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DESIGN TECHNOLOGY
STANDARD LEVEL
PAPER 3

Candidate session number

Wednesday 19 November 2014 (morning)

1 hour

Examination code

8 8 1 4 – 6 2 0 6

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. **Figure A1** shows a bowl of homemade mayonnaise. The ingredients are shown in **Figure A2**. Mayonnaise is a food emulsion that is made by beating egg yolks, salt, mustard, sugar, pepper, lemon juice (or vinegar) and sunflower oil until it is very thick. The mayonnaise should be stored chilled in the refrigerator for no longer than one week.

Figure A1: A bowl of homemade mayonnaise

Figure A2: Ingredients for mayonnaise

- 2 egg yolks
- 5 g mustard
- 5 ml vinegar
- 100 ml sunflower oil
- 10 ml lemon juice (or vinegar)
- 3 g sugar
- Salt and freshly cracked black pepper (to taste)

[Source: http://commons.wikimedia.org/wiki/File:Fresh_mayonnaise.jpg]

(a) State which ingredient listed in **Figure A2** acts as the emulsifying agent for the mayonnaise. *[1]*

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(b) Describe the structure of a food emulsion, such as mayonnaise. *[2]*

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(Option A continues on the following page)

(Option A, question 1 continued)

(c) Explain why the mayonnaise should be stored chilled in the fridge. *[3]*

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2. (a) Define *food intolerance.* *[1]*

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(b) Describe how a gluten-free diet can be achieved. *[2]*

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(Option A continues on the following page)

(Option A continued)

3. **Figure A3** shows a picture of a stall in a farmers' market in Santiago, Chile.

Figure A3: A stall in a farmers' market in Santiago, Chile.

[Source: © International Baccalaureate Organization 2015]

(a) Outline **one** advantage of farmers' markets, such as the one shown in **Figure A3**, to consumers. *[2]*

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(b) Outline **one** advantage of farmers' markets to farmers. *[2]*

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(Option A continues on the following page)

(Option A continued)

4. Outline **one** reason for the primary packaging of food. *[2]*

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5. Explain how obesity and a food poisoning outbreak impact differently on health services. *[6]*

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(Option A continues on the following page)

(Option A continued)

6. Explain **three** ways in which food choice would be affected by awareness of the implications of fat, fibre and salt intakes for health. *[9]*

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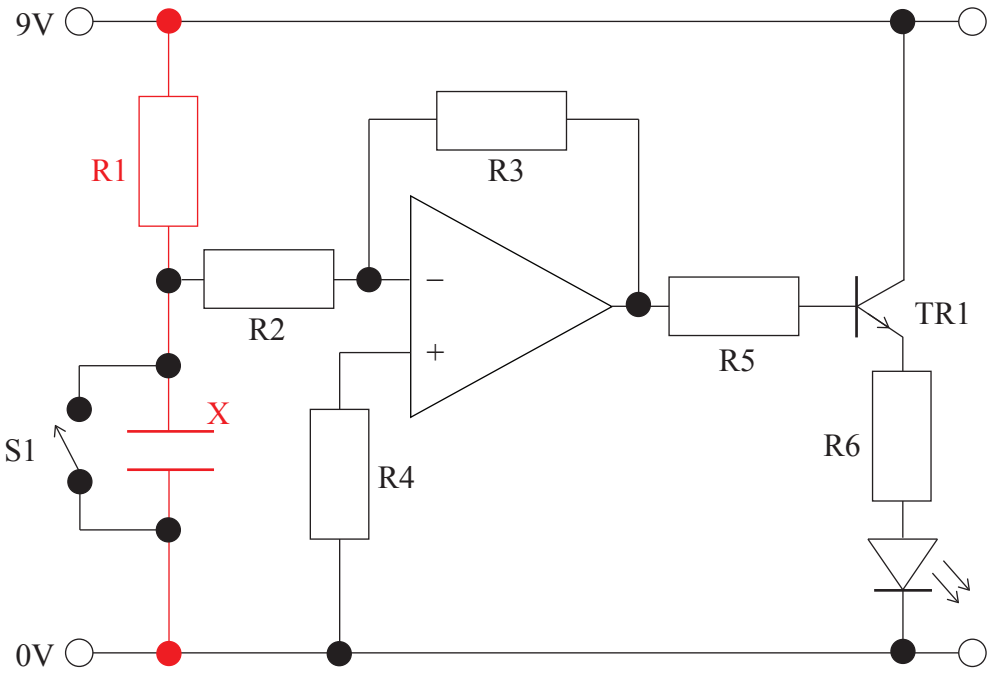
End of Option A

