2004 HSC Notes from the Marking Centre Engineering Studies

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2004 HSC NOTES FROM THE MARKING CENTRE
ENGINEERING STUDIES

Introduction

This document has been produced for the teachers and candidates of the Stage 6 course in Engineering Studies. It provides comments with regard to responses to the 2004 Higher School Certificate Examination, indicating the quality of candidate responses and highlighting the relative strengths and weaknesses of the candidature in each section for each question. Comments have often been made that are intended to indicate how candidates could improve their responses.

It is essential for this document to be read in conjunction with the relevant syllabus, the 2004 Higher School Certificate Examination, the Marking Guidelines and other support documents that have been developed by the Board of Studies to assist in the teaching and learning of Engineering Studies.

General Comments

In 2004, approximately 1410 candidates attempted the Engineering Studies examination.

Teachers and candidates should be aware that each examination includes a number of different question styles. These range from questions that require the simple recall of knowledge through to those that expect candidates to respond by integrating the knowledge and skills they have developed through a comprehensive understanding of the entire course.

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	1 mark/question	All Areas (multiple-choice)
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

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 or interpret graphics in order to select the most appropriate response from the four choices given.

Question	Correct Response
1	C
2	D
3	C
4	A
5	B
6	C
7	B
8	B
9	A
10	D

Section II – Extended Response Questions

General Comments

Overall, responses indicated that the majority of candidates had a good grasp of engineering concepts, appropriate for Higher School Certificate candidates. Candidates need to be aware that the answer space allocated for each question is a guide to the length of the required response.

Question 11 – Historical and Societal Influences, and the Scope of the Profession

Candidates were given the opportunity to demonstrate an understanding of the areas of knowledge an aeronautical engineer may apply to other fields of engineering design such as yacht or racing car design. Electronic control technology plays an important role in modern motor vehicle design and candidates were required to explain how this technology has improved the efficiency of the motor vehicle. Candidates were also asked for an explanation of how the environment is affected by a technological change in personal and public transport.

(a) Most responses demonstrated a sound understanding of the areas of aeronautical knowledge such as aerodynamics, materials, electronics or avionics. Many developed thoroughly only one area of knowledge instead of at least two areas as expected by the question. Some candidates were unable to clearly explain the relationship between the knowledge areas and particular applications within yacht design or racing car design. Racing car aerofoils, body shell design, yacht hull and sail design were commonly used in explanations predominantly revolving around the relationship to aerodynamics and materials knowledge.

(b) Candidates were well briefed on the areas of electronic control technology found within the modern motor vehicle. Anti-lock braking systems (ABS) and electronic fuel injection were frequently explained, some in very accurate detail. While there were numerous well-worded responses, many candidates did not fully develop their discussion. Further discussion should have led to the identification of improvements to braking efficiency or engine efficiency that has occurred as a result of the implementation of these control technologies.

(c) Responses were quite varied and often focused on more than one transport system. Many responses drew on transport from the past, for example steam to diesel electric trains, while others identified contemporary technological changes, such as petrol to hybrid powered motor vehicles. Some candidates named a technology without identifying a technological change. While relationships with the environment were explained by most candidates, a number did not demonstrate a sound in-depth understanding of the real benefits or detriments that technological changes in personal or public transport may have caused in the past or may present in the future.

The majority of candidates provided very good responses to all sections of this question. Candidates would be well served examining the relationships between the various engineering disciplines and how areas of engineering knowledge may be transferred and applied. Responses indicated a lack of in-depth understanding of the improvements and effects engineering technology has had on our society and the environment throughout history. Candidates should further develop this area of knowledge and be prepared to discuss the many effects and improvements engineering has provided our society.

Question 12 – Civil Structures

(a) (i) The majority of candidates made a sound attempt to identify the constituents of asphalt, naming the two constituents and then relating a function to each. A number of candidates answered correctly then incorrectly qualified their answer by adding cement as another constituent. Other candidates incorrectly suggested resin as the binder in asphalt instead of bitumen. Some did not understand the instructions 'identify the constituents' and 'explain their function', and incorrectly detailed the service properties of asphalt.

