



SUBJECT: **Design and Technology**
 PAPER NUMBER: IIA
 DATE: 25th June 2021
 TIME: 9:00 a.m. to 11:05 a.m.

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:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

$$t \approx R \times C$$

Resistor Colour Code Chart:

Colour	Value	Multiplier	Tolerance
Black	0	$\times 10^0$	-
Brown	1	$\times 10^1$	$\pm 1\%$
Red	2	$\times 10^2$	$\pm 2\%$
Orange	3	$\times 10^3$	-
Yellow	4	$\times 10^4$	-
Green	5	$\times 10^5$	$\pm 0.5\%$
Blue	6	$\times 10^6$	$\pm 0.25\%$
Violet	7	$\times 10^7$	$\pm 0.1\%$
Grey	8	$\times 10^8$	$\pm 0.05\%$
White	9	$\times 10^9$	-
Gold	-	$\times 10^{-1}$	$\pm 5\%$
Silver	-	$\times 10^{-2}$	$\pm 10\%$

READ the following theme and situation carefully before answering this paper.

Theme: Embracing Nature in Our Lifestyles

Situation: Plants and trees are beneficial for purifying the air we breathe but they might be difficult to combine with urban lifestyles. Thus designers are driven to create products which help in increasing greenery and improve human living spaces and lifestyles.

SECTION A: Core Design & Technology Principles

1. Underline the correct answer for each question:

- a. Which of the following is a smart material?
 - i. Simple mild alloy
 - ii. Cartridge paper
 - iii. Shape memory alloy
 - iv. Polyester resin

- b. Which of the following are types of belts for pulleys?
 - i. Toothed belt and flat belt
 - ii. A-belt and Z-belt
 - iii. X-belt and Y-belt
 - iv. Hooked belt and round belt

- c. Which of the following materials are **both** derived from mineral sources?
 - i. Walnut and block-board
 - ii. Oak and cotton
 - iii. PMMA and veneered boards
 - iv. Aluminium and gold

- d. Which of the following are **not** stakeholders affected by the design of a product?
 - i. Materials and tools
 - ii. Designers and users
 - iii. Society and personas
 - iv. Owners and clients

(Total: 4 marks)

2. Table 1 shows the main steps involved when performing soft soldering. Write numbers in the empty column so as to put the steps in the correct sequence.

Table 1

STEPS	SEQUENCE
Remove heat and let joint cool down.	
Clean joint and switch on the soldering iron.	
Apply solder until it is molten and covers the joint.	
Heat the joint for few seconds using the soldering iron.	

(Total: 2 marks)

3. Rewrite the following sentence so as to form correct statements. The first one is given as an example.

a. A back saw is used to cut curved edges.
 A back saw is used to cut straight edges.

b. Electrical power is measured in Newton-metres.

_____ (1)

c. Spreadsheets are research tools.

_____ (1)

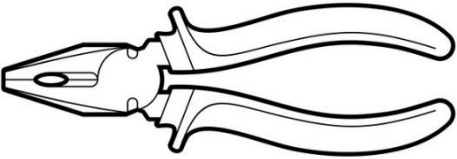
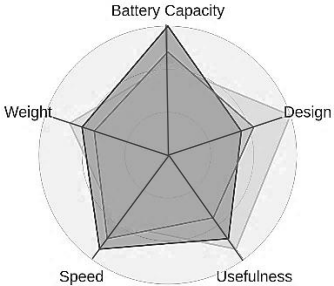
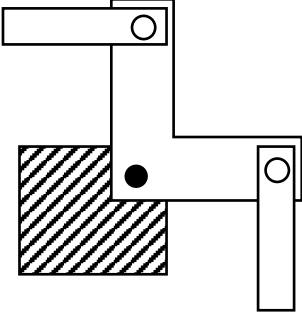
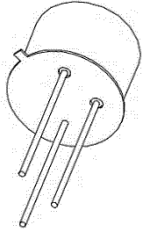
d. An alloy is a type of wood.

_____ (1)

(Total: 3 marks)

4. Name the items shown in Table 2.

Table 2

 <p>_____ (1)</p>	 <p>_____ (1)</p>
 <p>_____ (1)</p>	 <p>_____ (1)</p>

(Total: 4 marks)

5. Complete Table 3 by naming the fabrication processes described.

Table 3

DESCRIPTION	NAME OF PROCESS
The quick production of prototypes using 3D CAD models to evaluate design products.	
The heat treatment of a metal to make it more ductile and less hard.	
The looping of yarn to form a stretch fabric.	

(Total: 3 marks)

6. Figure A shows a working drawing of a new product called "TimeLife".

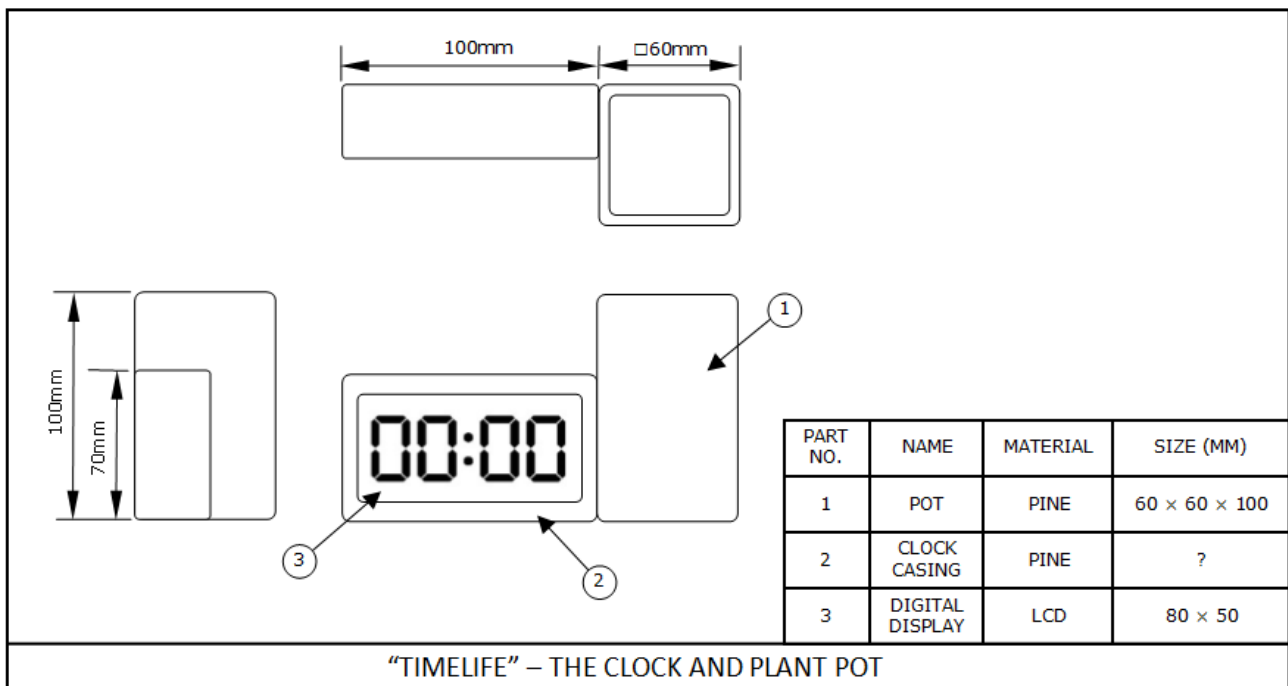


Figure A

a. Give the name of the type of drawing used in Figure A.

_____ (1)

b. Give the name of the table shown in Figure A.

_____ (1)

c. Find the size of "Part 2", assuming any missing dimensions.

_____ (1)

d. Suggest a suitable finish for the wooden parts of the product.

_____ (1)

(Total: 4 marks)

SECTION B: Design Aspect

REFER back to the situation on Page 2 and READ it carefully.

Classrooms are common living spaces which do not always have space for indoor plants. As classroom floor space is limited, placing plants in an area above the floor would be ideal. However these should still be accessible for watering.

- 7. A system that holds a number of plants is going to be introduced. The plants will be planted in plastic bottles by students, therefore the size of the plant organiser must be appropriate. Refer to Figure B for bottle shape and size.

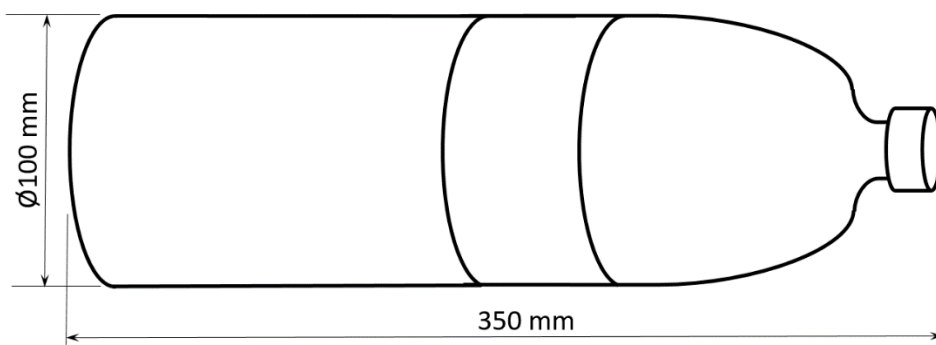


Figure B

- a. The plastic bottles need to be cut before students can put soil in them. In the space provided below sketch **ONE** way how the bottle can be cut to be used for planting. Include dimensions in your sketch.

