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DESIGN TECHNOLOGY
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PAPER 2

Tuesday 3 November 2009 (afternoon)

1 hour 45 minutes

Candidate session number

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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 of Section A in the spaces provided.
- Section B: answer one question from Section B. Write your answers on answer sheets. Write your session 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.

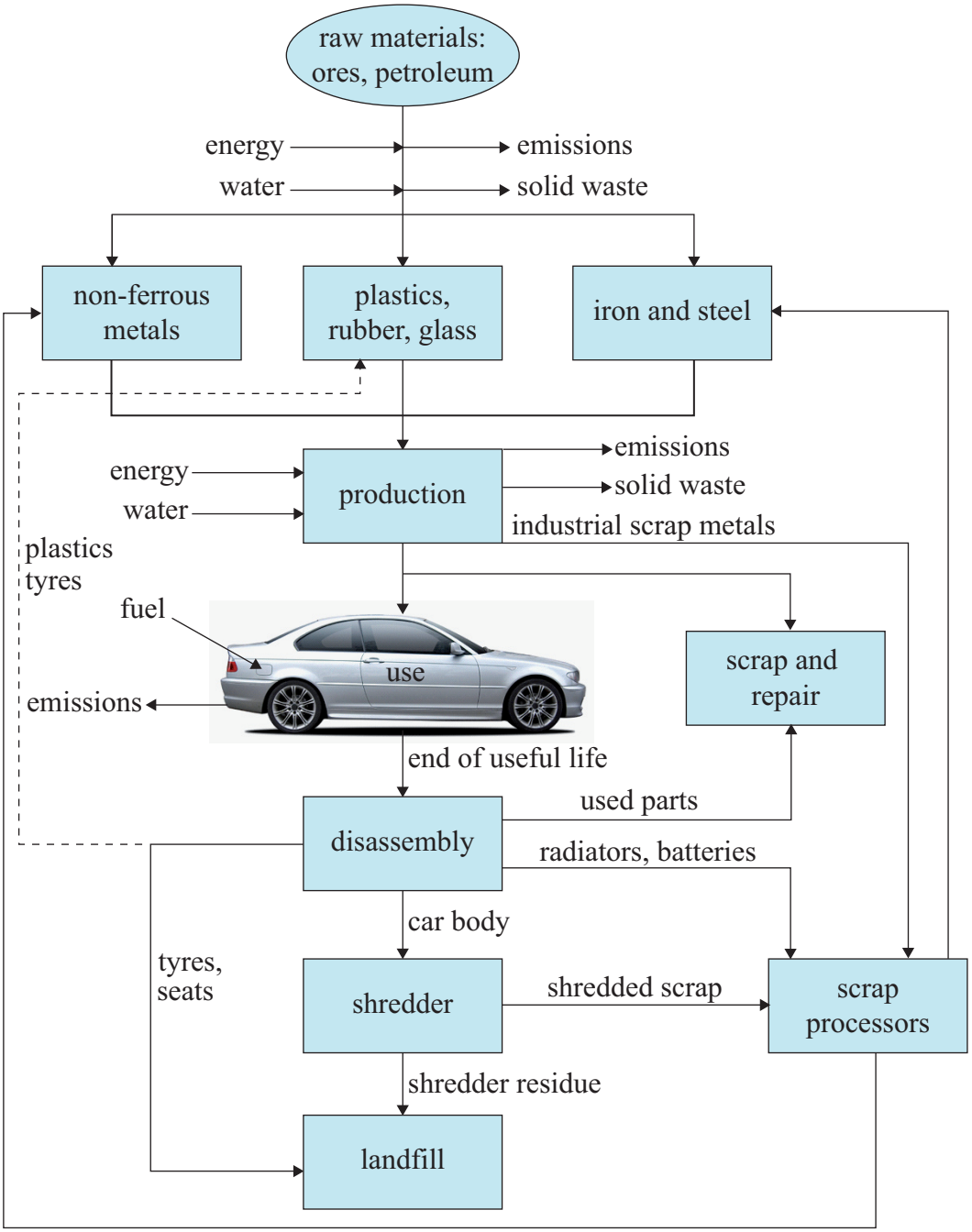
0110

SECTION A

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

1. **Figure 1** depicts the environmental impacts of a motor car during its life cycle.

