

Markscheme

November 2015

Design technology

Standard level

Paper 3

This markscheme is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of the IB Assessment Centre.

Subject Details: Design Technology SL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer questions from **ONE** of the Options [**1 × 30 marks**].

Maximum total = [**30 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 a reason why The Nordic Keyhole food labelling system is particularly useful for processed foods.*
 processing often involves the addition of sugar or salt or reduction of the fibre content;
 processed foods are often high in sugar and salt and low in fibre; **[1 max]**
- (b) *Award [1] for identifying one way in which The Nordic Keyhole food labelling system is likely to have an impact on the design of processed foods and [1] for a brief explanation [2 max].*
 it will stimulate manufacturers to develop healthier food products to meet the requirements of the Keyhole food labelling system;
 and to reformulate existing products (to reduce sugar /salt content and increase fibre content); **[2]**
- (c) *Award [1] for each of three distinct correct points in an explanation of why it is likely that the Keyhole food labelling system would be adopted by manufacturers despite the fact that it is a voluntary labelling system. [3 max].*
 early adoption would lead to competitive advantage;
 “Keyhole labelled” products are likely to become the preferred products for consumers;
 and thus the manufacturer’s product could become the market leader/make more profit;

 independent validation of the product;
 enhances its perceived value in the eyes of consumers;
 promotes sales;

 if the manufacturers do not adopt the Keyhole labelling then the public may not buy their products;
 this would result in loss of market share;
 the company might not remain economically viable and is likely to go out of business; **[3 max]**
2. (a) *Award [1] for a definition to the effect of:*
 how much of the nitrogen content of a food is retained by the body / a measure of the proportion of the absorbed protein from a food which becomes incorporated into the proteins of the body; **[1]**
- (b) *Award [1] for a reason for low biological value foods being complemented.*
 if a food low/deficient in one essential amino acid is eaten with a food low/deficient in a different essential amino acid then they will complement each other;
 one example is the complementation of rice and beans; **[2]**

3. (a) Award **[1]** for identifying one reason for some of the ingredients (Milk, Hazelnuts, Soya and ingredients containing Gluten) being shown in a bold font and **[1]** for a brief explanation **[2 max]**.
these ingredients are common allergens;
in people who are allergic they can cause a severe allergic reaction or even death; **[2]**
- (b) Award **[1]** for a reason why a number of products **not** containing nuts may be labelled with warnings that they may contain nuts and **[1]** for a brief explanation **[2 max]**.
food processing machines may be used for different products, some containing nuts and some not;
the potential for cross-contamination within a factory is high, even airborne nut dust can contaminate other food; **[2]**
4. Award **[1]** for each of two correct points in a description of the role of antioxidants in foods (eg the role of the antioxidant ascorbyl palmitate in vegetable oils) **[2 max]**.
some components in foods (eg vegetable oils (have high levels of unsaturated fats which)) are susceptible to (oxidative) rancidity which results in off flavours in the food;
the antioxidant is oxidised more easily than the components/oil and protects it from rancidity;

antioxidants are increasingly important in food processing and food stability;
they inhibit the development of oxidative rancidity in fat and oil-based foods; **[2 max]**
5. Award **[1]** for each distinct correct point in a discussion of the influence of market pull and technology push on the development of new food products explanation **[3 max for market pull and 3 max for technology push 6 max in total]**.
Market pull:
a new product results from a manufacturer responding to market forces, eg:
demand from consumers for a new/improved product;
launch of a competing product by another manufacturer;
to enable a manufacturer to increase their share of a particular market;

Technology push:
a new product results from the re-designed of an existing product to changes in materials or manufacturing methods, eg because:
new materials with improved properties have become available;
new manufacturing processes can enable a manufacturer to make the product more efficiently reducing manufacturing costs;
new domestic equipment means that consumers use products in different ways,
eg when the microwave became available in homes; **[6]**

6. Award **[1]** for each distinct correct point in an explanation of each of three ways in which on-farm food processing contributes to economic, social and environmental sustainability for a farm and the rural economy **[3 max per way, 9 max in total]**.

