

**Design technology**  
**Standard level**  
**Paper 3**

Monday 16 November 2015 (morning)

Candidate session number

1 hour

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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.
- Answer all of the questions from one of the options.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[30 marks]**.

Option	Questions
Option A — Food science and technology	1 – 6
Option B — Electronic product design	7 – 12
Option C — CAD/CAM	13 – 18
Option D — Textiles	19 – 24
Option E — Human factors design	25 – 30



**Option A — Food science and technology**

1. The Nordic Keyhole is a voluntary food labelling system used in Sweden, Denmark and Norway (see **Figures A1** and **A2**). It certifies food products as meeting the nutritional guidelines for salt, sugar, fat and fibre content and is particularly useful in relation to processed foods.

**Figure A1: The Nordic Keyhole****Figure A2: Requirements for the placement of The Nordic Keyhole food labelling system on packaging**

[Source: Swedish National Food Authority]

- (a) State **one** reason why The Nordic Keyhole food labelling system is particularly useful for processed foods. [1]

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- (b) Outline **one** way in which The Nordic Keyhole food labelling system is likely to have an impact on the design of processed foods. [2]

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(Option A continues on the following page)



(Option A, question 1 continued)

- (c) Explain why it is likely that The Nordic Keyhole food labelling system would be adopted by manufacturers despite the fact that it is a voluntary labelling system. [3]

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- 2. (a) Define *biological value*. [1]

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- (b) Outline **one** reason for low biological value foods being complemented. [2]

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(Option A continues on the following page)



(Option A continued)

- 3. **Figure A3** shows the list of ingredients in a box of assorted chocolates produced in Belgium for Marks and Spencer plc.

**Figure A3: The wording from the label on a box of assorted Belgian chocolates**

Assorted Belgian chocolates with milk (33%), dark (23%), and white (4%) chocolate

**INGREDIENTS:** Sugar, Cocoa Mass, Dried Whole **Milk**, Cocoa Butter, Butter oil (**Milk**), Palm Oil, Glucose Syrup, Ground **Hazelnuts**, Lactose (**Milk**), Raspberry Puree, Dried Skimmed **Milk**, Humectant: Sorbitol, Glycerol, Palm Kernel Oil, Passion Fruit Puree, Fat Reduced Cocoa Powder, Rapeseed Oil, Freeze-Dried Raspberry Pieces, Emulsifier, **Soya** Lecithin, Sunflower Lecithin, Dextrose, Flavourings, Vanilla Extract, Dried **Milk Fat**, **Wheatflour** (contains **Gluten**), Caramelised Sugar, Acid, Citric Acid, Gelling Agent: Pectin, Lemon Puree, Malted **Wheat** (contains **Gluten**), Salt, Cocoa Powder, Raising Agent: Sodium Bicarbonate, **Wheat Gluten**, **Wheat** Starch (contains **Gluten**), Vanilla Bean Seeds, Acidity Regulator: Ascorbic Acid.

Dark Chocolate contains Cocoa Solids (56% minimum). Milk Chocolate contains Cocoa Solids (30% minimum).

- (a) Outline **one** reason for some of the ingredients (Milk, Hazelnuts, Soya and the ingredients containing Gluten) being shown in a bold font.

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- (b) Outline **one** reason why a number of products **not** containing nuts may be labelled with warnings that they may contain nuts.

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(Option A continues on the following page)







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**Option B — Electronic product design**

7. **Figure B1** shows a seven-segment display. It can be driven by a binary-coded decimal (BCD) to seven-segment decoder (**Figure B2**). **Figure B3** shows the BCD decoder circuitry.

**Figure B1: Seven-segment display**

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**Figure B2: BCD to seven-segment decoder with seven-segment display**

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**Figure B3: Elements in the BCD decoder circuitry**

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(Option B continues on the following page)





**(Option B, question 7 continued)**

- (a) State which segments of the seven-segment display need to be “on” to represent the binary code 0110 as a decimal numeral. [1]

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- (b) State the inputs to, and the outputs from, the AND gates Q and R for the binary-coded input 0110 where  $A_0 = 0$ ,  $A_1 = 1$ ,  $A_2 = 1$  and  $A_3 = 0$ . [2]

