Mark scheme

Section A – Core technical principles

Q1) A

Q2) D

Q3) A

Q4) B

Q5) C

Q6) B

Q7) D

Q8) A

Q9) B

Q10) A

Q11ai)

2 marks for a detailed description

1 mark for a simplistic description

Maximum 6 marks

For the eccentric and pear cams – do NOT accept 'can rotate in either direction'

- Eccentric cam – rise and fall which are of equal length (1) Smooth motion (1) Simple Harmonic Motion S.H.M. (1)

Q11aii)

- Pear shaped cam – rise and fall are rapid (1) with a dwell (1)

Q11aiii)

- Snail cam – a smooth continuous rise (for almost 360 degrees) (1) rapid fall (1) can only rotate in one direction (1)

Q12)

1 mark for each point of explanation.

One point explained and clarified in more detail, e.g. with example is worth 2 marks

Indicative content

- Production can be quickly altered allowing fast response to market changes / shorter lead times / increased market share.
- Smaller batches of products can be manufactured when needed reducing capital tied up in unsold stock.
- Products can be customized for individual consumers increasing the appeal / sales / profits from the product.
- Less reject components as FMS systems are able to check the quality of their own work.
- Large capital investment needed for initial set up which would be off-set against minimal alteration costs when production is changed.
- Production rate could reduce on large batches due to CNC machines being slower than automated machinery.
- Staff would need retraining / new staff recruited as different skills are needed to operate the new equipment.
- Consideration of the downtime needed to install new systems is needed so that it is minimized / does not lead to financial problems.

Q13)

A calculation that includes:

- Calculation of the length of the semi-circle (1) $\pi D/2 = \pi (2 \times 9) / 2 =$ 28.278cm

- Calculation of the total length of the part required (1) 28.278cm + (2 x 16) = 60.278cm

- Calculation of how many whole strips can be cut from long length of the sheet (1) 244 / 30 = 8

- Calculation of how many whole strips can be cut from width of the sheet (1) 122 / 60.278 = 2

- Calculation of the number of whole pieces that can be cut from a single sheet (1) 8 x 2 = 16 pieces Alternative method from Step 3 (Step 1 and 2 same as above)

- Calculation of small sheet area 60.278 x 30 = 1808.34 cm^2 (1)

- Calculation of total sheet area 244 x 122 = 29768 cm^2 (1)

- Calculation of number of sheets 29768 / 1808.34 = 16.46 rounded to 16 (1)

Q14)

Indicative content

Offset lithography	• Aluminium printing plate prepared with image and nonimage areas • Plate is dampened with water (non-image areas attract water) • Ink applied (only sticks to image areas) • Image transferred to a rubber blanket cylinder • Rubber blanket prints image onto paper (indirect printing)
Casting	• Mould created in shape of final product (sand, die, or investment) • Material (usually metal or plastic) melted to liquid form • Molten material poured into mould cavity • Left to cool and solidify into shape • Removed from mould, excess material trimmed to tolerance
Extrusion	• Material heated until soft (thermoplastic or metal) • Forced through a shaped die using pressure (ram or screw)

	• Produces long, continuous sections with consistent profile • Cooled (air or water bath) to set shape • Cut to length; dimensional tolerance controlled by die and cooling
Flow soldering	• PCB prepped with components inserted • Flux applied to clean contact surfaces • Board passed over wave or bath of molten solder • Solder adheres to exposed metal pads and component leads

Q15)

2 marks	Complete description demonstrating both knowledge and understanding of how materials and/or products are strengthened or reinforced. Student makes reference to examples.
1 mark	Simple description with some misunderstanding of how materials and/or products are strengthened or reinforced.
0 marks	Nothing worthy of credit.

Indicative content:

Candidates will draw on their own experience of different material areas to answer the question. For each example, candidates should fully explain each point to access full marks. Both materials and products are acceptable if adequately explained.

The following are possible examples answers but any other examples must be given credit where correct.

- Plywood is created in layers to strengthen the material.
- Plywood layers are laid with the grain in different directions. This ensures the weak lines of the grain are strengthened.
- Many buildings use reinforced concrete to improve the tensile strength of the material.
- Reinforced concrete uses the compressive strength of concrete and the tensile strength of steel combined to make a more suitable building material.

- Interfacing can be used to stiffen the collar of a cotton shirt.
- Laminating of fabrics can be used to stiffen and strengthen.
- Corrugated cardboard is made using layers of cardboard with a corrugated middle layer. This strengthens the material.
- Packaging is also strengthened using structural pieces of corrugated card e.g. a wine carrier. This uses internal pieces which separate the products but also provide internal struts.