Figure 1: Environmental impact of a car during its life cycle



[Source: Deborah L Thurston, "Environmental design trade-offs", *Journal of Engineering Design*, vol 5, number 1, pp. 25-36. Reprinted by permission of Taylor & Francis Ltd, http://www.tandf.co.uk/journals]

(This question continues on the following page)

(Question 1 continued)

(a) (i) State the major material group recycled from the motor car. *[1]*

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(ii) State which material group is processed from the raw material ores. *[1]*

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(iii) List **two** resources that input into the life cycle. *[2]*

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(b) (i) Identify which stage of the life cycle is likely to create the most emissions. *[2]*

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(ii) Outline the life cycle stage which is based on re-use. *[2]*

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(c) (i) State the life cycle stage where an end-of-pipe approach would be used. *[1]*

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(ii) Evaluate the role of reconditioning in the life cycle of the motor car. *[3]*

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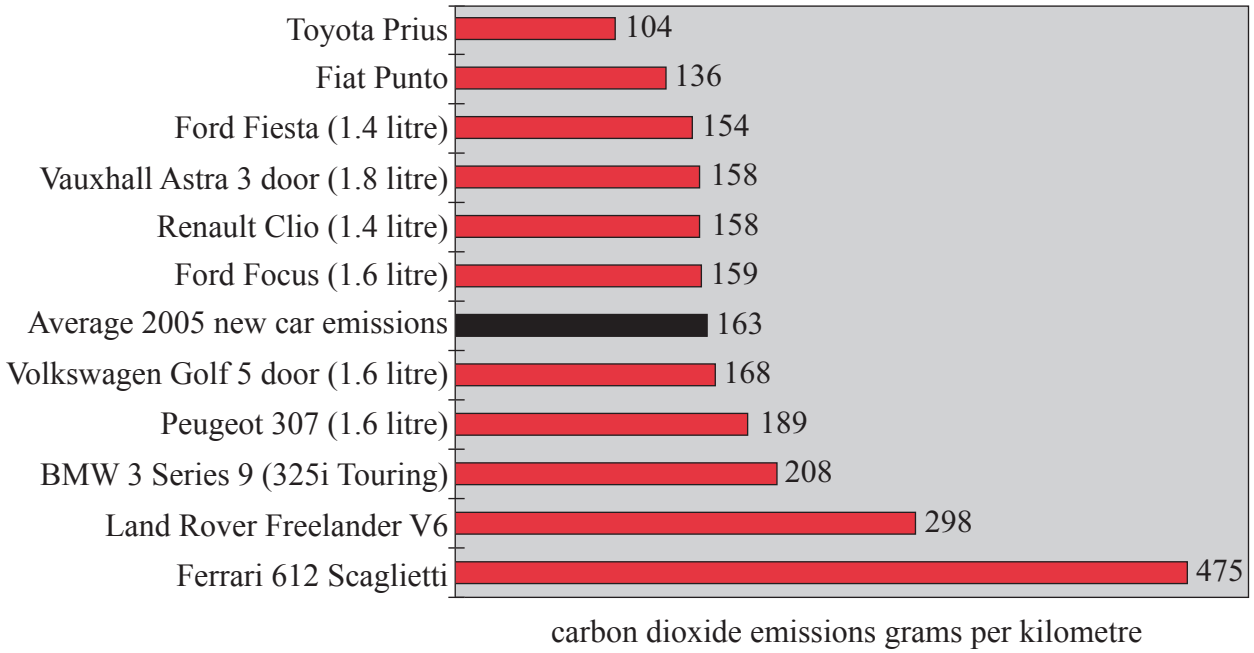
(Question 1 continued)

Car manufacturers are under pressure to reduce the carbon dioxide emissions for their cars with 130 grams per kilometre being the 2012 legal target. **Figure 2** shows the carbon dioxide emissions for a range of cars in grams per kilometre. All the cars are petrol models except for the Toyota Prius which is a hybrid model.

Figure 2: Carbon dioxide emissions of a range of cars



[Source: Department of Transport (UK)]

(d) (i) Calculate the percentage reduction of average new car emissions in 2005 required to meet the 2012 legal target. *[2]*

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(ii) Explain the changes that are needed in order to achieve the 2012 target. *[3]*

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(Question 1 continued)

(e) (i) Calculate, as a percentage, the emissions of the Ferrari 612 Scaglietti car compared to the Fiat Punto car. *[1]*

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(ii) Outline **one** likely impact of car price on volume of sales and the effect of this on total carbon dioxide emissions of cars. *[2]*

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2. (a) State a non-renewable energy source other than coal. *[1]*

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(b) Explain the importance of coal to the development of mechanisation and automation. *[3]*

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3. (a) List **two** considerations in the choice of an adhesive to join two materials. *[2]*

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(b) Outline **one** consideration in laminating a timber product with tight curves. *[2]*

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4. (a) Define *sustainable development*. *[1]*

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(b) Explain **one** key dimension of triple bottom line sustainability. *[3]*

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5. (a) Describe how the tensile strength of a metal is increased by alloying. *[2]*

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(b) Outline **one** advantage of using superalloys in a rocket engine. *[2]*

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6. (a) State **one** reason why innovators may have difficulty in obtaining financial support for an invention. *[1]*

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(b) Compare the lone inventor with the product champion. *[3]*

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SECTION B

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

7. **Figure 3** shows the Solea MF wood-burning stove which can be rotated. It has a secondary combustion system meaning that the fuel is burnt twice.

