M11/4/DESTE/HP2/ENG/TZ0/XX

22116202

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

DESIGN TECHNOLOGY
HIGHER LEVEL
PAPER 2

Candidate session number

0	0							

Monday 9 May 2011 (afternoon)

1 hour 45 minutes

Examination code

2	2	1	1	–	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.

20 pages

SECTION A

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

1. Approximately 900 million car trips are made each day in the US, half by people travelling alone and for less than five miles. The Segway® Personal Transporter is a green transport system for short-distance single-occupancy journeys. **Figure 1** shows the basic model for urban use. There are several different models, *e.g.* for commuting to work, as a golf cart and for off-road use (see **Figure 2**). The Segway® is powered by Lithium-ion batteries which take 8–10 hours to charge (equivalent to 0.704 kg CO_2). Once charged the Segway® has an average range of 20 km (16–24 km depending on a range of factors). **Figure 3** shows the average fuel mix used for electricity production in the US. **Table 1** shows the fuel efficiency of different vehicles. 1 gallon of fuel contains 2.421 kg of carbon and oxidises to produce 8.788 kg of carbon dioxide emissions.

Figure 1: The Segway® Personal Transporter for Urban Use

[Source: www.segway.com]

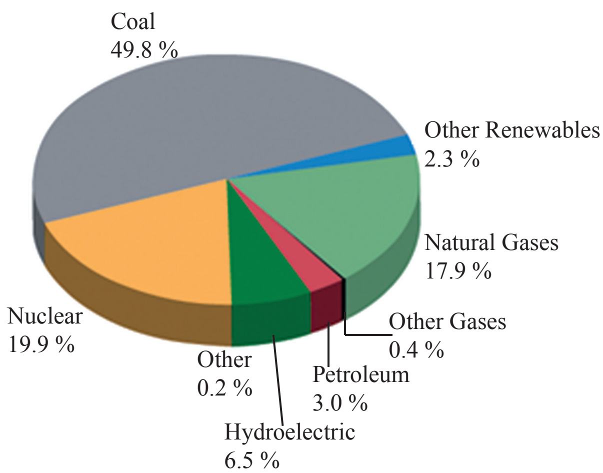
Table 1: Fuel efficiency of different vehicles

	Km per Gallon
Large car	15
Small diesel car	37
Motorbike	50
Hybrid car	55

Figure 2: The off-road model of the Segway® Personal Transporter

[Source: www.segway.com]

Figure 3: Average fuel mix for electricity production in the US.



[Source: www.segway.com]

This question continues on the following page)

(Question 1 continued)

(a) (i) State the major fuel used in electricity production in the US. *[1]*

. . . .

. . . .

(ii) State **one** factor which will determine the actual range of the Segway® Personal Transporter once fully charged. *[1]*

. . . .

. . . .

(iii) Outline **one** way in which the design of the off-road model of the Segway® Personal Transporter shown in Figure 2 differs from the basic model shown in Figure 1. *[2]*

. . . .

. . . .

. . . .

(This question continues on the following page)

(Question 1 continued)

(b) (i) Identify why the Segway® Personal Transporter does not produce carbon dioxide emissions during use but is quoted as creating 0.704 kg of CO_2 per recharge, *i.e.* per 20 km. *[2]*

. . . .

. . . .

. . . .

(ii) Calculate the carbon dioxide emissions which would be produced by the small diesel car in travelling 20 km. *[2]*

. . . .

. . . .

. . . .

(c) (i) State **one** dimension of the Segway® Personal Transporter which is adjustable for different users. *[1]*

. . . .

. . . .

(ii) Explain the percentile range that the Segway® Personal Transporter would be designed for. *[3]*

. . . .

. . . .

. . . .

. . . .

(This question continues on the following page)

(Question 1 continued)

Protective head gear design is a compromise between the level of protection it offers, how heavy it is and how hot it makes the wearer. Users prefer light and well vented designs even though they may offer less protection. Designs are evaluated against standards (see **Table 2**), *e.g.* for the amount of impact they can withstand. In an impact test a helmeted headform is dropped from different heights against different shaped anvils (see **Figure 4**).

Figure 4: Evaluating protective head gear on a hemispherical anvil

Table 2: Required impact energies for protective head gear in different standards

DIFFERENT STANDARDS					
	IMPACT ENERGIES, FOR EACH ANVIL SHAPE USED				
	Flat Anvil	**Hemispherical Anvil**	**Kerbstone Anvil**	**No. of impacts per helmet**	**Total Impact Energy/helmet**
Snell B-84	97.8 joules	58.7 joules	N/A	4 (2 each anvil)	313 joules
BS: 6863	52.2 joules	N/A	52.2 joules	2 (1 each anvil)	104 joules
Snell B-90	100 joules	65 joules	N/A	4 (2 each anvil)	330 joules
Snell B-95	110 joules	72 joules	72 joules	4 (1 each anvil + 1)	Min 326 joules Max 364 joules
EN 1078	S – M – L 46 – 69 – 90	N/A	S – M – L 35 – 49 – 64	2 (1 each anvil)	Min 81 joules Max 154 joules
Note: European EN helmet standards uses test headforms varying from 3.1kg for the smallest to 6.1kg for the largest size. The different weights, and tests, are listed for small, medium and large headforms.					