Option B — Electronic product design

7. **Figure B1** shows a circuit to operate a time delay on an LED.

Figure B1: Circuit diagram



(a) State the type of the component labelled X in **Figure B1**. *[1]*

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(b) Describe the function of the R1-X combination (shown in red) in **Figure B1**. *[2]*

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(Option B continues on the following page)

(Option B, question 7 continued)

(c) Explain how the circuit shown in **Figure B1** works when the switch labelled S1 is open. *[3]*

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8. (a) Define *bandwidth.* *[1]*

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(b) Outline **one** disadvantage of copper cables for information transfer. *[2]*

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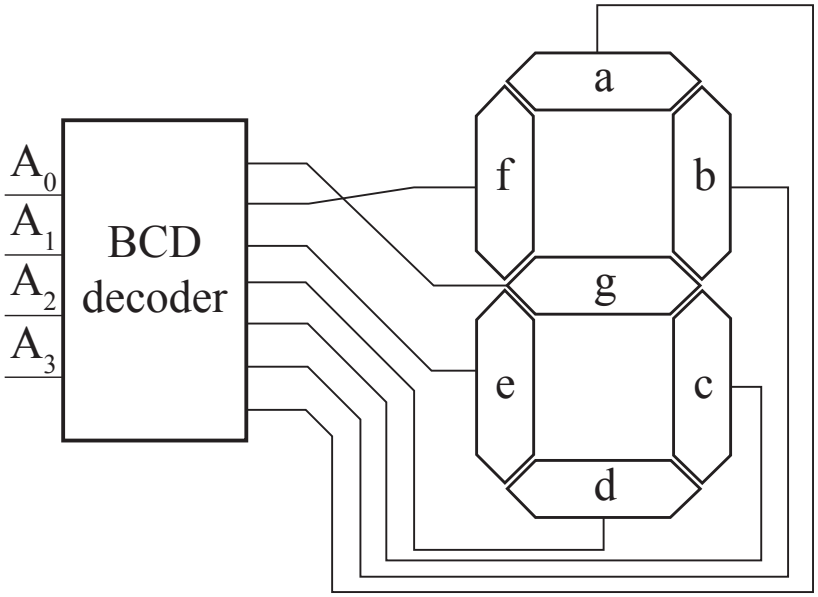
(Option B continues on the following page)

(Option B continued)

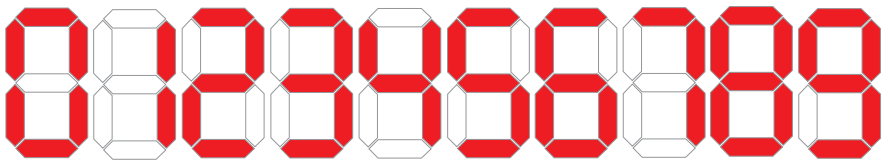
9. **Figure B2** shows a binary coded decimal (BCD) to seven-segment decoder. The segments are made of light-emitting diodes (LEDs). **Figure B3** shows the combinations of segments that result in the various digits from 0 to 9.

Figure B2: A binary coded decimal to seven-segment decoder



[Source: © International Baccalaureate Organization 2015]

Figure B3: 0-9 on a seven-segment display.



