Diploma Programme
Programme du diplôme
Programa del Diploma

Design technology
Higher level and standard level
Paper 2

Thursday 5 November 2020 (afternoon)

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]**.

8820 – 6203

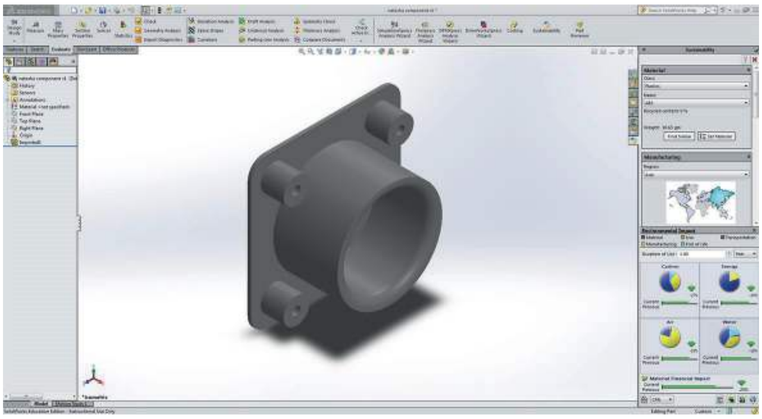
23 pages

Section A

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

1. **Figure 1** shows design for environment software that can be used to analyse the environmental impact of a component using life cycle analysis (LCA).

Figure 1: Component in design for environment software



The software generates a sustainability report, see **Figure 2**. This can be used by designers and manufacturers to make informed choices regarding the environmental impact of the component.

Figure 2: Sustainability report for the component generated by the software

Material: ABS	Total mass per unit of ABS:	0.253 kg
	Material Unit Cost:	2.90 USD/kg
Manufacturing	Region:	Asia
	Process:	Injection Moulded
	Electricity consumption:	1.8 kWh/lbs
	Designed to last:	2.0 years
	Scrap rate:	2.0 %
Use	Region:	North America
	Duration of use:	2.0 years
End of Life	Recycled:	33 %
	Incinerated:	13 %
	Landfill:	54 %

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(Question 1 continued)

(a) (i) State **one** reason why the product was designed to only last two years. [1]

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(ii) Outline **one** reason why using injection moulding has resulted in a low estimated material unit cost. [2]

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(Question 1 continued)

(b) (i) Outline how finite element analysis (FEA) could be used to further develop the process during the component's manufacture by injection moulding. [2]

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(ii) Outline why solid modelling rather than surface modelling would have been used in the computer-aided design (CAD) development of the component designed in **Figure 1**. [2]

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(Question 1 continued)

(c) (i) Outline **one** possible impact on the sustainability report in **Figure 2** if the material of the component is changed from a thermoplastic to a thermosetting plastic. [2]

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(ii) Explain **one** waste mitigation strategy the designer could use to reduce the percentage of ABS sent to landfill at the end of the product's life. [3]

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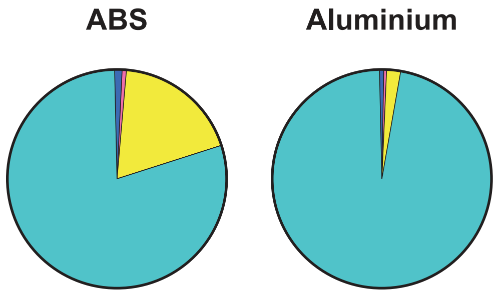
(Question 1 continued)

Design for environment software can be used to calculate the energy consumed if the component was made from different materials. The pie charts in **Figure 3** show the energy consumed by ABS and aluminium at the pre-production, production, distribution and disposal stages of the product life cycle for the component. The unit of measurement of energy is megajoules (MJ).

Figure 3: Energy consumed during the lifecycle of the component for ABS and aluminium



	ABS	Aluminium
Pre-production	0.933 MJ	4.800 MJ
Production	0.224 MJ	0.134 MJ
Distribution	0.004 MJ	0.011 MJ
Disposal	0.004 MJ	0.006 MJ

(d) (i) List **one** reason why the design for environment software does not generate a result for energy consumed at the utilization stage of the product lifecycle. [1]

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(This question continues on the following page)

(Question 1 continued)

(ii) Calculate the embodied energy of the component if it is made from ABS. Give your answer to one decimal point and show your workings. [2]

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(e) (i) Outline why the energy consumed at the pre-production stage is greater for aluminium than for ABS. [2]

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(ii) Explain how end-of-pipe technologies can reduce the environmental impact of manufacturing. [3]

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2. The Anglepoise lamp was originally designed in 1932 by George Carwardine and is considered a classic design. The Anglepoise lamp has undergone many iterations since 1932 and is now mass-produced as a modern consumer product, see **Figure 4**.

