Diploma Programme
Programme du diplôme
Programa del Diploma

Design technology
Higher level and standard level
Paper 2

Wednesday 9 November 2022 (morning)

Candidate session number

1 hour 30 minutes

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]**.

8822 – 6203

21 pages

Section A

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

1. **Figure 1** shows the BIC® Cristal® ballpoint pen created by Marcel Bich in 1950 as an alternative to the fountain pen shown in **Figure 2**. Since 1950 over 100 000 million BIC® ballpoint pens have been sold.

The BIC® Cristal® ballpoint pen is considered a classic design.

Figure 1: The BIC® Cristal® ballpoint pen

Figure 2: A fountain pen and ink

(a) (i) Relative advantage is one of Rogers' characteristics of innovation and consumers.

State **one** relative advantage of the BIC® Cristal® ballpoint pen over the fountain pen. [1]

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(ii) List **two** characteristics of the BIC® Cristal® ballpoint pen that make it a classic design. [2]

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(Question 1 continued)

The BIC 2021 Universal Registration Document in **Figure 3** shows the annual waste produced by BIC factories.

Figure 3: Annual waste produced by BIC factories between 2019 and 2021 (tonnes)

(b) (i) Calculate the total change in waste produced by BIC factories between 2019 and 2021. Show your workings. [2]

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(ii) Outline how BIC might use life cycle analysis (LCA) to help reduce waste. [2]

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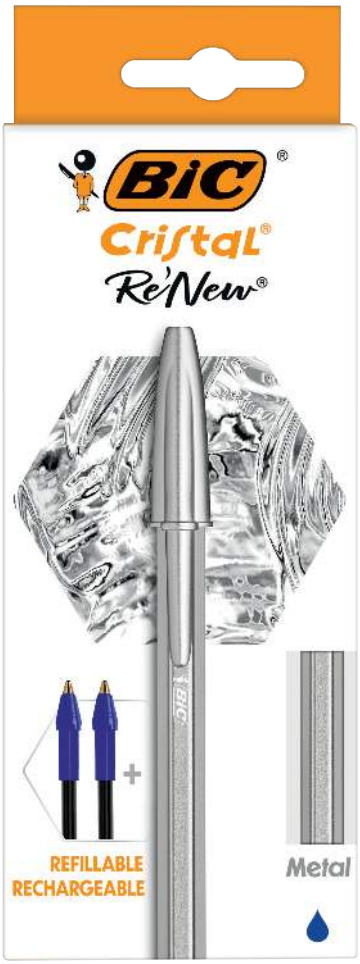
(Question 1 continued)

BIC have released a number of new product versions of the BIC® ballpoint pen since the original BIC® Cristal®. These include the BIC® Cristal® Soft, BIC® 4-Color® pen and the BIC® Cristal® Re'New®, see **Figure 4**, **Figure 5** and **Figure 6**.

Figure 4:
BIC® Cristal® Soft

Figure 5:
BIC® 4-Color® pen

Figure 6:
BIC® Cristal® Re'New®



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(Question 1 continued)

(c) (i) Outline **one** way that BIC may have used psychological factor data in the design of the BIC® Cristal® Soft in **Figure 4**. [2]

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(ii) The key stages of the product life cycle are launch, growth, maturity and decline.

Explain how product versioning can help extend the life cycle of a product. [3]

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(Question 1 continued)

Zarpens is a Taiwanese pen manufacturer. Zarpens have brought to market a range of pens that feature a fountain pen nib, see **Figure 7**.

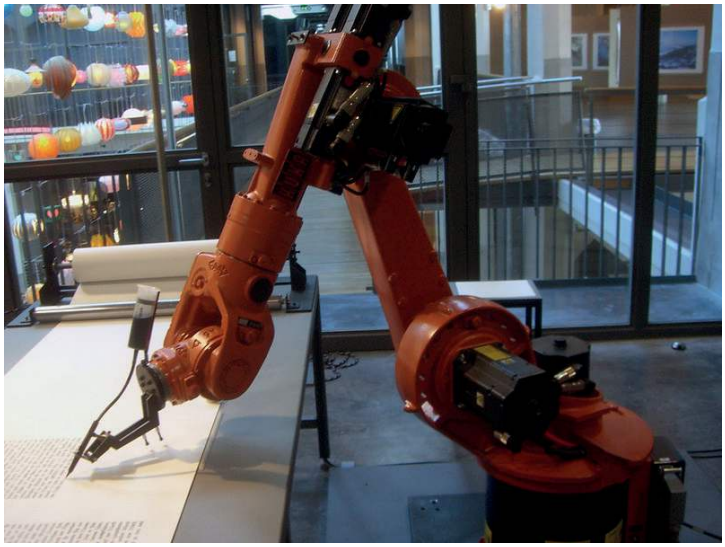
These pens have a mechanism to allow the barrel of the pen to be refilled with ink. **Figure 8** shows how the pen is refilled.

