N14/4/DESTE/HP3/ENG/TZ0/XX/M

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MARKSCHEME

November 2014

DESIGN TECHNOLOGY

Higher Level

Paper 3

23 pages

General Marking Instructions

Assistant Examiners (AEs) will be contacted by their team leader (TL) through Scoris™, by e-mail or telephone – if through Scoris™ or by e-mail, please reply to confirm that you have downloaded the markscheme from IBIS. The purpose of this initial contact is to allow AEs to raise any queries they have regarding the markscheme and its interpretation. AEs should contact their team leader through Scoris™ or by e-mail at any time if they have any problems/queries regarding marking. For any queries regarding the use of Scoris™, please contact emarking@ibo.org.

1. Follow the markscheme provided, award only whole marks and mark only in **RED**.

2. Make sure that the question you are about to mark is highlighted in the mark panel on the right-hand side of the screen.

3. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded.**

4. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases use Scoris™ annotations to support your decision. You are encouraged to write comments where it helps clarity, especially for re-marking purposes. Use a text box for these additional comments. It should be remembered that the script may be returned to the candidate.

5. Personal codes/notations are unacceptable.

6. Where an answer to a part question is worth no marks but the candidate has attempted the part question, use the "ZERO" annotation to award zero marks. Where a candidate has not attempted the part question, use the "SEEN" annotation to show you have looked at the question. Scoris™ will apply "NR" once you click complete.

7. If a candidate has attempted more than the required number of questions within a paper or section of a paper, mark all the answers. Scoris™ will only award the highest mark or marks in line with the rubric.

8. Ensure that you have viewed **every** page including any additional sheets. Please ensure that you stamp "SEEN" on any additional pages that are blank or where the candidate has crossed out his/her work.

9. There is no need to stamp an annotation when a candidate has not chosen an option. Scoris™ will apply "NR" once you click complete.

10. Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have got wrong. However, a mark should not be awarded where there is contradiction within an answer. Make a comment to this effect using a text box or the "CON" stamp.

Subject Details: Design Technology HL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer questions from **ONE** of the Options **[1 × 40 marks]**.
Maximum total = **[40 marks]**

1. A markscheme often has more marking points than the total allows. This is intentional.

2. Each marking point has a separate line and the end is shown by means of a semicolon (;).

3. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.

4. Words in brackets ( ) in the markscheme are not necessary to gain the mark.

5. Words that are underlined are essential for the mark.

6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by ***WTTE*** (or words to that effect).

8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking indicate this by adding **ECF** (error carried forward) on the script.

10. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the markscheme.

Option A — Food science and technology

1. (a) *Award **[1]** for stating which ingredient listed in Figure A2 acts as the emulsifying agent for the mayonnaise:*
egg yolk/lecithin in the egg yolk; ***[1]***

(b) *Award **[1]** for each of two distinct correct points in a description of the structure of a food emulsion, such as mayonnaise **[2 max]**.*
two phases – oil and lemon juice/vinegar;
stabilized by the emulsifying agent; ***[2]***

(c) *Award **[1]** for each of three distinct correct points in an explanation of why the mayonnaise should be stored chilled in the fridge for no longer than a week **[3 max]**.*
chilling prevents the growth of food spoilage organisms;
this extends the safe storage life of food;
ensures it remains fit for consumption;

egg yolk is a high risk food;
if the mayonnaise were contaminated and stored in the temperature danger zone (10 – 63˚C) food poisoning bacteria could grow;
this would result in food poisoning; ***[3 max]***

2. (a) *Award **[1]** for a definition of genetically modified organism to the effect of:*
a plant or animal in which the DNA has been altered through the insertion of genetic material from another source; ***[1]***

