



L-Università  
ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE  
EXAMINATIONS BOARD

**SECONDARY EDUCATION CERTIFICATE LEVEL  
2024 MAIN SESSION**

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SUBJECT:	<b>Design and Technology</b>
PAPER NUMBER:	IIA
DATE:	7 <sup>th</sup> May 2024
TIME:	9:00 a.m. to 11:05 a.m.

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### **Instructions**

Answer **ALL** questions in **ALL** sections.

Non-programmable calculators and drawing instruments are allowed.

Show **ALL** the working for mathematical calculations.

Coloured pencils and/or markers may be used for sketches.

---

### **Useful Information**

#### **Formulae:**

$$V = I \times R$$

$$V_T = V_1 + V_2 + V_3$$

**Velocity ratio: (T)Driver / (T)Driven**

**Read the following theme and situation carefully before answering this paper.**

**Theme:** Science Fair

**Situation:** Science fairs provide a good opportunity to entertain through Scientific knowledge, creativity, and innovation. The organisers of a local, annual Science Fair want to make their event as interactive and appealing as possible, by having new attractions, props, and interactive installations.

**SECTION A: CORE DESIGN & TECHNOLOGY PRINCIPLES**

1. Materials originate from organic, mineral and petroleum sources. Classify the different materials listed in the word bank below by writing them underneath the correct column in Table 1.

brass	pine	(GRP-polyester) resin
nylon	copper	cardboard

Table 1

ORGANIC	MINERAL	PETROLEUM

**(Total: 3 marks)**

2. There are different types of fabrication processes. Name **ONE** reforming and **ONE** deforming fabrication process.

a. Reforming: \_\_\_\_\_ (1)

b. Deforming: \_\_\_\_\_ (1)

**(Total: 2 marks)**

3. Underline the correct answer for each question.

- a. Which **ONE** of the following is an organic material?

Acrylic	Nylon	Cotton	Polythene
---------	-------	--------	-----------

(1)

- b. In a workshop, one would find a number of emergency stop buttons such as the one shown in Figure 1. What type of switch is this?

Push-to-make switch	Reed switch	Push-to-break switch
---------------------	-------------	----------------------

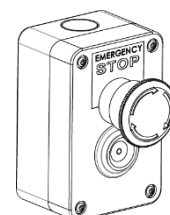


Figure 1

(1)

c. A lamp is designed to automatically switch on in the darkness. What component was included in this system to do this function?

Diode	Light dependent resistor	Thermistor
-------	--------------------------	------------

(1)

d. Which of the following are parts of a sewing machine?

Grinding wheel and shaft	Battery pack and chuck	Foot press and bobbin case
--------------------------	------------------------	----------------------------

(1)

e. Which of the sustainability 'R's does the symbol shown in Figure 2 indicate?

Reuse	Reduce	Recycle	Recover
-------	--------	---------	---------

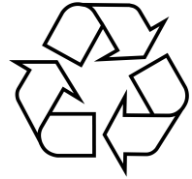


Figure 2 (1)

**(Total: 5 marks)**

4. Match the fasteners with the most appropriate tool.

Fasteners
Pop rivets
Nails
Buttons
Nuts and bolts
Screws

Tool
Screwdriver
Pop riveter
Sewing thread and needle
Hammer
Spanner

**(Total: 5 marks)**

5. Sketch the cross-sectional pattern of the following materials:

a. 3 ply Plywood;

(1)

b. chipboard;

(1)

c. corrugated cardboard.

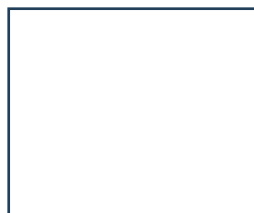
(1)

**(Total: 3 marks)**

***Please turn the page.***

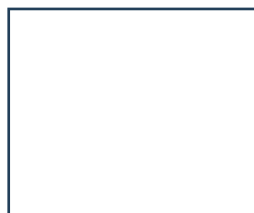
6. Draw the schematic symbol for the following electronic components:

a. a variable resistor;



(1)

b. DPDT switch.



(1)

**(Total: 2 marks)**

**SECTION B: DESIGN ASPECT**

**Refer back to the situation on page 2 and read the following broad Design Brief carefully to answer this section.**

**Broad Design Brief:** The organisers of the Science Fair would like to have a SCIENCE FICTION themed photo booth with diverse wearable props which visitors can put on themselves and then take a photo. The props accompanying the photo booth will represent fictional characters from story books and movies and should include electronic and/or mechanical parts.

7. The organisers researched about the genres of books and movies that are most popular with children.

a. To acquire this data, the organisers visited schools and met with children of different ages. Name **TWO** data collection methods that could have been used.

\_\_\_\_\_ (1)

\_\_\_\_\_ (1)

b. After collecting the data, they needed to plot a chart to organise this information. They discussed the use of pie charts and bar charts.

i. Suggest **TWO** other types of charts to help them out.

\_\_\_\_\_ (1)

\_\_\_\_\_ (1)

ii. Name **ONE** other use of infographic signs in places like a Science Fair hall or a school.

\_\_\_\_\_ (1)

- c. From the gathered information, Table 2 below was formulated. Table 2 shows the percentage of preferred genre (type) of science fiction books and movies of 150 students aged 10 to 13 years. Communicate the data given in Table 2 visually and in a well-presented manner by making use of a pie chart OR a bar chart. Name the type of infographic chart drawn. (3)

Table 2

<b>150 STUDENTS AGED 10-13</b>	
<b>SCIENCE FICTION GENRE</b>	<b>PERCENTAGE</b>
Mystery	29%
Superhero	47%
Fantasy	24%

Infographic chart type: \_\_\_\_\_

**(Total: 8 marks)**

8. Accompanying the photo booth, visitors will find wearable 3D props representing characters from SCIENCE FICTION books and movies. These props should include electronic and/or mechanical parts and need to be life sized for visitors to wear.

Write down **THREE** important specifications, needed while designing these 3D props.

Specification 1: \_\_\_\_\_ (1)

Specification 2: \_\_\_\_\_ (1)

Specification 3: \_\_\_\_\_ (1)

**(Total: 3 marks)**

9. Consider the given Situation, broad Design Brief and specifications to answer this question.
- a. Sketch **TWO** different Design Ideas for photo booth props representing characters from SCIENCE FICTION books and movies described in question 8. Use colour, annotations and indicate how this can be worn.

**ONE** Design Idea should include at least an electronic feature, and **ONE** Idea should include at least a mechanical feature.

i. **Idea 1**- Type of system/feature included: (Underline) Electronic, Mechanical



(5)

ii. **Idea 2**- Type of system/feature included: (Underline) Electronic, Mechanical

(5)

b. Choose and state the best idea from the sketches in part (a) and describe **ONE** advantage this offers to the following stakeholders: Chosen Idea: \_\_\_\_\_

i. The organisers of the Science Fair:

\_\_\_\_\_ (1)

ii. The visitors at the Science Fair:

\_\_\_\_\_ (1)

**(Total: 12 marks)**  
***Please turn the page.***

10. Sustainability is a key aspect for the Science Fair.

a. Suggest **ONE** way how to decrease the carbon footprint in manufacturing or distribution of the chosen idea in question 9.

\_\_\_\_\_ (1)

b. At the Science Fair there will be a stand exhibiting and explaining different renewable sources of energy, including solar energy. Name **ONE** other renewable source of energy.

\_\_\_\_\_ (1)

**(Total: 2 marks)**

**SECTION C: TECHNOLOGY ASPECT**

11. Figure 3 shows a quiz board game that was set up within a Maker section at the Fair. Complete the sign by filling in the blanks with the appropriate tool names and uses:


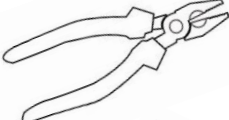



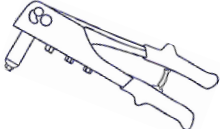
Tools/Equipment	Name	Use
	Spanner	A tool used to provide grip and mechanical advantage in applying torque to turn objects usually rotary fasteners or keep them from turning.
	_____	Used to hold objects firmly. Also used for bending, cutting, and compressing.
	Multi-meter	_____ _____
	Hot air blower	_____ _____
	Mallet	_____ _____
	_____	This tool can join two pieces of material together by inserting and expanding a metal fastener.

Figure 3

**(Total: 5 marks)**



12. A sign, as shown in Figure 4, was set up at the entrance of the Science Fair photo booth.

The sign was cut out digitally out of plywood with each letter cut individually from 3 mm plywood. It looked as if the edges were slightly burnt or looked darker.



Figure 4

Name the manufacturing process that was used to cut the letters seen in Figure 4?

\_\_\_\_\_ (1)

**(Total: 1 mark)**

13. At the Science Fair the students created an educational model of the solar system as seen in Figure 5. Metal and polymers were the materials used to create the model shown.

