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**Design technology**  
**Higher level and standard level**  
**Paper 2**

Wednesday 10 November 2021 (afternoon)

Candidate session number

1 hour 30 minutes

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**Instructions to candidates**

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer one question.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.



### Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

- 1. Forceps are tools used for grasping or holding objects. Most forceps have mechanisms consisting of multiple parts, see **Figure 1**.

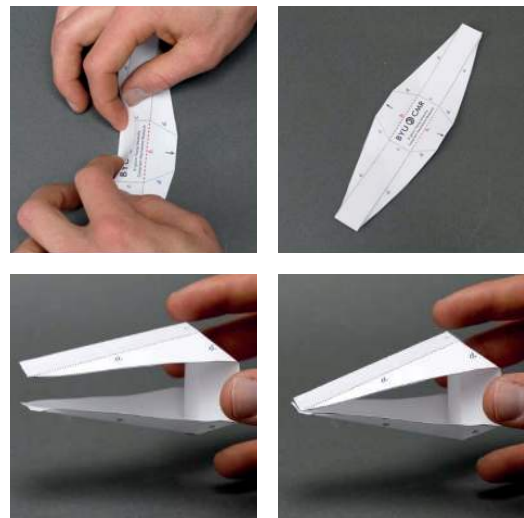
Some designers have developed alternative mechanisms for forceps that rely on the elasticity of the material for the transfer of force, movement or energy. These are often produced as one part.

“Oriceps” are forceps inspired by origami (the Japanese art of paper folding), see **Figure 2** and **Figure 3**.

**Figure 1: Forceps designed using a traditional mechanism that has multiple parts**



**Figure 2: “Oriceps” use an origami-inspired design**



**Figure 3: “Oriceps” in use**

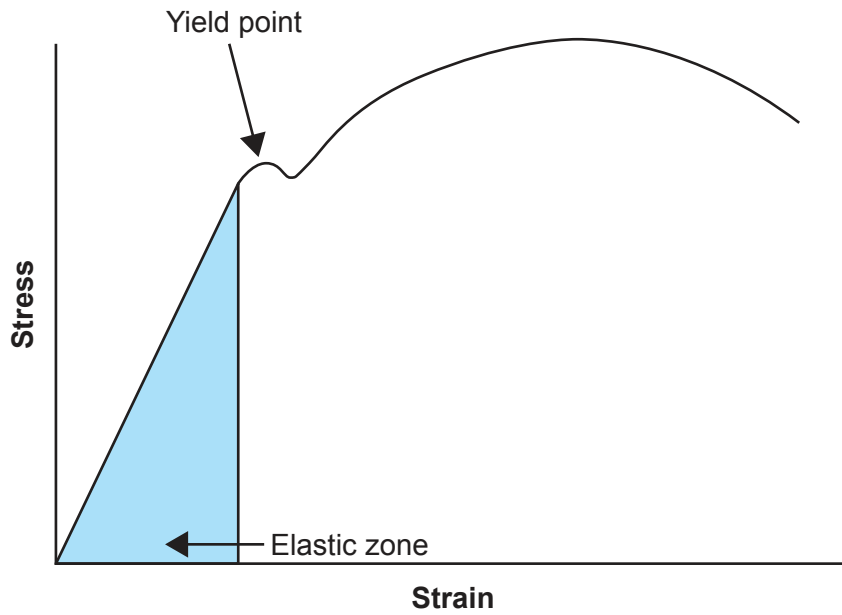


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(Question 1 continued)

Figure 4: An example of a stress / strain graph



(a) (i) Define *elasticity*. [1]

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(ii) **Figure 4** shows an example of a stress / strain graph.  
Describe what happens when the stress on a material causes it to exceed its yield point. [2]

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24EP03

Turn over

**(Question 1 continued)**

- (b) (i) Describe how biomechanical data would have been used in the development of the forceps in **Figure 1**.

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- (ii) Outline **one** way how products that are produced as a single part can reduce manufacturing costs.

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- (c) (i) Outline how design for disassembly can help extend the lifespan of products with multiple parts.

