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

M04/470/S(3)

DESIGN TECHNOLOGY
STANDARD LEVEL
PAPER 3

Candidate number

Wednesday 19 May 2004 (morning)

1 hour

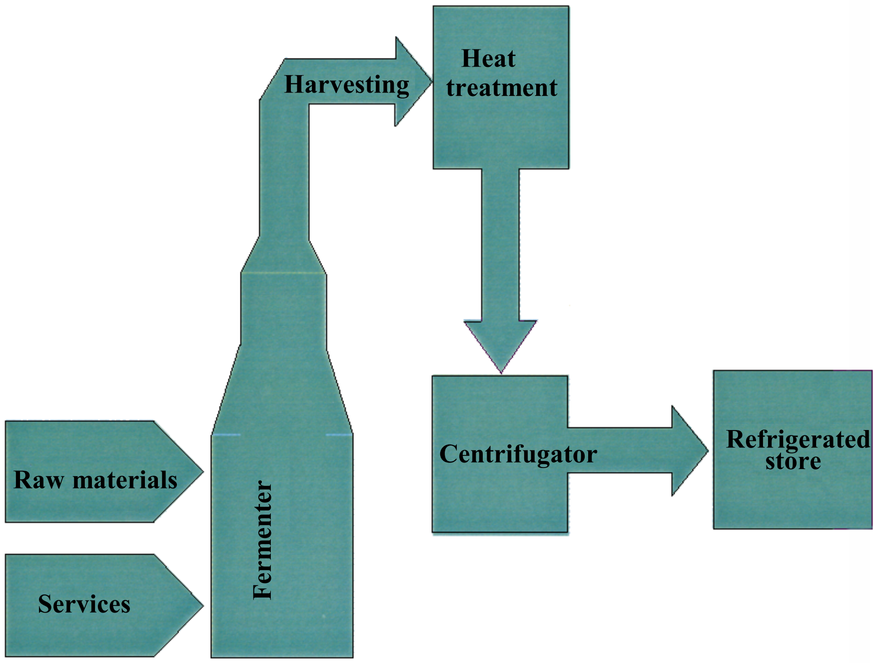
INSTRUCTIONS TO CANDIDATES

- 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. Mycoprotein is produced in extremely tall (approximately 45 m) sterile fermenters largely made of stainless steel (see **Figure A1**). The fermenter is filled with water and raw materials and a starter culture of fungal cells are added. Temperature, pH, nutrient and oxygen levels are carefully controlled. The cells multiply until the rate of multiplication enables cells to be removed without altering the number of cells left in the fermenter – a process is called harvesting. The harvested cells are heat treated to kill the cells and stop further growth. The cells, which are the mycoprotein, are separated from the liquid residue by centrifugation and then kept in a refrigerated store until used to make mycoprotein products.

Figure A1



(a) State **one** raw material (substrate) that can be used for mycoprotein production. *[1]*

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(b) Outline **one** characteristic of a raw material for use in commercial mycoprotein production. *[2]*

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(c) State **one** nutritional advantage of mycoprotein. *[1]*

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(This question continues on the following page)

(Question A1 continued)

(d) Describe how mycoprotein is processed to produce a mycoprotein product, *e.g.* a mycoprotein "chicken" joint. *[2]*

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A2. Explain why stainless steel is an appropriate material for manufacturing the equipment for mycoprotein production. *[3]*

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A3. Explain why timber needs to be seasoned after conversion and the consequences of using unseasoned timber in the manufacture of products. *[6]*