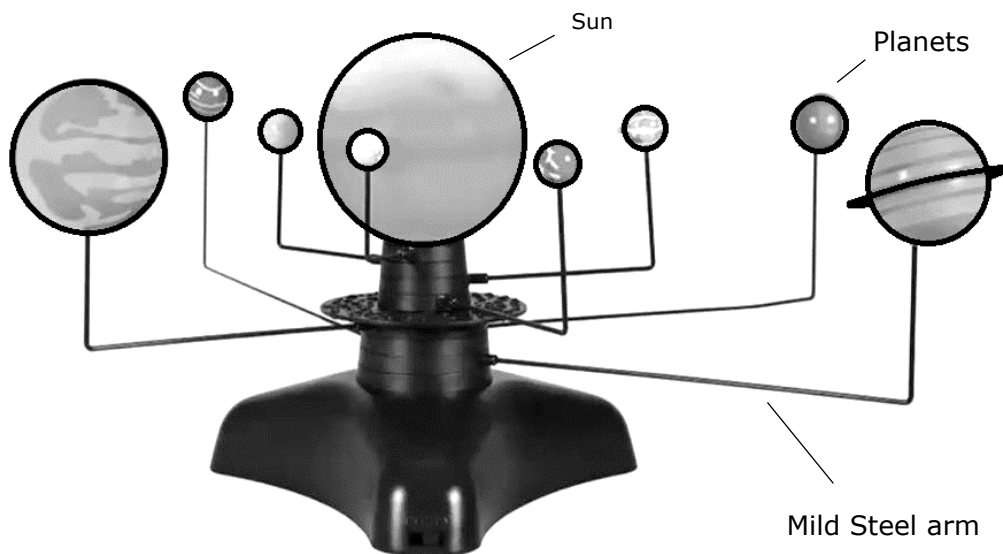


Figure 5

a. Each planet is held by a mild steel arm. Name the metal category.

\_\_\_\_\_ (1)

b. A layer of zinc was applied on the mild steel arms as a surface finish. This process is called galvanising. Give **ONE** reason for applying this process.

\_\_\_\_\_ (1)

***This question continues on next page.***

c. Explain another reason for applying a surface finish on metal.

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(1)

d. Instead of mild steel the arm could be made from another type of metal. Name **TWO** suitable metals which do **not** rust.

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(1)

(1)

**(Total: 5 marks)**

14. The spherical objects that represent the planets of the solar system, as seen in Figure 6, are made from a polymer called HIPS.

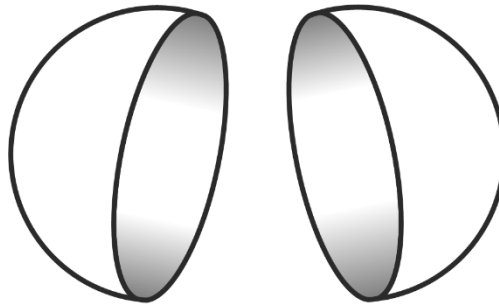


Figure 6

a. The planets are constructed out of two separate hemispheres of HIPS as seen in Figure 6. Name the type of structure of the plastic hemispheres.

---

(1)

- b. The two hemispheres were created by using the vacuum forming fabrication process. This process is described in Table 3. However, the steps are **not** in order.

Write down the correct numeric order for the given steps for this process. Use numbers from **1** to **6**.

Table 3

Steps Order	Description
	The heater is switched on. The HIPS sheet will now begin to soften.
	The lever is pressed down which raises the mould. The HIPS now takes the shape of the mould.
	A mould is placed into the vacuum forming machine.
	Air is sucked out from beneath the mould. The HIPS is left to cool before it is removed from the machine.
	A HIPS sheet is placed over the mould and clamped into position using the two clamps on the machine.
	The HIPS sheet becomes flexible.

(3)

**(Total: 4 marks)**

15. An exhibitor was selling clothes and accessories made from smart materials.

- a. Some of the clothing items sold were covered with thermochromic ink. Describe thermochromic ink.

\_\_\_\_\_

\_\_\_\_\_ (1)

- b. The same exhibitor also sold reading glasses made from shape memory alloy. A sample is shown in Figure 7. Describe what a shape memory alloy material is.



Figure 7

\_\_\_\_\_

\_\_\_\_\_ (1)

**(Total: 2 marks)**

***Please turn the page.***

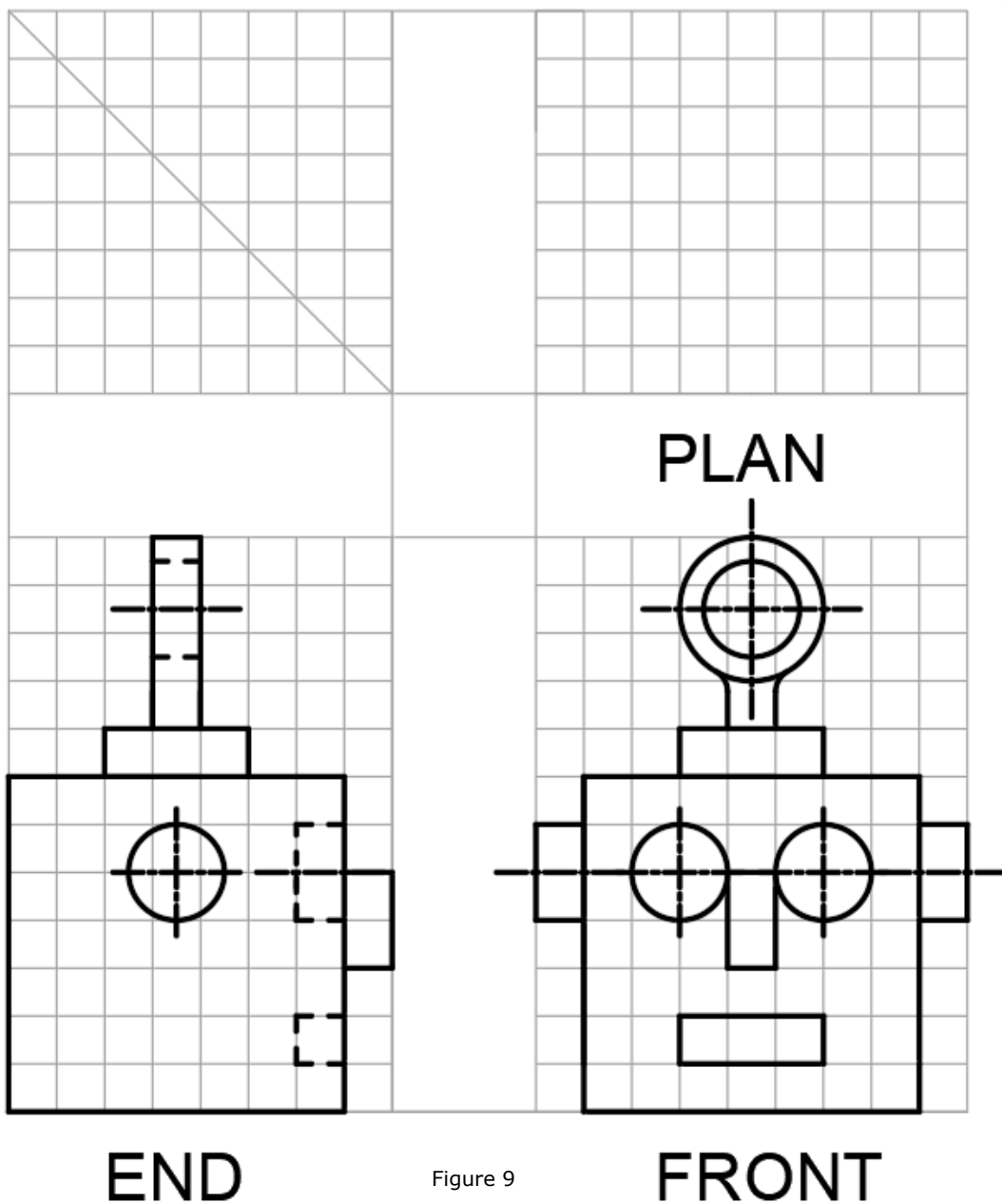
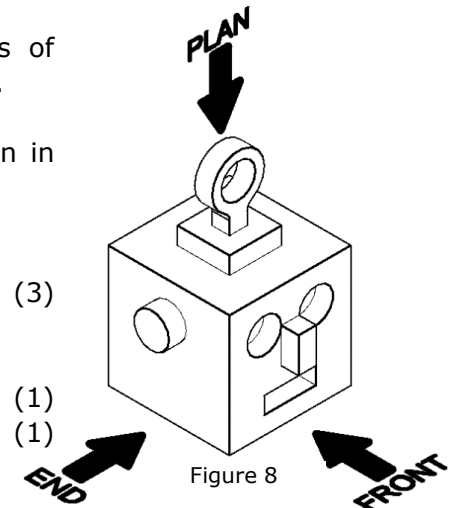
16. A robotics section at the Science Fair exhibited robots of different shapes and sizes. Figure 8 shows a robot's head.

a. On Figure 9, draw the Plan of 3D robots' head shown in Figure 8.

Use the proper drawing instruments.  
**no** hidden lines or centre lines are required.

b. On the End View label with arrows:

- i. **ONE** centre line;
- ii. **ONE** hidden line.



(Total: 5 marks)

17. The working model of the solar system, previously shown in Figure 5, was developed further.

The model consists of a sun in the centre of the solar system, and the planets orbiting around the sun. A low voltage light output was included in the sun sphere.

