FORM 5 DESIGN & TECHNOLOGY TIME: 1h 45min

Name: ____________________________ Form: _______ Set: ________

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Note to student: --------------------------

You are required to answer all questions.

Useful Formulae:

Gear Ratio = Speed of Input : Speed of Output

\[ V_t = V_1 + V_2 + \ldots \quad P = I \times V \]

FOR TEACHERS' USE ONLY

<table>
<thead>
<tr>
<th>Areas corrected</th>
<th>Marks for Written Exam</th>
<th>Marks for Design Folio</th>
<th>TOTAL</th>
<th>FINAL MARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>RM</td>
<td>E</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>Max. Marks</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Student’s mark</td>
<td></td>
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</tbody>
</table>

Enter student’s mark obtained in every area of study in the above table.
D for Design, RM for Resistant Materials, E for Electronics, T for Textiles and F for Food
SECTION A: DESIGN

IMPORTANT: FIRST READ THE FOLLOWING SITUATION CAREFULLY.

<table>
<thead>
<tr>
<th>SITUATION</th>
</tr>
</thead>
</table>

Your local council intends to organise a day dedicated to your village. During this day the council wishes to provide various items to the vendors and participants. You are asked to take part in the design of ONE product from the following list:

- TEXTILES BANNERS TO BE HUNG AT VARIOUS PLACES AROUND THE VILLAGE.
- A TRADITIONAL LOCAL DISH WITH A TWIST TO BE SOLD FROM STALLS.
- RESISTANT MATERIAL MEMENTOS TO BE DISTRIBUTED DURING THIS DAY.
- AN ELECTRONIC LIGHTENING DISPLAY THEMED WITH THE VILLAGE COAT OF ARMS TO BE PLACED IN THE VILLAGE MAIN SQUARE.

Underline your choice before answering questions 1 to 7.

1. According to your choice, write a design brief and underline TWO keywords.

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

2 marks + (½ mark × 2) = 3 marks

2. Name the most suitable method of production for making the product you intend to design. Give ONE reason for your answer.

<table>
<thead>
<tr>
<th>METHOD OF PRODUCTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>REASON:</td>
</tr>
</tbody>
</table>

1 mark × 2 = 2 marks

3. In the space provided list TWO research items you would expect the designer to find information about.

___________________________________________________________________________
___________________________________________________________________________

1 mark × 2 = 2 marks
4. Give THREE design specifications that you would consider important for your chosen product.

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

1 mark \times 3 = 3 \text{ marks}

5. Sketch ONE idea for your chosen product. Add notes and enhance your sketches with colour.

6. After choosing the most suitable idea, what is the next step in the Design Process?

_________________________________________________________________________

1 mark

7. The last stage of the design process is Testing and Evaluation. Mention THREE questions that you may ask during this stage.

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

1 mark \times 3 = 3 \text{ marks}
A company is considering environmental issues for designing a new garden cultivator. **Figure A** shows the present design of the cultivator which uses fossil fuel to operate a small engine, while **Figure B** shows the new proposed design which uses solar energy to operate a powerful d.c. motor.

![Figure A: Present cultivator](image1)

![Figure B: New proposed cultivator](image2)

8. The new cultivator needs to have a lighter weight than the current design because of the additional weight of the solar panels. However, parts must maintain their strength and resist to outdoor conditions. Choose the most suitable material for each of the following parts by underlining the correct answer from the brackets.

   a. cultivator’s hollow frame structure: ( white deal / aluminium alloy / oak / cast iron )
   
   b. casing for control unit: ( high-density polythene / heat-treated steel / plywood / MDF )
   
   c. safety guard sheet: ( acrylic / plywood / aluminium alloy / cast iron )
   
   d. rotating blades: ( cast iron / oak / heat-treated steel / acrylic )

   **1 mark × 4 = 4 marks**

9. The structure is made from a square hollow section, whereas the safety guard is made of sheet material. Explain, through labelled sketches, how the guard can be joined to the frame structure. Remember that the joint has to withstand vibrations.