(2)

This question continues on next page.

- b. Considering the given situation and the sketch you have drawn in question 7a, produce **TWO** different ideas of plant organisers that can hold at least **FIVE** cut bottles with plants in a classroom. Use the spaces provided below.

Idea 1

(5)

Idea 2

(5)

(Total: 12 marks)

Please turn the page.

8. This question is about scale of production.

- a. Suggest which scale of production is most likely to be used to manufacture the plant organisers you have designed in Question 7b.

_____ (1)

- b. Give a reason for your answer.

_____ (1)

(Total: 2 marks)

9. This question is about social groups.

- a. Suggest which social group would most likely be interested to use such a product outside schools.

_____ (1)

- b. Give **ONE** reason why the social group you mentioned in question 9a would be interested in using such a plant organiser.

_____ (1)

(Total: 2 marks)

10. Sustainability and design should go hand in hand, and the 3Rs (Reuse, Reduce, and Recycle) help us in minimising waste. For every 'R': mention **ONE** example of how you would put these terms into practice while designing and making **ANY** product.

- a. Reuse:

_____ (1)

- b. Reduce:

_____ (1)

- c. Recycle:

_____ (1)

(Total: 3 marks)

11. Figure C shows some aspects of the four main stages of the Iterative Design Process: Explore, Design, Make and Evaluate. Complete Figure C by giving **TWO** more aspects for **EACH** stage.

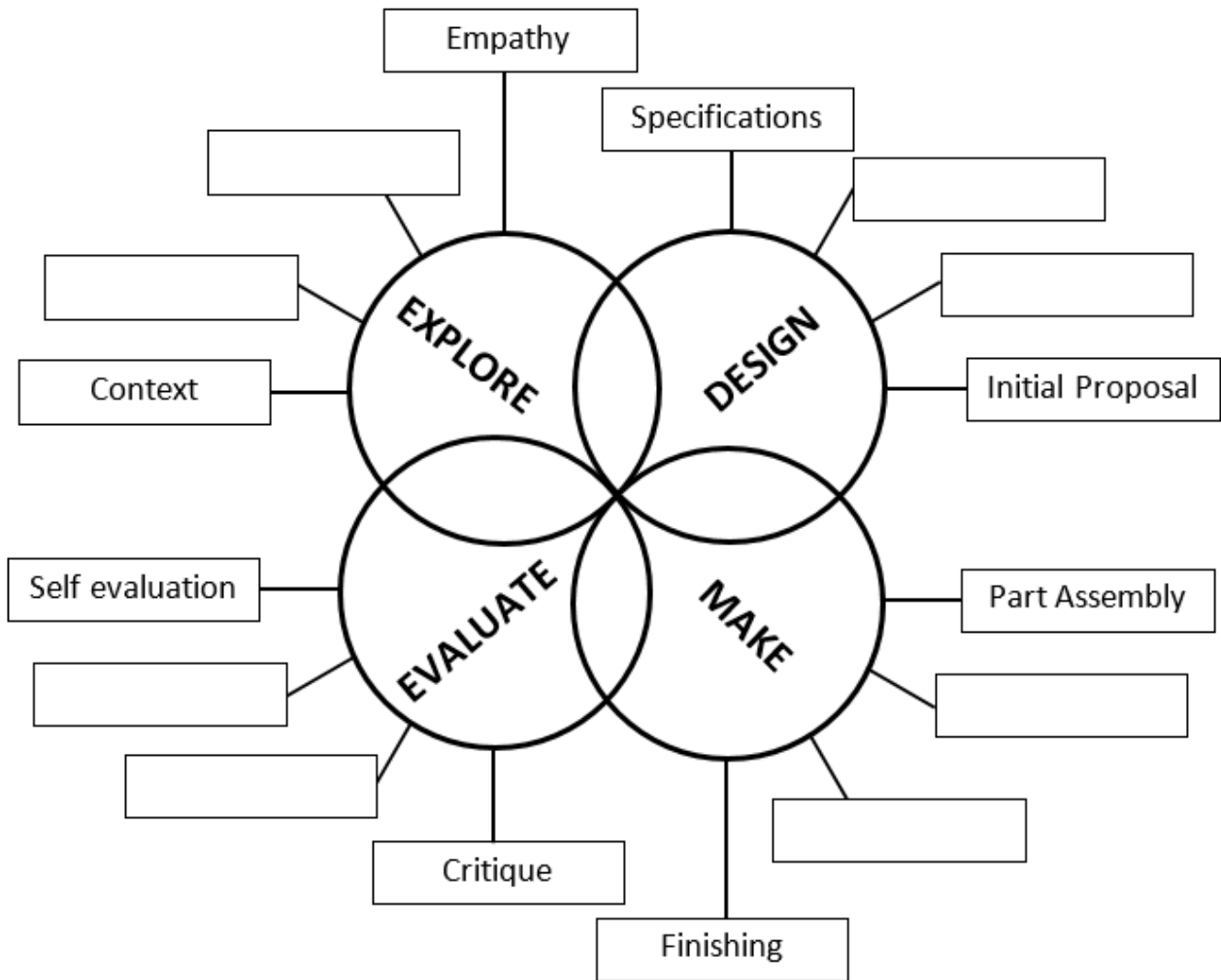


Figure C

(Total: 4 marks)

12. Describe **ONE** difference between market and industry.

(Total: 2 marks)

Please turn the page.

SECTION C: Technology Aspect

13. Figure D shows a sketch of a garden soil scoop made from sheet material. A model will be made before producing the actual product.

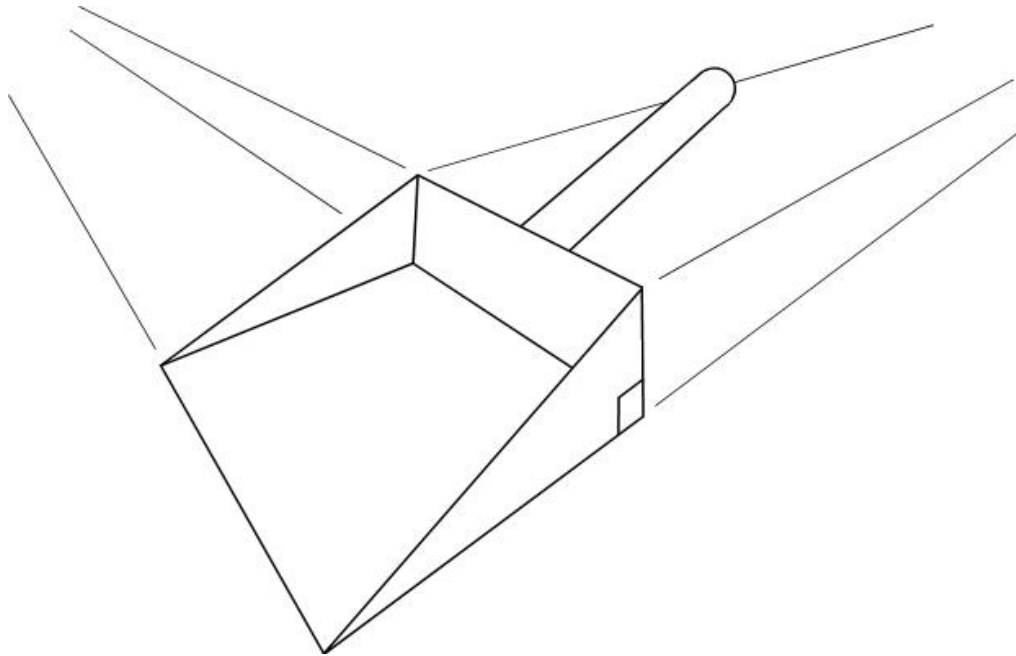


Figure D

a. Name the 3D pictorial projection used in Figure D.

_____ (1)

b. Give **ONE** reason why a model is needed before making the actual product.

_____ (1)

c. Suggest a modelling material suitable for the model of the scoop shown in Figure D.

_____ (1)

d. Referring to the modelling material suggested in part c, mention the tools needed for:

i. marking out the correct lengths of the model of the scoop;

_____ (1)

ii. cutting out the model of the scoop.

_____ (1)

e. Scoring may be needed when using certain modelling materials.

i. Give a reason why scoring is needed.

_____ (1)

ii. Describe how to perform scoring.

_____ (2)

iii. Mention **ONE** safety precaution that should be observed while scoring.

