OCR
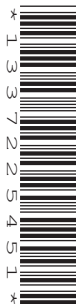## Oxford Cambridge and RSA

Wednesday 12 June 2024 – 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.
• Use the Resource Booklet to 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 use.

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.

Turn over

Read the **Resource Booklet** before you answer the questions.

1 Since the 5th century BC there has been evidence of play equipment used for the enjoyment of children. Whilst the basic concept has remained the same the technologies and legislation behind this equipment have changed significantly.

A manufacturing company wishing to enter the play area market would need to explore relevant legislation and design standards.

Critically examine the benefits of exploring legislation and associated design standards when entering a new market such as the play area market.

In your answer you **must** consider the benefits to:

- a manufacturing company
- any other relevant stakeholders.

Refer to information on **pages 2 and 3** of the Resource Booklet. **[12]**

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2* **Page 4** in the Resource Booklet contains a case study for a series of play areas which were proposed for Cotton Mill Park.

When designing the play equipment for Cotton Mill Park, **designing for manufacture (DFM)** played a key role.

With specific reference to the Cotton Mill Park case study, discuss the considerations a Design Engineer would have to make in relation to DFM.

Refer to information on **page 4** of the Resource Booklet. **[14]**

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Turn over

3

(a) The designers of Cotton Mill Park have developed a design for a single swing. The design is shown on **Page 5** of the Resource Booklet.

The swing requires two ropes. The designers would like to use rope made from recycled polymer bottles.

A specification for the proposed rope is shown on **page 5** of the Resource Booklet.

(i) Calculate the cross-sectional area of the rope. Give your answer in m² to **3** significant figures. Show your working.

Use the formula: cross-sectional area = $\frac{\pi d^2}{4}$

Refer to information on **page 5** in the Resource Booklet, specifically **Fig. 6**. **[2]**

Cross-sectional area of the rope ....m²

(ii) A child with a mass of 78 kg sits on the swing seat, without swinging.

Determine by calculation that the stress in **one** of the swing ropes is 3.39 MPa. Show your working.

You **must** use your answer from part **(a)(i)** and the following information:

1 MPa = 1 × 10⁶ N/m²
Gravitational field strength = 9.81 N/kg
stress = force/cross-sectional area **[4]**

(iii) Calculate the extension of a swing rope caused by a stress of 3.39 MPa. Give your answer in mm to **1** decimal place. Show your working.

Refer to the information on **page 5** of the Resource Booklet, specifically **Fig. 5** and **Fig. 6**.   **[3]**

Extension of a swing rope .... mm

(b) The manufacturer wants to add decorative panels to one of the play areas.

The design of one of the decorative panels is shown on **page 6** of the Resource Booklet.

The panels will be cut from 12 mm thick aluminium using a MolsCat CNC plasma cutter.

The specification for the plasma cutter is given on **page 6** of the Resource Booklet.

Calculate the time it would take for the MolsCat CNC plasma cutter to cut out one of the decorative panels. In your calculation include the cutting of the perimeter of the panel and the cutting of the inlay section. Give your answer in minutes and show your working.

The inlay path length is 1260 mm.

Refer to information on **page 6** of the Resource Booklet, specifically **Fig. 7** and **Fig. 8**.   **[3]**

Time ....minutes

Turn over

4 Most new play area developments are surrounded by a perimeter fence to keep children safe and to stop dogs from entering the area.

The county recreation department for the Cotton Mill Park development would also like the fence to function as a deterrent to people using the equipment during the hours of darkness. It is hoped this will minimise possible antisocial behaviour.

A decision has been made to use the MB400 play area gate, details of which are given on **page 7** of the Resource Booklet. Designers are asked to modify the MB400 play area gate so that it locks during the hours of darkness.

The design engineers have two issues that need to be overcome:

Issue 1

It is required that the MB400 play area gate locks when the light level falls to 10 lux and unlocks again the following morning when the light level rises to 100 lux. A decision has been made to use the NSL-19M51 light dependent resistor to sense the light level and a LA080Z linear solenoid to operate the lock mechanism. Data for both components is given on **page 7** of the Resource Booklet.

An electronic system is required that will activate the solenoid during the hours of darkness. The system should run off 12 volts.

Issue 2

The developers have discovered that the movement of the LA080Z linear solenoid is not enough to move the bolt to lock the play area gate. The bolt needs to move through a distance of 24 mm.