Figure 10 shows an incomplete electronic circuit diagram to be used inside the solar system.

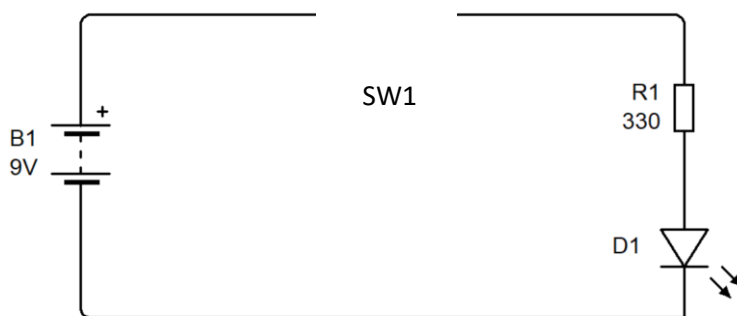


Figure 10

a. Complete the electronic circuit diagram in Figure 10 by drawing a SPST type switch SW1. (1)

b. An LED D1 is found in the circuit. What happens when the LED is connected in a forward bias and the circuit is closed?

Complete the following sentence.

The LED \_\_\_\_\_ (1)

c. Refer to the circuit in Figure 10. On the strip board template given in Figure 11, draw the component layout of the circuit. Draw and label the power supply leads. (3)

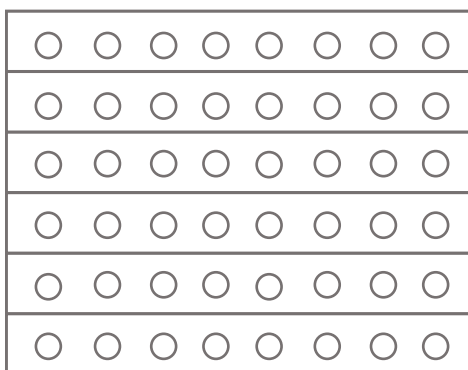


Figure 11

(3)

**Please turn the page.**

d. Calculate the current flowing in the circuit shown in Figure 10, if the voltage drop across the LED is 2.4V. Include the unit in your answer.



(3)

e. A breadboard is normally used in electronics to test a circuit. Mention **ONE** other advantage for using the breadboard.

\_\_\_\_\_ (1)

f. Hand tools suitable for electronics fabrication were used to build the circuit. Name **ONE** hand tool suitable for electronics work and explain what its use is.

Tool: \_\_\_\_\_ (1)

Use: \_\_\_\_\_

\_\_\_\_\_ (1)

g. Safety is an important aspect that should be kept in mind while working. Mention **TWO** safety rules that should be observed while soldering electronic components.

\_\_\_\_\_  
\_\_\_\_\_ (2)

**(Total: 13 marks)**

18. A gear system is attached to a d.c. motor. Figure 12 shows the gear system. Gear A is the input gear and is moving in clockwise direction.

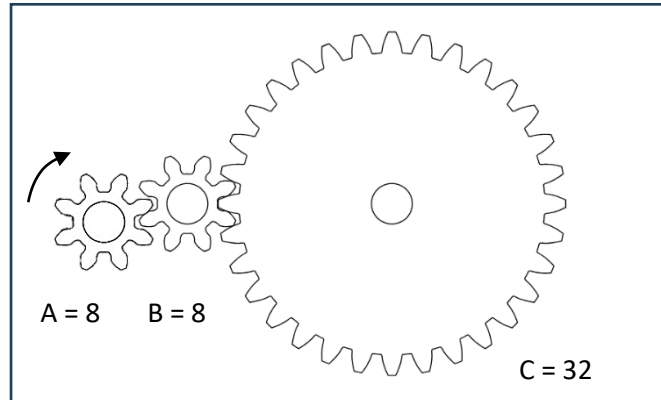


Figure 12

a. Complete the specific name for the gear composition shown in Figure 12.

Simple \_\_\_\_\_ (1)

b. Draw the direction of rotation for Gear C on Figure 12. (1)

c. State the specific name for Gear B in its current position.  
 \_\_\_\_\_ (1)

d. Describe the function of Gear B in the mechanism.  
 \_\_\_\_\_ (1)

e. Figure 12 also shows the number of teeth within the gear system. Gears A and B have 8 teeth, while Gear C has 32 teeth.

i. Find the velocity ratio of the gear system. Show your working. (2)

ii. Explain the answer obtained in the previous question.  
 \_\_\_\_\_ (1)

**(Total: 7 marks)**

***Please turn the page.***

19. The solar model shown previously in Figure 5, was designed to be educational and interactive.

Every planet can be switched individually by a touch sensitive switch. When the switch is ON, an LED lights up inside the planet for a small time period and the planets turn around the sun for one revolution.

In order to achieve this function, a microcontroller circuit was developed, as in Figure 13.

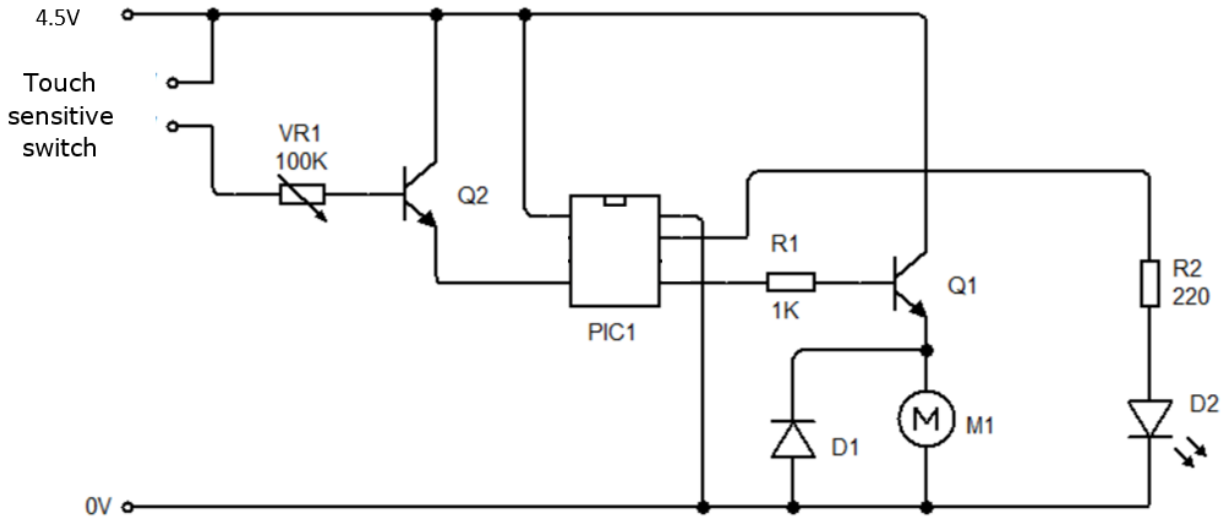


Figure 13

a. Name the component Q2. \_\_\_\_\_ (1)

b. On Figure 14 fill in the block diagram, according to the circuit shown in Figure 13.

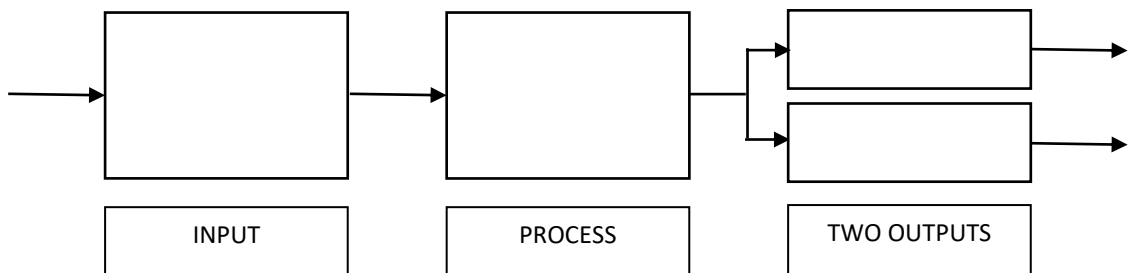


Figure 14

(4)

c. PIC1 is PIC microcontroller. Mention **ONE** advantage of using PIC over discrete components in a circuit.

\_\_\_\_\_ (1)

**(Total: 6 marks)**



20. Figure 15 shows the flowchart used to program a part of the microcontroller circuit. Its function is written here for reference.

Circuit Function: The PIC shall control 2 devices (C.0 and C.4) to switch on for 2 seconds. Afterwards, these will turn off and stay off for 2 seconds. The circuit, when powered, shall keep waiting for a user input.

