



L-Università
ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

**SECONDARY EDUCATION CERTIFICATE LEVEL
2020 MAIN SESSION**

SUBJECT:	Design and Technology
PAPER NUMBER:	IIA
DATE:	11 th September 2020
TIME:	9:00 a.m. to 11:05 a.m.

Instructions

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

Non-programmable calculators are allowed.

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

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

Useful Information

Formulae:

$$V_T = V_1 + V_2 + \dots$$

$$V = I \times R$$

$$\text{Moments} = F \times D$$

For equilibrium: Clockwise Moments = Anticlockwise Moments

$$\text{Mechanical Advantage} = \frac{\text{Output Force}}{\text{Input Force}} = \frac{\text{Input Length}}{\text{Output Length}}$$

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

Theme: Wellbeing in Urban Spaces

Situation: Urban spaces are getting more crowded and people are limited in finding areas for outdoor physical activities. Some trainees make use of outdoor gyms for their healthy routine but others end up using busy roads and expose themselves to unnecessary dangers.

SECTION A: Core Design & Technology Principles

1. Considering the situation given above.
 - a. Complete the situation analysis in Figure A by answering all the **FOUR** questions on the diagram.

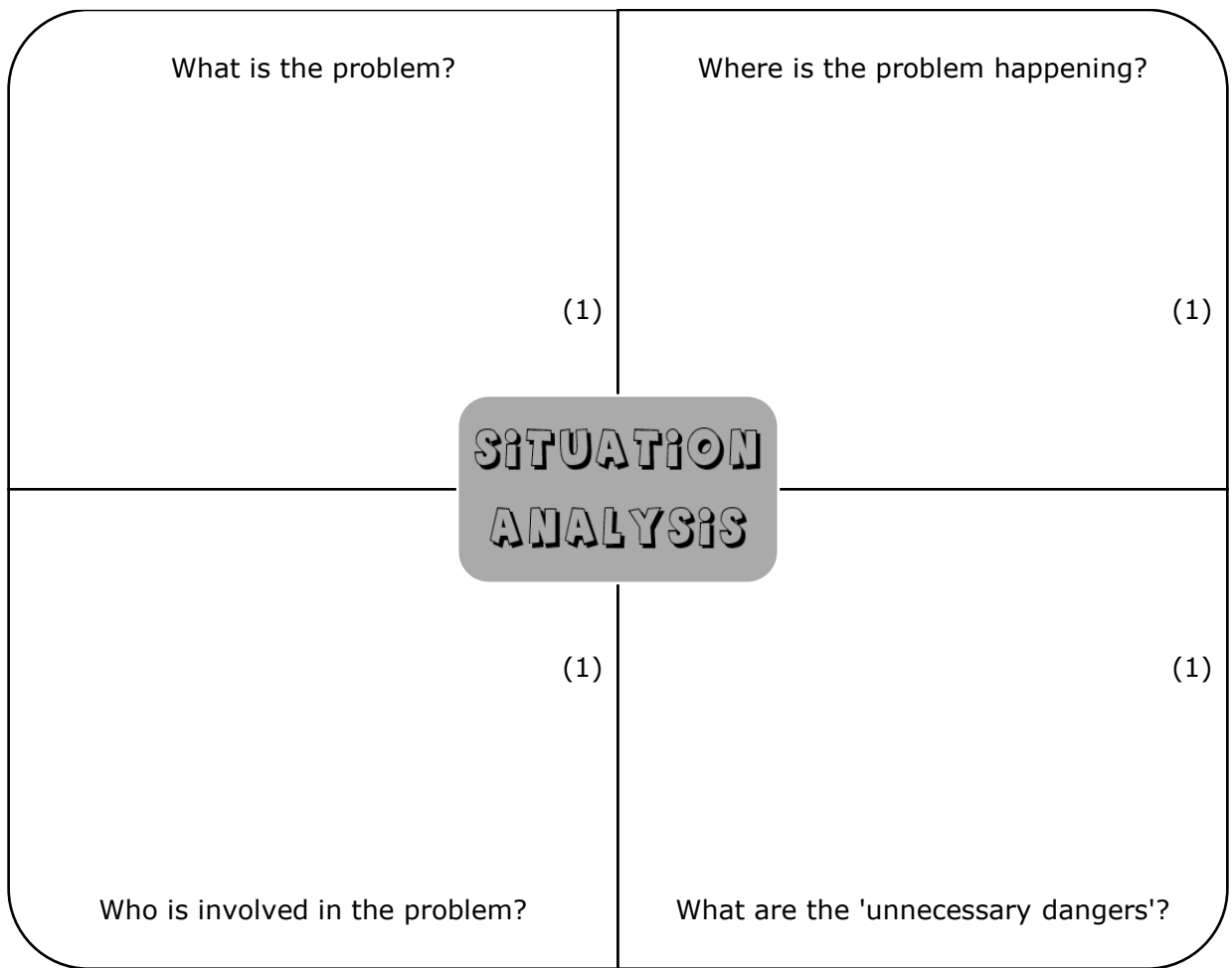


Figure A

- b. A designer can use a mood board to show the narrative and identity of the design concept. Mention **ONE** feature which can be shown on a mood board.

_____ (1)

(Total: 5 marks)

2. Underline **ONE** correct answer from the given selection.

a. Which of the following materials are **both** organic textiles?

- i. Fibreglass and Carbon Fibre
- ii. Wool and Cotton
- iii. Nylon and Silk
- iv. Spandex and Polyester

(1)

b. Which of the following are **both** heat treatment processes?

- i. Annealing and Tempering
- ii. Pleating and Flame Proofing
- iii. Injection Moulding and Extrusion
- iv. Drilling and Threading

(1)

c. What is **not** a function of a transistor?

- i. Amplifying electrical current
- ii. Switching electrical signals
- iii. Amplifying voltage signals
- iv. Directing current in one direction

(1)

(Total: 3 marks)

3. On Table 1 draw the schematic symbol for the given electronic components.

Table 1

Polarised Capacitor	Thermistor
(1)	(1)

(Total: 2 marks)

4. Answer the following questions about classification of materials.

a. Name **ONE** hardwood.

_____ (1)

b. State the type of plastic which ABS is.

_____ (1)

c. Give the definition of the term alloy.

_____ (1)

(Total: 3 marks)

5. Complete the following sentences by choosing a word/phrase from the list provided. A word/phrase may only be used **ONCE**.

Multimeter	Thermal conductivity	Perspective
Sheet	Flame proofing	Nuts and bolts

- a. The _____ is an instrument used to measure the voltage, current and continuity.
- b. Two-point _____ is a method of drawing an object in three-dimension.
- c. A _____ is a standard form of supply for a material.
- d. _____ is a type of chemical process applied to fabrics.

(Total: 4 marks)

6. Match the correct definition for the following phrases by putting the corresponding letter near the definition.

Phrase		Definition	
a.	Circular economy		A renewable source of energy.
b.	Carbon footprint		Keeping resources in use for as long as possible, recovering products after their life service.
c.	Solar power		The amount of greenhouse gases released into the atmosphere by particular products or activities.

(Total: 3 marks)

SECTION B: Design Aspect

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

Statistics show that a large number of road fatalities in Malta involve vulnerable road users such as pedestrians (walkers/joggers/runners) and cyclists. The following pie chart shows the percentages of pedestrians and cyclists who suffered from accidents in the year 2017:

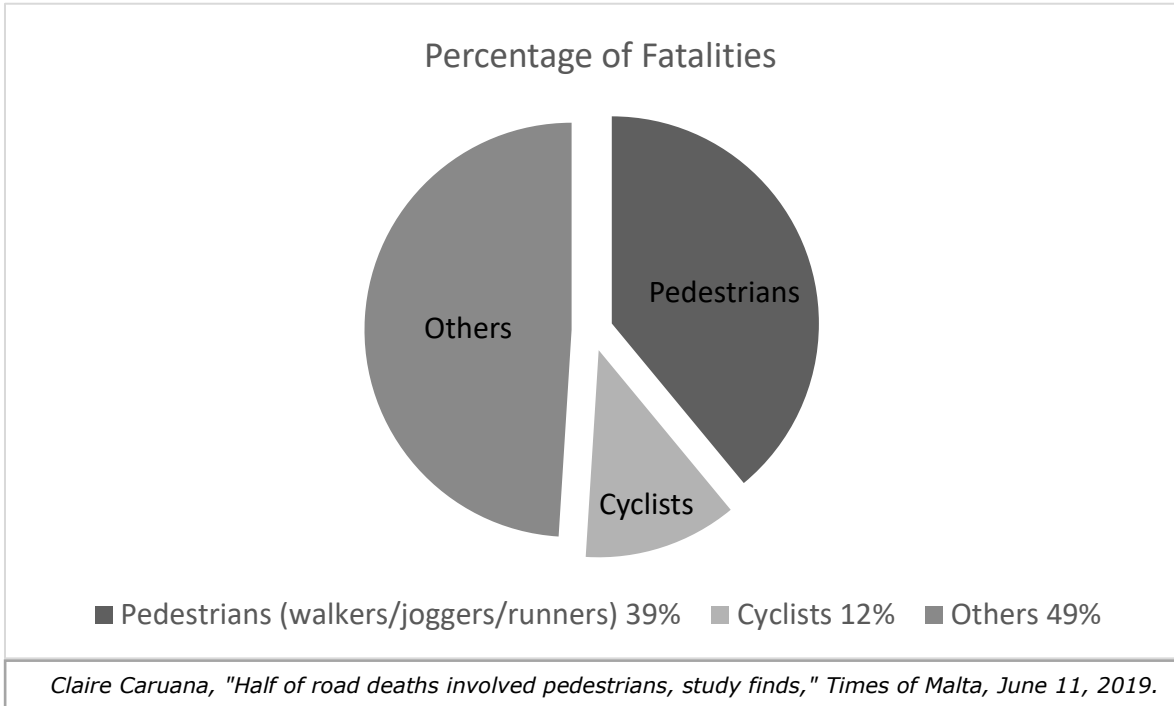


Figure B

7. Look at the pie chart in Figure B.

a. State what the information in the box below the pie chart is called.

