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M07/4/DESTE/HP2/ENG/TZ0/XX/M+

MARKSCHEME

May 2007

DESIGN TECHNOLOGY

Higher Level

Paper 2

19 pages

If you do not have a copy of the current Design Technology Guide, please request one from IBCA.

Subject Details: Design Technology HL Paper 2 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in Section A (total 40 marks) **ONE** question in Section B [20 marks]. Maximum total = 60 marks.

General

A markscheme often has more specific points worthy of a mark than the total allows (especially for essay questions). This is intentional. Do not award more than the maximum marks allowed for part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.
- Words in (…) in the markscheme are not necessary to gain the mark.
- Words that are <u>underlined</u> are essential for the mark.
- The order of points does not have to be as written (unless stated otherwise).
- If the candidate's answer has the same "meaning" or can be clearly interpreted as being the same as that in the mark scheme then award the mark.
- Mark positively. Give candidates credit for what they have achieved, and for what they have got correct, rather than penalising them for what they have not achieved or what they have got wrong.
- Remember that many candidates are writing in a second language; be forgiving of minor linguistic slips. Effective communication is more important than grammatical niceties.
- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalised. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with **"ECF"**, error carried forward.
- Units should always be given where appropriate. Omission of units should only be penalised once. Indicate this by **"U-1"** at the first point it occurs. Ignore this, if marks for units are already specified in the markscheme.
- Do not penalise candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

SECTION A

1. (a) (i) *Award **[1]** for calculating the length of the self-adhesive label required for the base of the bottle shown in Figure 1. Subtract 1 for omitting units.*
Length of half the base = Πd/2
= 3.14 x 70 / 2
= 109.9 mm; ***[1 max]***

(ii) *Award **[1]** for number of bottles per shift, **[1]** for the actual number of labels and **[1]** for rounding up to 6 rolls of labels.*
Maximum speed = 440 bottles/min.
Therefore number of bottles per shift = 440 x 60 x 8;
Number of rolls of labels = 440 x 60 x 8/36000 = 5.87 rolls of labels;
Round up to 6 rolls of labels per shift; ***[3 max]***

(b) (i) *Award **[1]** for identifying an appropriate visual check that might be employed to assess the effectiveness of the labelling process for the can.*
Is the label stuck properly to the container;
Is the label the right way up;
Is it positioned accurately on the can;
Are the ends of the label aligned accurately;
Are there any stains or wrinkles in the label; ***[1 max]***

(ii) *Award **[1]** for a reason why a thermoset adhesive is used to fix the label to the can and **[1]** for a brief explanation.*
The cans are labelled when the contents are hot and heat causes plastic deformation in a thermoplastic adhesive so the label would not adhere to the can while the can cools;
A thermoset plastic however is not affected by heat and so the label will stick to the can; ***[2 max]***

(iii) *Award **[1]** for identifying an advantage for using a water-soluble adhesive for the self-adhesive label for the glass bottle and **[1]** for a brief explanation.*
Glass bottles can easily be recycled but to do so the glass needs to be separated from other materials, e.g. the label;
Hence label needs to be removed and water-soluble adhesive makes this easier to achieve; ***[2 max]***

(c) *Award **[1]** for each point in a distinct explanation of why the labelling process used for the can is much more complex than using the self adhesive labelling process.*
Before the label can be applied to the can it needs to be sliced to size;
Thermoset adhesive must be applied to the label at each end as shown in Figure 3;
There is less margin for error in placement on the can as it goes to the edges of the can;
Label needs to be applied to the can straight so that the ends overlap; ***[3 max]***

(d) (i) *Award **[1]** for identifying the correct data for the two long and three short dividers and **[1]** for the correct answer including units.*
Long dividers = ((4 x 70) + (3x5)) x 2 dividers = 590 mm
Short dividers = ((3 x 70) + (2x5)) x 3 dividers = 660 mm;
Total length of cardboard = 590 + 660 = (17x70) + (12x5) = 1250 mm; ***[2 max]***

