M13/4/DESTE/HP2/ENG/TZ0/XX

22136202

DESIGN TECHNOLOGY
HIGHER LEVEL
PAPER 2

Thursday 16 May 2013 (afternoon)

1 hour 45 minutes

Candidate session number

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Examination code

2	2	1	3	–	6	2	0	2

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.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is *[60 marks]*.

SECTION A

*Answer **all** questions. Write your answers in the boxes provided.*

1. **Figure 1**, **Figure 2** and **Figure 3** show the Terrafugia Transition, a dual-purpose vehicle which changes from a two-seater light aircraft into a car. **Table 1** shows performance data and dimensions for the Transition. The motor can either drive the propeller or the rear wheels. The Transition was developed in the US by Terrafugia. In 2011, the US highway authority made changes to the law to allow the Transition on American roads. It costs approximately $279 000 and after further prototype testing it will be marketed in Europe as well as the US. The first 100 vehicles are due for delivery in 2013 to the customers who have paid a substantial deposit in the previous two years. Terrafugia offers a course to obtain a "Sports" pilot licence in a minimum of 20 hours.

Figure 1: The Transition in flight **Figure 2: The Transition on the road** **Figure 3: The Transition at home**

[Source: Please go to this link: http://www.terrafugia.com/aircraft/transitionR]

Table 1: Performance data and dimensions for the Transition

Conversion from aircraft to car in 15 secs
No trailer or hangar needed
Maximum weight for take-off: 1430 lbs
Vehicle weight: 970 lbs
Fuel consumption in flight at cruising height: 5 gallons per hour
Useable fuel: 23 gallons
Fuel consumption on road at maximum speed: 35 mpg
Maximum speed on road: 65 mph

[Source: Please go to the following link: http://www.terrafugia.com/aircraft/transitionR]

(a) (i) State the maximum weight for the occupants and luggage when using the Transition for flying. *[1]*

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(Question 1 continued)

(ii) Calculate the number of hours that the Transition can be driven on the road before refuelling if it is driven at maximum speed. *[1]*

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(iii) Estimate the maximum safe flying time for the Transition before refuelling. *[2]*

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(b) (i) Outline **one** potential barrier for the successful innovation of the Transition as a global product, other than price. *[2]*

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(ii) Outline **one** advantage of the Transition for consumers who mainly want to use it for flying. *[2]*

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(Question 1 continued)

(c) (i) State the scale of production for the Transition. *[1]*

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(ii) Suggest a potential market segment for the Transition. *[3]*

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(Question 1 continued)

Table 2: Size of the Transition

Driving	Flying
80 inches (2 m) height	80 inches (2 m) height
90 inches (2.3 m) wide	26 foot 6 inches (7.6 m) wingspan
18 foot 9 inches (5.6 m) long	19 foot 9 inches (5.9 m) long

Table 3: Cockpit

- 48 inches from the floor to the pilot's shoulder
- Space for carry on luggage including golf clubs
- Space for two people, side-by-side

Table 4: Safety Data

- Proven 100 hp Rotax 912ULS engine
- Full vehicle parachute
- Automated electro-mechanical folding wing
- Modern glass avionics
- Automotive crash safety features

[Source: Please go to the following link: http://www.terrafugia.com/aircraft/transitionR]

(d) (i) State **one** evaluation strategy the manufacturer would have used to prove the reliability of the engine. *[1]*

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(ii) Suggest **one** reason why the Transition is equipped with a full vehicle parachute rather than the occupants having individual parachutes. *[3]*

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(Question 1 continued)

(e) (i) Outline **one** reason why the manufacturers refer to "*48 inches from the floor to the pilot's shoulder*". *[2]*

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(ii) Outline **one** reason why maintenance costs will be high for the Transition. *[2]*

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2. (a) State what is meant by *work hardening* a metal. *[1]*

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(b) Compare work hardening and alloying in terms of increasing the strength of a material. *[3]*

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3. (a) Outline **one** reason why hardwood timber may be considered as a non-renewable resource. *[2]*

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(b) Outline **one** way in which active solar collection can help reduce the energy used in a domestic building. *[2]*

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4. (a) State the formula used to calculate strain in a material. *[1]*

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(b) Explain why a glass bottle dropped on a hard surface smashes, but a metal drink can dropped from the same height, dents. *[3]*

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5. (a) Describe a cantilever beam. *[2]*

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(b) Outline **one** limitation of a cantilever beam in relation to size. *[2]*

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6. (a) State the primary source of energy used in the Industrial Revolution. *[1]*

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(b) Explain why steam power replaced water power during the Industrial Revolution in relation to efficiency of energy conversion. *[3]*