- a. On the given flowchart identify and label **ONE** input and **ONE** output. (2)
- b. On the given flowchart there is an error. Identify and correct the error by labelling a corrected version next to the error. (2)

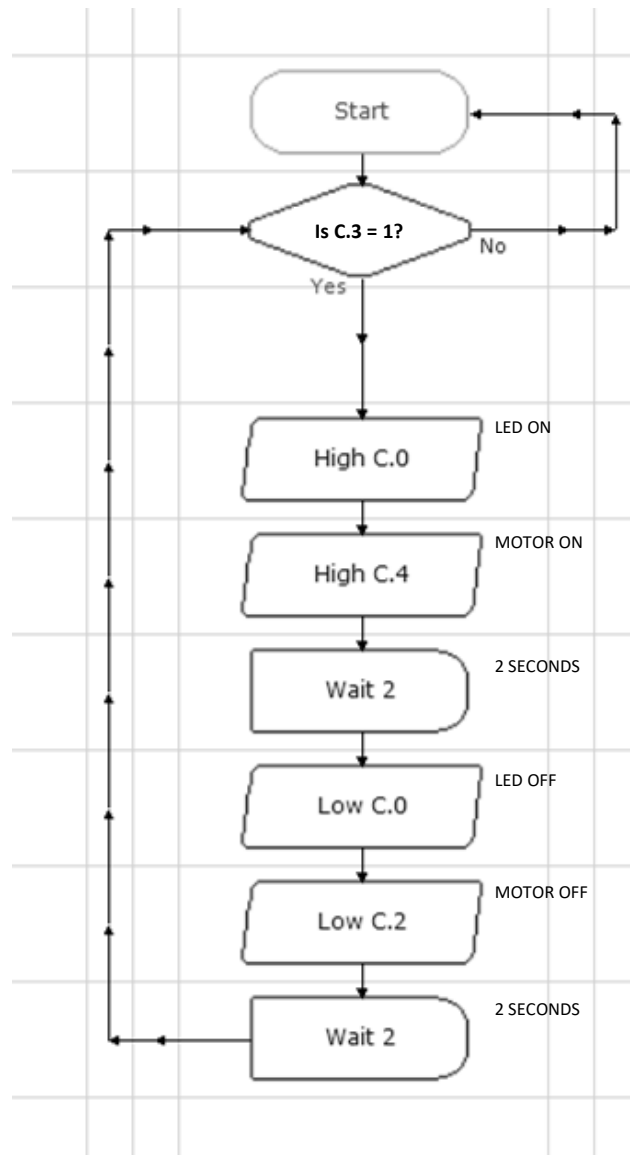


Figure 15

***This question continues on next page.***

c. Explain why a connector loop was added from the last command back to the decision command in the flowchart.

\_\_\_\_\_ (1)

d. On Figure 16 add **ONE** command, that would include another decision to the programme in Figure 15.

By adding this command, the system would work when the following conditions are all met:

- The current condition of C.3 is met AND
- A new condition for C.1 is also met when it is in the range of 30 to 100. This would be obtained from an LDR that senses low light conditions.

Ignore all other flowchart commands. (2)

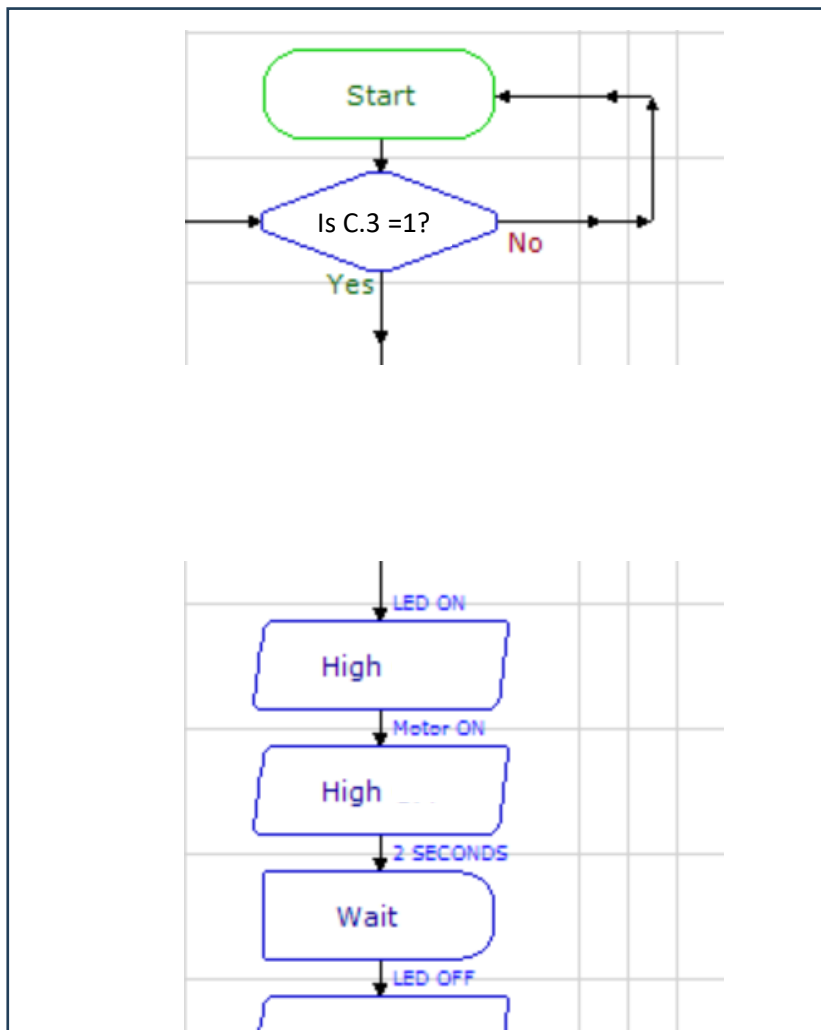


Figure 16

**(Total: 7 marks)**

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$$V_T = V_1 + V_2 + V_3$$

**Velocity ratio: (T)Driver / (T)Driven**

**Read the following theme and situation carefully before answering this paper.**

**Theme:** Science Fair

**Situation:** Science fairs provide a good opportunity to entertain through scientific knowledge, creativity, and innovation. The organisers of a local, annual Science Fair want to make their event as interactive and appealing as possible, by having new attractions, props, and interactive installations.

**SECTION A: CORE DESIGN & TECHNOLOGY PRINCIPLES**

1. Materials originate from organic, mineral and petroleum sources. Classify the different materials listed in the word bank below by writing them underneath the correct column in Table 1.

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nylon	copper	cardboard

Table 1

ORGANIC	MINERAL	PETROLEUM

**(Total: 3 marks)**

2. There are different types of fabrication processes. Name **ONE** reforming and **ONE** deforming fabrication process.

a. Reforming: \_\_\_\_\_ (1)

b. Deforming: \_\_\_\_\_ (1)

**(Total: 2 marks)**

3. Underline the correct answer for each question.

a. Which **ONE** of the following is an organic material?

Acrylic	Nylon	Cotton	Polythene
---------	-------	--------	-----------

(1)

b. In a workshop, one would find a number of emergency stop buttons such as the one shown in Figure 1. What type of switch is this?

Push-to-make switch	Reed switch	Push-to-break switch
---------------------	-------------	----------------------



Figure 1

(1)

c. A lamp is designed to automatically switch on in the darkness. What component was included in this system to do this function?

Diode	Light dependent resistor	Thermistor
-------	--------------------------	------------

(1)

d. Which of the following are parts of a sewing machine?

Grinding wheel and shaft	Battery pack and chuck	Foot press and bobbin case
--------------------------	------------------------	----------------------------

(1)

e. Which of the sustainability 'R's does the symbol shown in Figure 2 indicate?

Reuse	Reduce	Recycle	Recover
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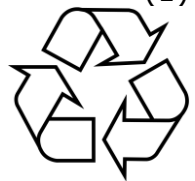


Figure 2 (1)

**(Total: 5 marks)**

4. Match the fasteners with the most appropriate tool.

Fasteners
Pop rivets
Nails
Buttons
Nuts and bolts
Screws

Tool
Screwdriver
Pop riveter
Sewing thread and needle
Hammer
Spanner

**(Total: 5 marks)**

5. Sketch the cross-sectional pattern of the following materials:

a. 3 ply Plywood;

(1)

b. chipboard;

(1)

c. corrugated cardboard.

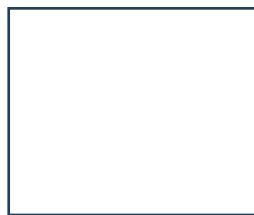
(1)

**(Total: 3 marks)**

***Please turn the page.***

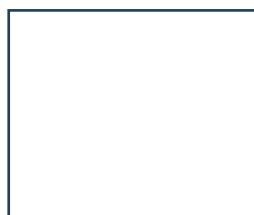
6. Draw The schematic symbol for the following electronic components:

a. a variable resistor



(1)

b. DPDT switch



(1)

**(Total: 2 marks)**

**SECTION B: DESIGN ASPECT**

**Refer back to the situation on page 2 and read the following broad Design Brief carefully to answer this section.**

**Broad Design Brief:** The organisers of the Science Fair would like to have a SCIENCE FICTION themed photo booth with diverse wearable props which visitors can put on themselves and then take a photo. The props accompanying the photo booth will represent fictional characters from story books and movies and should include electronic and/or mechanical parts.

7. The organisers researched about the genres of books and movies that are most popular with children.

a. To acquire this data, the organisers visited schools and met with children of different ages. Circle **THREE** data collection methods that could have been used from Table 1.