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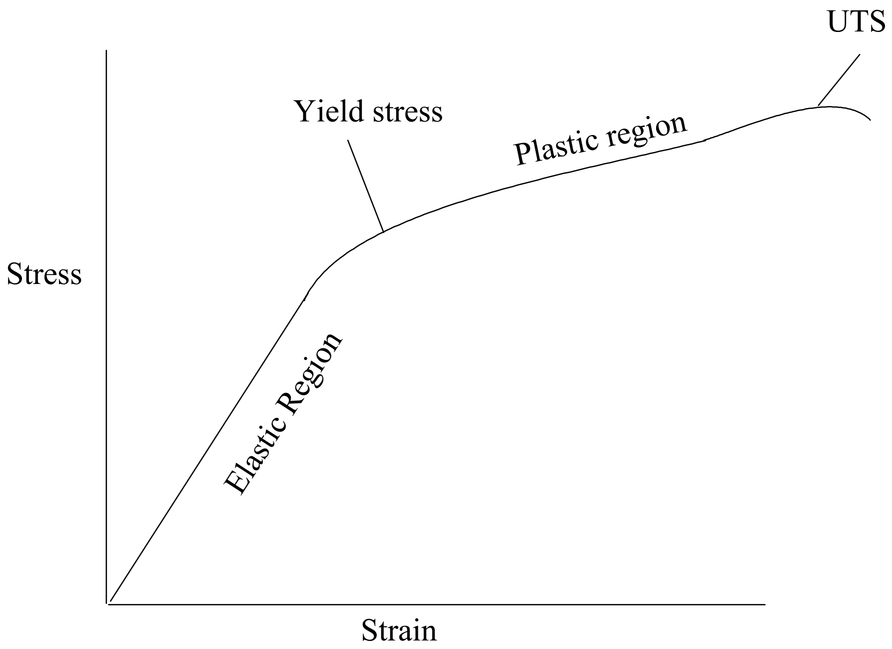
Option B – Microstructures and Macrostructures

B1. Wire is drawn by pulling a metal or alloy rod through a series of holes of decreasing diameter until it passes through a hole of the desired final diameter. The metal plates with the holes are known as drawplates or dies. Power-driven cylinder blocks are used to pull and coil the wire. Tensile strength and ductility are important properties of the metals used in wire manufacture. Secondary properties, *e.g.* electrical conductivity, depend upon the specific application for the wire. **Figure B1** below shows a stress-strain graph.

Figure B1: A stress-strain graph



(a) List **two** design contexts in which wire is used. *[2]*

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(b) Outline **one** effect of alloying on ductility. *[2]*

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

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(b) Explain why metals have very high electrical and thermal conductivity. *[3]*

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B3. Explain the stress/strain graph in Figure B1 and its relevance to the manufacture of wire. *[6]*

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Option C – Appropriate Technologies

C1. The ENERGY STAR® label (see **Figure C1**) is the registered mark of the United States Environmental Protection Agency and was introduced in 1992 as a voluntary labelling program. ENERGY STAR® is designed to identify and promote energy-efficient products and reduce carbon dioxide emissions. ENERGY STAR® has become an international standard and is now used widely, *e.g.* in Australia. ENERGY STAR® now covers a wide range of areas, including consumer electronics such as televisions (TVs) (see **Figure C2**). Americans spend over $1 billion each year on energy to power TVs and VCRs when they are switched “off”! ENERGY STAR® labelled TVs and VCRs are designed to consume up to 75 % less energy when switched “off” than conventional models. Purchasing ENERGY STAR® labelled TVs and VCRs would result in $500 million savings on energy bills and cuts in air pollution equivalent to one million cars each year would be achieved.

Figure C1: ENERGY STAR® label

Figure C2: ENERGY STAR® **TV**

[Source: http://yosemite1.epa.gov/estar/consumers.nsf/content/tvs_and_vcrs.htm]

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

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(b) State **one** renewable energy resource. *[1]*

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(c) Outline how the planned obsolescence of televisions and other products can help shift consumers towards more energy-efficient products. *[2]*

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C2. Explain why a market pull has been created for ENERGY STAR® and other energy-efficient products. *[3]*

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C3. List **two** proposals agreed by participants as part of the Agenda 21 conference. *[2]*

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C4. Explain **two** ways in which energy utilization in manufacturing is consistent with sustainable development. *[6]*

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Option D – Food Technology

D1. Ice cream is produced commercially by blending cream, concentrated skimmed milk or skimmed milk powder, sugar or corn syrup, stabilizers and emulsifiers. The mixture is then pasteurised and homogenized. After standing for at least four hours and usually overnight, the mixture is frozen very quickly in a tubular heat exchanger and aerated by having air whipped in. The mixture is then packaged and blast frozen.

Figure D1 shows a flavour development specialist who tastes ice cream to develop the specifications for new ice cream products. Potential new products are produced in very small quantities and tested with taste panels. Once the specification is confirmed, larger volumes of product can be produced and wider market testing undertaken.

Figure D1: Flavour development specialist

[Source: http://www.outtakes.com/work/taster.html and http://www.benjerry.co.uk]

(a) List **two** organoleptic properties of food. *[2]*

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(b) Explain how taste panels are used in the development of the specification for an ice cream. *[3]*

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D2. Outline how freezing extends the safe storage life of ice cream. *[2]*

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D3. Outline how aeration affects the physical properties of ice cream. *[2]*

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D4. Explain **two** ways in which the packaging of food products, such as ice cream, can contribute to the development of brands. *[6]*

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Option E – Computer-aided Design, Manufacture and Production

E1. **Figure E1** shows a screen shot of the home page of a website which enables users to personalise the sports shoes that they are going to purchase. Using the website customers can choose the style of shoe, colour the various parts of the shoe, add their name and complete the purchase.

Figure E1

(a) Define *mass customisation*. *[1]*

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(b) State **one** input device used by customers to customise the design to their own requirements. *[1]*

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(c) Outline how mass customisation transforms the relationship between the manufacturer and the customer. *[2]*

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E2. Explain **one** advantage of Just-in-case (JIC) to manufacturers. *[3]*

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E3. List **two** types of computer software that can be used for modelling. *[2]*

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E4. Discuss **one** advantage and **one** disadvantage of mass customisation for manufacturers. *[6]*

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Option F – Invention, Innovation and Design

F1. James Dyson (see **Figure F1**) is an example of an inventor-entrepreneur who has designed some extremely successful products. The original idea for his bagless vacuum cleaner (see **Figure F2**) came to Dyson while he was renovating his house. He spent five years developing the idea and producing a prototype. For two years he looked for someone to license the product. Multinational companies were reluctant to invest in Dyson because of the potential impact on the market for the replacement bags used in traditional vacuum cleaners. Ongoing re-innovation has resulted in a range of cleaners, including a cleaning robot (see **Figure F3**).

Figure F1:

Figure F2:

Figure F3:

[Source: http://www.dyson.co.uk]

(a) Outline **one** reason why Dyson's bagless vacuum cleaner is an example of radical design. *[2]*

(b) Outline why the cleaning robot shown in Figure F3 is an example of incremental and radical design. *[2]*

(c) Outline why inventor-entrepreneurs, like Dyson, often have difficulty in obtaining financial support for an invention. *[2]*

F2. Discuss the implications of adopting a pioneering strategy. *[3]*

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F3. Explain **two** reasons, apart from lack of financial support, why many inventions fail to become innovations. *[6]*

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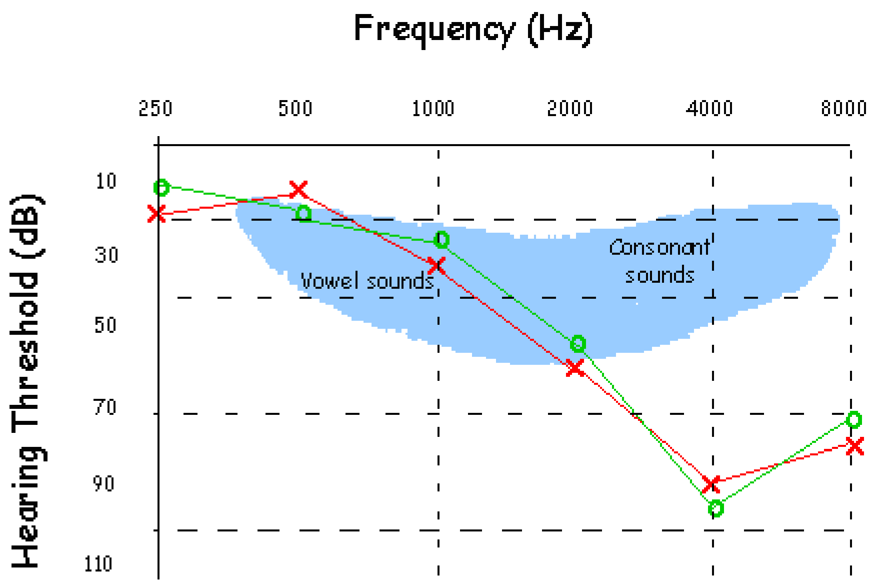
Option G – Health by Design

G1. **Figure G1** shows an audiogram, *i.e.*: a graphical representation of the results of a hearing test. The blue shaded region represents the human voice in normal conversation. Every point plotted on the audiogram represents the softest sound the person can hear at each frequency (**×** for the right ear and **o** for the left ear) and is called the hearing threshold. Thresholds of 0-25 dB are considered normal. The audiogram shown in **Figure G1** is for an older person who has been working for years in a noisy factory.