(ii) Most candidates answered well, recognising that the reinforced concrete provided the required strength for the cantilever design while the asphalt was used as a resilient, impervious cover for the platform. A number of candidates did not recognise the main function of the reinforced concrete and gave its use as only a compressive material. Some candidates explained the use of only one of material, usually reinforced concrete.

(b) (i) Most candidates answered this question well, but there were some common errors. These included using incorrect distances for moment arms, leaving the weight force out of the calculations, taking moments about a given force instead of one of the supports and not using clockwise and anticlockwise moments correctly. Some candidates answered correctly by using the longer method of finding the reaction at support 2 by moments then using the sum of vertical forces to find the reaction at support 1. This method took longer to achieve the answer.

(ii) This part was poorly answered by many candidates. Many did not even attempt any calculations. The majority of candidates who answered correctly used the method of sections to determine the magnitude and nature of the force in the member. Common errors included calculating an incorrect perpendicular distance from the moment point to member A, considering both sides of the truss and using incorrect distances for the moment arm. A smaller number of candidates used the method of joints and were able to successfully arrive at a correct solution.

Question 13 – Personal and Public Transport

(a) The majority of candidates experienced difficulty in converting the weight force into the desired perpendicular and parallel forces. Some candidates confused the 'normal' reaction with the component of the weight force acting down the plane, therefore using an incorrect force in their equation. As a result, only a small number of candidates were able to calculate the two forces which had to be overcome to move the suitcase up the ramp. Many candidates also did not realise that friction always opposes motion. The candidates who approached this problem using the 'angle of friction' method were generally more successful. However, a common error was to not add the angle of friction to the angle of inclination. Although only a small number of candidates attempted a graphical solution, they were mostly successful.

(b) (i) Many candidates were not able to interpret the half-sectional view of the train wheel. As a result, only a small number of candidates identified that the mode of failure was probably due to the stress concentration at the sharp corners of the structure. Many candidates incorrectly interpreted the sectioned area of the drawing as an 'I' beam while others thought that the area was made up of a number of parts welded together. This misinterpretation led candidates to describe different manufacturing processes and a selection of different materials as a design modification to overcome the problem. A significant number of candidates did correctly prescribe the use of rounded corners or webs as a design improvement to help distribute the stress concentrations.

(ii) The descriptions of non-destructive tests were generally well attempted by most candidates, with the majority being able to give numerous features and characteristics of the testing procedures. A small number of candidates confused X-ray testing with ultrasonic testing while others incorrectly listed the steps involved in the dye-penetrant test in the wrong order. Some candidates did not appear to understand that some tests are only used for the detection of surface faults while others only detect internal flaws.

(c) (i) The majority of the candidates correctly analysed the diagram and were able to establish the correct mechanical advantage provided by the pulley system. A large number of candidates interpreted the counterweight as the load rather than the effort. This led to the mechanical advantage being applied as a mechanical disadvantage. Some candidates were not able to manipulate the formula $MA = {}^{L}/_{E}$.

(ii) The majority of the candidates correctly identified a material for the insulating disc. A few were able to give very specific details about the material used. A very small number of candidates incorrectly identified copper, aluminium and other metals as good insulators. Most candidates were quite successful in describing the reasons why insulators did not conduct electricity, relating the structures of ionic and covalent bonds to restricting electron flow. Some candidates also discussed valency and conducting band gaps as reasons why some materials were insulators. A number of candidates incorrectly described the material's lattice structures as the main cause of electron restriction.

Question 14 – Lifting Devices

(a) (i) This question encompassed power concepts with DC electric motors in a practical lifting application. Many candidates recognised power to be the rate at which work is done, and that work resulted from energy calculations. Many candidates simplified the problem by overlooking one of the energies. This was usually the kinetic energy as candidates ignored the residual 2m/s velocity of the mass at the top of the 'lift'. A number of candidates converted mass to a force before incorrectly using the force value in their energy equations. Work could also be determined by multiplying the average lifting force by the displacement. This however, required the student to use the formula F=M(g+a) which is not on the Engineering Studies formulae sheet.