[Source: © International Baccalaureate Organization 2015]

(a) List **two** reasons for using LEDs for the segments of the seven-segment display. *[2]*

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(b) Complete the truth table for the decimal number 7. *[2]*

Number	A_3	A_2	A_1	A_0	a	b	c	d	e	f	g
7											

(Option B continues on the following page)

(Option B continued)

10. **Table B1** shows a truth table for a digital logic gate.

Table B1: A truth table

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

State the name of the digital logic gate and the Boolean expression equivalent to the truth table shown in **Table B1**. *[2]*

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(Option B continues on the following page)

(Option B continued)

11. Explain how programmable interface controllers (PICs) can contribute to the implementation and on-going sustainability of hearing aids. *[6]*

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(Option B continues on the following page)

(Option B continued)

12. In September 2012 Apple launched its new iPhone with a 19-pin (Lightning) connector (**Figure B4**) rather than the 30-pin connector used on all its portable devices (**Figure B5**). While the change made sense for Apple – the smaller connector gives more space inside the phone for a bigger battery – it caused a heated debate amongst existing customers who were upset at the change of connector which forced them to buy a new adapter (**Figure B6**).

Figure B4: Apple's new 19-pin Lightning connector

Figure B5: Apple's original 30-pin connector

Figure B6: Lightning to 30-pin adapter

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Fig. B4 Please go t:o http://cdn1.appleinsider.com/lightning-120914.jpg
Fig. B5 please go to: http://images.intomobile.com/wp-content/uploads/2012/06/apple-30-pin-dock-connector.jpg
Fig. B6 please go to: http://store.storeimages.cdn-apple.com/3582/as-images.apple.com/is/image/AppleInc/MD823?wid=400&hei=400&fmt=jpeg&qlt=95&op_sharpen=0&resMode=bicub&op_usm=0.5,0.5,0,0&iccEmbed=0&layer=comp&.v=1352513162037

Discuss the implications of changing company-specific standards, such as the Apple connectors, for brand loyalty, accessories and patents. *[9]*

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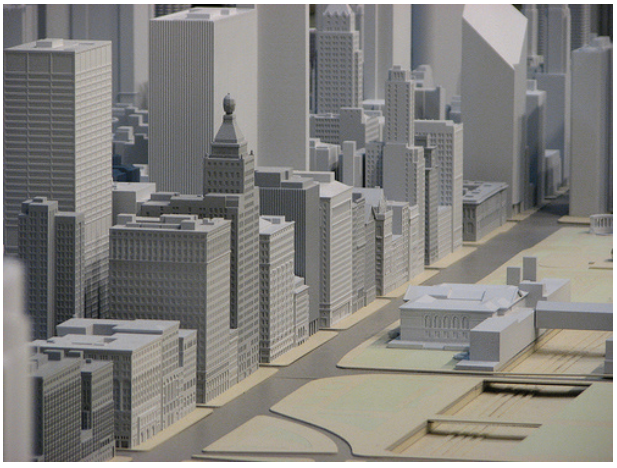
End of Option B

Option C — CAD/CAM

13. The Chicago Architecture Foundation has built a model of the city (**Figure C1**). The 1000 buildings took 3000 hours to build using stereo lithography.

Figure C1: The Chicago Model City



[http://chicagomodelcity.org]

(a) State **one** reason why the production of the model city's buildings using stereo lithography resulted in very little waste. *[1]*

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(b) Outline **one** advantage of choosing stereo lithography rather than fuse deposition modelling (FDM) to produce the model. *[2]*

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(Option C continues on the following page)

(Option C, question 13 continued)

(c) Suggest **one** possible method the Chicago Architecture Foundation may have used to generate the necessary CAD files for use with stereo lithography. *[3]*