_____ (1)

(Total: 9 marks)

14. The pot shown in Figure E was designed to encourage the growth of root vegetables like potatoes and carrots in households. It is made out of fabric.

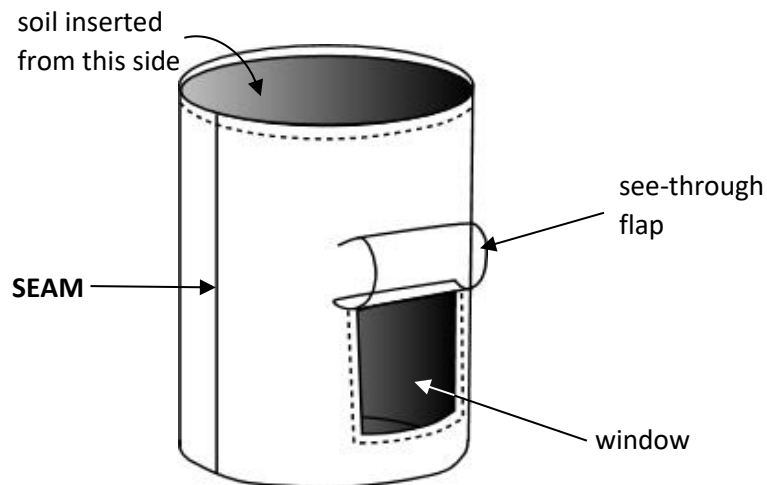


Figure E

a. Mention **TWO** tools which can be used to mark out the fabric before cutting it.

_____ (2)

b. Mention the machine which is used to stitch the parts of the product together.

_____ (1)

c. Name the labelled seam on the fabric pot in Figure E.

_____ (1)

This question continues on next page.

- d. The pot in Figure E has a window with a see-through flap to check whether the root vegetables are mature enough.
 - i. Name **ONE** fastener which can be used to secure the flap to the window and seal the soil inside the pot.

_____ (1)

- ii. In the space provided below sketch how the fastener mentioned in part di can be attached to the fabric. Include notes/annotations to your drawing.

(4)

(Total: 9 marks)

15. Figure F shows an incomplete drawing of an automata which makes a plastic flower rise and fall. The automata uses a cam and follower mechanism.

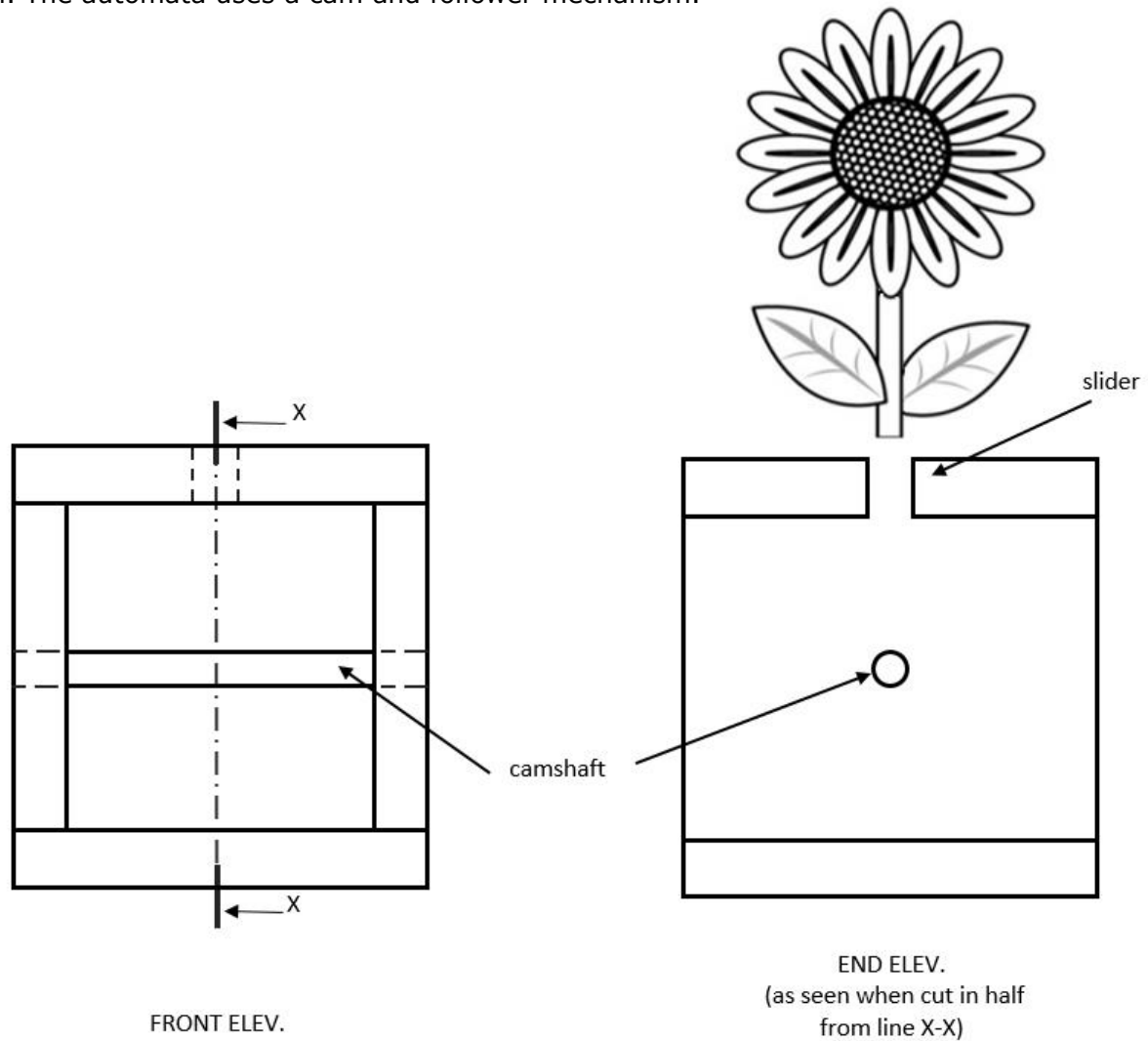


Figure F

- a. On the end elevation of Figure F, draw:
 - i. a cam which makes the flower rise, fall and pause once every cycle; (2)
 - ii. a flat follower. (1)

- b. State the type of motion occurring at the following parts:
 - i. Camshaft: _____ (1)
 - ii. Follower: _____ (1)

- c. On Figure F, colour the petals of the plastic flower using a primary colour and leaves using a secondary colour. (2)

- d. Assuming that the automata shown in Figure F is made from natural wood, name the type of joint used to assemble the top and bottom parts to the sides of the toy. (1)

_____ (1)

(Total: 8 marks)

16. The electronic circuit in Figure G is used as emergency lighting in a glasshouse for when a mains electricity power cut occurs.

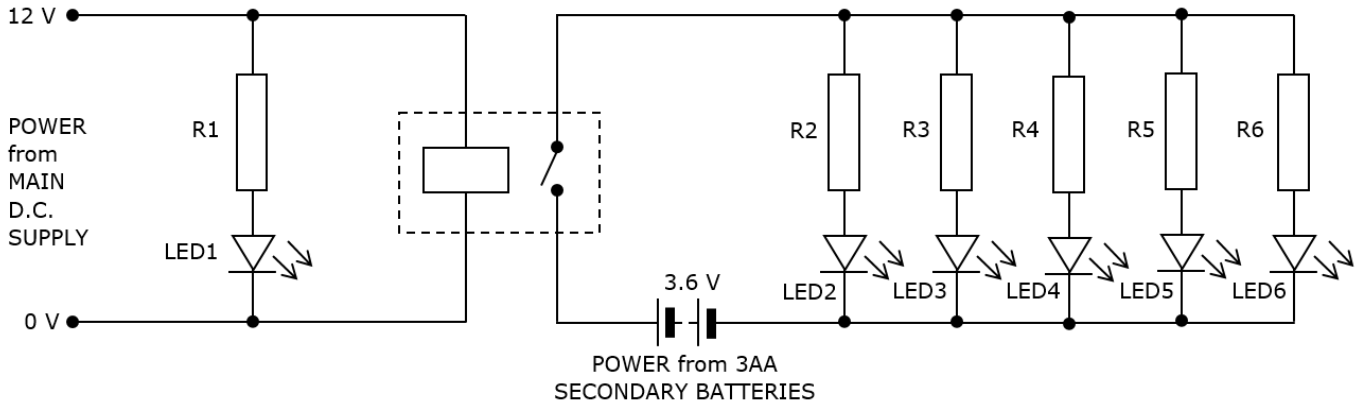


Figure G

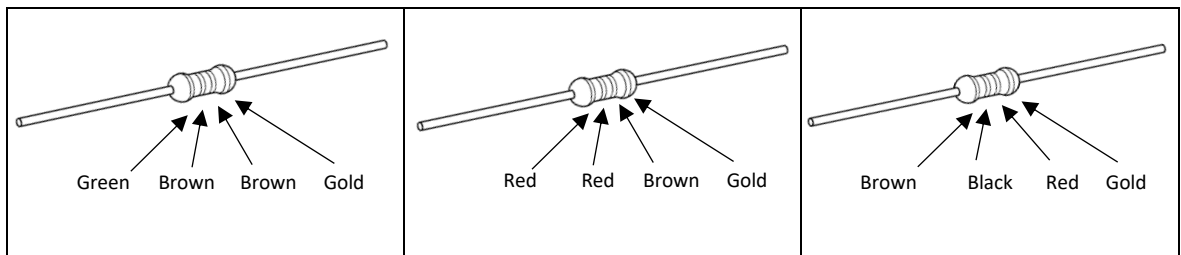
a. The system in Figure G makes use of an actuator.