Q16)

3 marks for a detailed descriptive point with an example.

2 marks for a detailed descriptive point or simple descriptive point with an example.

1 mark for a simple descriptive point.

Indicative content:

- colour – ability to colour co-ordinate a product within an environment eg curtain fabric in a lounge
- texture – upholstery fabric for use on a seat eg in a car to improve driving sensation
- finish – a smooth finish pleasant to touch
- shape/form – geometric or organic forms eg architecture. Accept other correct responses.

Q17)

5.6kg Copper x 4 = 22.4

1.4kg Zinc x 3.10 = 4.34

Total = £26.74

Q18)

7 – 8 marks	Detailed analysis and evaluation of several appropriate methods used by manufacturers to conserve energy and materials during product development and manufacture. In-depth judgement and clear understanding shown through evaluative comments on the effectiveness of different methods. Several relevant examples linked to manufacturing processes, technologies, and material conservation are used to support and clarify the response.
5 – 6 marks	Good analysis and evaluation with appropriate consideration of several methods used by manufacturers to conserve energy and materials during product development and manufacture. Some evaluative comments and attempt to offer judgement are evidenced. Some relevant examples linked to manufacturing methods and material or energy conservation are used to support and clarify the response.
3 – 4 marks	Basic analysis of some methods used to conserve energy or materials. Limited linking to product development and/or manufacturing processes. No clear evaluation or judgement offered. Limited or irrelevant examples used to support the response.
1 – 2 marks	One or two limited methods for conserving energy or materials identified.
0 marks	No response or nothing worthy of credit.

Indicative content

- CAD modelling to simulate material tessellation prior to cutting on CNC machinery.
- Greater use of CNC machinery for greater accuracy and therefore less waste.
- Low energy lighting factories.
- Electrical equipment going into standby when not in use.
- Use of renewable sources of power.
- Use of recycled materials wherever possible.
- Use of rapid prototyping to produce testable prototypes before full scale production.
- Reduction of parts (combination) to reduce assembly requirements.

- Use of redistribution production techniques wherever possible.
- The use of reusable metal moulds when forming products removes the need for reproduction.
- Manufacturing plants make use of renewable energy sources, such as solar/wind to power factories.
- CAD simulation can be used to calculate the most efficient tool paths to reduce machining times.
- Manufacturers may aim to reduce the thickness or volume of some components to make savings in the amount of materials used.

Q19)

1 mark per correct point. Maximum 2 marks

Indicative content:

- Compression
- Tension
- Bending

Q20.1)

Marks	Description
3 – 4 marks	The response gives a detailed explanation of different market research methods and identifies their suitability to different stages of the design process. Some inaccuracies may be seen but will not detract from the quality of the answer.
1 – 2 marks	The response gives a generic explanation of market research with some reference to how it may be used in the design process.
0 marks	No response or nothing worthy of credit

Indicative content

- Focus groups used to gather feedback on market trends, concepts etc from a specific demographic
- Use of focus groups etc. to gather views on development models

- Surveys allow designers to gather information through targeted questioning using closed and open responses.
- Surveys are ideal for gathering information from a large range of potential customers and analysing for trends.
- Interviews allow a designer to gather specific information from an individual that can be tailored to the specific interviewee.
- Secondary data allows designers to use pre-gathered information available from reputable sources quickly for initial design development etc.
- Primary research allows tailored research specific to the individual project.
- By using social media analysis of current trends and habits.

Q20.2)

1 mark per relevant method (maximum 2 marks).

- Comparison with the specification.
- Evaluating in context.
- User group evaluation.
- Safety testing.
- Mechanism testing.

Q21)

2 marks per relevant point (maximum 4 marks).

- So that the components are made to the correct size / standard ensuring the product fits / functions appropriately
- To set up parameters for quality control checks ensuring that only correct components will pass
- So components are not made more accurate than they need to be (1) saving time / money

Q22.1)

5 – 6 marks	• Comprehensive discussion that makes effective links between a wide range of factors, demonstrating thorough understanding. • Considered and effective application of understanding to the context of the question. • The candidate demonstrates a developed understanding of the conflicting needs of form and function
3 – 4 marks	• Coherent discussion that makes some relevant links between a sufficient range of factors, demonstrating competent understanding. • Generally sound application of understanding to the context of the question. • The candidate demonstrates a good understanding of the conflicting needs of form and function
1 – 2 marks	• Superficial discussion that considers a narrow range of factors, demonstrating limited understanding. • Partial application of understanding to the context of the question. • The candidate demonstrates a limited understanding of the conflicting needs of form and function
0 marks	No response or nothing worthy of credit