Economic sustainability:

processed (consumer-ready) food products cost more than unprocessed food products;
so the farmer gets a larger proportion of the food dollar;
and more money circulates in the local economy;

Social sustainability:

on farm-processing will create more jobs in the rural economy;
these jobs will require different and higher skills;
more opportunities for local people;

Environmental sustainability:

organic waste can be composted on the farm;
reducing waste to landfill;
enhancing soil quality;

no need for centralised monopolies;
reduces amount of transport required (food miles);
better for the environment;

[9]

Option B — Electronic product design

7. (a) Award **[1]** for stating which segments of the seven-segment display need to be “on” to represent the binary code 0110 as a decimal numeral. Markers please note that the acdefg can be listed in any order – they just all need to be identified. acdefg; **[1]**

(b) Award **[1]** for correctly identifying both inputs and award **[1]** for correctly identifying both outputs.
Award **[1]** for correctly identifying two or three correct inputs and outputs out of the 4 possible.

	P $\bar{A}_2 \bar{A}_0$	Q $A_2 A_0$	R $A_2 A_1$	S $\bar{A}_0 \bar{A}_1$	T $A_1 \bar{A}_0$	U $A_1 \bar{A}_2$	V $A_2 \bar{A}_1$	W $A_2 \bar{A}_1$	X $A_2 \bar{A}_0$
							A_0		
INPUT	00	10	11	10	01	10	100	10	10
OUTPUT	0	0	1	0	0	0	0	0	0

[2]

(c) Award **[1]** for each of three distinct correct points in an explanation of why 4-input OR gates are selected as the gates a, b, c, d, e, f, g to drive the seven-segment display **[3 max]**.
the seven segments of the display have to be on in various combinations for each of the ten different digits 0–9;
as long as the gate receives one 1 as input;
it will generate a 1 as output; **[3]**

8. (a) Award **[1]** for a definition of time constant to the effect of:
the time required for the current or voltage in a circuit to rise or fall exponentially through approximately 63% of its amplitude; **[1]**

(b) Award **[1]** for each of two distinct correct points in a description of the difference between a digital and an analogue signal **[2 max]**.
digital signals have a fixed number of states;
analogue signals have an infinite number of states; **[2]**

9. (a) Award **[1]** for an advantage of using a PIC to implement the circuitry for a hearing aid and **[1]** for a brief explanation **[2 max]**.
miniaturization;
a PIC allows the production of a smaller hearing aid which will be more comfortable and discrete for the user;

reprogrammability;
as a person’s hearing changes over time the hearing aid can be reprogrammed rather than the person having to buy a new one; **[2 max]**

(b) Award **[1]** for a reason why a filter is a key element in a digital hearing aid and **[1]** for a brief explanation **[2 max]**.
only certain frequencies need to be amplified;
the filter will determine which frequencies are amplified and which are not; **[2]**

10. Award **[1]** for each of two distinct points in a description of how a light dependent resistor (LDR) can be used to produce a light sensor switch **[2 max]**.
one of the two resistors in a potential divider circuit should be replaced with a light dependent resistor and input to an operational amplifier;
as the light level changes the resistance of the light-dependent resistor will change its resistance and so the output from an operational amplifier will change from high to low or vice versa; **[2]**
11. Award **[1]** for each of three distinct points in an explanation of each of two implications of there being no national grid in remote areas of developing countries for an aid agency which has to respond to a humanitarian crisis **[3 max per implication, 6 max]**.
the aid agency would need to be self-sufficient in responding to a crisis in a remote area of a developing country;
they would need to take a generator and fuel to be able to operate electrical equipment;
this will limit the equipment they can use;
- portability;
the equipment the aid agency will use needs to be portable;
moving heavy equipment over rough terrain would be a major issue;
- power requirements;
using a generator may limit the power rating of the items of electrical equipment used by the aid agency;
this may limit their capacity to respond to the crisis on the ground; **[6 max]**
12. Award **[1]** for each of three distinct correct points in a discussion of the implications of company-specific standards for brands, accessories and patents in the marketplace **[3 max for brands, accessories and patents, 9 max in total]**.
Brands:
develop a customer's emotional attachment to a company's products;
promotes customer loyalty;
makes it easier for a company to launch new products;
- Accessories:**
a company-specific standard should enable accessories to be interchangeable within a product range and thus a company to be more competitive in the marketplace;
eg chargers for electronic products;
reinforces branding and customer loyalty so that one accessory can be used with several different products;
- Patents:**
the development of a standard requires a large investment in research and development;
but if patented the standard can become a product in itself;
selling under licence could enable a company to recoup some of the development costs;
- a patent prevents other companies copying the product;
if there is no patent the standard could be copied by other companies;
undermining the original company's success in the marketplace; **[9]**

