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Diploma Programme
Programme du diplôme
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Design technology
Higher level
Paper 3

Monday 16 November 2015 (morning)

1 hour 15 minutes

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 **[40 marks]**.

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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)

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(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) State the temperature danger zone for bacterial growth. [1]

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(b) Outline **one** reason why large items of food, such as a joint of meat, need longer cooking times than smaller items of food. [2]

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(Option A continues on the following page)

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(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]

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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. [2]

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(Option A continues on the following page)

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(Option A continued)

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

(Option A continues on the following page)

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(Option A continued)

5. (a) List **two** factors that drive the development of genetically modified organisms in the food industry. [2]

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(b) Outline **one** reason for the importance of genetically modified (GM) foods being traceable. [2]

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(c) Outline **one** reason why it is important for a manufacturer to establish a market for a new food product. [2]

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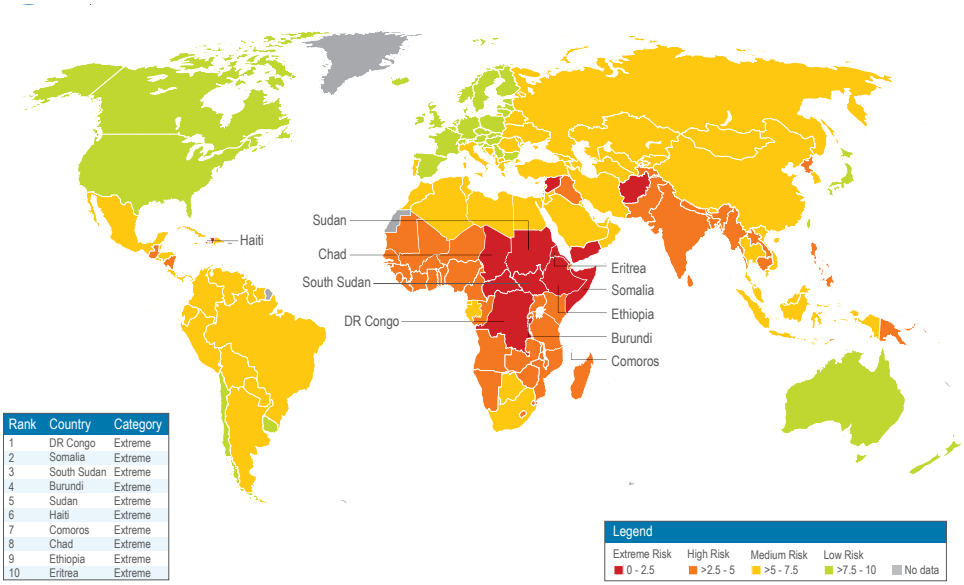
(Option A continued)

6. **Figure A4** shows a global map of food security risk.

Figure A4: Global map of food security risk



Rank	Country	Category
1	DR Congo	Extreme
2	Somalia	Extreme
3	South Sudan	Extreme
4	Burundi	Extreme
5	Sudan	Extreme
6	Haiti	Extreme
7	Comoros	Extreme
8	Chad	Extreme
9	Ethiopia	Extreme
10	Eritrea	Extreme

[Source: Verisk Maplecroft. www.maplecroft.com]

(a) Explain why sub-Saharan Africa is particularly vulnerable to food insecurity. [3]

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(Option A, question 6 continued)

(b) Explain how poor road infrastructure contributes to local and national strategies for food security. [3]

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(Option A continued)

7. 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

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Option B — Electronic product design

8. **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)

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(Option B, question 8 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	$\bar{A}_0\bar{A}_1$	$A_1\bar{A}_0$	$A_1\bar{A}_2$	$A_2\bar{A}_1A_0$	$A_2\bar{A}_1$	$A_2\bar{A}_0$
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]

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(Option B continued)

9. (a) Define *bit rate*. [1]

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(b) List **two** limitations of a home security data link with a limited bit rate capacity. [2]

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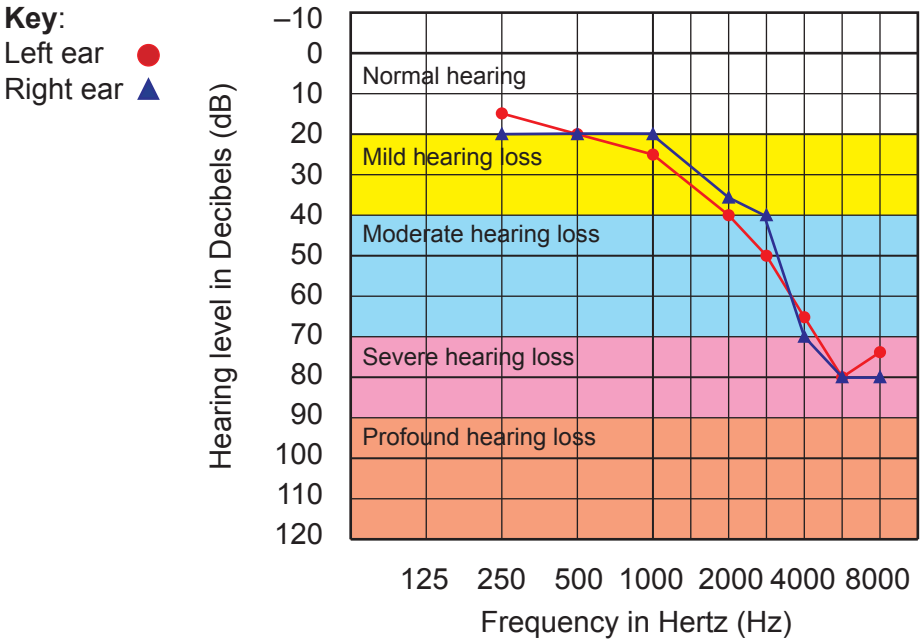
(Option B continued)