Indicative content:

- Form follows function
- Function follows form
- Shape/form
- Key functions
- Ergonomics and anthropometrics
- Demographics of the user group
- Proximity of key controls to fingers and thumbs
- Range of hand movement
- Shape of handles
- Comfort in use
- Ease of use
- Aesthetics

Q22.2)

5 – 6 marks	• Comprehensive evaluation that makes effective links between a wide range of ergonomic, aesthetic and functional factors, demonstrating thorough understanding. • Considered and effective application of understanding to the PS5 controller and its target users. • The candidate demonstrates a developed understanding of the conflicting needs of form and function, such as comfort, usability, appearance and performance.
3 – 4 marks	• Coherent evaluation that makes some relevant links between a sufficient range of ergonomic, aesthetic and functional factors, demonstrating competent understanding. • Generally sound application of understanding to the PS5 controller and its users. • The candidate demonstrates a good understanding of the conflicting needs of form and function.
1 – 2 marks	• Superficial evaluation that considers a narrow range of ergonomic or functional factors, demonstrating limited understanding. • Partial application of understanding to the PS5 controller context. • The candidate demonstrates a limited understanding of the conflicting needs of form and function.
0 marks	No response or nothing worthy of credit

Indicative content:

- Comfortable for long gaming sessions
- Ergonomic shape fits the user's hands well
- Buttons and triggers are easy to reach
- Minimal hand movement improves reaction time
- Textured grips improve control during use
- Suitable for teenage/adult gamers
- Intuitive layout makes it easy to use

- Haptic feedback improves user experience
- Modern appearance appeals to the target market
- Size/weight may not suit users with smaller hands
- Large number of controls may confuse inexperienced users

Q23)

5 – 6 marks	• Comprehensive discussion of why collaborative design is important, with effective links to products and design practice. • Clear understanding of how different skills, expertise and teamwork improve design outcomes. • Relevant examples used effectively to support points.
3 – 4 marks	• Coherent discussion of collaborative design with some relevant links to products or design practice. • Sound understanding of how designers work together to improve products. • Some relevant examples used.
1 – 2 marks	• Superficial discussion with limited understanding of collaborative design. • Narrow range of points with limited application to products or design practice. • Few or basic examples used.
0 marks	No response or nothing worthy of credit

Indicative content

Products:

- Mobile phones – many different parts requiring people with different skills to design them
- Product packaging – package itself, secondary packaging all need designing and will be done outsourced to different companies with different skills, equipment and expertise.
- Motor vehicles, complex products needing the input of team with various skills to meet technical, legal and user requirements.

- Public transport, requiring technical engineering expertise, ergonomic knowledge and interior design
- Medical equipment, requiring medical knowledge, technical and manufacturing expertise and human factors application.

Designing:

- The need to obtain specialist expertise; e.g. electronic engineers working with product designers, architects working with structural engineers
- Companies purchasing outside design ideas e.g. Products marketed as being “Porsche design”
- Where designers work together to solve problems
- Working with other people and not in isolation designers can feed off each other in terms of ideas or experience.
- Chance of designs based on the work of one individual becoming stale and not effective for purpose
- Commercially, companies may become slow to react to changing market demands – collaborative design could ‘future proof’ against this. • eg IKEA now looking to involve designers from outside the organisation (Tom Dixon)
- Fashion stores will commission designs from designers outside of their own organisation.
- Belief that solutions to problems generated in isolation can be of a lower quality and not address all the needs of the client or user (especially if complex or extensive), due to limitations of expertise or experience.
- Used to increase the range and quality of solutions/ possibilities generated to solve a need eg by using teams of designers in competition
- Use different people with different skills, experience and expertise during the design process. Thus, ensuring a better end result.
- Designers can inspire each other leading to innovative and creative solutions to problems
- Shorter design timescale, as designers can work concurrently

Q24)

1 mark for each relevant point to a maximum of 3 marks.

