OCR
Oxford Cambridge and RSA

A Level in Design and Technology: Design Engineering

H404/02 Problem Solving in Design Engineering

Practice Paper – Set 1

Time allowed: 1 hour 45 minutes

You must have:
- Resource Booklet

You may use:
- a scientific calculator
- a ruler
- pencils/pens
- geometric instruments

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. HB Pencil may be used for diagrams and graphs only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- The recommended reading time for the Resource Booklet is **35 minutes**.
- Write your answer to each question in the space provided. Additional paper may be used if necessary, but you must clearly show your candidate number, centre number and question number(s).
- Where appropriate, your answers should be supported by workings. Marks may be given for the correct method even if the answer is incorrect.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an (*).
- This document consists of **12** pages.

Answer **all** the questions.

Before responding to the questions in this paper you must spend time reading and familiarising yourself with the Resource Booklet.

1* Every year, thousands of people across the world are born without limbs, or lose a limb through accidents. In any society this can be life changing but in the developing world it can have devastating effects across the community.

Charities are looking into the effects of supplying these developing communities with the ability to produce 3D-printed prosthetic limbs to improve the quality of life of those affected.

Critically examine the **social**, **moral** and **ethical** considerations of developing countries being given access to the use of 3D printing for the production of prosthetic limbs for those affected in their communities.

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

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[14]

2 **Page 2** of the Resource Booklet explains how a prosthetic specialist produces a positive model of a patient's affected limb. This positive model is then used to create the socket of the prosthetic leg shown in **Fig. 1** of the Resource Booklet.

Other than 3D printing, explain using sketches and/or notes a suitable manufacturing process which could be used to make the upper limb socket for an individual as shown in **Fig. 1** of the Resource Booklet.

In your response you must include:

- technical details of methods of manufacture;
- appropriate materials and their properties;
- manufacturing processes to appropriately finish the socket.

[14]

3 Engineers have been working on a 3D-printed prosthetic arm which is easy to manufacture and simple to use. The design is shown in **Fig. 4** of the Resource Booklet. It has a loose elbow joint which is held at a fixed 90° angle by a tie attached between the upper arm and the forearm. **Fig. 5** shows a force diagram for the 3D-printed prosthetic arm.

(a) Calculate the angle C in **Fig. 5** formed between the tie and the forearm. Show your working.

C ..... °

[3]

(b) Calculate the length of the tie in **Fig. 5** to the nearest mm. Show your working.

Length of tie ..... mm

[3]

(c) **Fig. 5** of the Resource Booklet shows a force diagram for the 3D-printed prosthetic arm.

Using the product information from **Fig. 6** in the Resource Booklet, calculate the tensile force (F) in the tie when the maximum recommended load is being held in the hand.

You will find it useful to consider the moments acting about the elbow joint. Show your working.

Gravitational field strength g = 9.81 N kg^{-1}

Tensile force (F) in tie ..... N

[6]

4 The design engineers have been challenged to further develop the Endo-wrist described on **page 5** of the Resource Booklet. They have identified that the current movement of the Endo-wrist does not sufficiently fulfil the movements of a surgeon's hand and wrist, specifically when the Endo-wrist is being used with a forceps attachment as shown in **Fig. 10** of the Resource Booklet.

Use sketches and/or notes to determine suitable technical solutions that overcome the following problems identified by the design engineers:

Problem 1: Opening and closing of forceps using the existing linear actuator.

Problem 2: Rotation of forceps.

In your response you must include details that demonstrate:

- appropriate mechanical function;
- appropriate electronic control systems;
- materials and components to be used.

[14]

5* Advancements in medical technology are one of the pioneering areas of design engineering.

Critically evaluate how technological advancements have assisted design engineers in the design and development of products to progress medical science.

You may refer to any of the products outlined in the Resource Booklet and also other products with which you are familiar.

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[16]

END OF QUESTION PAPER

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