A mechanical system is required which will amplify the output motion of the linear solenoid to the required amount to lock the play area gate.
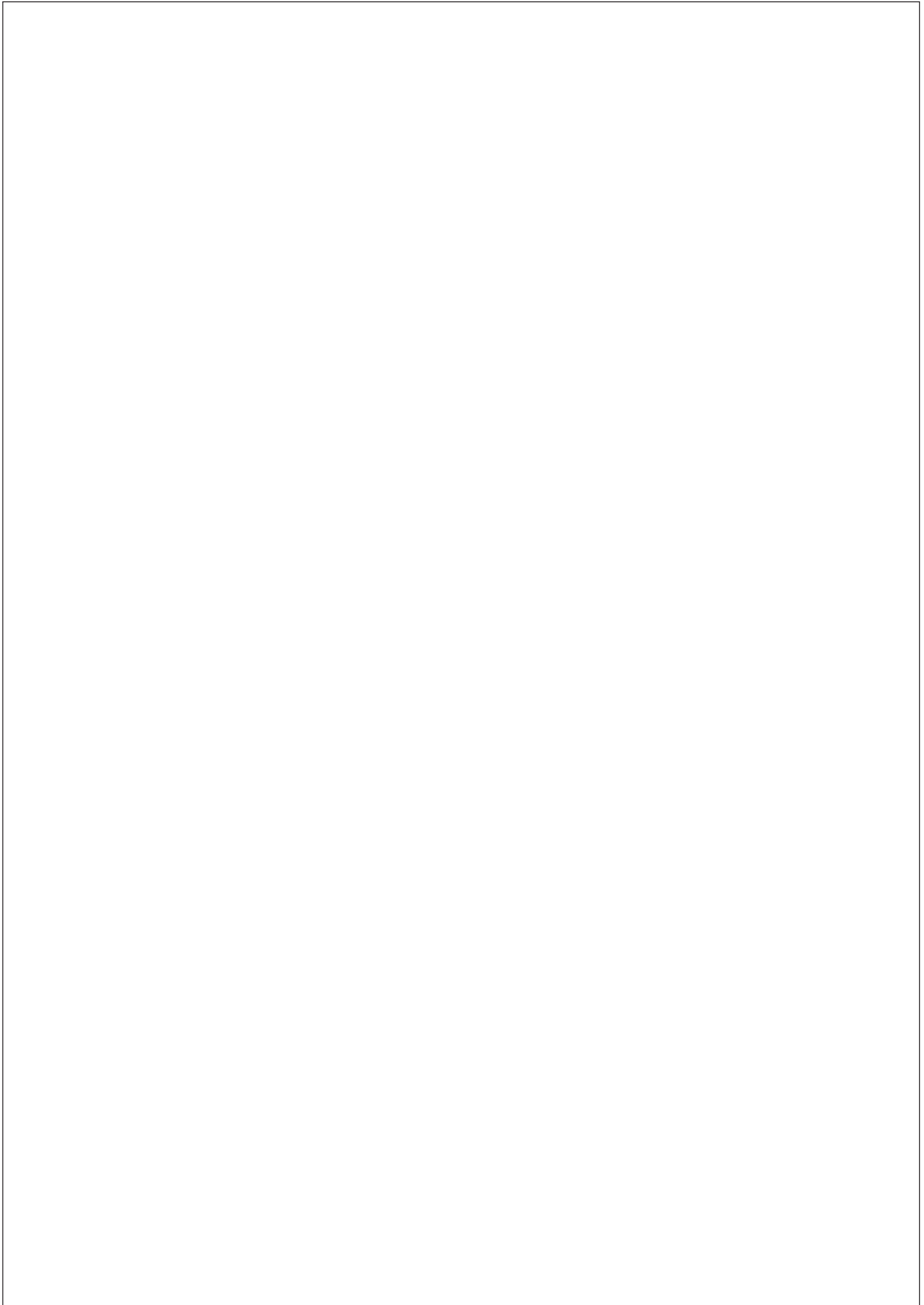
Use annotated sketches and/or notes to determine suitable technical solutions that overcome the **two** issues identified.