	P	Q	R	S	T	U	V	W	X
	$\bar{A}_2\bar{A}_0$	$A_2A_0$	$A_0A_1$	$\bar{A}_0\bar{A}_1$	$A_1\bar{A}_0$	$A_1\bar{A}_2$	$A_2\bar{A}_1A_0$	$A_2\bar{A}_1$	$A_2\bar{A}_0$
<b>Input</b>	00			10	01	10	100	10	10
<b>Output</b>	0			0	0	0	0	0	0

- (c) Explain why 4-input OR gates are selected for the gates a, b, c, d, e, f, g to drive the seven-segment display. [3]

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**(Option B continues on the following page)**



**(Option B continued)**

8. (a) Define *time constant*. [1]

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(b) Describe the difference between a digital and an analogue signal. [2]

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**(Option B continues on the following page)**

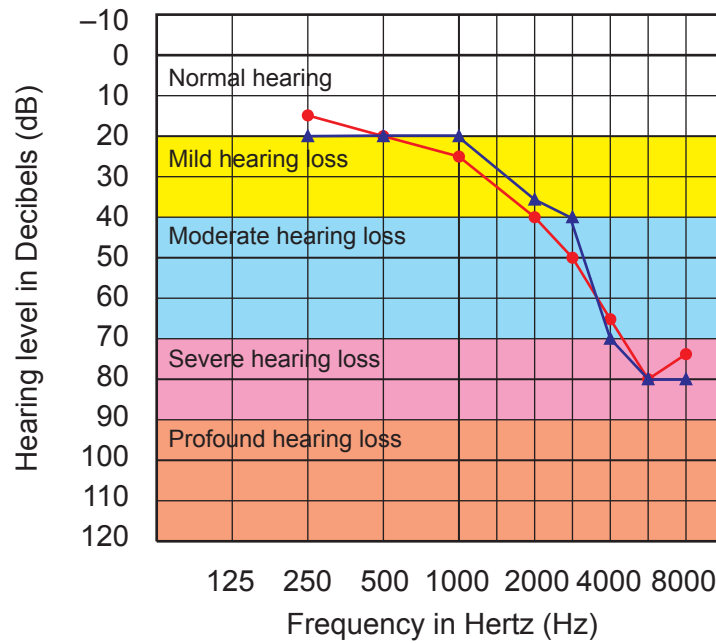


(Option B continued)

9. Figure B4 shows an audiogram for a person with age-related hearing loss.

Figure B4: An audiogram

Key:  
 Left ear ●  
 Right ear ▲



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

(a) Outline **one** advantage of using a programmable interface controller (PIC) to implement the circuitry for a hearing aid. [2]

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(b) Outline **one** reason why a filter is a key element in the design of a digital hearing aid. [2]

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**Option C — CAD/CAM**

13. Fuse deposition modeling (FDM) was used to make a lightweight plastic jacket/exoskeleton for a two-year-old child born with a rare condition that weakened her muscles and joints preventing her from lifting her arms. The child was too small to be fitted with a conventional metal exoskeleton and so was given plastic arms attached to a plastic jacket fitted around her body (**Figure C1**).

**Figure C1: A small child fitted with a lightweight plastic exoskeleton**



[Source: Wilmington Robotic Exoskeleton (WREX) developed by researchers at Nemours/Alfred I. Dupont Hospital for Children. Used with permission.]

- (a) State **one** advantage of using FDM to produce the child's plastic jacket and arms. [1]

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- (b) Outline **one** benefit of using FDM in the design and development of the child's plastic jacket and arms. [2]

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(Option C continues on the following page)



**(Option C, question 13 continued)**

- (c) Explain how FDM can contribute to the customization of plastic arms for other children with the same condition. [3]

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- 14. (a) Define *G code*. [1]

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- (b) Describe how a 3D CAD drawing is converted into a file suitable for use in a CNC machine using G codes. [2]

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**(Option C continues on the following page)**



(Option C continued)

15. Figure C2 shows a section from the assembly instructions for a piece of flat-pack furniture.

**Figure C2: A section from the assembly instructions for a piece of flat-pack furniture**



(a) Outline how the increased use of CAD/CAM in furniture manufacture has developed the need for a wider range of knock down fittings. [2]