(b) *Award **[1]** for a reason for the genetic modification of food crops and **[1]** for a brief explanation **[2 max]**.*
to enhance the resistance of the food crop to pathogens;
results in healthier/disease-free plants;

increased resistance to pesticides/herbicides;
eg resistance to Roundup Ready™;

enhanced growth rate;
take advantage of short growing season/enable planting of second crop;

enhance nutritional properties of food;
eg golden rice has higher content of vitamin A than normal rice;

increased profit;
less work for farmer/reduced tillage/reduced energy for fertilizer application;

reduced wastage;
many GM crops have longer shelf lifes;

enhanced growth rate;
able to grow in low moisture/desert conditions;

increased yield;
less land needed for cultivation; ***[2 max]***

3. (a) *Award **[1]** for one advantage of farmers' markets such as the one shown in Figure A3 to consumers and **[1]** for a brief explanation **[2 max]**.*
they allow direct contact between farmers (producers) and customers;
so customers know the origin/provenance of their produce;

shorter time to market;
food is fresher/better nutritional content;

farmers can help to inform consumers;
about how to cook and prepare fresh ingredients;

reduced food miles;
more environmentally friendly;

consumers support local businesses;
expression of community support / sustains local economy; ***[2 max]***

(b) *Award **[1]** for one advantage of farmer's markets to farmers and **[1]** for a brief explanation **[2 max]**.*
direct selling to consumers;
can sell produce at a higher price than to a supermarket / achieve a regular cash flow;

farmers can get direct feedback from the consumer;
on produce quality/prices;
cost effectiveness;
transport/packaging requirements reduced;

secure/regular access to market/local market penetration;
small-scale producers may not produce enough to sell to supermarkets;

farmers can sell what is ready;
more of some items and less of others;

reduced wastage of produce that is surplus to agreements with buyers;
the market allows this to be sold more easily; ***[2 max]***

4. *Award **[1]** for each distinct point in an explanation of how obesity and a food poisoning outbreak impact differently on health services **[3 max per type, 6 max]**.*
Obesity:
chronic/long-term impact;
more call on medical services (GP/hospital)/additional prescription costs;
cause long-term drain on resources of health services;

knock-on effects;
obesity causes other illnesses;
increases ongoing drain on resources of health services;

Food poisoning outbreak:
acute/short-term impact;
can involve a large number of people if caused in a public space, *eg* a hotel or a restaurant;
difficult for health services to plan for; ***[6 max]***

5. (a) *Award **[1]** for each of two distinct points in a description of how infective bacterial food poisoning is caused and **[1]** for a brief explanation **[2 max]**.*
food poisoning bacteria continue to grow in the gut of the person who has eaten the food;
their growth (and death) in the gut causes the symptoms of food poisoning; ***[2]***

(b) *Award **[1]** for each of two distinct points in a description of how toxin-type bacterial food poisoning is caused and **[1]** for a brief explanation **[2 max]**.*
bacteria growing in food produce toxins;
when the food is consumed the toxin causes illness; ***[2]***

(c) *Award **[1]** for a reason why cooking is ineffective in controlling toxin-type bacterial food poisoning and **[1]** for a brief explanation **[2 max]**.*
the toxin produced by the bacteria is not destroyed by heat;
so cooking does not control toxin-type bacterial food poisoning; ***[2]***

6. (a) *Award **[1]** for each of three distinct correct points in an explanation of the significance of poverty **[3 max]**.*
poverty is caused by the lack of basic education and access to resources;
poverty is the world's biggest killer / contributes to disease and premature death / can diverts government resources from other projects / prevents people from focusing on tasks beyond staying alive (*eg* Maslow's hierarchy);
overcoming poverty enables social and economic progress; ***[3]***

(b) *Award **[1]** for each of three distinct correct points in an explanation of the value of the human development index at a country level in the fight against poverty **[3 max]**.*
it combines key poverty-related issues into one holistic measure / considers poverty as more than a financial issue;
it can compare socio-economic trends in a country over time;
it can enable the evaluation of poverty alleviation strategies; ***[3]***

7. *Award **[1]** for each distinct correct point in an explanation of how food choice would be affected by awareness of the implications of fat, fibre and salt intakes for health **[3 max per way, 9 max total]**.*

Fat:
fat is essential for energy production;
however, high intakes of saturated fat contribute to cardio-vascular disease;
unsaturated vegetable oils rather than saturated animal fats should be eaten;

essential fatty acids are required for the structure of cell membranes;
they cannot be produced in the body and must be provided by the diet;
oily fish, certain seeds, vegetables and nuts are good sources of essential fatty acids;