Table 1

surveys	block diagram	interviews
datasheet	questionnaires	iterative process

(3)

b. After collecting the data, they needed to plot a chart to organise this information. They discussed the use of infographic charts, including histograms and spider charts.

Suggest **TWO** other types of charts to help them out.

\_\_\_\_\_ (1)

\_\_\_\_\_ (1)

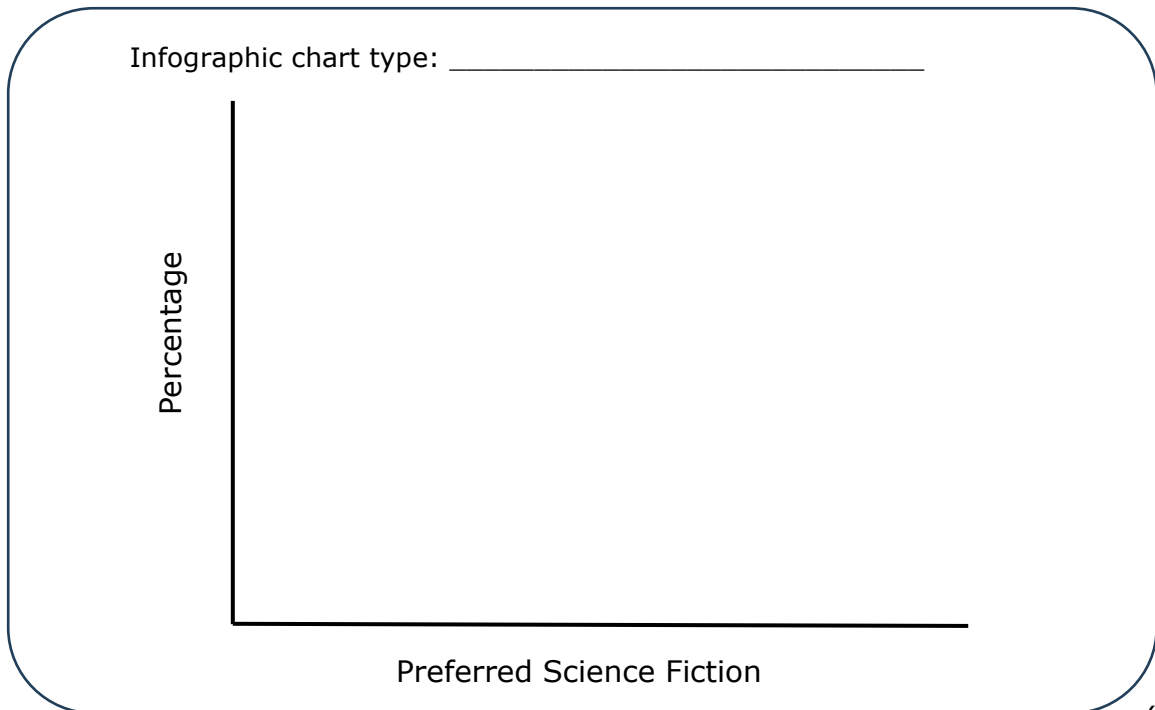


c. From the gathered information, Table 2 below was formulated. Table 2 shows the percentage of preferred genre (type) of science fiction books and movies of 150 students aged between 10 to 13 years.

Table 2

<b>150 STUDENTS AGED 10-13</b>	
<b>SCIENCE FICTION GENRE</b>	<b>PERCENTAGE</b>
Mystery	29%
Superhero	47%
Fantasy	24%

Communicate the data given in Table 2 visually and in a well-presented manner by completing the infographic chart below. Name the type of infographic chart drawn. Marks will be awarded for accuracy, clarity and colour.



(3)

**(Total: 8 marks)**

8. Accompanying the photo booth, visitors will find wearable 3D props representing characters from SCIENCE FICTION books and movies. These props should include electronic and/or mechanical parts and need to be life sized for visitors to wear.

a. Write down **THREE** important specifications that need to be kept in mind while designing these props by completing the sentences below. The first two specifications need to focus on: (i) functions/systems included and (ii) a detailed safety precaution. Specification (iii) is left open.

Specification (i): *The props must include* \_\_\_\_\_

\_\_\_\_\_ (1)

***This question continues next page.***

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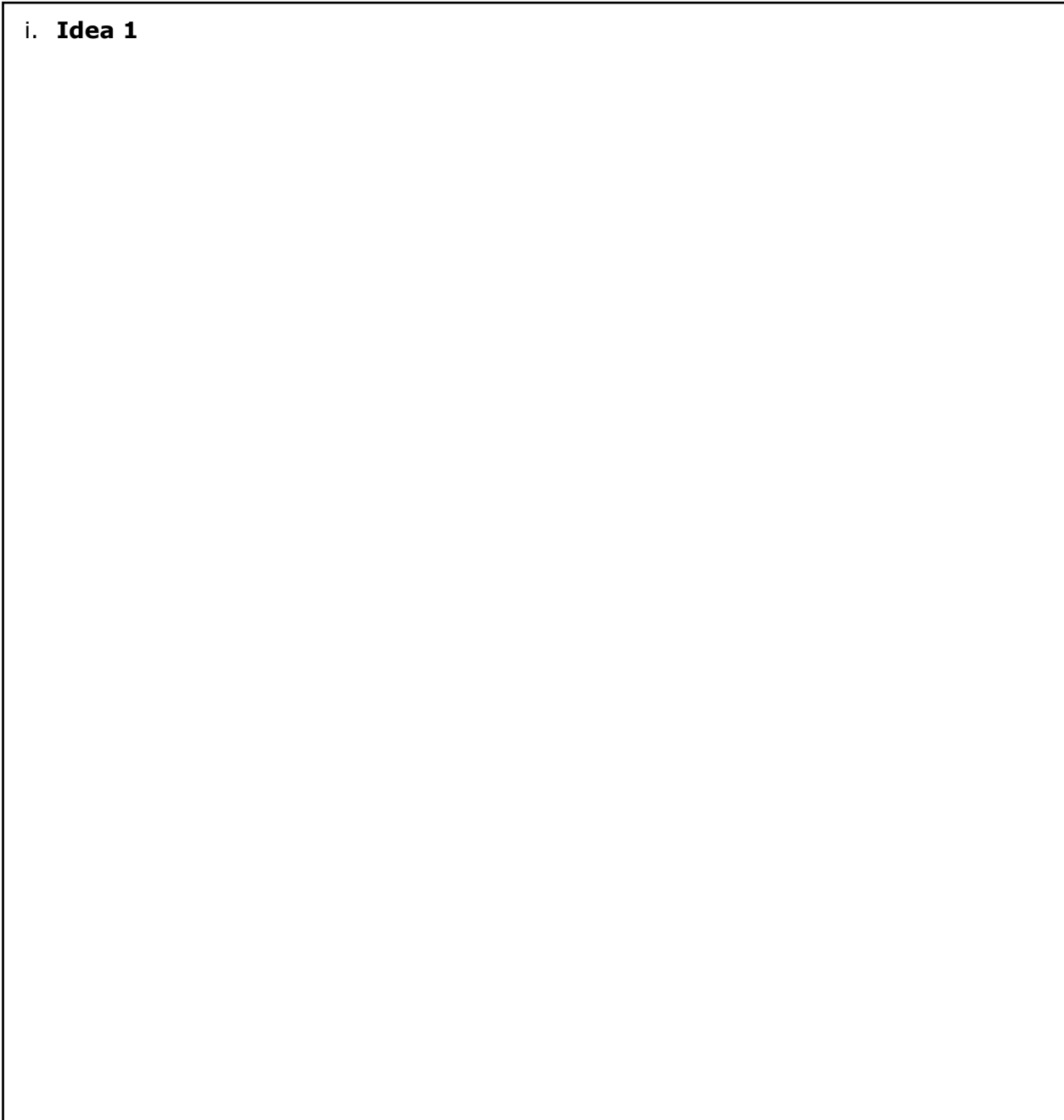
Specification (ii): *The props must be* \_\_\_\_\_  
\_\_\_\_\_ (1)

Specification (iii): \_\_\_\_\_  
\_\_\_\_\_ (2)

**(Total: 4 marks)**

9. Sketch **TWO** different Design Ideas for photo booth props representing characters from SCIENCE FICTION books and movies described in question 2. Consider the given Situation, broad Design Brief and specifications to answer this question. Use colour, annotations and indicate how this can be worn. Ideas must include moving or electronic parts.

i. **Idea 1**



(5)

ii. **Idea 2**

(5)

**(Total: 10 marks)**

10. Choose and state the best idea from the sketches in question 9 and describe **TWO** advantages this offers. Chosen Idea: \_\_\_\_\_

i. Advantage 1:

\_\_\_\_\_ (1)

ii. Advantage 2:

\_\_\_\_\_ (1)

**(Total: 2 marks)**  
***Please turn the page.***

11. At the Science Fair there will be a stand exhibiting and explaining different renewable sources of energy, including solar energy. Name **ONE** other renewable source of energy:

\_\_\_\_\_ (1)

**(Total: 1 mark)**

**SECTION C: TECHNOLOGY ASPECT**

12. Figure 3 shows a quiz board game set up within the 'MAKER' section of the fair. Fill in the table by placing the right tool name next to its correct description. Then draw an arrow from the description to the picture of the tool. The first one has been completed as an example.

