N15/4/DESTE/HP3/ENG/TZ0/XX/M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

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Design technology

Higher level

Paper 3

21 pages

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 ***OWTTE*** (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 stating the temperature danger zone for bacterial growth.*
40–140°F/5°C to 60/63°C; **[1]**

(b) *Award **[1]** for identifying a reason why large items of food, such as a joint of meat, need longer cooking times that smaller items of food and **[1]** for a brief explanation **[2 max]**.*
meat/food is a poor conductor of heat;
it takes longer for heat to reach the centre of a large piece of meat and to cook it and kill microorganisms than it does to reach the centre of a smaller piece of meat; **[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 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]**

5. (a) *Award **[1]** for each of **two** factors that drive the development of genetically modified organisms in the food industry **[2 max]**.*
increased yield;
improved resistance to attack by pathogens;
enhanced storage characteristics;
enhanced eating quality;
improved nutritional value; **[2 max]**

(b) *Award **[1]** for a reason for the importance of GM foods being traceable and **[1]** for a brief explanation **[2 max]**.*
to be able to distinguish GM foods from non-GM foods;
consumers in many countries are often unwilling to buy genetically-modified foods; **[2]**

(c) *Award **[1]** for a reason why it is important for a manufacturer to establish a market for a food product and **[1]** for a brief explanation **[2 max]**.*
market development/uptake of the product must be rapid enough for the product to maintain its commercial viability;
else it will not be financially viable; **[2]**

6. (a) *Award **[1]** for each distinct correct point in an explanation of why sub-Saharan Africa is particularly vulnerable to food insecurity **[3 max]**.*
lack of availability of food;
drought, soil erosion, poor land management, climate;
poor growth of plants reduces capacity to produce food;

lack of access to land resources and poor land management;
nowhere for growing foods;
promotes reliance on food production/distribution systems;

low levels of education;
farmers may be unaware of how to increase yields;
reduced capacity to produce food;

high rates of poverty;
people cannot afford to buy food;
may lead to war/conflict over scarce resources; **[3 max]**

(b) *Award **[1]** for each of three distinct correct points in an explanation of how poor road infrastructure contributes to local and national strategies for food security **[3 max].***
poor road infrastructure reduces the capacity for the distribution of food;
so food cannot reach the people who need it;
distribution strategies are an important part of a local and national strategy for food security;
need to encourage local food production; **[3]**

7. *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

8. (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_2A_0	**R** A_2A_1	**S** $\bar{A}_0\bar{A}_1$	**T** $A_1\bar{A}_0$	**U** $A_1\bar{A}_2$	**V** $A_2\bar{A}_1A_0$	**W** $A_2\bar{A}_1$	**X** $A_2\bar{A}_0$
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 for 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]**

9. (a) *Award **[1]** for a definition of bit rate to the effect of:*
the number of bits per second produced by a digital system; **[1]**

(b) *Award **[1]** for identifying each of two limitations of a home security data link with a limited bit rate capacity **[2 max]**.*
low resolution;
slow refresh rate;
limited number of monitors; **[2 max]**

10. (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]**

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. (a) *Award **[1]** for one way in which miniaturization has helped to promote design for dematerialization and **[1]** for a brief explanation **[2 max]**.*
smaller components;
less material needed to implement a design/deliver the same functionality; **[2 max]**

(b) *Award [1] for a strategy that can be used to promote the disassembly of electronic products and **[1]** for a brief explanation **[2 max]**.*
use of temporary fittings;
makes the product easier to disassemble to harvest the components;

use of thermoplastic adhesives;
the product can be heated and it will fall apart;

shredding;
facilitates the recycling of material from obsolete electronic products;

use of metals;
metals tend to be more valuable so disassembly becomes more economically viable; **[2 max]**

(c) *Award **[1]** for each of two implications of product stewardship for manufacturers **[2 max]**.*
designing products that are more easily disassembled for recycling of materials and reuse of components;
using less toxic materials;
using recycled and more recyclable materials;
designing products that last longer;
designing products that can be repaired;
designing products that are upgradeable;
developing a system for the take back of products at the end of life;
designing products that are safer; **[2 max]**