(ii) *Award **[1]** for two slits in the cardboard shape and **[1]** for them being at the lower edge of the shape.*

[2 max]

(e) (i) *Award **[1]** for calculation and **[1]** for correct answer including units.*
Price difference = 30$ - 14$ = 16$ per 1000 bottles;
Therefore price difference on 1000 cases (12000 bottles) = 12 x 16$ = 192$; ***[2 max]***

(ii) *Award **[1]** for each of two advantages of distributing drinks in plastic rather than glass bottles, other than cost, for use on an aircraft for in-flight meals.*
Lighter;
Possible to squash when empty so uses less volume;
Safer as plastic does not shatter on being broken; ***[2 max]***

2. (a) *Award **[1]** for a definition to the effect of:*
A measure of the degree of increase in dimensions when an object is heated; ***[1 max]***

(b) *Award **[1]** for identifying a design context where thermal expansion is an important consideration and **[1]** each for two distinct correct points of explanation.*
Glass door of oven/glass lid for saucepan;
Materials of similar thermal expansivities selected and joined together;
As they expand they will then maintain their integrity and lid/door does not fall out/crack;

Bimetal strip for thermostat of central heating system;
Materials of dissimilar thermal expansivity selected and riveted together;
As they expand they are forced to stay together and bending force produced which can be used to turn central heating system on and off;

Railway tracks/road bridge;
Thermal expansion of the tracks has to be taken into account in the design to allow for expansion, e.g. through consideration of expansion joints;
If not the tracks will buckle as the temperature rises and be unsafe; ***[3 max]***

3. (a) *Award **[1]** for identifying an appropriate reason for a manufacturer to evaluate a product prototype before going into production and **[1]** for a brief explanation*
Financial/time issues/saves time/saves money;
It is important that the design is right before a manufacturer gets set up for volume production to save wasting money/time;

To get feedback from customers;
To ensure that the design meets the needs of its intended market;

To ensure that the design is safe in use;
Difficult to predict how a design may be used or abused which could make it unsafe; ***[2 max]***

(b) *Award **[1]** for identifying an appropriate strategy for evaluating the usability of a product and **[1]** for a brief explanation*
User trail;
Enables a designer to collect data on use and abuse of a product from a wide range of users;

Expert appraisal;
Useful to get feedback from expert on safety or other aspects of a design;
Expert's opinion may be biased and not reflect views of user;

Performance test;
Can see how the design performs against specific performance criteria;

User research;
Gets comments from potential users on a product; ***[2 max]***

4. (a) *Award **[1]** for each of any two appropriate materials. Accept either words or chemical notation.*
Sand/Silica/Silicon Dioxide ($Si0_2$);
Sodium Oxide (Na_2O);
Limestone / Calcium Oxide (CaO) / Recycled Glass; ***[2 max]***

(b) *Award **[1]** for identifying a design context where thermal expansion is an important consideration and **[1]** each for two distinct correct points of explanation.*
Toughened glass shatters into small granular pieces not sharp shards when broken;
Whereas laminated glass (which is a sandwich - usually of plastic between the layers) does not shatter as the plastic strengthens it; ***[2 max]***

5. (a) *Award **[1]** for identifying two materials, other than paper, glass and steel, that can be easily and economically recycled.*
Thermoplastic (any named thermoplastic);
Cardboard;
Wood;
Most metals, e.g. gold, silver, platinum, copper, aluminium; ***[2 max]***

(b) *Award **[1]** for identifying an appropriate green design strategy and **[1]** for a product to which that strategy may be applied.*
Reuse;
Nuts/bolts/other components from within a product;

Repair;
Washing machine/television/video/car/etc;

Recycle;
Drinks cans/glass bottles;

Recondition;
Car engines/tyres;

Use of biodegradeable packaging/composting;
Fresh food products;

Lean production;
Cars;