Indicative content

- Objective: A document that can be easily interpreted by all without subjectivity.
- Formed from research: A document which consists of points key characteristics gathered from research.
- Gives a clear list of criteria for evaluation.
- A document that is flexible/a working document that can be updated/reflected upon during the whole design process.
- A document that includes measurable criteria to assess design suitability.
- A document that addresses client needs
- Justifies reason for points included on the specification
- Inclusion of specific quantitative data
- Comprehensive list of criteria

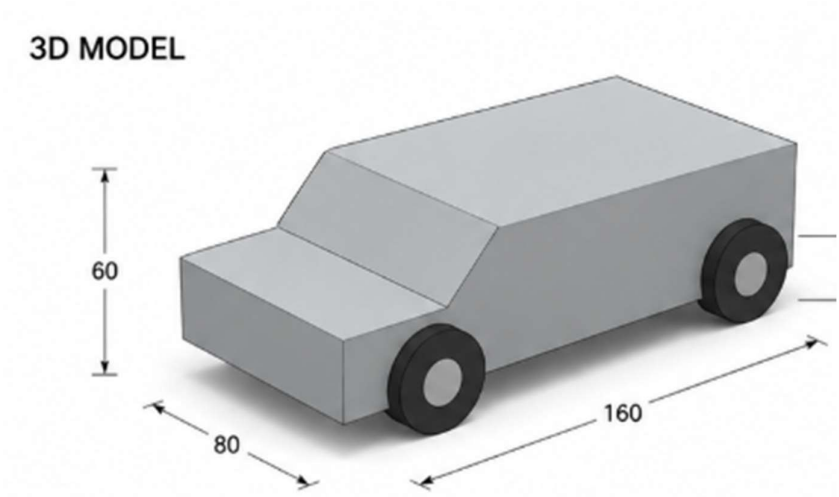
Q25a)

- Use of Pythagoras' Theorem with correct substitution:
  → $\text{Length}^2 = 2675^2 + 2024^2$ (1)
- Correct calculation of squared values and their sum:
  → $7155625 + 4096256 = 11251881$ (1)
- Correct square root and final answer:
  → $\sqrt{11251881} \approx 3353.65\,\text{mm}$ → **Answer: 3354 mm** (1)

Q25b)

- Calculate the volume of one concrete beam using cross-section and length
  → e.g. $250 \times 550 \times 6000 = 825,000,000\,\text{mm}^3 = 0.825\,\text{m}^3$ (1)
- Calculate the volume of 6 steel rebars (each 36 mm diameter and 6000 mm long)
  → Use $\pi r^2 h = \pi \times 18^2 \times 6000 \approx 6.11 \times 10^6\,\text{mm}^3$ (1)
  → Multiply by 6 rebars = approx. $36.66 \times 10^6\,\text{mm}^3 = 0.03666\,\text{m}^3$
- Subtract rebar volume from concrete beam volume
  → $0.825 - 0.03666 = 0.78834\,\text{m}^3$ (1)
- Multiply by 2 to find total for both beams
  → $0.78834 \times 2 = \boxed{1.58\,\text{m}^3}$ (1)

Q26)



Q27)

5 – 6 marks	Clear, well-developed answer including multiple design features/techniques and specific product examples, showing understanding of what made the designer successful.

3 – 4 marks	Some relevant features or techniques identified, with at least one specific product mentioned.
1 – 2 marks	Basic statements with limited reference to a designer or their work.
0 marks	No response or nothing worthy of credit

Indicative content:

This mark scheme uses Philippe Starck as an example, but there are 28 possible designers to choose from in total. Any of the listed designers could be used, as long as the answer includes relevant design features, techniques, and specific product examples.

- Known for innovative and unconventional designs that combine form and function.
- Often uses humour and surprise in everyday objects (e.g. Juicy Salif lemon squeezer).
- Incorporates organic and sculptural shapes that are visually striking.
  • Embraces mass production techniques, making his designs widely accessible.
- Uses a wide range of materials including plastic, aluminium, and glass, often pushing boundaries of conventional use.
- Works across a variety of products — furniture, homeware, hotels — showing versatility.
- Designs often have aesthetic impact as well as practical use, appealing to both consumers and critics.
- Ghost Chair made from a single piece of moulded polycarbonate, showcasing modern materials and industrial techniques.

Q28)

1 mark for a simple point with a second mark for a well explained point

Indicative content: 1 mark responses:

- Visual check/test
- Use a ruler
- Use of a multimeter
- Use a jig/fixture or template

- Use of a go/no go jig
- Testing against a specification
- Check seam strength
- Check seams are neatened
- Check within tolerances
- Testing product to see if it works

2 mark responses:

- Dimensional accuracy, e.g. use of micrometer, Vernier calipers
- Use of jigs and fixtures, e.g. go/no go jigs and depth stops
- Registration mark e.g. CMYB
- Alignment of printing plates, hinges, catches, other interlocking parts, e.g. cross lines
- Material quality e.g. surface inspections for defects
- Electrical continuity, e.g. visual inspection of PCB tracks, use of multimeter
- Safety e.g. loose parts, sharp edges
- Flammability e.g. textiles
- Check zips and fastenings are inserted correctly and work Accept all other valid responses