Fibre:
fibre is an important non-nutrient for health of the gut;
it bulks the material left in the gut after digestion and decreases the time that it takes for food residues to pass through the gut;
high fibre foods, *eg* wholemeal bread, fruit, vegetables, promote health;

Salt:
excessive salt intake can cause high blood pressure/hypertension;
this can cause stroke and cardio-vascular disease;
salt intake should be moderated but is important for health;

some salt is needed in the diet;
it plays a role in water retention and muscle contraction;
processed foods may contain high levels of salt; ***[9 max]***

Option B — Electronic product design

8. (a) *Award **[1]** for stating the type of the component labelled X in Figure B1.*
capacitor; ***[1]***

(b) *Award **[1]** for each of two distinct points in a description of the function of the R1-X combination (shown in red) in Figure B1 **[2 max]**.*
it acts as a timer;
time constant (t in seconds) = R (in ohms) x C (in farads);

it is a time delay arrangement;
it can be charged slowly and then discharged according to time constant of the capacitor; ***[2 max]***

(c) *Award **[1]** for each of three distinct correct points in an explanation of how the circuit shown in Figure B1 works when the switch labelled S1is open **[3 max]**.*
when the switch is open the capacitor charges;
the op-amp drives the transistor on and lights the LED;
when S1 is closed, the LED stays on for the time equal to the time constant of the capacitor; ***[3]***

9. (a) *Award **[1]** for a definition of service costs to the effect of:*
the cost required to maintain or repair a product or system; ***[1]***

(b) *Award **[1]** for an outline of one way in which way in which service costs may encourage a consumer to replace an electronic product rather than repairing it and **[1]** for a brief explanation **[2 max]**.*
the service cost can include a call out charge;
a customer might get charged for a call out even if the product is not repairable;

the call out charge might not cover the cost of replacement parts/it may be cheaper to replace a product than repair it;
call out costs can be considerable;

labour costs as a component of service costs;
might be greater than the cost of a replacement; ***[2 max]***

10. (a) *Award **[1]** for each of two reasons for using LEDs for the segments of the seven-segment display. **[2 max]***
cost;
power consumption;
size;
longlife;
visible in the dark; ***[2 max]***

(b) *Award **[1]** for correctly completing the truth table for $A_3/A_2/A_1/A_0$ and **[1]** for correctly completing the truth table for a/b/c/d/e/f/g **[2 max]** as shown below:*

Number	**A_3**	**A_2**	**A_1**	**A_0**	**a**	**b**	**c**	**d**	**e**	**f**	**g**
7	0	1	1	1	1	1	1	0	0	0	0

[2]

11. *Award **[1]** for each distinct point in an explanation of each how programmable interface controllers (PICs) can contribute to the implementation and on-going sustainability of hearing aids. **[3 max per type, 6 max]**.*
Implementation:
a PIC can use a number of input and output devices;
it processes the input signal to generate an appropriate output signal;
in the processing it can amplify some wavelengths and filter others to match a person's hearing;

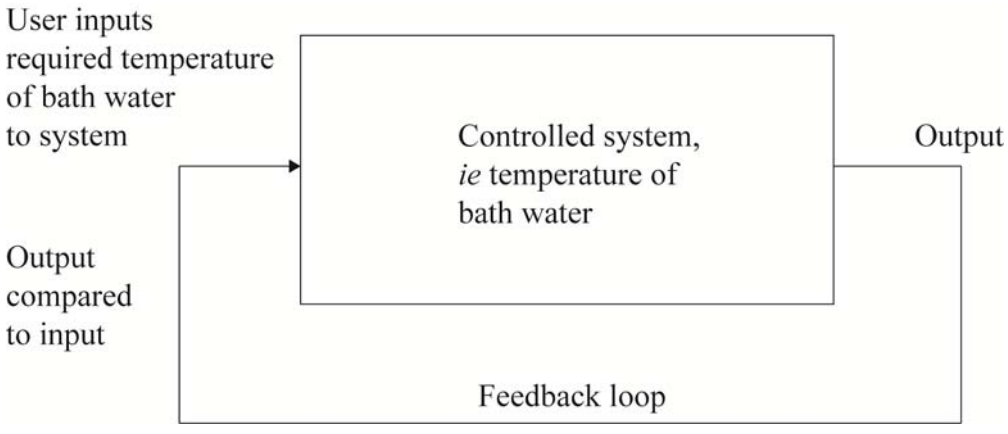
On-going sustainability:
the PIC can be reprogrammed to match a person's hearing as it changes over time;
thus it overcomes planned obsolescence;
the rest of the hearing aid can be used on an ongoing basis; ***[6]***