Use of renewable energy resources/reduction in energy consumption;
eg. solar powered calculator, wind up radio;

Reducing toxic emissions;
Cars;

Energy/eco-labelling;
Washing machine;

Reduce amount of waste on disposal;
Packaging; ***[2 max]***

6. (a) *Award **[1]** for identifying one characteristic of an appropriate technology.*
Low in capital costs;
Uses local materials wherever possible;
Creates jobs (employing local labour and skills);
Involves decentralized renewable energy sources;
Makes technology understandable to the people who use it;
Is not detrimental to the quality of life or the environment; ***[1 max]***

(b) *Award **[1]** for identifying a way in which energy considerations may influence the design of a **named** consumer product, **[1]** for identifying a product in which that may have been deployed and **[1]** for a brief explanation.*

Raw material selection **for a named consumer product**;
Materials may be selected on the basis of the energy required to produce them or to convert them into components/product;
Low energy consuming materials may be selected, e.g. thermoplastics;

Minimizing the amount of material used **for a named consumer product**;
Lightweighting reduces the amount of material required to produce a component/product by building in spaces in the design strategically (these may actually make the design stronger);
It also makes the component/product cheaper to distribute;

Assembly arrangements **for a named consumer product**;
Design for manufacture takes into account the way energy is required for manufacture;
The design may be modified to enable it to be more energy efficient in its assembly;

Number of components used **for a named consumer product**;
More components, more energy required to produce them;
Lean manufacture seeks to reduce number of components used in a design and so reduce energy consumption;

Use **for a named consumer product**;
Engine size/provision of insulation/low energy versions of products e.g. light bulbs;
all affect the amount of energy consumed during use of a product;

Source of energy **for a named consumer product**;
Products may be designed to use renewable energy sources rather than batteries or mixed fuels;
This would mean they can be used in emergency situations without worrying about batteries, e.g. windup mechanisms; ***[3 max]***

Section B

7. (a) (i) *Award **[1]** for identifying an appropriate mechanical property and **[1]** for a brief explanation.*

Toughness;
The ability of the deck material to resist the propagation of cracks;

Tensile strength;
The ability of the deck material to resist pulling forces; ***[2 max]***

(ii) *Award **[1]** for an appropriate disadvantage and **[1]** for each distinct correct point of explanation.*

Labour intensive;
Can't realistically be done automatically;
Needs the various layers laid up by hand and set into the mould;

Production of the mould;
Very time-consuming;
Needs high level of finish and accuracy;

Limitations of the glue;
Glue is usually more brittle than laminates;
Flexible adhesives are not often water resistant;

Size may be restricted;
Laminations are usually timber;
Sizes of tree are limited and large ones are expensive;

Clamping;
The deck must be appropriately clamped while the adhesive sets;
Jigs or air-pressure bags are required to achieve this;

Shape of the curves;
Must not be too complex;
Complexity exacerbates clamping and mould manufacturing issues; ***[3 max]***

(b) (i) *Award **[1]** for identifying an appropriate describing a property that makes nylon suitable for injection moulding and **[1]** for a brief explanation.*

Melting point

Melts at a low temperature to make it economic for use in injection moulding.

Thermal expansivity;

It is important that the nylon contracts slightly on cooling to help release it from the mould but not so much that it does not match the size of the mould. ***[2 max]***

(ii) *Award **[1]** for each of two correct points in a brief description of how one-off production might contribute to the batch production of the trucks for the skateboard.*

One-off production is used to produce the mould for injection moulding;

The mould is then used for production of batches of trucks;

One-off production of a product prototype;

This would enable product evaluation prior to batch production; ***[2 max]***

(c) (i) *Award **[1]** for a way in which using standardized components contribute to green design strategies and **[1]** for a brief explanation.*

Promotes potential for reuse;

Standard components are worth removing from a product on disposal for reuse in other products;

Promotes potential for repair of product;

