Design & Technology
(Product Design)

DTBase©

OCR A-Level

Modelling Ideas: Hand Tools & Digital Methods (7.1b)

Materials required for questions

- Pencil
- Rubber
- Calculator

Instructions

- Use black ink or ball-point pen
- Try answer all questions
- Use the space provided to answer questions
- Calculators can be used if necessary
- For the multiple choice questions, circle your answer

Advice

- Marks for each question are in brackets
- Read each question fully
- Try to answer every question
- Don’t spend too much time on one question

Good luck!

Q1. Which of the following is a primary benefit of using **digital simulation** during the iterative design process?

A It completely eliminates the need for any physical prototypes.

B It allows for testing and optimization of designs virtually, reducing time and material costs.

C It guarantees that the final product will be perfectly manufactured.

Q2. A designer uses a **laser cutter** to create precise acrylic components for a prototype. This process is an example of:

A Traditional hand tool modelling

B Digital fabrication / rapid prototyping

C Digital simulation

Q3. Which hand tool process would be most appropriate for quickly shaping the basic form of a wooden concept model?

A Using a lathe

B Sanding by hand

C Carving with a chisel and mallet

Q4. Finite Element Analysis (FEA) is a type of digital simulation used primarily to:

A Create photorealistic renderings of a product

B Analyse stresses, strains, and thermal effects on a digital model

C Simulate the ergonomics of a user interface

Q5. The designer of the frying pan used digital design software in the development of the design. Discuss the role of digital design software during design development. Refer to specific examples in your answer. **(6 marks)**

Q6. Explain the specific virtual modelling techniques that may be used to test the design of a submarine before production. **(6 marks)**

Q7. Many businesses manufacture models of designs using rapid prototype machines rather than traditional modelling methods. Explain the advantages for a business of using rapid prototype machines when modelling designs. **(8 marks)**

Q8. Explain three benefits of using rapid prototyping using CAD/CAM as an alternative method to block modelling. **(6 marks)**

Answers

Q1. B
Q2. B
Q3. C
Q4. B

Q5.
Indicative content:

- Mathematical modelling is used to optimise the design The results can also be presented as graphs and charts.
- Generative design tools produce optimum forms e.g. Adidas 3D printing customised midsoles for their runners or airbus to achieve lightest, strongest design that uses the minimal amount of material.
- Communication of ideas through visual presentation, rending and photo quality rendering.
- Online collaboration to discuss and exchange ideas with experts and/or other designers. This could also include discussing ideas/ designs with stakeholders.
- Product simulation and testing, and test weak areas that may fail, (Finite Element Analysis (FEA).
- Scientific analysis of real-world physical factors to determine whether a product will work in the way it's intended. This can also be used to optimise the design.
- Rapid prototyping such as 3D printing can be used to test ideas.
- Any other valid suggestion.

Q6.
Indicative content:

- CFD: Computational Fluid Dynamics used to simulate pressures and the flow of liquids around the submarine to prevent the need to test in deep water.
- FEA: Finite Element Analysis used to simulate force loadings on individual components and assess the risk of collapse/failure without risking human life.
- By inputting material properties weight distribution and overall mass calculations can be observed.
- Assembly models can be used to ensure components fit accurately.
- Visibility from port holes can be simulated using VR models

- Virtual testing can be used to test electronic control systems prior to production.
- Hydraulic and pneumatic systems can be simulated with mechanisms prior to operation.
- Internal control panels and access can be modelled in VR.

Note: This indicative content is not exhaustive: other creditworthy responses should be awarded marks as appropriate.

Q7.

Any of the following with a linked relevant explanation also from the following:-

- Prototypes are made faster / work through the night / 24/7 (1)
- Prototypes are made more accurately / higher quality / reduced errors (1)
- Prototypes can be more complex / intricate / finely detailed (1)
- Changes / edits are easier to produce (1)
- More modifications / variations can be considered (1)
- Better testing / analysis / judgements / decisions made (1)
- Improved outcomes are developed (1)
- Reduced development time / time to market / meet customer demand / satisfaction / increased competitiveness (1)
- Saves money (due to reduced labour / materials / energy / resources) (1)

Q8.

- RPT can be done extremely quickly compared to traditional methods (1) therefore saving lead time/money (1)
- RPT models can be made extremely accurately (1) with out the need for highly skilled craftsmen (1)
- RPT models can be made as hollow formings (1) due to tool-less technology (1)
- RPT models can be made with intricate detail (1) allowing more realistic prototypes to be produced (1)