IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M03/470/S(3)

DESIGN TECHNOLOGY
STANDARD LEVEL
PAPER 3

Candidate number

Thursday 15 May 2003 (morning)

1 hour

INSTRUCTIONS TO CANDIDATES

- Write your candidate number in the box above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your candidate number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.

Option A – Raw material to final product

A1. Figure A1 shows a superconducting magnetic levitating train which is being developed in Japan and which can reach speeds of over 480 km/hr. Superconducting magnets (SCMs) on-board the train and on the sidewalls of the guideway provide levitation, keep the train in the centre of the guideway and propel it along the track.

Figure A2 shows the undercarriage of the train on which two SCMs are mounted. Figure A3 shows more detail of the SCM – at the top is a cylindrical unit which holds liquefied helium and nitrogen and a refrigerator which re-liquefies the helium gas as it vaporizes during operation.

Figure A1

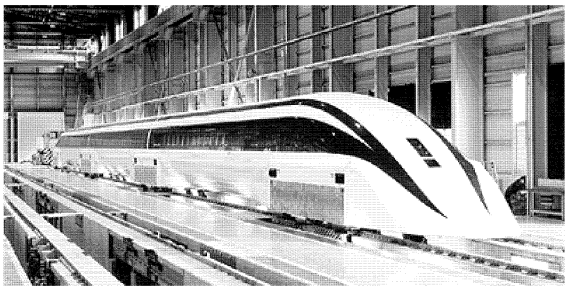


Figure A2

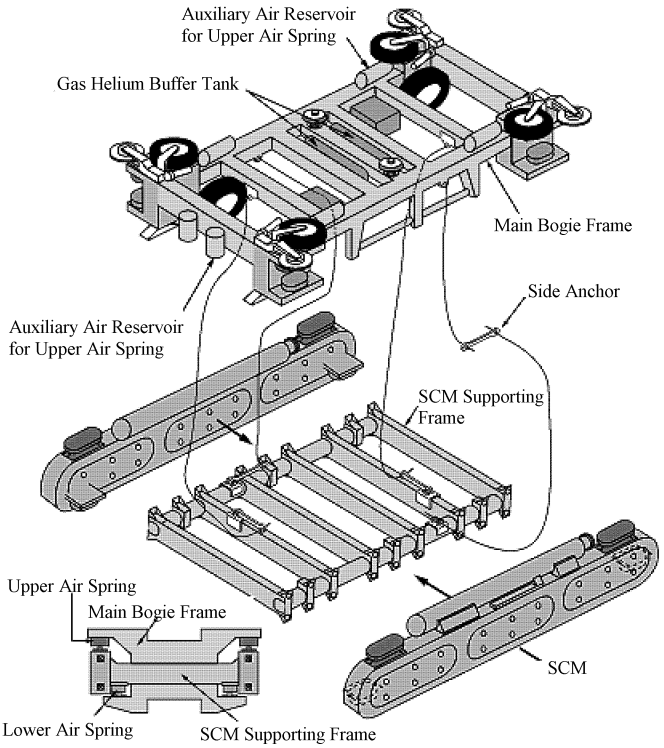
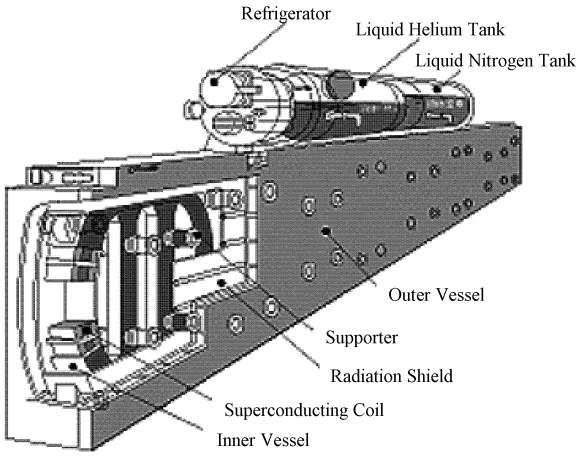


Figure A3



[Source: www.rtri.orijp and www.personal.psu.edu]

(This question continues on the following page)

(Question A1 continued)

(a) Outline why the resistivity of superconductors becomes nearly zero at temperatures of liquid helium and liquid nitrogen. *[2]*