(ii) Quite a number of candidates were able to adequately explain the role of the commutator in a DC motor. Sketches were helpful to aid explanations. Many candidates were able to describe the commutator's role of changing the polarity of the armature (rotor) coils but did not detail the need for this change in keeping the armature rotating in one direction. A number of candidates simplified the role of the commutator by suggesting it only provided a continuity of current flow from the external power source to the armature.

(b) (i) Most candidates attempted this part but a number of candidates only addressed one concept of drop forging or gave a limited description of the process. The two main concepts of a shaped die and an impact force appeared to be poorly understood or were poorly described. Some candidates demonstrated an understanding of grain flow and the resultant increase in mechanical properties but often did not describe the process as the question asked. Some candidates described incorrect processes such as casting, pressing, drawing and extrusion.

(ii) Better responses to this part described an appropriate heat treatment process and then described the resulting structure in both the surface and the core of the tine. Many candidates named an inappropriate heat treatment processes or confused the names of processes. Some candidates also described processes that were different to the one they had named. Some named annealing as the process and attempted to describe hardening. There was a significant misunderstanding of the structures that result from heat treatment processes.

Question 15 – Aeronautical Engineering

(a) (i) Most candidates were able to recognise that the leading edge of the propeller would be more exposed to damage during everyday usage than would other areas of the propeller. These candidates then stated that the replaceable edge either was cheaper than replacing the complete propeller or that it helped maintain a flight-efficient shape. A number of candidates incorrectly stated that change to the propeller resulted from friction, corrosion, speed or heat.

(ii) A majority of candidates displayed a good knowledge of Bernoulli's principle applied to a wing, but did not relate this knowledge to a propeller. Correct responses required candidates to relate the effect of the aerofoil-shaped cross-section to forward thrust. Some candidates correctly identified that the pitch of the propeller blades provides the thrust to the aircraft, but the question asked them to explain the contribution made by the shape of the blade to the thrust. Nearly all candidates used meaningful diagrams to assist their explanations.

(b) Many candidates incorrectly interpreted information given in the exploded pictorial drawing. For example, they sketched the handle assembly using four washers instead of realising that four identical washers were used at different locations in the assembly. A significant number of candidates appeared to be unfamiliar with, or could not interpret, the symbols used to dimension the counterbore of the handle. The knowledge of AS1100 standards was poor, with a large number of candidates sectioning nuts, washers and bolts.

It was also notable that candidates were unable to copy standard representations for the mushroom head bolts that were given in the partially completed orthogonal view, and instead produced their own versions. Candidates are presenting drawings that are obviously drawn with instruments or they are using rulers to aid their drawings. Candidates are given grids to assist their answer and it is apparent that they are not comfortable sketching. Marks are awarded for understanding engineering component assembly and drawing standards and not for 'straight lines' and 'perfect arcs'. Candidates would be advised to gain more confidence in their freehand sketching techniques and thereby save time in examinations.

(c) (i) Examples of innovations identified by candidates included the Wright brothers, jumbo jets, turbojets, GPS navigation, composite materials, fly-by-wire and early collision warning systems. Many candidates were able to identify two innovations but often did not provide appropriate explanations of how these innovations affected society. Better responses linked the identified innovation to cheaper costs for transporting freight or passengers, the increased safety of passengers or improved environmental impacts, such as noise and air pollutants.

(ii) Responses to this question displayed a lack of understanding, not just about the two-way hydraulic ram, but hydraulics in general. Correct responses indicated an understanding that the pressure in the hydraulic ram fluid was constant and then the explanation was related to the appropriate surface area of the ram for each case. These responses identified that the surface area for F_1 was the full surface of the ram, while the surface area for F_2 was reduced because of the ram arm. A number of candidates annotated the given diagram to assist in the explanation. Common incorrect responses from candidates indicated that F_1 and F_2 were inputs for both cases instead of recognising them as outputs. Other candidates incorrectly used the differences in volume of the liquid on either side of the ram to explain the differences in F_1 and F_2.

Question 16 – Telecommunication

(a) (i) Most candidates did not provide the characteristics and features of the process of frequency modulation as required. Those who did, mentioned that the main characteristic of FM is the superimposing of a signal wave onto a high-frequency carrier wave. A significant feature of FM is that the frequency of the carrier wave varies according to the amplitude of the signal wave. Quite a few candidates simply described the diagram provided in the question.

(ii) In this part candidates were asked to 'explain' which means to relate a cause and effect. Many candidates provided effects but omitted a cause. The main effects or advantages of FM over AM are higher quality reproduction of signal and less interference from electrical activity. This part, in terms of effects, was well answered by most candidates. The main cause, which most candidates omitted, is that electrical interference affects the amplitude of a wave and not the frequency to which an FM receiver is uniquely sensitive.

(b) (i) While the question was generally answered well, candidates erroneously associated the asynchronous orbit solely with a polar orbit. When differentiating between the orbits, some candidates confused one with the other as well as making limited reference to the different altitudes the satellites use. Weather monitoring was overused as a use and GPS was often wrongly attributed to the synchronous orbit.

(ii) This question was generally not well answered. Candidates neglected to construct their answers around the key words of 'sound', 'vision' and '… reception of the broadcast' as stated in the question. Candidates incorrectly focused on the transmission of the signal and corruption/interference of the broadcast rather than its reception. The effect of low bandwidth on reception was also often ignored.

(c) (i) The question was well answered by the majority of candidates. Common errors included the selection of an inappropriate type of pictorial view that limited the amount of detail that could be given in the answer. Many candidates did not take sizes from the orthogonal drawing as requested in the question.

(ii) This part required candidates to calculate the maximum allowable tensile stress for the cable and it was generally well answered. Common errors included not knowing the meaning of GPa and not being able to denote this value in terms of standard notation, ie 210×10^9; failing to change the subject of an equation; not knowing that a Pascal is a N/m^2 and therefore not converting mm to metres; not realising that stress is load divided by area as provided in the formula $E = {}^{PL}/_{eA}$; making simple arithmetic errors often due to poor setting out of solutions; using an incorrect formula such as $\sigma = {}^{My}/_{I}$ or incorporating a factor of safety.

Section III

This section of the examination paper includes questions 17 and 18 and relates to engineering and the engineering report.

Question 17

(a) Outlining two societal factors that influenced the change of style in bus shelters was the focus of this part. It was answered well with the majority of candidates receiving maximum marks. Typically these better responses identified the two social factors in relation to the change of style of the shelters shown. Poorer responses were generally too vague and did not relate to the societal influence on the change of style.

(b) (i) This part was well answered by the majority of candidates. Candidates were able to offer a large variety of technical and societal issues to be considered in an engineering report to address the reasoning behind the material's selection. A small number of candidates offered invalid reasons for consideration, which were either economic or environmental issues.

(ii) Candidates correctly identified and justified a number of suitable engineering materials that could be manufactured to form the frame of the modern-style shelter. A small number of candidates identified incorrect engineering materials but were rewarded for providing valid reasons why the material was chosen.

(c) This part challenged a number of candidates, requiring them to correctly explain the mechanisms of corrosion that may occur in an engineering situation. Many candidates identified the environments for corrosion (dry, wet and stress), rather than the type of corrosion that could occur on the modern-style shelter: galvanic, concentration cell, stress, pit or crevice corrosion. The candidates who were able to correctly identify the possible types of corrosion often demonstrated a sound understanding of the mechanisms for corrosion in terms of anodic and cathodic reactions, metal reactivity and the presence of an electrolyte. The majority of candidates were able to identify potential sites where corrosion was likely to occur. Poorer responses were typically vague, omitting the type of corrosion and its mechanism, only identifying the possible corrosion sites.

Question 18

(a) Very few candidates identified the correct beam. Candidates needed to understand that the beam with the largest value of 'I', that will produce the lowest bending stress, will also support the greatest load. Candidates also needed to be aware that the $^{Y}/_{I}$ value given in the table could have saved them valuable calculation time. Many candidates incorrectly selected the weakest beam (D) because it had the largest $^{Y}/_{I}$ value. Many of the candidates who selected the wrong beam were then able to correctly calculate the bending stress for their selected beam.

