



**DESIGN TECHNOLOGY  
HIGHER LEVEL  
PAPER 2**

Monday 18 November 2002 (afternoon)

1 hour 30 minutes

Name

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Number

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**INSTRUCTIONS TO CANDIDATES**

- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: Answer all of Section A in the spaces provided.
- Section B: Answer one question from Section B. Write your answers in a continuation answer booklet, and indicate the number of booklets used in the box below. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.
- At the end of the examination, indicate the number of the Section B question answered in the boxes below.

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QUESTIONS ANSWERED		EXAMINER	TEAM LEADER	IBCA
SECTION A	ALL	/32	/32	/32
SECTION B	.....	/20	/20	/20
NUMBER OF CONTINUATION BOOKLETS USED	.....	TOTAL /52	TOTAL /52	TOTAL /52

## SECTION A

Candidates must answer **all** questions in the spaces provided.

- Mechanical puppets are often used for advertising, *e.g.* in shop window displays. The base board and mechanism of each of the examples shown in Figures 1 and 2 are made from wood and the heads from papier mâché. The puppets can easily be adapted by adding clothes made from textiles and attaching different objects to the hand.

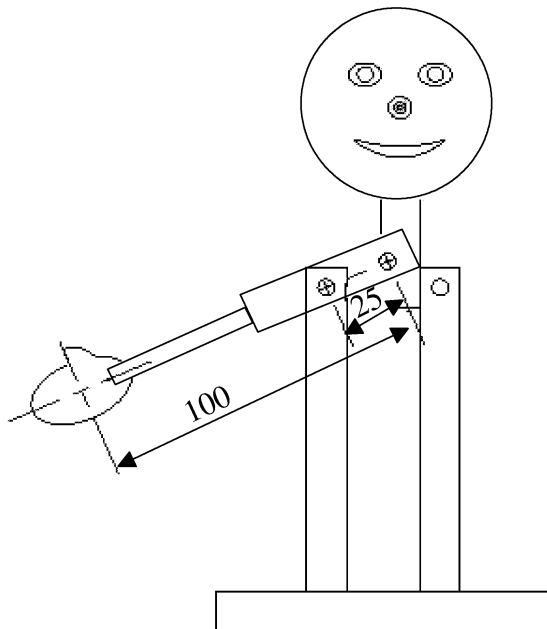


Figure 1

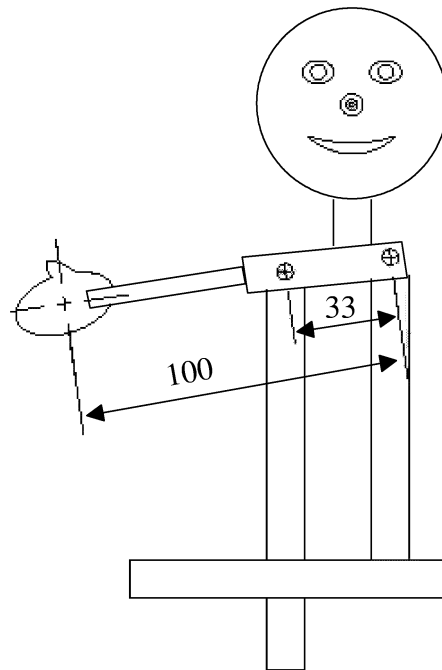


Figure 2

All dimensions in mm

### Parts List

Part number	Description	Material	Figure 1	Figure 2
1	Base	Plywood	✓	✓
2	Pushrod	Softwood		✓
3	Leg	Softwood	✓✓	✓
4	Arm (moving)	Softwood	✓	✓
5	Head	Papier Mâché	✓	✓
6	Neck	Softwood	✓	✓
Total components			6	6

(This question continues on the following page)

*(Question 1 continued)*

- (a) Outline why less material is used for the puppet shown in Figure 1 than for the one in Figure 2. [2]

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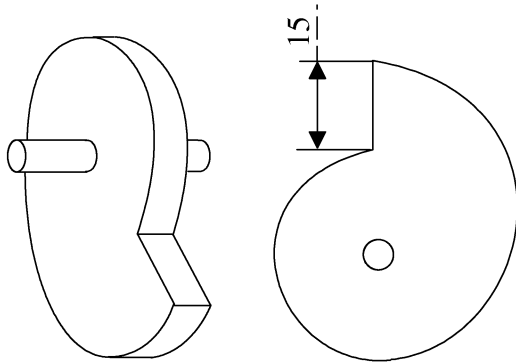
- (b) Suggest **two** reasons why the designer has chosen plywood for the base instead of softwood, as for the other parts. [4]

