allows teachers to support the progress of their students and it divides the lesson into phases to allow an optimum comprehension of the lessons for students. It also provides a plenty of advices for the teachers to follow in class promoting various teaching methodologies, practices and strategies. It contains answer keys for all the questions and activities within the book, in order to provide teachers with model answers that guarantee a moderate and consistent level for answers across the country.

As a CDI teacher for Grade 12 students, you have a great responsibility of enlightening your students with the available opportunities in their higher education studies. CDI is a very important and rich subject that eventually feeds into many science engineering and design fields. Please demonstrate this importance at the beginning and throughout the term. This will allow students to give extra attention to the subject and motivate students to explore the subject outside the classroom. Also, as G12 students are seeking high grades for their university acceptance, it is extremal important to draw their attention to the assessment approach in G12. This can be achieved through familiarising them with project-based learning and its assessment scheme in details.

Wishing you a very successful and fruitful term with your creative and innovative students!

The authors,

April 2019.

Instructional Planner:

Trimester Planner (Instructional Planner)
Term three 2018/2019

SUBJECT: Creative Design and Innovation (CDI)

Grade 12 General

Note: All **blue** Learning outcomes are from Chapter 1: the design process but completed throughout the term as further chapters are studied. All learning outcomes are essential unless highlighted in **green**, they are not directly assessed but contribute to project assessment.

Week	Period	Chapter	Overview	Learning Outcomes
1 14/04	1	1	**Chapter 1 - Section 1:** The design process: Design of a SumoBot	• **Analyse a brief.** • **Distinguish between different types of research.** • **Present research and investigation techniques.**
	2	2	**Chapter 2- Section 1:** Vehicle design specifications	• **Carry out and present research and investigation.** • Define a SumoBot. • Compare possible drivetrains. • Complete drivetrain rpm calculations. • Differentiate between brushed and brushless motors. • Analyse possible power sources. • **Carry out and present research and investigation** • Identify suitable motors and power sources for a SumoBot. • Differentiate between steering mechanisms.
	3			
2 21/04	1	3	**Chapter 3 - Section 1:** Introducing SumoBot	• Recognise the history and objective of the sumo sport. • Recognise the history of the SumoBot battles. • Identify the different robot designs and sizes. Identify what motivates roboteers to participate in SumoBot matches.

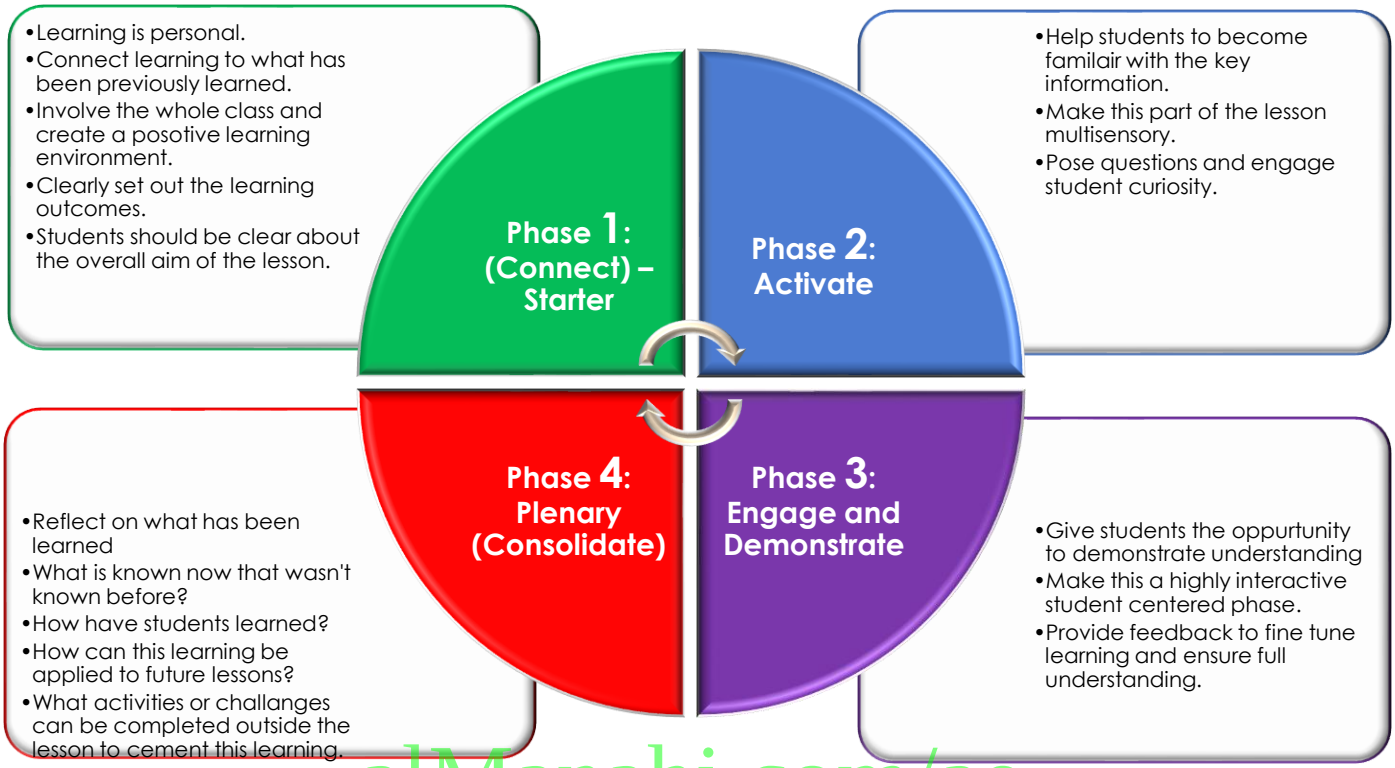
2 21/04	0		**Section 2:** Design analysis of a SumoBot	• Differentiate between motor types and identify how they work. • Explain the function of a motor driver. • Discover methods of wireless control. • Categorise inputs, controllers and outputs of an electrical circuit.
	2	3	**Chapter 3 - Section 3:** Robotic sumo control mechanism	• **Carry out and present research and investigation** • Design a circuit to drive DC motors using a Bluetooth device. • Build and test a circuit to drive DC motors using a Bluetooth device. • Develop an Arduino code to control the DC motors using a Bluetooth device. • Test the Arduino code and verify that the system works as desired.
	3			
3 28/04	1			
	2	4	**Chapter 4 - Section 1:** Fusion 360 recap **Chapter 4 - Section 2:** Introduction to basic modelling *Note: The amount of time spent on section 1 and 2 should be determined by your classes level and previous experience on fusion 360. Students will have covered these sections in previous terms a quick 15 minute recap should be enough for the sections 1-2.* **Chapter 4 - Section 3:** Assemblies and Multiple body design	• Register for Fusion 360. • Open a new design in Fusion 360. • Save a file in Fusion 360. • Navigate the toolbar. • Open and navigate the data panel. • Share work from your data panel. • Download files and upload files to your data panel. • Identify 2D sketch tools. • Identify and distinguish between planes. • Create dimensioned 2D sketch. • Create a 3D model using extrude tool. • Understand how to model different bodies and components in one design. • Use combine tool to create one body or component. • Save separate components as parts.
	3		**Chapter 4 - Section 3:** Assemblies and Multiple body design	• Insert an existing part into a design. • Differentiate between joint types.
4 05/05	1	4	**Chapter 4 - Section 3:** Assemblies and Multiple body design	• Create an assembly using all joint types. • Apply joint limits to moving joints.
	2		**Chapter 4 - Section 4:** Chassis base design and positioning the motors	• Identify the required chassis type and size. • Create the required 2D sketch. • Extrude a 2D sketch. • Insert and position the motors onto your base. • Create motor mounts within the design. • Create holes to secure motors to the mounts.
	3			

5 12/05	1	4	**Chapter 4 - Section 4:** Chassis base design and positioning the motors	• Mirror components and bodies. • Assemble most electric components within the chassis.
	2 3	4	**Chapter 4 - Section 5:** Multibody SumoBot design	• Create a chassis body to hold all the required components. • Create an offset plane. • Shell the chassis body. • Split a body to create a top cover piece. • Create screw mounts within the design to secure the top cover to chassis. • Create holes to secure the top cover of the mounts. • Mirror features and bodies.
6 19/05	1 2 3		**Summative Assessment Week**	
7 26/05	1	4	**Chapter 4 - Section 5:** Multibody SumoBot design	• Further develop your modelling skills by reshaping the design.
		1	**Chapter 1 - Section 1:** The design process: Design of a SumoBot (Stage 4- 5: Possible and Final Solutions)	• **Create neat possible solution sketches.** • **Create an improved final solution design**
	2 3	4	**Chapter 4 - Section 5:** Multibody SumoBot design	• Create your very own SumoBot design using all the skills you have acquired in grade 12.
8 02/06	1 2 3	4	**Chapter 4 - Section 5:** Multibody SumoBot design	• Create your very own SumoBot design using all the skills you have acquired in grade 12.
9 09/06	1 2 3	4	**Chapter 4 - Section 5:** Multibody SumoBot design	• Create your very own SumoBot design using all the skills you have acquired in grade 12. • **Evaluate the final project. (Remind students that evaluation is a continuous process and they should also evaluate after assembly but this will not be assessed)**
10 16/06	1	5	**Chapter 5 - Section 1:** Manufacturing and assembly of a SumoBot	• Combine bodies for 3D printing. • Convert 3D models to STL files. • Insert and set up STL files for 3D printing in FlashPrint.

	2 3			• 3D print all SumoBot components. • Assemble all parts using suitable joining methods. • Fully assemble the electronic circuit. • Test the Arduino program to control the circuit and fully satisfy the brief.
11 23/06 **12** 30/06			**SumoBot Competitions**	• Students will have their SumoBots compete against their classmates' bots to see who is crowned SumoBot champion.

Using the provided lesson plans

Lesson plans are provided to work with the instructional planar. The lesson plan contains 4 key learning phases. The generic lesson progression is demonstrated below, please follow the phases (clockwise).



When following the lesson plan work from left to right, completing each phase in that row before moving to the next row (see next page). The lesson should always begin with the **connect** phase and end with the **plenary** phase; however, the lesson may move between phases several times throughout the period.

The example figure below explains this flexibility of moving between phases for Period 1.

Phase 1: (Connect) – Starter →	Phase 2: Activate →	Phase 3: Engage and Demonstrate →	Phase 4: Plenary (Consolidate) Return to begging of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Discuss prior knowledge of the engineering design process. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to explain the importance of a brief and key areas in a brief. Introduce the given brief Introduce analysis of brief and identify key words to be defined.	a) Divide students into groups assigning each group a number of key words. Facilitate students analyse the brief using activities from 1.1.3		Questioning	
	b) Introduce students to different methods of research and design inspiration. Analyse a given example mood board	b) Facilitate as students explore the research questions in activity's 1.4 and 1.5.	Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Have learning outcomes been met? Has lesson aim been achieved? All students must complete the activities for homework if not complete.		

Notes should be made by the teacher on activities or tasks to cater for differentiation specific to your class group.

Lesson Plans:

Week 1 Lesson Plan:

<table>
<tr><td rowspan="4">Content</td><td colspan="2">Grade 12 General</td></tr>
<tr><td>Chapter 1: Engineering design</td><td>Section 1: The design process: Design of a SumoBot</td></tr>
<tr><td>Chapter 2: SumoBot vehicle design</td><td>Section 1: Vehicle design specifications</td></tr>
<tr><td rowspan="2">Chapter 3: Design and Control of a SumoBot</td><td>Section 1: Introducing SumoBot</td></tr>
<tr><td>Section 2: Design Analysis of a SumoBot (Self-Study)</td></tr>
<tr><td rowspan="2">Time allocated</td><td colspan="2">Ch1, Ch2 2 x 45-minute periods</td></tr>
<tr><td colspan="2">Ch3_Section 1: 1 x 45-minute period (to be continued in period 1 of week 2)</td></tr>
<tr><td>Keywords</td><td colspan="2">What are the keywords the students must learn?</td></tr>
<tr><td colspan="2">• analysis
• aesthetics
• research
• design realisation
• evaluate
• Arduino board
• Arduino IDE
• SumoBot
• Sumo sport
• Sumo ring
• drivetrain
• combustion
• crankshaft
• armature
• brush
• electromagnet
• velocity ratio
• differential steering</td></tr>
<tr><td>Resources</td><td colspan="2">What resources are required?
• textbooks
• projector
• sketching equipment</td></tr>
<tr><td>Prior Knowledge</td><td colspan="2">• Sketching
• Fusion 360
• Basic electronics
• 3D printing
• Robotics
• Operation of DC motor</td></tr>
</table>

Aim:

In the first two lessons of this week, students will be introduced to the design process. They will understand the stages of the design process and the importance of each stage. Students will also learn why the design process follows a specific loop and stages that cannot be skipped or left out without affecting the finished design. For the first stage, students will be given a design brief to solve. They must analyse this brief and show understanding of the problem to be solved. Stage 3 involves research and investigation to solve the brief. Students will learn

about the types of research before moving onto chapters 2 and 3 to aid students research and understanding of vehicle design and more specifically SumoBot design.
In the following lessons, students will be introduced to the Sumo and SumoBots. Students will learn about the history of the game, its objective and rules. They will also learn about the various designs and sizes of sumo robots.

Teacher Learning Objectives:
Learning objective refers to what you as a teacher will have taught the student by the end of the lesson. Teachers are to tick the box when they have covered a learning objective.

Student Learning Outcomes: Learning outcomes refer to what the student can expect from the lesson, Teachers must share these outcomes with all students. Teachers are to tick the box when the outcome is achieved. Learning outcomes can be assessed using oral questioning and the written activities.

Teacher should: *(tick as you complete)*	***Students should:*** *(tick as students complete)*
☐ Introduce the given brief.	☐ Analyse a brief.
☐ Introduce different types and techniques of research and investigation.	☐ Distinguish between different types of research. ☐ Carry out and present research and investigation.
☐ Explain the functions of a SumoBot.	☐ Define a SumoBot.
☐ Demonstrate possible drivetrains.	☐ Compare possible drivetrains.
☐ Demonstrate sample rpm calculations.	☐ Complete drivetrain rpm calculations.
☐ Explain possible steering mechanisms.	☐ Differentiate between steering mechanisms.
☐ Give introduction to the history and objective of the sumo sport and its robotic counterpart.	☐ Give the definition of the sumo sport. ☐ Recognise the history of the SumoBot battles.
☐ Introduce the SumoBot rules and regulations.	☐ Identify the different robot designs and sizes.
☐ Remind students of the relevant research questions to be answered from Chapter 2	☐ **Carry out and present research and investigation**

Possible teaching method(s) or approach for this lesson

(teacher to tick the relevant method)

- ☐ Collaborative Teaching (student centred)
- ☐ Instructional / Demonstrative Teaching (teacher centred)
- ☐ Inquiry-based Teaching (student centred)
- ☐ Lecture Style Teaching (teacher centred)
- ☐ Coach Style Teaching (teacher centred)
- ☐ Facilitator Style Teaching (student centred)

Essential and non-essential Sections:

In some lessons it may not be possible to cover every section of the book due to time constraints or lesson variables. Below is a guideline to essential sections for examination and project knowledge.

Topic			Page	
Chapter	**Section**	**Focus**	**Essential**	**Non-essential/Self Study**
CH. 1	**Sec. 1**	Design process (part 1)	13-30	-
CH. 2	**Sec. 1**	Vehicle design specifications	47-62	
CH. 3	**Sec. 1**	History of the sumo sport	65-70	-
		History of the SumoBot	70	-
		What is SumoBot?	71-74	-
		SumoBot design process	75-78	-
	Sec. 2	Arduino board	-	90-93
		Electric motors	-	94-108
		Motor drivers	-	109-116
		Wireless communication	-	117-124

Learning Phases – Week 1: Ch1 Section 1 – Period 1

Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to beginning of next	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Discuss prior knowledge of the engineering design process. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to explain the importance of a brief and key areas in a brief. Introduce the given brief Introduce analysis of brief and identify key words to be defined.	a) Divide students into groups assigning each group a number of key words. Facilitate as students analyse the brief using activities 1.1.1 - 1.1.3		**Oral Questioning** **Written Activity 1.1.1 – 1.1.3**	
	b) Introduce students to different methods of research and design inspiration.	b) Facilitate as students explore the research questions in activity's 1.1.4 and 1.1.5.	Teacher to facilitate as students evaluate learning.	**Written Activity 1.1.4 - 1.1.6**	

	Analyse given example mood board.	*(Studying chapters 2 and 3 in the following lessons will aid students in answering these questions so it is important they explore and understand each question.)*	Question pupils on what they have learned. Have learning outcomes been met? Has the lesson aim been achieved? All students must complete the activities for homework if not complete.	**Student reflection**	

Answer Key

QR code links:		
Page	***Topic***	***Link***
10	Intro-basic SumoBot	https://www.youtube.com/watch?v=3RvtxHr_nnM&feature=youtu.be
10	SumoBot competitions	https://www.youtube.com/watch?v=30sbXfiHrqw&feature=youtu.be
30	Sketching	https://www.youtube.com/watch?v=OezMavBqWXc

Activity 1.1.1

Keyword	Meaning:
Fusion 360	A computer software for 3D modelling.
Arduino board	A simple microcontroller board that reads sensory inputs and translates them into outputs performing a specific function
SumoBot	a robot that attempts to push another robot out of a circle, as in the sumo sport
Bluetooth	a standard for the short-range wireless interconnection of mobile phones, computers, and other electronic devices.
Differential steering	also known as skid steer; individual motors on the left and right steer a vehicle by one motor producing less drive torque than the other

Activity 1.1.2

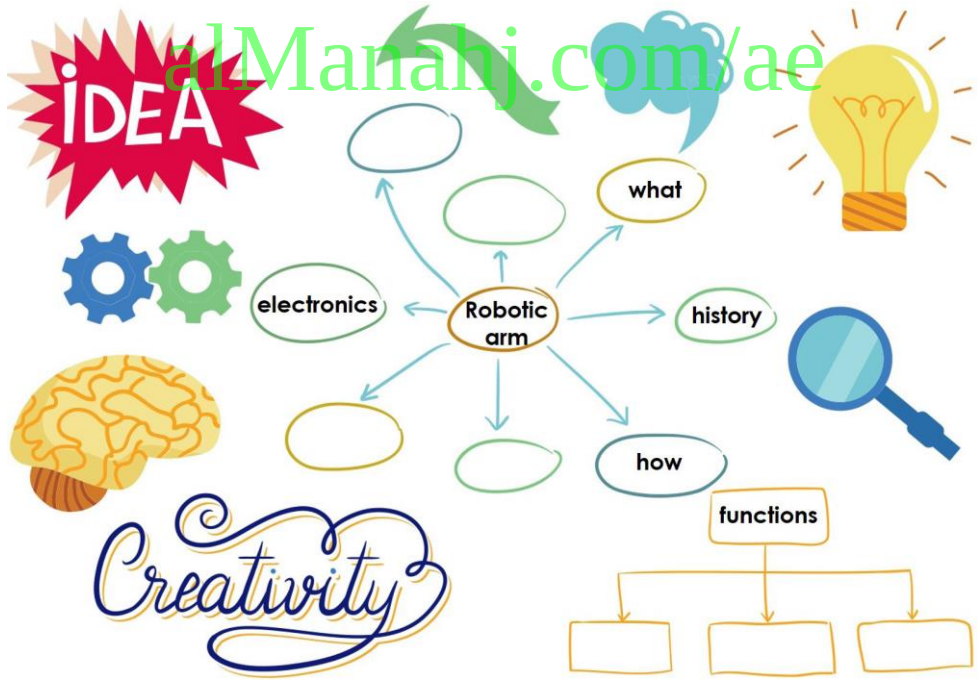
Key areas of brief:	Possible Questions	Explain the key areas in the SumoBot brief
Aims and objectives	What is the overall aim? What steps will you take to meet this aim?	The overall aim is to design and manufacture a SumoBot to enter in a SumoBot competition. The bot must be able to drive forward/ backwards and left/right and push its opponents out of the ring. It must also be controlled through Bluetooth.
		I will complete the SumoBot circuit and further my electronic and soldering skills
		I will improve my Arduino knowledge to control the SumoBot.
		I will develop a 3D model on Fusion 360 and 3D print the model.
		I will complete the SumoBot circuit and further my electronic and soldering skills

Budget and schedule	Do you have a budget? When must your project be completed?	The SumoBot must be completed with the given materials. The SumoBot must be completed by week 10 of term 3.
Target Audience	Who do you think might purchase this SumoBot?	Kids would really enjoy playing with these SumoBots, or anyone with interest in robotics or works in that field
Materials	What restrictions will you have to deal with when choosing materials for manufacture?	3D printers can print PLA or ABS
Style or theme	Is there a style or theme required for the SumoBot?	Students can choose any style or theme. For example, adapting a fighting theme in my final design.