(b) Most candidates were able to discuss the implications of this statement and there was a reasonable range of responses. Many candidates, however, simply restated the question and did not recognise the cause and effect of errors in the table, and the implications for the engineer or end-user if this statement is ignored. Candidates need to understand that the end-user of an engineering table is still responsible and accountable and needs to recheck these figures to ensure the resulting design is safe. Better responses related the cause of errors in an engineering table, such as errors in the initial tests and printing errors, to the possible consequences such as design failure and litigation.

(c) (i) This part was well answered with many candidates able to justify the selection of tempered glass. Many candidates recognised that tempered glass is tougher and breaks into small granules that are relatively safe, compared to laminated glass that breaks more easily and into long dangerous shards. However, the majority of candidates did not compare the poor scratch resistance of polycarbonate to the hardness and durability of tempered and laminated glasses. Some candidates simply listed rather than comparing the properties of these materials.

(ii) Generally this part was well answered with most candidates able to give a basic reason for tapering the cantilevered beams. These responses included reference to the increased cross-sectional area needed to support the load at the rear, or larger cross-sectional area needed to attach the beam to the supporting post. Many candidates gave a better response, explaining that the cantilevered beams were tapered to reduce the weight which effectively reduced the bending moment and shear force at the rear support.

Engineering Studies

2004 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus outcomes
Section I			
1	1	Concurrent forces	H3.1
2	1	Graphics – sectioning	H3.3
3	1	Graphics – standards	H3.3
4	1	Metals – forming	H2.1
5	1	Bending moments	H3.1, H6.2
6	1	Shear stress	H2.2, H6.1
7	1	Heat treatment	H1.2
8	1	Geotextiles	H4.2, H4.3
9	1	Control systems	H6.2
10	1	Electricity	H2.2, H3.1
Section II **Question 11 — Historical and Societal Influences, and the Scope of the Profession**			
11 (a)	4	Range and nature of Aeronautical Engineering	H1.1
11 (b)	3	Control technology	H4.2
11 (c)	3	Environmental effects of transport systems	H4.3
Section II **Question 12 — Civil Structures**			
12 (a) (i)	2	Materials – asphalt	H1.2
12 (a) (ii)	3	Materials selection – concrete & asphalt	H2.1, H2.2
12 (b) (i)	2	Reactions at supports	H3.1, H6.1
12 (b) (ii)	3	Truss Analysis	H3.1, H3.3, H6.1
Section II **Question 13 — Personal and Public Transport**			
13 (a)	2	Friction	H3.1, H3.3, H6.2
13 (b) (i)	2	Crack Theory	H2.1, H2.2, H6.2
13 (b) (ii)	2	Materials testing	H2.1, H5.2
13 (c) (i)	2	Mechanic – Pulley Systems	H3.1, H6.2
13 (c) (ii)	2	Materials – Ceramics	H1.2, H2.1, H6.2

Question	Marks	Content	Syllabus outcomes
Section II Question 14 — Lifting Devices			
14 (a) (i)	3	Power / Energy	H3.1
14 (a) (ii)	2	Electronics/motors	H1.2
14 (b) (i)	2	Materials in Forging Process	H1.2
14 (b) (ii)	3	Heat treatment process	H1.2, H2.1
Section II Question 15 — Aeronautical Engineering			
15 (a) (i)	2	Composite Materials	H1.2, H4.1, H6.2
15 (a) (ii)	3	Bernoulli's Principle	H6.2
15 (b)	4	Graphics	H3.3, H6.1
15 (c) (i)	4	Technological / Society	H3.2, H4.1, H4.3
15 (c) (ii)	2	Hydraulics	H1.2, H2.2, H4.1, H6.2
Section II Question 16 — Telecommunication			
16 (a) (i)	2	Telecommunication/electricity	H1.2, H3.2, H6.2
16 (a) (ii)	2	Electricity/electronics	H1.2, H4.3
16 (b) (i)	3	Satellite communications	H1.2, H4.1, H6.2
16 (b) (ii)	2	Satellite communications	H4.3, H6.2
16 (c) (i)	3	Graphics	H3.2, H3.3
16 (c) (ii)	3	Strength of materials	H3.1, H6.2
Section III Question 17 — Engineering and the Engineering Report			
17 (a)	2	Historical/design	H1.2, H2.2, H4.3, H6.2
17 (b) (i)	2	Engineering materials	H1.2, H2.1, H4.2
17 (b) (ii)	2	Engineering materials	H1.2, H2.1, H3.2
17 (c)	4	Materials – corrosion	H1.2, H3.1, H6.2
Section III Question 18 — Engineering and the Engineering Report			
18 (a)	3	Civil – Bending Stresses	H1.2, H3.1, H6.1, H6.2
18 (b)	2	Report writing	H1.1, H5.2
18 (c) (i)	3	Materials selection/justification	H2.1, H2.2, H3.2
18 (c) (ii)	2	Mechanics – materials selection	H2.1, H3.1, H6.2

