Diploma Programme
Programme du diplôme
Programa del Diploma

Design technology
Standard level
Paper 3

Monday 16 November 2015 (morning)

1 hour

Candidate session number

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

8815 – 6206

31 pages

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]

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

(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]

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

(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]

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

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

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

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

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

(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. [2]

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

(b) Outline **one** reason why a number of products **not** containing nuts may be labelled with warnings that they may contain nuts. [2]

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

(Option A continues on the following page)

(Option A continued)

4. Describe the role of antioxidants in foods (for example the role of the antioxidant ascorbyl palmitate in vegetable oils). [2]

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

5. Discuss the influence of market pull and technology push on the development of new food products. [6]

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

(Option A continues on the following page)

(Option A continued)

6. Explain **three** ways in which on-farm food processing contributes to economic, social and environmental sustainability for a farm and the rural economy. [9]

End of Option A

Please **do not** write on this page.

Answers written on this page
will not be marked.

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

Removed for copyright reasons

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

Removed for copyright reasons

Figure B3: Elements in the BCD decoder circuitry

Removed for copyright reasons

(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]

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

(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	$\bar{A}_0\bar{A}_1$	$A_1\bar{A}_0$	$A_1\bar{A}_2$	$A_2\bar{A}_1A_0$	$A_2\bar{A}_1$	$A_2\bar{A}_0$
Input	00			10	01	10	100	10	10
Output	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]

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

(Option B continues on the following page)

(Option B continued)

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

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

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

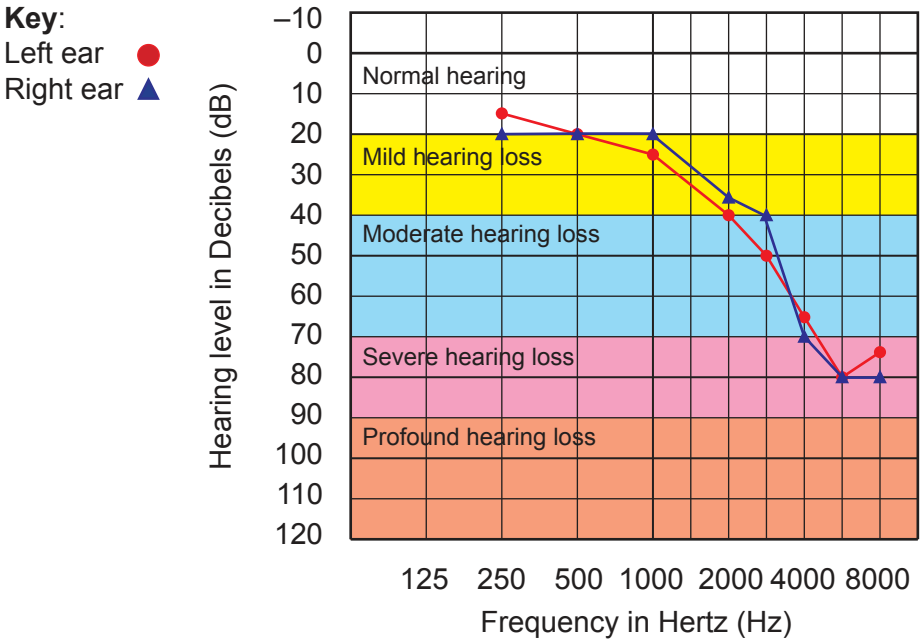
. . . . . .
. . . . . .
. . . . . .
. . . . . .

(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



[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]

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

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

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

(Option B continues on the following page)

(Option B continued)

10. Describe how a light-dependent resistor (LDR) can be used to produce a light sensitive switch. [2]

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

11. Explain **two** implications of there being no national power grid in remote areas of developing countries for an aid agency which has to respond to a humanitarian crisis. [6]

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

(Option B continues on the following page)

(Option B continued)

12. Discuss the implications of company-specific standards for brands, accessories and patents in the marketplace. [9]

End of Option B

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]

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

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

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

(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]

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

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

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

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

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

(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

Removed for copyright reasons

(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]

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

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

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

(Option C continues on the following page)

(Option C continued)

16. Describe subtractive manufacturing techniques. [2]

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

17. Discuss **two** considerations for a manufacturer when choosing CNC equipment. [6]

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

(Option C continues on the following page)

(Option C continued)

18. Discuss **three** contexts in which haptic technology has enhanced design capability. [9]

End of Option C

Please **do not** write on this page.

Answers written on this page
will not be marked.

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]

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

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

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

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

(Option D continues on the following page)

(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]

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

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

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

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

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

(Option D continues on the following page)

(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]

(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]

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

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

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

(Option D continues on the following page)

(Option D continued)

22. Describe **one** way in which the development of Gore-tex material has contributed to the improved performance of sportsmen/women. [2]

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

23. Discuss **two** limitations for the consumer of buying clothing via the Internet. [6]

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

(Option D continues on the following page)

(Option D continued)

24. Discuss **three** reasons why natural silk remains a popular material for clothing despite the existence of cheaper synthetic alternative materials. [9]

End of Option D

Please **do not** write on this page.

Answers written on this page
will not be marked.

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://earlyears.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]

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

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

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

(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]

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

26. (a) State why intuitive logic is an important characteristic of a good user-product interface. [1]

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

(b) Outline **one** reason why designers knowingly design products which have a high memory burden. [2]

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

(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]

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

(b) Describe how legislation is used to decide the range of temperature suitable for a working environment. [2]

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

(Option E continues on the following page)

(Option E continued)

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

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

(Option E continues on the following page)

(Option E continued)

29. **Figure E3** shows one of the first mobile phones available in 1984. It was commonly referred to as "the brick" phone. **Figure E4** shows a mobile phone, commonly referred to as "the candy bar" from 2003.

Figure E3: "The brick" mobile phone

Figure E4: "Candy bar" mobile phone

[Source: For "the brick": "DynaTAC8000X" by Redrum0486 - http://en.wikipedia.org/wiki/File:DynaTAC8000X.jpg. Licensed under CC BY-SA 3.0 via Wikimedia Commons - https://commons.wikimedia.org/wiki/File:DynaTAC8000X.jpg#/media/File:DynaTAC8000X.jpg
For "the candy bar": "Nokia E51 Black" by The original uploader was Feci1024 at English Wikipedia - Transferred from en.wikipedia to Commons by Sevela.p using CommonsHelper. Licensed under Public Domain via Commons - https://commons.wikimedia.org/wiki/File:Nokia_E51_Black.jpg#/media/File:Nokia_E51_Black.jpg]

Compare the two phones in relation to the influence of anthropometrics on their designs. [6]

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

(Option E continues on the following page)

(Option E continued)

30. Compare the use of clay, card and polymorph as effective materials for human factors modelling. [9]

End of Option E

Please **do not** write on this page.

Answers written on this page
will not be marked.