- i. Circle the actuator in Figure G. (1)
- ii. Explain how the actuator in Figure G works as part of the system.

(2)

b. Focus on the part of the circuit which is connected to the main d.c. supply.

- i. Suggest a reason why LED1 was used in the circuit. (1)
- ii. Assuming that R1 has a value of 485Ω , choose the most appropriate standard value resistor from the table below.



Tick here			
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(2)

c. Figure H shows the same circuit as in Figure G with some missing wires. Wire the circuit and add a component so that the user of the glasshouse is able to switch OFF the emergency lighting even if there is a mains power cut.

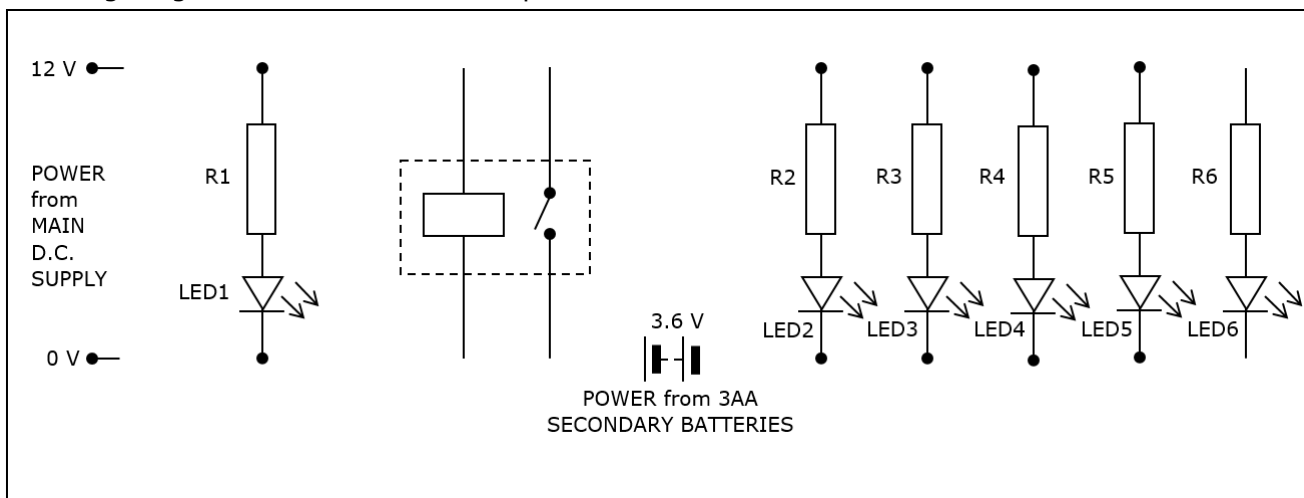


Figure H

(3)

d. Figure I shows the 3 AA secondary batteries use to light up LED2 to LED6 in the emergency light circuit.



Figure I

- i. On Figure I, draw wires to connect the batteries in a way to supply 3.6 V. Label the positive and negative terminals. (2)
- ii. State **ONE** advantage of using secondary batteries over primary battery in the system shown in Figure H.

_____ (1)

This question continues on next page.

e. Calculate the total resistance of the circuit shown in Figure J.

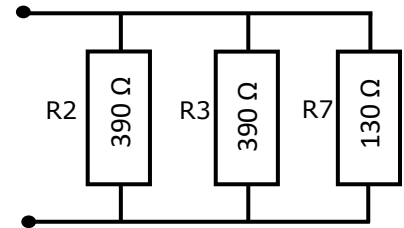


Figure J

(2)

f. State a difference between the power consumption of an LED compared to a bulb.

_____ (1)

(Total: 15 marks)

17. An automatic irrigation system was installed in a yard to water plants. When the soil gets dry, a sensor switches ON the circuit controlling the d.c. motor of the pump for a period of time. The circuit is controlled via a microcontroller.

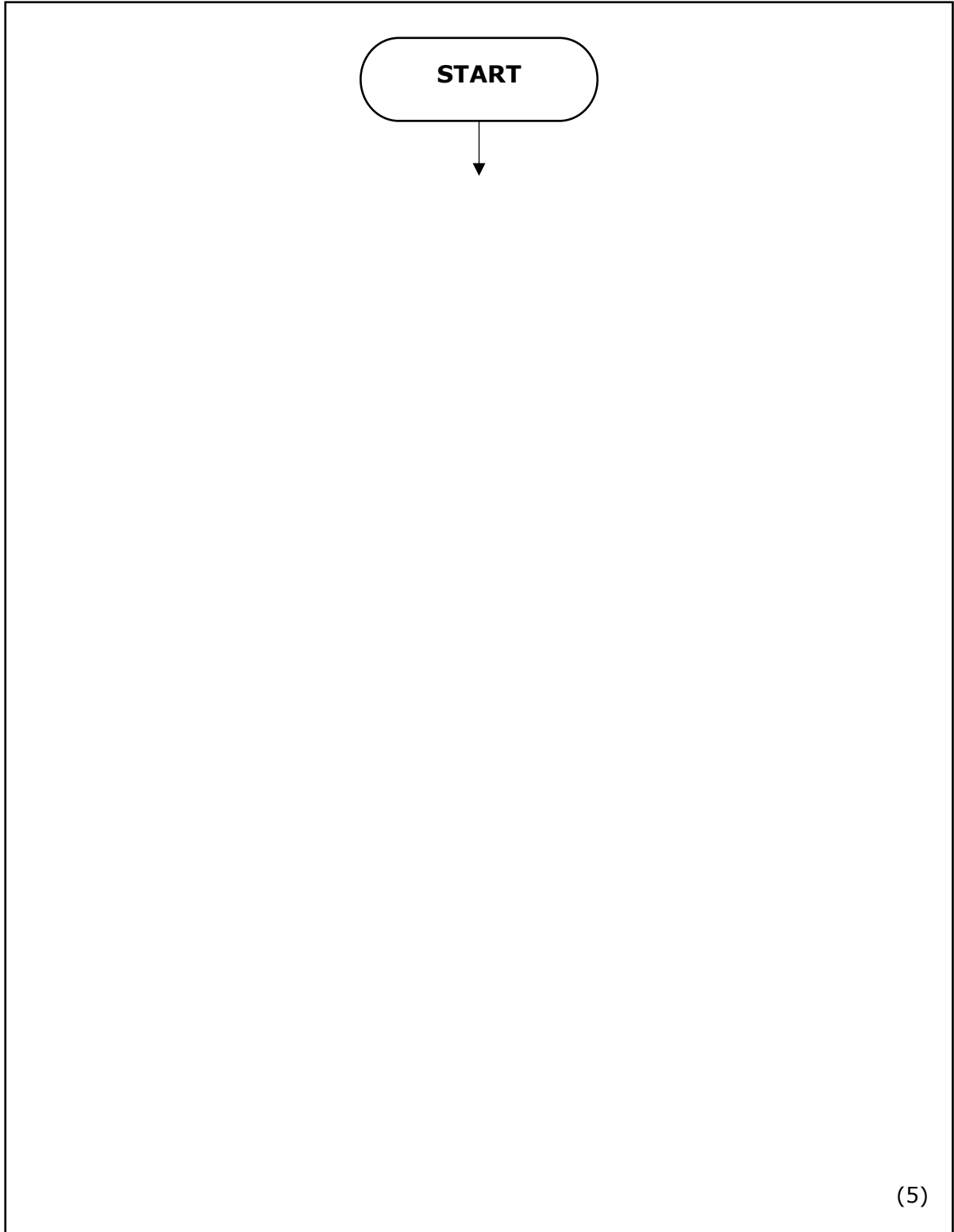
a. Describe what a microcontroller is.

_____ (1)

b. The automatic irrigation system mainly consists of a sensor, a microcontroller and a d.c. motor. In the space provided below complete the block diagram to explain how the irrigation system works.



- c. Assume that the sensor gives a low signal when the soil is dry and is connected to pin C.1 of the microcontroller. Assume also that the d.c. motor is connected to pin C.2 of the microcontroller. In the space provided below, complete the flowchart to write a program which switches ON the d.c. motor for a period of 5 minutes whenever the soil gets dry.