Standard components are easier (and cheaper) to source; ***[2 max]***

(ii) *Award **[1]** for each of three distinct correct points identifying an appropriate implication for the designer, the manufacturer, and the user.*

Designer ***[3 max]***

Parts already available, so does not have to design from first-principles;

CAD drawings readily available;

No need to undertake lengthy evaluation trials;

Constraints on designer;

May effect creativity;

May not allow use of advanced technology;

Manufacturer ***[3 max]***

Can buy in parts from third party;

No need to have expensive manufacturing equipment (e.g. die casting);

Cost effective;

User ***[3 max]***

Part could be reused on another board saving money;

Should reduce the price of the final product;

Spare parts more readily available; ***[9 max]***

8. (a) (i) *Award **[1]** for identifying an appropriate property of a thermoplastic that makes it suitable for injection moulding of components for the MP3 player and **[1]** for a brief explanation.*

Ease of forming/plasticity;
So it will retain the shape of the mould on cooling;
Thermal expansivity;
It is important that the thermoplastic contracts slightly on cooling to help release it from the mould but not so much that it does not match the size of the mould;
Melting point;
Melts at a low enough temperature to be formed easily and to be economically viable; ***[2 max]***

(ii) *Award **[1]** for identifying one economic reason why injection moulding is used for the volume production of thermoplastic products and **[1]** for each distinct point of explanation.*

Appropriate scale of production;
Injection moulding is a volume production method;

Low variable costs;
Although capital costs are high, once system is set up it is a very cost-effective production method;

Flexible production system;
Machine can be used for different products just by changing the mould;

No need for finishing;
saves time, cost;

Complexity of product;
The product is not extremely complex and lends itself to injection moulding;
Different moulds can be used in the injection moulding machine to produce the various components for the MP3;

Material sources;
The case of the MP3 player is made of thermoplastic;
Injection moulding is an ideal production method for thermoplastic products;

Skills required;
Injection moulding does not require a highly sophisticated skill set;
A range of different components can be made relatively quickly particularly if linked to CAD/CAM for the production of the moulds; ***[3 max]***

(b) (i) *Award **[1]** for identifying an aspect of the design of the MP3 player which has been influenced by anthropometric considerations and **[1]** for a brief explanation.*
The controls on the MP3 player are far enough apart;
Thus they can be operated accurately by the user;

The controls on the MP3 player are reasonably close together;
This aids ease of operation by the user;

The weight of the MP3;
Lightweight ensures portability;

The controls will be able to be operated with the normal pressure of a hand;
This promotes ease of operation and ensures that superhuman strength is not required;

The size of the controls *eg*. the joystick;
Need to be large enough to be operated easily; ***[2 max]***

(ii) *Award **[1]** for identifying an aspect of the design of the MP3 player which has been influenced by ergonomic considerations and **[1]** for a brief explanation.*
Body tolerances are taken into account;
e.g. how far the fingers can stretch to reach the buttons over a prolonged period of time;

The MP3 player is designed so that it will fit comfortably into the hand;
This makes it comfortable in use; ***[2 max]***

(c) (i) *Award **[1]** for identifying the stage of the product life cycle that MP3 players as a product category are currently at and **[1]** for a brief explanation.*
MP3 is in mature stage of its product life cycle;
Having gained acceptance, as a product it has diffused into the market and sells well; ***[2 max]***

(ii) *Award **[1]** for identifying three product characteristics that the MP3 player would need to be considered as consistent with sustainable development and **[1]** for each of two points of explanation, **[3 max]** per characteristic.*
The MP3 player should be simple to use/not demand exceptional user skill;
Consumer products of this type are made to be very simple and intuitive to use;
They can then be used without specialist training;

The use value of the player should be more important than its resale/exchange value;
MP3 players should be produced because they are of use in society;
Not be produced just to resell or exchange;

The player should be compatible with prevailing culture of its intended use;
It should meet the cultural, historical and other requirements of its users;
If it does not it will have a negative impact on society;