The Zarpens fountain pens are assembled by multitask robots, see **Figure 9**.

Figure 7: A Zarpens fountain pen

Figure 8: Refilling the pen

Figure 9: Multitask robots used for the assembly of the pen



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(Question 1 continued)

(d) (i) State the production system used by Zarpens. [1]

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(ii) Outline why multitask robots are used in the assembly of the Zarpens fountain pen. [2]

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(e) (i) Outline **one** reason why multitask robots are considered a clean technology. [2]

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(ii) Explain why Zarpens have used retro-styling to increase sales of the fountain pen. [3]

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2. **Figure 10** shows the Banana 88 bicycles for adult and child. The adult bicycle is foldable and has a motor that is powered by a lithium polymer (LiPo) battery. The child version of the bicycle aims to introduce young children to cycling.

The bicycles were developed through a series of freehand sketches, see **Figure 11**. The design for the adult bicycle was further explored using physical models such as the mock-up in **Figure 12**.

Figure 10: Banana 88 bicycles

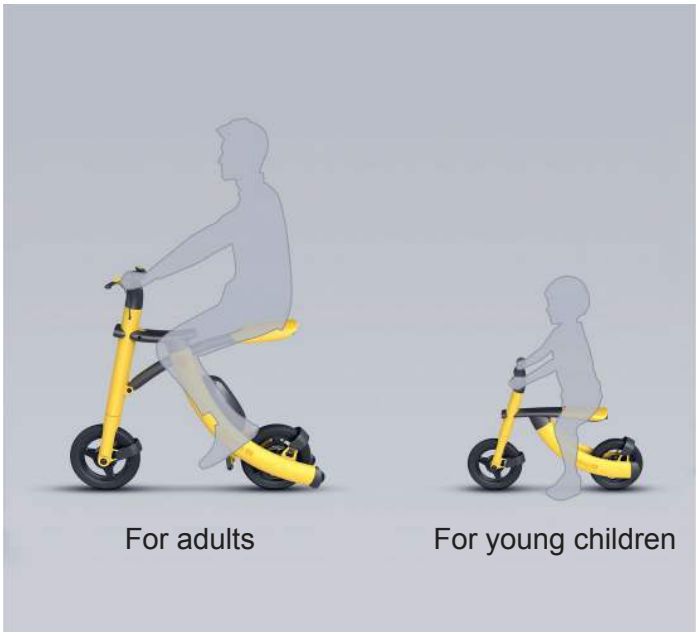

Figure 11: Freehand sketches of the Banana 88 bicycle

Figure 12: Mock-up of the adult bicycle

(a) Outline **one** reason why the designer produced the freehand sketches in **Figure 11**. [2]

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(b) Outline **one** reason why the mock-up in **Figure 12** was used in the development of the bicycle. [2]

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3. Explain why products benefit from a multidisciplinary approach to innovation. [3]

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4. Explain **one** reason why lithium polymer (LiPo) batteries contribute to efficient energy use. [3]

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Section B

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

5. In 1954, Buckminster Fuller patented the iconic geodesic dome shape. Geodesic domes have since become a classic design and have been used in various design contexts, see **Figure 13**.

Figure 14 shows geodesic domes as part of the Eden Project. The geodesic domes were built on an old claypit. The architect was inspired by the way soap bubbles adapt to changing conditions and surfaces.

The geodesic dome of the Eden Project uses an inflated thermoplastic within a steel frame. This helps create the conditions for the world's largest rainforest in captivity.

The Eden Project is constructing a geothermal energy project at the site in Cornwall, UK, see **Figure 15**. This will provide heat for the Eden Project and local homes.

