IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M04/470/H(2)

DESIGN TECHNOLOGY
HIGHER LEVEL
PAPER 2

Candidate number

Tuesday 18 May 2004 (afternoon)

1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES

- Write your candidate number in the box above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided.
- Section B: answer one question from Section B. Write your answers on answer sheets. Write your candidate number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the numbers of the questions answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

SECTION A

*Answer **all** the questions in the spaces provided.*

1. Concrete crash barriers can be used to channel traffic on roads, airport runways and racetracks although they can cause considerable damage to vehicles (see **Figure 1**). **Figure 2** shows a portable plastic safety barrier module, which can be quickly interlocked with other modules (see **Figure 3**) to form long sections of barrier. When empty the modules are easily portable, weighing 80 kg. When filled with water (density of water = 1000 kg/m^{-3}) up to the maximum water level mark, the weight of each module increases to 480 kg stabilizing the safety module and ensuring the greatest energy absorbing capacity. The dimensions of the safety modules in inches are shown in **Figure 4**.

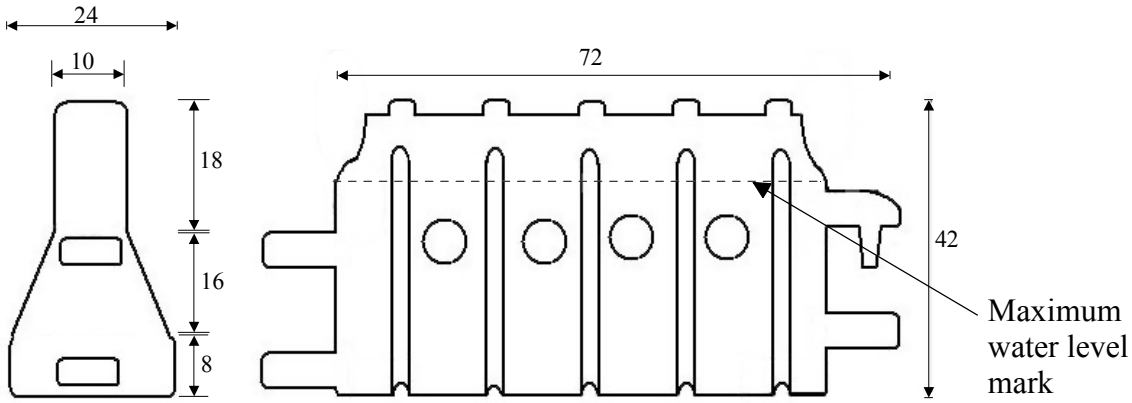
Figure 1: A concrete crash barrier can cause considerable vehicle damage

Figure 2: Portable safety barrier

Figure 3: Interlocking of modules

[Source: http://www.rsea.com.au]

Figure 4: Dimensions of the safety modules



All dimensions are in inches. 1 inch = 2.54 cm.

(a) (i) State the height of the plastic safety barrier module. *[1]*

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(ii) Calculate the internal volume of the plastic safety barrier module up to the maximum water level mark. *[3]*

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(b) (i) Outline **one** criterion of the material related to safety, to be considered in preparing a product design specification for the plastic safety barrier module. *[2]*

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(This question continues on the following page)

(Question 1(b) continued)

(ii) Outline **one** disadvantage of using physical models to evaluate the plastic safety barrier module against the specification. *[2]*

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(c) (i) State **one** reason for the inclusion of the ribbed sections in the design of the plastic safety barrier module. *[1]*

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(ii) Explain how the plastic safety barrier module would be produced. *[3]*

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The algorithm below shows a sequence of instruction to produce a length of crash barrier using plastic safety barrier modules loaded onto a vehicle.

While length of barrier is less than required length:
Drive vehicle into next position (10 seconds);
Lower safety barrier module from vehicle and link into position (1 minute 10 seconds);
Check that the drain hole plug is in place (10 seconds);
Remove fill cap (15 seconds);
Insert hose and fill to maximum water mark (2 minute 15 seconds);
Replace fill cap (15 seconds);

(d) Calculate how many minutes it would take to assemble a minimum of 100 metres of safety barrier. *[4]*

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(Question 1 continued)

(e) (i) Outline **one** ergonomic advantage of the plastic safety barrier modules being distributed empty and filled with water on site. *[2]*

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(ii) Outline **one** situation where concrete barrier modules might be selected in preference to plastic safety barrier modules. *[2]*

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2. Wooden toys, *e.g.* the wooden dolls' house shown in **Figure 5**, can be manufactured by wasting timber by cutting and machining followed by abrading to produce suitably-shaped pieces which are then assembled into the product.