Many designers have been influenced by the Anglepoise lamp. *The Agency of Design*, a design company, set themselves a challenge to redesign the Anglepoise lamp by using the lowest possible embodied energy. The lamp is made from a hardwood structure with a bottle cork as an adjustment mechanism, see **Figure 5**.

Figure 4: A modern version of the Anglepoise lamp

Figure 5: *The Agency of Design* redesign

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(Question 2 continued)

(a) Describe how the designer of the modern Anglepoise lamp in **Figure 4** has achieved a compromise between form and function. [2]

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(b) Outline **one** aesthetic characteristic of hardwood that makes it suitable for use in the redesigned Anglepoise lamp. [2]

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3. With the growth in virtual reality (VR), augmented reality (AR) and mixed reality (MR)* there has been an increasing interest in virtual interaction design.

Mixed reality interfaces can be accessed by the user through wearing mixed reality glasses. The software maps the physical environment and matches the size of the virtual interface to the size of the user's hand.

Figure 6 and **Figure 7** show a user interacting with virtual menus linked to physical objects in the environment.

Figure 6: Mixed reality interfaces

Figure 7: A user interacting with a mixed reality interface

* mixed reality (MR): overlays and anchors virtual objects to the real world

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(Question 3 continued)

Explain **one** physiological benefit to the user of interactions through a mixed reality interface instead of a physical interaction with the product. [3]

4. Explain why consumers of first to market technologies are likely to be innovators. [3]

Section B

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

5.

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6. It is estimated that shipping is responsible for between 2 and 3 percent of the world's total greenhouse gas emissions. The United Nations' International Maritime Organization (UNIMO) has set targets for shipping companies to reduce their current emissions by at least 50 percent by 2050. In response to this requirement, designers are working on clean technologies to power large ships.

Rotor sails made from carbon glass fibre are one example of a clean technology. Rotor sails were first developed in the 1920s but interest in them was not revived until the early 21st century, see **Figure 11**.

Electricity powers a mechanism within the cylindrical rotor sail which provides the thrust to move the ship, see **Figure 12**.

Figure 11: Rotor sails from 1924 and 2018

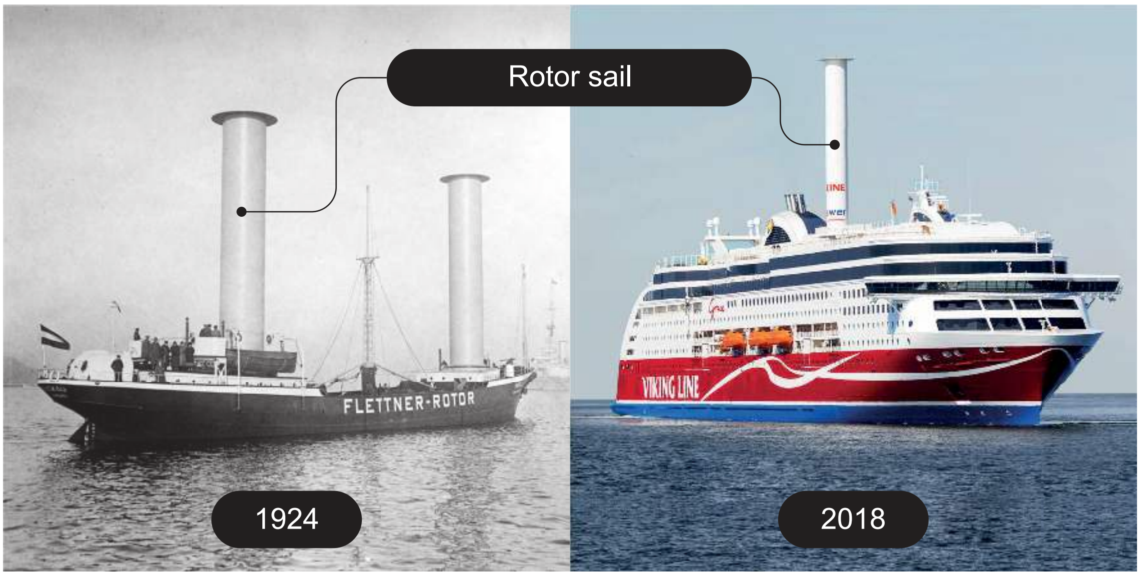
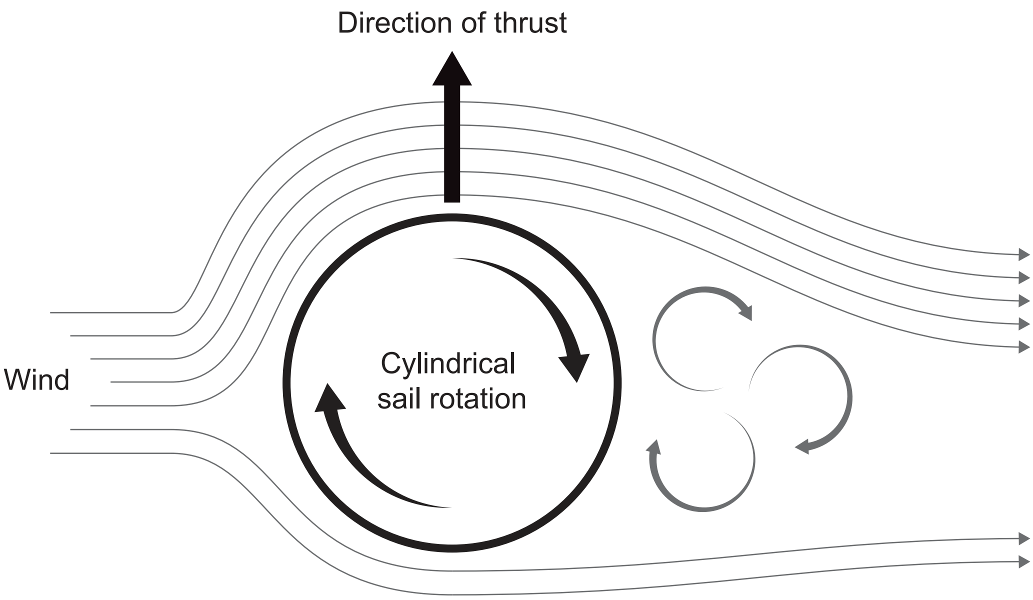