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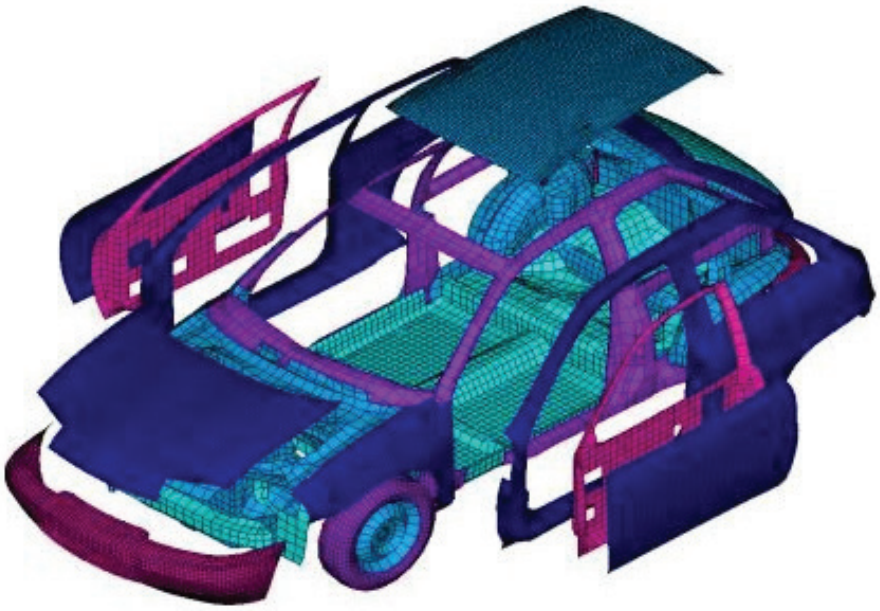
(Option C continues on the following page)

(Option C continued)

14. **Figure C2** shows a finite element analysis (FEA) simulation for the structure of a car during its design development.

Figure C2: Finite element analysis of a car during its design development



[Source: www.fea-optimization.com]

(a) State **one** reason why designers need to specify materials prior to an FEA simulation. *[1]*

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(b) Outline **one** advantage of FEA simulation over real-life testing for the structural analysis of a car. *[2]*

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(Option C continues on the following page)

(Option C continued)

15. CAD software can be used for "top down" or "bottom up" modelling of parts, components and complete products, such as the Moon exploration vehicle and its wheels (**Figure C3**).

Figure C3: Exploded solid CAD model of a Moon exploration vehicle

Please go to the link: http://www.rocketcityspacepioneers.com/space/lunar-rover-design-challenges—-environmental-issues

(a) Outline **one** benefit of using "bottom up" modelling in the development of the solid CAD model of the Moon exploration vehicle. *[2]*

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(b) Identify **one** limitation of surface modelling for rapid prototyping (RP) the model of the Moon exploration vehicle shown in **Figure C3**. *[2]*

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(Option C continues on the following page)

(Option C continued)

16. Describe **one** way in which the use of CAD can contribute to the reduction in design costs. *[2]*

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17. Explain **two** ways in which a CAD/CAM system aids manufacturing for a multinational cosmetic company. *[6]*

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(Option C continues on the following page)

(Option C continued)

18. Explain how machine tool step variables, cutting tool diameter and machine path impact on the surface finish of a computer numerical control (CNC) machined metal mould for use in injection moulding. *[9]*