Figure 13: Geodesic dome structures used in a variety of design contexts

Figure 14: The Eden Project

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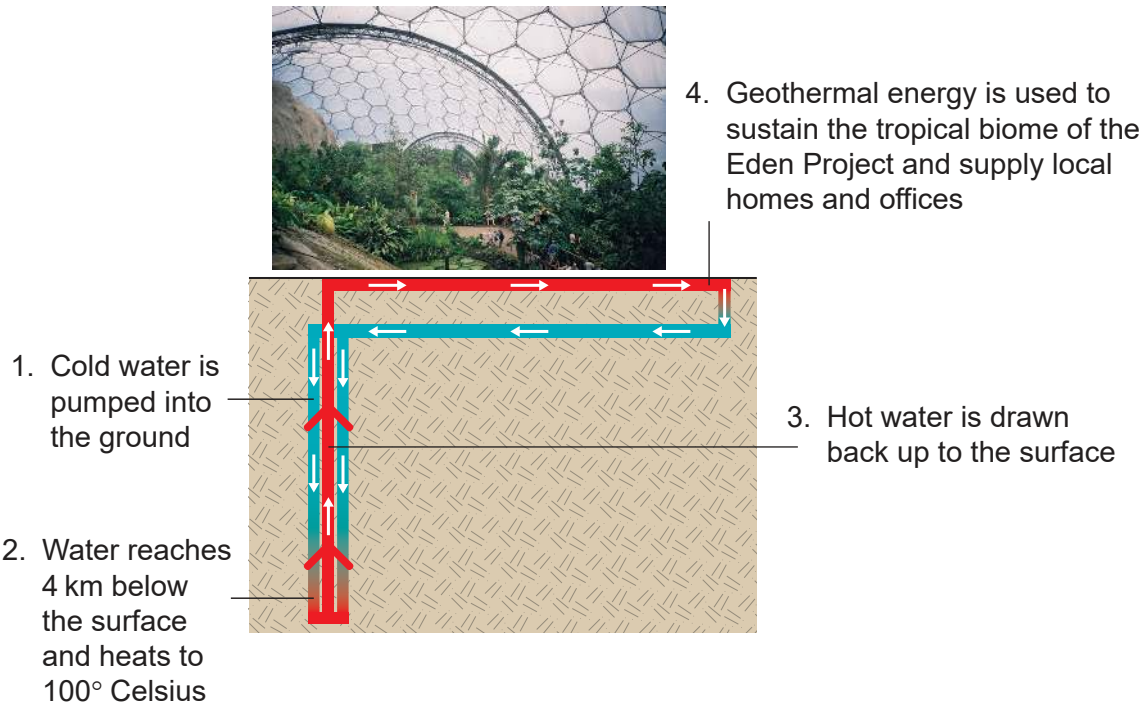
(Question 5 continued)

Figure 15: The geothermal energy project at the Eden Project



(a) Outline the strategy for innovation for the Eden Project. [2]

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(Question 5 continued)

(b) Explain **one** characteristic that make geodesic domes a classic design. [3]

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(c) Compare the advantages **and** disadvantages to the local area in the development of the geothermal energy project. [6]

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(Question 5 continued)

(d) A thermoplastic material was chosen for the cladding of the geodesic dome in **Figure 14** because of its mechanical, physical and aesthetic properties.

Explain one mechanical, one physical **and** one aesthetic property of the thermoplastic material that has led to its selection for use in the cladding of the Eden Project. [9]

6. Designers are developing new umbrellas after identifying problems with the design of existing umbrellas, such as the one in **Figure 16**.

A new umbrella design features a mechanism that allows the outside of the umbrella to fold inwards. This keeps water droplets on the inside of the umbrella so they do not drip on the floor, see **Figure 17**.

Another umbrella design features a C-shaped handle to allow users to hold the umbrella without gripping it, see **Figure 18**.

Figure 16: Existing umbrella design

Figure 17: Mechanism of a new umbrella used to keep water droplets on the inside

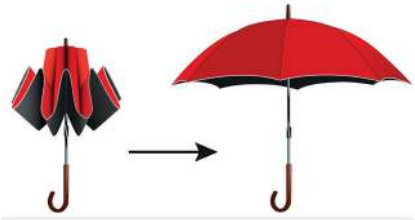

Figure 18: New umbrella with a C-shaped handle

(a) List **two** properties of polyester that make it a good choice for the canopy of an umbrella. [2]

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(Question 6 continued)

(b) Explain one driver for the invention of the new umbrella mechanism in **Figure 17**. [3]

(c) Explain **two** ways how a study of biomechanics in existing umbrella handle designs could have been used to develop the C-shaped handle in **Figure 18**. [6]

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will not be marked.