12. (a) *Award **[1]** for each of two distinct correct points in a description of how the automated bath system with water of the right temperature **[2 max]**.*
use of a temperature sensor and two valves;
to adjust the flow of hot and cold water into the bath; ***[2]***

(b) *Award **[1]** for each of two disadvantages of using a timer delay to determine the level of water in the bath in comparison to measuring the depth of water in the bath.*
bath may not be empty;
incoming pipes may be wider / narrower than expected; ***[2]***

flow rate of the tap may be variable over time;
time required may vary and preset timings may not be appropriate;

(c) *Award **[1]** for correctly drawing the closed loop system and **[1]** for the correct annotation of the closed loop system **[2 max]**.*



[2]

13. (a) *Award **[1]** for each of three distinct correct points in an explanation of one way in which product take-back legislation has impacted on the design of electronic products **[3 max]**.*
careful selection of recyclable materials/use of standard parts;
manufacturing products to make them easy to disassemble;
thus increasing reuse/recycling of components/materials; ***[3]***

(b) *Award **[1]** for each of three distinct correct points in an explanation of one way in which take-back legislation has impacted on the price of electronic products **[3 max]**.*
it becomes the manufacturers responsibility to take back the obsolete product for recycling/reuse rather than it being disposed to landfill;
the manufacturer needs to include in the cost of collecting and disposing of the obsolete product at the end of life;
this will increase the cost of the product; ***[3]***

14. *Award **[1]** for each distinct correct point in a discussion of the implications of changing company-specific standards, such as the Apple connectors, for brand loyalty, accessories and patents **[3 max per way, 9 max total]**.*
Brand loyalty:
the change could put off loyal customers who have invested in Apple products;
it may reinforce brand loyalty but equally it might not so it is a high risk strategy;
however the change to the product may make it more competitive, *eg* the Lightning connector allows more space for enhanced battery power;

Accessories:
the change of connector makes the accessories a consumer has purchased redundant;
so the user had to purchase an adaptor;
however, the adaptor represents an income stream for the manufacturer;

Patents:
Apple will have to take out a new patent on the new connector;
they can recoup this cost by licencing the connector to third party manufacturers;
however policing the licence agreements can be problematic; ***[9]***

Option C — CAD/CAM

15. (a) *Award **[1]** for stating a reason why the production of the model city's buildings using stereo lithography resulted in very little waste.*
stereo lithography is an additive manufacturing technique;
stereo lithography builds 3D models layer by layer; ***[1 max]***

(b) *Award **[1]** for identifying one advantage of choosing stereo lithography rather than fuse deposition modelling (FDM) to produce the model and **[1]** for a brief explanation **[2 max]**.*
speed;
FDM only uses one extrusion head to deposit molten material; ***[2]***

(c) *Award **[1]** for each of three distinct correct points in a suggestion of one possible method the Chicago Architecture Foundation may have used to generate the necessary CAD files for use with stereo lithography **[3 max]**.*
photographs;
collected from different sources *eg* Google Earth, aerial photographs;
input to a CAD system and edited to create an individual CAD file per building;
use existing CAD files;

can be purchased from architects/owners;
any missing information can be commissioned; ***[3 max]***

16. (a) *Award **[1]** for stating a characteristic of natural timber that makes it unsuitable for use with CAM.*
grain structure varies according to climatic condition and annual growth;
rarely defect free; ***[1 max]***