   **3 marks**
10. The output force and motion of the motor is transferred to the shaft of the blades by means of gears and pulleys as shown in Figure C.

![Diagram of Cultivator's mechanism](image.png)

**Figure C: Cultivator's mechanism**

a. The gear mechanism consists of two meshing gears which reduce the speed of the motor. The shaft of the motor rotates at 300 r.p.m., but the blades of the cultivator are needed to rotate at 60 r.p.m. Assuming that there is no change in speed from the pulley and belt mechanism, find the gear ratio of the meshing gears.

3 marks

b. If the input gear has 20 teeth, calculate the number of teeth of the output gear.

2 marks

c. Explain the effect that this gear mechanism has on rotational force.

1 mark

d. In the space below, draw a labelled diagram of the pulley and belt mechanism, assuming no change in speed and direction of motion.

2 marks
e. Give ONE reason why the pulley and belt mechanism was introduced in the transmission system even if it has no effect on the speed.
________________________________________________________________________
________________________________________________________________________

2 marks

11. Consider these manufacturing processes:
■ casting ■ injection moulding ■ bending ■ facing ■ extrusion
Using the above list, suggest the manufacturing process which the following parts went through:

a. the square hollow section of the frame structure: __________________________

b. the handles: __________________________

c. the safety guard: __________________________

1 mark × 3 = 3 marks

SECTION C: ELECTRONICS

12. Figure D shows a group of photovoltaic cells used to form the required solar panel to power the cultivator’s motor.

a. Give TWO advantages of using solar cells over other methods used to power up electronic devices.
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
½ mark × 2 = 1 mark

b. Complete the table below by indicating whether these statements are TRUE or FALSE.

<table>
<thead>
<tr>
<th>Statement</th>
<th>TRUE/FALSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Solar cells are cheaper to buy compared to primary batteries.</td>
<td></td>
</tr>
<tr>
<td>ii. The output from a solar cell is d.c.</td>
<td></td>
</tr>
<tr>
<td>iii. Solar cells convert heat energy to electrical energy.</td>
<td></td>
</tr>
</tbody>
</table>

1 mark × 3 = 3 marks
13. **Figure E** shows the six groups of photovoltaic cells forming the solar panel used to power the cultivator’s motor together with its unconnected circuit.

![Solar Cell Diagram](image)

**Figure E: Cultivator’s motor circuit**

a. On **Figure E** show how to connect:
   1. the six groups of solar cells in series
   2. the cells connected in series with SW1, D1 and M1 to complete a closed circuit.
   1 mark × 2 = 2 marks

b. If the output of each group of solar cells is 6V, calculate the total voltage for all the cells connected in series.

   1 mark

   1 mark

c. Calculate the total power generated by the six groups of solar cells connected in series. Assume total current through all six group of cells connected in series is 50mA.

   1 mark

d. Component D1 shown in **Figure E** is used to control the flow of current in one direction, hence controlling the motor to turn in only one direction.

   i. Name component D1. ________________________________  

   1 mark
ii. In the space provided below, draw the physical appearance of D1 and label its ANODE and CATHODE.

1 mark

e. The company producing the electronic circuit for the cultivator, decided to design the circuit on a PCB. What does PCB refer to?

_______________________________________________

1 mark

14.

Figure F shows the handles of the cultivator from which the user controls its movement. The designers attached a lever to each handle to satisfy the following safety specification:

*The cultivator’s motor must only rotate when BOTH switch levers are simultaneously pressed, while if only one lever is released the motor will automatically turn off.*

During research the designers found two types of switches: a latched type switch and a non-latched type switch.

a. Which of the two types of switches better meets the specification above? Give ONE reason for you answer.
   TYPE OF SWITCH: _______________________________________________________
   REASON:  ____________________________________
   _______________________________________________________________________

1 mark × 2 = 2 marks

b. SPST lever type micro switches were a possible solution to be used for this design. What does SPST refer to? ____________________________

1 mark
c. In the space provided below explain how a digital multimeter (DMM) is used to check the function of an SPST switch. Use diagrams to explain your answer.

