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**DESIGN TECHNOLOGY**
**HIGHER LEVEL**
**PAPER 2**

Candidate session number

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Monday 7 November 2011 (afternoon)

1 hour 45 minutes

Examination code

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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.
- Write your answers in the boxes provided.

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## SECTION A

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

**1.** **Figure 1** shows the Leaf car produced by Nissan. It is one of the first mass-produced electric cars and is designed to compete with traditional petrol (gas) powered 5-door family cars so it is priced accordingly. **Table 1** lists some of the specifications of the Leaf car and **Table 2** lists some of the infrastructure developments planned to assist with the diffusion of electric cars in the UK.

**Figure 1: Nissan Leaf car**


Image by Tennen Gas.

**Table 1: Specifications for the Leaf car**

- almost silent engine
- zero emissions
- made from recyclable materials and all components recyclable at disposal
- looks like a conventional car
- minimum servicing required
- running costs of $3/100 miles
- investment costs of $600 000 000
- initial production of 150 000 in Europe and 200 000 in the US/Japan
- lithium–ion battery which powers an 80kW electric motor
- battery charge time 8 hours (200 volt outlet) or 30 min "top up" using Dc 50kW charger (80% charge)
- top speed 87 mph with a range of 90 miles before a re-charge
- minimum battery life cycle of 10 years/150 000 miles
- 20% loss of charge capacity after 5 years
- dashboard display shows nearest charge point and automatically updates list of charging points
- navigation system which can report how far you can travel on the remaining charge
- possible to communicate with the car via mobile (cell) phone *i.e.* to switch on charger
- on-board remote controlled timer that can be pre-programmed to recharge the battery

[Source: http://en.wikipedia.org/wiki/File:Nissan_Leaf_001.JPG]

*(This question continues on the following page)*

*(Question 1 continued)*

(a) (i) State the type of fixed cost which is represented by the $600 million investment. *[1]*

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(ii) State **one** reason why the running costs for the car may vary. *[1]*

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(iii) Outline **one** reason why the servicing costs of the Leaf car should be lower than those for a petrol (gas) car. *[2]*

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(b) (i) Outline **one** reason for naming the Nissan car "Leaf". *[2]*

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*(Question 1 continued)*

(ii) Outline **one** reason why an electric car may **not** be considered a green design. *[2]*

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(c) (i) State **one** benefit of the incremental design of the Leaf car in relation to its shape and form. *[1]*

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(ii) Explain **one** limitation of the Leaf car for people living in apartments. *[3]*

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*(Question 1 continued)*

**Table 2: Infrastructure development**

In order that a large number of car owners may change from driving petrol (gas) cars to electric cars a network of charging points needs to be established throughout the country.

- In 2010, the UK government allocated £250 million investment in a trial network of charging points to link three major cities in the north of the country.
- The Mayor of London has pledged to use taxpayers' money to establish 25 000 electric charging points throughout the capital.
- Research shows that the majority of daily car journeys are less than 30 miles.
- Most charging points will be established as "top up" points so users can extend the range of their journeys until they get home.

(d) (i) State why the design of the Leaf car is not based on the typical daily journey data. *[1]*

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(ii) Discuss why investment in the network of charging points is supported by the government. *[3]*

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*(Question 1 continued)*

(e) (i) Outline **one** reason why private companies may establish charging points for their employees. *[2]*

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(ii) Outline **one** reason why the UK government decided to create a pilot network of charge points in three major cities of one region of the country rather than trial the scheme in just one city. *[2]*

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**2.** (a) State the power source which was used before electricity in mass production systems. *[1]*

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(b) Explain the contribution of electricity to the evolution of assembly-line production. *[3]*

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**3.** (a) Describe a bevel gear. *[2]*

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(b) List the **two** components of a worm gear. *[2]*

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**4.** (a) State the manufacturing technique which uses a parison. *[1]*

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(b) Explain why compression moulding is an appropriate technique to manufacture plastic saucepan handles. *[3]*

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**5.** (a) Describe filament winding. *[2]*

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(b) List **two** reasons why filament winding is suitable to manufacture fishing rods. *[2]*

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**6.** (a) State the equation used to calculate heat gain or loss through a wall in a building. *[1]*

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(b) Explain how the U value of a material affects heat gain or loss for the walls of a building. *[3]*

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## SECTION B

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

**7.** **Figure 2** shows a bag manufactured from an obsolete fire hose and fasteners. The company Fire-hose.co.uk makes bags and belts from hoses discarded by the fire brigade. The hoses are made from a thermoplastic material. Half the profits for products made from the hoses go to the Fire Fighters charity.