Option C — CAD/CAM

13. (a) *Award [1] for stating one advantage of using FDM to produce the child's plastic jacket and arms.*
quality;
cost;
accuracy;
can be easily scaled to different sizes; **[1 max]**
- (b) *Award [1] for identifying a benefit of using FDM in the design and development of the child's plastic jacket and arms and [1] for a brief explanation [2 max].*
rapid prototyping and testing;
reduces development time;
- low cost;
so provides a cost-effective way of implementing designs;
- the size of the product can be scaled up and down according to the size of the child;
thus it can be customized to meet an individual child's specific needs; **[2 max]**
- (c) *Award [1] for each of three distinct correct points in an explanation of how FDM can contribute to the customization of plastic arms for other children with the same condition [3 max].*
different children will be different size;
the size of the design can be easily scaled to any size;
this will enable it to be customized to meet the needs of other children; **[3]**
14. (a) *Award [1] for a definition of G code to the effect of:*
a coordination-based code that includes feed speed and stop/start;
a G code is the common name for the most widely-used numerical control (NC) programming language used in CAM for controlling automated machine tools (CNC machines); **[1 max]**
- (b) *Award [1] for each of two distinct correct points in a description of how a 3D CAD drawing is converted into a file suitable for use in a CNC machine using G codes [2 max].*
the CAD drawing is converted to a stereolithography (STL) file;
G codes are produced from the STL file; **[2]**

15. (a) Award **[1]** for the increased use of CAD/CAM in furniture manufacture has developed the need for a wider range of knock down fittings and **[1]** for a brief explanation **[2 max]**.
flat pack furniture tends to be made from manufactured timbers rather than natural timber and cannot be joined with traditional joining techniques;
knock down fittings are used for joints and as the ways that components need to be joined increased so there is an increased need for a wider range of knock down fittings; **[2]**
- (b) Award **[1]** for each of two distinct correct points in a description of how drawings in assembly instructions help consumers when assembling flat-pack furniture **[2 max]**.
they show how the various components of the product should be assembled;
they are easier to understand than written explanations/quicker to read than words/avoid the use of words so can be understood in different languages/countries; **[2]**
16. Award **[1]** for each of two distinct correct points in a description of subtractive manufacturing techniques **[2 max]**.
wasting;
unwanted material is cut from a solid block to produce the artefact; **[2]**
17. Award **[1]** for each of three distinct correct points in a discussion of each of two considerations for a manufacturer when choosing CNC equipment **[3 per consideration, 6 max]**.
costs;
capital costs can be high;
the capital costs would be reflected in the fixed costs;

flexibility;
ie the machine can achieve a wider range of processes;
the more flexible the machine, the better for the manufacturer;

maintenance;
the cheaper/easier the machine is to maintain, the cheaper it will be to run in the medium and long term;
regular maintenance will enhance reliability;

tooling;
if the existing tools the manufacturer has fit the new machine;
this will be more cost-effective for the manufacturer;

(re)training of operatives;
training is a costly and time-consuming process;
if there are fewer retraining needs then the new machinery will be more cost-effective to implement;

speed;
the faster the machine is the more productive the manufacturer can be;
higher productivity results in better profitability;

quality of finish;
if the machine can produce a high quality of finish;
additional finishing operations may not be required and this will save money;
compatibility with complete process;
no need for conversion programmes;
suitability for materials used; **[6 max]**

18. Award **[1]** for each distinct correct point in a discussion of each of three contexts in which haptic technology has enhanced design capability **[3 max per way, 9 max]**.

haptic technology allows the user to become part of a computer simulation and to interact with it;

this enables the designer to observe the user's performance;

so more ergonomic products will be produced;

haptic technology can be used for training purposes in environments where it would be difficult to train people safely;

it provides more realistic simulations;

so trainees get a better training experience;

it can be used in home entertainment consoles;

the game will better simulate the real world;

so users get a more realistic experience;

safety features for users;

interactive warning systems;

aids for people with disabilities;

[9]