Activity 1.1.3

In the space below, create your own Mind Map. Add key information you have taken from activity 1.1.2.

Encourage students to really explore every aspect of the brief here. Use as many branches as necessary to demonstrate the brief on a mind map. Use colour to show clarity.



Where can I encourage my students to look for inspiration?
You could do up a powerpoint presentation addressing some of the points below or you could even ask a guest speaker to come into school to speak about design.
When designing a product, designers often look at various areas for inspiration. Some of these include:

- **nature -** The natural patterns and forms found in nature are often used as a starting point for fresh ideas.
- **architecture -** Common shapes or forms can provide inspiration when thinking of creative ideas.
- **design movements -** Design movements such as Art Nouveau, Modernism, Bauhaus, Art Deco, etc. can provide inspiration for new innovative ideas.
- **past and future solutions -** Looking at previous designs of can really help. Most modern-day inventions or designs are an improvement on, or inspired by, an existing product. Futuristic or concept designs can really get creativity flowing.
- **internet and social media –** Google images, Pinterest, YouTube and Instagram can be great assets in gaining inspiration for a design.

Teacher Tip: Put up various images of successful designers work or quotes on your walls to help develop the interest of your students in design.

Stage 3: Research and investigation of possible solutions

What should my students include in this section?

Students should clearly show the investigation that has been completed. The investigation should display your understanding of the brief. Students can use images, notes, and sketches. They should avoid having just a collection of information gathered. There is little value in reproducing material gathered from the internet, magazines, books, etc. Students should research and analyse all aspects of SumoBots.

What methods of research should the students use?

You could start by introducing students to the two types of research- primary and secondary research.

Primary research involves the observation of associated objects in your immediate environment or locality.

Secondary research involves gathering information from existing sources. You should encourage students to consider the following sources.

- Libraries
- Books
- Magazines
- Catalogues
- Homecare and hardware stores
- Exhibitions
- Websites

Students should take note of any inspiration gathered at any stage of this process as this will be useful for their presentation of investigation. These images can be used in the mood board.

Teacher Tip: Encourage students to use forms of research they might enjoy like capturing and sharing images on Snapchat or Instagram.

What is required of my students in this section?
Each time they carry out research they should be posing questions about their design. Activity 1.1.4 and 1.1.5 show suitable research questions.

Activity 1.1.4

Design research

Answer the questions below to help you carry out design research:

1) Will the colour of the design affect the finished product? How?

Some colours will retain or reflect heat, Bright colours may attract attention to interest buyers. (any relevant point to justify colour selection.)

2)What mechanisms must my design include?

3) What type of steering mechanisms are suitable for a SumoBot?

The steering should operate using a skid steer mechanism.

4) What materials are suitable for 3D printing?

PLA and ABS. Aluminium can now be 3D printed with advancing printing methods.

5)What is the maximum 3D printing area of the 3D printer in your classroom?

140mm x 140mm

6) What are the dimensions of the DC motors supplied for this project? How will this affect the design?

69x37x23mm. This will affect the design dimensions of the joints and base as you need to ensure the correct size to house the servo motors.

Activity 1.1.5

SumoBot control circuit research

Answer the questions below to help you carry out research on the SumoBot circuit:

1) What control boards can be used to control the circuit?

-Arduino Leonardo board.

- Arduino is a single-board microcontroller that can be programmed using an easy-to-use software.

2) What is the function of the motor driver?

Takes a low current control signal and turn it to a high current signal that can drive a motor. The L298N motor driver allows you to control the speed and direction of two DC motors; it can be used with motors that have a voltage of between 5 and 35V DC.

3) Identify the motor type (DC or AC) that will be used to drive the robot. Justify your Answer?

DC motor, because it is powered by a direct current power source (battery).

4) What voltage is needed to drive the circuit?

9-12V.

5) What other components are needed to complete the wireless control circuit?

DC motors, Bluetooth module, motor driver, toggle switch, Power supply, Arduino Leonardo, Jumper wires.

Learning Phases – Week 1: Period 2

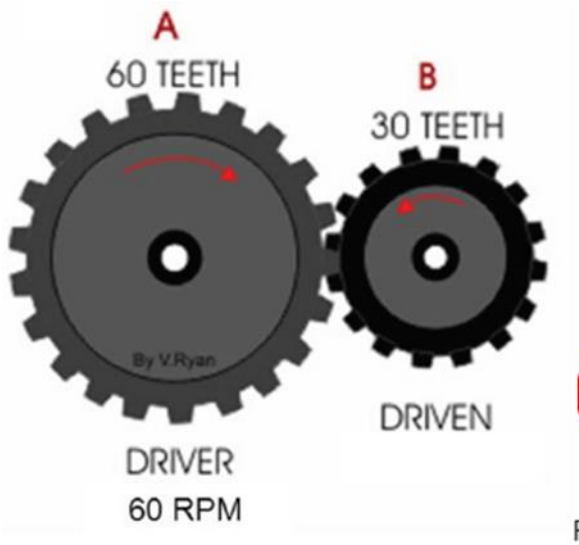
Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to beginning of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Discuss prior knowledge of chassis and vehicle design specification. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to explain the operation and functions of a SumoBot.	a) Students to contribute with any existing knowledge they have on SumoBots.		**Oral Questioning**	
	b) Teacher to introduce pupils to vehicle chassis.	b) Facilitate and provide feedback as student's complete activity 2.1.1		**Written activity 2.1.1**	
	c) Teacher to introduce fossil fuels as a power source for internal combustion engine. Teacher will introduce electricity and DC motors as an alternative power source in chapter 3 next week.	c) Divide students into groups assigning each group a power source and engine/motor type. Use an "Each on teach one" approach to have groups show their understanding and improve other groups understanding.		**Oral Questioning** **Written activity 2.1.2 - 2.1.3**	

		Students demonstrate learning by completing activities 2.1.2 - 2.1.3. Teacher to facilitate and provide feedback.			
	d) Teacher to explain the function of drivetrains and complete sample calculations	d) Divide students into groups assigning each group a drivetrain. Use an "Each on teach one" approach to have groups show their understanding and improve other groups understanding of drivetrains. Students demonstrate learning by completing activity 2.1.4. Students to demonstrate learning by completing activity 2.1.5-2.1.7. Teacher to facilitate and provide feedback.	Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Have learning outcomes been met? Has the lesson aim been achieved? All students must complete the activities for homework if not complete.	**Oral Questioning** **Written activity 2.1.4** **2.1.5 - 2.1.7** **Student reflection**	

Answer Key

Note there is a typo on Pg. 57 in the example calculation.

The motor rpm is 300 rpm and should read: 300 rpm x 2 = 600rpm



VR = Driver/Driven
VR = 60/30
VR = 2
If this motor rotates at 300 rpm what speed will the wheel rotate at?
Motor rpm x VR = **Wheel rpm**
600 rpm x 2 = 600 rpm

Figure 2.1.20

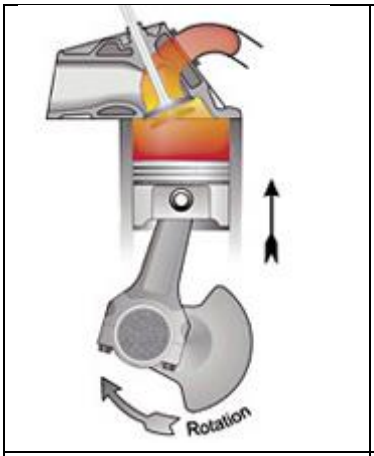
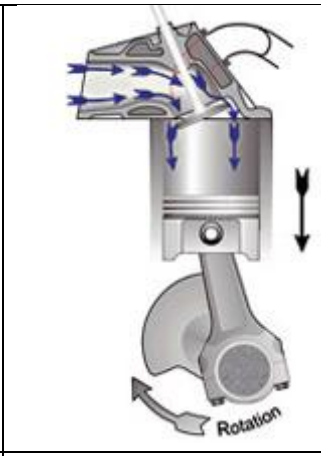
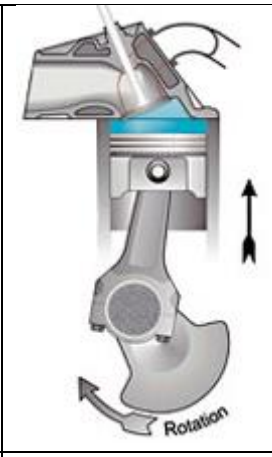
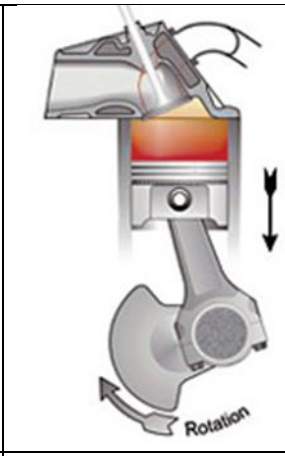
Activity 2.1.1

The image below shows a body on frame chassis vs a unibody chassis. List the advantages and disadvantages of each type in the space below.

Body on frame	**Unibody**
Advantages	***Advantages***
High load capacity	*Lightweight*
Easy to design	*More comfortable / less rattles*
Easy to manufacture	*Better performance / handling*
Strong and safe	*Better economy*
Easy to repair	
Disadvantages	***Disadvantages***
Heavy	*Not as strong*
Lower performance	*Lower load capacity*
Lower Economy	*More easily damaged*
	Difficult to repair

Activity 2.1.2

Label the strokes of an internal combustion engine as shown below.

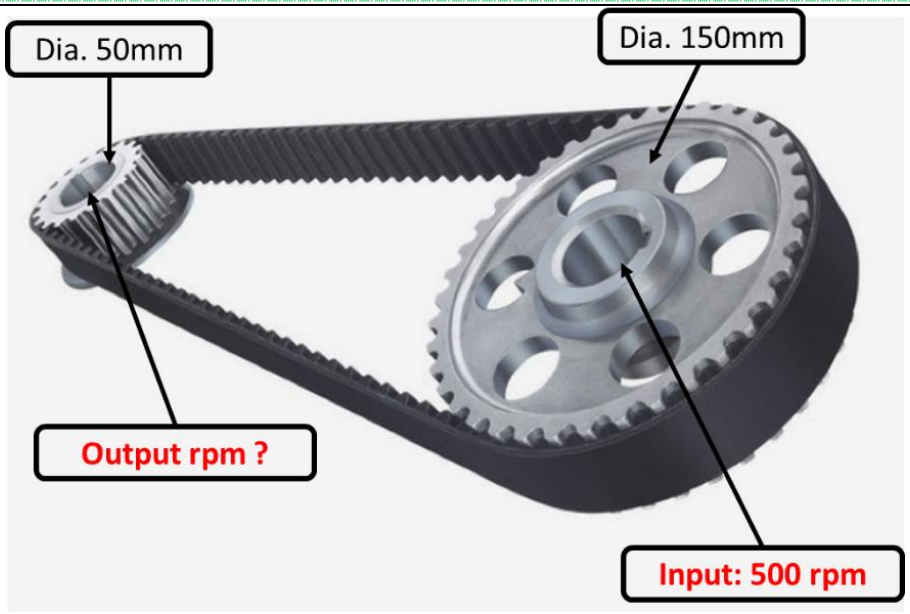
			
Exhaust stroke	Intake stroke	Compression stroke	Power stroke

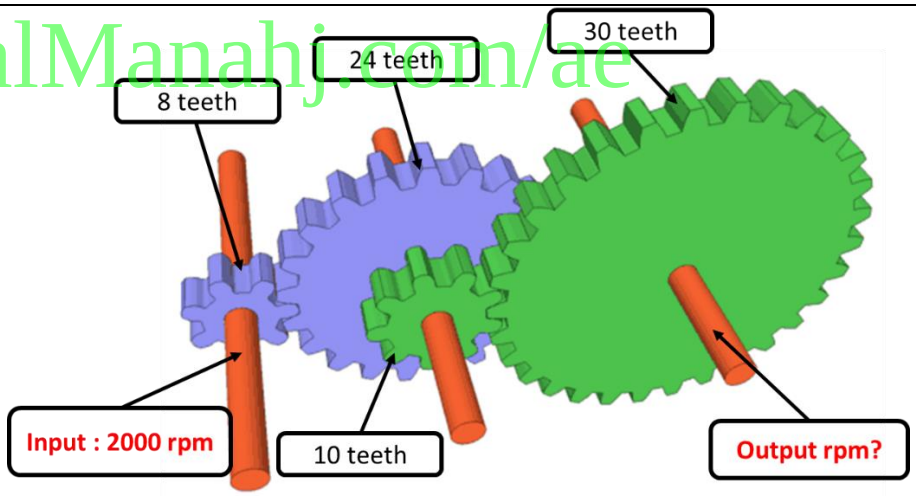
Activity 2.2.3

In the table below, match the correct stroke to the description.

Stroke:	**Description**
Compression stroke	The fuel and air mixture is compressed in the cylinder by the piston.
Exhaust stroke	Waste fumes are expelled from the cylinder.
Power stroke	A spark plug ignites the compressed fuel mixture.
Intake stroke	Flammable fuel is fed into the cylinder through the inlet valve.

Activity 2.1.4

Calculate the output rpm of the drivetrain shown.	
VR = driver/ driven	
VR = 150/50	
VR = 3	
Output RPM = Input RPM x VR	
Output = 500 x 3	
Output = 1500rpm	

Calculate the output rpm of the drivetrain shown.	
First, we need to calculate rpm of the middle or idle shaft. VR = driver/ driven	
VR = 8/24	
VR = 1/3	
Output RPM = Input RPM x VR	
Output = 2000 x 1/3	
Output = 666.67 rpm	
Now we can calculate the output using this idler rpm and	

both green gear sizes.	
VR = driver/ driven	
VR = 10/30	
VR = 1/3	
Output = 666.67 x 1/3	
222.23 rpm	

Activity 2.1.5

What type of steering mechanism would be most suitable for your SumoBot? Give two reasons for your choice:

-Skid steer allows vehicles to rotate on the spot when needed in comparison to the wide turning circle of traditional steering mechanisms.

-Differential steering allows all-wheel drive to be easily incorporated.

-Differential steering does not contain as many moving parts such as a rack and pinion.

Activity 2.1.6

Which is the most suitable power source and motor system for your SumoBot? Give at least two reasons for your choice.

A battery bank combined with brushless DC motors is the most suitable system for a SumoBot.

Brushless Dc motors are a good option as they provide high power density.

Activity 2.1.7

List two vehicles that use the steering mechanisms below.

Rack and pinion	Differential (skid) steering
Car	Tank
Dunne Buggy	Track Digger

Learning Phases – Week 1: Ch3 Section 1 – Period 3

Phase 1: (Connect) – Starter	Phase 2: Activate	Phase 3: Engage and Demonstrate	Phase 4: Plenary (Consolidate) Return to the beginning of the next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes of lesson. Teacher to ask the students if they know what the sumo sport is. Suggested starter activity is to play a video illustrating robot battles. **Teacher Tip:** When explaining always relate back to everyday examples from their lives. Teacher to set high expectations which inspire, motivate and challenge pupils.	Teacher to introduce all key words, discuss meaning and ensure understanding before progressing. **Teacher Tip:** *Teacher can use the projector to display the vocabulary words with flashing pictures and their definitions on the board.* *Teacher can use elicitation and CCQ's after explaining the words to ensure students' understanding of the technical terms.*	**Task 1:** Teacher to introduce the history of the sumo sport, while students research the topic. Students complete activity 3.1.1. **Task 2:** Teacher introduce the history of SumoBot. Students read 'What is SumoBot?' section then share what they learned with the class. Students complete activity 3.1.2. **Task 3:** Teacher divide the students into groups, assign each group a design process area to study. Students should then share what they understood with the rest of the class.		**Questioning**	***Note:*** *All lessons can be different depending on ability and success of previous lesson. Place additional notes or activities to cater for differentiation where necessary throughout the lesson.*

		Students should then complete activities 3.1.3 and 3.1.4. **<u>Teacher Tip:</u>** *Use groupwork as appropriate, get to know your class and organise groups to support mixed ability.*			
			Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Have learning outcomes been met? Has the lesson aim been achieved? All students must complete the official assessment tasks and reflections.	**Oral Assessment** **Student evaluation**	

Answer Key

QR code links:		
Page	***Topic***	***Link***
71	SumoBot	https://youtu.be/uUqfD97OJ0Q
79	Traction control in cars	https://www.youtube.com/watch?v=iBU2n-HI2oM

Activity 3.1.1

Conduct research and write one page on the sumo sport. What are the principles and rules of the game?

Students can use various research method (refer to Ch1, stage 3).

Answers may vary for activities 3.2.1 – 3.1.4.

