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MARKSCHEME

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DESIGN TECHNOLOGY

Standard Level

Paper 3

19 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 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 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 max]***

(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 food intolerance to the effect of:*
an adverse food-induced reaction that does not involve the immune system; ***[1]***

(b) *Award **[1]** for each of two distinct correct points in a description of how a gluten-free diet can be achieved **[2 max]**.*
a gluten-free diet excludes foods containing wheat protein;
gluten is in wheat and oats and is a widely-used food additive used for flavouring, stabilizing and thickening; ***[2]***

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 advantage of farmers' 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 a reason for the primary packaging of food and **[1]** for a brief explanation **[2 max]**.*
to contain the product;
liquids/powders need to be contained;

to physically protect the product;
keep the contents clean, safe and fresh;

to control the atmosphere in which the food is stored;
keep it dry with desiccants/ modified atmosphere to extend shelf life;

To provide consumer information;
nutritional information/product usage information/cooking instructions/storage instructions/use by or best before information/ recycling information;

marketing;
the packaging can carry promotional material;

security;
tamper-proof/tamper-evident;

convenience;
packages can have features which add convenience in distribution, handling, stacking, display, sale, opening, reclosing, use, and reuse;

portion control;
The volume/amount of the contents are appropriate to the needs of individual people/households; ***[2 max]***

5. *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]***

6. *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

7. (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*) × 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 S1 is 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]***

8. (a) *Award **[1]** for a definition of bandwidth to the effect of:*
the width of the electromagnetic spectrum that a signal occupies / the capacity of a connection either wired or wireless when transmitting data; ***[1]***

(b) *Award **[1]** for an outline of a disadvantage of copper cables for information transfer and **[1]** for a brief explanation **[2 max]**.*
limited bandwidth capacity;
so limited support for users;

noise is electromagnetic;
vulnerable to interference;

ohmic losses in copper cables are significant;
to cover large distances signal amplifiers are needed;

expensive / environmentally inappropriate;
copper is a scarce resource;

copper wires need maintenance;
this can increase running costs; ***[2 max]***

9. (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]

10. *Award **[1]** for the name of the digital logic gate and **[1]** for the Boolean expression equivalent to the truth table shown in **Table B1 [2 max]**.*
AND;
$Q = (A.B)$; ***[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. *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 licensing the connector to third party manufacturers;
however policing the licence agreements can be problematic; ***[9]***

Option C — CAD/CAM

13. (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]***

14. (a) *Award **[1]** for stating one reason why designers need to specify materials prior to a prior to an FEA simulation.*
different materials change the way structures react under test conditions; ***[1]***

(b) *Award **[1]** for one advantage of FEA simulation over real-life testing for the structural analysis of a car and **[1]** for a brief explanation **[2 max]**.*
reduced R&D;
FEA simulates the stress the car structure undergoes in accidents without the need for destructive testing/prototypes;
colour codes indicate high stress areas;
results will be used to modify the structural design to improve car safety;
virtual testing is cheaper;
FEA is used to develop the design virtually thus saving resources;
enhanced accuracy;
an FEA simulation provides a better insight into critical design parameters; ***[2 max]***

15. (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 max]***

(b) *Award **[1]** for identifying one limitation of surface modelling for rapid prototyping (RP) the model of the Moon exploration vehicle shown in Figure C2 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]***

16. *Award **[1]** for each of two distinct correct points in a description of one way in which the use of CAD reduces design costs **[2 max]**.*
virtual products/virtual inventory;
reduced capital investment as the product can be produced on order;
reduced development time;
designs may be modified/customized easily *eg* CAD allows designs to be resized, settings visualized, colours and shapes edited, *etc*; ***[2 max]***

17. *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]***

18. *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 computerised numerical control (CNC) machined metal mould for use in injection moulding **[3 max for each way, 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

19. (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 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]***

20. (a) *Award **[1]** for stating the importance of biocompatibility in the design of a textile vascular graft.*
if the graft is not biocompatible the body will reject it; ***[1]***

(b) *Award **[1]** for stating a reason why regulatory bodies only approve the use of new textile materials for specific medical applications and **[1]** for a brief explanation **[2 max]**.*
a material appropriate for one application may not be safe for another application;
due to biocompatibility considerations concerned with specific applications;

materials developed from one application may not work in another;
lab testing does not always replicate real life use so each new product must be considered uniquely; ***[2 max]***

21. (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]***

22. *Award **[1]** for a way in which ecofans can ensure they purchase environmentally friendly textile garments when considering care and maintenance of the garments and **[1]** for a brief explanation **[2 max]**.*
check the label;
to see if the garment is washable at low temperatures/able to be cleaned with low detergent use/able to be cleaned with environmentally-friendly detergents; ***[2]***

23. *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]***

24. *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

25. (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 87 db 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 87 db **[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]***

26. (a) *Award **[1]** for a definition of anthropometrics to the effect of:*
the aspect of ergonomics/human factors that deals with body measurements; ***[1]***

(b) *Award **[1]** for identifying **one** variable that may affect the data collected apart from inaccurate measuring and **[1]** for a brief explanation **[2 max]**.*
amount of hair on the head;
large amount/dense hair may add to the height;

stature;
some students may stand against the wall stiffly while others slouch;
if heels are not against the wall then accurate measurement impossible;
a person will measure smaller than s/he actually is; ***[2 max]***

27. (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]***

28. *Award **[1]** for each of two distinct correct points in a in a description of the function of a Harpenden anthropometer **[2 max]**.*
to collect (static) anthropometric data/record the distance between two points;
of different parts of the body; ***[2]***

29. *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]***

30. *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]***