Option D — Textiles

19. (a) *Award [1] for stating one reason why a shirt made from 100% cotton fabric may be given a surface finish.*
 more durable;
 more resistant to detergent;
 more comfortable against the skin;
 less likely to absorb moisture;
 less likely to pick up dirt; **[1 max]**
- (b) *Award [1] for one reason why cotton thread has a very high tensile strength in relation to its mass and [1] for a brief explanation [2 max].*
 cotton fibres are weak and lightweight/low mass;
 the fibres which are spun/twisted into thread/filaments which makes them very strong but still lightweight/low mass; **[2]**
- (c) *Award [1] for each of three distinct correct points in an explanation of one reason why a shirt made from polyester is more environmentally friendly than one made from cotton in relation to maintenance [3 max].*
 polyester is more resistance to staining/less absorbent than cotton so dirt/microbes will not penetrate polyester as much as cotton;
 so less detergent is required to clean the polyester shirt resulting in less pollution from waste detergent;
 a polyester shirt can be washed at a lower temperature than a cotton shirt which will save energy from machine washing;

 more crease resistant;
 so less ironing;
 and less energy resources consumed;

 resistant to shrinkage; strong durable fibres hold the garments shape better;
 so likely to have a longer product life;
 less disposal to landfill; **[3 max]**
20. (a) *Award [1] for stating one piece of information provided on textile labels other than care instructions and [1] for a brief explanation [2 max].*
 material(s) used;
 country of manufacture; **[1 max]**
- (b) *Award [1] for one reason why many textile garments are displayed in retail outlets without packaging and [1] for a brief explanation [2 max].*
 so customers can feel the fabric;
 and check the quality of manufacture;

 so customers can try on the garment;
 and check it fits;

 it is cheaper to display garments without packaging;
 which may be important in a competitive situation;

 retail space;
 unpackaged garments can be stacked/racked more easily; **[2 max]**

21. (a) Award **[1]** for one reason, other than cost, why the socks shown in **Figure D2** may be made from a mix of wool (62%) and nylon (38%) and **[1]** for a brief description **[2 max]**.
62% wool so the garment will look like and feel like it is made from wool and will keep the feet warmer than if made entirely of nylon;
38% nylon will make the garment more durable/easier to wash/helps prevent socks shrinking in the wash; **[2]**
- (b) Award **[1]** for one reason why wool is a suitable raw material for use in craft production by local people in communities world-wide and **[1]** for a brief explanation **[2 max]**.
wool can be obtained from a variety of animals;
in different parts of the world;

wool is relatively easy to obtain from animals;
and to form into yarn;

wool can be hand-woven/knitted/crocheted;
which are inexpensive techniques/easy manufacturing techniques to learn;

wool is a renewable resource;
so it is sustainable for local people;

wool is easily stored;
and will not deteriorate as long as it is dry;

wool is easy to dye;
so different designs can be created; **[2 max]**
22. Award **[1]** for each distinct point in a description of how the development of Gore-Tex material has contributed to the improved performance of sportsmen/women. **[2 max]**.
Gore-Tex is a lightweight, breathable fabric suitable for protective clothing when engaging in outdoor activities;
it protects against wind and moisture and does not restrict movement of the body/prevents athletes from overheating; **[2]**
23. Award **[1]** for each distinct point in a discussion of two limitations for the consumer of buying clothing via the internet. **[3 max per limitation, 6 max]**.
fit;
although clothing is sold in pre-determined sizes the accuracy of the sizing may vary due to the nature of the fabric/manufacture/size intervals can be quite large;
consumers can try on a garment for size if buying in a shop;

aesthetics;
consumers want to experience what the garment feels like when worn and see colours/patterns clearly;
the type of fabric/finish is often important to consumer purchasing and is difficult to assess from internet images;

quality;
Internet images are designed to promote the garment and focus on style/aesthetics;
consumers cannot inspect the garment for quality of manufacture until bought;

delivery;
time delay between ordering and receipt;
returns are also delayed; **[6 max]**

24. Award **[1]** for each distinct correct point in a discussion of three reasons why natural silk remains a popular material for clothing despite the existence of cheaper synthetic alternative materials **[3 max per reason, 9 max total]**.

