

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

Wednesday 7 November 2018 (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. The Boeing 787 aircraft was designed to be 20% more fuel efficient than its predecessors and is based on light-weight construction. The Boeing 787 is the first major commercial aircraft to have a composite fuselage, composite wings, and to use composites in most other components, see **Figure 1**.

The Boeing 787's cabin windows are larger than any other civil aircraft and are composed of photochromatic smart glass.

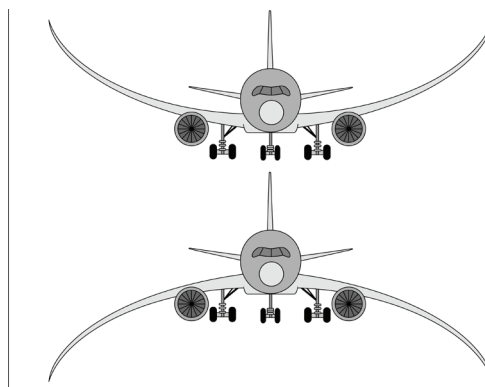
Figure 1: Materials used in 787 aircraft body

Material	Percentage of the total weight
Composites	50 %
Aluminium	20 %
Aluminium alloy/titanium alloy	15 %
Steel	10 %
Other	5 %

[Source: © International Baccalaureate Organization 2018]

Figure 2 shows the use of an instrumented model during the development of the aircraft's wings.

Figure 2: Boeing 787 passing a wing stress test



[Source: © International Baccalaureate Organization 2018]

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24EP02

(Question 1 continued)

- (a) (i) State the percentage of composite used in the production of a Boeing 787. [1]

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- (ii) Outline which physical property would have the greatest impact on the fuel consumption of a plane. [2]

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- (b) (i) Outline why photochromatic glass is an appropriate material for the windows of the Boeing 787. [2]

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- (ii) Outline why magneto-rheostatic smart materials would be used in the landing gear of the Boeing 787. [2]

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(Question 1 continued)

- (c) (i) List **two** advantages of using finite element analysis (FEA) for the design of the Boeing 787 wings.

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- (ii) Explain how instrumented models have been used in the development of Boeing 787 wings.

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(Question 1 continued)

The LEAP aircraft engine series, see **Figure 3**, is the first to contain 3D printed components, see **Figure 4**. It is also the first to receive simultaneous type certification by the Federal Aviation Administration and European Aviation Safety Agency.

Figure 3: LEAP engine



[Source: Courtesy of GE Aviation]

Figure 4: 3D printed fuel nozzle from LEAP engine



[Source: Courtesy of GE Aviation]

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(Question 1 continued)

- (d) (i) Outline why an aluminium alloy would be used in the construction of the aircraft parts.

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- (ii) List **two** reasons why super alloys would be used in aircraft engines.

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- (e) (i) Describe the difference between additive and subtractive manufacturing.

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(Question 1 continued)

- (ii) List **two** advantages for the aircraft industry of using additive manufacture. [2]

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2. German brand e15 is taking IKEA to Germany's highest court claiming IKEA's Malm bed, see **Figure 5**, is a copy of e15's SL02 Mo bed, see **Figure 6**, and infringes its design protection. Like the SL02 Mo, the Malm bed has a flat headboard and footboard, with a wide edge on the sides of its frame that can act as a slim bedside shelf.

IKEA's Malm bed was released three months after e15 launched its SL02 Mo bed. The beds have an aesthetic likeness. However, the SL02 Mo is made from solid wood and retails for US\$5 000, while IKEA's Malm bed is made of particle board with an oak veneer and costs US\$250.

IKEA has argued the beds were a parallel creation, meaning the Malm bed was developed independently and with no knowledge of the e15 SL02 Mo bed.

Figure 5: IKEA Malm bed



[Source: Image provided with permission from IKEA]

Figure 6: e15 SL02 Mo bed



[Source: Image provided with permission from e15 Design and Distributions GmbH]

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24EP08

(Question 2 continued)

- (a) Particle board is a composite. List the **two** materials used in its manufacture. [2]

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- (b) List **two** advantages for IKEA of manufacturing the Malm bed from particle board. [2]

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24EP10

3. Suggest the scale of manufacture suitable for manufacturing the SL02 Mo bed. [3]

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4. Explain why e15 would want to defend its design protection. [3]

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Section B

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

5. During World War II, the US Navy called upon Charles and Ray Eames to create a lightweight, inexpensive leg splint. Previous splints had been made from steel or aluminium but these materials were in short supply during war time. The resulting design, see **Figure 7** and **Figure 8**, is modular and can be mass-produced. Development of the Eames splint was made possible by their access to military technology and manufacturing facilities.

Figure 7: Eames splint in use



Figure 8: Eames splint



[Source: © 2019 Eames Office, LLC (eamesoffice.com)]

- (a) Outline the nature of the anthropometric data that would have been collected for the Eames splint.

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(Question 5 continued)

- (b) Explain **one** physiological factor the designers of the Eames splint would have considered in its development.

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- (c) Explain **two** reasons why prototypes would have been used in the development of the Eames splint.

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24EP14

(Question 5 continued from page 13)

- (d) Explain **three** mechanical properties of the laminated plywood that make it suitable for use in the Eames splint.

[9]



6. The first-generation iPad (2010) is a tablet computer designed and marketed by Apple Inc., see **Figure 9**. The device features a touchscreen display, with the ability to play music, send and receive email, browse the web, play games and access social media services, all of which can be enabled by downloading apps.

The iPad was labelled as a competitor to laptops and was the first product of its kind to diffuse into the market. Even though the iPad is a relatively new product, it has already been recognized as a design classic.

Figure 9: Apple iPad



[Source: Age Fotostock/Media Bakery]

- (a) The Apple iPad is an example of shelved technology. Outline **one** reason why technology may be shelved.

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(Question 6 continued)

- (b) Explain **one** advantage to Apple of the iPad being first to market.

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- (c) Explain how **two** of Rogers' characteristics apply to consumer adoption of the Apple iPad.

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(Question 6 continued from page 17)

- (d) Explain **three** characteristics that have led to the Apple iPad being considered a classic design.

[9]



7. In southern India, the Ripple Effect project, a collaborative effort between Acumen Fund, Gates Foundation and IDEO, aimed to help existing social enterprises in the water sector increase their ability to distribute clean drinking water.

Previously, people had been required to carry up to 20kg barrels of water nearly 2 kilometers to their homes (see **Figure 10**).

One part of improving access to water was the water trolley made by using locally sourced materials that are easy to obtain. IDEO collaborated with local craftsmen to model a number of design options (see **Figures 11 and 12**).

Figure 10: Traditional water carrying



[Source: Courtesy of IDEO]

Figure 11: IDEO water trolley



[Source: Courtesy of IDEO]

Figure 12: IDEO water trolley



[Sources: Courtesy of IDEO]

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(Question 7 continued)

- (a) Outline how the IDEO trolley is an example of incremental green design strategy. [2]

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- (b) Suggest the percentile the designer has used for the fixed height of the handlebar. [3]

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(c) Explain why designers used graphical modelling **and** physical modelling in the development of the IDEO trolley.

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24EP22

(d) Explain **three** ways that the IDEO trolley uses waste mitigation strategies.

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