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**(Question 1 continued)**

- (ii) Explain how finite element analysis (FEA) can be used to test products with multiple parts.

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24EP05

**Turn over**

**(Question 1 continued)**

Designed by George Nelson in 1958, the Nelson Swag Leg Desk is named after “swaging”, a manufacturing process that allowed the legs to be curved easily. The lightweight desk features walnut sides, four coloured hardwood dividers, laminate surface and legs shaped from chrome steel tubes, see **Figure 5**.

The desk is designed to be flat-packed and assembled by the consumer.

**Figure 5: The Nelson Swag Leg Desk**



- (d) (i) State **one** possible joining method used to attach the legs to the other parts of the desk.

[1]

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**(This question continues on the following page)**



24EP06

**(Question 1 continued)**

- (ii) Outline the percentile range used to calculate the reach from the front of the desk to the coloured dividers. [2]

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- (e) (i) Outline **one** reason why the Nelson Swag Leg Desk achieved classic design status. [2]

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- (ii) Suggest **one** reason why the depletion of hardwood reserves may have political implications. [3]

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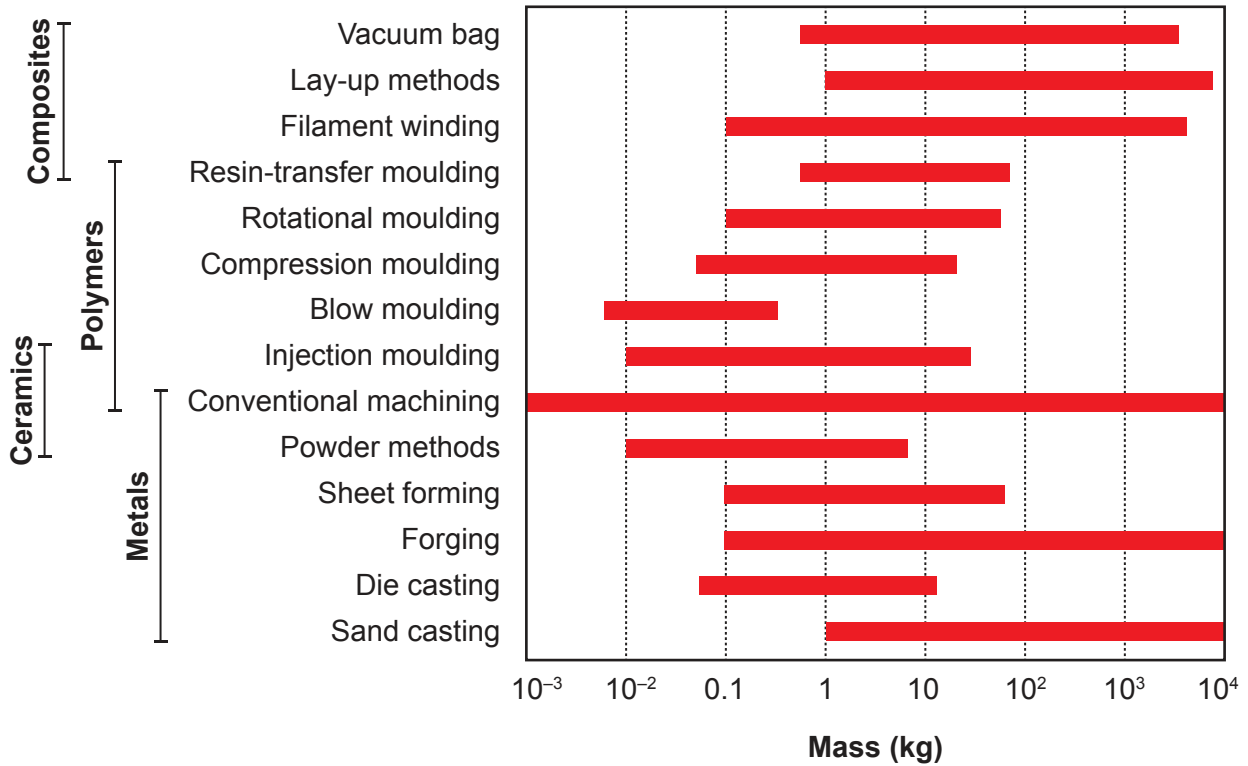
24EP07

Turn over



- 2. To select suitable manufacturing processes for products, designers use process selection charts such as the one shown in **Figure 6**.