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(b) Describe how drawings in assembly instructions help consumers when assembling flat-pack furniture. [2]

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Option D — Textiles

19. Figure D1 shows a shirt which can be manufactured from cotton and/or polyester.

Figure D1: A shirt which can be manufactured from cotton and/or polyester



[Source: "Arrow Dress Shirt producing in a RMG factory of Bangladesh" by Fahad Faisal - Own work. Licensed under CC BY-SA 4.0 via Commons - [https://commons.wikimedia.org/wiki/File:Arrow\\_Dress\\_Shirt\\_producing\\_in\\_a\\_RMG\\_factory\\_of\\_Bangladesh.jpg#/media/File:Arrow\\_Dress\\_Shirt\\_producing\\_in\\_a\\_RMG\\_factory\\_of\\_Bangladesh.jpg](https://commons.wikimedia.org/wiki/File:Arrow_Dress_Shirt_producing_in_a_RMG_factory_of_Bangladesh.jpg#/media/File:Arrow_Dress_Shirt_producing_in_a_RMG_factory_of_Bangladesh.jpg)]

(a) State **one** reason why a shirt made from 100% cotton fabric may be given a surface finish. [1]

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(b) Outline **one** reason why cotton thread has a very high tensile strength in relation to its mass. [2]

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(Option D continues on the following page)



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(Option D, question 19 continued)

- (c) Explain **one** reason why a shirt made from polyester is more environmentally friendly than one made from cotton in relation to maintenance. [3]

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- 20. (a) State **one** piece of information provided on textile labels other than care instructions. [1]

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- (b) Outline **one** reason why many textile garments are displayed in retail outlets without packaging. [2]

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(Option D continues on the following page)



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(Option D continued)

21. Figure D2 shows some socks manufactured in wool and nylon.

Figure D2: Socks manufactured in wool and nylon



[Source: "Rainbow Toe Sock Challenge" by S B from Sydney, Australia - The toe sock challenge. Licensed under CC BY 2.0 via Commons -

[https://commons.wikimedia.org/wiki/File:Rainbow\\_Toe\\_Sock\\_Challenge.jpg#/media/File:Rainbow\\_Toe\\_Sock\\_Challenge.jpg](https://commons.wikimedia.org/wiki/File:Rainbow_Toe_Sock_Challenge.jpg#/media/File:Rainbow_Toe_Sock_Challenge.jpg)]

(a) Outline **one** reason, other than cost, why the socks shown in **Figure D2** may be made from a mix of wool (62%) and nylon (38%). [2]

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(b) Outline **one** reason why wool is a suitable raw material for use in craft production by local people in communities world-wide. [2]

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**Option E — Human factors design**

25. **Figure E1** shows a 2D anthropometric model made from plastic and commercially available in a range of sizes/scales.

**Figure E1: 2D plastic anthropometric model**



[Source: <http://earlyyears.com.au/magnetic-human-manikin-cb849.html>]

- (a) State the percentile range that determines the size of 2D anthropometric models most likely to be used by manufacturers working on products for the mass market. [1]

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- (b) Describe the function of the 2D model in **Figure E1**. [2]

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(Option E continues on the following page)



**(Option E, question 25 continued)**

- (c) Compare the effectiveness of the use of appearance prototypes with functional prototypes in relation to obtaining human factors data.

[3]

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- 26. (a) State why intuitive logic is an important characteristic of a good user-product interface.

[1]

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- (b) Outline **one** reason why designers knowingly design products which have a high memory burden.

[2]

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**(Option E continues on the following page)**



(Option E continued)

27. Figure E2 shows an open-plan office.

Figure E2: "Bullpen" open-plan office



[Source: "OpenPlanRedBalloon1" by VeronicaTherese - Own work. Licensed under CC BY-SA 3.0 via Commons - <https://commons.wikimedia.org/wiki/File:OpenPlanRedBalloon1.jpg#/media/File:OpenPlanRedBalloon1.jpg>]

(a) Outline how air velocity affects thermal comfort in an open-plan office such as the one shown in Figure E2.

[2]

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(b) Describe how legislation is used to decide the range of temperature suitable for a working environment.

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(Option E continues on the following page)



**(Option E continued)**

**28.** Outline the function of sensory processes in a human-information processing system. [2]

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