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End of Option C

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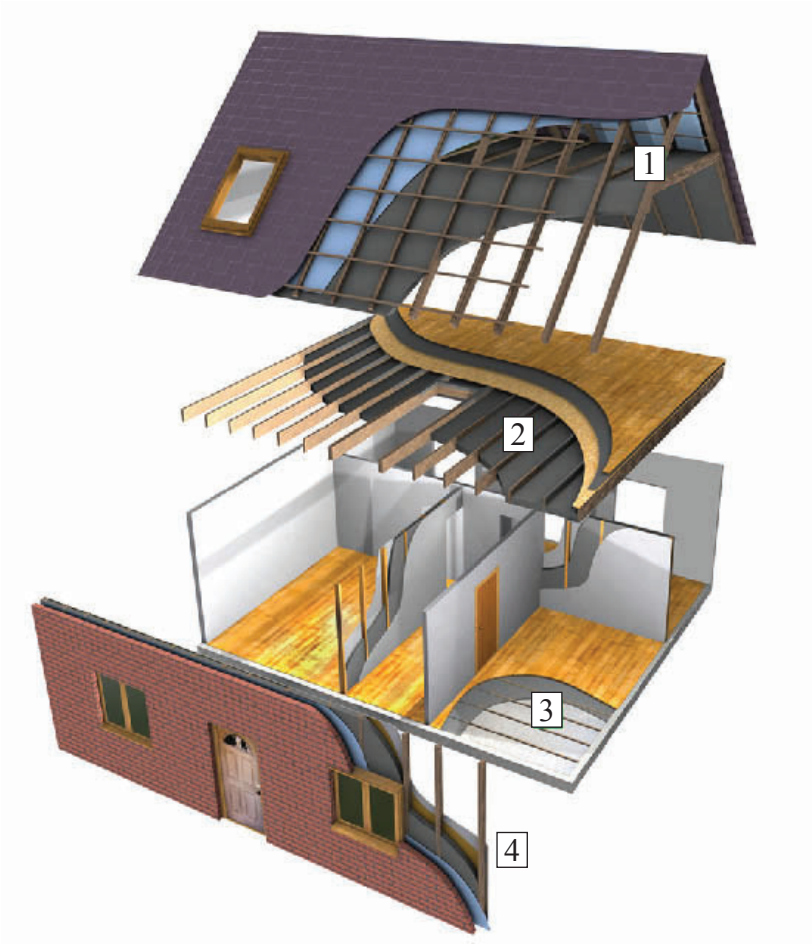
Option D — Textiles

19. Wool can be used as an insulating material to enhance the energy efficiency of buildings as shown in **Figure D1**.

Figure D1: Natural wool insulation



1: Attic/Loft Ceiling Level
2: Between Floors
3: Ground Floor
4: Within Walls

[Source: http://uk.sheepwoolinsulation.com]

(a) Define *fibre*. *[1]*

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(Option D continues on the following page)

(Option D, question 19 continued)

(b) Outline **one** reason why wool needs to be treated before being used as an insulating material in the walls of a building. *[2]*

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(c) Explain **one** reason why wool is an appropriate insulating material for the walls of a building. *[3]*

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20. (a) State the importance of biocompatibility in the design of a textile vascular graft. *[1]*

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(b) Outline **one** reason why regulatory bodies only approve the use of textile materials for specific medical applications. *[2]*

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(Option D continues on the following page)

(Option D continued)

21. In 1928 Speedo® introduced the first non-wool swimsuit – the Racerback which revolutionized competitive swimming. In 2000, it introduced Fastskin® technology which again revolutionized swimwear for elite swimmers. **Figure D2** shows an enlarged image of Speedo® Fastskin® material which is used for the manufacture of swimwear for elite swimmers.

Figure D2: enlarged image of Speedo® Fastskin® material

Removed for copyright reasons
Please go to: scienceinthenews.org.uk/contents/?article=8

(a) Outline **one** reason why Speedo® Fastskin® is an example of a biomimetic material. *[2]*

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(b) Outline **one** reason why wool is an unsuitable material for swimsuits. *[2]*

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(Option D continues on the following page)

(Option D continued)

22. Outline **one** way in which ecofans can ensure they purchase environmentally-friendly textile garments when considering care and maintenance of the garments. *[2]*

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(Option D continues on the following page)

(Option D continued)

23. **Figure D3** shows men's ties which can be produced from 100 % silk or 100 % polyester.

Figure D3: Men's ties

[Source: «Krawaty». Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Krawaty.jpg#mediaviewer/File:Krawaty.jpg]

Compare **two** characteristics of a tie made from silk with the same design as a tie made from polyester. *[6]*

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(Option D continues on the following page)

(Option D continued)

24. Compare nylon with cotton as the material for expedition tents used by backpackers in relation to tensile strength, density and thermal conductivity. *[9]*

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End of Option D

Option E — Human factors design

25. **Table E1** shows data relating to the Control of Noise at Work Regulations which came into force in the UK in 2006.