(5)

This question continues on next page.

d. A timing circuit can be built with two discrete components.

i. Figure K shows an incomplete timing circuit. Draw the missing component. (1)

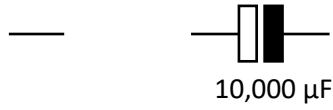


Figure K

ii. State the type of capacitor shown in Figure K. _____ (1)

iii. In the space provided below calculate the value of the missing component to obtain a time period of 5 minutes.

(3)

(Total: 14 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

**SECONDARY EDUCATION CERTIFICATE LEVEL
2021 MAIN SESSION**

SUBJECT:	Design and Technology
PAPER NUMBER:	IIB
DATE:	25 th June 2021
TIME:	9:00 a.m. to 11:05 a.m.

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:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

$$t \approx R \times C$$

READ the following theme and situation carefully before answering this paper.

Theme: Embracing Nature in Our Lifestyles

Situation: Plants and trees are beneficial for purifying the air we breathe but they might be difficult to combine with urban lifestyles. Thus designers are driven to create products which help in increasing greenery and improve human living spaces and lifestyles.

SECTION A: Core Design & Technology Principles

1. Underline the correct answer for each question:

- a. Which of the following is a smart material?
 - i. Simple mild alloy
 - ii. Cartridge paper
 - iii. Shape memory alloy
 - iv. Polyester resin

- b. Which of the following are types of belts for pulleys?
 - i. Toothed belt and flat belt
 - ii. A-belt and Z-belt
 - iii. X-belt and Y-belt
 - iv. Hooked belt and round belt

- c. Which of the following materials are **both** derived from mineral sources?
 - i. Walnut and block-board
 - ii. Oak and cotton
 - iii. PMMA and veneered boards
 - iv. Aluminium and gold

- d. Which of the following are **not** stakeholders affected by the design of a product?
 - i. Materials and tools
 - ii. Designers and users
 - iii. Society and personas
 - iv. Owners and clients

(Total: 4 marks)

2. Table 1 shows the main steps involved when performing soft soldering. Write numbers in the empty column so as to put the steps in the correct sequence.

Table 1

STEPS	SEQUENCE
Remove heat and let joint cool down.	
Clean joint and switch on the soldering iron.	
Apply solder until it is molten and covers the joint.	
Heat the joint for few seconds using the soldering iron.	

(Total: 2 marks)

3. Rewrite the following sentence so as to form correct statements. The first one is given as an example.

a. A back saw is used to cut curved edges.
 A back saw is used to cut straight edges.

b. Electrical power is measured in Newton-metres.

_____ (1)

c. Spreadsheets are research tools.

_____ (1)

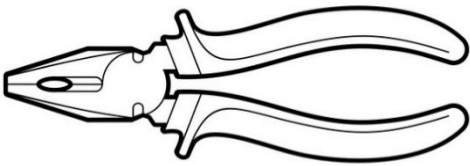
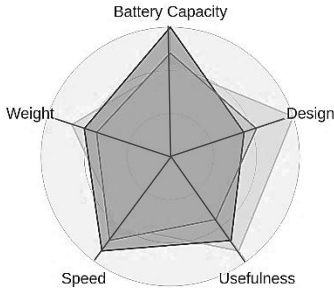
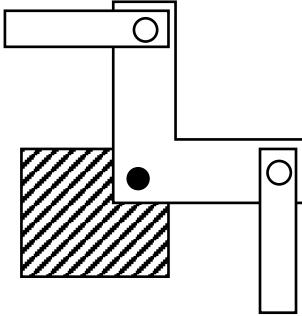
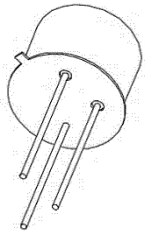
d. An alloy is a type of wood.

_____ (1)

(Total: 3 marks)

4. Name the items shown in Table 2.

Table 2

 <p>_____ (1)</p>	 <p>_____ (1)</p>
 <p>_____ (1)</p>	 <p>_____ (1)</p>

(Total: 4 marks)

5. Complete Table 3 by naming the fabrication processes described.

Table 3

DESCRIPTION	NAME OF PROCESS
The quick production of prototypes using 3D CAD models to evaluate design products.	
The heat treatment of a metal to make it more ductile and less hard.	
The looping of yarn to form a stretch fabric.	

(Total: 3 marks)

6. Figure A shows a working drawing of a new product called "TimeLife".

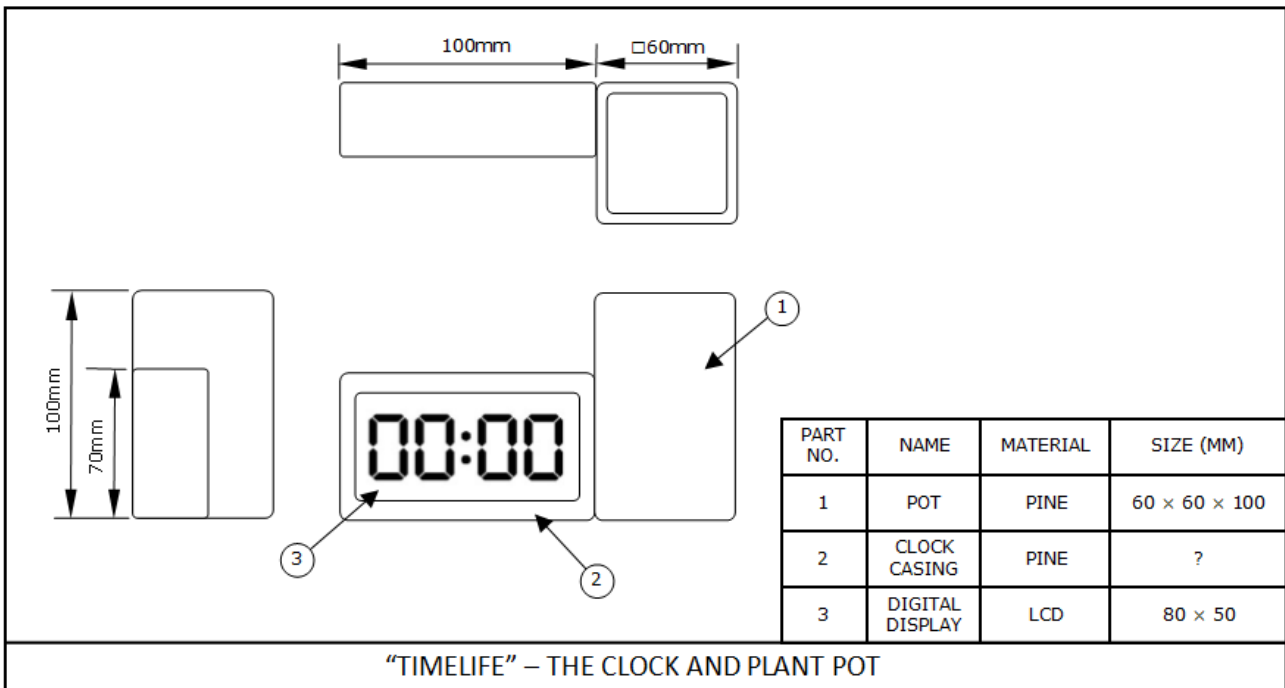


Figure A

a. Give the name of the type of drawing used in Figure A.

_____ (1)

b. Give the name of the table shown in Figure A.

_____ (1)

c. Find the size of "Part 2", assuming any missing dimensions.

_____ (1)

d. Suggest a suitable finish for the wooden parts of the product.

_____ (1)

(Total: 4 marks)

SECTION B: Design Aspect

REFER back to the situation on Page 2 and READ it carefully.

Classrooms are common living spaces which do not always have space for indoor plants. As classroom floor space is limited, placing plants in an area above the floor would be ideal.

- 7. A system that holds a number of plants is going to be introduced. The plants will be planted in cut plastic bottles, therefore the size of the plant organiser must be appropriate. Refer to Figure B for cut bottle shape and size.

In the spaces provided, produce **TWO** different ideas of a plant organiser that can hold at least **FIVE** cut bottles with plants inside a classroom. Marks will be awarded for dimensions, annotations (including materials), presentation (including colour) and relevance of idea.

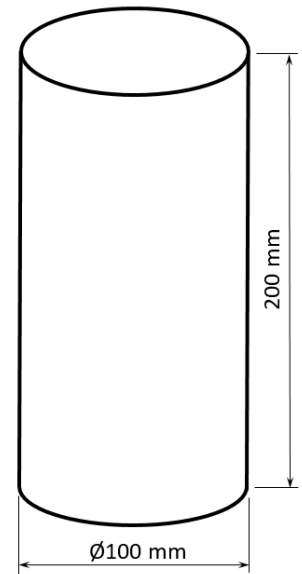


Figure B

Idea 1

(5)

Idea 2

(5)

(Total: 10 marks)

8. This question is about scale of production.

a. Suggest which scale of production is most likely to be used to manufacture the plant organisers you have designed in Question 7 for a number of schools.