13. (a) *Award **[1]** for each distinct correct point in an explanation of how modern electronic computer systems are used to monitor and perform functions in the home **[3 max]**.*
a range of input devices can be used to monitor different aspects of a home, *eg* light levels and temperature;
lights or heaters /coolers can be turned on and off according to a programme;
voice control and mobile phones can be used to supplement automatic monitoring and turn things on and off; **[3]**

(b) *Award **[1]** for each three distinct correct points in each of three ethical issues relating to the use of a home security systems **[3 max]**.*
data security;
data from the home security system needs to be held securely;
access to the data by unscrupulous persons would potentially compromise the safety of the home owner and the security of his/her home;

privacy versus security;
there is a trade-off between privacy and security;
in enhancing the security of his/her home a homeowner will lose some of his/her privacy; **[3 max]**

14. *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

15. (a) *Award **[1]** for stating one advantage of using FDM to produce the child's plastic jacket and arms.*
quality;
cost;
accuracy/precision;
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]**

16. (a) *Award **[1]** for stating **one** way in which information and communication technologies enable clients to be more involved in the design process.*
information and communication technologies, *eg* Skype, email and electronic file transfer, facilitate interaction between designers and clients so regular discussion can take place about aspects of the design; **[1]**

(b) *Award **[1]** for a benefit of clients being more involved in the design process and **[1]** for a brief explanation **[2 max]**.*
the product will better meet the needs of the client;
the client will be more satisfied; **[2]**

17. (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]**

18. *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]**

19. (a) *Award **[1]** for identifying one way in which robots contribute to quality control in manufacture and **[1]** for a brief explanation **[2 max]**.*
robots are able to work to small tolerances/error-free;
resulting in precision engineering of parts, sub-assemblies and products;

robots can maintain accuracy 24/7;
no "Friday" products/products of lower quality due to human fatigue;

use of feedback;
self-checking; **[2 max]**

(b) *Award **[1]** for identifying a way in which robots facilitate waste reduction in manufacturing and **[1]** for a brief explanation **[2 max]**.*
fewer errors;
therefore fewer defective parts and less waste material; **[2 max]**

(c) *Award **[1]** for identifying an issue relating to replacing the human workforce with robots and **[1]** for a brief explanation **[2 max]**.*
loss of jobs/robots will replace jobs undertaken by the human workforce;
effect on the local community/morale;

high investment costs;
robots are expensive to purchase and commission;

training costs;
are high for the highly-skilled technical jobs required in a robotised operation;

high maintenance costs;
to ensure reliable operation; **[2 max]**

20. (a) *Award **[1]** for each of three distinct correct points in an explanation of one way in which CAD/CAM enhances quality assurance in manufacturing **[3 max]**.*
higher precision;
reduced tolerance;
greater accuracy;
fewer errors; **[3 max]**

(b) *Award **[1]** for each of three distinct correct points in an explanation of one characteristic of a material that makes it unsuitable for CAM **[3 max]**.*
warping;
if a material warps it will be unsuitable for CAM;
low warping is required;

stability;
low stability materials are unsuitable for CAM;
high stability is required;

porosity;
highly porous materials are unsuitable for CAM;
low porosity is required;

uniform grain structure;
to be machined accurately;
the material must have a uniform grain structure; **[3 max]**

21. *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

22. (a) *Award **[1]** for stating one reason why a shirt made form 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]**

23. (a) *Award **[1]** for stating one way in which fair trade regulations impact on workers in a factory operated by a multi-national company situated in a developing country.*
protects workers rights / wages / working conditions / minimises exploitation; **[1]**

(b) *Award **[1]** for one reason for the imposition of import quotas on textile products and **[1]** for a brief explanation **[2 max]**.*
many large companies manufacture their products in countries with cheap labour so the products can be lower priced than competitive products produced in other countries;
import quotas on these products are levied to protect a domestic market for textile products; **[2]**