Answer Key/ Resources

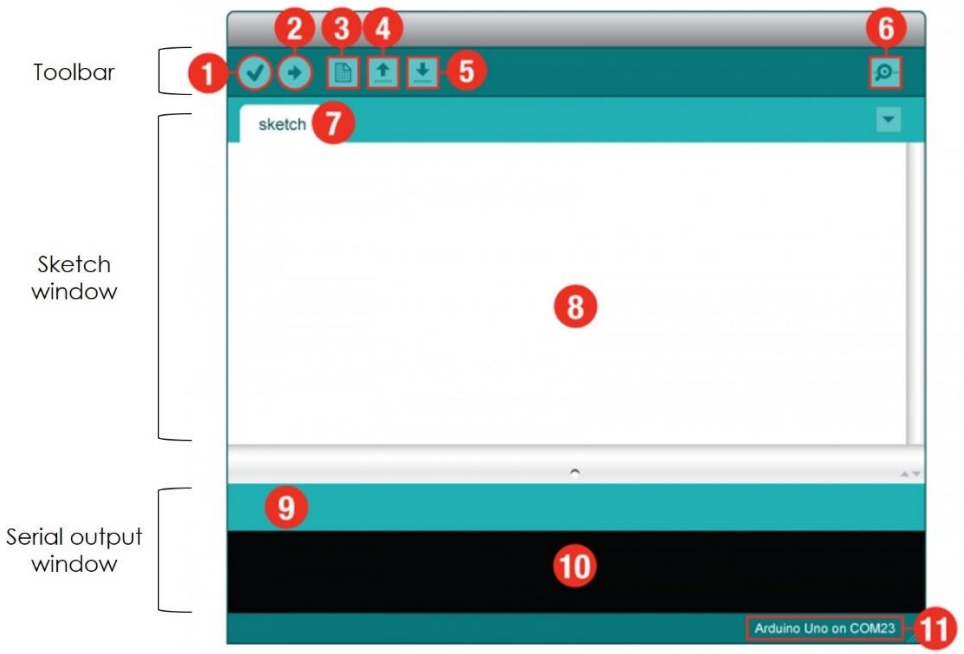
NOTE: the following answer keys are for the non-essential/self-study activities of Ch3, section 2

Section 2

QR code links:		
Page	**Topic**	**Link**
103	working mechanism of a PMDC motor	https://www.youtube.com/watch?v=7bb7vQI3wpQ
104	PWM tutorial	https://www.youtube.com/watch?v=B_Ysdv1xRbA
111	DC motor with the L298N driver and Arduino	https://www.youtube.com/watch?v=dyZolgNOomk
123	Mobile app	https://play.google.com/store/apps/details?id=Qwerty.BluetoothTerminal&hl=en

Activity 3.2.1

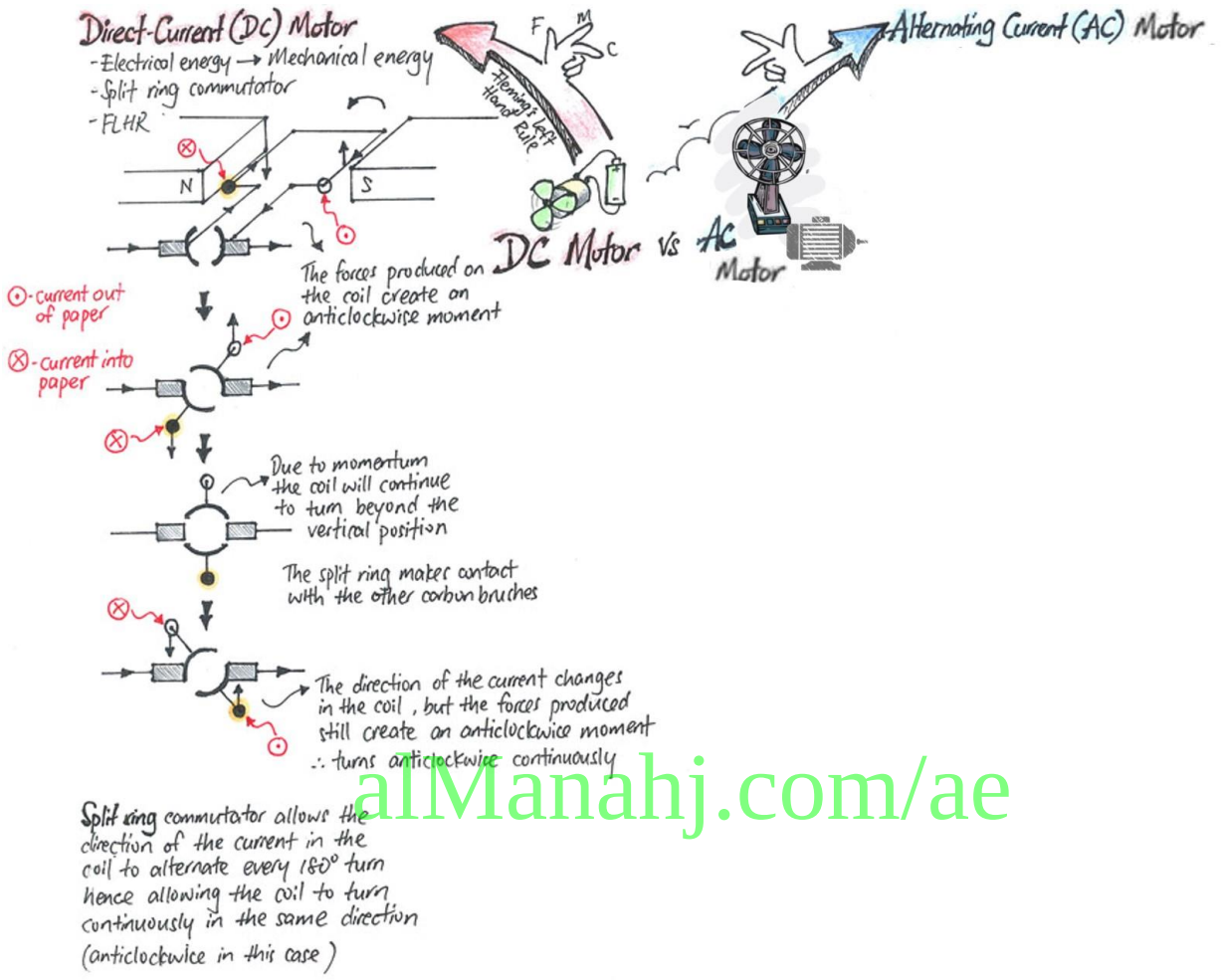
- Arduino IDE is a programming interface that allows the user to write codes that define what the Arduino board will do. As shown in figure below, the IDE interface is split into three main parts: toolbar menu, sketch window, and a serial output window.
- Use your knowledge from previous terms to identify the name and function of the numbered areas 1 – 10. The first one is done for you.



1	verify/ compile	• checks the code for syntax errors (like missing semicolons or parentheses) • converts the Arduino code into machine code, a language that the microcontroller on the Arduino board can understand
2	Upload	• sends the code to the Arduino board
3	New	• opens a new code window tab/new sketch
4	Open	• opens an existing sketch
5	Save	• saves the currently active sketch
6	Serial monitor	• opens a window that displays any serial information the Arduino board is transmitting or receiving
7	Sketch name	• the name of the sketch
8	Code editor	• an area where you can write the code for the sketch
9	Message area	• a message that reports the success or failure of compiling the code
10	Text console	• a window that displays full error messages
11	Board and serial port	• shows the model name of the used Arduino board, and the serial port it is connected to

Activity 3.2.2 – research activity

The figure below illustrates the working principle of a DC motor. Research how AC motors work to complete the comparison for the AC motor on the right-hand side.



An **AC motor** is an electric motor driven by an alternating current (AC). The AC motor commonly consists of two basic parts, an outside stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft producing a second rotating magnetic field. The rotor magnetic field may be produced by permanent magnets, reluctance saliency, or DC or AC electrical windings.

Answers may vary.

Activity 3.2.3

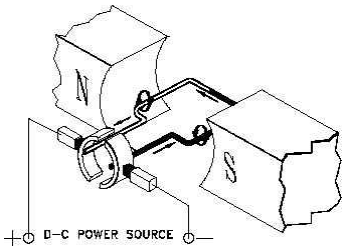
Controlling the speed by varying the input voltage is one of the advantages of using a DC motor. What are the other advantages of DC motors?

Simple, efficient design
Often, the lower cost option
Easy to service and maintain

Answers may vary.

Activity 3.2.4

In the diagram below, the current is moving anticlockwise around the coil. Which way does the coil rotate?



counter-clockwise direction

Activity 3.2.5

Write a code to manipulate the speed of a DC motor, as detailed below:

1. Define a variable to store the PWM value.
2. Initialise an output pin.
3. Generate the PWM signal using the PWM value.
4. Apply a delay to observe the speed.
5. Increase the PWM value by 50.
6. Repeat from step 3.

Arduino code:

```
int PWM_value = 50;
int motor = 3;
void setup(){
  pinMode(motor, OUTPUT);
}

void loop(){
  analogWrite(motor,PWM_value);
  delay(100);
}
```

Activity 3.2.6

Edit the following code to manipulate the speed of a DC motor. On the following page, the complete code is shown with boxes hiding the parts that you should complete. Upon completion of the activity, copy the full code into Arduino IDE and test the circuit.

1. Defining pins and variables
   - Define the enable pin as "enA" and connect it to pin 9 of the Arduino board.
   - Define the first input of the motor driver module as "in1" and connect it to pin 6 of the Arduino board.
   - Define the second input of the motor driver module as "in2" and connect it to pin 7 of the Arduino board.
   - Define the pushbutton as "button" and connect it to pin 4 of the Arduino board.

```
#define enA 9
#define in1 6
#define in2 7
#define button 4
```

2. Using the "pinMode" function, set the pin modes of pins {9, 6, 7, 4} as outputs or inputs.

```
pinMode(enA, OUTPUT);
pinMode(in1, OUTPUT);
pinMode(in2, OUTPUT);
pinMode(button, INPUT);
```

3. Read the value from the potentiometer and store it in "potValue".

```
int potValue = analogRead(A0);
```


4. Send the PWM signal to the motor driver enable pin.

```
analogWrite(enA, pwmOutput);
```

5. Set the "in1" pin as high and the "in2" pin as low.

```
digitalWrite(in1, HIGH);
digitalWrite(in2, LOW);
```

6. Reverse the direction of motor rotation.

```
digitalWrite(in1, LOW);
digitalWrite(in2, HIGH);
```

Activity 3.2.7

What are the advantages and disadvantages of using wireless communication technology.

Advantages	Disadvantages
1) Data can be transmitted faster and with a high speed. 2) The cost of maintenance and installation is not high.	1) Wireless signals can be captured by an unauthorised person. 2) The wireless network needs to be secured so that the information is not misused by unauthorised users.

Activity 3.2.8 – research activity

Select any two communication technologies of the ones shown in **Error! Reference source not found.** and compare between them. Highlight the similarities and differences between the two technologies and give your opinion on which method is better.

Answers may vary.

Activity 3.2.9

What are the advantages and disadvantages of using Bluetooth communication technology.

Advantages of Bluetooth Technology

- It is cheap
- Easy to install
- It makes connecting to different devices convenient
- It is wireless
- It is free to use if the device is installed with it

Disadvantages of Bluetooth Technology

- It can be hacked into
- If installed on a cellphone it is prone to receiving cell phone viruses
- It only allows short range communication between devices
- It can only connect two devices at once
- It can lose connection in certain conditions

Week 2 Lesson Plan:

<table>
<tr><td rowspan="3">Content</td><td colspan="2">Grade 12 General</td></tr>
<tr><td rowspan="2">Chapter 3: Design and Control of a SumoBot</td><td>Section 2: Introducing SumoBot</td></tr>
<tr><td>Section 3: Robotic sumo control mechanism</td></tr>
<tr><td>Time allocated</td><td colspan="2">Ch3_Section 2: 1 x 45-minute periods</td></tr>
<tr><td></td><td colspan="2">Ch3_Section 3: 2 x 45-minute periods (to be continued in period 1 of week 3)</td></tr>
<tr><td>Keywords</td><td colspan="2">What are the keywords the students must learn?</td></tr>
<tr><td></td><td colspan="2">• -</td></tr>
<tr><td>Resources</td><td colspan="2">What resources are required?
• textbooks
• projector
• DC motor
• L298N motor driver
• Arduino board</td></tr>
<tr><td>Prior Knowledge</td><td colspan="2">• Computer science
• Engineering
• Basic electronics</td></tr>
</table>

Aim:

In this week, students will continue to study the design areas of a SumoBot. Upon completion, students will develop a full understanding of the basic electronic components that are needed for creating a SumoBot. Students will learn about the different types of components and their functions.

Teacher Learning Objectives:

Learning objective refers to what you as a teacher will have taught the student by the end of the lesson. Teachers are to tick the box when they have covered a learning objective.

Student Learning Outcomes: Learning outcomes refer to what the student can expect from the lesson, Teachers must share these outcomes with all students. Teachers are to tick the box when the outcome is achieved. Learning outcomes can be assessed using oral questioning and the written activities.

Teacher should: *(tick as you complete)*	***Students should:*** *(tick as students complete)*
☐ Explain the function of a motor driver	☐ Identify the function of a motor driver.
☐ Facilitate as students categorise electrical components.	☐ Catagorise inputs, controllers and outputs of an electrical circuit.
☐ Facilitate as students design and build a circuit to drive DC motors.	☐ Design a circuit to drive DC motors from a Bluetooth device.
	☐ Build and test a circuit to drive DC motors from a Bluetooth device.
☐ Remind students of the relevant research questions to be answered from Chapter 3	☐ **Carry out and present research and investigation**

Possible teaching method(s) or approach for this lesson

(teacher to tick the relevant method)

- ☐ Collaborative Teaching (student centred)
- ☐ Instructional / Demonstrative Teaching (teacher centred)
- ☐ Inquiry-based Teaching (student centred)
- ☐ Lecture Style Teaching (teacher centred)
- ☐ Coach Style Teaching (teacher centred)
- ☐ Facilitator Style Teaching (student centred)

Essential and non-essential Sections:

In some lessons it may not be possible to cover every section of the book due to time constraints or lesson variables. Below is a guideline to essential sections for examination and project knowledge.

Topic			Page	
Chapter	**Section**	**Focus**	**Essential**	**Non-essential/Self Study**
CH. 3	**Sec. 1**	SumoBot design process	79-87	-
		Robots safety	88	-
		Find your motivation	-	88
	Sec. 3	Working principle of the circuit	126-135	-

Learning Phases – Week 2: Ch3 Section 1 – Period 1

Phase 1: (Connect) – Starter	Phase 2: Activate	Phase 3: Engage and Demonstrate	Phase 4: Plenary (Consolidate) Return to the beginning of the next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes of lesson. Teacher to ask the students if they know what the sumo sport is. Suggested starter activity is to play a video illustrating robot battles. **Teacher Tip:** When explaining always relate back to everyday examples from their lives. Teacher to set high expectations which inspire, motivate and challenge pupils.	Teacher to introduce all key words, discuss meaning and ensure understanding before progressing.	**Task 1:** Teacher to recap on what the students took in W1. **Teacher Tip:** *Teacher can use elicitation and CCQ's, mini-whiteboards, true/false cards...etc or any fun way to revise the previous lesson.* **Task 2:** Teacher to continue with the SumoBot design areas. Divide the students into groups, assign each group a design process area to study. Students should then share what they understood with the rest of the class. Students should then complete activities 3.1.5 – 3.1.9. **Teacher Tip:** *Use groupwork as appropriate, get to know*		**Questioning**	***Note:** All lessons can be different depending on ability and success of previous lesson. Place additional notes or activities to cater for differentiation where necessary throughout the lesson.*

		your class and organise groups to support mixed ability. **<u>Task 4:</u>** Teacher introduce the robot safety precautions and explain why it is important to follow the safety measures when designing any robot.			
			Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Have learning outcomes been met? Has the lesson aim been achieved? All students must complete the official assessment tasks and reflections.	**Oral Assessment** **Student evaluation**	

Answer Key

QR code links:		
Page	***Topic***	***Link***
88	Motivation	https://moeae87206-my.sharepoint.com/:b:/g/personal/fatima_shawish_moe_ae/EbkmUi_oQI9LosN2qV10pD8Bqh5lPC81w51N8pDZ1qTTOw?e=UrUjmQ

Answers may vary for activities 3.2.5 – 3.1.9.

Learning Phases – Week 2: Ch3 Section 3 – Periods 2 and 3

Phase 1: (Connect) – Starter	Phase 2: Activate	Phase 3: Engage and Demonstrate	Phase 4: Plenary (Consolidate) Return to the beginning of the next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes of lesson. **Teacher Tip:** Teacher to set high expectations which inspire, motivate and challenge pupils.	Teacher to introduce all components needed to build the circuit of the SumoBot. Explain the function of motor drivers. Demonstrate connecting a L298N motor driver to the Arduino and DC motors **Teacher Tip:** *Teacher can use elicitation and CCQ's after explaining the words to ensure students' understanding of the technical terms.*	**Task 1:** Teacher to explain the working principle of the circuit. **Teacher Tip:** Teacher to demonstrate good subject and curriculum knowledge. **Task 2:** Divide the students into groups, ask them to follow the instructions given in step 1 to connect the DC motors to the motor driver. Students complete activity 3.3.1. **Task 3:** Teacher to monitor the students' progress throughout the lesson by using the different assessment opportunities.		**Questioning**	***Note:*** *All lessons can be different depending on ability and success of previous lesson. Place additional notes or activities to cater for differentiation where necessary throughout the lesson.*

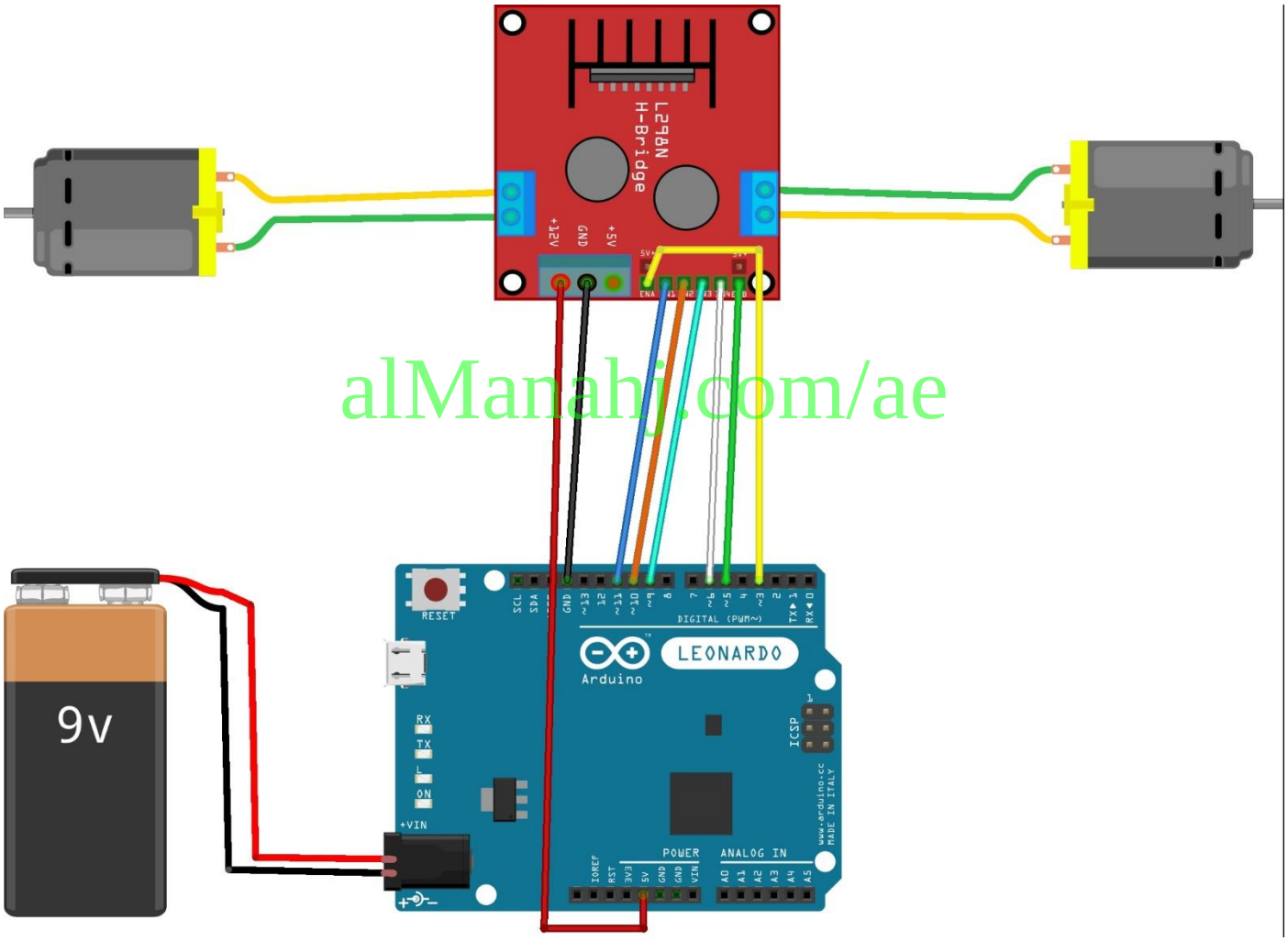
		Teacher Tip: *Teacher can use fun applications to form groups, for example, the 'Team Shake' app. All the teacher needs to do is enter the students name list and the number of groups to form and the app will for the teams randomly.* https://itunes.apple.com/us/app/team-shake/id390812953?mt=8 **Teacher Tip:** *Use groupwork as appropriate, get to know your class and organise groups to support mixed ability.*			
	Explain the Arduino code to control DC motor rotation and direction.	**Task 1:** Teacher to facilitate and provide feedback as student's program and test the circuit in activities 3.3.2 and 3.3.3.			
			Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Have learning outcomes been met? Has the lesson aim been achieved? All students must complete the official	**Oral Assessment** **Student evaluation**	

			assessment tasks and reflections.		