_____ (1)

b. Give a reason for your answer.

_____ (1)

(Total: 2 marks)

9. This question is about social groups.

a. From the list below, underline the social group which is most likely to be interested in using the plant organisers you have designed in Question 7 outside schools.

ethnic minority visually-impaired people people having low income

(1)

b. Give **ONE** reason why the social group you mentioned in part a would be interested in using such a plant organiser.

_____ (1)

(Total: 2 marks)

10. Sustainability and design should go hand in hand, and the 3Rs (Reuse, Reduce, and Recycle) help us in minimising waste. State which of the 3Rs the following procedures refer to.

PROCEDURE	REUSE / REDUCE / RECYCLE
Transforming an old shirt into a cushion.	
Avoiding waste when marking / cutting out.	
Designing products with minimal material.	
Melting metal parts to produce new products.	
Dismantling electronic products to use parts.	
Processing used paper to produce cardboard sheets.	

(Total: 3 marks)

11. This question is about the Design Process.

a. Briefly explain what "specifications" are.

_____ (1)

This question continues on next page.

b. Figure C shows some aspects of the four main stages of the Iterative Design Process: Explore, Design, Make and Evaluate. Use the words/phrase in the following word-bank to complete Figure C.

Manufacturing	Problem analysis	Idea Modelling	Feedback analysis
Working drawing	Improvements	Questionnaire	Chosen idea

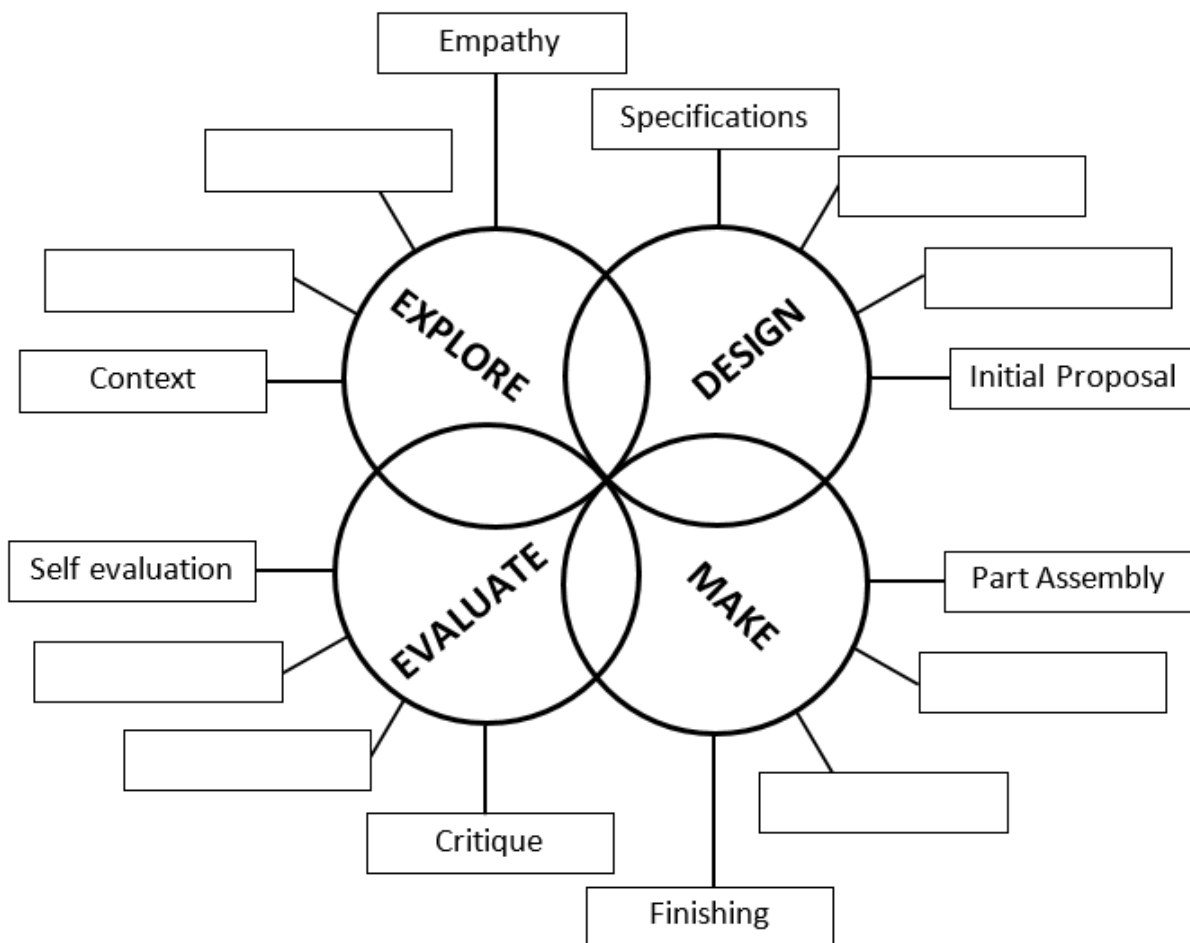


Figure C

(4)

(Total: 5 marks)

12. Fill in Table 4 by putting the following sectors under the correct column.

pet owners	adolescents	cheese-making enterprise
cotton weaving plant	travellers	furniture manufacturing company

Table 4

MARKET	INDUSTRY

(Total: 3 marks)

SECTION C: Technology Aspect

13. Figure D shows a sketch of a garden soil scoop made from sheet material. A model will be made before producing the actual product.

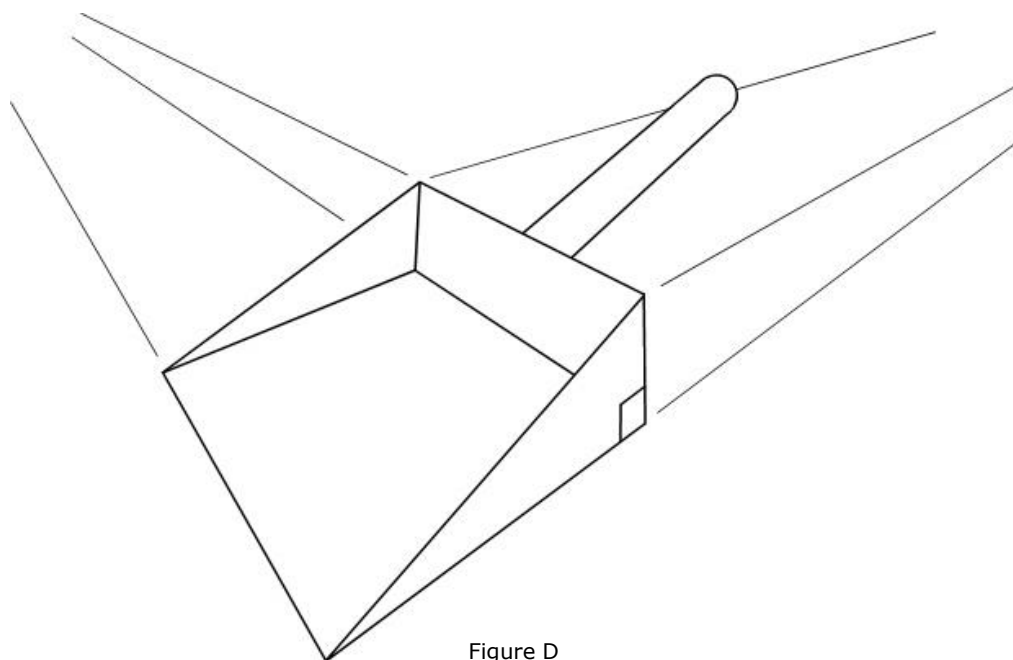


Figure D

a. Name the 3D pictorial projection used in Figure D.

_____ (1)

b. Give **ONE** reason why a model is needed before making the actual product.

_____ (1)

c. Use the following word-bank to answer the questions below.

cardboard	pencil	craft knife	scoring
-----------	--------	-------------	---------

i. Name a modelling material which is suitable for making the model of the scoop shown in Figure D.

_____ (1)

ii. Name a tool used for marking out on the model of the scoop.

_____ (1)

iii. Name a tool used for cutting out the model of the scoop.

_____ (1)

iv. Name the process used to produce a sharp and clean folding edge.

_____ (1)

This question continues on next page.

d. Underling the correct word from the brackets.

Creasing is a process which (reduces / cuts / increases) the thickness of sheet material to create a bending line for optimal folding. A die and creasing (saw / blade / ruler) are used to achieve this process.

(2)

e. Mention **ONE** safety precaution that should be observed while performing creasing on sheet material.

_____ (1)

(Total: 9 marks)

14. The pot shown in Figure E was designed to encourage the growth of root vegetables like potatoes and carrots in households. It is made out of fabric.