(b) *Award **[1]** for identifying one precaution that a manufacturer would need to consider when using medium-density fibreboard (MDF) in a CAM system and **[1]** for a brief explanation **[2 max]**.*
protection from dust;
exposure to MDF dust can cause health issues;

regular maintenance;
MDF generates a very fine dust which can clog the machine;

regular replacement/cost of cutting tools;
machining MDF blunts cutting tool quickly;

shortened life of cutting tools;
tools blunt quickly due to glue used to bond the MDF; ***[2 max]***

17. (a) *Award **[1]** for one benefit of "bottom up" modelling in the development of the solid CAD model of the Moon exploration vehicle and **[1]** for a brief explanation **[2 max]**.*
the different parts of the model are created independently;
existing library of parts from CAD software or previous designs may be brought together to help create the model; ***[2]***

(b) *Award **[1]** for identifying one limitation of surface modelling for rapid prototyping (RP) the model of the Moon exploration vehicle shown in Figure C3 and **[1]** for a brief explanation. **[2 max]**.*
surface modelling does not contain interior data;
surface models do not provide a rapid prototyping machine with a complete set of data for realizing a functional prototype (working model);

movement is important when testing lunar rover prototypes;
surface models provide a rapid prototyping machine with only enough data to realize an appearance prototype;

limited evaluation;
prototypes produced from surface models may only be used for evaluating the exterior of the Moon exploration vehicle; ***[2 max]***

18. *Award **[1]** for each of three distinct correct points in an explanation of two ways in which a CAD/CAM system aids manufacturing for a multinational cosmetic company **[3 max per reason, 6 max]**.*
global communication;
global communication systems can be used to enable 24 hour working in different countries;
design may take place in one country and manufacturing in another;

mass customization;
changes to the design to suit different markets/cultures/resources can be made using CAD;
revised designs can then be produced using existing CAM capabilities; ***[6]***

19. (a) *Award **[1]** for one disadvantage for manufacturers who replace a human workforce with robots for the production of the solid wood coffee table shown in **Figure C4** and **[1]** for a brief explanation **[2 max]**.*
increased costs;
the addition of robots substantially increases the fixed costs linked to purchase of machinery and variable costs associated with its maintenance;

flexibility;
skilled craftsmen can adapt their skills to maximise the characteristics of the product / work on a variety of products without expensive / time consuming reprogramming; ***[2]***

(b) *Award **[1]** for one advantage of robots in batch production and **[1]** for a brief explanation **[2 max]**.*
reprogrammable;
minimises downtime between different batches; ***[2]***

(c) *Award **[1]** for one reason why a manufacturer may combine robots with a human workforce to produce the solid wood coffee table shown in **Figure C3** and **[1]** for a brief explanation **[2 max]**.*
robots are better at repetitive tasks;
humans are better at more skilled/aesthetic activities; ***[2 max]***

20. (a) *Award **[1]** for each of three distinct correct points in a discussion of the effect of CAM systems on employment **[3 max]**.*
CAM take jobs held by workers;
CAM leads to the redundancy of many workers;
CAM leads to the nature of the local labour market changing;

CAM leads to the nature of many jobs radically changing;
CAM leads to a changing in the skill-sets required by workers;
CAM leads to workers retraining to be able to use the new technology; ***[3 max]***

(b) *Award **[1]** for each of three distinct correct points in a discussion of the effect of CAM systems on work patterns **[3 max].***
CAM allows 24-hour working;
shift patterns have to change to accommodate this;
employees may be required to adopt more flexible working patterns to retain their jobs; ***[3]***

21. *Award **[1]** for each of three distinct correct points in a explanation of 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 **[3 max per, 9 max]**.*
Machine tool variables:
variables can be set to determine the amount of cutting tool passing over work already cut or passing over new work;
the higher/lower the percent of machine tool step variable the higher/lower the surface finish quality;
the lower/higher the percent the machine tool step over variable the higher/lower the surface finish quality;

Cutting tool diameter:
cutting tool diameters gradually reduced as work progresses;
roughing starts with large diameter tools to cut away large areas with a poor surface finish;
semi finishing then finishing the mould needs smaller diameter tools to cut away smaller areas/details;

Machine path:
spiral cutting used for cutting the circular parts of the mould;
reducing/increasing number of step variable passes reduces/increases quality for raster and spiral cutting;
pocket cutting requires very little surface finishing/produces smoother finish; ***[9]***