Answer Key

Activity 3.3.1

Complete the circuit below to show how two DC motors can be controlled by Arduino using an L298N motor driver.



Activity 3.3.2

Modify the code in **Error! Reference source not found.** to rotate the DC motors in the opposite direction.

Arduino code:

```
//speed of motors between 0 and 255, if you like you can change it
int pwm_speedA = 255;
int pwm_speedB = 240;


void setup() {
Serial1.begin(9600);
//pins for motor controller
pinMode(11, OUTPUT);
pinMode(10, OUTPUT);
pinMode(9, OUTPUT);
pinMode(6, OUTPUT);
pinMode(5, OUTPUT);
pinMode(3, OUTPUT);

}

void loop() {


digitalWrite(10, LOW);
digitalWrite(11, HIGH);
analogWrite(3, pwm_speedB);

digitalWrite(9, LOW);
digitalWrite(6, HIGH);
analogWrite(5, pwm_speedA);

}
```


Activity 3.1.3

Modify the code in **Error! Reference source not found.** to control the DC motors to turn left.

Arduino code:

```
//speed of motors between 0 and 255, if you like you can change it
int pwm_speedA = 255;
int pwm_speedB = 240;
void setup() {
Serial1.begin(9600);
//pins for motor controller
```

```
pinMode(9, OUTPUT);
pinMode(6, OUTPUT);
pinMode(5, OUTPUT);
pinMode(11, OUTPUT);
pinMode(10, OUTPUT);
pinMode(3, OUTPUT);

}
 void loop() {
//turning left
digitalWrite(9, HIGH);
digitalWrite(6, LOW);
analogWrite(5, pwm_speedA);

digitalWrite(10, LOW);
digitalWrite(11, LOW);
analogWrite(3, 0);

}
```

Week 3 Lesson Plan:

<table>
<tr><td rowspan="4">Content</td><td colspan="2">Grade 12 General</td></tr>
<tr><td>Chapter 3: Design and Control of a SumoBot</td><td>Section 3: Robotic sumo control mechanism</td></tr>
<tr><td rowspan="3">Chapter 4 – 3D Modelling</td><td>Section 1 – What is Fusion 360</td></tr>
<tr><td>Section 2 – Introduction to basic modelling</td></tr>
<tr><td>Section 3: Assemblies and multibody design</td></tr>
<tr><td>Time allocated</td><td colspan="2">Ch4: 1 x 45-minute periods</td></tr>
<tr><td></td><td colspan="2">Ch4: 2 x 45-minute periods</td></tr>
<tr><td>Keywords</td><td colspan="2">What are the keywords the students must learn?</td></tr>
<tr><td></td><td colspan="2">• CAD
• Fusion 360
• data panel
• toolbar
• 2D Sketch
• Extrude
• Chassis
• Assemble
• Joint
• Translate
• Gimbal</td></tr>
<tr><td>Resources</td><td colspan="2">What resources are required?
• textbooks
• projector
• sketching equipment</td></tr>
<tr><td>Prior Knowledge</td><td colspan="2">• Sketching
• 3D Printing</td></tr>
</table>

Aim:

In this week, students will continue with building the control circuit of the SumoBot. They will program the circuit to control the robot wirelessly. Upon completion of the section, you should have a fully functioning system. You will analyse your system and understand how it can be integrated with different fields of study.

Students will complete sections 1-2 and begin section 3 of the 3D modelling chapter. You should spend an adequate amount of time on sections 1 and 2 depending on student ability and prior knowledge / exposure to Fusion 360 in previous terms. The outlined time in the IP is a maximum time for recap. If students show good knowledge during recap move straight along to section 3: Assemblies and multibody design. In section 3 students will learn the basics of assemblies by creating multiple bodies in one design and defining part positions and movement using joints.

Teacher Learning Objectives:
Learning objective refers to what you as a teacher will have taught the student by the end of the lesson. Teachers are to tick the box when they have covered a learning objective.

Student Learning Outcomes: Learning outcomes refer to what the student can expect from the lesson, Teachers must share these outcomes with all students. Teachers are to tick the box when the outcome is achieved. Learning outcomes can be assessed using oral questioning and the written activities.

Teacher should: *(tick as you complete)*	***Students should:*** *(tick as students complete)*
Introduce various methods of wireless control	Identify methods of wireless control.
☐ Introduce Lesson aim and outcomes. ☐ Introduce Design realisation stage of chapter 1. ☐ Recap on Fusion 360 as a 3D modelling solution.	☐ Register for Fusion 360. ☐ Open a new design in Fusion 360. ☐ Save a file in Fusion 360. ☐ Navigate the toolbar. ☐ Open and navigate the data panel. ☐ Share work from your data panel. ☐ Download files and upload files to your data panel.
☐ Recap on creating 2D sketches and extruding to 3D.	☐ Identify 2D sketch tools. ☐ Identify and distinguish between planes. ☐ Create dimensioned 2D sketch. ☐ Create a 3D model using extrude tool.
☐ Demonstrate multibody design and creating components.	☐ Understand how to model different bodies and components in one design. ☐ Use combine tool to create one body or component. ☐ Save separate components as parts.
☐ Demonstrate inserting and defining a parts motion using joints. ☐ Demonstrate all joint types and their uses.	☐ Insert an existing part into a design. ☐ Differentiate between joint types.

Possible teaching method(s) or approach for this lesson

(teacher to tick the relevant method)

- ☐ Collaborative Teaching (student centred)
- ☐ Instructional / Demonstrative Teaching (teacher centred)
- ☐ Inquiry-based Teaching (student centred)
- ☐ Lecture Style Teaching (teacher centred)
- ☐ Coach Style Teaching (teacher centred)
- ☐ Facilitator Style Teaching (student centred)

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Topic			Page	
Chapter	**Section**	**Focus**	**Essential**	**Non-essential/Self Study**
3	**Sec. 3**	Working principle of the circuit	136-148	
4	**1**	What is fusion 360		Pg. 150 - 157
4	**2**	2D sketching and 3D modelling		Pg. 158 - 166
4	**3**	Section 3: Assemblies and multibody design	Pg.167 - 205	

Learning Phases – Week 3: Ch3 Section 3 – Period 1

Phase 1: (Connect) – Starter	Phase 2: Activate	Phase 3: Engage and Demonstrate	Phase 4: Plenary (Consolidate) Return to the beginning of the next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes of lesson. **Teacher Tip:** Teacher to set high expectations which inspire, motivate and challenge pupils.	Teacher to introduce all key words, discuss meaning and ensure understanding before progressing.	**Task 1:** Teacher to recap on what the students took in W1. **Teacher Tip:** *Teacher can use elicitation and CCQ's, mini-whiteboards, true/false cards...etc or any fun way to revise the previous lesson.*		**Questioning**	***Note:*** *All lessons can be different depending on ability and success of previous lesson. Place additional notes or activities to cater for differentiation where necessary throughout the lesson.*
	Introduce Bluetooth as a method of wireless control for Arduino. Demonstrate how to connect the Arduino and Bluetooth module correctly	**Task 1:** Facilitate and provide feedback as student's complete activities 3.3.4 and 3.3.5.			
	Introduce switch statements and the Bluetooth RC controller application.	Students to demonstrate understanding by completing activity 3.3.6 and complete writing the Arduino code. Teacher to facilitate and provide feedback to fine tune circuits and program to ensure DC motor			

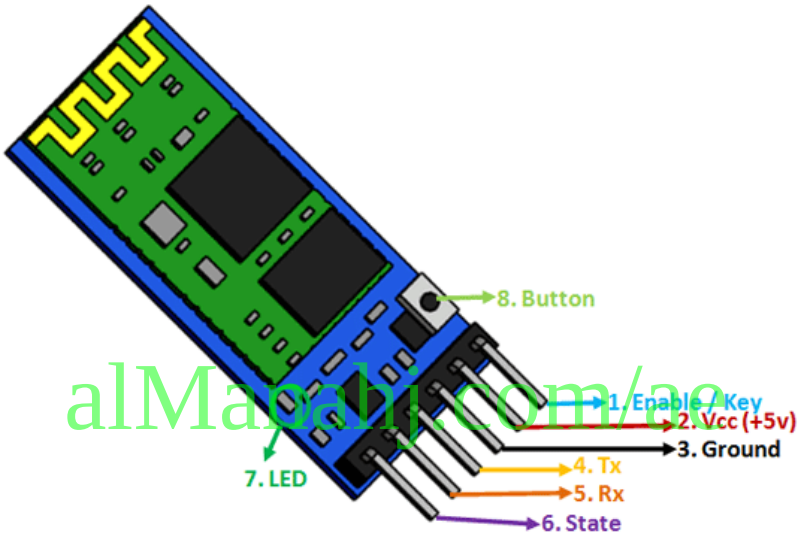
		control from the Bluetooth app.			
			Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Have learning outcomes been met? Has the lesson aim been achieved? All students must complete the official assessment tasks and reflections.	**Oral Assessment** **Student evaluation**	

Answer Key

QR code links:		
Page	***Topic***	***Link***
140	RC App	https://play.google.com/store/apps/details?id=braulio.calle.bluetoothRCcontroller&hl=en

Activity 3.3.4

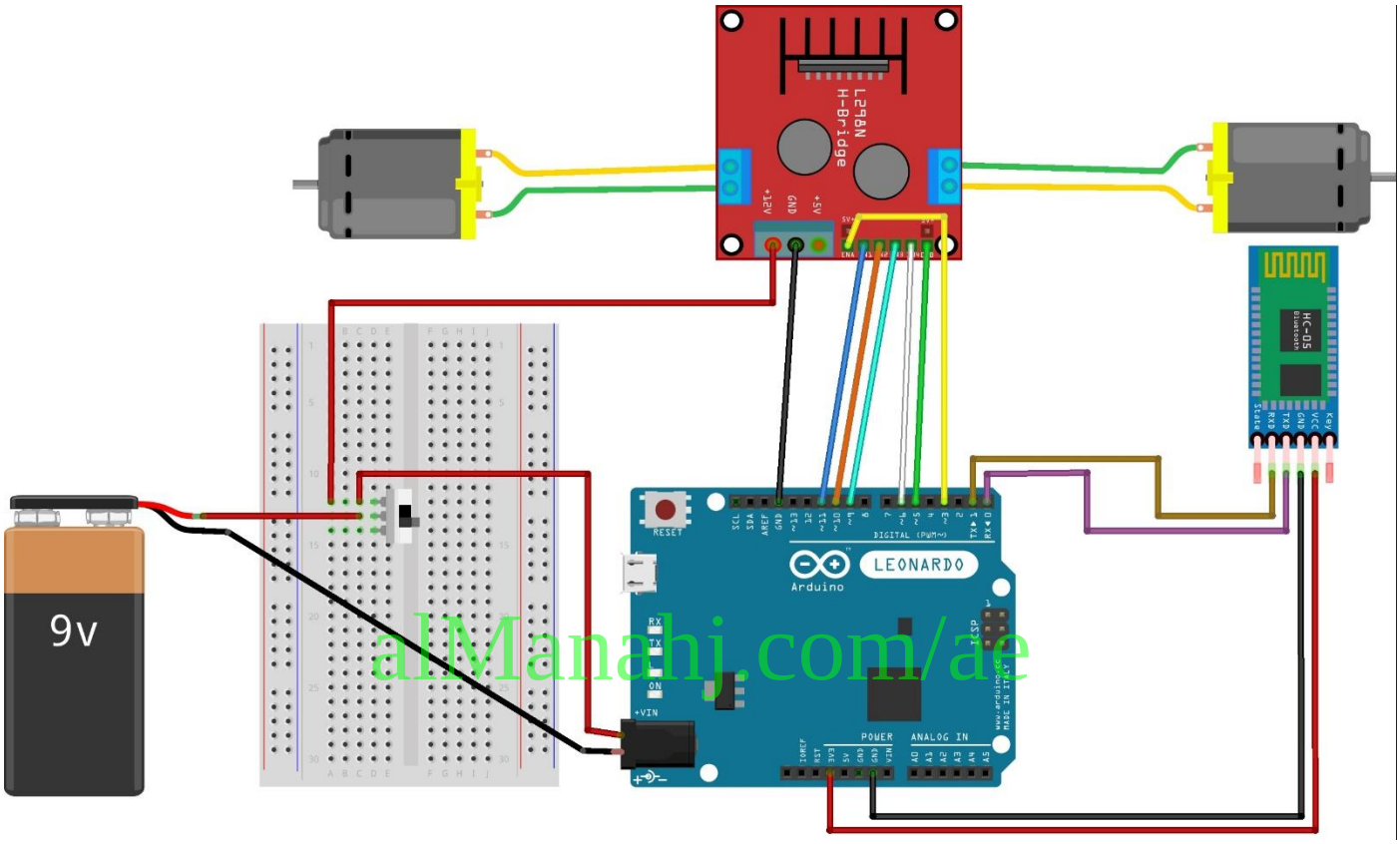
Match the correct Arduino pins to the Bluetooth module pins



Arduino pins		Bluetooth pins
RX (Pin 0)	→	Tx
TX (Pin1)	→	Rx
3.3V	→	Vcc
GND	→	Ground

Activity 3.3.5

In the diagram below, connect the lines to create a circuit that drives two DC motors through Bluetooth using Arduino and a motor driver. Your circuit must also include a switch to isolate power to the motor driver and Arduino.



Activity 3.3.6

The switch case statements needed for your circuit are shown below. Fill in the blanks with the correct code for each statement. Refer to Table 2.3. 2 and Table 2.3. 3 for the correct pin connections.

```
void loop() {
if(Serial1.available() > 0){
command = Serial1.read();
motors_stop();
switch(command){
case 'F':
forward();
break;
case 'B':
backward();
break;
case 'L':
left();
break;
case 'R':
right();
break;
}
 }
  }
```



```
// function for driving straight
void forward(){
```

```
digitalWrite(10, HIGH);

digitalWrite(11, LOW);


digitalWrite(9, HIGH);

digitalWrite(6, LOW);


analogWrite(5, pwm_speedA);

analogWrite(3, pwm_speedB);
```

```
}
```

```
//function for reversing
void backward(){

  digitalWrite(10, LOW);

  digitalWrite(11, HIGH);


  digitalWrite(9, LOW);

  digitalWrite(6, HIGH);


  analogWrite(5, pwm_speedA);

  analogWrite(3, pwm_speedB);

}

//function for turning right
void right(){

  digitalWrite(10, HIGH);

  digitalWrite(11, LOW);

```



```
  digitalWrite(9, LOW);

  digitalWrite(6, LOW);


  analogWrite(3, pwm_speedB);

  analogWrite(5, 0);

}
```

```
//function for turning left
void left(){

  digitalWrite(11, LOW);
  digitalWrite(10, LOW);


  digitalWrite(9, HIGH);
  digitalWrite(6, LOW);


  analogWrite(3, 0);
}

//function for stopping motors
void motors_stop(){

  digitalWrite(11, LOW);
  digitalWrite(10, LOW);


  digitalWrite(9,LOW);
  digitalWrite(6, LOW);


  analogWrite(5, 0);
  analogWrite(3, 0);
}
```

Writing the code

1. Define the variables below.
   - **pwm_speedA** – Define the variable as an integer and give it a value from 0-255.
   - **pwm_speedB** – Define the variable as an integer and give it a value from 0-255.
   - **command** – Define the variable as a character.

```
int pwm_speedA=255;
int pwm speedB=240;
char command;
```

2. Void setup
   - Start a serial communication to be able to use the serial monitor (Serial1.begin(9600)).
   - Define the pins for the motor driver as outputs. Refer to **Error! Reference source not found.** and **Error! Reference source not found.** for the correct pin connections.

```
void setup() {

Serial1.begin(9600);
//pins for motor controller
pinMode(11, OUTPUT);
pinMode(10, OUTPUT);
pinMode(9, OUTPUT);
pinMode(6, OUTPUT);
pinMode(5, OUTPUT);
pinMode(3, OUTPUT);

}
```


3. Void loop

```
void loop() {
if(Serial1.available() > 0){
command = Serial1.read();
motors_stop();
switch(command){
case 'F':
forward();
break;
case 'B':
backward();
break;
case 'L':
left();
```

```
break;
case 'R':
right();
break;
}
 }
  }

// function for driving straight
void forward(){
digitalWrite(10, HIGH);
digitalWrite(11, LOW);

digitalWrite(9, HIGH);
digitalWrite(6, LOW);

analogWrite(5, pwm_speedA);
analogWrite(3, pwm_speedB);




}

//function for reversing
void backward(){

digitalWrite(10, LOW);
digitalWrite(11, HIGH);

digitalWrite(9, LOW);
digitalWrite(6, HIGH);

analogWrite(5, pwm_speedA);
analogWrite(3, pwm_speedB);



}

//function for turning right
void right(){

digitalWrite(10, HIGH);
digitalWrite(11, LOW);


digitalWrite(9, LOW);
digitalWrite(6, LOW);

analogWrite(3, pwm_speedB);
analogWrite(5, 0);
```

```
}

//function for turning left
void left(){

digitalWrite(11, LOW);
digitalWrite(10, LOW);

digitalWrite(9, HIGH);
digitalWrite(6, LOW);

analogWrite(3, 0);
analogWrite(5, pwm_speedA);



}

//function for stopping motors
void motors_stop(){

digitalWrite(11, LOW);
digitalWrite(10, LOW);

digitalWrite(9,LOW);
digitalWrite(6, LOW);

analogWrite(5, 0);
analogWrite(3, 0);



}
```

Learning Phases – Week 3: Periods 2 and 3 (Ch. 4: Section 1-3)

Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to beginning of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Discuss prior knowledge of design realization from previous terms. Discuss prior knowledge of Fusion 360 from previous terms. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to recap what is Fusion 360. b) Teacher to recap on basic 3D modelling.	a) Students to show level of understanding through answers and fusion 360 tasks. b) Students to complete revision activities 4.2.1 - 4.2.2		**Oral Questioning** **Activity 4.2.1 -4.2.2**	
	c) Teacher to introduce and explain joint types.	c) Students to show level of understanding through answers and previous use of joints.			

	d) Teacher to introduce multibody design and its uses.	d) Students to create the cube, joint rectangle and pin for the joints exercise as multi bodies in one design.			
		e) Facilitate and provide feedback as student's complete activity 4.3.1		**Activity 4.3.1**	
	f) Teacher to demonstrate all the joint types using the joint cube, rectangle and pin.	f) Facilitate as students complete all the joint types.	Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Relate questions to Fusion 360 features used. Have learning outcomes been met? Has the lesson aim been achieved?.	**Visual inspection of Fusion model** **Student evaluation**	

Answer Key

QR code links:		
Page	***Topic***	***Link***
151	Download fusion	https://www.autodesk.com/products/fusion-360/students-teachers-educators
151	Fusion app	https://play.google.com/store/apps/details?id=com.autodesk.fusion&hl=en
151	Fusion app	https://itunes.apple.com/us/app/fusion-360/id991074843?mt=8
153	Data panel	https://help.autodesk.com/videos/YxdDhhbjqwuccpnsqjraCEnee5N-l_Ln/video.webm
155	Downloading DC motor files	https://a360.co/2Gd0fVh

Activity 4.1.1

What 2D shape would you sketch to create a 3D cylinder?