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SECTION B

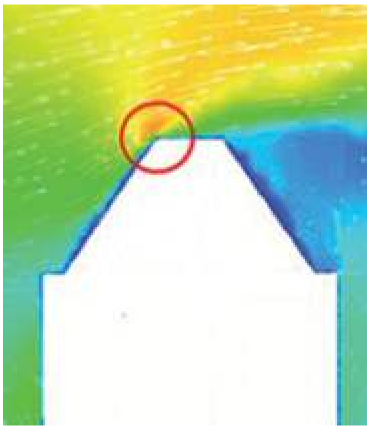
*Answer **one** question. Write your answers in the boxes provided.*

7. **Figure 4** and **Figure 5** show the Ridgeblade rooftop wind turbine designed by Win Keech. The Ridgeblade is a narrow box containing a wind turbine that sits on the ridge of a pitched roof. As wind hits a pitched roof it accelerates – a wind speed of 5 ms^{-1} increases to 15 ms^{-1} (**Figure 6**). The Ridgeblade costs three times the amount of a conventional wind turbine but its makers claim it generates ten times more electricity for the same amount of wind.

Figure 4: The Ridgeblade Rooftop Wind Turbine

Figure 5: The Ridgeblade Rooftop Wind Turbine (case removed)

Figure 6: Wind velocity on a roof ridge



[Source: http://www.thepowercollective.com/. Used with permission (figures 4 and 5) & http://www.thepowercollective.com/. /, with thanks to Delft University. Used with permission (figure 6)]

(a) (i) Outline **one** way in which the Ridgeblade wind turbine may be considered a key feature of a living building. *[2]*

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(Question 7 continued)

(ii) Outline **one** way in which the choice of different surface finishes for the Ridgeblade wind turbine could help it to blend into the environment. *[2]*

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(b) (i) Describe the type of mechanical motion involved in the performance of the Ridgeblade wind turbine. *[2]*

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(ii) Compare the Ridgeblade wind turbine with a conventional wind turbine in relation to safety. *[3]*

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(Question 7 continued)

(c) (i) Outline **one** advantage for the local environment of the design of the Ridgeblade wind turbine. *[2]*

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(ii) Suggest **three** possible barriers to diffusion into the marketplace for the Ridgeblade wind turbine. *[9]*

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8. **Figure 7** shows the Isokon Penguin Donkey. It was originally designed in 1939 by Egon Riss and was quickly adopted for use at that time by the head of Penguin book publishers who realized that its shelves were the perfect size for the company's paperbacks – hence the name "penguin" was incorporated into the title for the book/magazine rack along with "donkey" because of its four legs and two "panniers". The Penguin Donkey is made from laminated birch plywood.

Figure 7: The Isokon Penguin Donkey Magazine/book rack

[Source: www.isokonplus.com. Used with permission.]

(a) (i) List **two** advantages of using an adhesive to join together the components of the Penguin Donkey. *[2]*

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(ii) Describe a suitable adhesive for joining together the component parts of the Penguin Donkey. *[2]*

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(Question 8 continued)

(b) (i) Outline **one** performance test the manufacturer of the Penguin Donkey could employ to ensure quality assurance for the consumer. *[2]*

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(ii) Evaluate the importance of strength and stiffness in the design of the Penguin Donkey. *[3]*

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(c) (i) Describe the importance of the technique of abrading to the manufacture of the Penguin Donkey. *[2]*

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(Question 8 continued)

(ii) Explain **three** advantages of using laminated timber to produce the Penguin Donkey. *[9]*

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9. **Figure 8** shows the Alessi Officina-Socrates corkscrew designed by Jasper Morrison. It is named after the philosopher Socrates who established the Socratic Method of obtaining knowledge by recognizing the essential answers in a conversation, *i.e.* getting to the core of the issue in the same way that the corkscrew gets to the "core of a wine bottle" – the cork. The Alessi Officina-Socrates is made from top quality 18/10 steel which means that it contains 18 % chromium and 10 % nickel and is referred to as stainless steel. The corkscrew has a highly-polished (mirror) finish and costs approximately €120.

Figure 8: The Socrates corkscrew

[Source: JM06 – Socrates Corkscrew in 18/10 stainless steel mirror polished by Jasper Morrison for Alessi. Used with the permission of Alessi S.p.A., Crusinallo, Italy]

(a) (i) List the two sub-divisions into which metals are classified. *[2]*

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(Question 9 continued)

(ii) Describe how the rate of cooling of a metal controls grain size. *[2]*

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(b) (i) Outline the manufacturing technique used to join the linkages in the Socrates corkscrew together. *[2]*

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(ii) Explain how the use of the linkages in the Socrates corkscrew enhances the mechanical advantage of the corkscrew. *[3]*

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(Question 9 continued)

(c) (i) Outline the scale of production of the Socrates corkscrew. *[2]*

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(ii) Compare price with value when assessing the Socrates corkscrew for value for money. *[9]*

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