# 2001 HSC
# Notes from
# the Examination Centre
# Engineering Studies

Published by Board of Studies NSW
GPO Box 5300
Sydney 2001
Australia

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Internet: http://www.boardofstudies.nsw.edu.au

ISBN: 1 74099 026 9

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# 2001 HSC NOTES FROM THE EXAMINATION CENTRE ENGINEERING STUDIES

## Introduction

The purpose of this document is to provide an indication of the performance of the 2001 Engineering Studies candidature in the Higher School Certificate Examination. The Senior Markers have carefully analysed each question and then reflected on the candidates' responses to each part. They have typically commented on the relative difficulty of each part, indicated common styles of responses and often suggested how candidates could have improved their response.

While the comments on each question provides a simple overview of the content, any reader of these 'Notes from the Examination Centre' will find great benefit in reading them in conjunction with the examination paper and the Marking Guidelines. An electronic copy of the 2001 Engineering Studies HSC Examination can be found on the Board of Studies' website at www.boardofstudies.nsw.edu.au.

It would also be helpful for the reader of these 'notes' to refer to the Engineering Studies syllabus document. An electronic version of this is also available on the Board's website. This syllabus will provide the reader with a clearer understanding of the outcomes and content of the course and will give some indication of the depth of response required in each question. Page 53 of this syllabus provides a clear outline of the structure of the examination.

In 2001, 1450 candidates presented for the examination in Engineering Studies. The examination paper closely followed the Specimen Paper and, from the candidates' responses, the majority had a sound understanding of the new Engineering Studies syllabus. In this examination paper, all questions were compulsory and candidates were expected to complete eighteen questions that followed the format outlined below.

| | Question/s | Mark Value | Syllabus Area |
|---|---|---|---|
| Section I | 1-10 | 10 marks | Application modules (ie, Civil Structures, Personal and Public Transport and Lifting Devices) |
| Section II | 11 | 10 marks | Historical and Societal Influences, and the Scope of the Profession |
| | 12 | 10 marks | Civil Structures |
| | 13 | 10 marks | Personal and Public Transport |
| | 14 | 10 marks | Lifting Devices |
| | 15 | 15 marks | Aeronautical Engineering |
| | 16 | 15 marks | Telecommunications Engineering |
| Section III | 17 | 10 marks | Engineering and the Engineering Report |
| | 18 | 10 marks | Engineering and the Engineering Report |

The candidates appeared to allocate their time well with most making a satisfactory attempt at all questions. For future examinations, candidates must ensure that they understand the meanings of the words in the Board's 'Glossary of Key Words'. Those terms used most often in the Engineering Studies examination were 'identify', 'describe', 'discuss' and 'explain'.

## Section I – Multiple Choice

### General Comments

This section contained ten multiple-choice questions that covered all areas of the syllabus. In several of these questions candidates were expected to complete calculations to achieve an answer while in others, candidates were required to respond to diagrams or drawings.

| Question | Correct Response |
|---|---|
| 1 | B |
| 2 | A |
| 3 | B |
| 4 | D |
| 5 | C |

| Question | Correct Response |
|---|---|
| 6 | B |
| 7 | A |
| 8 | C |
| 9 | A |
| 10 | D |

## Section II

### General Comments

This section of the examination paper was made up of questions 11 through 16 and contained questions relating to historical and societal influences, and the scope of the profession, followed by a question related to each of the three engineering application modules and the two engineering focus modules.

### Specific Comments

### Question 11 - Historical and Societal Influences, and the Scope of the Profession

This question focused on historical aspects of personal and public transport and the scope of the aeronautical engineering profession.

In future, candidates will be served well if, along with a sound knowledge of the historical influences, they develop a good understanding of the major impacts those influences have had on society and our environment. Engineering is a broad collection of interrelated areas of endeavour. Candidates must not only be able to identify these areas, but also discuss the interrelationship these areas have and their role within our society.

(a) Candidates were required to select a mode of transport, state a material once used and a material that has replaced it. Candidates were also required to explain the reasons for the change. This allowed candidates to demonstrate an understanding of a mode of transport they had studied. Many candidates selected the bicycle for the mode of transport while others selected trains, boats or planes. A majority of candidates were able to identify the changes in materials used and explain an acceptable engineering reason for that change. Many candidates used terms that were not specific, possibly indicating a lack of detailed knowledge of

materials. For example steel instead of mild steel, carbon fibre instead of carbon fibre reinforced polyester.