Figure 5: A wooden dolls' house

[Source: http://allwoodtoys.com/]

(a) Outline **one** mechanical property of timber that affects the ease with which it can be wasted by cutting and machining and then abrading. *[2]*

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(This question continues on the following page)

(Question 2 continued)

(b) Outline **one** aesthetic characteristic of timber that makes it appropriate for use in the manufacture of the doll's house. *[2]*

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3. (a) Define *lamination*. *[1]*

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(b) List **three** advantages of lamination. *[3]*

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4. (a) Outline how iron is converted to steel. *[2]*

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(b) Outline why steel must be treated or finished. *[2]*

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5. (a) Define *alloy*. *[1]*

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(b) Explain why metals are very good electrical and thermal conductors. *[3]*

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6. (a) Define *renewable resource*. *[1]*

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(b) Explain **one** factor that determines whether a reserve is exploited. *[3]*

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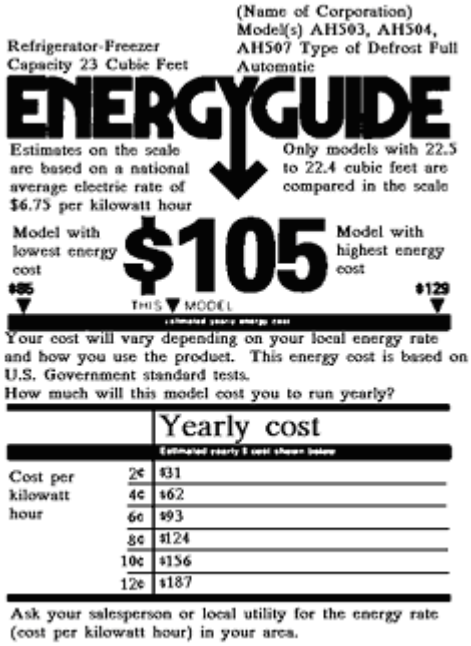
SECTION B

*Answer **one** question. Write your answers on the answer sheets provided. Write your candidate number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

7. A refrigerator-freezer works 24 hours a day to keep foods cold or frozen. However, they use more energy than any other appliance in the kitchen - being third in energy use in most homes to house heating/cooling and water heating. **Figure 6** shows an US energy label for a domestic refrigerator-freezer and **Figure 7** shows a refrigerator-freezer.

Figure 6: US energy label


(Name of Corporation)
Model(s) AH503, AH504, AH507 Type of Defrost Full Automatic
Refrigerator-Freezer
Capacity 23 Cubic Feet

ENERGYGUIDE

Estimates on the scale are based on a national average electric rate of $6.75 per kilowatt hour

Only models with 22.5 to 22.4 cubic feet are compared in the scale

Model with lowest energy cost $85

$105 THIS MODEL

Model with highest energy cost $129

Your cost will vary depending on your local energy rate and how you use the product. This energy cost is based on U.S. Government standard tests.

How much will this model cost you to run yearly?

		Yearly cost
Cost per kilowatt hour	2¢	$31
	4¢	$62
	6¢	$93
	8¢	$124
	10¢	$156
	12¢	$187

Ask your salesperson or local utility for the energy rate (cost per kilowatt hour) in your area.

Figure 7: Refrigerator-freezer

[Source: http://www.agen.ufl.edu/~fees/pubs/eh232f2.gif]

(a) (i) Define *divergent thinking*. *[1]*

(ii) Outline how constructive discontent contributes to the re-design of a refrigerator-freezer. *[2]*

(iii) Identify **one** stage in the re-design process for a refrigerator-freezer where orthographic drawings would be relevant and state why they would be used. *[2]*

(b) (i) Outline **one** disadvantage of planned obsolescence to the consumer. *[2]*

(ii) Outline **one** way in which the consideration of planned obsolescence would influence the design specification of a refrigerator-freezer. *[2]*

(c) (i) Describe how fixed costs contribute to the final cost of the refrigerator-freezer. *[2]*

(ii) Explain **three** limitations of energy-labelling schemes in comparison to ecolabelling schemes. *[9]*

8. **Figure 8** shows a domestic washing machine. The washing machine is part of a range of washing machines in which the basic product has been re-designed to include different features, *e.g.* larger capacity for family use and the inclusion of a dryer.