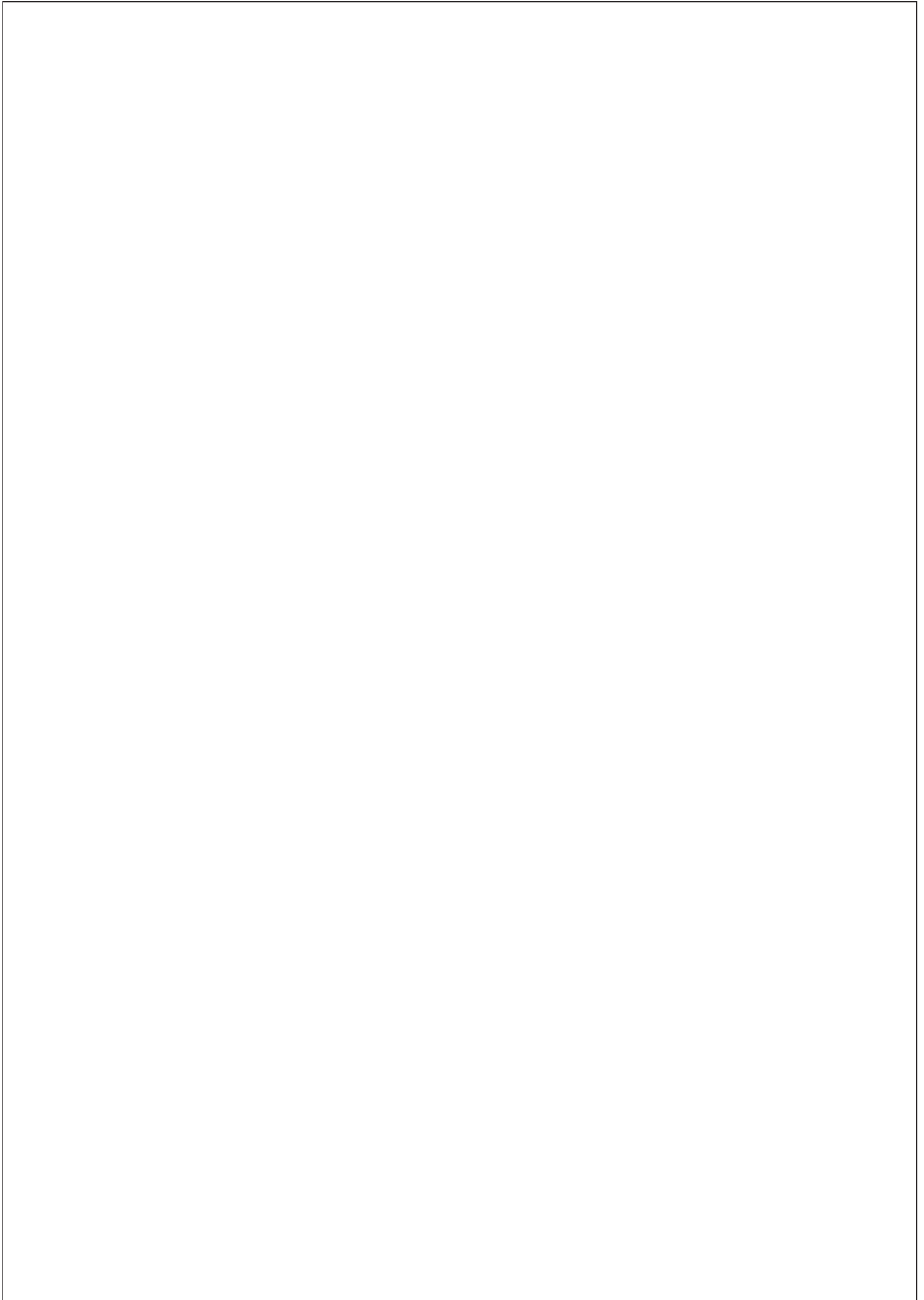Refer to information on **page 7** of the Resource Booklet. **[16]**

Issue 1:

Issue 2:

Issue 2:

Turn over

5* Developers and local residents are keen for new children's outdoor public play areas to be built from sustainable materials.

Discuss the sustainability issues relating to materials choice when developing new children's outdoor public play areas.

In your answer you **must** consider:

- recycling considerations
- up-cycling possibilities
- material availability
- cost implications.

Refer to information on **page 8** of the Resource Booklet and also information from your own studies or experience. **[16]**

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END OF QUESTION PAPER

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