(b) Many candidates were able to identify a change related to long-distance travel but struggled to provide characteristics and features of a major impact on society or the environment that occurred due to those changes.

(c) (i) Most candidates were able to provide areas of involvement that described the role of the aeronautical engineer. Areas such as mechanical, electrical, design, manufacture and management were all identified. Often candidates were unable to provide characteristic features of those areas that enabled a full description of that role. This possibly indicates a good general knowledge but a lack of detailed understanding of the role of the aeronautical engineer. This lack of detailed understanding was further highlighted with the discussion of how collaboration between different types of engineers in the aviation industry contributes to maintaining high standards of safety.

(ii) Few candidates were able to fully explain how collaboration between different engineers contributes to the maintenance of high standards of safety. A majority of candidates were able to identify the different engineers but found it difficult to articulate an extended response relating to the important role that collaboration between different engineers in the aviation industry plays in ensuring high standards of safety. Few candidates identified the inter-relationships that exist due to collaboration in the systems that engineers develop and maintain. Most candidates recognised the importance of safety standards but were unable to discuss those standards.

**Question 12 – Civil Structures**

This question involved the analysis of a number of structures and the completion of an orthogonal sketch of a turnbuckle assembly.

(a) (i) This part was well answered by the majority of candidates who were able to successfully use a moment equation to correctly calculate the reaction at 'A'. However, a significant number of candidates were unable to correctly transfer their answer, calculated in Newtons (N), into the answer space where an answer in kN (kilo Newtons) was required.

(ii) Most candidates demonstrated a clear understanding of shear-force diagrams and were able to successfully complete the shear force diagram for the given loaded beam.

(b) Many candidates answered this part poorly. Initially they were unable to demonstrate an understanding of a 'half-sectional view' of the turnbuckle assembly. Also, many candidates were unable to apply correct drawing standards to their sketches for features like the screw thread, the bottom of drilled holes and sectioning of components. Most candidates were, however, able to produce reasonably clear and accurate sketches.

(c) (i) Most candidates were able to correctly select the appropriate formula, $\sigma = My/I$, from the formula sheet and complete the substitution of appropriate values to obtain a correct solution. The most common error in this part involved the distance from the neutral axis, 'y'. Many candidates incorrectly used a value of 300 mm instead of 150 mm in their substitutions.

(ii) This part was reasonably well answered with the candidates outlining a variety of benefits for using, in many structural applications, an 'I' shaped beam, rather than a beam of rectangular section.

**Question 13 – Personal and Public Transport**

This question focused on some of the materials typically used in vehicles with references to identification of specific materials, manufacturing processes and structure/property relationships. Candidates displayed some general knowledge of the various areas examined by the question, but often lacked the ability to provide the specific details required in the answers.

(a) In this part, candidates needed to identify a suitable material for a bearing and then explain why the properties of the identified material made it suitable when in service. Few candidates were successful. Many candidates suggested a material and its general physical or mechanical properties, rather than the service properties required of the bearing. Many responses to this question displayed a lack of understanding of the purpose of solid bearings, and incorrectly chose steel as the bearing material, rather than a bronze or a brass alloy.

(b) Many candidates were able to explain why the safety glass is used in preference to annealed glass but many responses displayed confusion between annealed, tempered and laminated glass. Few candidates were able to adequately contrast the manufacturing processes of the annealed and safety glasses.

(c) Generally candidates were unable to correctly select and then explain a suitable heat treatment process for a medium-carbon steel axle. Many incorrectly nominated case hardening processes, such as carburising, as a suitable heat treatment process. Better responses were able to link the tempering process with the service properties required of the axle, rather than to just state the resultant properties produced in the steel by the tempering process. Very few candidates were able to explain the changes in structure to the steel as a result of the hardening process.

**Question 14 – Lifting Devices**

This question involved the analysis of lifting devices and considered calculation, safety and materials.

(a) (i) A high proportion of candidates were able to achieve full marks for this part of the question. Many others were awarded marks for correct working or for identifying and using the correct information needed to develop the solution.

Common errors made by candidates included:

- poor interpretation of the diagram, confusing the float chamber and the load
- calculation of a velocity ratio using sizes given on the diagram rather than the velocity ratio given in the question
- poor substitutions into equations. Candidates are encouraged to set out solutions carefully, indicating the formula to be used, thereby reducing the likelihood of error
- incorrect use of efficiency and velocity ratio in calculations.