(d) (i) State the type of evaluation shown in Figure 4. *[1]*

. . . .

. . . .

(This question continues on the following page)

(Question 1 continued)

(ii) Explain why user trials are not used to evaluate the protective head gear. *[3]*

. . . .

. . . .

. . . .

. . . .

(e) (i) Identify **one** reason for using test headforms of different weights. *[2]*

. . . .

. . . .

. . . .

(ii) Identify **one** reason why different anvil shapes are used to test the head gear. *[2]*

. . . .

. . . .

. . . .

2. James Dyson invented the Ball-barrow in 1974 after becoming dissatisfied with the wheels of traditional wheelbarrows (see **Figure 5**) sinking into soft ground. The Ball-barrow has a ball-shaped wheel which rides over soft ground without sinking and absorbs shock when used on rough ground. It also has feet that don't sink in mud and a plastic bin that doesn't rust.

Figure 5: Traditional wheelbarrow

[http:/en.wikipedia.org/wiki/File:2008-07-185_Construction_wheelbarrow_at_duke.jpg. Image by Ildar Sagdejev]

Figure 6: Dyson's Ball-barrow

www.dyson.co.uk. Used with permission.

(a) Outline **one** way in which Dyson's Ball-barrow is an example of constructive discontent. *[2]*

. . . .

. . . .

. . . .

(b) Identify **one** way in which Dyson might have worked with users to develop a clearer understanding of problems experienced with the traditional wheelbarrow. *[2]*

. . . .

. . . .

. . . .

3. **Figures 7** and **8** show a spun carbon fibre chair designed by Mathias Bengtsson and produced by filament winding.

Figures 7 and 8: Spun Carbon Chair

www.bengtssondesign.com. Used with permission.

(a) Describe the process of filament winding. *[2]*

. . . .

. . . .

. . . .

(b) Outline **one** advantage of producing the chair using filament winding. *[2]*

. . . .

. . . .

. . . .

4. Injection-moulded preforms and caps (see **Figure 9**) can be purchased in standard sizes for the production of bottles for water and soft drinks (see **Figure 10**).

Figure 9: Standard preforms and caps

Source: www.teachersource.com. Used with the permission of Educational Innovations.

Figure 10: PET water bottles

Source: www.get-inc.com/BottleMfgBlowMolding.htm. Used with the permission of Global Water & Energy Ltd.

(a) State the process which would be used for the production of PET water bottles from the preforms shown in Figure 9. *[1]*

. . . .

. . . .

(b) Discuss **one** advantage of purchasing standard preforms and caps for the production of PET water bottles for the manufacturer. *[3]*

. . . .

. . . .

. . . .

. . . .

5. The Powertraveller company has developed a range of portable battery products for use with laptops and other electronic devices, including the Minigorilla (see **Figure 11**). Powertraveller was the first company to develop this type of product.

Figure 11: Minigorilla

Source: www.powertraveller.com/iwantsome/primatepower/minigorilla. Used with permission.

(a) Identify the corporate strategy adopted by the Powertraveller company. *[2]*

. . . .

. . . .

. . . .

(b) Outline **one** way in which the Minigorilla can be described as a global product. *[2]*

. . . .

. . . .

. . . .

6. (a) Describe a superalloy. *[2]*

. . . .

. . . .

(b) Outline **one** reason why nickel-based superalloys are appropriate materials for application in aircraft engines. *[2]*

. . . .

. . . .

. . . .

. . . .

SECTION B

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

7. **Figure 12** shows the Tandem Sling Chair. It was originally designed by husband and wife design team Charles and Ray Eames for airports in Washington and Chicago. It is now widely used in airports and other public buildings around the world. The brief was to develop a multiple-seating system which facilitated security checks, looked good (aesthetics) and was easy to maintain (see **Figure 13**). The aluminium frame is produced by high-pressure die casting.

Figure 12: Tandem Sling Chair

www.hermanmiller.co.uk. Used with permission

Figure 13: The chair is widely used in airports and other public access areas

www.hermanmiller.co.uk. Used with permission

(a) (i) Describe the process of high-pressure die casting. *[2]*

. . . .

. . . .

. . . .

(ii) Outline **one** advantage of using high-pressure die casting to produce the metal frame. *[2]*

. . . .

. . . .

. . . .

(This question continues on the following page)

(Question 7 continued)

(b) (i) Describe what is meant by the term factor of safety. *[2]*

. . . .

. . . .

. . . .

(ii) Explain why the Tandem Sling Chair would be designed to have a high factor of safety. *[3]*

. . . .

. . . .

. . . .

. . . .