_____ (1)

b. Give **ONE** reason why such information needs to be included.

_____ (1)

(Total: 2 marks)

8. Data recording is an important part of the research process.

a. Explain why data recording is important for a designer.

_____ (2)

b. Name **TWO** tools that a designer can use to record data in an orderly manner.

_____ (2)

(Total: 4 marks)

9. In order to help people stay safe on busy roads while they carry out their daily fitness routine, safety products can be worn or attached.

a. Name **TWO** market sources that a designer would need to consider when researching about such safety products.

(2)

b. Choose **ONE** of the following fitness activities.

Activity	Tick your choice
Walking / jogging / running	
Cycling	

Using the choice you have made above, sketch **TWO** different ideas of products which increase the visibility of persons performing the activity to help them stay safe. Use the spaces provided below.

IDEA 1

(5)

IDEA 2

(5)

(Total: 12 marks)

10. Refer to your sketches in Question 9.

a. Choose **ONE** idea and write a strength and a weakness for that idea.

Idea number: _____	Strength: _____ (1)
	Weakness: _____ (1)

b. Suggest how you would add further design value to the idea chosen in Question 10a.

_____ (2)

(Total: 4 marks)

11. After a prototype is built, testing is carried out.

a. List **TWO** criteria which need to be tested out on a prototype.

_____ (2)

b. Describe how you would perform a test for one of the criteria you have mentioned in part a.

Criteria: _____

Test: _____

_____ (1)

(Total: 3 marks)

SECTION C: Technology Aspect

12. Figure C shows a device used by individuals to perform exercise in an outdoor gym. The structure of the device consists of handle and foot sections which are made out of pipes. The top end of the handle section is covered with a plastic material to provide better grip as shown in Detail A in Figure C.

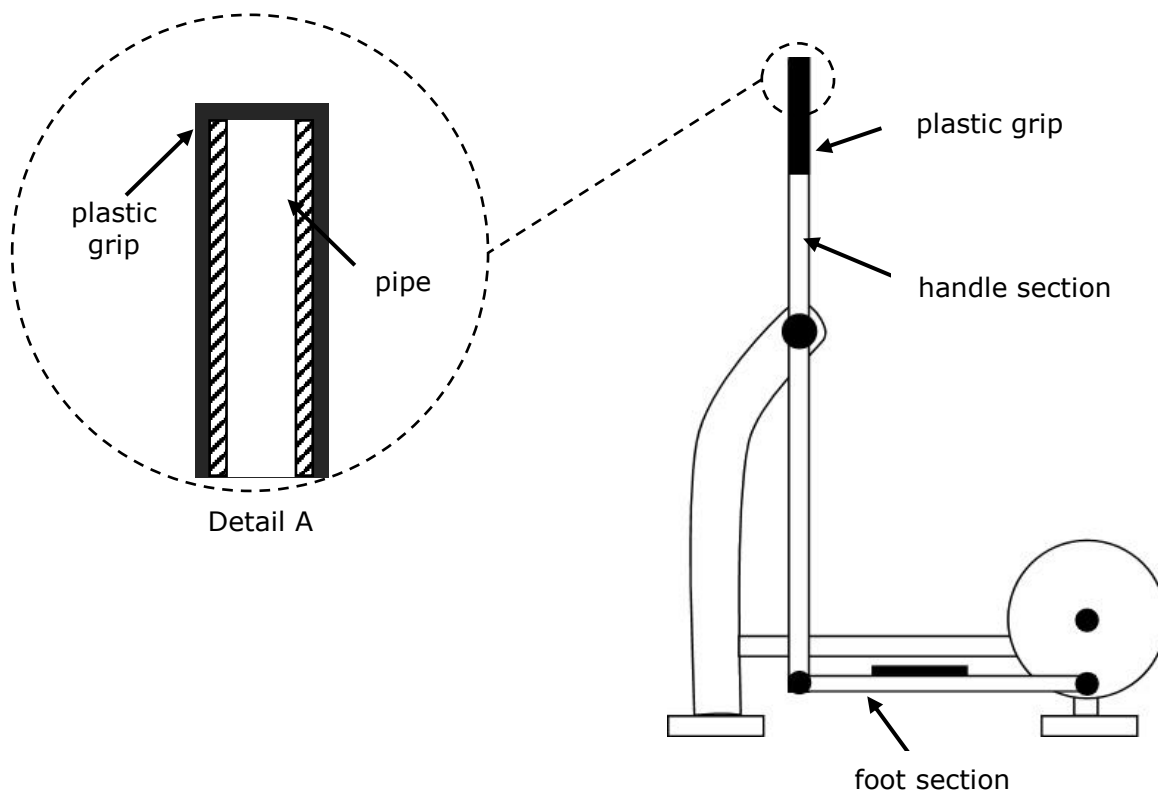


Figure C

- a. In Table 2 write down **TWO** key mechanical properties which should be considered when selecting a material for the pipes of the handle and foot section. Provide **ONE** justification for **EACH** property.

Table 2

Mechanical Property	Justification

(4)

- b. Name **ONE** suitable material which can be used for the pipes of the device shown in Figure C.

_____ (1)

- c. During manufacturing, the pipes are cut to specific lengths and joined permanently together.

- i. Describe the process of using a hack saw to cut the pipes to the required length.

 _____ (3)

- ii. Mention **ONE** health and safety hazard associated with the use of a hack saw.

_____ (1)

- iii. Suggest **TWO** ways how to reduce the health and safety risks associated with the use of a hack saw.

 _____ (2)

- iv. Identify **ONE** joining process which would be suitable to permanently join the pipes.

_____ (1)

This question continues on next page.

d. The outdoor gym structure shown in Figure C will have a colour scheme.

i. Name a set of **TWO** complementary colours suitable for the outdoor gym structure.

_____ (1)

ii. Suggest **ONE** finishing process which can be used to apply colour on the outdoor gym structure.

_____ (1)

e. The plastic grips of the gym device are fabricated using injection moulding. Table 3 shows the different steps involved during the injection moulding process. Write numbers 1-4 in the column named Steps to show the correct sequence.

Table 3

Steps	Different steps involved during the injection moulding process.
	The mould is cooled down and the injected plastic solidifies.
	Hopper is filled with plastic granules and the mould closes.
	The mould opens and the solid plastic component is ejected.
	The plastic granules are heated and injected into the mould.

(2)

(Total: 16 marks)

13. The gym device shown in Figure C includes an electronic system which signals whether a trainer has achieved the desired amount of exercise. The system functions by comparing the desired exercise signal with the actual exercise signal as shown in Figure D. When the actual signal is lower than the desired signal, LED1 lights up while LED2 stays OFF. When the actual signal is higher than the desired signal, LED2 lights up and LED1 goes OFF.