(ii) This part was well answered by the majority of candidates. They were required to provide a comparison, using advantages and disadvantages, of hydraulic and mechanical lifting systems. A list of the features of the relevant systems was not an adequate discussion comparing the two systems.

(b) Responses to this part were generally very good. Candidates were able to interpret correctly "describe an important safety feature" from the question and provide appropriate descriptions of the safety feature.

(c) Many candidates failed to achieve full marks for this part. Their responses often only identified one property, describing its importance, and then identifying and describing a relevant test for that property.

In many responses it was apparent to the examiners that candidates had not read the entire question before commencing their answer. This was obvious when candidates were able to identify the properties but were unable to describe an appropriate testing method that related to the properties selected.

**Question 15 – Aeronautical Engineering**

This question looked at the aerodynamics of flight, age-hardened aluminium alloys and required candidates to complete a pictorial sketch of an engine mounting bracket.

(a) (i) This question was well answered by the majority of candidates who were able to correctly identify the thrust, lift and weight forces.

(ii) Many candidates displayed a good understanding of the concept of an increased distance across the top of the aerofoil compared to the underside, resulting in an increased air velocity and a reduction in the air pressure, generating lift due to the difference in air pressures.

(b) This part produced varied responses. Many candidates drew accurate sketches with the correct orientation from the direction indicated, though others had difficulty producing pictorial representations of the bracket.

Isometric and oblique projections were the most common types of responses; however, the oblique sketches were generally less successful than the isometric sketches. When drawing oblique sketches, many candidates simply redrew the front view and then could not correctly project the depth or correctly show the position of the web. Oblique projection also made it difficult for candidates to draw the holes in the vertical and horizontal faces of the bracket.

Many of the candidates who attempted an isometric solution were unable to correctly represent the holes by drawing the elliptical shape in the correct orientation.

Candidates must have a clear understanding of the correct orientation of the pictorial sketch, as indicated by the 'Viewing direction' arrow in the question.

(c) Most candidates named duralumin as an appropriate alloy and then identified and described a suitable non-destructive test. The most common responses were x-ray, ultrasonic and dye-penetrant. Very few candidates described visual inspection as a suitable test.

Very few candidates were able to discuss adequately the properties that make duralumin suitable for aircraft construction. Many candidates were able to identify one or two reasons for duralumin being suitable, but were either not aware, or incapable of expanding their points into a discussion. Candidates needed to relate the properties of duralumin to construction or service requirements, or comparisons with other possible suitable materials. Very few candidates identified issues against the suitability of duralumin such as reduced corrosion resistance.

**Question 16 – Telecommunication**

Optic fibres, analogue to digital conversion, health and safety along with legal and ethical issues were all contained in this question.

(a) Both aspects of this part, the explanation of how fibre-optical cable transmits data and why it has replaced copper for this use, were generally well answered by candidates. Most were able to correctly explain the concept of light travelling through the optic fibre by total internal reflection at the interface between the glass core and cladding. Candidates were also able to provide excellent advantages and reasons for fibre-optical cable replacing the copper cable.

(b) Candidates had difficulty explaining the two main aspects of analogue to digital conversion: sampling at regular intervals and then encoding into a series of digital (on/off) electrical pulses. Some candidates correctly indicated that the sampling rate indicated on the diagram was inadequate.

Candidate responses regarding the importance of the sampling rate were much better, displaying some understanding of the implications of a slow sampling rate (loss of information). Few candidates, however, explained the implications of a fast sampling rate (too costly and excess bandwidth and memory used).

(c) (i) The overwhelming device studied by candidates for their response to this question was the ‘mobile phone’. Unfortunately this choice of device did not assist the quality of their answers. Many responses discussed only one health/safety issue, or alternatively only a mention was made of two health/safety issues, with no discussion.

(c) (ii) Many candidates displayed a misunderstanding of the differences between legal and ethical issues in their discussions. A number of candidates carried issues discussed in the previous question into this part and created confusion as they often discussed health issues.

Many candidates included issues related to society, the environment and the economy in their response, all of which were unrelated to the intent of the question. It was also apparent from many responses that candidates were unclear about the differences between societal, environmental and financial issues.

## Section III

### General Comments

This section of the examination paper included Questions 17 and 18 and related to the engineering report and the scope of the profession.

### Specific Comments

### Question 17 – Engineering and the Engineering Report

The focus of this question was a step and handrail construction with different parts relating to the analysis, function, social and environmental factors.