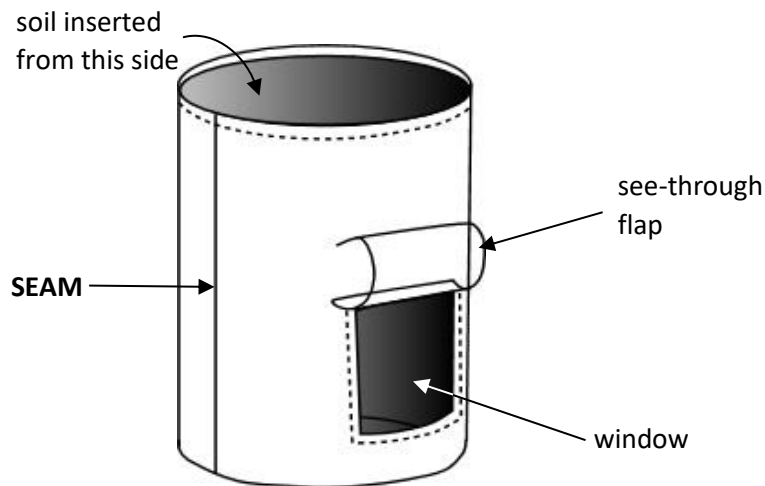


Figure E

a. Mention **TWO** tools which can be used to mark out the fabric before cutting it.

_____ (2)

b. Mention the machine which is used to stitch the parts of the product together.

_____ (1)

c. Name the labelled seam on the fabric pot in Figure E.

_____ (1)

d. The pot in Figure E has a window with a flap to check whether the root vegetables are mature enough. The flap is secured by the fastener shown in Figure F.

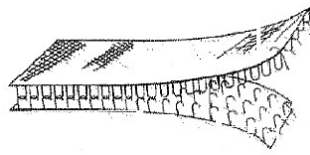


Figure F

i. Name the fastener shown in Figure F.

_____ (1)

ii. In the space provided below sketch how the fastener in Figure F can be attached to the fabric. Include notes/annotations to your drawing.

(4)

(Total: 9 marks)

15. Figure G shows an incomplete drawing of an automata which makes a plastic flower move up and down. The automata uses a cam and follower mechanism.

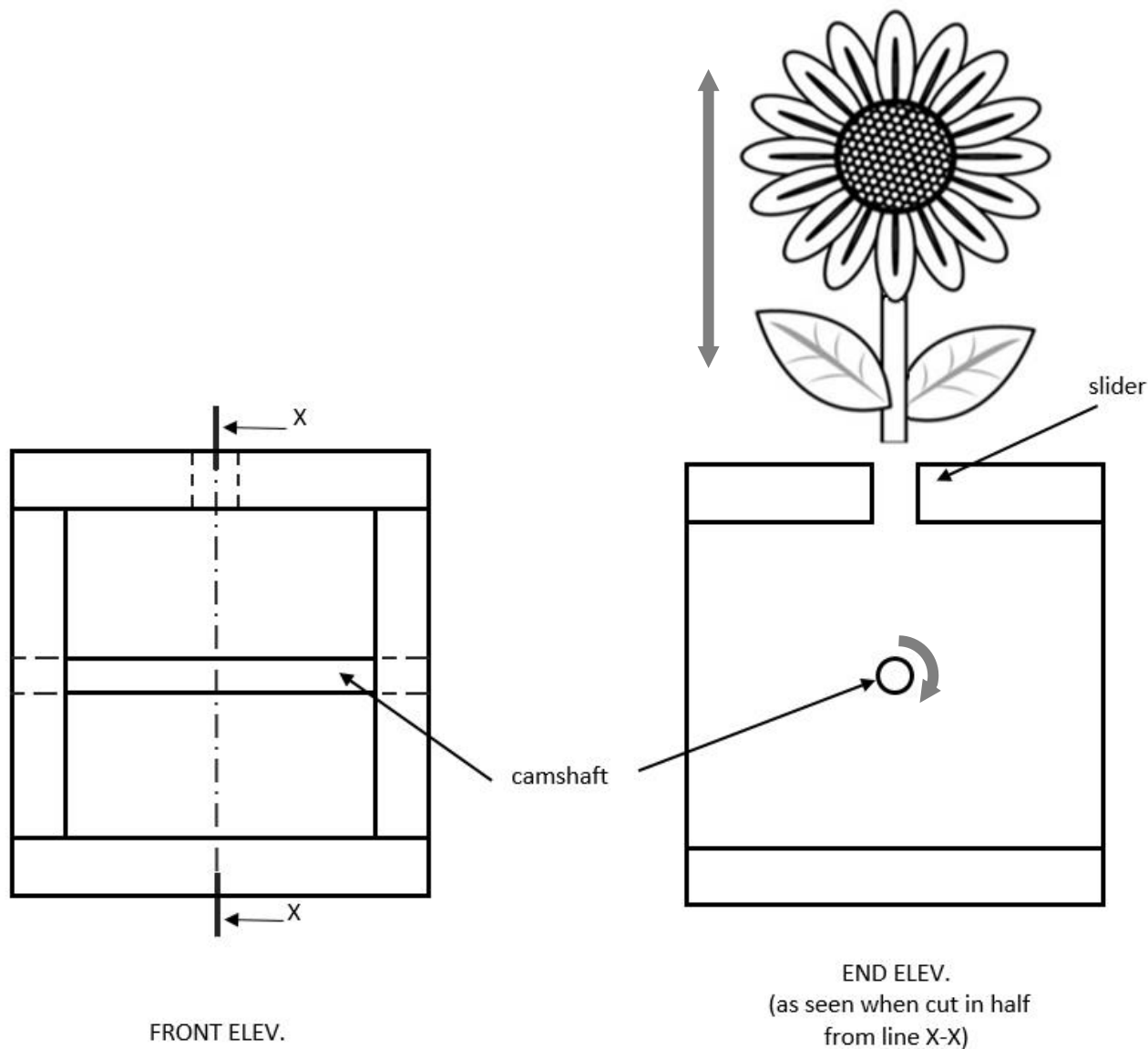


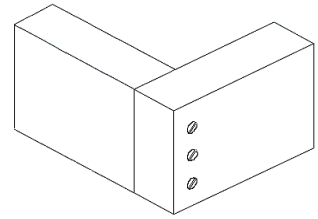
Figure G

- a. On the end elevation of Figure G, draw:
 - i. a pear-shaped cam fitted to the camshaft; (1)
 - ii. a follower attached to the stem of the flower. (1)

- b. Considering the directional arrows shown in Figure G, state the type of motion occurring at the:
 - i. Camshaft: _____ (1)
 - ii. Plastic flower: _____ (1)

- c. On Figure G, colour the petals of the flower using a primary colour and leaves using a secondary colour. (2)

d. Give the name of the wooden joint shown in Figure H which is used in the automata.



_____ (1)

(Total: 7 marks)

Figure H

16. The electronic circuit in Figure I is used as emergency lighting in a glasshouse for when a mains electricity power cut occurs.

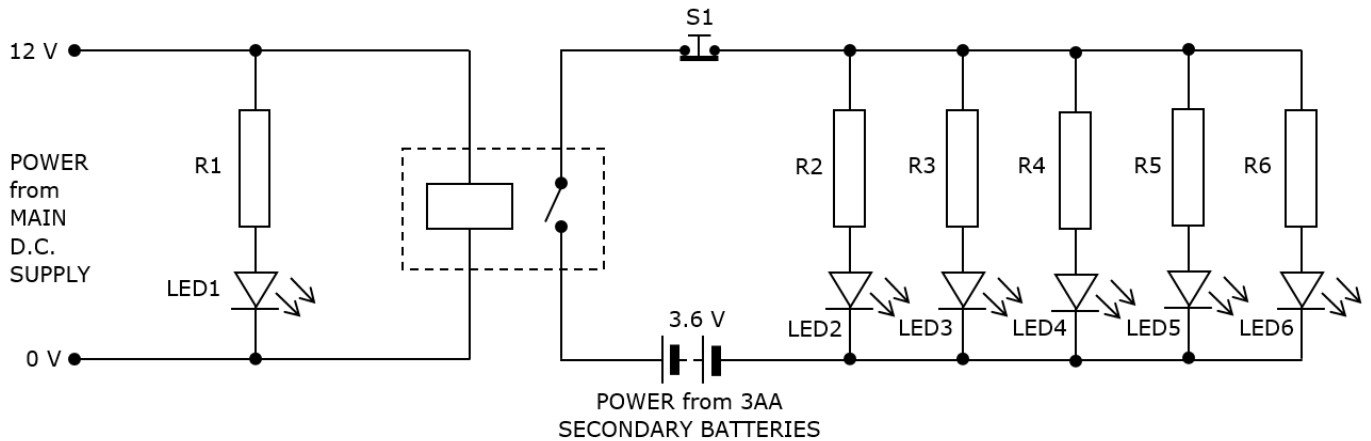


Figure I

a. The system in Figure I makes use of a relay.

i. Circle the relay in Figure I. (1)

ii. Explain how a relay works.