Option D — Textiles

22. (a) *Award **[1]** for a definition of fibre to the effect of:*
continuous filaments/long threads with a length to thickness ratio of at least 80;
a natural or synthetic filament or thread that can be spun into a yarn; ***[1 max]***

(b) *Award **[1]** for a reason why the wool needs to be treated before being used as an insulating material after in the walls of a building and **[1]** for a brief explanation **[2 max].***
if there any gaps in the structure insects/rodents could make their home in the wool;
so the wool needs to be treated to deter infestation;

fire;
wool is a very combustible material so needs treating to make it fire retardant; ***[2 max]***

(c) *Award **[1]** for each distinct correct point in an explanation of one reason why wool is an appropriate insulating material for the walls of a building **[3 max]**.*
wool is a fibrous material;
it traps heat easily between the fibres;
so lowering the thermal conductivity of the wall structure;

availability;
the raw material is available in various parts of the world;
which makes it economical to use it;

green / sustainable;
wool is a natural resource;
which is renewable / environmental friendly to use in its raw state; ***[3 max]***

23. (a) *Award **[1]** for stating one advantage of Elektex™ intelligent fabric.*
smooth surface finish;
durable;
flexible;
hand-washable;
soft;
lightweight;
expandable; ***[1 max]***

(b) *Award **[1]** each of two distinct points in a description of how Elektex™ would contribute to the performance of a fabric keyboard **[2 max].***
it is made up of three layers, two conducting outer layers separated by a partially conducting central layer which acts as an insulator when not pressed and as a conductor when pressed;
the fabric is sensitive to different applied pressures;

it accurately senses pressure on three axis;
it measures the amount of pressure applied and can provide precise electronic measurements;

it can act as an interface between a user and an electronic device;
it is composed of conductive fibres combined with more traditional fibres ***[2 max]***

24. (a) *Award **[1]** for a reason why Speedo® Fastskin® is an example of a biomimetic material and **[1]** for a brief explanation **[2 max]**.*
the idea for Speedo® Fastskin® came from nature;
the fabric mimics the scales/dermal denticles on a shark's skin and reduces drag in the water; ***[2 max]***

(b) *Award **[1]** for a reason why and **[1]** for a brief explanation **[2 max]**.*
high absorbency/high drag;
adds weight to the garment in the water;
low dimensional stability when wet;
garment becomes misshapen; ***[2 max]***

25. *Award **[1]** for a characteristic and **[1]** each for two points of explanation of how this characteristic compares for a tie made from silk with the same design as a tie made from polyester **[3 max per characteristic, 6 max total]**.*
cost;
silk is a more expensive raw material;
the manufacturing process is more complex;

texture;
both ties will look the same unless closely inspected;
the silk tie will be smoother to the touch/less dense;

durability;
polyester is a more durable material than silk;
so the polyester tie lasts longer;

drape;
silk is less stiff and hangs better;
it will be less intrusive/ more comfortable for the wearer;

maintenance;
polyester is machine washable;
cheaper to keep clean; ***[6 max]***

26. (a) *Award **[1]** for a limitation of the widespread use of organic cotton in the textile industry and **[1]** for a brief explanation **[2 max]**.*
cost;
organic cotton costs much more to produce as the yield from plants is typically much lower than from those where pesticides and fertilizers are used;

organic cotton is more expensive to grow;
due to increased labour / maintenance;

organic cotton is susceptible to disease / insect attack;
causing a low yield; ***[2 max]***

(b) *Award **[1]** for a reason why organic cotton continues to be a popular raw material for textiles products even though there are much cheaper man-made fibres that could be used in its place for many products and **[1]** for a brief explanation **[2 max]**.*
tradition;
many people are used to cotton products and do not see the need to replace them with alternative products;

market sectors;
in some parts of the world cotton is an abundant material produced locally;

biocompatibility;
for many people cotton is the preferred material to have next to the skin due to its absorbency/feel/texture; ***[2 max]***