Table E1: Daily or weekly noise level exposure levels (UK)

Exposure level	Action required by employer
80 db	Employers must carry out an assessment of the risk to employees health
85 db	Employers must provide hearing protection and hearing protection zones
87 db	Employers must not allow continuous employee exposure above this level

[Source:www.hse.gov.uk]

(a) State **one** health issue associated with exposure to excessive noise. *[1]*

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(b) Outline **one** reason why equipment, such as a road drill, that creates noise in excess of 87 db is allowed to be used. *[2]*

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(Option E continues on the following page)

(Option E, question 25 continued)

(c) Explain **one** reason why fire alarms are designed to exceed 87 db. *[3]*

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26. (a) Define *anthropometrics.* *[1]*

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(b) A student wants to measure the heights of her classmates in order to compare percentile values. She asks the students to stand against a wall (bare footed) so she can make a mark on the wall at the top of each of their heads.

Outline **one** variable that may affect the data collected apart from inaccurate measuring. *[2]*

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(Option E continues on the following page)

(Option E continued)

27. **Figure E1** shows a Kitchencraft butterfly can opener. **Figure E2** shows a can being opened using the can opener.

Figure E1: Kitchencraft butterfly can opener

[Source: http://smithandwebbcookshop.com]

Figure E2: Opening a can

Removed for copyright reasons

(a) Outline **one** human factor reason why the flat handle of the can opener has a twist in it. *[2]*

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(b) Outline **one** human factor reason for including the holes in the rotating head part of the can opener. *[2]*

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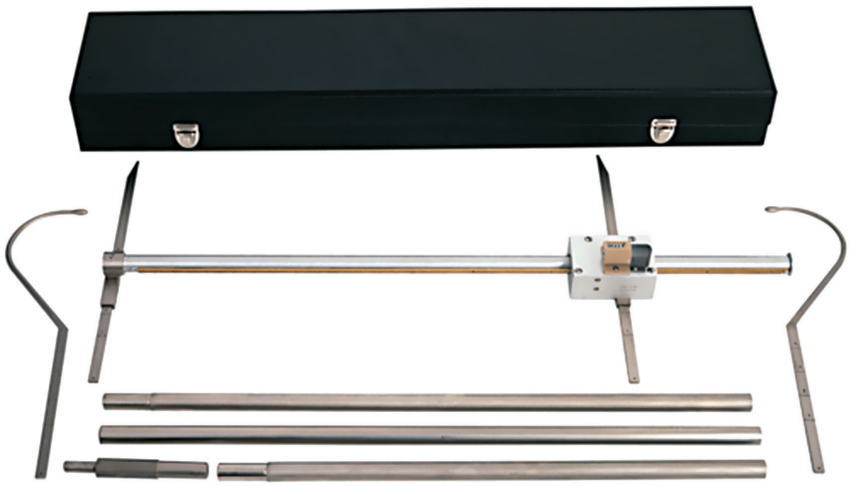
(Option E continues on the following page)

(Option E continued)

28. **Figure E3** shows a Harpenden anthropometer.

Figure E3: A Harpenden anthropometer



[Source: https://mentone-educational.com]

Describe the function of the Harpenden anthropometer shown in **Figure E3**. *[2]*

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(Option E continues on the following page)

(Option E continued)

29. Before the development of the QWERTY keyboard in 1873 by Christopher Sholes the keys of mechanical typewriters often jammed if two adjoining keys were struck rapidly in succession. Sholes rearranged the keys so that the most commonly-used letter sequences were spread out which meant typing took longer.

Discuss memory burden and mapping in relation to the use of the QWERTY keyboard. *[6]*

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(Option E continues on the following page)

(Option E continued)

30. Explain **three** ways in which the use of a kitchen work triangle at the design development stage can improve human factors considerations. *[9]*

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End of Option E

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