10. **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]

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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 B continued)

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]

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(Option B continued)

12. (a) Outline **one** way in which miniaturization has helped to promote design for dematerialization. [2]

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(b) Outline **one** strategy that can be used to promote the disassembly of electronic products. [2]

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(c) List **two** implications of product stewardship for manufacturers. [2]

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(Option B continued)

13. (a) Explain how modern electronic computer systems are used to monitor and perform functions in the home. [3]

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(b) Discuss **one** ethical issue relating to the use of a home security system. [3]

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(Option B continued)

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

End of Option B

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Option C — CAD/CAM

15. Fuse deposition modelling (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, question 15 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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16. (a) State **one** way in which information and communication technologies enable clients to be more involved in the design process. [1]

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(b) Outline **one** benefit of clients being more involved in the design process. [2]

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(Option C continues on the following page)

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(Option C continued)

17. **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]

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

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(Option C continues on the following page)

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(Option C continued)

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

(Option C continues on the following page)

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(Option C continued)

19. (a) Outline **one** way in which robots contribute to quality control in manufacture. [2]

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(b) Outline **one** way in which robots facilitate waste reduction in manufacturing. [2]

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(c) Outline **one** issue relating to replacing the human workforce with robots. [2]

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(Option C continued)

20. (a) Explain **one** way in which CAD/CAM enhances quality assurance in manufacturing. [3]

(b) Explain **one** characteristic of a material that makes it unsuitable for CAM. [3]

(Option C continues on the following page)

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(Option C continued)

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

End of Option C

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Option D — Textiles

22. **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]

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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, question 22 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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23. (a) State **one** way in which fair trade regulations have an impact on workers in a factory operated by a multi-national company situated in a developing country. [1]

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(b) Outline **one** reason for the imposition of import quotas on textile products. [2]

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(Option D continued)

24. **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]

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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 D continued)

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

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(Option D continued)

26. (a) Outline **one** reason why the EU Flower system has not been widely adopted by clothing manufacturers. [2]

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(b) Outline **one** limitation of the EU Flower system in relation to quality assurance for consumers. [2]

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(c) Outline **one** way in which the EU Flower system benefits the health of the user of a textile garment. [2]

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(Option D continued)

27. (a) Discuss how technology push has an impact on the wearable computing market. [3]

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(b) Discuss **one** reason why wearable computing garments are seen as niche market products. [3]

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(Option D continued)

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

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End of Option D

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Option E — Human factors design

29. **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]

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

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(Option E, question 29 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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30. (a) State **one** way in which legislation has improved access to buildings for wheelchair users. [1]

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(b) Outline **one** reason why pressure management is an important consideration in the design of a wheelchair. [2]

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(Option E continued)

31. **Figure E2** shows an open-plan office.

Figure E2: 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. [2]

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(Option E continued)

32. **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]

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(Option E continued)

33. **Figure E5** shows a jar opener designed for people with limited hand movement.

Figure E5: A jar opener

[Source: www.eddingtons.co.uk. Used with permission.]

(a) Describe how the jar opener makes it easier to open the jar for people with limited hand movement. [2]

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(b) Outline the impact of torque on the action of unscrewing the lid of a jar without the use of a jar opener. [2]

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(Option E continues on the following page)

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(Option E, question 33 continued)

(c) Outline **one** psychological human factor that would have an impact on the ability of able-bodied consumers to unfasten the lid of a jar. [2]

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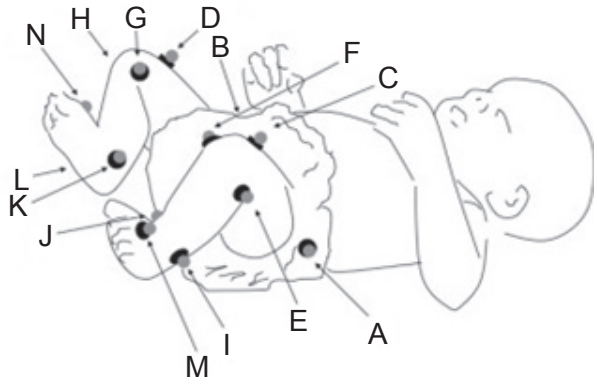
(Option E continued)

34. **Figure E6** shows where sensors/markers have been placed on a baby in order to track, via motion capture technology, its movement as it interacts with a mobile suspended over its cot as shown in **Figure E7.**

Figure E6: Digital human image



[Source: Reprinted from *Chaos, Solitons & Fractals*, 2012, 45(9–10), 1201. Damian G. Stephen, Wen-Hao Hsu, Diana Young, Elliot L. Saltzman, Kenneth G. Holt, Dava J. Newman, Marc Weinberg, Robert J. Wood, Radhika Nagpal, Eugene C. Goldfield, "Multifractal fluctuations in joint angles during infant spontaneous kicking reveal multiplicativity-driven coordination", with permission from Elsevier.]

Figure E7: A baby interacting with a mobile suspended over its cot

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

(a) Explain how motion capture technology is used to digitally represent the motion of the baby shown in **Figure E6**. [3]

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(Option E, question 34 continued)

(b) Explain how a digital image of the baby in **Figure E6** can be used in the design development of the cot mobile in **Figure E7**. [3]

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(Option E continued)

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

End of Option E

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