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(b) Explain how being able to produce superconducting materials that operate at room temperature would impact on the design of the SCM and undercarriage of the train. *[3]*

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A2. Describe how the chemical composition of mycoprotein is modified in the design of a range of novel food products. *[2]*

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A3. Outline how modifying the chemical composition of borosilicate glass impacts on its physical characteristics. *[2]*

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A4. Explain how cotton and nylon may be incorporated into a composite fabric for socks and how the composition of the fabric impacts on comfort and durability. *[6]*

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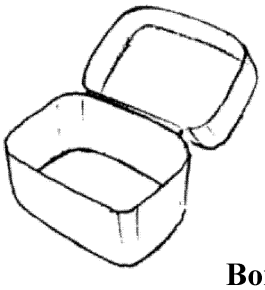
Option B – Microstructures and macrostructures

B1. Figure B1 shows a plastic box with a "living hinge" or integral hinge. A living hinge is a thin section of plastic that connects the lid and the body of the box together (see Figure B2) and allows the box to be opened and closed. Boxes with living hinges are injection moulded in one piece from flexible plastics, *e.g.* the thermoplastic polypropene produced from propene molecules. Following moulding, the fibres of the plastic are arranged randomly. However, for the living hinge to have an acceptable life the molecules have to be oriented across the hinge line. This is achieved by applying heat and pressure to the hinge and plastically deforming the material in the hinge – a process called "coining" (see Figure B3).

Figure B1



Box with living hinge

Figure B2

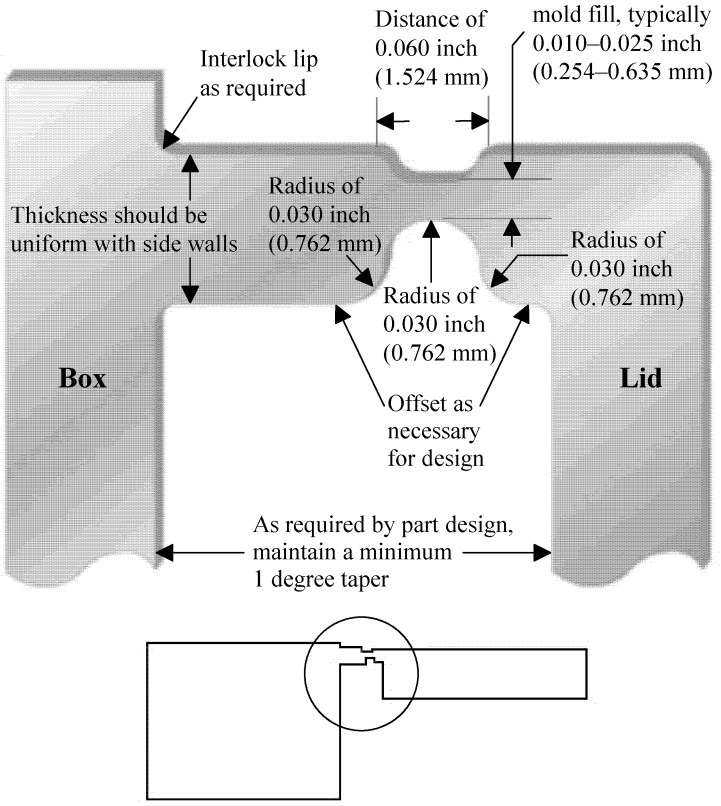
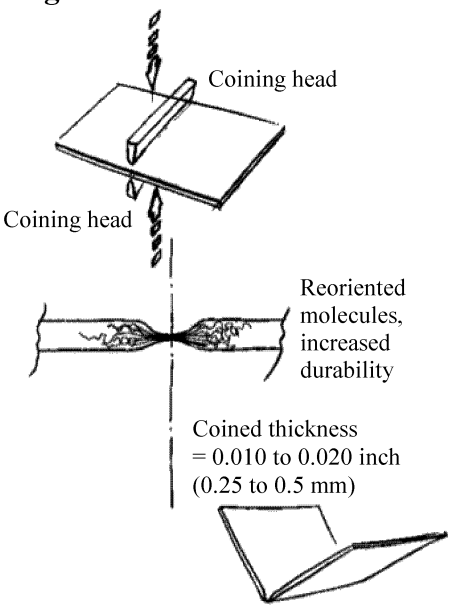


Figure B3



Coining of hinges to increase durability cycles

[Source: www.efunda.com/designstandards/plastic_design/hinge.cfm]

(This question continues on the following page)

(Question B1 continued)

(a) Describe the structure and bonding of a thermoplastic, *e.g.* polypropene. *[2]*

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(b) Explain how the reversible effect of temperature on a thermoplastic enables the orientation of polypropene chains along the hinge line in the coining process. *[3]*

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B2. Describe a covalent bond. *[2]*

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B3. Outline the importance of the properties of thermoplastics on recycling. *[2]*

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B4. Explain the relevance of a stress / strain graph in the coining stage of manufacturing a living hinge. *[6]*

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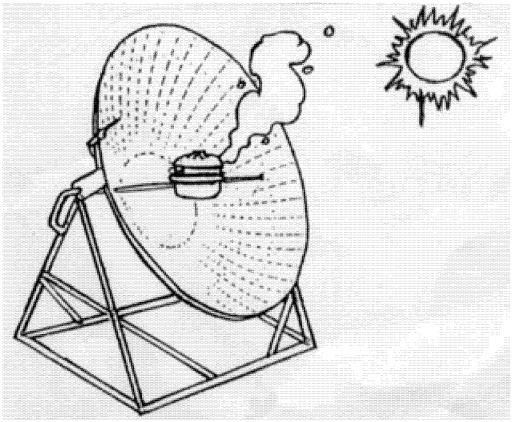
Option C – Appropriate technologies

C1. In Nepal energy supply is a major issue for urban and rural households. Approximately 90 % of Nepal's energy demand is met by fuelwood and agricultural residues. This leads to rapid depletion of forests and soil degradation and it takes considerable time and effort to collect and carry fuel. Importing kerosene and liquid petroleum gas has resulted in the spending of a significant amount of hard currency. The Nepalese Government is urgently investing in the development of alternative energy sources. One renewable energy source, which has great potential in Nepal, is solar energy – Nepal has about 300 sunny days a year. Figure C1 shows a parabolic solar cooker, which uses solar energy to cook food and is therefore, a sustainable household energy technology for Nepal.

Figure C1



Parabolic Solar Cooker

[Source: www.panasia.org.sg/nepalnet/crt/suncook.html]

(a) Define *renewable resource*. *[1]*

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(b) Define *appropriate technology*. *[1]*

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(c) Explain why the use of solar energy has been successful in Nepal. *[3]*

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C2. List **two** major proposals that were agreed by participants as part of Agenda 21 at the Rio Conference. *[2]*

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C3. List **two** characteristics of an appropriate technology. *[2]*

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C4. Explain how the characteristics of the parabolic solar cooker are consistent with sustainable development. *[6]*

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Option D – Food technology

D1. Figure D1 shows a domestic bread-making machine, which enables the one-off production of a loaf of bread from a pre-packaged bread mix or from basic ingredients using a wide range of recipes. After putting the ingredients in the bread maker the bread maker kneads, proves and bakes the bread either immediately (which takes about three hours) or after a time delay, *e.g.* overnight.

Figure D1

(a) Outline how **one** lifestyle factor is likely to contribute to the popularity of the bread-maker as a domestic appliance. *[2]*

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(b) Outline the influence of scale of production on the organoleptic properties of bread produced in the bread-maker. *[2]*

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(c) Explain how the consumption of bread contributes to a balanced diet. *[3]*

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D2. Outline how health awareness in relation to fibre intake affects food choice. *[2]*

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D3. Explain how the processes of aeration, protein coagulation and gelatinisation are used to affect the physical and chemical properties of bread. *[6]*

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Option E – Computer-aided design, manufacture and production

E1. The embroidery machine shown in Figure E1 has been designed for use in schools as an introduction to computer-aided design. It can also be used for small businesses to produce results such as that shown in Figure E2. The embroidery machine interfaces with a personal computer running computer software. All the machine's operations are controlled through the computer. The machine is suitable for embroidering on a range of different fabrics, *e.g.* felt, denim and towelling. The fabric is held, while sewing, by a frame. The user just has to fit fabric into the frame, thread the machine with suitable colour yarns and use the computer to start sewing.

Figure E1

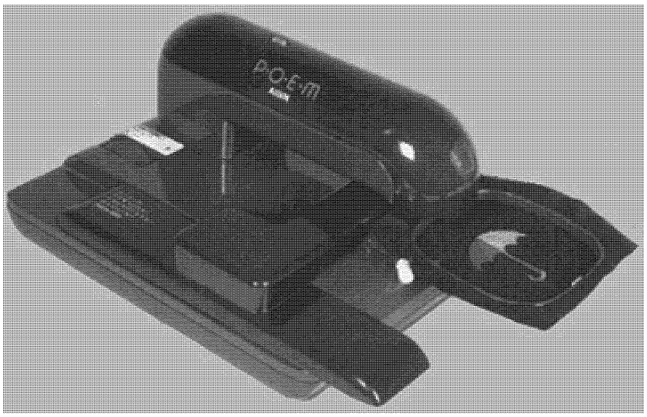
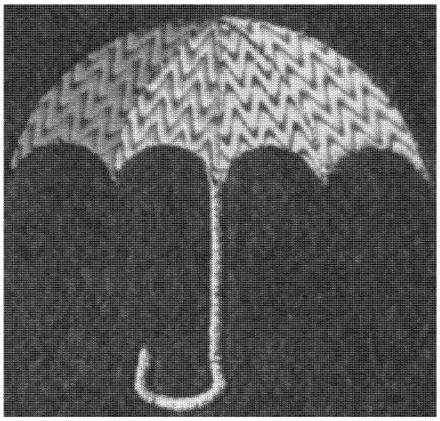


Figure E2



[Source: www.home.clear.net.nz/pages/techsoft/]

(a) Outline how the embroidery machine would be interfaced to the personal computer to produce a CAD/CAM system. *[2]*

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(b) Outline how a scanner might be used with the CAD/CAM system. *[2]*

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(c) Suggest **one** reason why a frame is used to hold the fabric whilst being embroidered. *[3]*

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E2. Outline **one** advantage of Just-in-time (JIT) to manufacturing. *[2]*

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E3. Discuss the implications of computerized manufacture on the infringement of copyright and patent laws. *[6]*

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Option F – Invention, innovation and design

F1. Figure F1 shows a Sony Walkman™ TPS-L2. According to Sony, *"In 1979, an empire in personal portable entertainment was created with the ingenious foresight of Sony Founder and Chief Advisor, the late Masaru Ibuka, and Sony Founder and Honorary Chairman Akio Morita. It began with the invention of the first cassette Walkman TPS-L2 that forever changed the way consumers listen to music."* Figure F2 shows a portable CD player also produced by Sony.

Figure F1

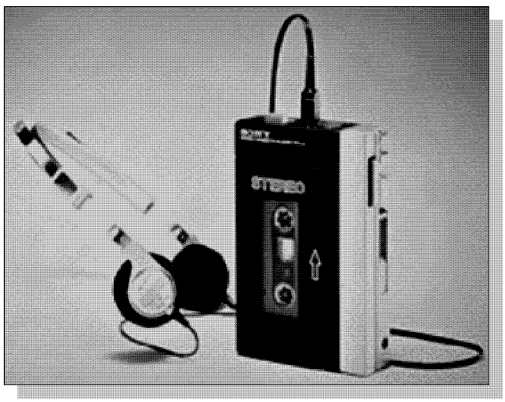

Figure F2

(a) Explain why the Sony Walkman™ shown in Figure F1 was an example of a pioneering innovation. *[3]*

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(b) Outline why the portable CD player shown in Figure F2 is an example of incremental design. *[2]*

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F2. Outline why Akio Morita can be regarded as a product champion. *[2]*

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F3. Outline the relevance of design to re-innovation. *[2]*

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F4. Discuss the corporate strategy referred to as “imitative”. *[6]*

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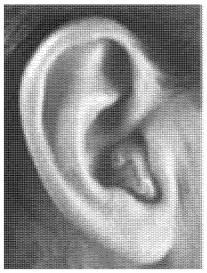
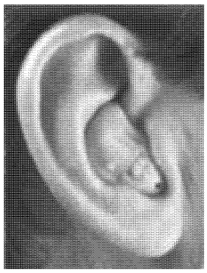
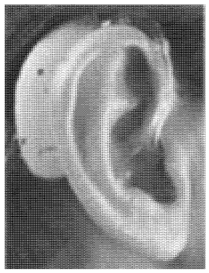
Option G – Health by design

G1. Hearing aids come in a wide range of styles and sizes including completely-in-canal (CIC) (Figure G1), in-the-canal (ITC) (Figure G2), in-the-ear (ITE) (Figure G3) and behind-the-ear (BTE) (Figure G4).