**Figure 6: Process selection chart**



- (a) List **two** materials in **Figure 6** that can be shaped using resin-transfer moulding. [2]

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- (b) List **two** suitable processes in **Figure 6** for a ceramic component with a mass of 10 kg. [2]

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3. Explain how the molecular structure of thermoplastics is affected by heat.

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4. The choice of production systems can be based on criteria such as time, cost and impact on the environment.

Explain **one** reason why designers would consider impact on the environment as a criterion for selecting manufacturing processes.

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24EP09

Turn over

Please **do not** write on this page.

Answers written on this page  
will not be marked.



24EP10

### Section B

Answer **one** question. Answers must be written within the answer boxes provided.

- 5. The Aria asthma inhaler was designed to address the disposable nature of the existing asthma inhaler, see **Figure 7**. Once the canister runs out it is thrown away.

The design team developed four refillable inhalers. Each targets a different audience; Aria Youth, Aria Contemporary, Aria Sport and Aria Heritage, see **Figure 8** and **Figure 9**.

The Aria asthma inhaler is supported by a smartphone app which offers information on weather and air quality, as well as giving personalised recommendations based on an individual's use, see **Figure 10**.

**Figure 7: Existing inhaler with disposable cartridge**



**Figure 8: Four versions of the Aria asthma inhaler**



**Figure 9: The Aria asthma inhaler in use**



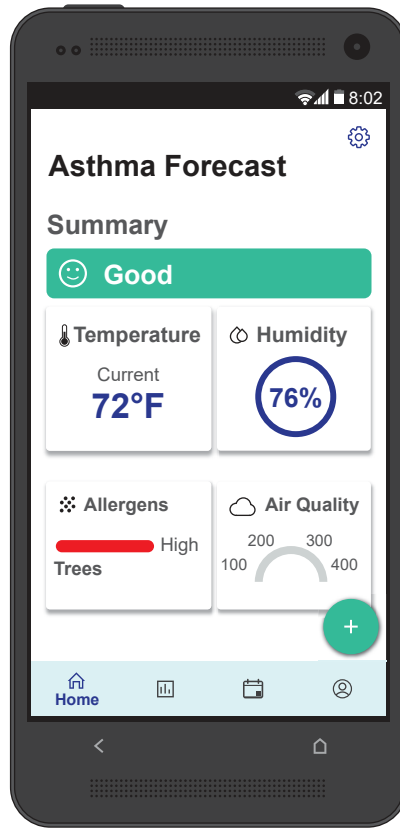
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Turn over

(Question 5 continued)

Figure 10: The Aria smartphone app



- (a) Outline how data modelling could have been used in the development of the Aria smartphone app in **Figure 10**.

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24EP12

**(Question 5 continued)**

(b) Explain **one** way how disposable products can have a negative impact on the environment.

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24EP13

**Turn over**

**(Question 5 continued)**

(c) Explain **two** ways how the design team have addressed the problem of disposability through the design of the Aria asthma inhaler.

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24EP14

**(Question 5 continued)**

- (d) Rogers' characteristics of innovation impact on the rate of consumer adoption of an innovation.

Explain the role of relative advantage, compatibility **and** observability on the rate of adoption of the Aria asthma inhaler.

[9]

A large rectangular area with horizontal dotted lines, intended for writing the answer to the question.



24EP15

Turn over



- 6. The Nano Cellulose Vehicle (NCV) is a concept car made from nano cellulose, a new material that can be made from unused biomass or locally sourced wood, see **Figure 11**. Nano cellulose can be manufactured into parts that are five times as strong as steel, yet one fifth of the weight.

There were a number of drivers (reasons) for the invention of the NCV.