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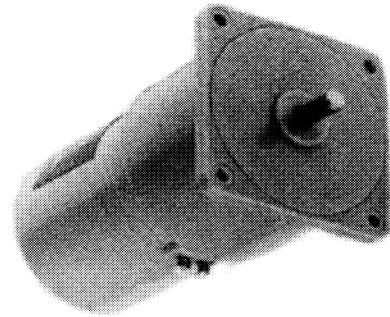
*(This question continues on the following page)*

(Question 1 continued)

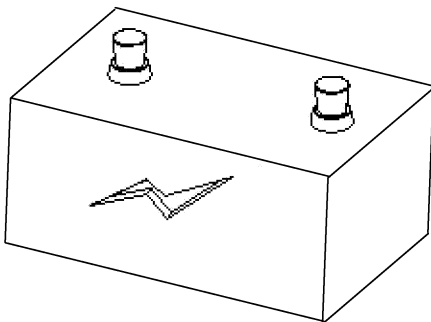
- (c) The components in Figure 3 have been selected by the designer to automate the puppets, either mechanically or electrically.



I. Cam



II. Motor Gearbox Unit  $2 \text{ revs min}^{-1}$



III. Control box Input 6 V. Output 3 V @ 180 mA. Switched to give square wave output.

Normal metals and alloys expand very slightly when heated and contract again as they cool. SMA has a transition temperature. Below the transition temperature it behaves normally but above it, it contracts powerfully. Nitinol is a SMA available in wire form which can be heated to the transition temperature by passing a small electric current through it. It has the following specification:

Nickel / Titanium wire (0.1 mm diameter).

Shortens by 5 % exerting a force of 1.4 N when heated by a 180 mA current.

Returns to normal length when current is removed.

Minimum cooling time is 0.25 s.

IV. Shape memory alloy (SMA) “Nitinol Wire”

All dimensions in mm

**Figure 3**

(This question continues on the following page)

*(Question 1 (c) continued)*

- (i) Draw a labelled 3D sketch to show how the cam and the motor gearbox unit can be attached to the puppet in Figure 2 to allow the arm to move up and down. [3]

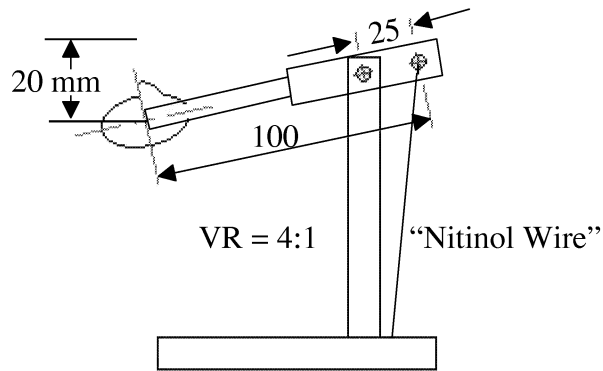
- (ii) Deduce the range of movement of the hand. [3]

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*(This question continues on the following page)*

(Question 1 continued)

(d)



All dimensions in mm

**Figure 4**

Figure 4 shows how “Nitinol Wire” can be used for the mechanism of the puppet shown in Figure 1.

- (i) Calculate the length of “Nitinol Wire” required to provide the range of movement shown. [2]

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- (ii) Explain how the puppet could be operated electrically using the components given. [4]

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2. Novel food products based on mycoprotein compete in the market place with traditional meat products.

Outline **two** hedonic properties the designer of the mycoprotein products needs to take into account in order to compete successfully against the traditional products. [4]

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3. Explain why sintering is an appropriate manufacturing technique for making superconductors. [3]

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4. Modern manufacturing processes rely heavily on electronic control systems. Explain **one** way in which the use of modern control systems can improve the quality control aspect of manufacturing. [3]

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5. (a) Outline the difference between mechanisation and automation. [2]

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- (b) State **two** effects of automating a production process on the nature of the workforce. [2]