(This question continues on the following page)

(Question 7 continued)

(c) (i) Outline **one** way in which consumer feedback could be collected to inform the development of the design. *[2]*

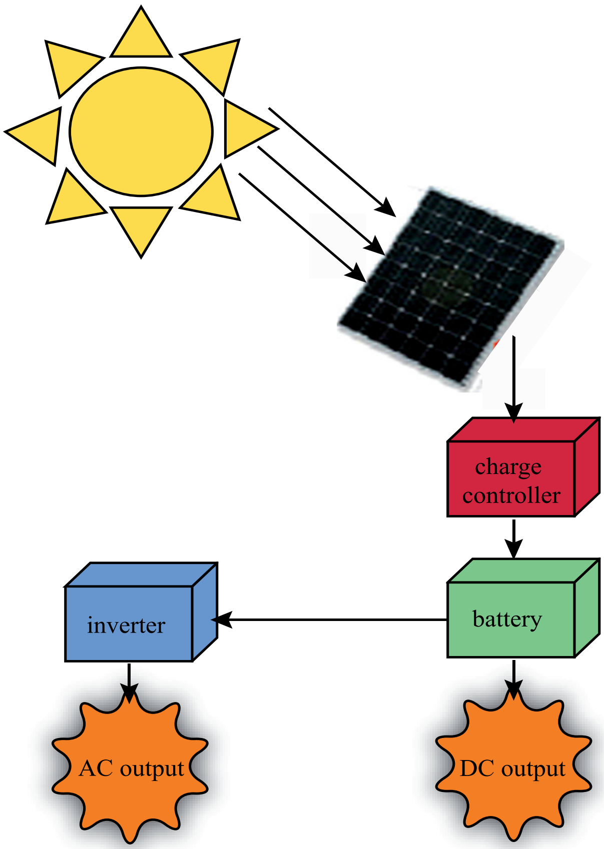
. . . .
. . . .
. . . .

(ii) Explain how the designers have met **three** potentially conflicting aspects of the specification for the Tandem Sling Chair: security; aesthetics; ease of maintenance. *[9]*

. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .

8. A homeowner is considering installing a photovoltaic power system (see **Figure 14**). Sunlight falling on the photovoltaic (PV) panel generates electricity which is passed via a charge controller to charge a 12-volt battery. It can be output directly as 12-volt direct current (DC) or passed to an inverter and alternating current (AC) produced.

Figure 14: Photovoltaic power system



(a) (i) Outline **one** limitation of the use of solar and wind energy as alternatives for fossil fuels. *[2]*

. . . .

. . . .

. . . .

(This question continues on the following page)

(Question 8 continued)

(ii) Explain how solar power is harnessed by the photovoltaic panel. *[3]*

. . . .

. . . .

. . . .

. . . .

(b) (i) Outline **one** reason why thermal conductivity is an important consideration in the design of the building envelope. *[2]*

. . . .

. . . .

. . . .

(ii) Describe how a designer can modify the heat lost or gained through the building envelope. *[2]*

. . . .

. . . .

. . . .

(This question continues on the following page)

(Question 8 continued)

(c) (i) Outline **one** reason why an active solar water heating system might be installed alongside the photovoltaic system shown in Figure 14. *[2]*

. . . .
. . . .
. . . .

(ii) Explain **three** ways in which buildings can be designed to reduce energy consumption. *[9]*

. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .
. . . .

9. **Figure 15** shows a double-winged lever design corkscrew patented by Dominick Rosati in 1930. The corkscrew is placed over the lip of the bottle and the worm screwed into the cork so that the wings lift up. When the worm is far enough into the corkscrew, the wings are pushed down and the cork is lifted out of the bottle. A force of 360 N is required to remove the cork from the bottle. **Figure 16** shows an Alessi Anna G novelty corkscrew designed by Alessandro Mendini. It works on the same principle as the corkscrew in **Figure 15**.

Figure 15: A double-winged lever design corkscrew

From: http://en.wikipedia.org/wiki/File:Corkscrew_P1150886.jpg
Image by David Monniaux

Figure 16: Alessi Anna G Corkscrew

[Source: www.alessi.co.uk]
www.alessi.com. Used with permission.

(a) (i) Identify the class of lever represented by the wing of the corkscrew shown in Figure 15. *[2]*

. . . .

. . . .

. . . .

(This question continues on the following page)

(Question 9 continued)

(ii) Calculate the force which would need to be applied to the end of each wing of the corkscrew shown in Figure 15 to lift the cork out of the bottle. *[3]*

. . . .

. . . .

. . . .

. . . .

(b) (i) Describe how design costs would contribute to the final cost of the Alessi Anna G corkscrew shown in Figure 16. *[2]*

. . . .

. . . .

. . . .

(ii) Describe how the concept of break-even relates to the production of the Alessi Anna G corkscrew. *[2]*

. . . .

. . . .

. . . .

(This question continues on the following page)

(Question 9 continued)

(c) (i) Identify how Alessandro Mendini has managed to balance form with function in the design of the Alessi Anna G corkscrew. *[2]*

. . . .

. . . .

. . . .

(ii) Discuss how consumers might use product image, performance and durability at different stages of the product lifecycle to evaluate the Alessi Anna G corkscrew. *[9]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .