IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
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M05/4/DESTE/SP3/ENG/TZ0/XX+

22056206

DESIGN TECHNOLOGY
STANDARD LEVEL
PAPER 3

Thursday 5 May 2005 (morning)

1 hour

Candidate session number

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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes 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 session 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 section of kitchen work surface in a kitchen showroom. The photograph shows a stainless steel hob, a glass chopping board and flat pack kitchen furniture. The furniture is made of a composite material which is made of particle board covered in a thermoplastic veneer.

Figure A1: Section of kitchen work surface

(a) Describe the chemical changes that take place in a blast furnace. *[2]*

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(b) Describe how iron is converted to steel. *[2]*

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(c) Explain why steel must be processed to make it suitable for the manufacture of the stainless steel hob. *[3]*

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A2. Outline **one** characteristic of glass that makes it suitable for the manufacture of the chopping board. *[2]*

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A3. Discuss **two** reasons for finishing the particle board with a thermoplastic veneer for use in the kitchen worksurface. *[6]*

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Option B — Microstructures and macrostructures

B1. Standardised tests are used to generate data relating to the mechanical properties of materials, *e.g.* tensometers are used to determine tensile strength. **Figure B1** below shows a typical tensile strength test specimen and **Figure B2** shows a Hounsfield tensometer that can be used for tensile strength testing. **Figure B3** shows the stress-strain curve for low carbon steel commonly used for the manufacture of body parts for motor cars.

Figure B1: Typical tensile strength test specimen

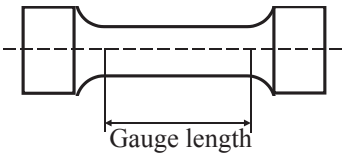


Figure B3: Stress-strain curve for low carbon steel

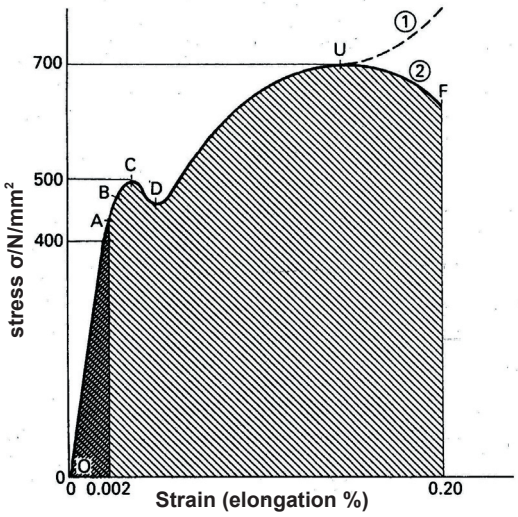
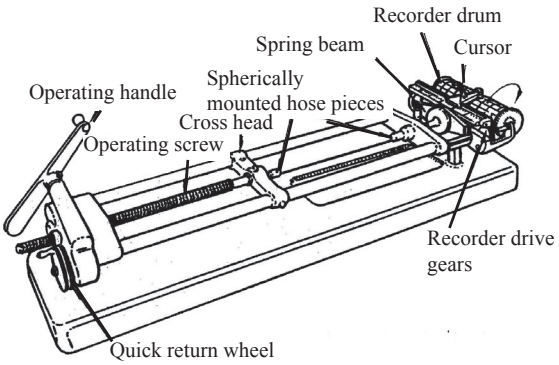


Figure B2: Hounsfield tensometer



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(Question B1 continued)

(a) Outline **one** reason why standardized tests are used. *[2]*

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(b) Identify **one** reason for the shape of the tensile test specimen. *[2]*

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B2. (a) Describe a metallic bond. *[2]*

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(b) Explain how metallic bonding contributes to the properties of steel. *[3]*

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(Option B continued)

B3. Identify the major regions of the stress/strain graph shown in Figure B3 and explain the relevance of this information to the manufacturers of body parts for cars. *[6]*

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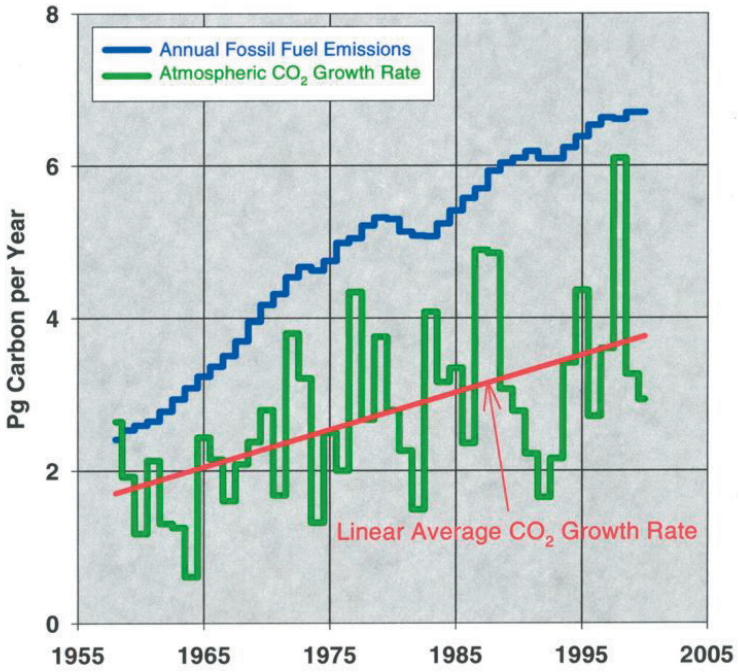
Option C — Appropriate technologies

C1. Regular monitoring of atmospheric carbon dioxide (CO_2) since 1958 shows it has been steadily rising (see **Figure C1**) as a result of fossil fuel burning and has made a major contribution to climate change (global warming). In 1988, the United Nations Environment Programme and the World Meteorological Organization set up the Intergovernmental Panel on Climate Change. Its conclusions led to the Kyoto protocol of the United Nations Framework Convention on Climate Change, which requires **industrialized** countries to take action to return their greenhouse gas emissions to 5 % below 1990 levels by the year 2012 through sustainable development policies including: energy efficiency and use of renewable forms of energy; sustainable forest management; sustainable forms of agriculture; controlling greenhouse gas emissions.

Figure C1: Fossil Fuel Emissions and Atmospheric CO_2 Growth Rates (Pg – a billion metric tons)



[Source: NOAA Climate Monitoring and Diagnostics Laboratory]

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(Question C1 continued)

(a) Outline **one** reason why industrialized rather than developing countries are required to commit to make positive efforts to control atmospheric CO_2 emissions by the Kyoto protocol. *[2]*

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(b) Explain why controlling climate change requires international cooperation through international agreements, such as the Kyoto protocol. *[3]*

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C2. Outline **one** disadvantage of fossil fuel burning apart from impacts on atmospheric CO_2. *[2]*

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C3. List **two** renewable sources of energy. *[2]*

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(Option C continued)

C4. Explain **two** reasons why meeting the requirements of the Kyoto protocol in any individual country requires systems-level changes in industry and society. *[6]*

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Option D — Food technology

D1. Fruit and vegetables are an important part of a balanced diet. The World Health Organization recommends that adults eat at least 400 g of fruit and vegetables a day. "Countries such as Australia, Canada, New Zealand, United Kingdom, United States, and others have adopted a "5-a-day" concept which recommends at least five servings of fruit and vegetables per day" (Yeung and Laquatra, 2003: 199). To facilitate consumers some food companies (*e.g.* Heinz) use pictograms to represent the fruit and vegetable content of their products. **Table D1** and **Figure D1** show information from the label of a can of tomato soup.

Table D1

Typical values	Amount per serving (200 g)
Energy	536 kJ
Protein	1.7 g
Carbohydrate	14.2 g
Fat (of which saturates)	7.2 g (0.5 g)
Fibre	0.8 g
Sodium	0.8

Figure D1

[Source: www.heinz.co.uk and Yeung DL and Laquatra I (Eds) (2003). Heinz Handbook of Nutrition (9th Edition). Heinz Corporate Research Centre: Heinz]

(a) Describe what is meant by a balanced diet. *[2]*

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(b) Outline **one** health consideration that has implications for food choice. *[2]*

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(c) Discuss the accessibility of the information in Table D1 and Figure D1 for consumers. *[3]*

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D2. Outline **one** way that the packaging of the tomato soup could contribute to the development of the brand of the food manufacturer. *[2]*

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D3. Explain how local farm cooperatives and on-farm processing can enhance farm sustainability. *[6]*

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Option E — Computer-aided design, manufacture and production

E1. The Toyota Production System (TPS) is a Just-in-Time system developed in the 1950s to control the flow of materials through a production facility. TPS made a major contribution to the global competitiveness of Toyota and has been adopted by many manufacturers in many industries to improve their manufacturing operations. TPS developed over a period of over 50 years, but interestingly has never been written down. An article by Steven Spear and H Kent Bowen in 1999 (*Decoding the DNA of the Toyota Production System.* Harvard Business Review, September-October, 96-106) identified four key rules implicit to TPS.

Rule #1: All work shall be highly specified as to content, sequence, timing and outcome.
This rule is about how workers do their work, for example: when a car seat is installed the bolts are always tightened in the same order, the time to turn each bolt is specified, and so is the torque to which the bolt should be tightened.

Rule #2: All worker interactions relating to the movement of parts must be direct and there must be an unambiguous yes-or-no to requests and responses.
When a worker needs more parts the request is made with kanbans – laminated cards specifying the part, the number of parts in a container, where they come from and who will install them.

Rule #3: Every single product and service travels a single, simple and direct path.
This rule determines how production lines are constructed.

Rule #4: Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization.
This rule is about how workers learn to improve the production process and makes people responsible for improving their work.

(a) Outline **one** impact of Rule #4 on the workforce. *[2]*

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(b) Explain how Rule #2 helps to reduce waste and conserve resources. *[3]*

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(c) Outline **one** way in which Rule #1 contributes to the quality of the finished car. *[2]*

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E2. Outline **one** way in which virtual reality helps a car manufacturer to communicate with consumers to implement mass customization. *[2]*

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E3. Discuss **one** advantage and **one** disadvantage of JIT to manufacturing. *[6]*

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Option F — Invention, Innovation and Design

F1. **Table F1** shows a range of specific features available on mobile phones that come in addition to common features such as an address book, calendar, alarm clock and games. Mobile phones are continuously being redesigned to become smaller and offer more, or improved, features.

E-mail	Provides e-mail access via the phone.
Tri-band	Tri-band phones are able to work on all three GSM frequencies, *i.e.* GSM 900; GSM 1800 (which is widely used in Europe) and GSM 1900 (which is used in USA and Canada).
GRPS (General Packet Radio Services)	GPRS allows the user to connect to the Internet and only pay for information sent or received.
Bluetooth®	Bluetooth® technology is the new standard for Wireless connectivity. It gives a wire-free connection between a phone and a headset or other compatible device, *e.g.* a laptop, up to a range of 10 m.
Photo Messaging	Allows the phone user to send and receive photos.

(a) Outline **one** reason why mobile phones are unlikely to be developed by a lone inventor. *[2]*

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(b) Compare the lone inventor with the product champion. *[2]*

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F2. Outline **one** lifestyle factor that has promoted the diffusion of the mobile phone into the marketplace. *[2]*

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F3. Explain how people can be classified according to their reaction to technological change. *[3]*

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F4. Discuss the implications of the corporate strategies referred to as "pioneering" and "imitative" for mobile phone manufacturers. *[6]*

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Option G — Health by design

G1. In 1981 the Food and Drug Administration (FDA) in the United States of America (USA) approved extended wear lenses to be worn for 30 days without removal. This approval was withdrawn when extended wear lenses were shown to cause oxygen deprivation to the cornea of the eye and a range of eye problems including microcysts. Oxygen permeability is expressed in units of Dk/T where a high value denotes high oxygen permeability. A new generation of contact lenses with high oxygen permeability (high Dk) (see **Figure G1**) have now been developed. **Figure G2** shows the results of a user trial with 18 subjects comparing the frequency of eyes with epithelial microcysts for high Dk (Dk/T=110) and low Dk (Dk/T=24.3) silicone hydrogel lenses. Fonn *et al.*[*], who are optometrists at the University of Waterloo, USA, conducted the trial.

Figure G1: A silicon hydrogel contact lens

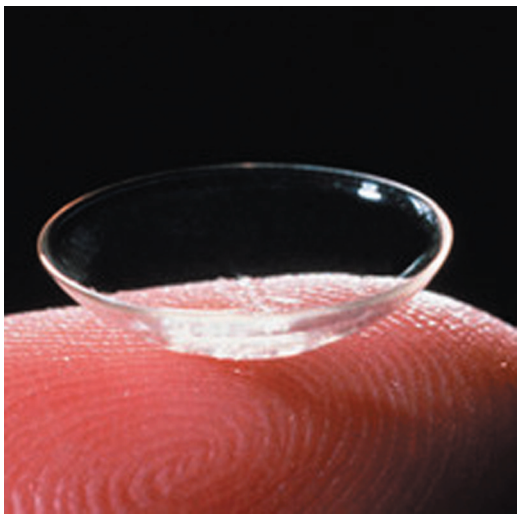
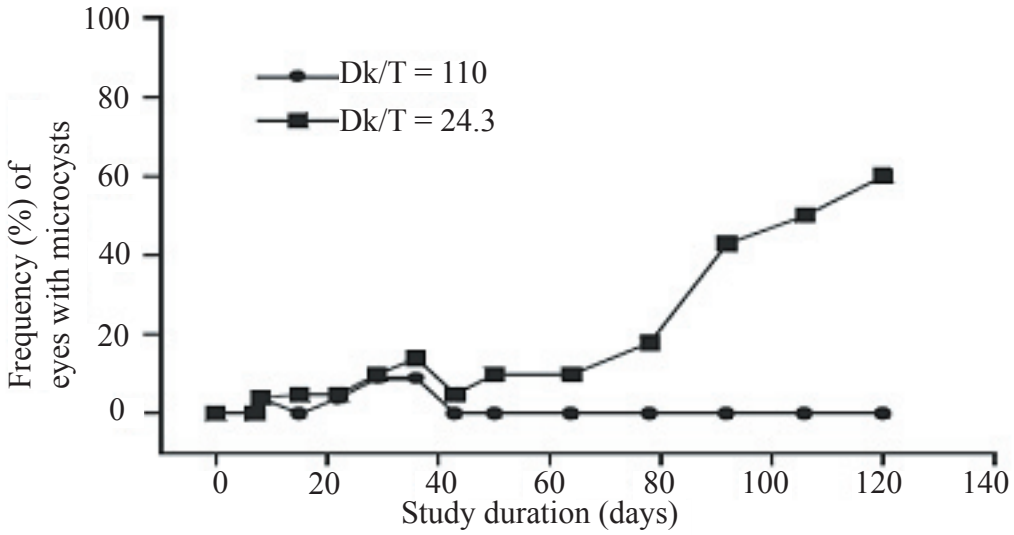


Figure G2: Comparison of the frequency of eyes with microcysts when using high Dk/T and low Dk/T contact lenses.



[Source: Fonn et al., 2002[*]]

[*] Fonn, D, MacDonald, K E, Ritcher, D and Pritchard N (2002). *The ocular response to extended wear of a high Dk silicone hydrogel contact lens.* Clinical and Experimental Optometry, 85 (3), 176-182.

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(Question G1 continued)

(a) Outline **one** lifestyle factor that leads to the popularity of extended wear lenses. *[2]*

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(b) Compare the frequency of microcysts for the two types of lens (high Dk or low Dk). *[2]*

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(c) Outline **one** reason why regulatory bodies, like the FDA, would not approve silicone hydrogel in isolation but would approve it for a specific purpose. *[2]*

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G2. Explain the benefit of being able to reuse hearing aid shells. *[3]*

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(Option G continued)

G3. Explain the role of legislation in encouraging motor vehicle research and development. *[6]*

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Option H —Electronic products

H1. Many cars now have cruise control systems, for use on long sections of straight road, so the driver does not have to keep pressing the throttle (accelerator pedal) to keep the car moving at a selected speed. The cruise control system uses sensors (see Figure H1) and controls the speed of the car by adjusting the throttle pedal. A cruise control system has a range of safety features, *e.g.* the system cuts out when the driver presses the brake or the clutch pedals.

Figure H1: Incomplete processing block diagram for the cruise control

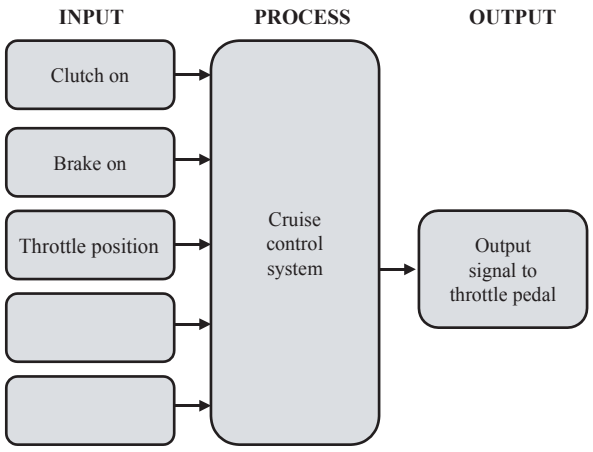

Table H1: Truth Table

Brake	Clutch	Cruise control system
0	0	1
0	1	0
1	0	0
1	1	0

(a) List **two** missing input signals needed by the cruise control computer in addition to the ones shown in Figure H1. *[2]*

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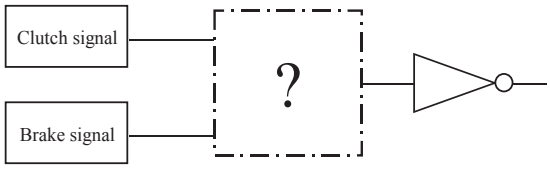
(b) Identify the gate missing in the logic circuit below required to achieve the truth table shown in Table H1 so the cruise control cuts out if the clutch or brake pedals are pressed. *[2]*



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(Question H1 continued)

(c) Describe a role for a comparator in the cruise control system. *[2]*

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H2. Explain why negative, **not** positive feedback is used in the cruise control system. *[3]*

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H3. Explain **two** benefits of fuzzy logic for the implementation of the cruise control system. *[6]*

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