Figure 12: Thrust produced by the cylindrical rotor sail



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(Question 6 continued)

(a) Outline **one** driver for the use of clean technology to develop the rotor sail. [2]

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(b) Explain why carbon glass fibre was chosen for the modern rotor sail. [3]

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(Question 6 continued)

(c) Suggest **two** reasons why the original rotor sail was a shelved technology in the 1920s. [6]

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(Question 6 continued)

(d) Explain the role of rapid prototyping, instrumented physical models **and** computer aided design (CAD) in the design of the modern rotor sail. [9]

7. The international patent pending JuNiki's® Double Neck® flask features a unique cap with two openings. One opening is narrow and the other is wider. Both openings are angled to allow for ease-of-use. The flask comes in two versions, one version with a body made from stainless steel and the other version made from borosilicate glass (Pyrex), see **Figure 13**. The flask also comes in a range of different sizes and finishes, see **Figure 14**.

Figure 13: Borosilicate glass JuNiki's® flask

Figure 14: JuNiki's® flask range

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(Question 7 continued)

(a) Outline the type of intellectual property (IP) required for the protection of the JuNiki's® flask cap design. [2]

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(b) Explain the mass production method used for the body of the borosilicate glass flask. [3]

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(Question 7 continued)

(c) Explain **two** reasons why the properties of borosilicate glass make it suitable for the body of the flask. [6]

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(Question 7 continued)

(d) Explain how the designer may have collected static anthropometric data, physiological data **and** psychological data to aid the development of the JuNiki's® flask. [9]

References:

Figure 1 [**environment software**] © International Baccalaureate Organization 2020.

Figure 2 [**sustainability report**] © International Baccalaureate Organization 2020.

Figure 3 [**energy consumed pie-chart**] © International Baccalaureate Organization 2020.

Figure 4 Image of the Anglepoise Original 1227 lamp shown with permission by Anglepoise Limited.

Figure 5 The Agency of Design, 2010. *A 10-megajoule lamp*. Available at: https://agencyofdesign.co.uk/projects/designing-with-energy. With permission from The Agency of Design.

Figure 6 Images provided with permission from Ultraleap.

Figure 11 [**Buckau ship**] George Grantham Bain Collection, Prints & Photographs Division, Library of Congress, LC-DIG-ggbain-37764.

[**Norsepower ship**] © Norsepower Oy Ltd 2020.

Figure 12 [**thrust produced by the cylindrical rotor sail**] © International Baccalaureate Organization 2020.

Figure 13 [**borosilicate glass JuNiki flask**] Picture provided by Dr. Christian Kehlenbeck, JuNiki´s Double Neck GmbH, Germany.

Figure 14 [**JuNiki flask range**] Picture provided by Dr. Christian Kehlenbeck, JuNiki´s Double Neck GmbH, Germany.