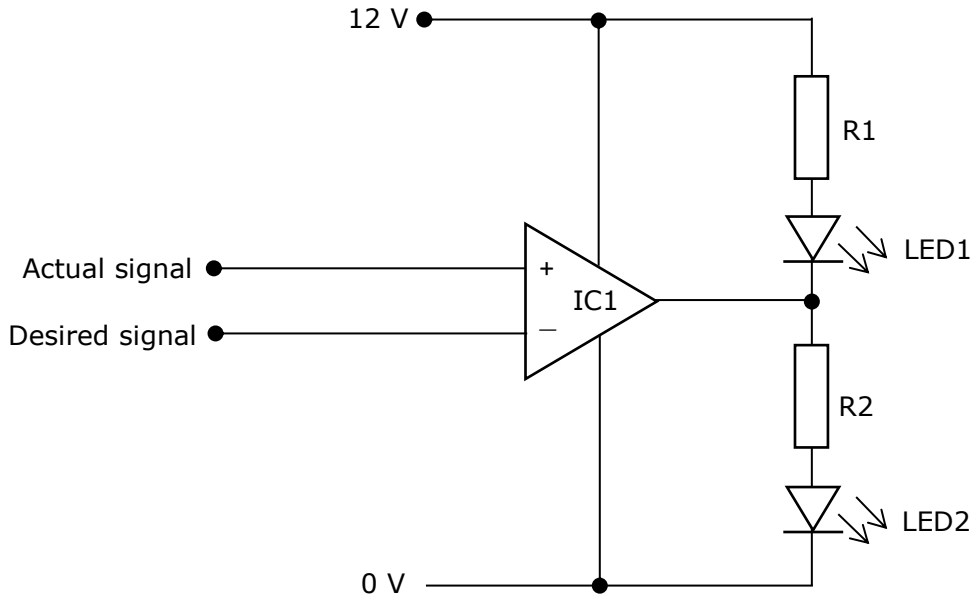


Figure D

- a. On Figure D, draw boxes to divide the circuit in three sections showing and labelling the **INPUT**, **PROCESS** and **OUTPUT**. (3)
- b. Considering the circuit shown in Figure D: if LED1 needs 2.2 V 20 mA and LED2 needs 3 V 30 mA, calculate the value of R1.

(4)

This question continues on next page.

c. Figure E shows the pinouts of IC1.

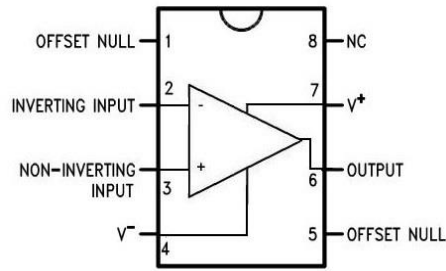


Figure E

i. State the source from where a designer obtains the information shown in Figure E.

_____ (1)

ii. Give the name of component IC1.

_____ (1)

iii. Figure F shows an incomplete breadboard layout of the circuit shown in Figure D. Use the information given about IC1 to draw and label the missing components, thus completing the circuit.

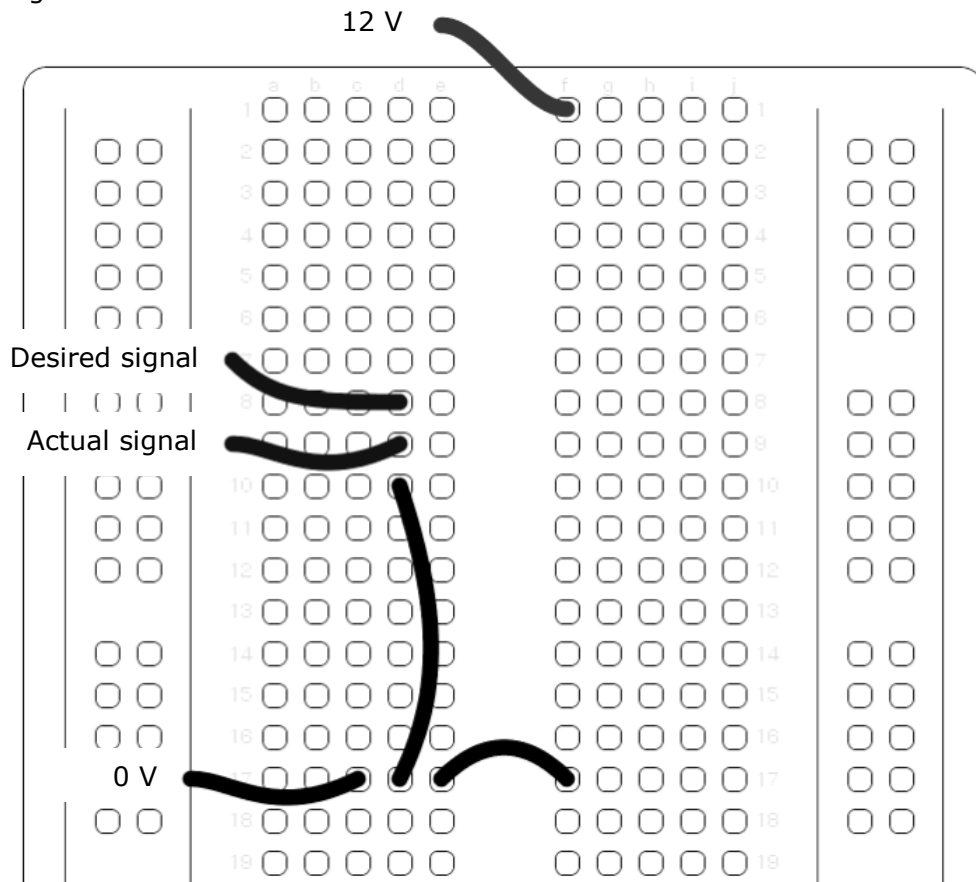


Figure F

(4)

(Total: 13 marks)

14. Outdoor gyms may also include a weight-lifting machine as shown in Figure G. The machine consists of weights and a pinned lever. The user is seated as indicated and lifts the weights by pulling down on the end of the handlebar.

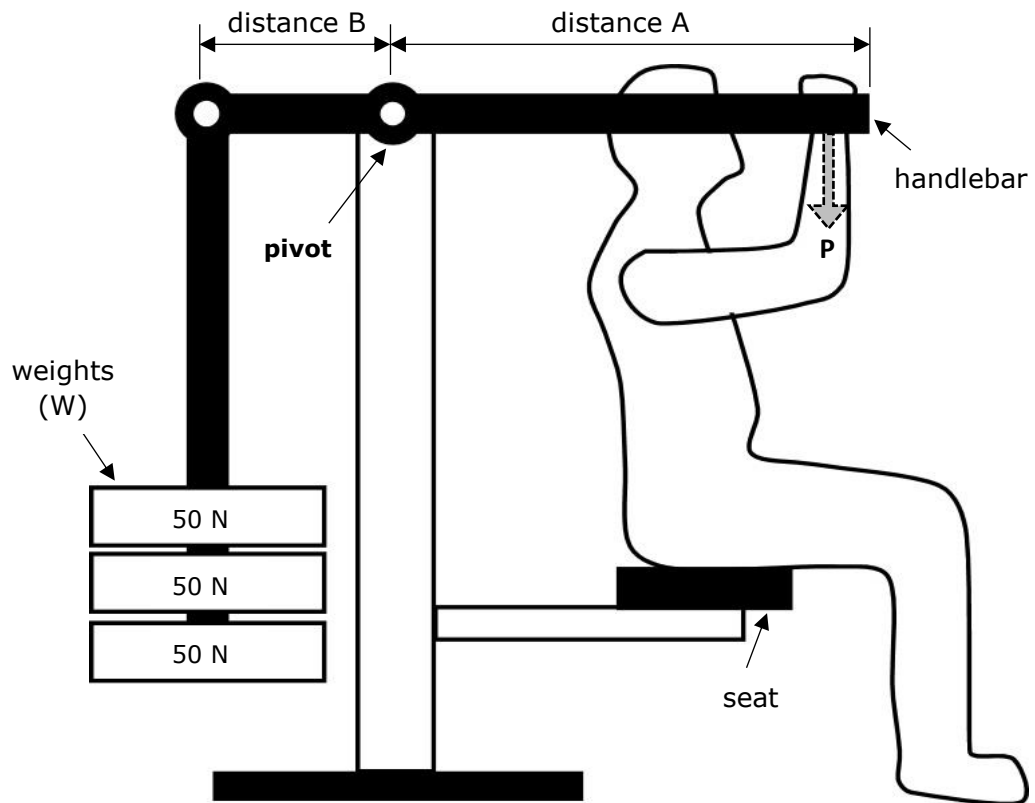


Figure G

- a. Determine the minimum force P which the user needs to exert in order to just lift **all** the weights shown in Figure G. Assume that distance A is 1.00 m and distance B is 25 cm.

(4)

This question continues on next page.

- b. The weight-lifting machine was designed to provide a mechanical advantage of 4. Calculate the effort which the user needs to exert to lift a weight of 15 N.

(3)

(Total: 7 marks)

15. The seat of the weight-lifting machine shown in Figure G is produced from GRP.

- a. State the class of material under which GRP falls.

_____ (1)

- b. List **TWO** reasons why GRP is used over other materials to produce the seat.

 _____ (2)

- c. Figure H shows a side elevation of the seat and part of machine structure of Figure G. Both the seat and machine have two pre-drilled holes.