Figure 3: Solea MF wood-burning stove

[Source: www.acrheatproducts.co.uk]

(a) (i) Outline **one** advantage of using glass for the front panel of the stove. *[2]*

(ii) Outline **one** safety consideration for the design of the stove. *[2]*

(b) (i) Outline **one** advantage of being able to rotate the stove. *[2]*

(ii) Evaluate the wood-burning stove in relation to convenience for the user. *[3]*

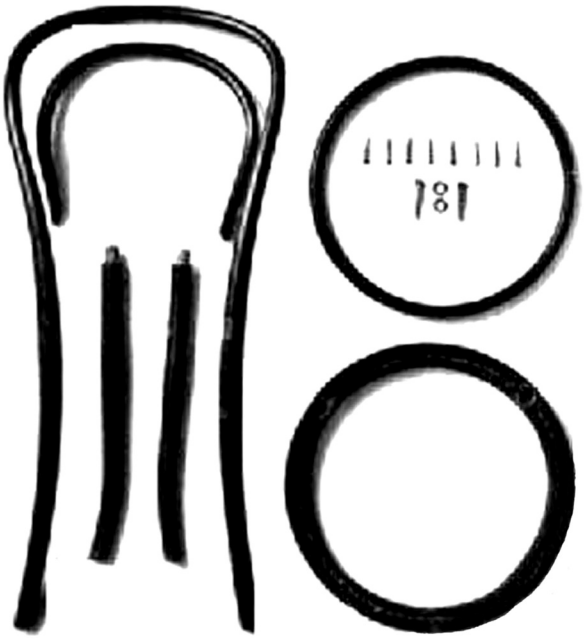
(c) (i) Outline **one** reason (not related to green design) why wood-burning stoves may be popular. *[2]*

(ii) Discuss **three** green design considerations relating to the wood-burning stove. *[9]*

8. **Figure 4** shows a chair designed by Michael Thonet to be suitable for mass production. At first the laminated parts of the chair were glued together, but by 1861 Thonet made the chair from steam-bent solid wood which was screwed together. Thonet continued to improve the design and by 1867 it could be made from six pieces of bent wood, ten screws and two washers (**see Figure 5**). The seat was usually made of woven cane or plywood. Different versions of the chair are still in production today.

Figure 4: The Thonet No. 14 chair (assembled)

Figure 5: The Thonet No. 14 chair (disassembled)



[Source: Gebruder Thonet products reproduced by permission of Poltrona Frau Group]

(a) (i) Outline **one** function of the smaller wooden circular component. *[2]*

(ii) Outline the type of force acting on the screws which join the legs to the smaller circular wooden component. *[2]*

(b) (i) Outline how the concept of *product family* applies to the Thonet chair design. *[2]*

(ii) Evaluate the Thonet chair design in relation to its suitability for batch production and mass production. *[3]*

(c) (i) Outline **one** physiological factor to be taken into account in the design of the Thonet chair. *[2]*

(ii) Explain **three** reasons why the Thonet chair in **Figure 4** is still a popular design today. *[9]*

9. **Figure 6** shows the Avelo Shimano 6–speed folding bicycle made from a metal alloy frame and available with 20 inch (50.8 cm) diameter alloy wheels. The seat is adjustable to different heights. **Figure 7** shows the Shimano bicycle folded. Sales of folding bicycles continue to rise globally.

Figure 6: Shimano bicycle

Figure 7: Shimano bicycle folded

[Source: www.amazon.co.uk]

(a) (i) Outline **one** reason why the bicycle in **Figure 6** is designed with an adjustable seat. *[2]*

(ii) Outline **one** advantage of using a metal alloy for the bicycle frame. *[2]*

(b) (i) Describe how the gear system of a bicycle interacts with the chain drive system. *[2]*

(ii) Explain how the efficiency of the bicycle as a mechanical system can be calculated. *[3]*

(c) (i) Describe the type of energy conversion involved in cycling. *[2]*

(ii) Discuss **three** reasons why the folding bicycle design may contribute to an increase in the popularity of cycling. *[9]*