Figure 8: Domestic washing machine

(a) (i) Describe **one** way in which a designer might use brainstorming when re-designing a washing machine. *[2]*

(ii) List **two** reasons why a designer might use 2D and 3D freehand drawing in the development of a new washing machine design. *[2]*

(b) (i) Define *percentile range*. *[1]*

(ii) List **two** limitations of using data for the 50th percentile adult female in the design of kitchen appliances. *[2]*

(iii) Outline **one** way in which fashion influences the design of kitchen appliances, such as the washing machine, in terms of the impact they have on the consumption of natural resources. *[2]*

(c) (i) Outline **one** way in which industrial robots offer greater flexibility to manufacturing the range of washing machines. *[2]*

(ii) Explain **three** benefits for the washing machine manufacturer of adopting a proactive environmental policy. *[9]*

9. Safety is a key consideration in the purchase of a car. Consumers need reliable and accurate comparative information about safety performance of individual cars. One set of tests for directly comparing different cars is Europe's **N**ew **C**ar **A**ssessment **P**rogramme (NCAP). In NCAP's front impact test the car is driven into a deformable barrier at 64 kph (see **Figure 9**). Readings taken from crash dummies assess the protection given by the car to front seat occupants (see **Figure 10**).

Figure 9: NCAP's front impact test

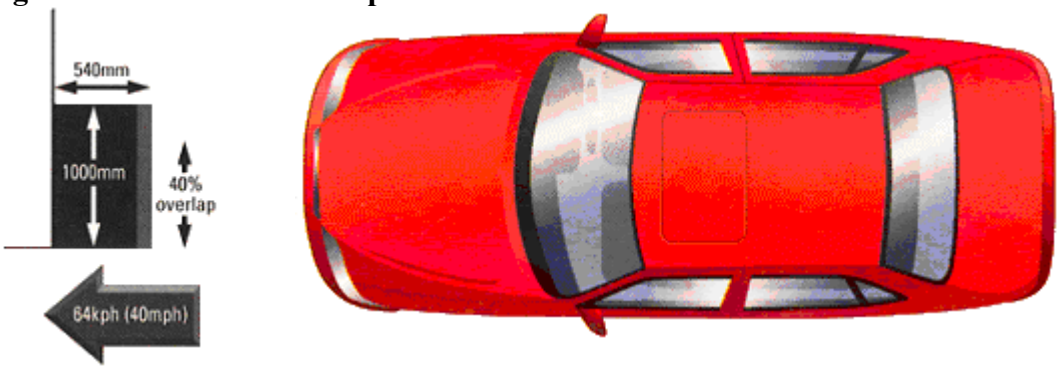
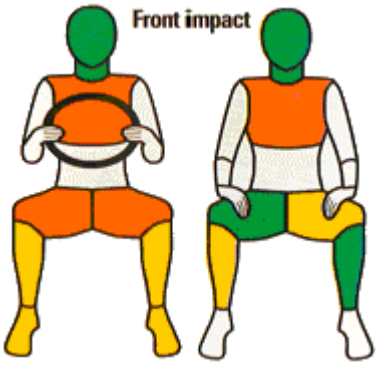


Figure 10: Crash dummies



Protection

- Good
- Adequate
- Weak
- Marginal
- Poor

[Source: http://www.euroncap.com/tests.htm]

(a) (i) Outline **one** disadvantage of using a performance test, *e.g.* the NCAP front impact test, in the evaluation of car safety. *[2]*

(ii) Outline **one** example of where bodily tolerances impact on the collection of data in relation to ergonomic design of the car. *[2]*

(b) (i) Define *incremental design*. *[1]*

(ii) Outline why the design of cars is a combination of incremental and radical design. *[2]*

(iii) Outline **one** advantage of producing physical models of the car to communicate with consumers. *[2]*

(c) (i) Outline why cars can be considered as being in the mature stage of the product life cycle. *[2]*

(ii) Explain **three** benefits for car manufacturers of adopting the design objectives for green products in the redesign of cars. *[9]*