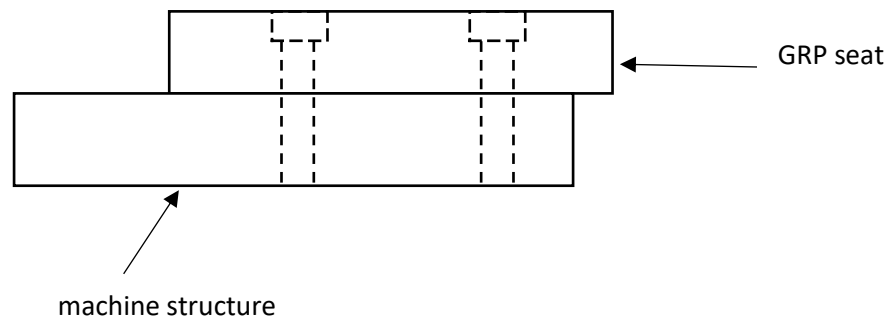


Figure H

- i. Name a suitable fastener that can be used to assemble the GRP seat to the structure.

_____ (1)

- ii. The machine shown in Figure I can be used to make the holes in the seat. On Figure I, give the name of the machine and label the parts indicated by the arrows.

Name of machine:

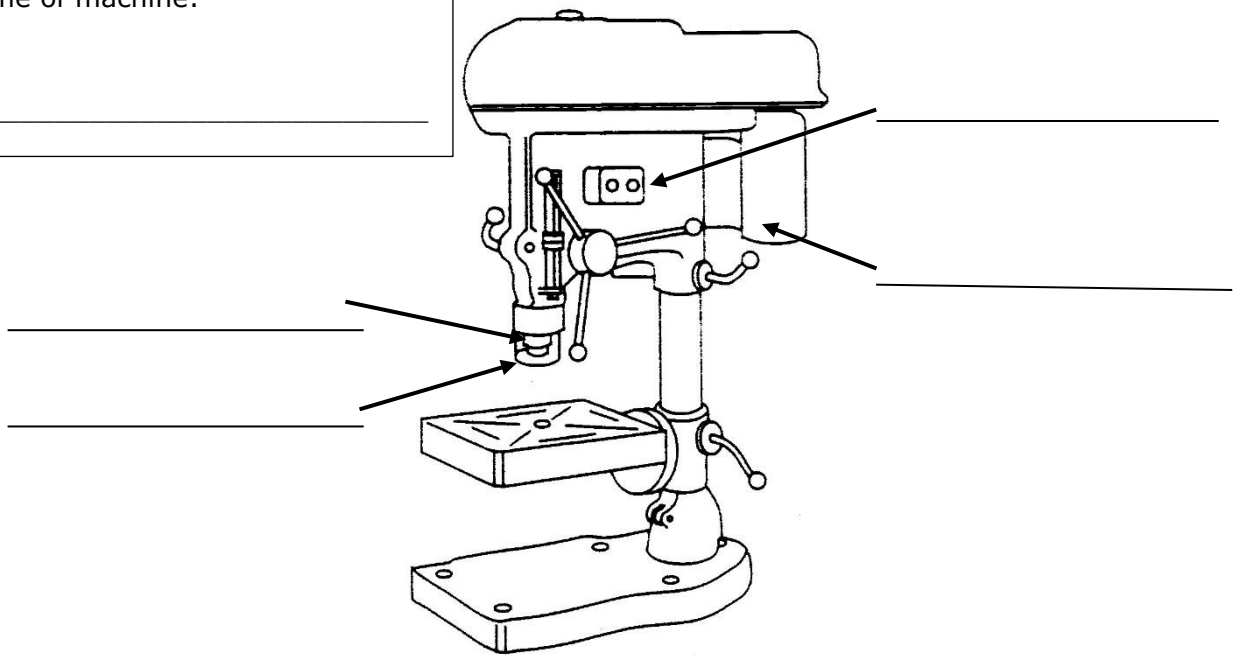


Figure I

(5)

- iii. Redraw the diagram shown in Figure H as a 2D sectional view. On the same diagram, show how the fasteners you mentioned in part c(i) could be used to assemble the two parts together.

(3)

This question continues on next page.

d. Name **TWO** benefits of using CAD software to produce the drawing shown in Figure G.

_____ (2)

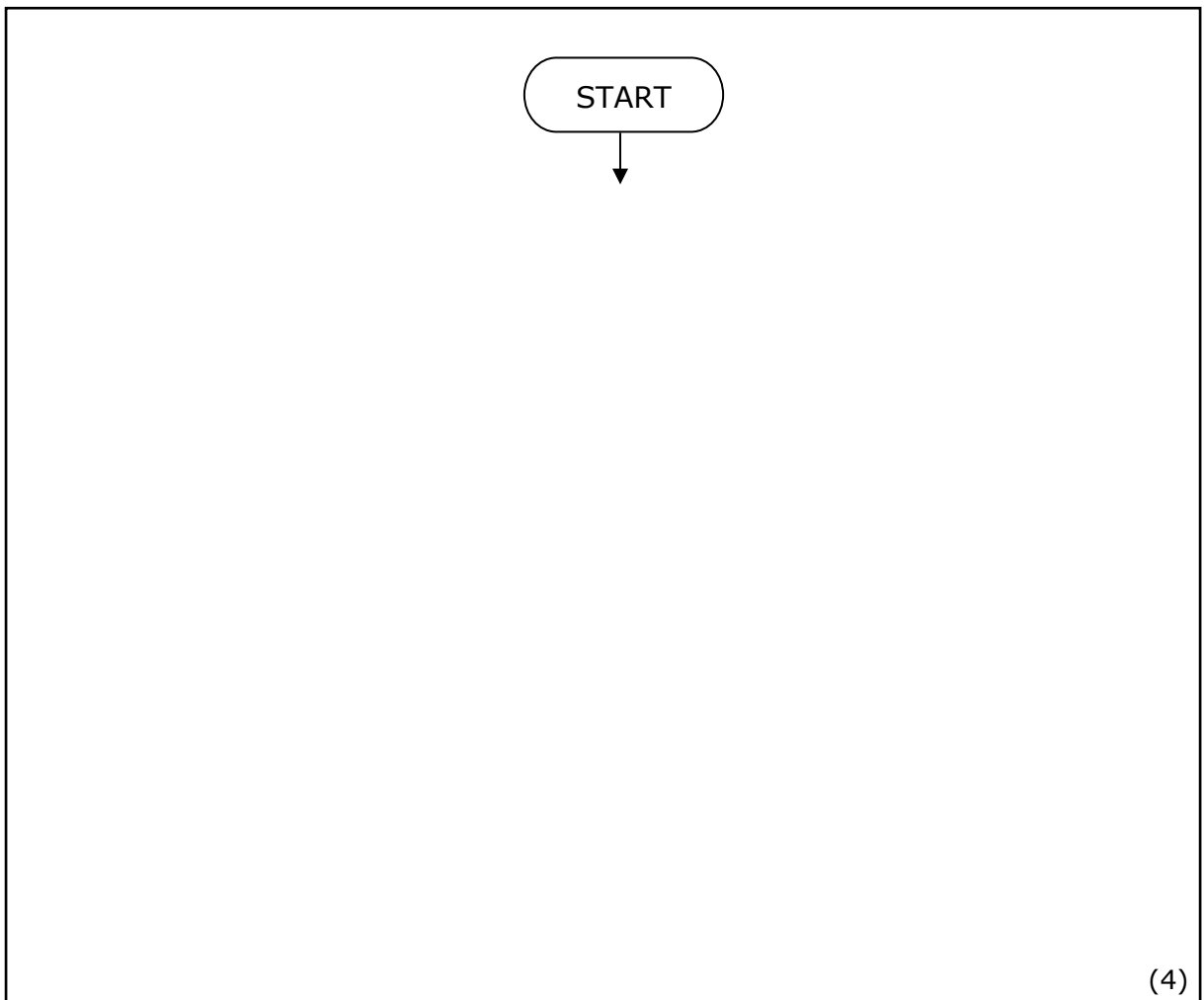
(Total: 14 marks)

16. The weight-lifting machine shown in Figure G includes a security feature which electronically blocks the machine if a trainer is not sitting on the seat. This feature is controlled via a microcontroller.

a. State **ONE** advantage of using microcontrollers.

_____ (1)

b. Assume that there is a micro-switch under the seat which is connected to pin C.3 of the microcontroller and the locking mechanism of the weight-lifting machine is connected to pin C.2. In the space provided below, complete the flowchart to write a program which allows the locking mechanism to go OFF when the micro-switch is pressed.



(4)

(Total: 5 marks)



L-Università
ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

**SECONDARY EDUCATION CERTIFICATE LEVEL
2020 MAIN SESSION**

SUBJECT:	Design and Technology
PAPER NUMBER:	IIB
DATE:	11 th September 2020
TIME:	9:00 a.m. to 11:05 a.m.

Instructions

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

Non-programmable calculators are allowed.

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

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

Useful Information

Formulae:

$$V_T = V_1 + V_2 + \dots$$

$$V = I \times R$$

$$\text{Moments} = F \times D$$

For equilibrium: Clockwise Moments = Anticlockwise Moments

$$\text{Mechanical Advantage} = \frac{\text{Output Force}}{\text{Input Force}}$$

2. Underline **ONE** correct answer from the given selection.

a. Which of the following materials are **both** organic textiles?

- i. Fibreglass and Carbon Fibre
- ii. Wool and Cotton
- iii. Nylon and Silk
- iv. Spandex and Polyester

(1)

b. Which of the following are **both** heat treatment processes?

- i. Annealing and Tempering
- ii. Pleating and Flame Proofing
- iii. Injection Moulding and Extrusion
- iv. Drilling and Threading

(1)

c. What is **not** a function of a transistor?

- i. Amplifying electrical current
- ii. Switching electrical signals
- iii. Amplifying voltage signals
- iv. Directing current in one direction

(1)

(Total: 3 marks)

3. On Table 1 draw the schematic symbol for the given electronic components.

Table 1	
Polarised Capacitor	Thermistor
(1)	(1)

(Total: 2 marks)

4. Answer the following questions about classification of materials.

a. Name **ONE** hardwood.

_____ (1)

b. State the type of plastic which ABS is.

_____ (1)

c. Give the definition of the term alloy.

_____ (1)

(Total: 3 marks)

5. Complete the following sentences by choosing a word/phrase from the list provided. A word/phrase may only be used **ONCE**.

Multimeter	Thermal conductivity	Perspective
Sheet	Flame proofing	Nuts and bolts

- a. The _____ is an instrument used to measure the voltage, current and continuity.
- b. Two-point _____ is a method of drawing an object in three-dimension.
- c. A _____ is a standard form of supply for a material.
- d. _____ is a type of chemical process applied to fabrics.

(Total: 4 marks)

6. Match the correct definition for the following phrases by putting the corresponding letter near the definition.

Phrase		Definition	
a	Circular economy		A renewable source of energy.
b	Carbon footprint		Keeping resources in use for as long as possible, recovering products after their life service.
c	Solar power		The amount of greenhouse gases released into the atmosphere by particular products or activities.

(Total: 3 marks)

SECTION B: Design Aspect

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

Statistics show that a large number of road fatalities in Malta involve vulnerable road users such as pedestrians (walkers/joggers/runners) and cyclists. The following pie chart shows the percentages of pedestrians and cyclists who suffered from accidents in the year 2017:

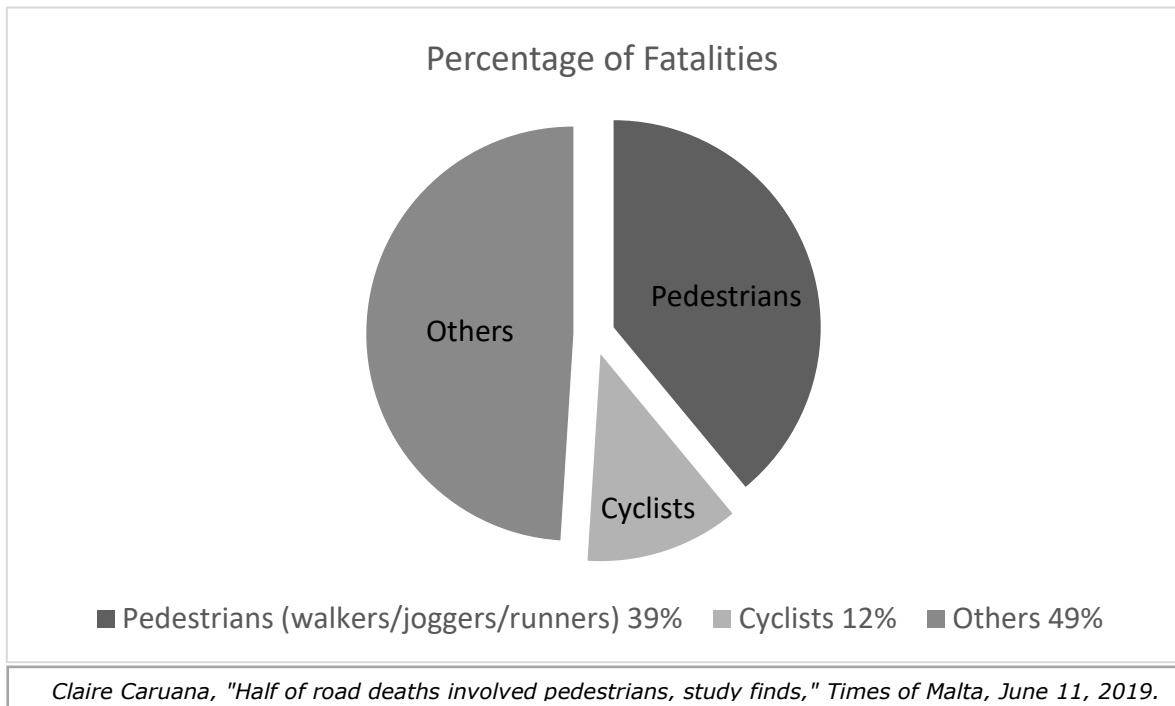


Figure B

7. Look at the information in the box underneath the pie chart in Figure B.
- a. Underline the correct answer from the brackets.
 - i. This information is called (reference / link / extra data).
 - ii. The (data analysis / research tool / data source) is an article from a newspaper. (2)
 - b. Give **ONE** reason why it is important to include such information.

_____ (1)

(Total: 3 marks)

8. Data recording is carried out during research.
- a. Identify **ONE** research tool which can be used to collect data and briefly describe how it is conducted.
- Name of research tool: _____ (1)
- Description: _____ (1)
- b. Name **TWO** tools that a designer can use to organise data.

_____ (2)

(Total: 4 marks)***Please turn the page.***

9. To help people stay safe on busy roads while they carry out their daily fitness routine, safety products can be worn or attached.

a. Name **ONE** market source that a designer would need to consider when researching about such safety products.

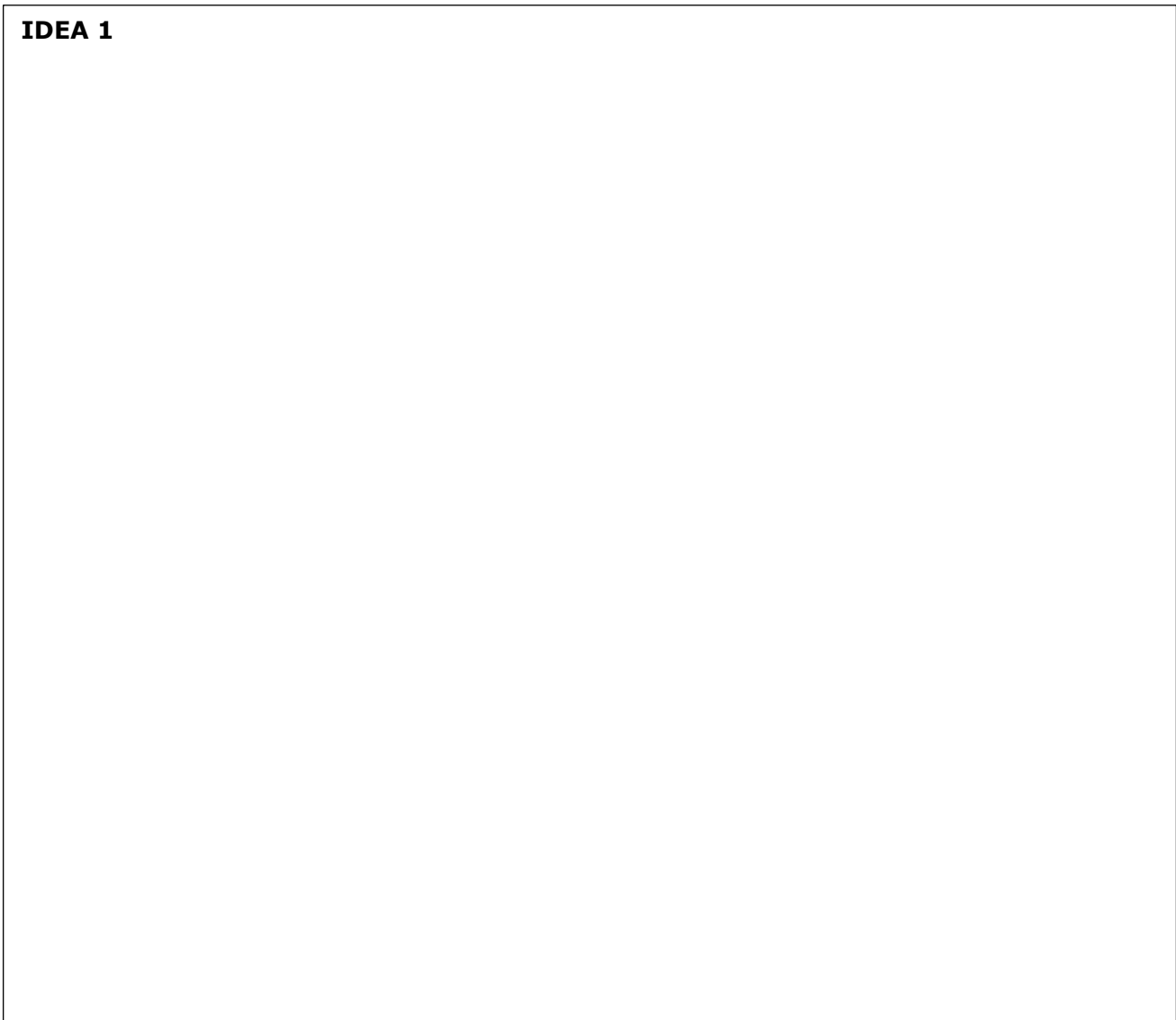
_____ (1)

b. Choose **ONE** of the following fitness activities.