tradition;

silk has been used for clothing for hundreds of years;

and in some parts of the world/cultures there is an expectation that it will still be used for some products e.g. saris;

personal health;

some people have an allergic reaction to the chemicals used to create synthetic materials;

and so have little alternative but to buy natural products;

status;

people able to afford to buy silk products;

may feel wearing silk items shows their wealth;

feel of the fabric;

silk is a delicate material;

which hangs well/feels smooth against the skin;

moral/social responsibility;

some people want to support local silk industries;

in poor parts of the world;

[9 max]

Option E — Human factors design

25. (a) *Award [1] for stating 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.*
5th – 95th; [1]
- (b) *Award [1] for each of two distinct correct points in a description of the function of the 2D model in **Figure E1 [2 max]**.*
it would be used with 2D drawings/orthographic drawings of the same scale as the model;
to assess the relationship of body sizes to parts of the drawing; [2]
- (c) *Award [1] for each of three distinct correct points in a comparison of the effectiveness of the use of appearance prototypes with functional prototypes in relation to obtaining human factors data. [3 max].*
functional prototypes are much more effective as they allow for interaction with potential users;
so data can be gathered from a wide user population/percentile range;
appearance prototypes show what the product will look like so they are used to gain reactions based on shape and form/aesthetics rather than human factors/ease-of-use;

some ergonomic factors can be tested with appearance models;
eg relating to human interaction with the product;
eg comfort when gripping or holding; [3 max]
26. (a) *Award [1] for stating why intuitive logic is an important characteristic of a good user-product interface.*
so people can work out how to use it easily/so people can work out the semantics of the product/how the product works and be able to use it intuitively; [1]
- (b) *Award [1] for one reason why designers knowingly design products which have a high memory burden and [1] for a brief explanation [2 max].*
design is a compromise;
other design consideration such as aesthetics/cost may be more important;

some consumers (technophiles) enjoy the challenge of working out how to use a product;
especially for high-tech products; [2 max]

27. (a) Award **[1]** for how air velocity affects thermal comfort in an open-plan office, such as the one shown in **Figure E2** and **[1]** for a brief explanation **[2 max]**.
still air (low air velocity) can make people feel stuffy;
can raise room temperature;
- moving air increases heat loss from the environment;
requiring increased heating;
- people who work near a draught;
will suffer different heat conditions than others in the working environment;
- perception;
different people have different perceptions of thermal comfort and how air velocity affects them; **[2 max]**
- (b) Award **[1]** per distinct point in a description of how legislation is used to decide the range of temperature suitable for a working environment. **[2 max]**.
legislation sets the minimum and maximum temperatures for a working environment;
the range varies depending on the nature of the work; **[2]**
28. Award **[1]** for stating the function of sensory processes in a human-information processing system and **[1]** for a brief explanation **[2 max]**.
the sensory processes in human-information processing are responsible for encoding information, eg environmental input into neural impulses/they are the inputs in the human-information processing system;
sensory impulses are passed to the brain and are processed; **[2]**
29. Award **[1]** for each distinct point in a comparison of the two phones in relation to the influence of anthropometrics on their designs. **[3 max per phone, 6 max]**.
“The Brick”:
the large buttons accommodate a wide range of fingertip sizes;
but it is not easy to hold/grip / it has uncomfortable square edges and is too large for many hands;
needs two hands to dial a number, one hand would grip/hold the phone and a finger on the other hand would be used to press the buttons;
- “The candy bar”**:
is much smaller in size than the brick phone and can be used with one hand, ie gripped by the fingers and buttons pressed with the thumb;
designers worked out how small the buttons could be;
yet still allow the majority of users to select a button accurately without misdialling the wrong number; **[6]**

30. Award **[1]** for each distinct correct point in a comparison of the use of clay, card and polymorph as effective materials for human factors modelling **[3 max per material, 9 max total]**.

Clay:

can be used wet in plastic form for sculpting and liquid form for casting;
easy to mould into a variety of shapes with basic tools;
can be re-used so cost-effective/recyclable/sustainable;
good for sculptural organic forms;

Polymorph:

used as pellets;
more expensive than clay;
but can be re-used so can still be cost-effective;
soft/pliable when heated to take the shape of a body parts *etc*;
models can be used as prototypes;

Card:

readily available in different sheet thicknesses so can be used pliable or rigid;
easy to cut/join so suitable for paper prototyping *etc*;
3D models of structures can be created for assessing the relationship of anthropometric models to spatial arrangements;
easy to use with graphics to explore different surface designs;

[9 max]