(c) *Award **[1]** for a reason why some developed countries impose import quotas on textile products and **[1]** for a brief explanation **[2 max]**.*
to protect the domestic textile industry from the influx of cheaper products;
and to maintain the quality of the domestic market for textiles; ***[2]***

27. (a) *Award **[1]** for each of three distinct points in a comparison of smart clothing and wearable computing **[3 max]**.*
smart clothing is a combination of new textile materials and miniaturized electronic components;
wearable computing incorporates a small portable computer integrated into the user's clothing or attached to the body;
wearable computing garments have more advanced applications than smart clothing; ***[3]***

(b) *Award **[1]** for each of three distinct correct points in a discussion of the impact of fashion on the market for wearable computing garments **[3 max]**.*
garments tend to be differentiated depending on the nature of the technology used;
the technology is specific to an application;
rather part of a fashion trend;

many people buy garments because they are fashionable;
wearable computing garments are not aligned with a particular style;
as they are a niche market;

the challenge is for designers to integrate wearable computing technology / electronic devices or circuits;
discreetly into fashionable garments;
so they look like any other garments; ***[3 max]***

28. *Award **[1]** for each of three distinct points in a comparison of nylon and cotton as the material for expedition tents used by backpackers in relation to tensile strength, density and thermal conductivity **[3 max per consideration, 9 max total]**.*

Tensile strength:
both nylon and cotton have tensile strength;
which is important to ensure that the tent material resists the forces applied when pitching the tent;
in order to ensure that the tent material is stretched taut so water runs off the surface effectively;

use of ripstop nylon;
will be more resistant to tearing than cotton;
particularly useful in windy conditions;

Density:
nylon has lower density;
a nylon tent will be lighter than a cotton tent;
making it easier to carry in a backpack;

nylon is waterproof unlike cotton;
so it will not absorb rainwater;
it will be easier to carry if used in wet conditions;

Thermal conductivity:
nylon has a higher thermal conductivity than cotton;
so it will gain more heat in hot conditions and lose more heat in cold conditions;
in extreme conditions this may cause possible discomfort to occupants; ***[9 max]***

Option E — Human factors design

29. (a) *Award **[1]** for stating a health issue associated with exposure to excessive noise.*
damage to hearing/hearing loss;
tinnitus; ***[1 max]***

(b) *Award **[1]** for stating one reason why equipment, such as a road drill, that creates noise in excess of 87db is allowed to be used and **[1]** for a brief explanation **[2 max]**.*
workers are instructed to wear personal protective equipment (PPE) such as ear defenders that reduce the noise exposure to an acceptable level;
this will not cause long-term damage to hearing; ***[2]***

(c) *Award **[1]** for each of three distinct correct points in an explanation of one reason why fire alarms are designed to exceed 87db **[3 max]**.*
alarms are designed so that all occupants of a building can hear them even when they are using noisy equipment;
the alarm is designed to be so noisy that occupants want to leave the building to get away from it even if they think it is a false alarm;
they are also designed to be heard outside the building when it is unoccupied; ***[3]***

30. (a) *Award **[1]** for stating the name of the rotational force employed when unscrewing the lid of a jar:*
torque; ***[1]***

(b) *Award **[1]** for a reason why a jar is manufactured with a tightly-fastened lid even though the manufacturer knows that it will be difficult to open for some consumers and **[1]** for a brief explanation **[2 max]**.*
security;
the jar is manufactured so the lid will not come loose easily during distribution;

safety;
so air will not get into the jar;

design compromise;
manufacturers prioritize security over ease of use; ***[2 max]***

31. (a) *Award **[1]** for stating one human factor reason why the flat handle of the can opener has a twist in it and **[1]** for a brief explanation **[2 max]**.*
to provide a flat surface for the thumb to press against;
keeps the can opener stable while the other hand turns the rotating head part;

it makes the opener comfortable to use;
helps the user keep a continuous downward pressure comfortably whilst the other hand rotates the turning/opening mechanism; ***[2 max]***

(b) *Award **[1]** for stating one human factor reason for including the holes in the rotating head part of the can opener and **[1]** for a brief explanation **[2 max]**.*
the thumb presses against a hole as force is applied;
prevents slipping;
the hand turns the head through 180 degrees/one half turn and the thumb then grips the other hole and turns the head again; ***[2 max]***