 _____ (2)

b. Focus on the part of the circuit which is connected to the main d.c. supply.

i. Suggest a reason why LED1 was used in the circuit.
 _____ (1)

ii. Assuming that R1 has a value of 485 Ω, choose the most appropriate standard value resistor from the table below. Circle your answer.

100 Ω	470 Ω	510 Ω	1 kΩ	2.2 kΩ
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(1)

This question continues on next page.

c. The circuit provided in Figure I makes use of a switch S1.

i. State what type of switch S1 is.

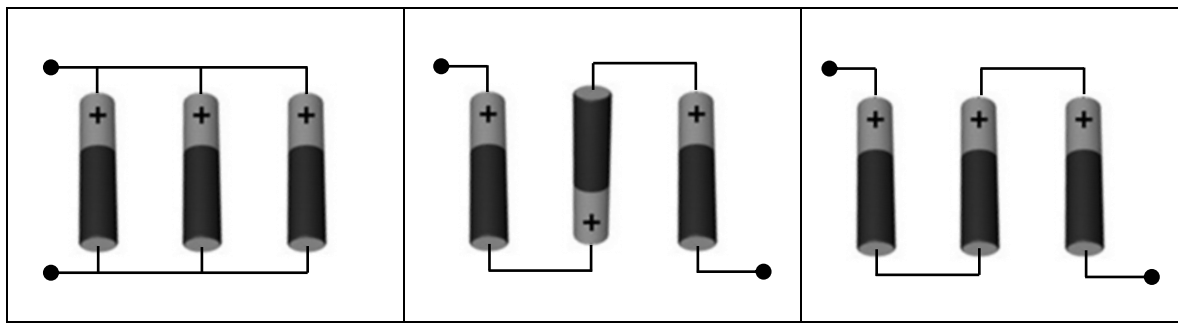
_____ (1)

ii. State the purpose of S1 in this circuit.

 _____ (2)

d. Table 5 shows different configurations of the 3 AA secondary batteries used to light up LED2 to LED6 in the emergency light circuit.

Table 5



Tick here			
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i. On Table 5, tick the battery configuration which supplies 3.6 V. (1)

ii. On the choice you have made in part di, label the positive and negative terminals of the configuration. (2)

iii. Describe **TWO** differences between primary and secondary batteries.

Difference 1: _____ (1)

Difference 2: _____ (1)

e. Calculate the total resistance of the system shown in Figure J.

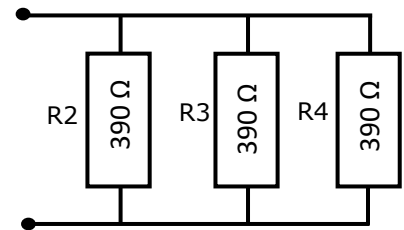


Figure J

(2)

f. State the difference between the power consumption of an LED compared to a bulb.

_____ (1)

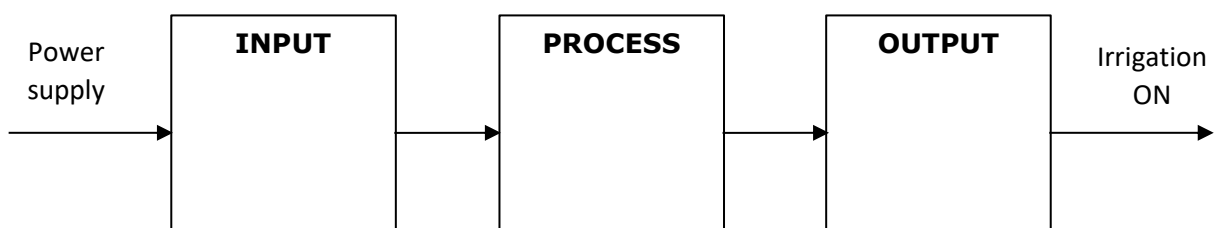
(Total: 16 marks)

17. An automatic irrigation system was installed in a yard to water plants. When the soil gets dry, a sensor switches ON the circuit controlling the d.c. motor of the pump for a period of time. The circuit is controlled via a microcontroller.

a. Describe what a microcontroller is.

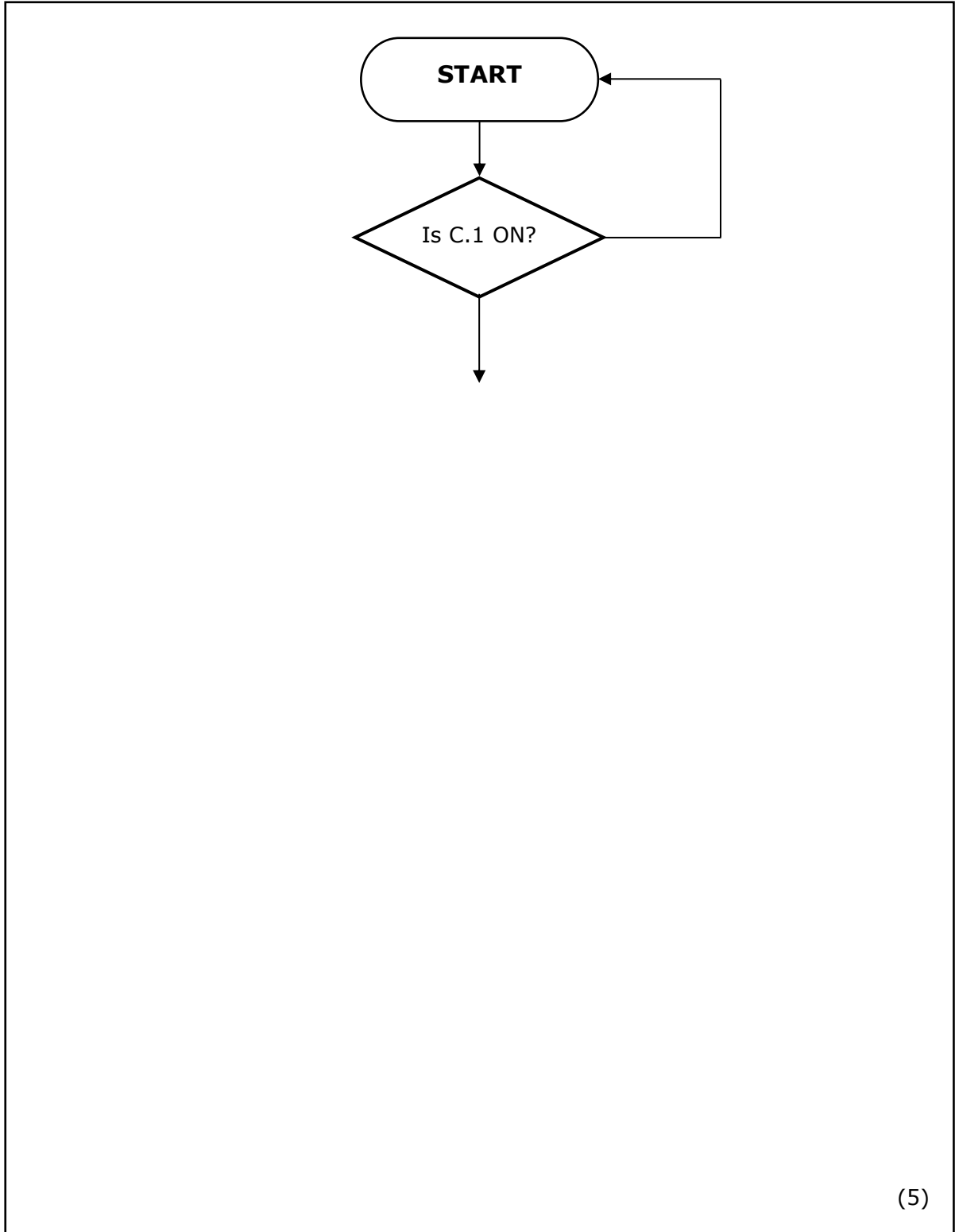
_____ (1)

b. The automatic irrigation system mainly consists of a sensor, a microcontroller and a d.c. motor. In the space provided below complete the block diagram to explain how the irrigation system works.



(3)

- c. Assume that the sensor gives a low signal when the soil is dry and is connected to pin C.1 of the microcontroller. Assume also that the d.c. motor is connected to pin C.2 of the microcontroller. In the space provided below, complete the flowchart to write a program which switches ON the d.c. motor for a period of 5 minutes whenever the soil gets dry.



(5)

d. A timing circuit can be built with two discrete components as shown in Figure K.

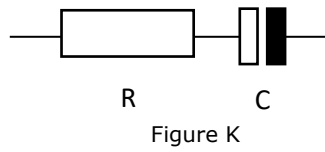


Figure K

i. State the name of component C.

_____ (1)

ii. State whether component C is electrolytic or non-electrolytic.

_____ (1)

iii. In the space provided below calculate the time period if the value of R is $30\text{ k}\Omega$ and the value of C is $10,000\ \mu\text{F}$.

(3)

(Total: 14 marks)

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