**Figure 11: Nano Cellulose Vehicle (NCV)**



**Figure 12: Interior of the NCV**



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24EP16

**(Question 6 continued)**

- (a) List **two** forms of graphical modelling used by car designers. [2]

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- (b) Explain **one** driver for invention of the NCV in **Figure 11**. [3]

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24EP17

Turn over

**(Question 6 continued)**

(c) A lack of alertness of car users is a major factor in road traffic accidents.

Explain how light **and** sound could be used by designers of the NCV in **Figure 12** to improve the alertness of the user.

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7. The Gramovox<sup>®</sup> bluetooth speaker design is based on gramophones from the 1920s, see **Figure 13**. For the prototype, stereolithography (SLA) was used to 3D print the S-curve horn.

Pavan Bapu the founder of Gramovox<sup>®</sup>, is an entrepreneur and a product champion, see **Figure 14**. He crowdsourced funding for manufacture through Kickstarter and promoted the concept through live online broadcasts and newspaper interviews. He was inspired to develop the Gramovox<sup>®</sup> bluetooth speaker after seeing a 1920s gramophone in a shop window.

**Figure 13: Gramovox<sup>®</sup> bluetooth speaker**



**Figure 14: Pavan Bapu, founder of Gramovox<sup>®</sup>**



- (a) Outline **one** physical property that makes hardwood a suitable choice for the base of the Gramovox<sup>®</sup> bluetooth speaker in **Figure 13**. [2]

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**(Question 7 continued)**

- (b) Explain how retro-styling has been used in the design of the Gramovox® bluetooth speaker.

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24EP21

**Turn over**

**(Question 7 continued)**

- (c) Explain Pavan Bapu’s role as entrepreneur **and** product champion in the success of the Gramovox® bluetooth speaker.

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24EP22





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- Figure 1** AfroBrazilian, 2012. Liston Bone Cutting Forecep curved 01. [image online] Available at: [https://commons.wikimedia.org/wiki/File:Liston\\_Bone\\_Cutting\\_Forcep\\_curved\\_01.jpg](https://commons.wikimedia.org/wiki/File:Liston_Bone_Cutting_Forcep_curved_01.jpg). Attribution-ShareAlike 3.0 Unported (CC BY-SA 3.0) <https://creativecommons.org/licenses/by-sa/3.0/deed.en> [Accessed 10 September 2020].
- Figure 2** BYU\_CMV, 2018. Oriceps: Origami Inspired Foreceps. [image online] Available at: <https://www.thingiverse.com/thing:2988740> [Accessed 10 September 2020].
- Figure 3** BYU\_CMV, 2018. Oriceps: Origami Inspired Foreceps. [image online] Available at: <https://www.thingiverse.com/thing:2988740> [Accessed 10 September 2020].
- Figure 5** Nelson Swag Leg Desk image provided by Herman Miller.
- Figure 7** InspiredImages, 2016. Asthma Ventolin Inhaler. [image online] Available at: <https://pixabay.com/photos/asthmaventolin-breathe-inhaler-1147735/> Pixabay.com [Accessed 10 September 2020].
- Figure 8** [Four design styles of Aria Inhalers] 2019. [image online] Available at: <https://www.trendhunter.com/trends/aria-inhaler> [Accessed 10 September 2020].
- Figure 9** [An Aria Inhaler] 2019. [image online] Available at: <https://www.trendhunter.com/trends/aria-inhaler> [Accessed 10 September 2020].
- Figure 11** Images provided with permission from Ministry of the Environment, Government of Japan.
- Figure 12** Images provided with permission from Ministry of the Environment, Government of Japan.
- Figure 13** Gramovox, 2013. Gramovox Bluetooth Gramophone. [image online] Available at: <https://www.kickstarter.com/projects/gramovox/gramovoxtm-bluetooth-gramophone> [Accessed 10 September 2020].
- Figure 14** Technori, 2015. Pavan Bapu Presents Gramovox. [video online] Available at: <https://www.youtube.com/watch?v=Mp5m8klziA> [Accessed 10 September 2020]. Source adapted.

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