Circle.

What plane would you select to create cylinder 2 and 3 shown in ***Error! Reference source not found.****?*

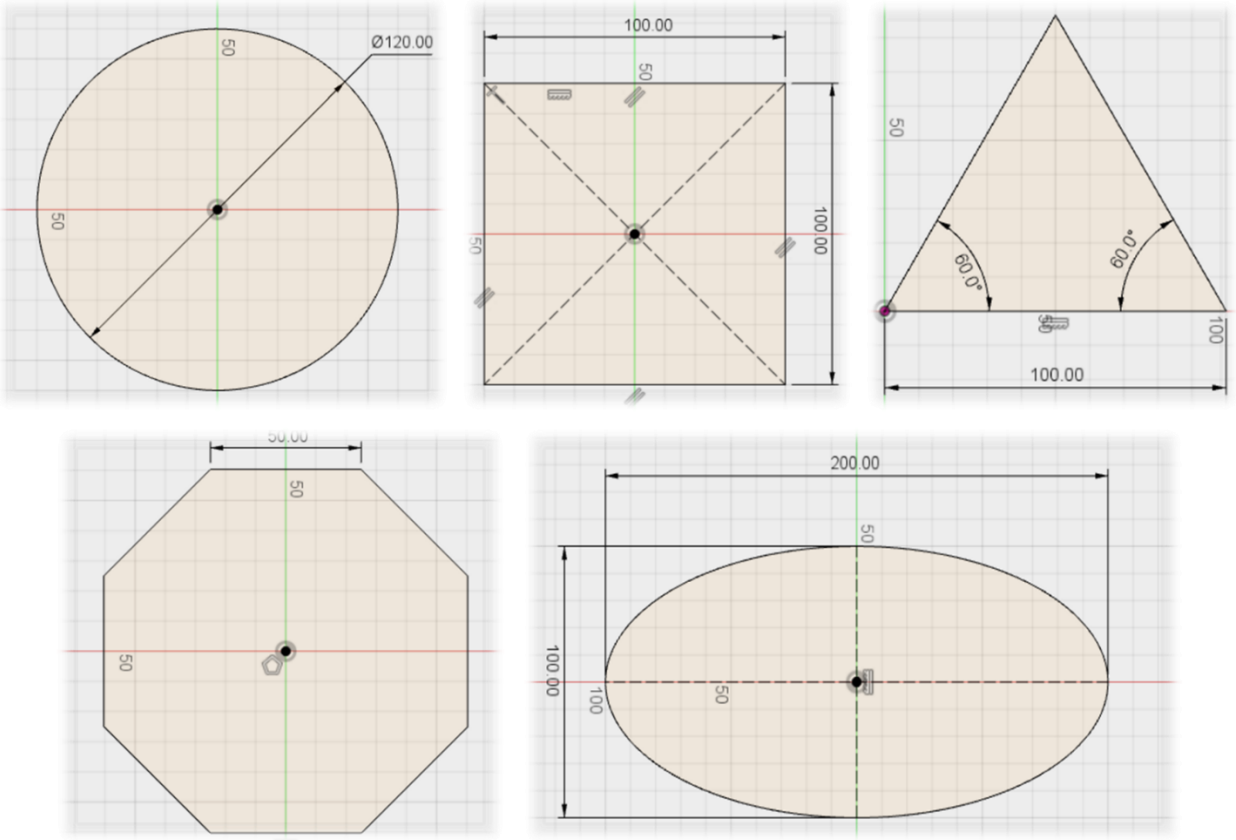
2) XY plane.

3) YZ plane.

Activity 4.1.2

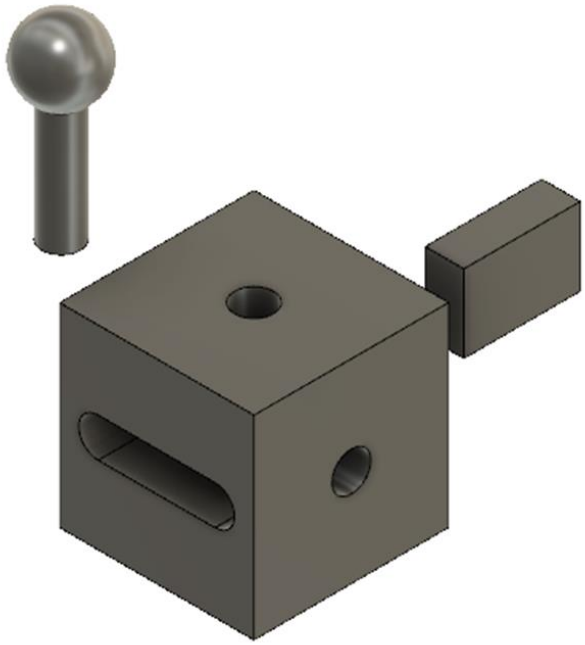
You now understand how to choose a plane for 2D sketching. Open a new design and create a new sketch on the XZ plane as shown below.

On the XZ plane sketch and dimension the shapes are shown below.



Activity 4.3.1

Create a new component from the body to create the joint pin component. Also, save it to your data panel. You should then have three separate components in your data panel: the joint cube, the rectangle cuboid and the joint pin. ***Save this design as a copy and name it 'cube with components.'***



Week 4 Lesson Plan:

<table>
<tr><td rowspan="2">Content</td><td colspan="2">Grade 12 General</td></tr>
<tr><td rowspan="2">Chapter 4 – 3D Modelling</td><td>Section 3 – Assemblies and multibody design</td></tr>
<tr><td></td><td>Section 4 - Chassis base design and positioning the motors</td></tr>
<tr><td>Time allocated</td><td colspan="2">3 x 45-minute periods</td></tr>
<tr><td>Keywords</td><td colspan="2">What are the keywords the students must learn?</td></tr>
<tr><td></td><td colspan="2">• 2D sketch
• extrude
• assemble
• joint
• translate
• gimbal
• chassis</td></tr>
<tr><td>Resources</td><td colspan="2">What resources are required?
• textbooks
• projector
• sketching equipment</td></tr>
<tr><td>Prior Knowledge</td><td colspan="2">• sketching tools
• create tools
• modify tools
• creating bodies</td></tr>
</table>

Aim:

In this lesson, students will complete section 3: Assemblies and multibody design. Upon completion of this section students should understand how to model various components within one design and define their movement by adding joints. In section 4 the students will first create a chassis base and they will then use their knowledge from section 3 to position the motors on the chassis base and build mounts around them.

Teacher Learning Objectives:

Learning objective refers to what you as a teacher will have taught the student by the end of the lesson. Teachers are to tick the box when they have covered a learning objective.

Student Learning Outcomes: Learning outcomes refer to what the student can expect from the lesson, Teachers must share these outcomes with all students. Teachers are to tick the box when the outcome is achieved. Learning outcomes can be assessed using oral questioning and the written activities.

Teacher should: *(tick as you complete)*	***Students should:*** *(tick as students complete)*
☐ Demonstrate inserting and defining a parts motion using joints. ☐ Demonstrate all joint types and their uses.	☐ Insert an existing part into a design.
	☐ Differentiate between joint types.
	☐ Create an assembly using all joint types.
	☐ Apply joint limits to moving joints.
☐ Demonstrate how to measure the sizes of the various components required for the SumoBot.	☐ Identify the required chassis type and size.
☐ Facilitate students as they create a base for the chassis.	☐ Create the required 2D sketch.
	☐ Extrude a 2D sketch.
☐ Demonstrate how to insert and position the motors.	☐ Insert and position the motors onto your base.
☐ Demonstrate how to create motor mounts within the design.	☐ Create motor mounts within the design.
	☐ Create holes to secure motors to the mounts.

Possible teaching method(s) or approach for this lesson

(teacher to tick the relevant method)

- ☐ Collaborative Teaching (student centred)
- ☐ Instructional / Demonstrative Teaching (teacher centred)
- ☐ Inquiry-based Teaching (student centred)
- ☐ Lecture Style Teaching (teacher centred)
- ☐ Coach Style Teaching (teacher centred)
- ☐ Facilitator Style Teaching (student centred)

Essential and non-essential Sections: 

In some lessons it may not be possible to cover every section of the book due to time constraints or lesson variables. Below is a guideline to essential sections for examination and project knowledge.

Topic			Page	
Chapter	**Section**	**Focus**	**Essential**	**Non-essential/Self Study**
4	**3**	Assemblies and multibody design	Pg.167 - 205	
4	**4**	Chassis base design and positioning the motors	Pg. 206-228	

Learning Phases – Week 4: Period 1(Ch. 4: Section 3)

Phase 1 of lesson (Connect) – Starter →	Phase 2 of lesson (Activate) →	Phase 3: (Engage and Demonstrate) →	Phase 4: Plenary (Consolidate) Return to beginning of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Discuss prior knowledge of assemblies from previous week. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Inform students that they must finish all the joint types, some of which they began last week.	a) Facilitate as students complete all the joint types.		**Oral Questioning**	
	b) Teacher to demonstrate creating an as built joint	b) Facilitate as students complete an as built joint in Activity 4.3.2		**Activity 4.3.2**	
		c) Provide feedback on students work in Section 3.	Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Relate questions to Fusion 360 joints used. Have learning outcomes been met? Has the lesson aim been achieved?	**Visual inspection of Fusion model** **Student evaluation**	

Learning Phases – Week 4: Periods 2 and 3 (Ch. 4: Section 4)

Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to beginning of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Discuss prior knowledge of Fusion 360 from previous lessons. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Introduce students to the chassis to be modelled. Recap on the electronic components to be used from chapter 3 and provide students with the circuits for reference and measurements.	a) Facilitate as students measure components and use this information to determine the correct chassis dimensions through Activity 4.4.1-4.3.3.		**Oral Questioning** **Activity 4.4.1 -4.4.3**	
	b) Teacher to demonstrate how to create a base for the chassis.	b) Facilitate students as they create a base for the chassis.			

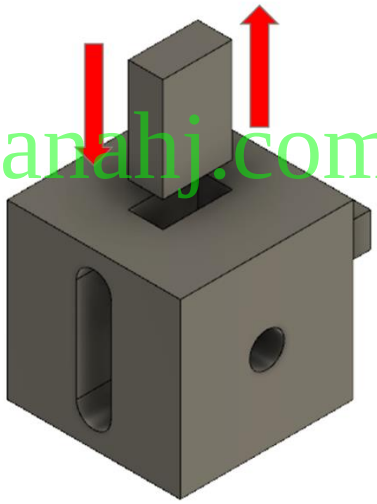
	c) Teacher to demonstrate how to insert and position the motors within the design.	c) Facilitate students as they insert and position the motors.			
	d) Teacher to demonstrate how to create mounts for the motors within the design. **NOTE: If students are provided with a single axel motor, they will not have to create the slot for the second axel demonstrated in the book.**	d) Facilitate students as they create mounts for the motors within the design.			
	f) Teacher to introduce Activity 4.4.4, where students will recap on their knowledge of creating holes.	f) Facilitate as students complete Activity 4.4.4, creating holes to secure motors to the mounts.	Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Relate questions to Fusion 360 features used. Have learning outcomes been met? Has the lesson aim been achieved?	**Activity 4.4.4.** **Visual inspection of Fusion model** **Student evaluation**	

Answer Key

QR code links:		
Page	***Topic***	***Link***
214	Section 4 tutorial	https://autode.sk/2RUAM5c
215	Dc Motor files	***https://a360.co/2Gd0fVh***

Activity 4.3.2

You have now created an 'as built joint' between the pin and cube using the original created position. You must now create an 'as built slider joint' between the cuboid component and the joint component as shown below.



Activity 4.4.1

The image below shows all the required electronic components you used to create and test the circuit in Chapter 3. Measure and dimension each component's actual length, width, and height. Fill in the dimensions in the boxes below. ***(Do not measure drawings shown. They are not to scale.)***