The player should be designed for high durability;
This will ensure that it has a long product life;
If it is not durable it will become obsolete very quickly;

The player should be designed for disassembly (e.g. active disassembly using smart materials);
This will ensure that its parts can be reused or recycled;
This will promote the sustainable use of the planet's resources;

The materials should be sourced locally;
Strengthens linkage to local economy;
Reduces transport costs;

The manufacturing process should use clean technology;
Reduces pollution;
Reduces energy costs;

Financial cost over the product life cycle should be as low as possible;
Rechargeable batteries/low cost thermoplastic components;
Batteries which cannot be recharged add to the cost of the product over its life cycle; ***[9 max]***

9. (a) (i) *Award **[1]** for each of two appropriate considerations in the design of the refrigerator that would minimize its environmental impact on disposal.*
Ease of disassembly so parts will be reused/recycled;
Use of standard parts so that it is worth salvaging the parts;
Use of materials that can be recycled, e.g. thermoplastic which can be remelted and extruded;
Use of non-toxic refrigerant;
Ease of removal of refrigerant on disposal;
Use of as little material as possible; ***[2 marks]***

(ii) *Award **[1]** for identifying a stage in the product life cycle at which designing the refrigerator to use less energy will have the greatest benefit for the environment and **[1]** for a brief explanation.*
Utilization stage of product life cycle;
Refrigerators are 'on' throughout their product life 24/7 and so over the life cycle of the product will consume an enormous amount of energy; ***[2 max]***

(b) (i) *Award **[1]** for each distinct point in a description of why the refrigerator is an example of incremental design.*
Although the product is a novel product it comprises two well-established products – a computer and a refrigerator;
The changes to the computer and the refrigerator to incorporate them into the product are trivial but the cumulative effect is significant; ***[2 max]***

(ii) *Award **[1]** for identifying one advantage of a user trial at the prototype type stage of the development of the refrigerator and **[1]** for each of two distinct points of explanation.*
User trials are relatively cheap to undertake;
They provide useful feedback from potential users which can inform future design development;
This will ensure product success in the marketplace;
It will ensure that the product meets the needs of users;
Health and safety issues particularly associated with use/abuse of the product which can be difficult for a designer to predict can be ironed out; ***[3 max]***

(c) (i) *Award **[1]** for each of two potential lifestyle changes that this product would be likely to promote in its users.*

Scanning technology promotes better utilization of food products in relation to best before/sell by dates reducing wastage and potential for food poisoning;

Quicker and easier to check the contents of the fridge and generate shopping list;

Better integration of technology into busy lifestyles so chef/family can catch up on emails/internet whilst in the kitchen;

Children/others can play computer games in kitchen which meals are being prepared so promotes social interaction amongst house mates;

Enhanced convenience in relation to reordering food items – user would not have to go to the supermarket but could order home delivery on-line; ***[2 max]***

(ii) *Award **[1]** for identifying each of three strategies in the design of the refrigerator to overcome early obsolescence of the refrigerator and **[1]** for each of two points of explanation, **[3 max]** per strategy.*

Use of standard components as far as possible;

This will make the product cheaper/easier to repair;

The design could incorporate easy access for the fridge motor and other parts to be replaced/repaired;

Ease of disassembly;

Easy access for removal of PC;

Repairs can then be undertaken without an engineer having to call;

This will facilitate upgrading and promote repairing/upgrading of components as appropriate;

Use of durable/long-lasting materials

Materials should not start to deteriorate in a time shorted than that planned to obsolescence;

Materials need to meet an appropriate specification or be suitably treated, e.g. stainless steel or plastic-coated mild steel to avoid rusting;

Upgradeability;

The computer part is likely to become obsolete sooner than the rest of the refrigerator in the product life cycle;

Ability to replace/upgrade key components of the on-board computer (operating system, memory, faster central processor) to keep pace with on-going development will help overcome obsolescence; ***[9 max]***