Combination Pliers	Hot air blower	Spanner
Multi-meter	Pop riveter	Mallet






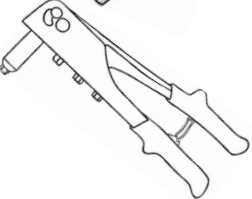
Tools/Equipment	Use	
	<p>A device used to measure Voltage, Current and Resistance.</p>	<p><i>Multi-meter</i></p>
	<p>Used to hold objects firmly. Also used for bending, cutting, and compressing.</p>	
	<p>Used to knock wooden pieces together and to drive chisels or dowels</p>	
	<p>A tool used to provide grip and mechanical advantage in applying torque to turn objects usually rotary fasteners or keep them from turning.</p>	
	<p>Used to produce hot air to soften, bend and mould plastic.</p>	
	<p>This tool can join two pieces of material together by inserting and expanding a metal fastener.</p>	

Figure 3

**(Total: 5 marks)**

13. A sign, as shown in Figure 4, was set up at the entrance to the Science Fair photo booth. The sign was cut out digitally out of plywood with each letter cut individually from 3mm plywood. It looked as if the edges were slightly burnt or looked darker.



Figure 4

Which manufacturing process was used to cut the letters seen on Figure 4? Underline the correct answer.

- 3D printing
- laser cutting
- CNC milling

**(Total: 1 mark)**

14. At the Science Fair students created an educational model of the solar system as seen in Figure 5. Metal and polymers were the materials used to create the model shown.

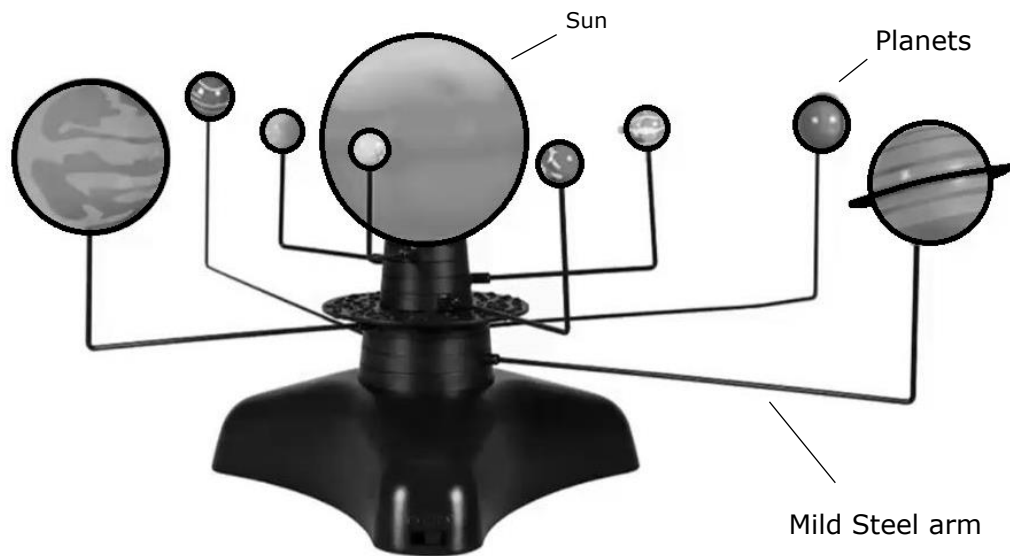


Figure 5

a. Each planet is held by a mild steel arm. Underline which category of metal is mild steel.

- ferrous
- non-ferrous
- thermoplastic

(1)

b. To prevent the mild steel arms from rusting they were given a protective layer in a molten metal called zinc applied by dipping it in bath.

Name this finishing process. \_\_\_\_\_ (1)

***This question continues on next page.***

c. Suggest another suitable surface finish which can be applied on mild steel to prevent it from rusting.

\_\_\_\_\_ (1)

d. Instead of mild steel the arm could be made from other types of metals that do **not** rust. Underline **TWO** other metals which do **not** rust.

- carbon steel
- aluminium
- stainless steel
- high speed steel

(2)

**(Total: 5 marks)**

15. The spherical objects that represent the planets of the solar system, as seen in Figure 6, are made with a polymer called HIPS.

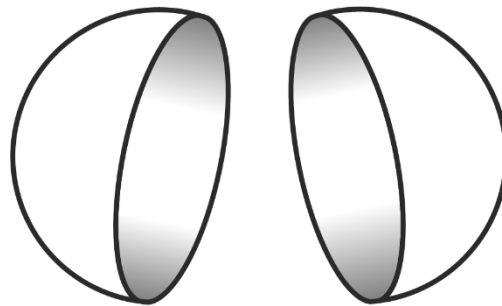


Figure 6

a. The planets are constructed out of two separate hemispheres of HIPS as seen in Figure 6. Underline the correct description of the planet's structural form.

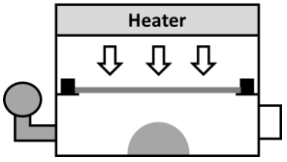
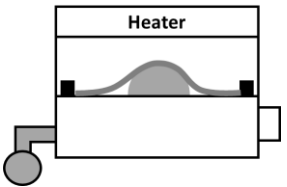
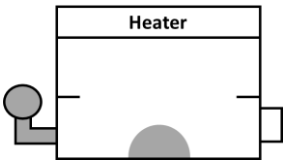
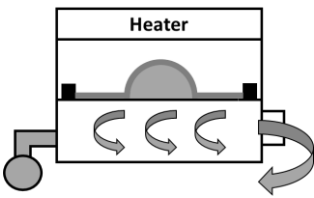
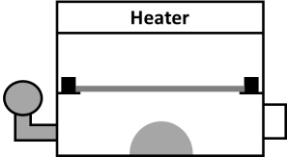
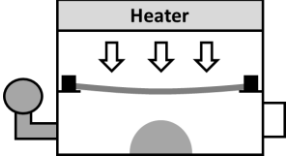
- solid
- organic
- irregular
- shell

(1)

b. The two hemispheres were created by using the vacuum forming fabrication process. This process is described in the grid below. However, the steps are **not** in order.

Write down the correct numeric order for the given steps for this process. Use numbers from **1** to **6**.

Table 3

Order of steps	Image	Description
<input type="checkbox"/>		The heater is switched on. The HIPS sheet will now begin to soften.
<input type="checkbox"/>		The lever is pressed down which raises the mould. The HIPS now takes the shape of the mould.
<input type="checkbox"/>		A mould is placed into the vacuum forming machine.
<input type="checkbox"/>		Air is sucked out from beneath the mould. The HIPS is left to cool before it is removed from the machine.
<input type="checkbox"/>		A HIPS sheet is placed over the mould and clamped into position using the two clamps on the machine.
<input type="checkbox"/>		The HIPS sheet becomes flexible.

(3)

**(Total: 4 marks)**

***Please turn the page.***

16. An exhibitor was selling clothes and accessories made from smart materials such as thermochromic ink and shape memory alloys.

Complete the following sentences with the words provided in the word bank.

Sound	Temperature	Cold
Shape	Light	Original
Deformed	Colour	Heat

a. Thermo-chromic pigments change \_\_\_\_\_ when the \_\_\_\_\_ changes. (1)

b. Shape Memory Alloys (SMAs) are a collection of metal alloys that can return to their original formed shape with \_\_\_\_\_ after they are \_\_\_\_\_. (1)

**(Total: 2 marks)**

17. A robotics section at the Science Fair exhibited robots of different shapes and sizes. Figure 7 shows a robot’s head.

a. In the space provided sketch neatly the End view of one of the robots’ head as seen in Figure 7. Centrelines lines should be included in the answer.

Hidden details are **not** required.  
The sketch must have good proportions.

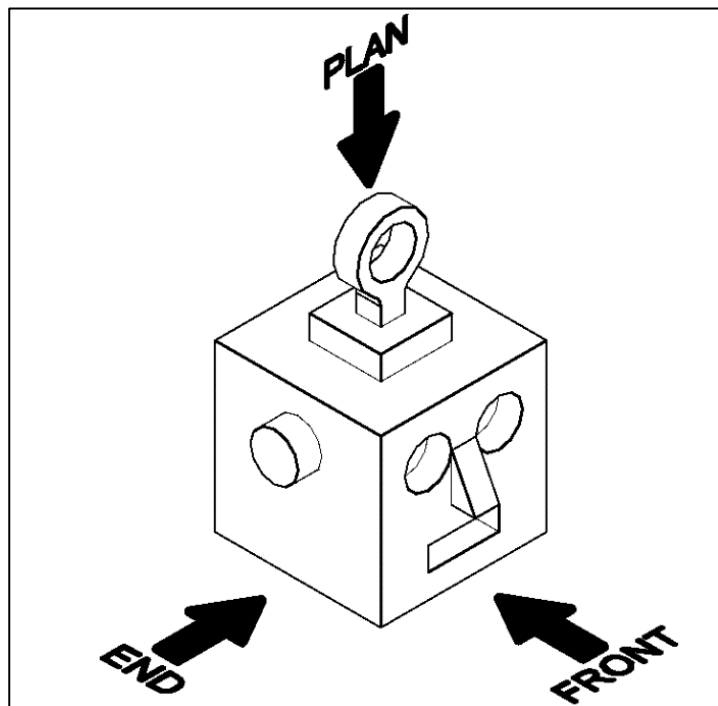


Figure 7



End view sketch of Figure 7:

(3)

b. Figure 8 shows a Front elevation of another robot part. Identify **ONE** hidden detail line and **ONE** centre line by labelling them using annotations.