**Figure 2: fire-hose.co.uk bag**

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

(a) (i) Outline **one** reason why the Fire-hose.co.uk bag may appeal to some consumers in relation to their set of values. *[2]*

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(ii) Outline **one** possible reason why the company is able to make a reasonable profit from the sale of the bags despite donating half of the profit to charity. *[2]*

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*(Question 7 continued)*

(b) (i) Outline **one** physical property which is important for the design of the Fire-hose.co.uk bag. *[2]*

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(ii) Explain why the type of bonding structure of the plastic material aids recycling of the Fire-hose.co.uk bag at the end of its life. *[3]*

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(c) (i) Outline **one** advantage of the use of rivets to attach the straps to the Fire-hose.co.uk bag. *[2]*

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*(Question 7 continued)*

(ii) Discuss how the company which manufactures the Fire-hose.co.uk bag promotes three different aspects of triple-bottom-line sustainability. *[9]*

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**8.** **Figure 3** shows the Eames Armchair RAR designed by Charles and Ray Eames and considered to be a classic design. The seat is made from a thermoplastic, the frame from steel and the rockers from a hardwood.

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(a) (i) Outline **one** reason why hardwood is an appropriate material to make the rockers of the Eames Armchair RAR. *[2]*

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(ii) Outline **one** advantage of making the rockers of the Eames Armchair RAR from laminated timber instead of a hardwood. *[2]*

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*(Question 8 continued)*

(b) (i) Outline **one** benefit of using plastic to make the seat of the Eames Armchair RAR. *[2]*

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(ii) Explain the most likely technique for joining the metal frame to the wooden rockers. *[3]*

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(c) (i) Outline the relationship of body load to the Eames Armchair RAR. *[2]*

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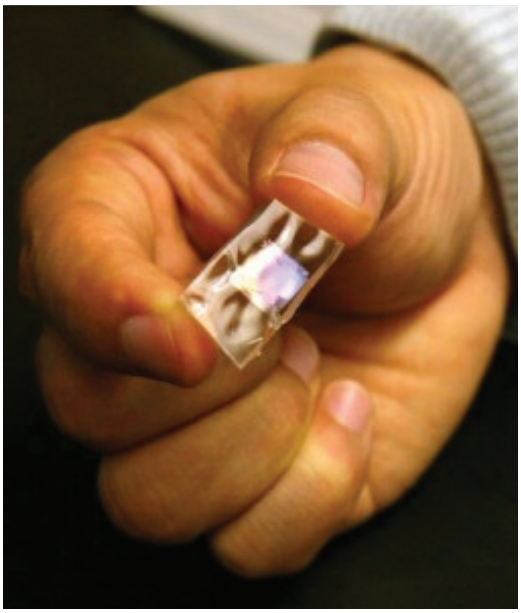
*(Question 8 continued)*

(ii) Explain the relationship between external loads and internal forces and how they affect equilibrium within the structure of the Eames Armchair RAR. *[9]*

**9.** **Figure 4** shows a device called the Human Dynamo being worn by a runner. The Human Dynamo is still at the research and development stage of its design. The device is made of tiny ribbons of a piezoelectric material which produce an electric current when flexed such as by the movement of the runner in **Figure 4**. The piezoelectric material is encased in silicon rubber which makes the device bio-compatible with the human body. The technology is being developed by a team of academics in the US backed by government funding. It is expected that within a short space of time, improved electronic chips will be developed so that enough electricity can be produced to power products such as mobile phones and iPods.

**Figure 4: Illustration of the Human Dynamo in action**



[Source: Photo by Frank Wojciechowski]

(a) (i) Outline the importance of density to the choice of material for the Human Dynamo. *[2]*

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*(Question 9 continued)*

(ii) Outline the materials group to which piezoelectric materials belong. *[2]*

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(b) (i) Describe the type of energy produced to create the electric current. *[2]*

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(ii) Explain why the material for the casing of the Human Dynamo needs to be bio-compatible with the human body. *[3]*

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*(Question 9 continued)*

(c) (i) Outline **one** physiological ergonomic factor important to the design of the Human Dynamo. *[2]*

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(ii) Discuss **three** issues concerned with the invention of the Human Dynamo becoming an innovation. *[9]*

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