(Question 6 continued)

(d) Explain how solid modelling, animation **and** finite element analysis (FEA) could help with the design and development of umbrellas. [9]

7. Masahiko Ito has developed a seat for school children that has been inspired by a horse saddle, see **Figure 19**.

Figure 20 and **Figure 21** show that the seat can be used in multiple ways to allow schoolchildren to change their body positions.

The seat is made from plywood and a steel alloy frame. The seat is attached to the frame using fasteners. Multiple chairs can be stacked on top of each other.

Figure 19:
Seat inspired by a horse saddle

Figure 20:
Schoolchildren using the seat

Figure 21:
The seat being used in multiple ways

(a) Outline **one** advantage of alloying steel. [2]

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(Question 7 continued)

(b) Explain the manufacturing process used in the production of the plywood seat. [3]

(c) Suggest how the designer might have collected primary **and** secondary anthropometric data to inform the design and development of the seat. [6]

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(Question 7 continued)

(d) Explain how the designer has reduced the environmental impact of the seat through the consideration of materials, energy **and** waste. [9]

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References:

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Figure 2 todabasura, 2014. Fountain pen. [image online] Available at: https://pixabay.com/photos/fountain-pen-ink-pen-business-1053692/ [Accessed 07 July 2021] Source adapted.

Figure 3 Images provided with permission from Société Bic S.A.

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Figure 9 Robot using a pen. Image by Mirko Tobias Schäfer. www.flickr.com/photos/gastev/2174505811. Under copyright and licensed under the Attribution 2.0 Generic licence. https://creativecommons.org/licenses/by/2.0/.

Figure 10 Mak, R. [Adult and child Banana 88 bicycles] n.d. [image online] Available at: www.yankodesign.com/2019/03/25/like-father-like-son/ [Accessed 20 December 2020].

Figure 11 Mak, R. [Working prototype of Banana 88 bicycles] n.d. [image online] Available at: www.yankodesign.com/2019/03/25/like-father-like-son/ [Accessed 20 December 2020].

Figure 12 Mak, R. [Wooden mock-up of the adult Banana 88 bicycle] n.d. [image online] Available at: www.yankodesign.com/2019/03/25/like-father-like-son/ [Accessed 20 December 2020].

Figure 13 [Black Geodesic dome structure]. Photo by: Lisa Vollmer. Interior Design by: Jess Cooney Interiors.

Lee, J., 2013. Atmos Modular Space. [image online] Available at: www.yankodesign.com/images/design_news/2013/06/12/atmos.jpg [Accessed 07 July 2021].

ODESD2, 2014. Q1 Lounge Chair. [image online] Available at: www.yankodesign.com/images/design_news/2014/03/20/q1_02.jpg [Accessed 07 July 2021].

Figure 14 [The Eden Project] n.d. [image online] Available at: https://commons.wikimedia.org/wiki/File:Eden_project.JPG [Accessed 07 July 2021].

Figure 15 Eden project tropical biome. Image by Stevekeiretsu. https://commons.wikimedia.org/wiki/File:Eden_project_tropical_biome.jpg. Under copyright and licensed under the Creative Commons Attribution-Share Alike 1.0 Generic license. https://creativecommons.org/licenses/by/1.0/deed.en.

Figure 16 [Blue umbrella] n.d. [image online] Available at: www.pxfuel.com/en/free-photo-jmzgh [Accessed 07 July 2021]. Source adapted.

Figure 19 Masahiko Ito, 2019. Saddle Seat Chair. [image online] Available at: https://competition.adesignaward.com/design.php?ID=69588 [Accessed 23 December 2020].

Figure 20 Masahiko Ito, 2019. [children sat on Saddle Seat Chair]. [image online] Available at: https://competition.adesignaward.com/design.php?ID=69588 [Accessed 23 December 2020].

Figure 21 Masahiko Ito, 2019. [multiple uses of the Saddle Seat Chair]. [image online] Available at: https://competition.adesignaward.com/design.php?ID=69588 [Accessed 23 December 2020].

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