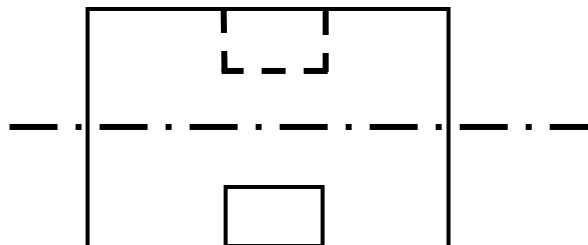


Figure 8

(2)

**(Total: 5 marks)**

***Please turn the page.***

18. The working model of the solar system, which was on display during the Science Fair, is shown again in Figure 9. The model was designed and built by a group of secondary school students who also wanted to make it functional.

The model consists of a sun in the centre of the solar system, and the planets going around the sun. A low voltage light output was included in the sun.

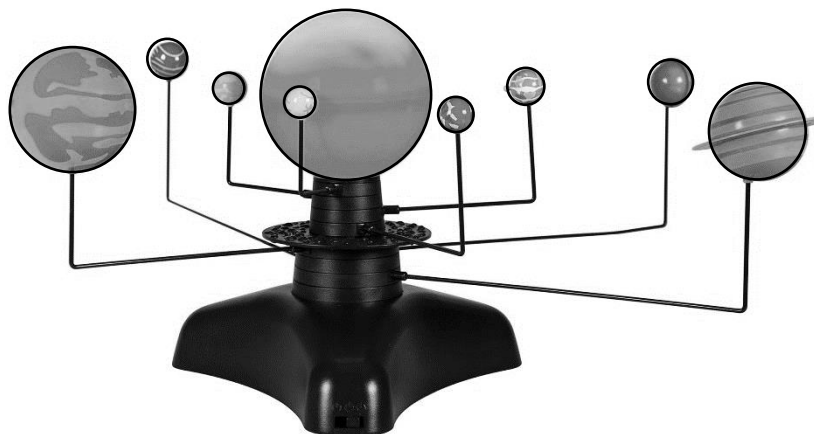


Figure 9

Figure 10 shows an electronic circuit diagram to be used inside the solar system model.

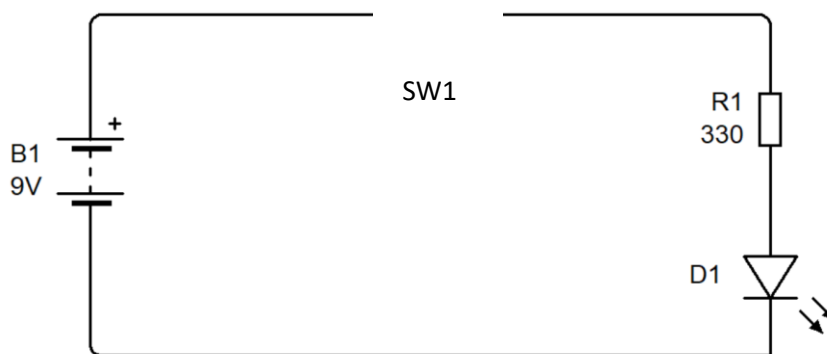


Figure 10

- a. An LED is an abbreviation for: Light (1)
- b. Complete the electronic circuit diagram in Figure 10 by drawing a SPST type switch SW1. (1)
- c. An LED D1 is found in the circuit.  
 What happens when the LED is connected in a forward bias and the circuit is closed?  
 Underline the correct answer from the following.

The LED lights up

The LED does not light up

(1)

- d. Calculate the current flowing in the circuit shown in Figure 10, if the voltage drop is 6.6V. Include the unit with your answer.



(4)

- e. Look again at the circuit in Figure 10. On the strip board template given in Figure 11, draw the component layout of the circuit. Label the power supply leads. Draw all the answers on Figure 11.

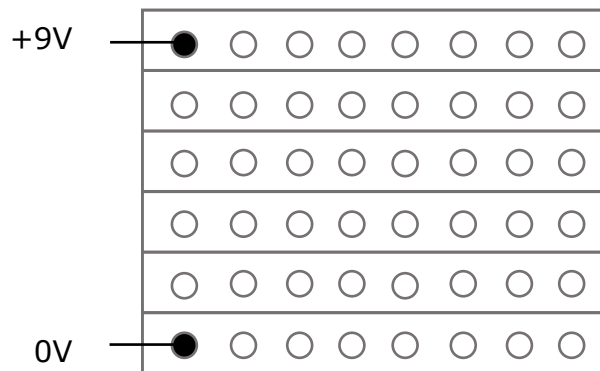


Figure 11

(3)

- f. Electronic circuits are tested before they are built on a stripboard. Mention **ONE** testing equipment to physically test an electronic working model.

\_\_\_\_\_ (1)

- g. Hand tools suitable for electronics fabrication were used to build the circuit. Write the correct number to match the hand tool with the corresponding use in Table 4.

Table 4

	Hand tools used for electronics		Use
1	Wire stripper		To remove solder from the strip board
2	Desoldering pump		To make a permanent joint between components and wire.
3	Track cutter		To remove insulation
4	Soldering iron		To cut strip board tracks

(2)

h. Safety is an important aspect that should be kept in mind while working. Mention **TWO** Health and Safety rules that must be observed while soldering electronic components.

\_\_\_\_\_ (2)

**(Total: 15 marks)**

19. The solar model shown previously in Figure 9, was designed to be educational and interactive. Every planet can be switched individually by a touch sensitive switch. When the switch is ON, an LED lights up inside the planet for a small time period and the planets turn around the sun for one revolution.

In order to achieve this function, a microcontroller circuit was developed, as shown in Figure 12.

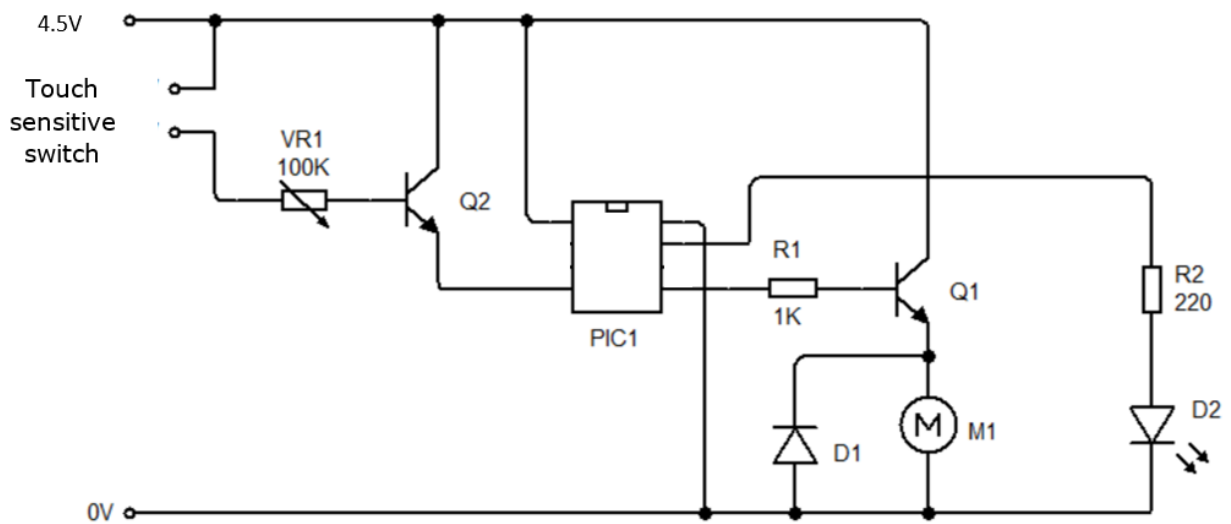


Figure 12

a. From the given word bank, underline the name of component Q2 used in Figure 12.

Diode

Resistor

Transistor

(1)

b. The circuit is recommended to operate with a 4.5 V d.c. supply. 3 AA batteries will be needed.

In the space provided below draw a circuit layout diagram to achieve 4.5 V by using AA batteries.



(2)

c. On Figure 13, fill in the block diagram, according to the circuit shown in Figure 12 and by using the following word bank.