24. (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]**

25. *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]**

26. (a) *Award **[1]** for* a reason *why the EU Flower system has not been widely adopted by clothing manufacturers and **[1]** for a brief explanation **[2 max]**.*
the EU flower refers to the whole life cycle for a textile product;
which makes it very difficult for manufacturers to meet the standards at each stage of the life cycle;
cost;
it is expensive to get accredited;
the system is voluntary so a manufacturer does not have to do it although it may make his/her products more competitive; **[2 max]**

(b) *Award **[1]** for one limitation of the EU Flower system in relation to quality assurance for consumers and **[1]** for a brief explanation **[2 max]**.*
the system is based on assessment of a product in relation to its impact on the environment;
it does not guarantee that the product is of high quality in other respects;

the EU flower is an EU standard not a global standard;
so manufacturers who sell to non-EU markets do not need to adopt it; **[2 max]**

(c) *Award **[1]** for one way in which the EU Flower system benefits the health of the user of a textile garment and **[1]** for a brief explanation **[2 max]**.*
in order to gain the EU Flower system accreditation, products are assessed to ensure that they have not been treated with chemicals which could be harmful to the health of the user;
such as causing an allergic reaction; **[2]**

27. (a) *Award **[1]** for each of three distinct correct points in a discussion of how technology push has an impact on the wearable computing market **[3 max]**.*
technological developments improve products;
offer a wider choice of products to suit different consumer needs;
may widen the market for wearable computing garments;

miniaturization of technology;
wearable components are less bulky and lighter (particularly batteries);
therefore easier to wear; **[3 max]**

(b) *Award **[1]** for each of three distinct correct points in a discussion of one reason why wearable computing garments are seen as niche market products **[3 max]**.*
wearable computing garments tend to be designed for specific purposes;
they use integrated technology relating to that particular purpose;
there is not a large market need for such garments;

economies of scale are difficult to achieve for such products;
so they tend to be quite expensive;
therefore only appealing to a limited market;

some consumers are wary of the technology used in the garments;
and perceive issues with health and safety/maintenance;
which may put them off purchasing the garments; **[3 max]**

28. *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

29. (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]**

30. (a) *Award **[1]** for stating one way in which legislation has improved access to buildings for wheelchair users.*
height of door controls/handles/ramps instead of steps/width of doors; **[1]**

(b) *Award **[1]** for one reason why pressure management is an important consideration in the design of a wheelchair and **[1]** for a brief explanation **[2 max]**.*
wheelchair users may experience discomfort/pain/pressure sores;
if the design of the wheelchair does not support the body well/allow for a degree of freedom of movement while seated/wriggle room; **[2]**

31. (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]**

32. *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]**

33. (a) *Award **[1]** per distinct point in a description of how the jar opener makes it easier to open the jar for people with limited hand movement. **[2 max]**.*
less effort required by the user than gripping the jar lid with the hand;
using the jar opener requires a turning action rather than a twisting action/the user can get more leverage with the handles rather than just gripping the lid; **[2]**

(b) *Award **[1]** for stating the impact of torque on the action of unscrewing the lid of a jar without the use of a jar opener and **[1]** for a brief explanation **[2 max]**.*
torque is a rotational force;
the user needs to apply this force by twisting the lid in order to open the jar; **[2]**

(c) *Award **[1]** for one psychological human factor which have an impact on the ability of able-bodied consumers to unfasten the lid of a jar and **[1]** for a brief explanation **[2 max]**.*
texture;
lids and jars are often smooth which makes gripping them without slipping difficult;
some jars/lids have a ridged surface to aid grip; **[2 max]**

34. (a) *Award **[1]** for each of three distinct correct points in an explanation of how motion capture is used to digitally represent the motion of the baby shown in **Figure E6** **[3 max]**.*
the letters represent the position of the markers on the body of the baby;
sensors track the position of the markers as the baby moves;
so developing a digital representation of the baby's movements; **[3]**

(b) *Award **[1]** for each of three distinct correct points in an explanation of how a digital image of the baby in **Figure E6** can be used in the design development of the cot mobile in **Figure E7** **[3 max]**.*
allows designers to optimize the cot mobile for the baby's reach and comfortable range of movements;
to ensure optimum engagement between the baby and the cot mobile in a safe manner; **[3]**

35. *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]**