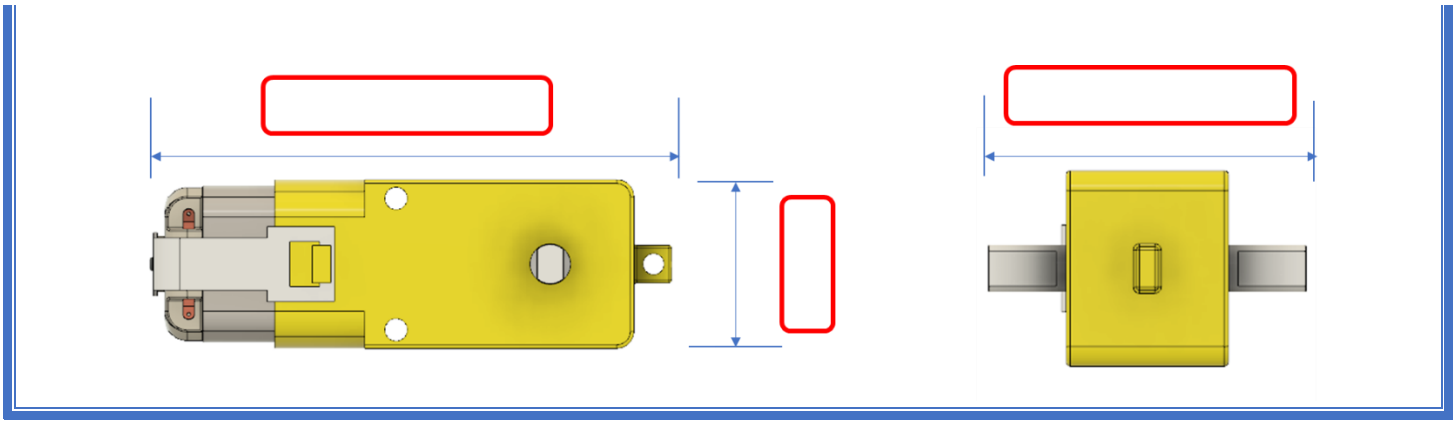


Figure 4.4 1

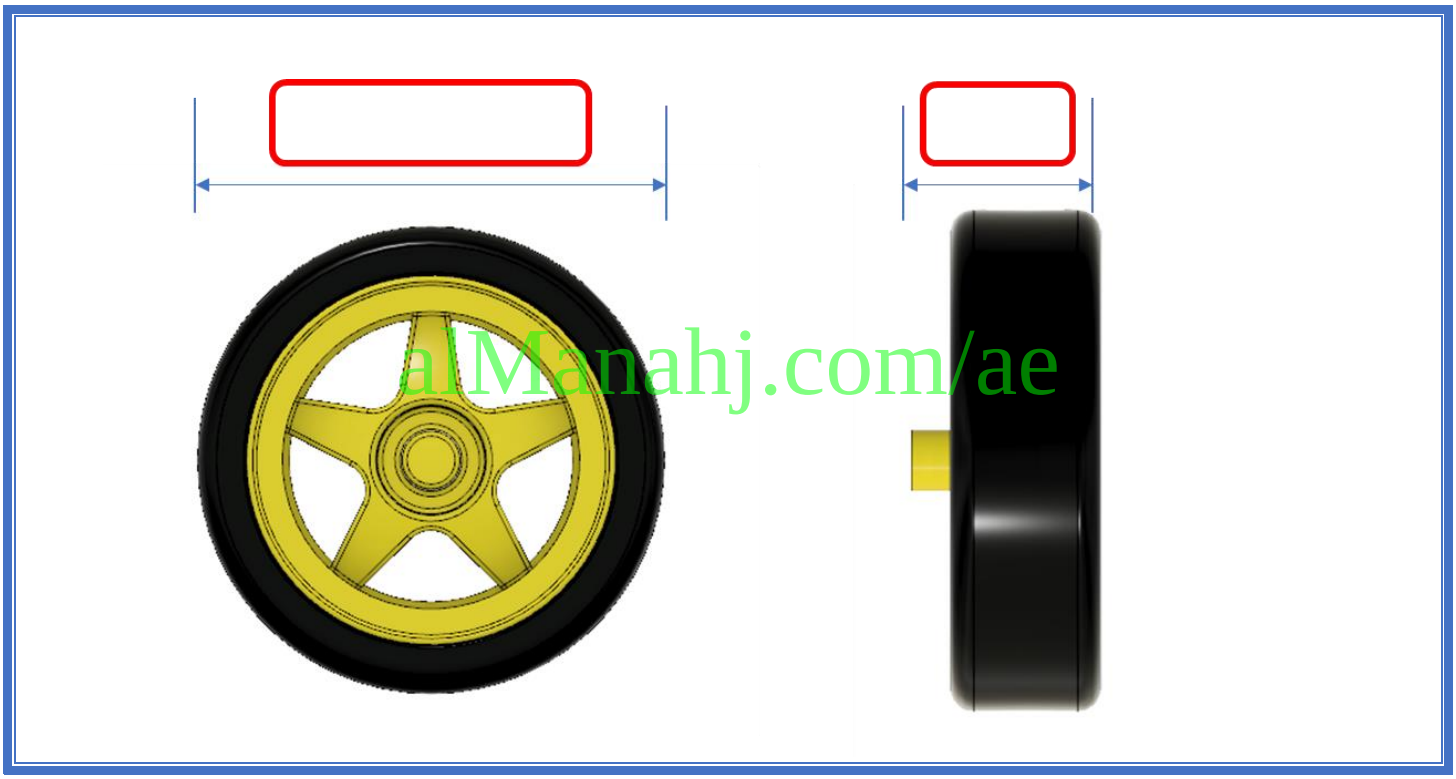


Figure 4.4 2

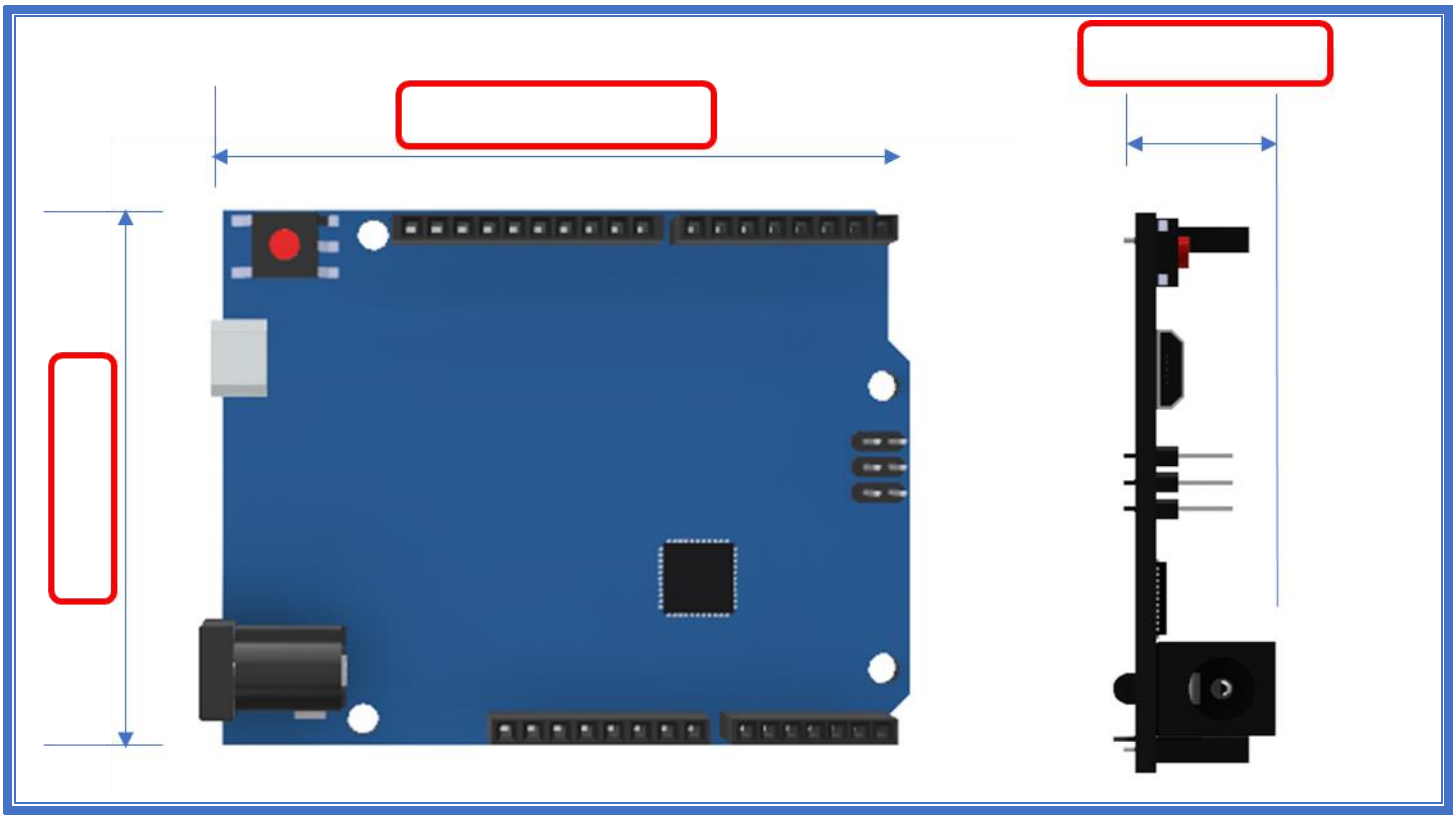


Figure 4.4 3

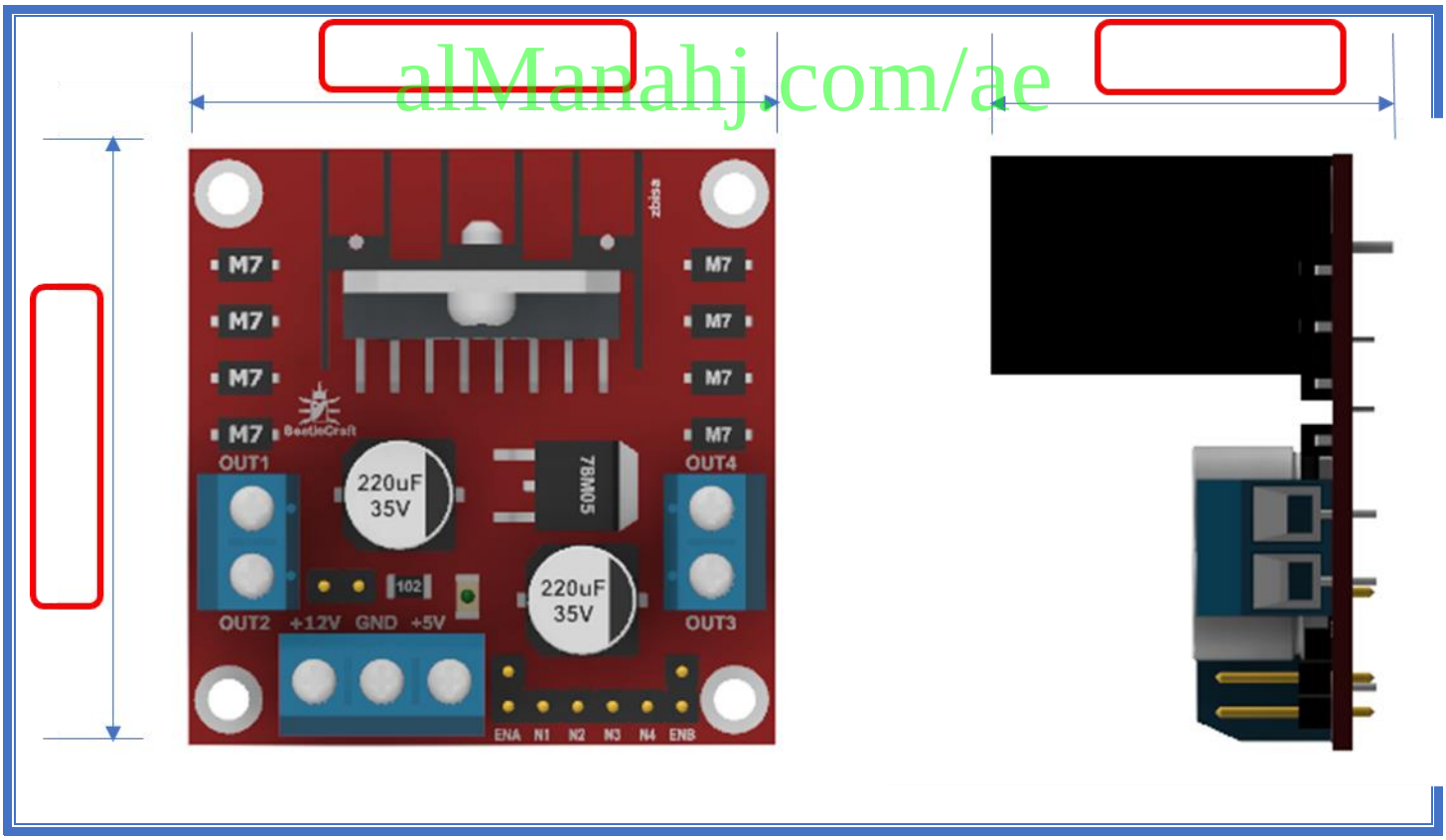


Figure 4.4 4

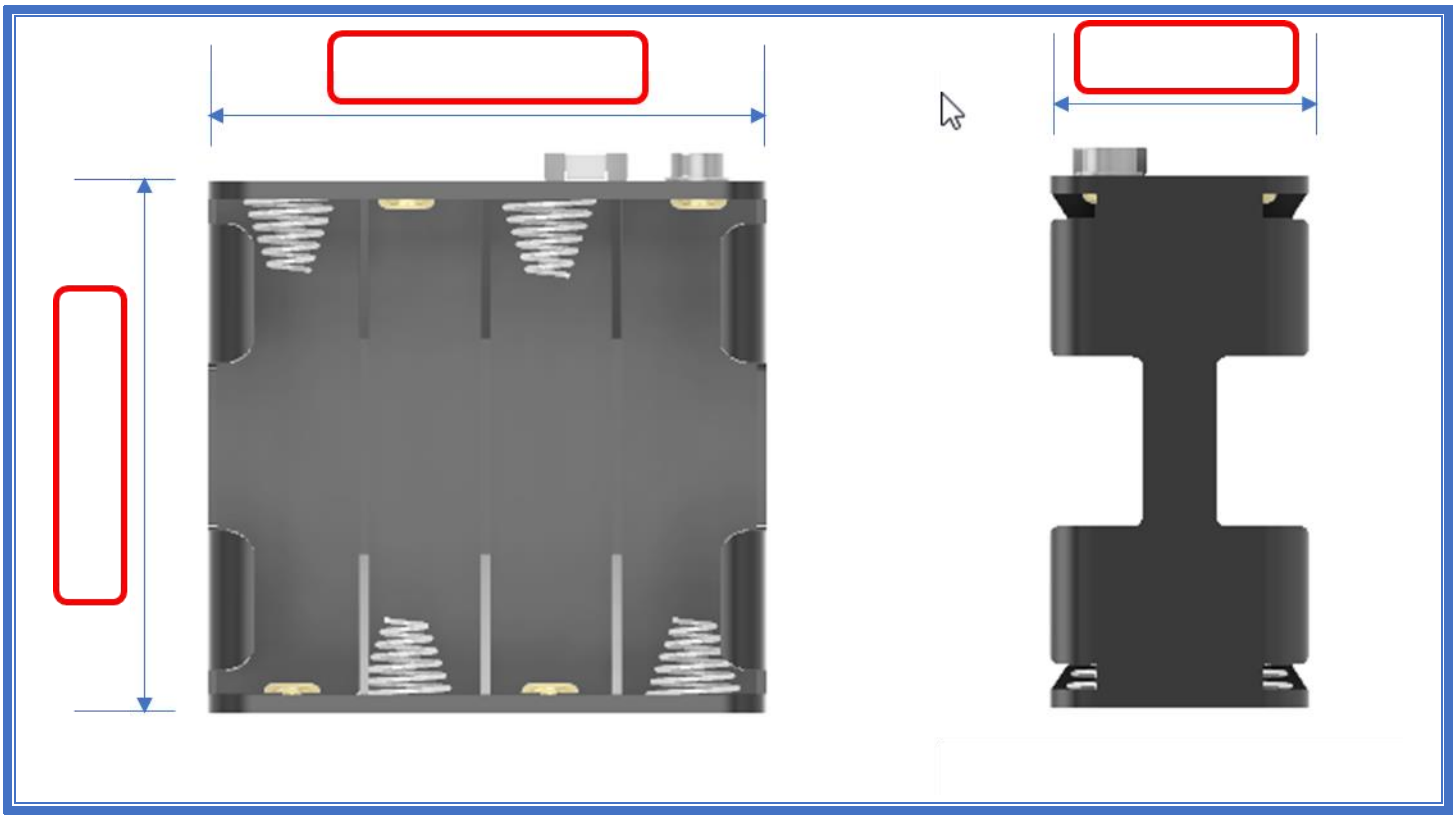


Figure 4.4 5

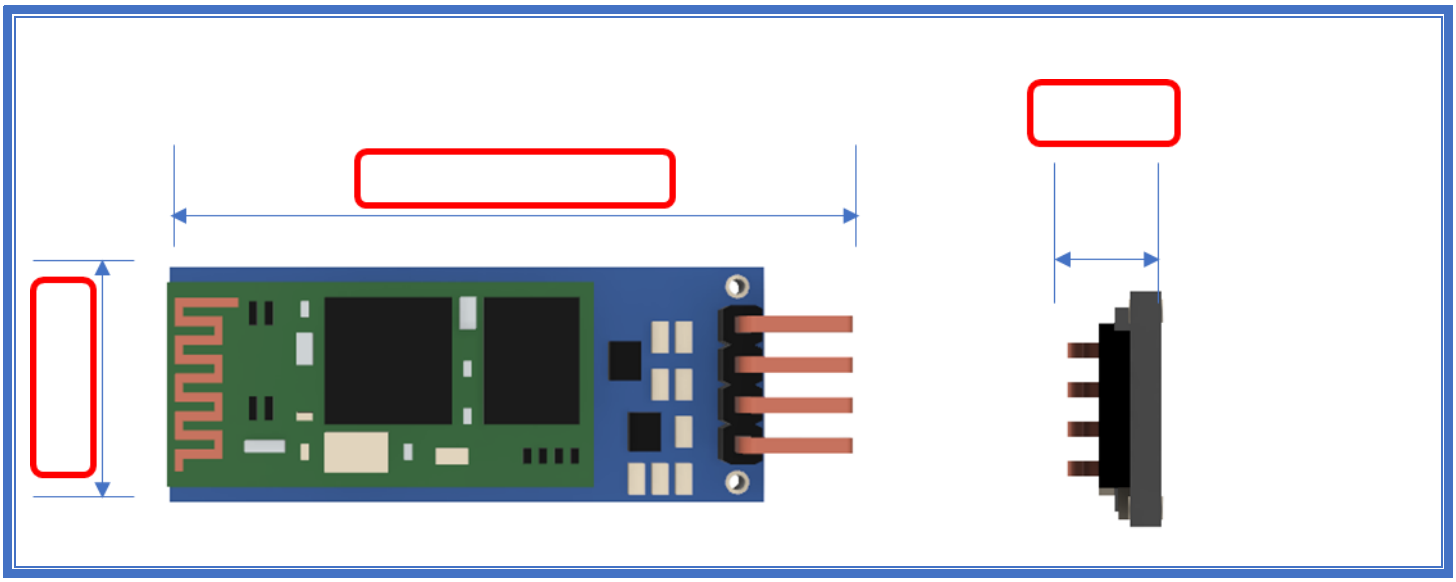
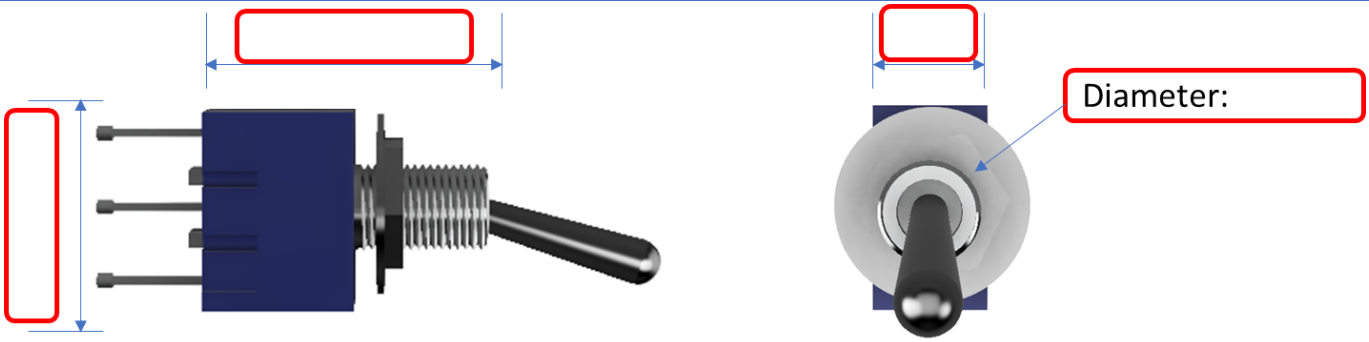
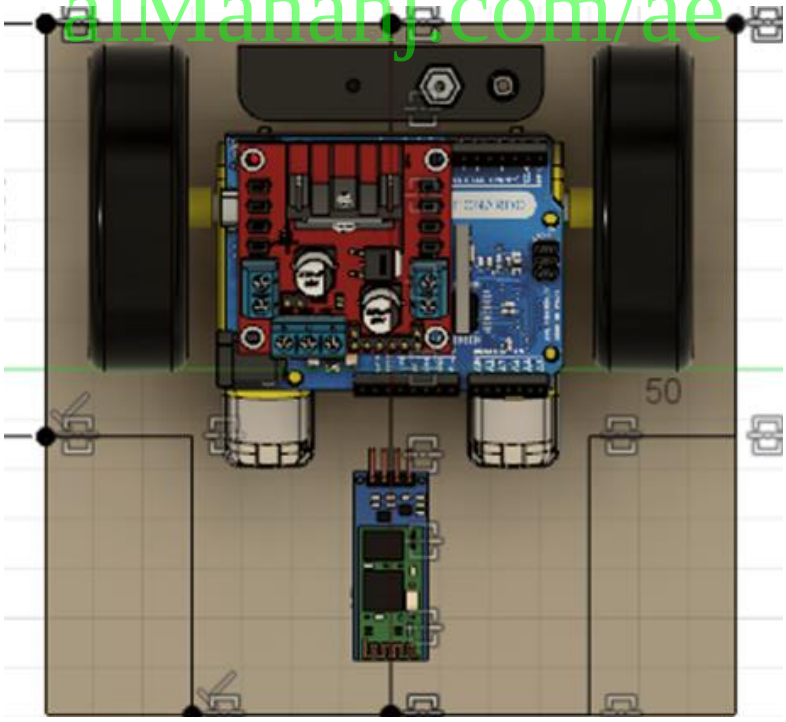


Figure 4.4 6



Activity 4.4.2

Using the measurements from Activity 4.4.1, create a full-sized sketch of how you would arrange the components inside your chassis. Don't forget, you may place some items on top of each other, you can also, for example, attach the battery pack outside of your chassis, but your completed SumoBot must fit within a 200 mm x 200 mm cuboid. ***(Remember that 140 mm is the maximum printing length.)***



Activity 4.4.3

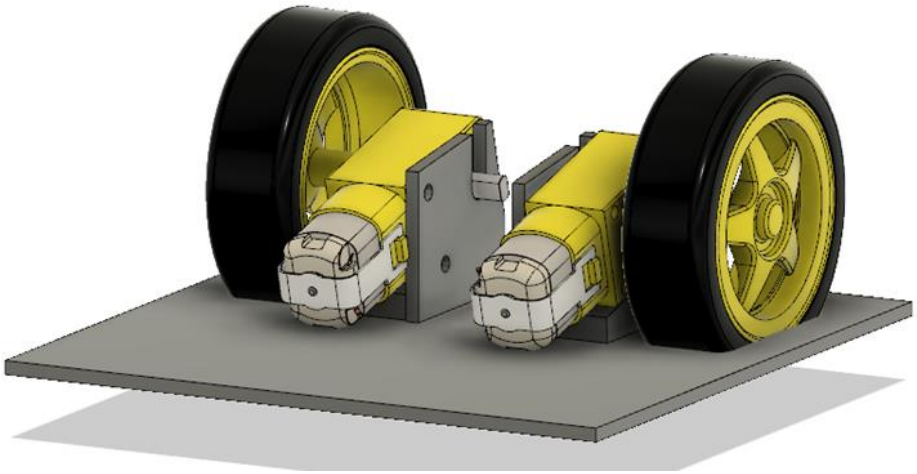


Figure 4.4 7

List the features and tools you will use to create the chassis base and mounts for the motors shown above:

Sketch.

Extrude.

Insert components.

Joint.

Sketch hole.

Create hole.

Mirror.

Activity 4.4.4

Using the same process, create two holes in the mount for your motor as shown below. You can create the holes from the centre points drawn in the previous sketch.

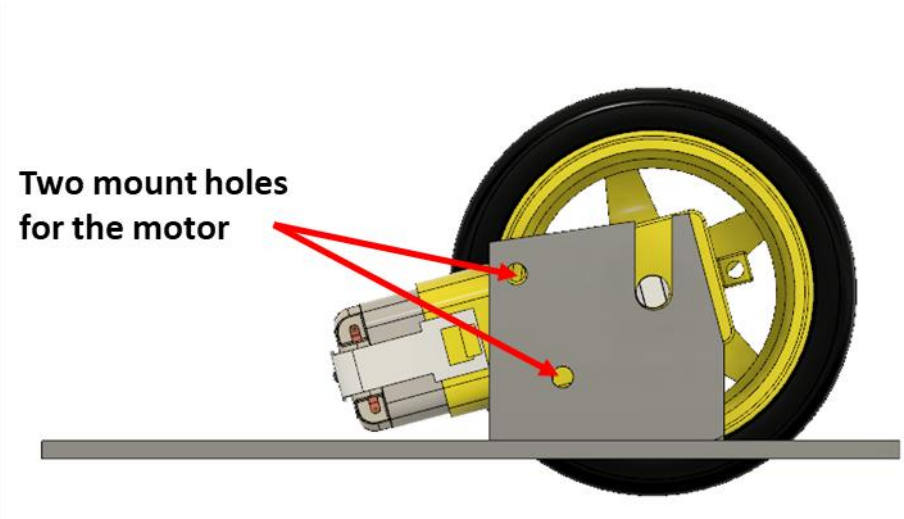


Figure 4.4 8

You should always measure the size of the screws provided before you set the sizes of any holes.

Week 5 Lesson Plan:

Content	**Grade 12 General**	
	Chapter 4 – 3D Modelling	**Section 4 - Chassis base design and positioning the motors.**
		Section 5: Multibody SumoBot design
Time allocated	**3 x 45-minute periods**	
Keywords	**What are the keywords the students must learn?**	
	• 2D sketch • extrude • chassis	
Resources	**What resources are required?** • textbooks • projector • sketching equipment	
Prior Knowledge	• sketching tools • create tools • modify tools • creating bodies	

Aim:

In this lesson, students will use their knowledge of assembling parts from section 3 to assemble all the electronic components within the chassis to verify it is the correct size. Students will demonstrate their full knowledge of basic 3D modelling by creating a full chassis body to surround the components they inserted in the previous section.