Micro controller      Motor      Touch sensor switch

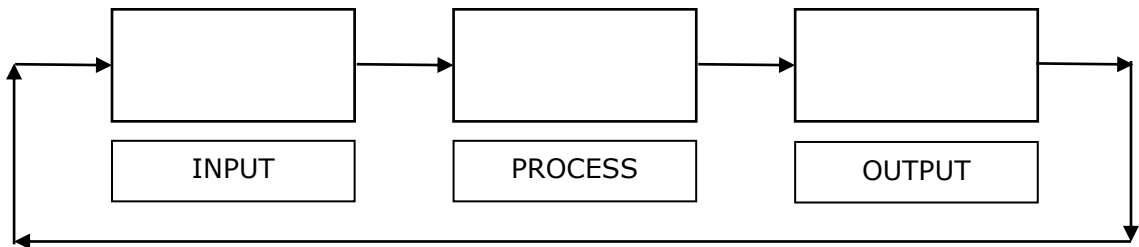


Figure 13

(3)

d. Figure 14 shows the pinout layout of PIC1, used in the circuit. Answer the following question referring to the IC shown.

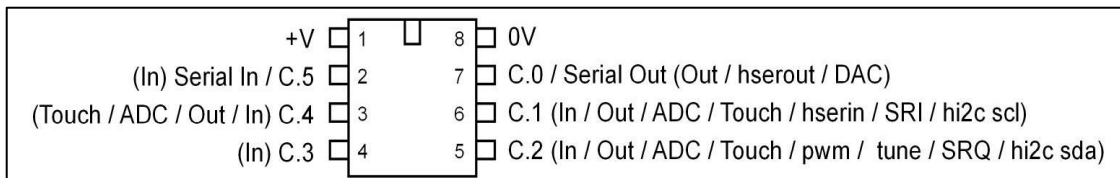


Figure 14

i. What do we call the sheet where one would find the type of detailed information shown in Figure 14? (Underline correct answer)

Data sheet                      Spread sheet                      Information sheet                      (1)

ii. PIC1 is a PIC microcontroller. Mention **ONE** advantage of using PIC over discrete components in a circuit.

\_\_\_\_\_ (1)

iii. Name the supply pinout for PIC1.

\_\_\_\_\_ (1)

**(Total: 9 marks)**  
**Please turn the page.**

20. Figure 15 shows the flowchart used to program the microcontroller circuit.

- a. On the given flowchart identify and label **ONE** digital input. (1)
- b. On the given flowchart there is a missing command regarding switching OFF C.4. Fill in the command in the empty flowchart symbol. (1)
- c. Refer to the connector labelled 'ITEM A' on the given flowchart. Choose the statement, which best describes the function of the connector. (1)

to loop the system	to take a decision	to give an output
--------------------	--------------------	-------------------

(1)

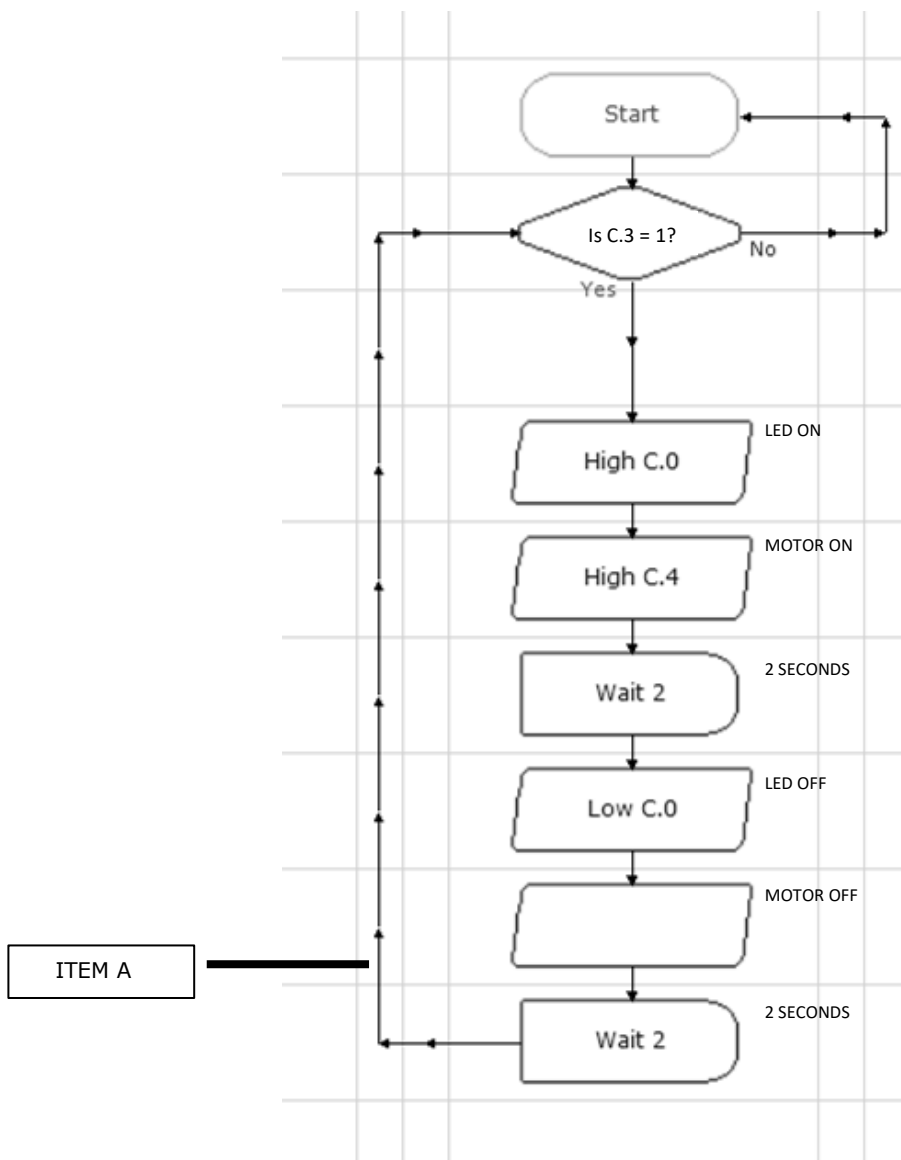


Figure 15

**(Total: 3 marks)**

21. A gear system is attached to the d.c. motor in order to add rotation to the planets. Figure 16a shows the gear system. Gear A is the input gear and is moving in clockwise direction.

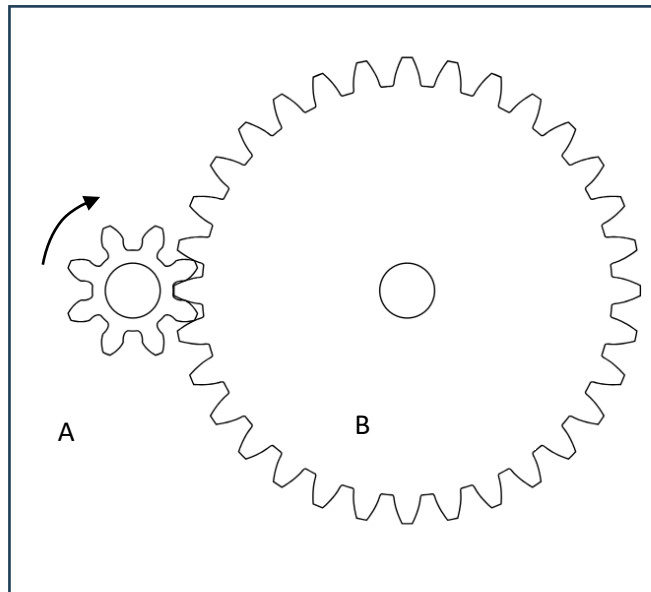


Figure 16a

a. Underline the specific name for the gear composition shown in Figure 16a.

Simple Train wheel                  Simple gear train                  Compound gear train                  (1)

b. Draw the direction of rotation for Gear B on Figure 16a. (1)

c. State whether this statement is TRUE or FALSE.

Gears are mechanisms that can transfer rotary movement between a shaft and another.

\_\_\_\_\_ (1)

***This question continues on next page.***

d. Figure 16b shows more detail of the gear system. Gears A has 8 teeth, while Gear B has 32 teeth.

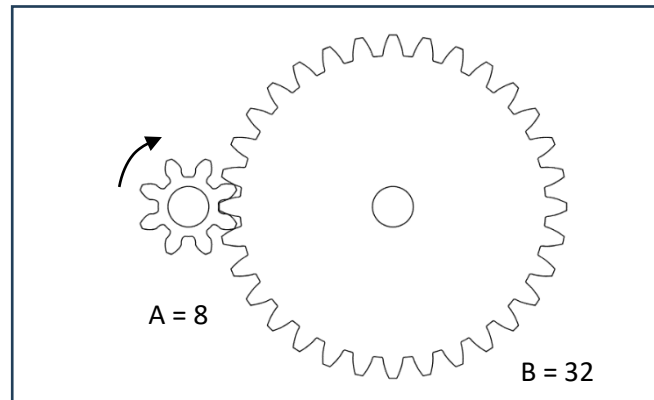


Figure 16b

i. Find the velocity ratio of the gear system. Show your working. (2)

ii. The sentence below explains the behaviour of the gear system in Figure 16b. Assuming that two full turns are applied to Gear A, fill in the missing information in the following sentence.

Gear A turns \_\_\_\_\_ revolution/s, while Gear B turns \_\_\_\_\_ revolution/s

(1)

**(Total: 6 marks)**