Activity	Tick your choice
Walking / jogging / running	
Cycling	

Using the choice you have made above, sketch **TWO** different ideas of products which increase the visibility of persons performing the activity to help them stay safe. Use the spaces provided below. Marks will be awarded for relevance of idea to brief, clarity of design concepts, proper annotations including realistic dimensions, presentation and use of colour.

IDEA 1



IDEA 2	
---------------	--

(5)

(Total: 11 marks)

10. Refer to your sketches in Question 9.

a. Choose **ONE** idea and name a strength and a weakness for that idea.

Idea number:	Strength: _____
_____	Weakness: _____

(2)

This question continues on next page.

b. Describe how the following stakeholders would benefit from the idea chosen in part a. Exclude any criteria already set in the brief.

i. the consumer: _____ (1)

ii. the entrepreneur: _____ (1)

(Total: 4 marks)

11. After a prototype is built, testing has to be carried out.

a. Complete the following sentence:

Testing is carried out to make sure that the product is _____. (1)

b. Describe how you would carry out a test to check the criteria you have mentioned in part a.

_____ (2)

(Total: 3 marks)

SECTION C: Technology Aspect

12. Figure C shows a device used by individuals to perform exercise in an outdoor gym. The structure of the device consists of handle and foot sections which are made out of pipes. The top end of the handle section is covered with a plastic material to provide better grip as shown in Detail A in Figure C.

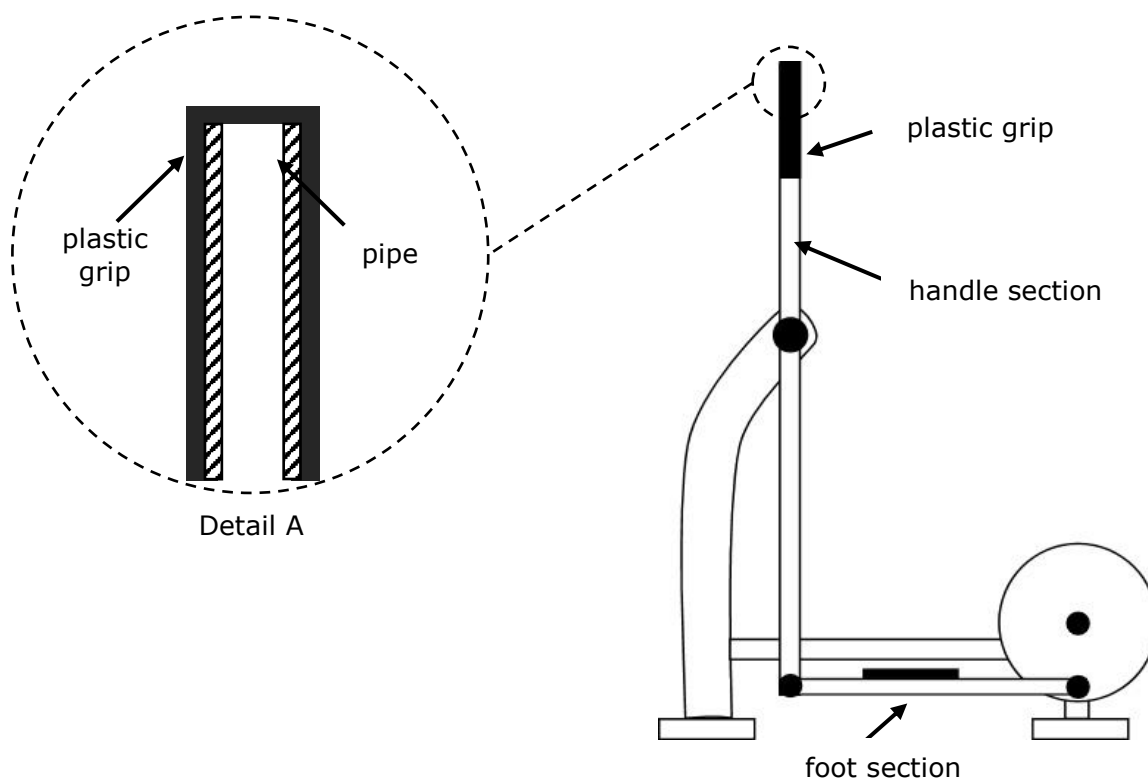


Figure C
Page 8 of 16

- a. The following properties were considered to be important for the selection of a suitable material to be used for the pipes. In Table 2, write down a description of **EACH** property.

Table 2

Property	Description
Toughness	
Durability	
Density	
Texture	

(4)

- b. Name **ONE** metal which could be used for the pipes of the device shown in Figure C.

_____ (1)

- c. During manufacturing, the pipes were cut into specific lengths and joined permanently together. Use the list of tools and machinery provided in Table 3 to answer the following questions.

Table 3

Sewing machine	Welding set	Hack saw	Oscilloscope
Scriber	Band saw	Dust Collector	Vernier Calliper

- i. Mention **ONE** tool which is used to mark out the metal pipe.

_____ (1)

- ii. Name **ONE** tool which can be used to cut the metal pipe to the required length.

_____ (1)

- iii. Identify **ONE** piece of equipment which can be used to permanently join the metal pipes together.

_____ (1)

- iv. Find **ONE** high-risk tool from the list in Table 3.

_____ (1)

This question continues on next page.

v. Highlight **TWO** health and safety hazards associated with the high-risk tool identified in part c(iv).

_____ (2)

d. The outdoor gym structure shown in Figure C will have a colour scheme.

i. Identify a set of **TWO** complementary colours suitable for the outdoor gym structure.

_____ (1)

ii. Underline **ONE** finishing process which is suitable to apply colour to the outdoor gym structure.

Plastic Coating Polishing Varnishing Oiling

(1)

e. The plastic grips of the gym device are fabricated using the injection moulding process as described below. Fill in the blanks by using some of the words in Table 4. Each word may only be used once.

Table 4

heated	solidifies	opens
quenched	hopper	ejected

Step 1: The _____ is filled with plastic granules and the mould closes.

Step 2: The plastic granules are _____ and injected into the mould.

Step 3: The mould is cooled and the injected plastic _____ inside the mould.

Step 4: The mould opens and the solid plastic component is _____.

(4)

(Total: 17 marks)

13. The gym device shown in Figure C includes an electronic system which signals whether a trainer has achieved the desired amount of exercise. The system functions by comparing the desired exercise signal with the actual exercise signal as shown in Figure D. When the actual signal is higher than the desired signal, LED1 lights up.

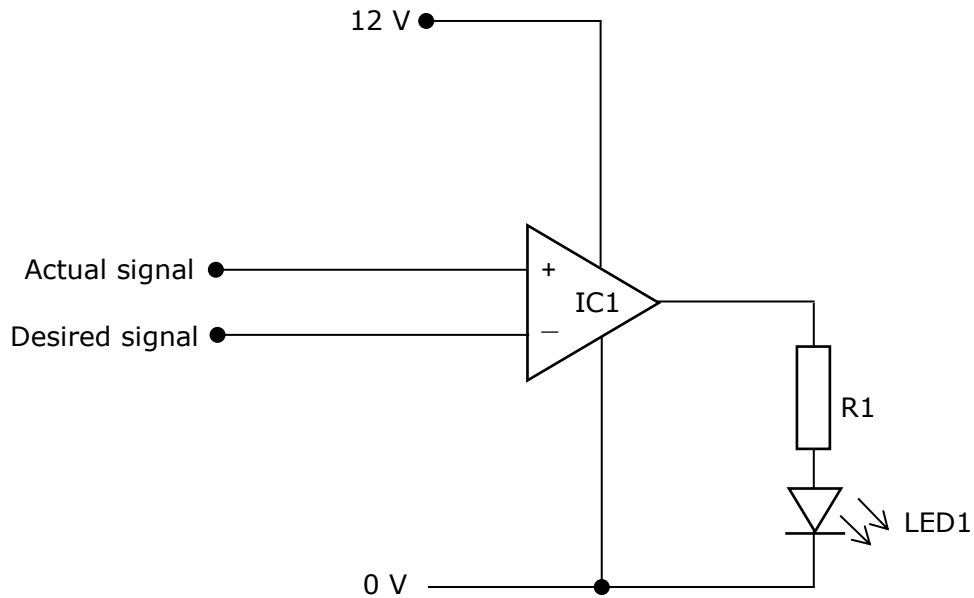


Figure D

- On Figure D, draw boxes to divide the circuit in three sections showing and labelling the **INPUT**, **PROCESS** and **OUTPUT**. (3)
- Considering the circuit shown in Figure D: if LED1 needs 2.2 V 20 mA, calculate the value of R1. Assume that the voltage across R1 is the difference between the output voltage (12 V) and the voltage across LED1.