Teacher Learning Objectives:

Learning objective refers to what you as a teacher will have taught the student by the end of the lesson. Teachers are to tick the box when they have covered a learning objective.

Student Learning Outcomes: Learning outcomes refer to what the student can expect from the lesson, Teachers must share these outcomes with all students. Teachers are to tick the box when the outcome is achieved. Learning outcomes can be assessed using oral questioning and the written activities.

Teacher should: *(tick as you complete)*	***Students should:*** *(tick as students complete)*
☐ Recap on and demonstrate how to mirror components and bodies.	☐ Mirror components and bodies.
☐ Facilitate as students assemble the various electronic components within their chassis.	☐ Assemble most electric components within the chassis.
☐ Demonstrate how to create a chassis body to surround the electronic components.	☐ Create a chassis body to hold all the required components.
☐ Facilitate students as they shell the chassis body.	☐ Shell the chassis body.
☐ Demonstrate how to create an offset plane and split a body.	☐ Create an offset plane.
	☐ Split a body to create a top cover piece.
☐ Demonstrate how to create screw mounts within the design to secure the top cover to chassis.	☐ Create screw mounts within the design to secure the top cover to chassis.
☐ Facilitate as students create holes to secure the top cover of the mounts.	☐ Create holes to secure the top cover of the mounts.
☐ Facilitate as students mirror features and bodies.	☐ Mirror features and bodies.

Possible teaching method(s) or approach for this lesson

(teacher to tick the relevant method)

- ☐ Collaborative Teaching (student centred)
- ☐ Instructional / Demonstrative Teaching (teacher centred)
- ☐ Inquiry-based Teaching (student centred)
- ☐ Lecture Style Teaching (teacher centred)
- ☐ Coach Style Teaching (teacher centred)
- ☐ Facilitator Style Teaching (student centred)

Essential and non-essential Sections: 

In some lessons it may not be possible to cover every section of the book due to time constraints or lesson variables. Below is a guideline to essential sections for examination and project knowledge.

Topic			Page	
Chapter	**Section**	**Focus**	**Essential**	**Non-essential/Self Study**
4	**4**	Chassis base design and positioning the motors	Pg. 206-228	
4	**5**	Multibody SumoBot design	Pg. 229-255	

Learning Phases – Week 5: Period 1 (Ch. 4: Section 4)

Phase 1 of lesson (Connect) – Starter →	Phase 2 of lesson (Activate) →	Phase 3: (Engage and Demonstrate) →	Phase 4: Plenary (Consolidate) Return to beginning of next row ↩	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Discuss prior knowledge of section 4 from last week. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to recap on students' knowledge of mirroring components and bodies.	a) Facilitate as students mirror both components and bodies in their design.			
	b) Teacher to recap on student's knowledge of assembling bodies.	b) Facilitate as students assemble the various electronic components within their chassis.		**Oral Questioning Visual inspection**	
		c) Provide feedback on students work in Activity 4.4.5-4.4.6.	Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Relate questions to Fusion 360 features used. Have learning outcomes been met? Has the lesson aim been achieved?	**Activity 4.4.5-4.4.6** **Visual inspection of Fusion model** **Student evaluation**	

Learning Phases – Week 5: Periods 2 and 3 (Ch. 4: Section 5)

Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to beginning of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Discuss prior knowledge of Fusion 360 from previous lessons. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to demonstrate to students how to create a chassis body around the inserted electronic components. b) Teacher to demonstrate how to shell the chassis properly.	a) Facilitate students as they create a chassis body around the electronic components. b) Facilitate students as they shell the chassis.		**Oral Questioning**	
	c)Teacher to briefly explain what an offset plane and what splitting a body is. Teacher will explain why you would use these.	c) Facilitate students as they create an offset plane and split a body.		**Oral Questioning**	
	d) Teacher to demonstrate how to create screw mounts for the top cover of the chassis. Teacher to remind students: **You should always measure the**	d) Facilitate students as they create screw mounts for the top cover of the chassis.		**Oral Questioning**	

	size of the screws provided before you set the sizes of any holes.				
	e) Recap on the student's knowledge of mirroring and introduce Activity 4.5.1.	e) Facilitate students as they complete Activity 4.5.1.		**Activity 4.5.1.**	
	e) Teacher to demonstrate how to create matching holes in the top cover for the screw mounts.	e) Facilitate students as they create matching holes in the top cover.			

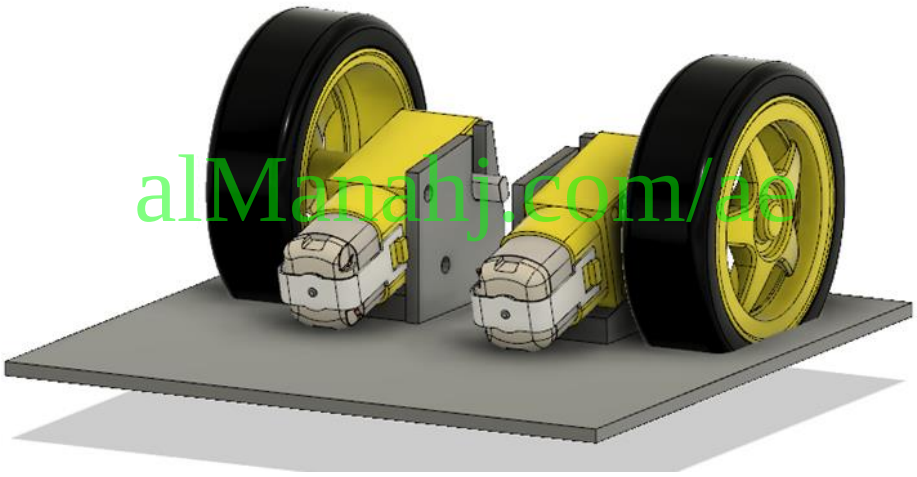
	f) Teacher to demonstrate how to create an extruded cut for the wheels.	f) Facilitate students as they create extruded cuts for the wheels. g) Facilitate students as they complete activity 4.5.2.	Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Relate questions to Fusion 360 features used. Have learning outcomes been met? Has the lesson aim been achieved?	**Activity 4.5.2.** **Visual inspection of Fusion model**	

Answer Key

QR code links:		
Page	***Topic***	***Link***
230	Section 5a video tutorial	***https://autode.sk/2GCG8jm***
233	Section 5b video tutorial	***https://autode.sk/2UPU9hv***
242	Section 5c video tutorial	***https://autode.sk/2WWGrLR***

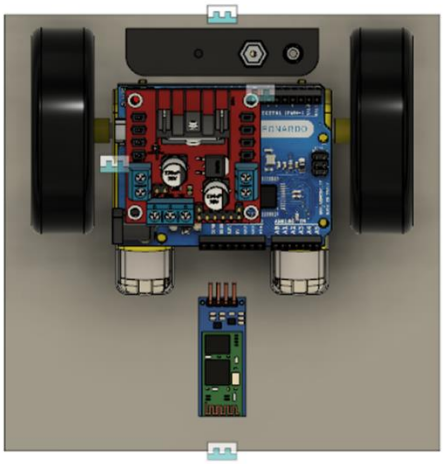
Activity 4.4.5

Paste an image of your 3D modelled base with motors attached to mounts. It must include a timeline view to show what tools/ features were used.



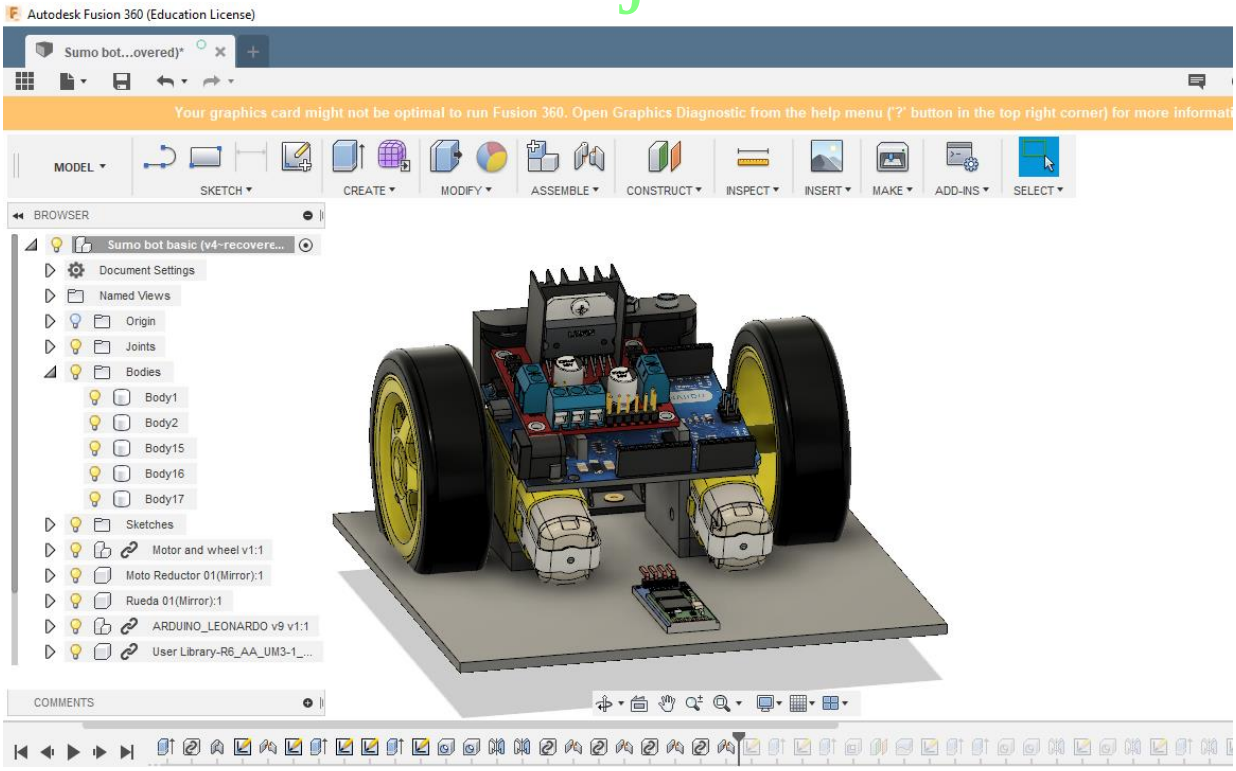
Activity 4.4.6

Import all the electric components to your data panel. Insert and assemble using rigid joints to position the components as shown in Figure 4.4.29



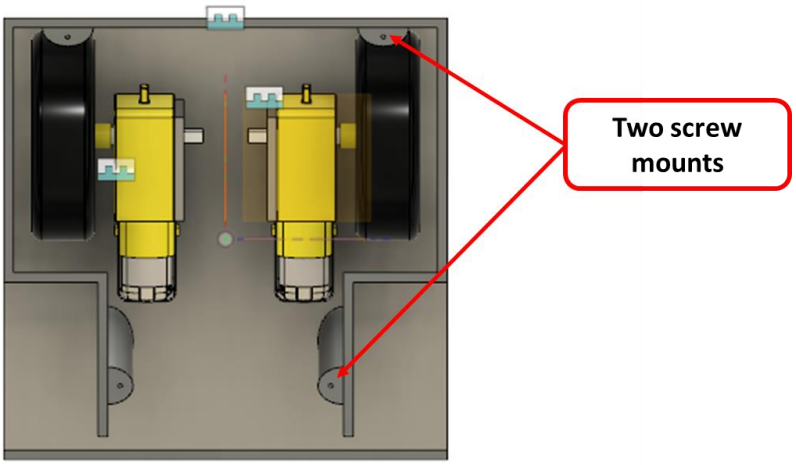
Hint: Create a joint between the bottom face of the component and the chassis base. Then use the triad to offset and position the component as required.

Paste a picture of your assembled chassis including a timeline view of the joints used.



Activity 4.5.1

Using the same process, you used to mirror the motor supports in section 3 of this chapter, mirror the two screw mounts over to the other side of your chassis as shown.



Activity 4.5.2

Mirror the extruded cut for one wheel over to the other side to create a slot for the second wheel.

Week 7 Lesson Plan:

Content	Grade 12 General	
	Chapter 4 – 3D Modelling	Section 5: Multibody SumoBot design
Time allocated	3 x 45-minute periods	
Keywords	**What are the keywords the students must learn?**	
	• 2D sketch • extrude • chassis	
Resources	**What resources are required?** • textbooks • projector • sketching equipment	
Prior Knowledge	• sketching • extrude tool • hole tool • mirror tool	

Aim:

In this lesson, students will further develop their modelling skills by reshaping the design of the basic SumoBot. Students will then be tasked with designing their very own SumoBot, they will have the choice between making 3 modifications to the SumoBot they just created or design their own unique SumoBot. Firstly, students will have to produce possible and final solutions for their designs in the design portfolio in Chapter 1 Engineering Design. Once the teacher has given the go ahead on their designs, students will use all the skills gained throughout grade 12 to begin creating their your very own SumoBot on Fusion 360.

Teacher Learning Objectives:

Learning objective refers to what you as a teacher will have taught the student by the end of the lesson. Teachers are to tick the box when they have covered a learning objective.

Student Learning Outcomes: Learning outcomes refer to what the student can expect from the lesson, Teachers must share these outcomes with all students. Teachers are to tick the box when the outcome is achieved. Learning outcomes can be assessed using oral questioning and the written activities.

Teacher should: *(tick as you complete)*	***Students should:*** *(tick as students complete)*
☐ Demonstrate how to reshape the SumoBot using advanced modelling skills.	☐ Further develop their modelling skills by reshaping the design.
☐ Facilitate and give feedback as student's complete designs.	☐ **Create neat possible solution sketches.**
	☐ **Create an improved final solution design.**
☐ Facilitate students as create their very own Sumobot design or make modifications to the existing design.	☐ Create their very own SumoBot design using all the skills they have acquired in grade 12.

Essential and non-essential Sections:

In some lessons it may not be possible to cover every section of the book due to time constraints or lesson variables. Below is a guideline to essential sections for examination and project knowledge.

Topic			Page	
Chapter	**Section**	**Focus**	**Essential**	**Non-essential/Self Study**
4	***5***	Multibody SumoBot design	Pg. 229-255	
1	**1**	Design Portfolio	Pg. 31-39	

Learning Phases – Week 7: Period 1 (Ch. 4: Section 5)

Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to beginning of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Discuss prior knowledge of section 5 from last week. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to demonstrate several skills to reshape the SumBot. b) Teacher to recap on the split body tool. c) Teacher to demonstrate how to sketch a plane between 3 points.	a) Facilitate as students reshape the SumoBot. b) Question students on use of split tool. c) Facilitate students as they sketch a plane between 3 points and use the split tool.			
	d)Teacher to demonstrate how to complete the reshaping of the SumoBot. e) Introduce students to Activity 4.5.3 in which they must make a hole for the switch and finish the step by step guide on making a basic SumoBot.	d) Facilitate students as they complete the reshaping of the SumoBot. e) Facilitate students as they complete Activity 4.5.3 and finish the step by step guide on making a basic SumoBot.		**Oral Questioning** **Visual inspection** **Activity 4.5.3-4.5.4**	

	f) Teacher to introduce students to Activity 4.5.5, the teacher will inform students they have a choice; **1. Create your own unique design of a SumoBot.** **or** **2. Make at least 3 modifications to the SumoBot created in this chapter.**	f) Assist students as the choose option 1 or 2, students will work on this over the coming weeks, creating their own SumoBot design	Teacher will give students task for homework, they must **go back to chapter 1 and complete Activities 1.1.7-1.1.9, possible and final solutions in relation to their choice of either option 1 or 2 for Activity 4.5.5** Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Relate questions to Fusion 360 features used. Have learning outcomes been met? Has the lesson aim been achieved?	**Activities 1.1.7-1.1.9** **Visual inspection of Fusion model**	

Learning Phases – Week 7: Periods 2 and 3 (Ch. 4: Section 5)

Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to beginning of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Recap on the skills used throughout the term. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to ask students to produce their possible and final solutions, activities 1.1.7-1.1.9.	a) Facilitate and provide feedback on student's homework activities 1.1.7-1.1.9		**Activity 1.1.7-1.1.9**	
	b) Teacher to sign off on students' final solutions and give them permission to start designing on fusion.	b) Facilitate students as they create their very own SumoBot design using all the skills they have acquired in grade 12.		**Activity 4.5.5**	
	c) Teacher to recap or demonstrate any of the skills students are having difficulty with.	d) Teacher to scan the room and ensure students are working	Teacher to facilitate as students evaluate learning.	**Visual inspection**	

		on their own designs on fusion.	Question pupils on what they have learned. Relate questions to Fusion 360 features used. Have learning outcomes been met? Has the lesson aim been achieved?	**of Fusion model** **Student evaluation**	

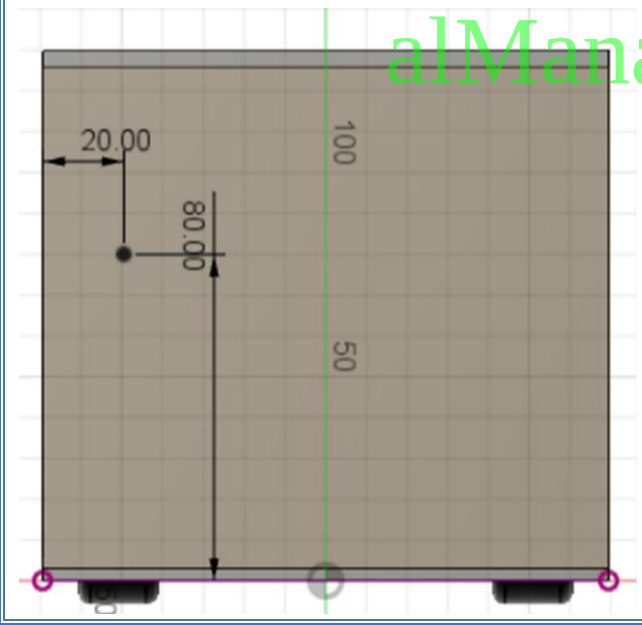
Answer Key

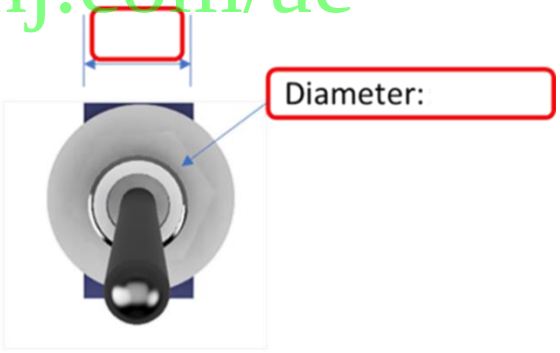
QR code links:		
Page	***Topic***	***Link***
242	Section 5c video tutorial	***https://autode.sk/2WWGrLR***
30	Sketching	https://www.youtube.com/watch?v=OezMavBqWXc

Activity 4.5.3

You must now add a hole to mount the power switch. Refer to Activity 4.3.1 and check the diameter of your toggle switch. First you should sketch a point like the one in the sketch below and then create a hole the correct size for the switch to fit.