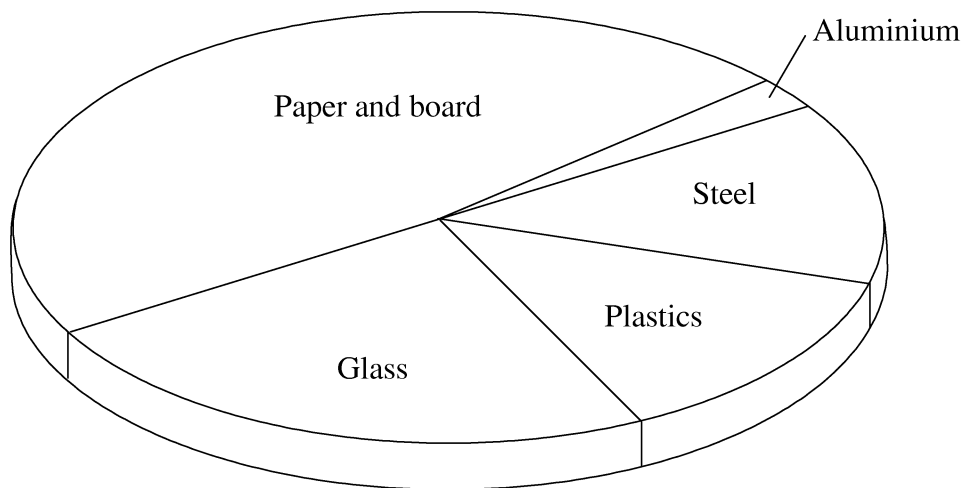
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## SECTION B

Answer **one** question. Up to three additional marks are available for the construction of your answer. Write your answers in a continuation answer booklet. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.

6. The pie chart shows the proportions of different materials used for packaging household commercial and industrial goods in a developed country.



- (a) Outline **one** reason why stainless steel is used for medical equipment. [2]
- (b) (i) Define *renewable resource*. [1]
- (ii) Identify **one** material from the pie chart which originates from a renewable resource. [1]
- (c) An aluminium drinks can has reduced in weight from 20 g in 1980 to 12 g in 2000. Outline **two** reasons for this. [4]
- (d) Discuss the reasons for the popularity of paper and board compared to plastics for use as packaging materials. [9]

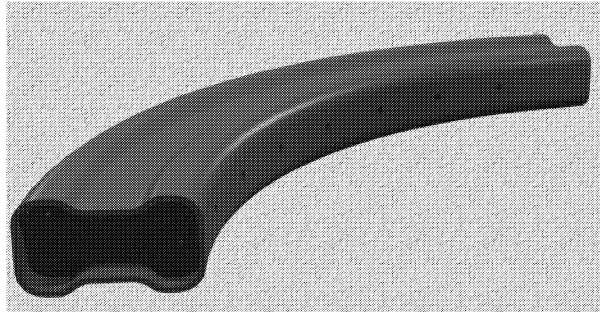
7. A leading manufacturer of household products has identified a market need for a kitchen work surface protector – a piece of toughened glass onto which very hot objects can be placed.

From market research the manufacturer determined that the shape of the work surface protector should be round and that consumers prefer a pattern to plain glass. Various patterns may be printed onto an adhesive backed paper which is then encapsulated within the glass.

- (a) State **two** characteristics of glass (other than resistance to heat) which makes it the preferred choice of material. [2]
- (b) Toughened glass is an example of a material with network covalent bonds. State the properties of network covalent bonds which make toughened glass suitable for this application. [4]
- (c) For safety the designer has decided to add four feet to the base of the protector. Outline **one** reason for this decision. [2]
- (d) Discuss the strategies the manufacturer may have used to collect data concerning the design for the work surface protector. [9]

8. Tennis racket designs have developed from using timber to metal alloys and now composite materials for making the frame.

Figure 5 shows a cross-sectional view of a modern tennis racket frame made from a nylon-carbon fibre composite material which has been injection moulded.



**Figure 5**

- (a) (i) State **two** properties of carbon fibre which makes it suitable for the design of the racket frame. [2]
- (ii) Outline how the constraints imposed by the properties of existing materials act as a stimulus for the development of new materials. [2]
- (b) Outline how the use of nylon in the composite material enables it to be injection moulded. [2]
- (c) Outline **one** reason why the design of the tennis racket frame could help to conserve material resources. [2]
- (d) Evaluate the importance of Young's modulus of materials, equilibrium of forces and the cross-sectional shape of the hollow frame to the design of the tennis racket as a structure. [9]
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