32. *Award **[1]** for each of three distinct correct points in a discussion of memory burden and mapping in relation to the use of the QWERTY keyboard **[3 max per reason, 6 max]**.*
Memory burden:
the QWERTY keyboard has a high memory burden;
but the arrangement of the keys is the dominant design;
therefore the "cost" of changing the layout of the keyboard is greater than the inconvenience of learning the "illogical" layout of the keys;

Mapping:
mapping of the letters on the keyboard is illogical now that boards are electronic;
whilst it might make more sense for the letters to be arranged alphabetically;
it would not necessarily be easier to learn to type as people would still need to learn where the letters were on each row of keys to be able to touch type; ***[6]***

33. (a) *Award **[1]** for stating one benefit of seating which is an example of design for discomfort for the owner of a fast food restaurant and **[1]** for a brief explanation **[2 max]**.*
discourages customers occupying the seats for a long period of time;
which could reduce (reducing) potential income streams;

seats which are not too comfortable will encourage customers to move out of the restaurant soon after eating their food;
this means more seats are available for the next users;

seats are cheaper to produce;
lower initial cost to the owner; ***[2 max]***

(b) *Award **[1]** for stating one benefit of design for discomfort for the user of a fast food restaurant and **[1]** for a brief explanation **[2 max]**.*
cost;
if seating is fairly basic there is no need to pass on the cost of expensive seating to the customer which keeps the price of food low;

higher volumes sold;
so the owner can buy in bulk gaining economies of scale leading to reduced process for the user;

as customers will not be inclined to linger due to discomfort;
seating becomes available for new customers more regularly;

seats are cheaper to produce;
less overheads to pass on to customer; ***[2 max]***

(c) *Award **[1]** for stating one responsibility for a designer when using the concept of design for discomfort in the design of seating for a fast food restaurant and **[1]** for a brief explanation **[2 max]**.*
although the designer does not want to make the seats too comfortable they should not be so uncomfortable that customers do not want to use them;
and the designer should ensure that other important design considerations are satisfied *eg* aesthetics, safety; ***[2]***

34. (a) *Award **[1]** for each of three distinct correct points in an explanation of one way in which digital humans can enhance human factors research in the development of ski clothing for competitive skiers **[3 max]**.*
digital humans can be used to simulate the movements of the skier as they take part in a race;
the effect of the clothing on the joints of the skier can be assessed;
and recommendations recorded for the optimum design of the clothing to enhance performance;

dynamic data can be obtained;
relating to the movement of skiers as they race;
enabling the clothing to be designed to cope with / enhance the range of movements; ***[3 max]***

(b) *Award **[1]** for each of three distinct correct points in an explanation of how motion capture technology is used to create the digital human **[3 max]**.*
a set of acoustic/inertial/LED/magnetic/reflective markers are placed at each joint;
sensors track the position of the markers as the person moves;
that develops a digital representation of the motion; ***[3]***

35. *Award **[1]** for each of three distinct correct points in an explanation of each of three ways in which the use of a kitchen work triangle at the design development stage can improve human factors considerations **[3 max per way, 9 max]**.*
efficiency;
the work triangle will be used to identify the shortest/most logical placement of key kitchen appliances *eg* sink, cooker and fridge;
as these appliances will be the most used;

safety;
by identifying the positions of the key appliances on the floor plan early in the design;
the designer ensures that the route between the appliances is free of obstacles/there is a short distance between the appliances for carrying food/dishes between them so reducing the chance of an accident;

performance;
there needs to be a suitable distance between key appliances;
so that heat from the oven does not affect the performance of the fridge/water from the sink does not splash onto the oven *etc*;

services;
the key appliances need appropriate services *eg* plumbing for the sink, electric sockets for the fridge/oven;
the position of these services needs to be identified early in the design to ensure they are put in place when the overall services are installed;

ease-of-use;
the designer needs to ensure that there is sufficient space between the appliances for work surfaces/cupboards *etc*;
as the user will need to prepare food before putting it in the oven/have space to put dishes taken from the oven *etc*; ***[9 max]***