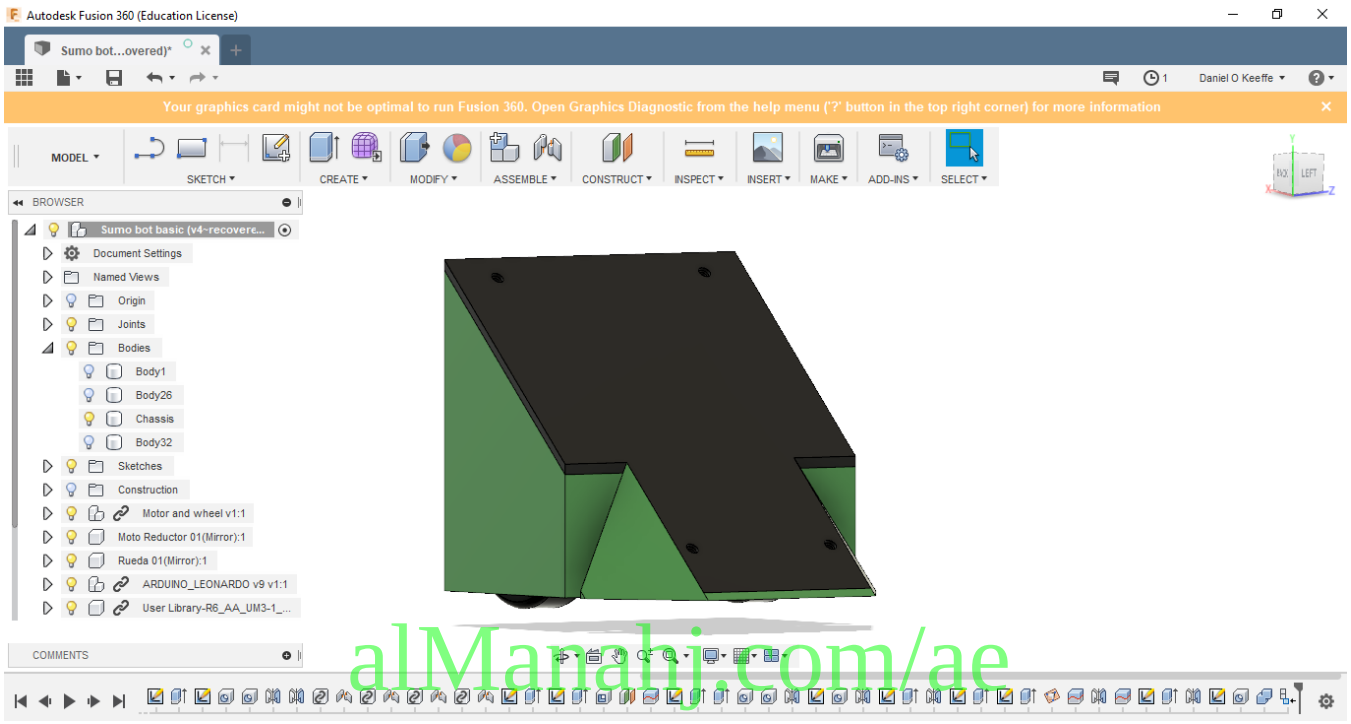
Dimension the hole in your chassis 0.5 mm larger than the diameter of the switch.





Activity 4.5.4

Paste an image of your 3D modelled guided basic SumoBot. *It must include a timeline view to show what tools/ features were used.*



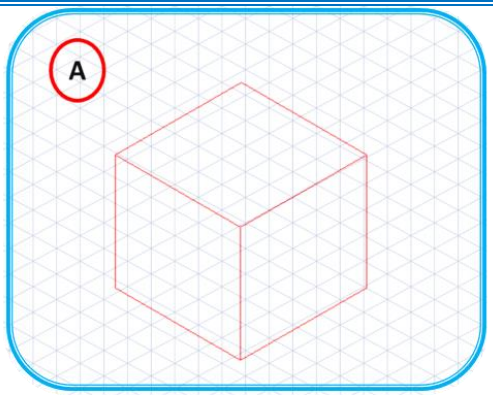
Activity 1.1.7 Possible solution 1

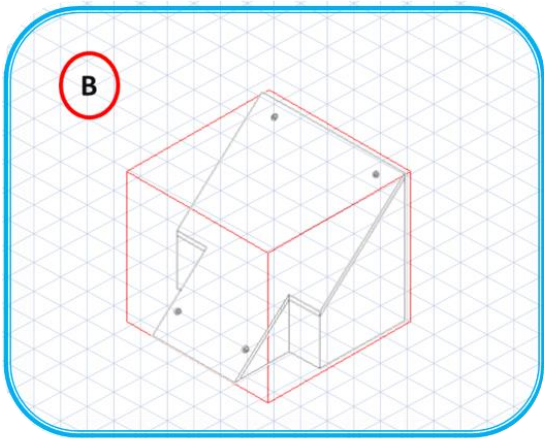
Sketching possible solutions

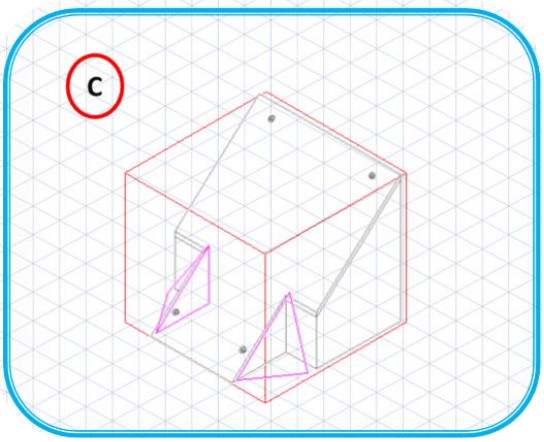
Use the isometric grid to sketch the basic SumoBot modelled in chapter 4 figure 4.5.1. The coloured points outline shape using the "crating" technique. Crating involves sketching very light isometric boxes that aid you to create more complex 3D shapes inside them. Sketch the SumoBot design in separate stages as shown below. ***Then add the 3 modifications to the sketch yourself.*** *Remember to sketch lightly in pencil then refine the sketch with heavy lines where needed.* ***All coloured lines are light construction sketches. Black lines represent final visible edges.***

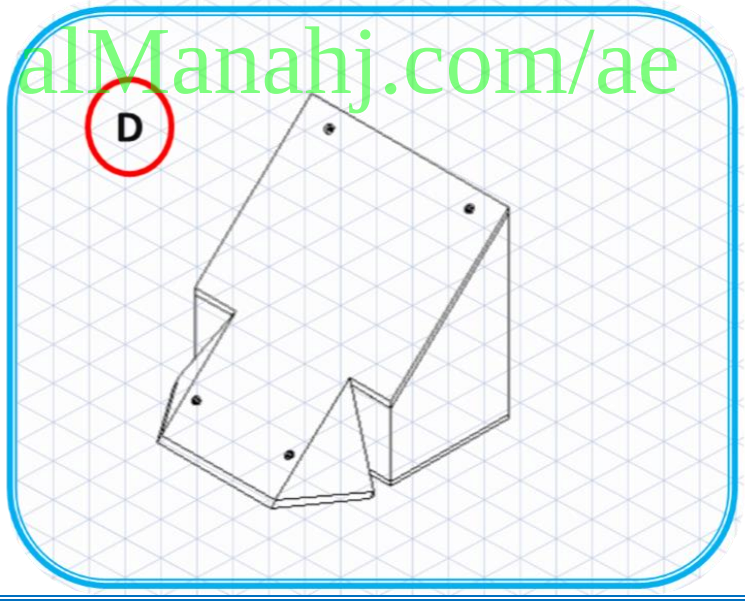
The ***grey*** *lines represent slightly heavier lines that outline the shape, however* ***they are not final lines.***

State two advantages and two disadvantages for this design.









Week 8 Lesson Plan:

Content	Grade 12 General	
	Chapter 4 – 3D Modelling	Section 5: Multibody SumoBot design
Time allocated	3 x 45-minute periods	
Keywords	**What are the keywords the students must learn?**	
	• 2D sketch • extrude • chassis	
Resources	**What resources are required?** • textbooks • projector • sketching equipment	
Prior Knowledge	• sketching • extrude tool • hole tool • mirror tool	

Aim:

In this lesson, students will continue using all the skills gained throughout grade 12 to create their your very own SumoBot on Fusion 360.

Teacher Learning Objectives:

Learning objective refers to what you as a teacher will have taught the student by the end of the lesson. Teachers are to tick the box when they have covered a learning objective.

Student Learning Outcomes: Learning outcomes refer to what the student can expect from the lesson, Teachers must share these outcomes with all students. Teachers are to tick the box when the outcome is achieved. Learning outcomes can be assessed using oral questioning and the written activities.

Teacher should: *(tick as you complete)*	***Students should:*** *(tick as students complete)*
☐ Facilitate students as create their very own Sumobot design or make modifications to the existing design.	☐ Create their very own SumoBot design using all the skills they have acquired in grade 12.

Essential and non-essential Sections:

In some lessons it may not be possible to cover every section of the book due to time constraints or lesson variables. Below is a guideline to essential sections for examination and project knowledge.

Topic			**Page**	
Chapter	**Section**	**Focus**	**Essential**	**Non-essential/Self Study**
4	***5***	Multibody SumoBot design	Pg. 229-255	

Learning Phases – Week 8: Periods 1-3 (Ch. 4: Section 5)

Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to beginning of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Recap on the skills used throughout the term. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to ask students to display what they have done so far on their own fusion design.	b) Facilitate and provide feedback on student's work so far.			
	b) Teacher to recap or demonstrate again any of the skills students are having difficulty with.	b) Facilitate students as they continue to create their very own SumoBot design using all the skills they have acquired in grade 12.		**Activity 4.5.5**	
		c) Teacher to scan the room and ensure students are able to work away on their own designs.	Teacher to facilitate as students evaluate learning. Question pupils on what they have learned.	**Visual inspection of Fusion model.**	

			Relate questions to Fusion 360 features used. Have learning outcomes been met? Has the lesson aim been achieved?	**Student evaluation**	

Week 9 Lesson Plan:

Content	**Grade 12 General**	
	Chapter 4 – 3D Modelling	**Section 5: Multibody SumoBot design**
Time allocated	**3 x 45-minute periods**	
Keywords	**What are the keywords the students must learn?**	
	• 2D sketch • extrude • chassis	
Resources	**What resources are required?** • textbooks • projector • sketching equipment	
Prior Knowledge	• sketching • extrude tool • hole tool • mirror tool	

Aim:

In this lesson, students will use all the skills gained throughout grade 12 to finish creating their your very own SumoBot on Fusion 360. Students will then complete final evaluation of their Fusion project.

Teacher Learning Objectives:

Learning objective refers to what you as a teacher will have taught the student by the end of the lesson. Teachers are to tick the box when they have covered a learning objective.

Student Learning Outcomes: Learning outcomes refer to what the student can expect from the lesson, Teachers must share these outcomes with all students. Teachers are to tick the box when the outcome is achieved. Learning outcomes can be assessed using oral questioning and the written activities.

Teacher should: *(tick as you complete)*	***Students should:*** *(tick as students complete)*
☐ Facilitate students as create their very own Sumobot design or make modifications to the existing design.	☐ Create their very own SumoBot design using all the skills they have acquired in grade 12.
☐ Facilitate and provide feedback as students evaluate.	☐ **Evaluate the final project.**

Essential and non-essential Sections:

In some lessons it may not be possible to cover every section of the book due to time constraints or lesson variables. Below is a guideline to essential sections for examination and project knowledge.

Topic			Page	
Chapter	**Section**	**Focus**	**Essential**	**Non-essential/Self Study**
4	***5***	Multibody SumoBot design	Pg. 229-255	
1	**1**	Evaluation	Pg. 43	

Learning Phases – Week 9: Periods 1-3 (Ch. 4: Section 5)

Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to beginning of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Recap on the skills used throughout the term. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to ask students to display what they have done so far on their own fusion design.	a) Facilitate and provide feedback on student's work so far.			
	b) Teacher to recap or demonstrate again any of the skills students are having difficulty with. c) Teacher to encourage students who are finished their fusion models to skip ahead to chapter 5 and begin 3D printing.	b) Facilitate students as they create their very own SumoBot design using all the skills they have acquired in grade 12.		**Activity 4.5.5**	
		d) Teacher to check student's final fusion models and ensure	Teacher to facilitate as students evaluate learning.	**Visual inspection**	

	e) Present the finalevaluation questions to students.	they are ready to start printing. e) Facilitate and provide constructive feedback as students reflect on and evaluate their finished project.	Question pupils on what they have learned. Relate questions to Fusion 360 features used. Have learning outcomes been met? Has the lesson aim been achieved?	**of Fusion model.** **Final evaluation**	

Week 10 Lesson Plan:

Content	Grade 12 General	
	Chapter 5 – Design realisation	**Section 1 – Manufacturing and assembly of a SumoBot.**
Time allocated 	**3 x 45-minute periods**	
Keywords 	**What are the keywords the students must learn?**	
	• Combine • CAM • CNC • FlashPrint	
Resources 	**What resources are required?** • textbooks • projector • sketching equipment	
Prior Knowledge 	• Design process • Vehicle technologies • Wireless Arduino control • Fusion 360 modelling	

Aim:

In this week, students will manufacture their SumoBot components. These parts will be manufactured using the 3D printing process. Students will then assemble all the parts using suitable joining methods. Finally, Students will assemble all electronic components with the 3D printed model to complete the SumoBot. Students will program and test the project before evaluating its performance.

Teacher Learning Objectives:

Learning objective refers to what you as a teacher will have taught the student by the end of the lesson. Teachers are to tick the box when they have covered a learning objective.

Student Learning Outcomes: Learning outcomes refer to what the student can expect from the lesson, Teachers must share these outcomes with all students. Teachers are to tick the box when the outcome is achieved. Learning outcomes can be assessed using oral questioning and the written activities.

Teacher should: *(tick as you complete)*	***Students should:*** *(tick as students complete)*
☐ Demonstrate how to combine bodies for 3D printing.	☐ Combine bodies for 3D printing.
☐ Recap on the 3D printing process.	☐ Convert 3D models to STL files.
	☐ Insert and set up STL files for 3D printing in FlashPrint.
	☐ 3D print all SumoBot components.
	☐ Assemble all parts using suitable joining methods.
☐ Demonstrate the assembly of the final electric circuit	☐ Fully assemble the electronic circuit.
☐ Ensure students have the correct Arduino program from their work in chapter 3.	☐ Program Arduino to control the circuit and fully satisfy the brief.

Possible teaching method(s) or approach for this lesson

(teacher to tick the relevant method)

- ☐ Collaborative Teaching (student centred)
- ☐ Instructional / Demonstrative Teaching (teacher centred)
- ☐ Inquiry-based Teaching (student centred)
- ☐ Lecture Style Teaching (teacher centred)
- ☐ Coach Style Teaching (teacher centred)
- ☐ Facilitator Style Teaching (student centred)

Essential and non-essential Sections: 

In some lessons it may not be possible to cover every section of the book due to time constraints or lesson variables. Below is a guideline to essential sections for examination and project knowledge.

Topic			Page	
Chapter	**Section**	**Focus**	**Essential**	**Non-essential/Self Study**
5	**1**	Manufacturing and assembly of a SumoBot	Pg. 258 - 276	

Learning Phases – Week 10: Period 1 (Ch. 5: Section 1)

Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to beginning of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Discuss previous knowledge of 3D printing and assembling **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher to present how CAD is used for CAM. Recap on the 3D printing process	a) Students to recap on 3D printing process.		**Oral questioning**	
	b) Demonstrate how to combine parts on fusion. e) Demonstrate how to save parts as STL files.	b) Facilitate students as they combine parts for 3D printing c) Facilitate students as they save all parts as STL files and begin 3D printing.	Teacher to facilitate as students evaluate learning. Question pupils on what they have learned. Relate questions to Fusion 360 features used. Have learning outcomes been met? Has the lesson aim been achieved?	**Activity 5.1.1** **Oral questioning** **Inspection of 3D printed parts**	

Learning Phases – Week 10: Periods 2-3 (Ch. 5: Section 1)

Phase 1 of lesson (Connect) – Starter	Phase 2 of lesson (Activate)	Phase 3: (Engage and Demonstrate)	Phase 4: Plenary (Consolidate) Return to begining of next row	Assessment opportunity	Notes for Differentiation
Teacher to introduce students to the lesson aim. Teacher to place all student learning outcomes on the board and ensure student understanding of aims and outcomes. Introduce all key words for the lesson. Recap on 3D printing and asses what point each group is at. Organise printing if more parts need to be printed. **Teacher Tip:** *Teacher to set high expectations which inspire, motivate and challenge pupils.*	a) Teacher ensure all parts are printed properly. b) Demonstrate assembling parts using the screws provided.	a) Facilitate and provide feedback as students finish their printing. b) Facilitate students on assembling the parts.		**Activity 5.1.1**	
	b) Demonstrate the assembly and soldering of the final electric circuit	b) Facilitate and provide feedback as students assemble and solder the electric circuit.		**Visual inspection circuit**	

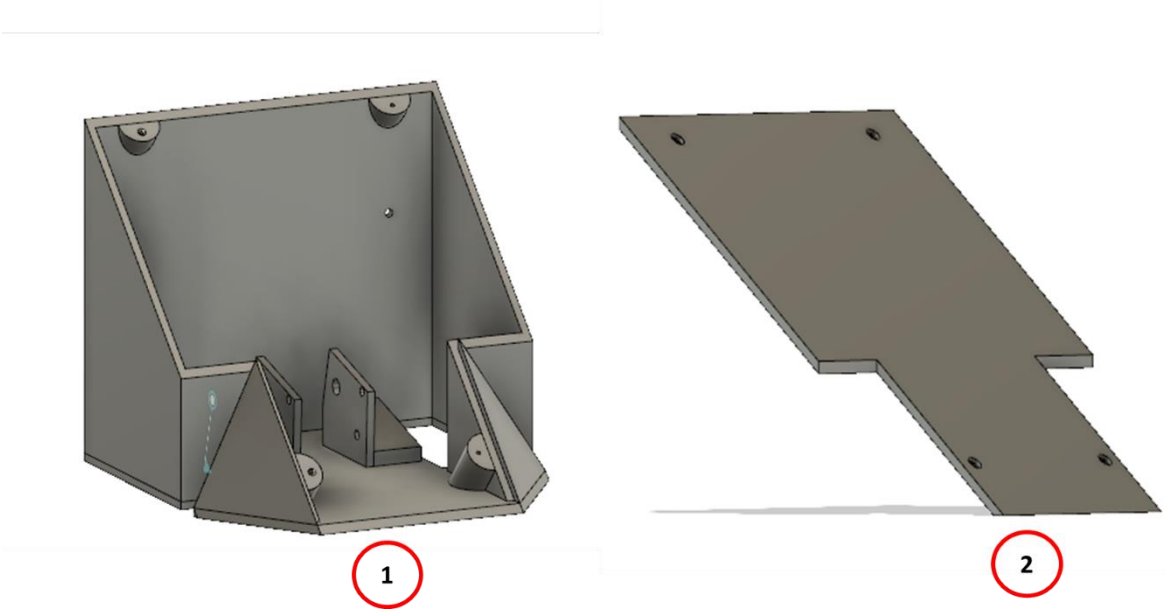
		c)Facilitate and provide feedback as students finalise the circuit and code.		**Visual inspection of finished project** **Activity 5.1.2**	
		d) Facilitate and provide constructive feedback as students reflect on final assembly of project.	Teacher to facilitate as students evaluate learning. Question pupils on what they have learned from the project. What would they do differently? Have learning outcomes been met? Has the brief been satisfied?	**Activity 1.1.10** **Student evaluation** **Final evaluation** .	

Answer Key

QR code links:		
Page	***Topic***	***Link***
260	5 axis machine cutting helmet	https://youtu.be/RnIvhlKT7SY
260	Robotic Arc-weld	https://youtu.be/R-W3y_gX_Mo

Activity 5.1.1

You must now print the top cover of the SumoBot. Figure 5.1.14 shows how to position the top cover at a diagonal as it is longer than 140 mm. Paste pictures of your printed parts below.



Activity 5.1.2

Paste an image of your fully assembled SumoBot with a working circuit.