Figure G1: Audiogram showing hearing thresholds (**×** = right ear; **o** = left ear)



(a) Outline how the hearing of the person whose audiogram is shown in Figure G1 would be affected. *[2]*

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(b) Explain the advantage of a digital hearing aid for the person whose audiogram is shown in Figure G1. *[3]*

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G2. Describe the function of a catalytic converter in a motor car. *[2]*

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G3. Describe **one** advantage of one-day disposable contact lenses. *[2]*

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G4. Discuss the properties of vascular prostheses produced by weaving and knitting. *[6]*

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Option H – Electronic Products

H1. Solar-powered garden lights (see **Figure H1**) are becoming extremely popular – they do not utilise mains electricity, do not require cabling and do not need to be installed by an electrician. The solar lamp comprises a solar cell that recharges a 12-Volt Ni-Cd battery during daylight hours. The battery, when fully charged, can provide sufficient energy to light the lamp for up to eight hours. Using a light-dependent resistor (LDR) with the characteristics as shown in **Table H1** as a light sensor, the light can be designed to turn on automatically at dusk although they can also incorporate a timer to control the time when it turns on. **Figure H2** shows an incomplete circuit for the charging of the cell and the control of the lamp. R1 is 16 kΩ and R2 is 8 kΩ.

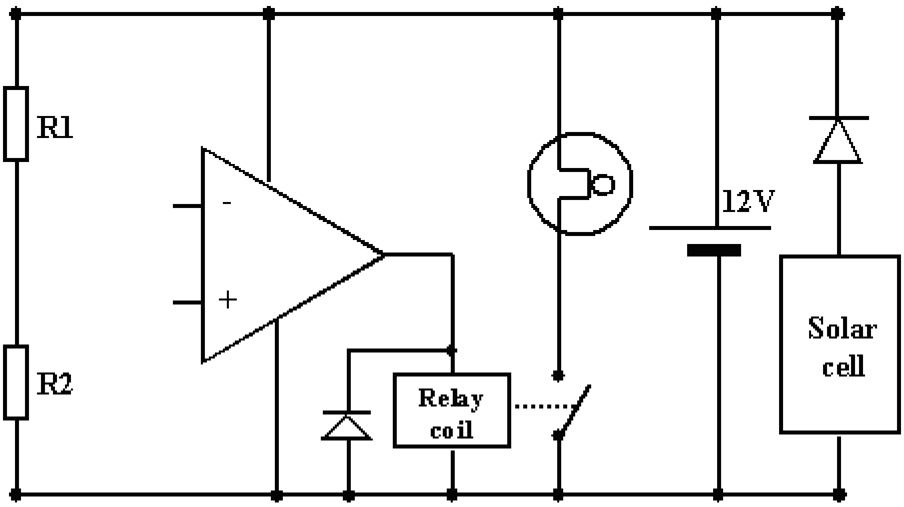
Figure H1: Solar-powered garden light

[Source: http://www.geocities.com/beamcoltd/sindex.html]

Table H1: Characteristics of the LDR

Lighting conditions	Resistance (Ω)
Bright Sunlight	80 Ω
Dusk	12 kΩ
Darkness	1 MΩ

Figure H2: Incomplete circuit for a solar garden light



Note: A relay enables the low current output from an op amp or logic gate to drive a high current load, such as a lamp. The relay contact closes to light the lamp when the output from the op amp is high.

(This question continues on the following page)

(Question H1 continued)

(a) Complete Figure H2, using the LDR and one other resistor (R3 – its value is not required at this stage), so that the operational amplifier operates as a comparator and the light comes on at dusk. *[3]*

(b) Calculate an appropriate value for R3 so that the light comes on at dusk, selecting appropriate values for any other components you include. *[2]*

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(c) Outline how the circuit could be modified to include positive feedback to prevent the lamp switching on and off around the time of dusk due to slight changes in light levels. *[2]*

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H2. Outline how a timer and a digital logic gate would be incorporated into the circuit so that the light will not turn on immediately at dusk but will remain off till after 2100 hours or dusk (whichever is the earlier). *[2]*

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H3. Explain the difference between a digital signal and an analogue signal and how a digital signal can be generated from an analogue signal. *[6]*

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