Figure G1 **Figure G2** **Figure G3** **Figure G4**

[Source: www.audiology.org/consumer/guides/wyskahl]

(a) Outline why hearing aid shells are examples of one-off production. *[2]*

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(b) Identify **one** disadvantage of the BTE hearing aid shown in Figure G4. *[2]*

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(c) Explain how the size of the hearing aid and its position in the ear determines the hearing aid battery life. *[3]*

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G2. Outline the impact of improvements in material technology on the availability of contact lenses for a wider range of optical defects. *[2]*

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G3. Discuss a design context in which user-centred design is particularly applicable. *[6]*

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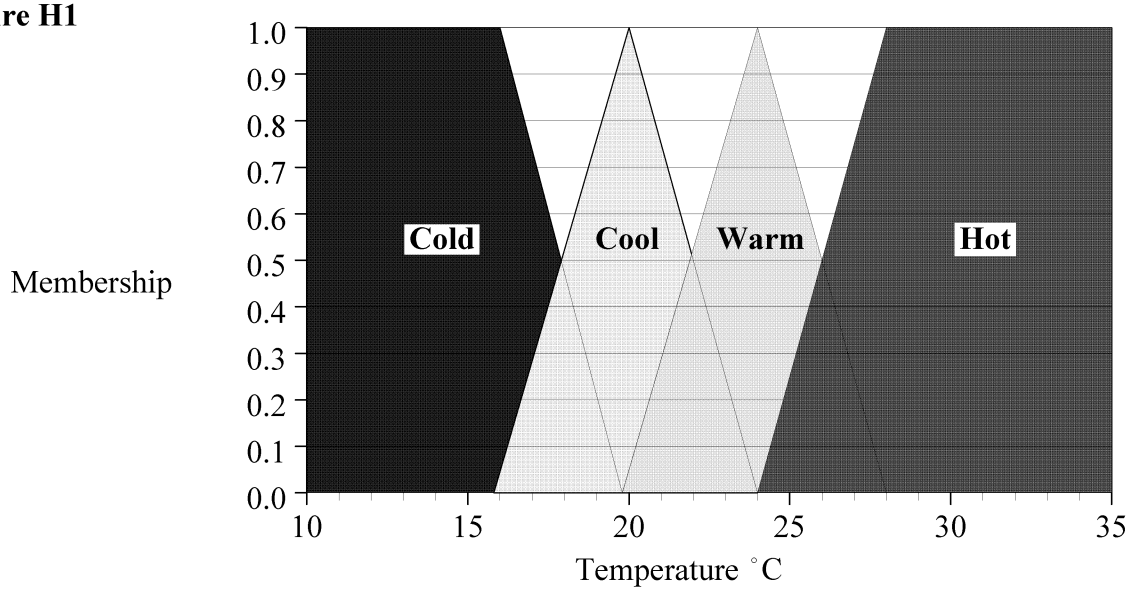
Option H – Electronic products

H1. Fuzzy logic can be used provide precise control in a number of design applications, *e.g.* temperature control in a room. Figure H1 shows how temperatures from 10 to 35°C are assigned to membership of four temperature ranges labelled cold, cool, warm and hot. Crisp input values for temperature are translated into fuzzy truth values in the fuzzification step. IF-THEN rules, such as those shown below, are used to control the heater system.

Figure H1



IF temperature is **cold** THEN heater is **high**
IF temperature is **cool** THEN heater is **medium**
IF temperature is **warm** THEN heater is **low**
IF temperature is **hot** THEN heater is **zero**

(a) Identify and draw the symbol for an electrical component that could be used to input a signal representing the room temperature into the fuzzy control system. *[2]*

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(This question continues on the following page)

(Question H1 continued)

(b) What fuzzy truth values would the input temperature of 22 °C be translated into? *[2]*

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(c) Explain how the IF-THEN rules would be used to control the heating system. *[3]*

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H2. Outline the effect of adding impurities to a semiconductor material. *[2]*

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H3. Explain the importance of critical damping in a position control servo-system. *[6]*

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