(4)

This question continues on next page.

c. Figure E shows the pinouts of IC1.

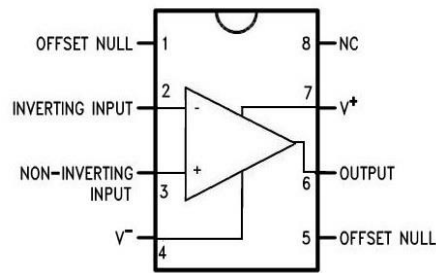


Figure E

i. State the source from where a designer obtains the information shown in Figure E.

_____ (1)

ii. Give the name of component IC1.

_____ (1)

iii. Figure F shows an incomplete breadboard layout of the circuit shown in Figure D. Use the information given about IC1 to draw and label the missing components and wires, thus completing the circuit.

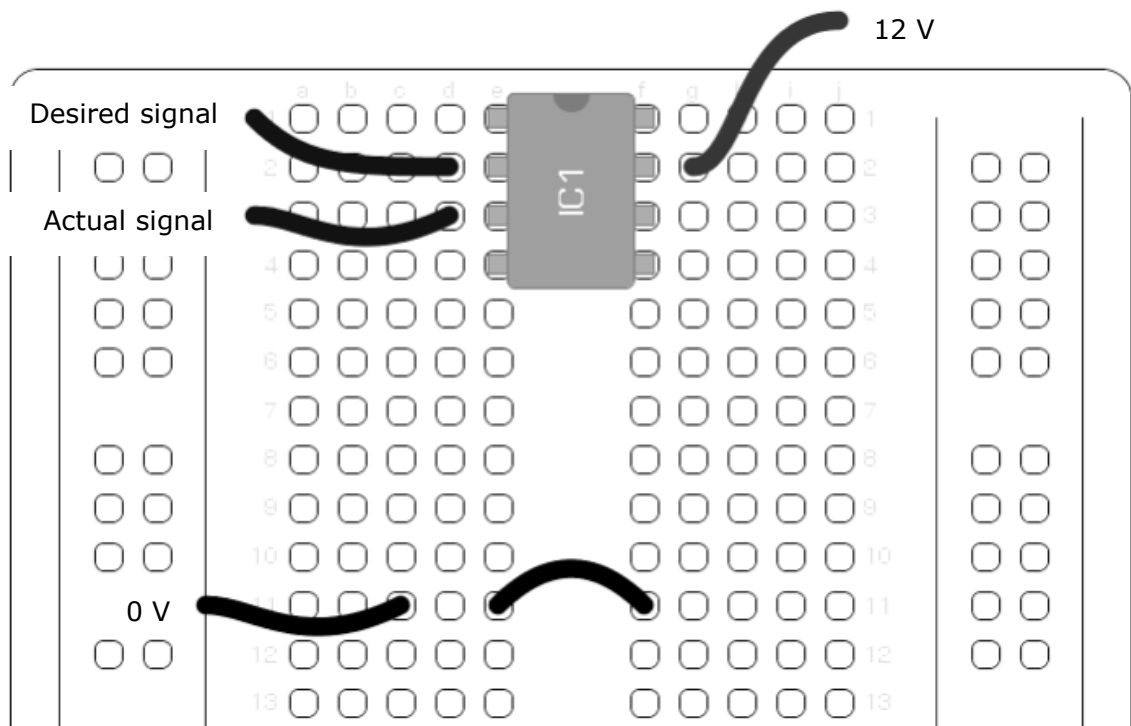


Figure F

(4)

(Total: 13 marks)

14. Outdoor gyms may also include a weight-lifting machine shown in Figure G. The machine consists of weights and a pinned lever. The user is seated as indicated and lifts the weights by pulling down on the end of the handlebar.

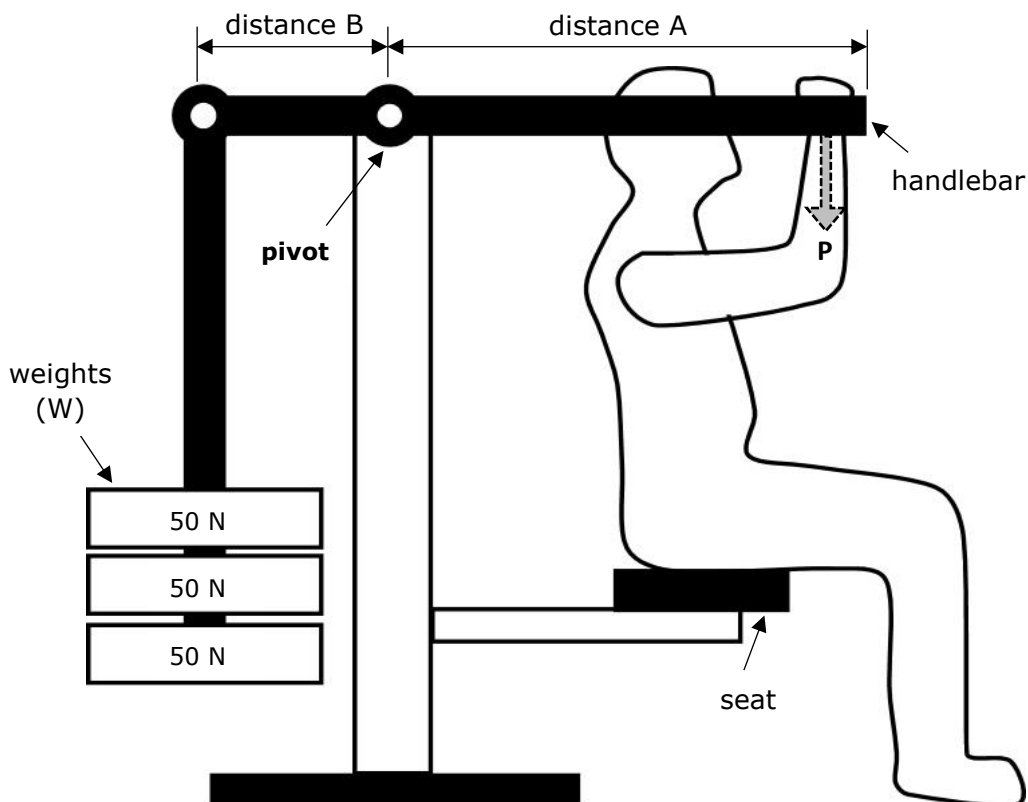


Figure G

a. Assuming that the weights (W) shown in Figure G amount to 150 N, determine the minimum force P which the user needs to exert in order to break the equilibrium and just lift the weights. Assume that distance A is 1.00 m and distance B is 0.25 m.

(4)

This question continues on next page.

- b. During testing it was determined that in order to lift a weight of 10 N, the user needs to exert an effort (P) of 2.5 N. Calculate the mechanical advantage of the system.

(3)

(Total: 7 marks)

15. The seat of the weight-lifting machine shown in Figure H is produced from GRP (Glass Reinforced Polymer).

- a. Underline the class of material under which GRP falls.

smart material

thermoplastic

composite material

(1)

- b. State **ONE** reason why GRP is used over other materials to produce the seat.

(1)

- c. Figure H shows a sectional view of the seat and part of machine structure of Figure G. Both the seat and machine have two pre-drilled holes in which fasteners will be fitted.