(a) A large number of candidates were unable to correctly identify the feature, a footing, and to state its purpose correctly, which was to increase strength and stability and prevent slip down the slope. Many responses were able to state the purpose of the feature, or simply identified the material from which it was constructed.

(b) (i) Less than half the responses to this part were correct. Most candidates were able to identify the part of the graph that represented the maximum load. Common errors included failure to correctly calculate the cross-sectional area of the sample or simply stating the maximum load as the ultimate tensile strength without completing a stress calculation.

(b) (ii) The majority of candidates were able to correctly identify the straight-line elastic portion of the graph relevant to the calculations. Common errors involved mathematical mistakes or the incorrect use of units.

(b) (iii) Most candidates were able to name a mechanical property but fewer were able to describe how the mechanical property could be obtained from the load-extension diagram.

(c) Many candidates did not cover the two major aspects of this part, the civil engineer and the design of the step and handrail construction. This resulted in discussion of various factors outside the role of the engineer. Candidates who did focus on the engineer and the design of the step and handrail construction were able to successfully identify areas such as the geometry of the steps, handrail dimensions, slip resistance and drainage considerations in their discussions.

### Question 18 – Engineering and the Engineering Report

Satellite communication was the focus of this question with candidates required to discuss the operation of satellite systems, their impact on society and the roles of engineers in the design, construction and maintenance of satellite communication systems.

(a) Few candidates were able to correctly identify (name) and outline the function of both part A, the ground station, and part B, the cell-base station. Most candidates were able to demonstrate an understanding of the process involving the flow of data from satellite to mobile phone.

(b) This part of the question was generally well attempted. Most candidates were able to gain marks by either identifying different types of satellite communication systems or by discussing the profound effect of these systems upon sections of society. Unfortunately, few candidates were able to integrate both aspects in their answer to gain full marks.

A common response referred to satellite phones providing improved communication in rural areas and, while this true statement implies an effect on society, candidates must understand that a discussion must identify issues and provide points for and against the initial statement.

(c) Most candidates were able to gain marks in this part of the question; however, very few were able to gain maximum marks. Many candidates did not identify the fact that more than one engineer would be involved in the 'design, construction and operation of satellite communication systems'.

Many candidates also tried to describe the design, construction and operation aspects of the engineers role, but succeeded in only describing different aspects, or examples of the one role.

# Engineering Studies

2001 HSC Examination Mapping Grid

| Question | Marks | Content | Syllabus outcomes |
|---|---|---|---|
| 1 | 1 | Civil structures: Engineering materials (p32) | H1.2 |
| 2 | 1 | Personal and public transport: Engineering electricity/electronics (p35) | H3.1 |
| 3 | 1 | Lifting devices: Engineering materials (p37) | H2.1 |
| 4 | 1 | Civil structures: Engineering mechanics and hydraulics, shear stress (p31) | H3.1, H6.1 |
| 5 | 1 | Personal and public transport: Engineering mechanics and hydraulics, static friction (p34) | H3.1, H6.1 |
| 6 | 1 | Personal and public transport: Engineering mechanics and hydraulics, static friction (p34) | H3.1, H6.1 |
| 7 | 1 | Lifting devices: Historical and societal influences, Historical development (p37) | H4.2, H4.3 |
| 8 | 1 | Personal and public transport: Engineering electricity/electronics, principles (p35) | H3.1 |
| 9 | 1 | Lifting devices: Engineering materials, heat treatment processes (p37) | H1.2 |
| 10 | 1 | Personal and public transport: Communication, CAD (p35) | H3.3 |
| 11(a) | 2 | Personal and public transport: Historical and societal influences (p34) | H4.2 |
| 11(b) | 2 | Personal and public transport: Historical and societal influences (p34) | H4.3 |
| 11(c)(i) | 2 | Aeronautical Engineering: Scope of the profession (p40) | H1.1 |
| 11(c)(ii) | 4 | Aeronautical Engineering: Scope of the profession, safety (p40) | H1.1, H4.3 |
| 12(a)(i) | 1 | Civil structures: Engineering mechanics and hydraulics (p31) | H3.1 |
| 12(a)(ii) | 1 | Civil structure: Engineering mechanics and hydraulics (p31) | H3.1 |
| 12(b) | 5 | Civil structures: Communication, AS1100 drawing standards (p32) | H3.3 |
| 12(c)(i) | 2 | Civil structures: Engineering mechanics and hydraulics, bending stress (p31) | H3.1 |
| 12(c)(ii) | 1 | Civil structures: Engineering mechanics and hydraulics, bending stress (p31) | H3.1, H6.2 |
| 13(a) | 2 | Personal and public transport: Engineering materials, powder forming (p34) | H1.2, H2.1 |
| 13(b) | 3 | Personal and public transport: Engineering materials, ceramics and glasses (p35) | H1.2, H2.1 |
| 13(c) | 5 | Personal and public transport: Engineering materials, heat treatment of ferrous metals (p34) | H1.2, H2.1 |
| 14(a)(i) | 2 | Lifting devices: Engineering mechanics and hydraulics (p37) | H3.1 |
| 14(a)(ii) | 2 | Lifting devices: Engineering mechanics and hydraulics (p37) | H4.1, H4.2 |

| Question | Marks | Content | Syllabus outcomes |
|---|---|---|---|
| 14(b) | 1 | Lifting devices: Engineering electricity/electronics, electrical safety (p37) | H1.2 |
| 14(c) | 5 | Lifting devices: Engineering materials, testing of materials used in lifting devices (p37) | H1.2, H2.1 |
| 15(a)(i) | 3 | Aeronautical engineering: Engineering mechanics and hydraulics (p40) | H6.2 |
| 15(a)(ii) | 3 | Aeronautical engineering: Engineering mechanics and hydraulics (p40) | H6.2 |
| 15(b) | 4 | Aeronautical engineering: Communication, pictorial and orthogonal projections (p41) | H3.2 |
| 15(c) | 5 | Aeronautical engineering: Engineering materials (p40) | H1.2, H6.2 |
| 16(a) | 3 | Telecommunication: Engineering materials (p43) | H1.2 |
| 16(b) | 5 | Telecommunication: Engineering electricity/electronics (p43) | H1.2, H6.2 |
| 16(c)(i) | 4 | Telecommunication: Scope of the Profession, health and safety issues (p43) | H4.3 |
| 16(c)(ii) | 3 | Telecommunication: Scope of the Profession, legal and ethical implications (p43) | H4.3 |
| 17(a) | 2 | Civil structures: Engineering materials (p32) | H1.2, H2.1 |
| 17(b)(i) | 1 | Civil structures: Engineering mechanics and hydraulics, stress and strain (p31) | H3.1 |
| 17(b)(ii) | 2 | Civil structures: Engineering mechanics and hydraulics, stress and strain (p31) | H3.1 |
| 17(b)(iii) | 1 | Civil structures: Engineering mechanics and hydraulics, stress and strain (p31) | H2.1, H3.1 |
| 17(c) | 4 | Civil structures: Historical and societal influences (p31) | H4.3 |
| 18(a) | 2 | Telecommunication: Engineering electricity/electronics (p43) | H1.1, H4.1 |
| 18(b) | 3 | Telecommunication: Historical and societal influences, Engineering electricity/electronics (p43/44) | H4.3 |
| 18(c) | 5 | Telecommunication: Scope of the Profession, Engineering electricity/electronics (p43/44) | H1.1 |

BOARD OF STUDIES
NEW SOUTH WALES

# 2001 HSC Engineering Studies
# Marking Guidelines

**Question 11 (a)** (2 marks)

*Outcomes assessed: H4.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • States a valid material once used extensively, and a valid material that has replaced it, and gives a valid reason relating to this change | 2 |
| • States a valid material once used extensively, and a valid material that has replaced it<br>OR<br>• States a current material and gives valid reasons for its use<br>OR<br>• Student gives a good reason for change in materials, eg. reduction in weight, but DOES NOT state materials | 1 |

NB: Statement of mode of transport is not essential to gain marks, provided that the change is obviously related to a mode of transport. Mode of transport nomination is only to assist markers.