1 mark

15. **Figure G** shows the block diagram for the electronic design used for the cultivator’s control system.

![Figure G: Cultivator’s control system](image)

**a.** On the block diagram of **Figure G**, draw lines and label the INPUT, PROCESS and OUTPUT sections.  
**1 mark**

**b. i.** Name the logic gate needed to satisfy the safety specification stated in question 14.  
_____________________________  
**1 mark**

**ii.** In the box provided on **Figure H**, draw the symbol of this logic gate.  
**1 mark**

![Figure H: Cultivator’s electronic circuit](image)
c. Complete the electronic circuit design on Figure H to show how:
   i. the two switches are connected to the logic gate
   ii. the logic gate is connected to the Darlington amplifier circuit
   iii. the motor is connected to the Darlington amplifier circuit ½ mark × 4 = 2 marks

SECTION E: TEXTILES

16. Note that questions in this area are related to the same garden cultivator mentioned in previous areas.

a. Give TWO reasons why fabrics are commonly used to produce a cover for a garden cultivator.

________________________________________________________________________

1 mark x 2 = 2 marks

b. State TWO main properties that the chosen fabric should have to satisfy the purpose of the cover.

________________________________________________________________________

1 mark x 2 = 2 marks

17. Give TWO reasons why it may be necessary to neaten the edge of a seam allowance in the cover.

________________________________________________________________________

2 marks x 2 = 4 marks

18. Explain TWO points that must be considered when cutting pattern pieces from fabric to manufacture the cover.

________________________________________________________________________

2 marks x 2 = 4 marks

19. Fastenings on a product are important for the application and proper use of a cover.
   a. Name TWO types of fasteners which may be used on the cover.

________________________________________________________________________

2 marks x 2 = 4 marks

   b. Give ONE advantage for your choice.

________________________________________________________________________

2 marks
c. In the space provided draw an annotated diagram of the fastener used on the cover.

SECTION D: FOOD

20. You are doing voluntary work in the kitchen of an elderly people’s home. People over the age of 65 are at a higher risk of food poisoning. Special care should be taken when preparing meals and snacks for this group of people.

a. State THREE precautions you would take to lower or eliminate this risk.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

1 mark x 3 = 3 marks

b. What is meant by high risk food?

__________________________________________________________________________

1 mark

c. Where should high risk food be stored?

__________________________________________________________________________

½ mark

d. At what temperature should high risk food be stored?

__________________________________________________________________________

½ mark

e. Mention TWO things that bacteria need to reproduce.

_________________________________________ ______________________________

1 mark x 2 = 2 marks

21. As most of the residents in this home have different health conditions some recipes have to be modified and ingredients are replaced by alternative healthy ones.

a. Suggest healthier alternatives you would use instead of:
Salt : ___________________________
Mayonnaise: ______________________________________________________________
Sugar: ________________________________________________________________
Cream: ________________________________________________________________

1 mark x 4 = 4 marks

b. Which method of cooking would you use to prepare the following food. Give a reason why this method was chosen.

<table>
<thead>
<tr>
<th>Food</th>
<th>Method of cooking</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef burgers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 mark x 4 = 4 marks

c. As people get older they may find difficulties in coping with certain food but eating well helps them to maintain a positive outlook and reduce the risk of diseases.

i. In the diagram below draw and name food items you would prepare for people in this age group indicating the main nutrients in the chosen food.

![Diagram of a plate with food items]

Plate

4 marks

ii. Use TWO sensory descriptors to describe the characteristics of the chosen food.

________________________________________  ______________________________

½ mark x 2 = 1 mark