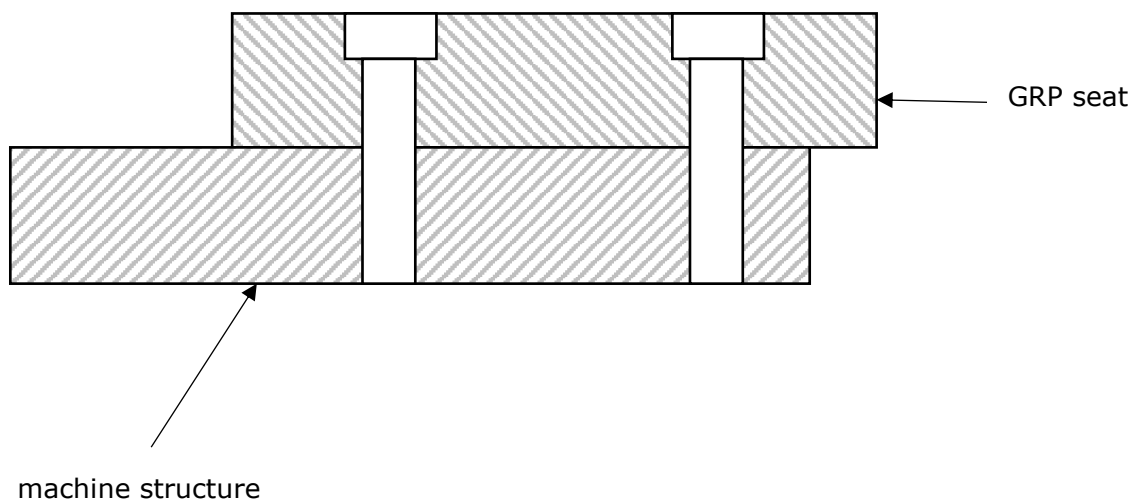
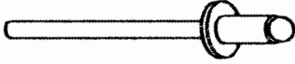
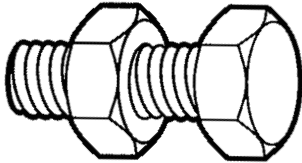


Figure H

i. Write the name of the fasteners shown in Table 5.

Table 5

	
	(2)

ii. Considering the pre-drilled holes, choose the most suitable fastener from Table 5 that can be used to assemble the GRP seat to the structure.

_____ (1)

iii. On Figure H, draw the fastener you have chosen in part c(ii) in both holes to show how the seat is assembled to the machine structure. (3)

iv. The pillar drill shown in Figure I was used to make the holes in the seat. Use the following word bank to label the parts indicated by the arrows.

Power Switch	Electric Motor	Needle	Guard
Heated bed	Extruder	Chuck	Tool Post

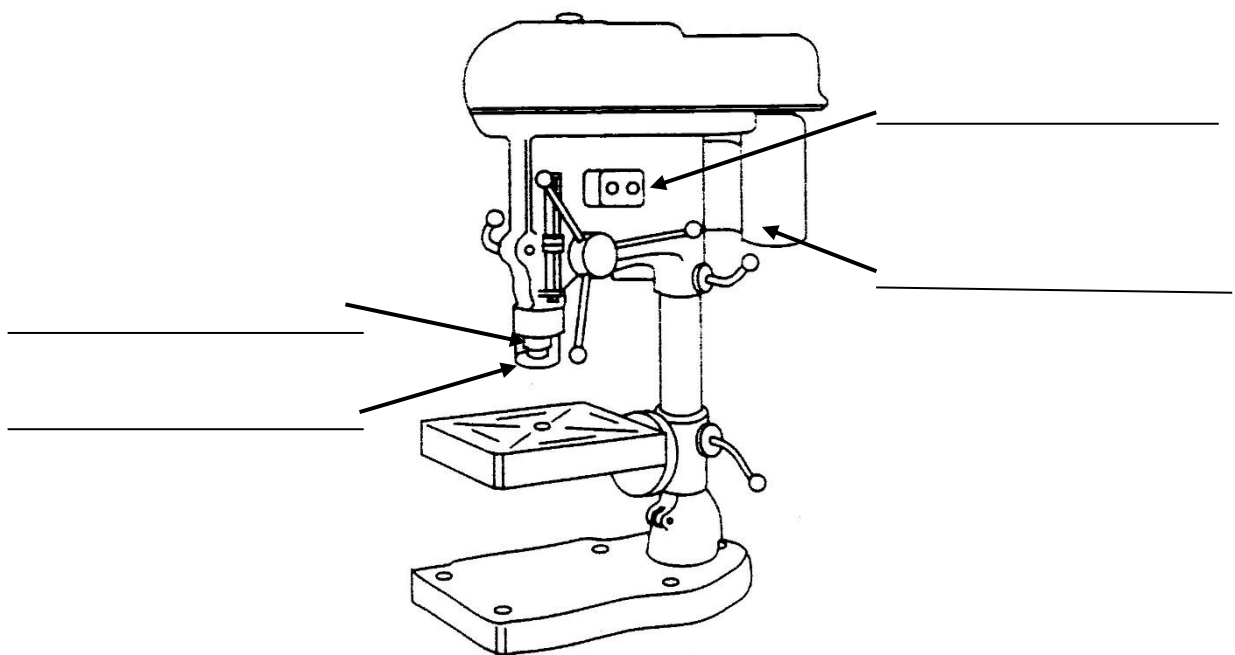


Figure I

(4)

This question continues on next page.

d. Describe **ONE** benefit of using CAD software to produce the drawing shown in Figure H.

_____ (1)

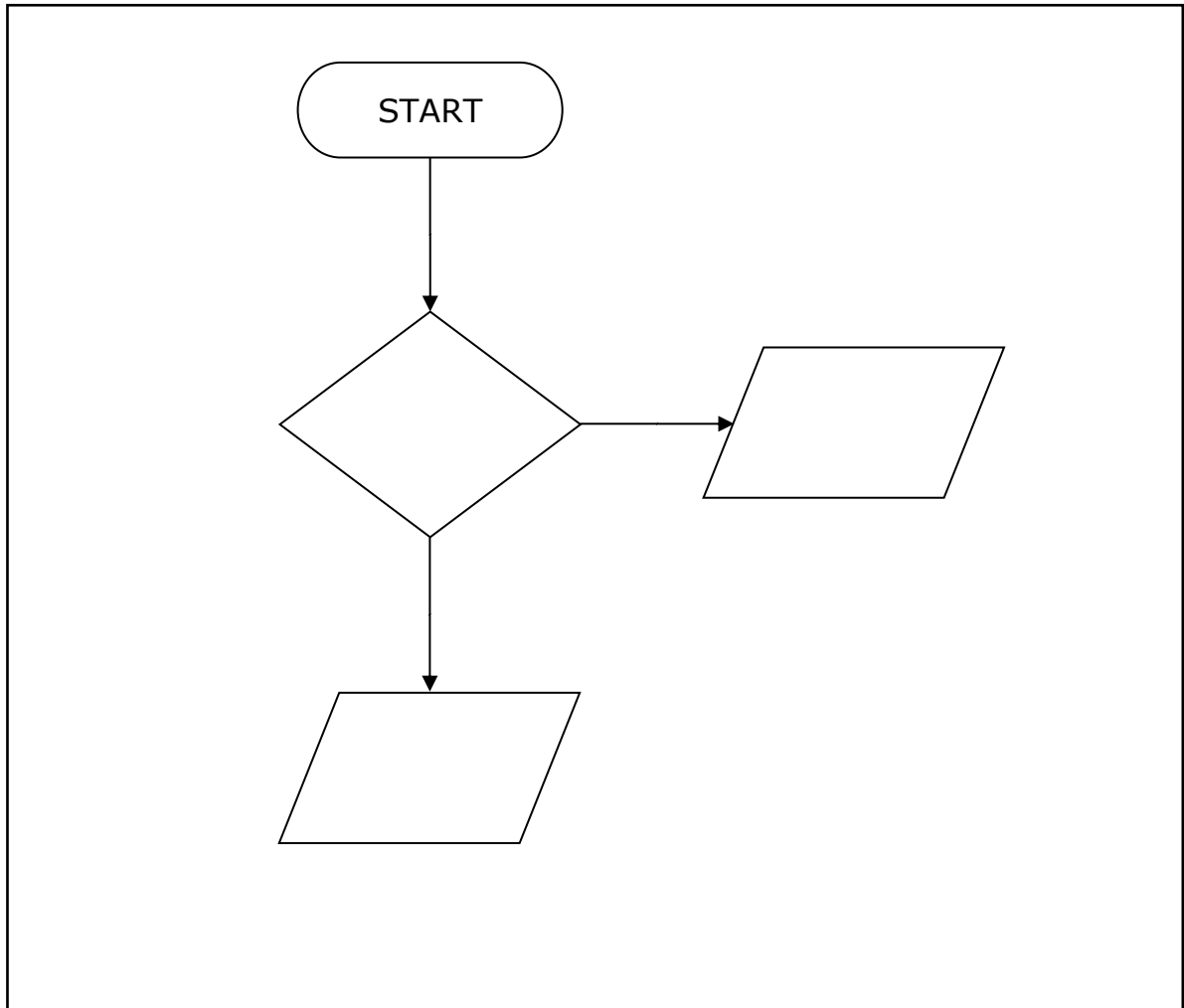
(Total: 13 marks)

16. The weight-lifting machine shown in Figure G includes a security feature which electronically blocks the machine if a trainer is not sitting on the seat. This feature is controlled via a microcontroller.

a. State **ONE** advantage of using microcontrollers.

_____ (1)

b. Assume that there is a switch under the seat which is connected to pin C.3 of the microcontroller and the locking mechanism of the weight-lifting machine is connected to pin C.2. In the space provided below, complete the flowchart to write a program which allows the locking mechanism to go OFF when the switch is pressed.



(4)

(Total: 5 marks)