**Question 11 (b)** (2 marks)

*Outcomes assessed: H4.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • States one valid significant change and describes an effect it has on society OR the environment. The effect must be caused by the change | 2 |
| • States a valid significant change without an impact<br>OR<br>• An impact that is acceptable even though the change is not a correct one | 1 |

**Question 11 (c) (i)** (2 marks)

*Outcomes assessed: H1.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides characteristic features of the areas of involvement of aeronautical engineers such as design, construction, maintenance or air traffic control | 2 |
| • States any two areas of involvement<br>OR<br>• Provides characteristic features of one area of involvement | 1 |

**Question 11 (c) (ii)** (4 marks)

*Outcomes assessed: H1.1, H4.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Two different types of engineers are mentioned, a description of a collaboration between the two with a detailed discussion of how it relates to issues of safety | 4 |
| • Two different engineers mentioned and a general discussion of collaboration and related safety issues | 3 |
| • Two different engineers mentioned, collaboration discussed but not related to safety | 2 |
| • Two different engineers mentioned with limited mention of collaboration OR safety<br>OR<br>• Mention of collaboration and safety without mention of the specific fields of engineers | 1 |

**Question 12 (a) (i)** (1 mark)

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Correct answer of 130 N or 0.13 kN<br>NOTE: Units of kN are given for the answer. If correct working is shown leading to answer of 130, the mark should be awarded | 1 |

**Question 12 (a) (ii)** (1 mark)

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Shear force diagram correctly drawn | 1 |

**Question 12 (b)** (5 marks)

*Outcomes assessed: H3.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Sketch shows clear understanding of 'half-sectional' view – ie top half not sectioned and sectioning lines indicated<br>• AS1100 drawing standards applied throughout; ie<br>– details of high tensile rod and hexagonal body shown<br>– details of threaded eye bolt shown, with threading shown correctly<br>• lengths and diameters all correct (to within tolerances – 2 mm)<br>NB: Line work — the thickness/straightness not essential | 5 |
| • Sketch shows clear understanding of 'half-sectional' view, with AS1100 applied correctly<br>• Minor error in dimensions/detail/conventions<br>OR<br>• Correct fully sectioned drawing | 4 |
| • Sketch shows understanding of 'half-sectional' view<br>• AS1100 applied reasonably well, possibly with a substantial number of errors<br>OR<br>• Fully sectioned drawing with minor errors | 3 |
| • Sketch shows basic understanding of 'half-sectional' view<br>• Minimal application of AS1100<br>• Major error(s)/incomplete<br>OR<br>• Correct unsectioned sketch<br>OR<br>• Fully sectioned drawing with major errors | 2 |
| • Only minimal understanding of 'half-sectional' view shown<br>• Most details/conventions/dimensions incorrect<br>OR<br>• Fully sectioned drawing with most details incorrect<br>OR<br>• Correct unsectioned sketch with minor errors | 1 |

**Question 12 (c) (i)** (2 marks)

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Correct answer (including units) from correct calculation | 2 |
| • Uses correct formula and reasonable substitution | 1 |

**Question 12 (c) (ii)** (1 mark)

*Outcomes assessed: H3.1, H6.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Suggests why the I-beam is used in preference to the rectangular beam<br>Note: Single word answers = 0 | 1 |

**Question 13 (a)** (2 marks)

*Outcomes assessed: H1.2, H2.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Names a suitable metal. States a property and relates this property to its suitability | 2 |
| • States one property<br>OR<br>• Names a suitable metal | 1 |

**Question 13 (b)** (3 marks)

*Outcomes assessed: H1.2, H2.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Description of annealed and a safety glass manufacture processes<br>• Outline of the reason for use of safety glass | 3 |
| • Description of annealed and safety glass manufacture processes<br>OR<br>• Description of safety glass process and resultant benefits | 2 |
| • Description of manufacture of either annealed glass or safety glass<br>OR<br>• Outline of reason for use of safety glass | 1 |

**Question 13 (c)** (5 marks)

*Outcomes assessed: H1.2, H2.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Correctly describes a suitable process that will produce a hardened and tempered structure<br>• Explains the structural and property changes that result from hardening<br>• Identifies why tempering is necessary | 5 |
| • Correctly describes a suitable process that will produce a hardened and tempered structure<br>• Describes the structural and property changes that result from hardening | 4 |
| • Describes hardening and tempering basically<br>• Describes the structural changes and states the resulting properties | 3 |
| • Describes hardening and tempering<br>• States the resultant property changes | 2 |
| • Basic description of hardening and tempering process | 1 |

**Question 14 (a) (i)** (2 marks)

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Correct answer of 1.7 tonnes | 2 |
| • Correct substitution into either formula but incorrect calculation of final answer | 1 |

**Question 14 (a) (ii)** (2 marks)

*Outcomes assessed: H4.1, H4.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Discusses two advantages of hydraulic systems or one advantage and one disadvantage | 2 |
| • Identifies one advantage or one disadvantage | 1 |

**Question 14 (b)** (1 mark)

*Outcomes assessed: H1.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides characteristics and features of a safety feature in a lifting device. (If the feature is not named but the description is clear enough to identify it, then full marks as its name was not necessarily requested) | 1 |

**Question 14 (c)** (5 marks)

*Outcomes assessed: H1.2, H2.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Lists two relevant properties for the material<br>• Provides characteristics and features of each property<br>• Provides characteristics and features of appropriate testing method for each property | 5 |
| • Lists two appropriate properties and describes the importance of both but states only one appropriate testing method<br>OR<br>• Lists two appropriate properties and gives only three of four descriptions required | 4 |
| • Lists one or two appropriate properties and gives only two of four descriptions required | 3 |
| • Lists two appropriate properties and gives one of four descriptions required | 2 |
| • Lists two appropriate properties<br>OR<br>• Lists one appropriate property and describes its importance or testing | 1 |

**Question 15 (a) (i)** (3 marks)

*Outcomes assessed: H6.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Correctly names all three forces | 3 |
| • Correctly names two forces | 2 |
| • Correctly names one force | 1 |

**Question 15 (a) (ii)** (3 marks)

*Outcomes assessed: H6.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Indicates airflow from left to right across aerofoil correctly<br>• Explains the difference in airflow above and below the aerofoil<br>• Relates airflow speed to outward pressure and resultant lift | 3 |
| Any TWO of the following:<br>• Indicates airflow from left to right<br>OR<br>• Describes speed of airflow above and below aerofoil<br>OR<br>• Relates differences in pressure to create lift | 2 |
| • Indicates airflow from left to right<br>OR<br>• Relates differences in pressure to create lift<br>OR<br>• States air above aerofoil travels faster than below aerofoil | 1 |

**Question 15 (b)** (4 marks)

*Outcomes assessed: H3.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Correct overall shape of bracket showing its bend, web correctly positioned, large hole in approximate position (thickness also indicated) and the six smaller holes shown in position and correctly orientated. Reasonable linework and proportion | 4 |
| • Reasonable overall shape and proportion. Web is correctly positioned. Holes correctly shown in at least two faces | 3 |
| • Shape of bracket shown. Reasonable proportions. Attempt to draw web. Holes on at least one face<br>OR<br>• Correct overall shape and proportions, including web but with no holes | 2 |
| • Bent shape of bracket shown with an attempt to show web. Poor proportion<br>OR<br>• Correct bracket, including holes, without web | 1 |

**Question 15 (c)** (5 marks)

*Outcomes assessed: H1.2, H6.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Names an appropriate alloy<br>• Discusses at least two reasons or other features, that make it suitable for this application<br>• Identifies and describes a suitable non-destructive test | 5 |
| Any four of the five required responses ie: four of :<br>• Names an appropriate alloy<br>• Discusses a reason for suitability<br>• Discusses a second reason for suitability<br>• Identifies a suitable non-destructive test<br>• Describes a suitable non-destructive test | 4 |
| • Names an appropriate alloy<br>• Discusses one reason for suitability or identifies two reasons for suitability<br>• Describes suitable non-destructive test<br>OR<br>• Discusses two reasons for suitability<br>• Describes suitable non-destructive test | 3 |
| • Names an appropriate alloy<br>• Describes a suitable non-destructive test<br>OR<br>• Names an appropriate alloy<br>• Discusses one reason for suitability<br>OR<br>• Discusses one reason or identifies two reasons for suitability<br>• Describes a suitable test | 2 |
| • Names an appropriate alloy<br>• Names a suitable non-destructive test<br>OR<br>• Names and describes a suitable, non-destructive test | 1 |

**Question 16 (a)** (3 marks)

*Outcomes assessed: H1.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Explanation of the internal reflection along the inner core, caused by the refraction at the meeting surfaces<br>• Explanation of reason for use of optic fibre rather than copper | 3 |
| • Description of light travelling along inner core without explanation of difference refractive indices<br>• Explanation of why optic fibre is better<br>OR<br>• Description of transmission of light wave along core and explanation of refractive index of the two cores | 2 |
| • Description of light travelling along inner core without explanation<br>OR<br>• Reason for use of optic fibre rather than copper | 1 |

**Question 16 (b)** (5 marks)

*Outcomes assessed: H1.2, H6.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • An explanation of how analogue to digital is converted using correct terminologies<br>• Discussion of consequences of sampling rate being too slow and/or too fast | 5 |
| • An explanation of how analogue to digital is converted<br>• Discussion of consequences of sampling rate being too slow or too fast | 4 |
| • An explanation of how analogue to digital is converted<br>• General discussion of importance of sampling rate | 3 |
| • An explanation of how analogue to digital is converted only | 2 |
| • An incomplete or vague explanation of an analogue and digital signal | 1 |

**Question 16 (c) (i)** (4 marks)

*Outcomes assessed: H4.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Discussion of two health and safety issues with a detailed response to combat and overcome these issues | 4 |
| • Discussion of two health and safety issues with only basic strategy to overcome the issue<br>OR<br>• Discussion of one health and safety issue with one or more strategies to overcome the issue | 3 |
| • Two discussion issues on health and safety only<br>OR<br>• One health and safety issue discussed with one strategy<br>OR<br>• Two strategies to overcome possible health and safety issues not mentioned | 2 |
| • One discussion issue on health and safety only<br>OR<br>• One strategy to overcome possible health and safety issues not mentioned | 1 |

**Question 16 (c) (ii)** (3 marks)

*Outcomes assessed: H4.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Identifies two legal and ethical issues related to modern telecommunications devices giving points for and/or against | 3 |
| • Lists one issue and discussion of points for or against | 2 |
| • Lists two issues with no discussion | 1 |

**Question 17 (a)** (2 marks)

*Outcomes assessed: H1.2, H2.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Correct name and purpose<br>Purpose can be:<br>– increased strength/stability<br>– prevent sliding | 2 |
| • Name only given<br>OR<br>• Purpose only given | 1 |

**Question 17 (b) (i)** (1 mark)

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Ultimate tensile strength = 996 Mpa. (Answer within range) | 1 |

**Question 17 (b) (ii)** (2 marks)

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Reading or extrapolating modulus line correctly and getting correct answer (within tolerances) for Young's modulus | 2 |
| • Reading or extrapolating modulus line correctly and misusing data in calculation, to incorrect answer | 1 |

**Question 17 (b) (iii)** (1 mark)

*Outcomes assessed: H2.1, H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Identification of a property and a description of how that property is obtained from the load-extension diagram | 1 |

**Question 17 (c)** (4 marks)

*Outcomes assessed: H4.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Names two factors of importance that would be considered<br>• Discussion of these two factors giving points for and/or against both of these factors and their social and/or environmental importance | 4 |
| • Names two factors of importance<br>• Discussion of these factors but not related to social/environmental importance or limited discussion of factors and social/environmental importance | 3 |
| • Names two factors of importance<br>• Only one factor discussed<br>OR<br>• Names two factors<br>• Social/environmental importance of both factors mentioned<br>OR<br>• One factor of importance discussed in detail giving points for and against relating to social/environmental | 2 |
| • Names two factors of importance | 1 |

**Question 18 (a)** (2 marks)

*Outcomes assessed: H1.1, H4.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Correct naming of parts and description of function for each part | 2 |
| • Naming and description of one component only<br>OR<br>• Description of the function for both parts<br>OR<br>• Naming of both parts only | 1 |

**Question 18 (b)** (3 marks)

*Outcomes assessed: H4.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Discussion using two examples with issues and points for each that relate to a section of our society | 3 |
| • Discussion with two examples with no reference to a section of our society<br>OR<br>• Discussion with one example with a relevant effect on a section of our society | 2 |
| • Discussion of only one example | 1 |

**Question 18 (c)** (5 marks)

*Outcomes assessed: H1.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Description of the roles of different types of engineers in relation to design, construction and operation of satellite communication systems | 5 |
| • Description of the roles of different types of engineers in relation to two of: design, construction and operation of satellite communication systems<br>OR<br>• Description of the role of one type of engineer in relation to design, construction and operation of satellite communication systems | 4 |
| • Description of roles of two different types of engineer in relation to one of: design, construction and operation of satellite communication systems<br>OR<br>• Description of the role of one type of engineer in relation to two of: design, construction and operation of satellite communication systems | 3 |
| • Description of roles of two different types of engineers in telecommunications engineering, unrelated to satellite communication systems<br>OR<br>• Description of the role of one type of engineer in telecommunications engineering related to one of design or construction or operation | 2 |
| • Description of the role of one type of engineer in telecommunications engineering, unrelated to satellite communication systems | 1 |