OCR
Oxford Cambridge and RSA

Monday 20 June 2022 – Morning

A Level in Design and Technology: Design Engineering

H404/02 Problem Solving in Design Engineering

Time allowed: 1 hour 45 minutes

You must have:
- the Resource Booklet

You can use:
- a ruler (cm/mm)
- a scientific calculator
- geometrical instruments

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. You can use extra paper if you need to, but you must clearly show your candidate number, the centre number and the question numbers.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- Each question tells you which part of the Resource Booklet to refer to.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **16** pages.

ADVICE
- Read each question carefully before you start your answer.

Answer **all** the questions.

1* Stand-up paddle boarding (SUP) has become popular in recent years with a rapid growth in the number of people trying out the sport, leading to an increase in sales of stand-up paddle boards.

The market now boasts a large selection of stand-up paddle boards with prices ranging from a few hundred pounds to thousands of pounds.

Critically examine the factors that a company looking to develop a new stand-up paddle board would need to consider, making specific reference to the different stakeholders affected.

Refer to information on **page 2** and **page 3** of the Resource Booklet. **[14]**

2 Selecting the correct paddle for riding a stand-up paddle board is vital for an efficient paddling action and to reduce the strain on the user's back.

Use the information on **page 4** and **page 5** of the Resource Booklet to identify the design features and relevant data which a design engineer would need to consider when designing a successful paddle for the SUP market.

Your response **must** refer to ergonomic and anthropometric requirements as well as the use of materials in the paddle construction. You may use annotated sketches to explain your response.

[14]

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Space for annotated sketches

3 **(a)** Stand-up paddle boards are made in different sizes to suit the weight of the user and the load they wish to carry. The Resource Booklet contains data for five stand-up paddle boards.

A user has a mass of 80 kg and they will also carry a backpack of mass 12 kg and a paddle of mass 3 kg. They will use the stand-up paddle board in the sea.

Determine by calculation the most suitable stand-up paddle board for this user, ignoring the weight of the paddle board.

Refer to **Fig. 7** and the information on **page 6** of the Resource Booklet. **[6]**

Most suitable stand-up paddle board .....

(b) The NW20 air pump, described on **page 7** of the Resource Booklet, has been specifically designed to inflate a stand-up paddle board and is run from a 12 V car battery.

The NW20 air pump is being used to inflate Board-16 to the pressure shown in **Fig. 7** on **page 6** of the Resource booklet.

(i) Using **Fig. 9** as the basis for your calculations, estimate the time taken for the NW20 air pump to inflate Board-16 to the required pressure. Give your answer in seconds (s) and show your working.

You will need to use the information on **page 6** and **page 7** of the Resource Booklet. **[3]**

Time taken ..... s

(ii) Use your answer from **part (b)(i)** and the information on **page 7** of the Resource Booklet to calculate the electrical energy used by the NW20 air pump to fill Board-16 to the required pressure. Give your answer in joules (J) to **0** decimal places and show your working. **[3]**

Electrical energy used ..... J

4 A start-up company wishes to develop an electronic Paddle Board (PB) Speedometer which gives an indication to the user of the speed that the stand-up paddle board is travelling through the water. Information for the proposed product is given on **page 8** of the Resource Booklet.

The design engineers have been instructed to solve the following two issues to help with the development of the PB Speedometer.

Issue 1:

To measure the speed that the stand-up travel board travels through the water, a suitable sensor needs to be designed. This sensor must be able to be firmly attached to an inflated stand-up paddle board but must be removable when the stand-up paddle board is deflated and packed away. The electronic output signal from the sensor will be processed by a microcontroller.

An electronic sensor is required which can be attached to an inflated stand-up paddle board and removed when the stand-up paddle board is packed away.

Issue 2:

The signal from the sensor will be processed by a GENIE-14 microcontroller and the speed of the stand-up paddle board will be displayed to the user on a 5-LED bar graph display. Details of the GENIE-14 microcontroller and the bar graph display are shown on **page 8** of the Resource Booklet.

A circuit diagram and a program flowchart are required to enable the PB Speedometer system to function as described. The circuit diagram must show how the sensor and the five LEDs are connected to the microcontroller. The program flowchart should indicate how increasing speed causes more LEDs to light.

Use sketches and/or notes to determine suitable technical solutions that overcome the **two** issues identified. Refer to information on **page 8** of the Resource Booklet.

[16]

Issue 1

Issue 2

5* As a new company, the developer of the PB Speedometer will require investment for further development and for getting the product onto the market.

Explain how **enterprise** can help drive the development of a new product such as the PB Speedometer. Your answer **must** make use of examples from your own studies. **[14]**

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END OF QUESTION PAPER

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