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Marking Guidelines

Section II

Question 11 (a)

Outcomes assessed: H1.1

MARKING GUIDELINES

Criteria	Marks
• Clearly makes the relationships between the areas of knowledge and the application to the design	4
• Makes limited relationships between the areas of knowledge and the application to the design	4
• Identifies one specific area of knowledge and makes clear its relationship to the design OR • States areas of knowledge that relate to the design	2
• Names a relevant area of knowledge of aeronautical engineering OR • Identifies a relevant design feature	1

Question 11 (b)

Outcomes assessed: H4.2

MARKING GUIDELINES

Criteria	Marks
• Clearly explains how the application of an appropriate electronic control technology has resulted in the improvement	3
• Identifies an appropriate electronic control technology and gives the characteristics of the technology (how it works)	2
• Identifies an appropriate electronic control technology OR • Identifies one improvement	1

Question 11 (c)

Outcomes assessed: H4.3

MARKING GUIDELINES

Criteria	Marks
• Identifies a technological change and clearly provides the relationship between the change and the environment	3
• Identifies a technological change and provides a limited relationship between the change and the environment	2
• Identifies a technological change OR • States an environmental effect	1

Question 12 (a) (i)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• Identifies at least two constituents and provides the relationship between the constituents and the asphalt	2
• Identifies one constituent and provides its relationship to the asphalt OR • Identifies at least TWO constituents	1

Question 12 (a) (ii)

Outcomes assessed: H2.1, H2.2

MARKING GUIDELINES

Criteria	Marks
• Provides why reinforced concrete and asphalt are used, with clear reference to their properties	3
• Provides why one of the materials is used, with clear reference to its properties OR • Provides the characteristics and features of the material(s) or properties	2
• Provides a characteristic or a feature of the material(s) or properties	1

Question 12 (b) (i)

Outcomes assessed: H3.1, H6.1

MARKING GUIDELINES

Criteria	Marks
• Uses an appropriate method or gives correct solution	2
• Uses an appropriate method with minor errors	1

Question 12 (b) (ii)

Outcomes assessed: H3.1, H3.3, H6.1

MARKING GUIDELINES

Criteria	Marks
• Uses correct method or working or gives correct answers	3
• Uses an appropriate method with minor errors	2
• Demonstrates a limited understanding of the problem	1

Question 13 (a)

Outcomes assessed: H3.1, H3.3, H6.2

MARKING GUIDELINES

Criteria	Marks
• Uses correct method or gives a correct answer	2
• Uses an appropriate method with errors	1

Question 13 (b) (i)

Outcomes assessed: H2.1, H2.2, H6.2

MARKING GUIDELINES

Criteria	Marks
• Provides why/how the failure occurred and provides features of a suitable design modification	2
• Provides why/how the failure occurred OR • Provides features of a suitable design	1

Question 13 (b) (ii)

Outcomes assessed: H2.1, H5.2

MARKING GUIDELINES

Criteria	Marks
• Provides the features and characteristics of a suitable non-destructive test	2
• Names a suitable non-destructive test OR • Provides limited features and characteristics of a suitable non-destructive test	1

Question 13 (c) (i)

Outcomes assessed: H3.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Uses an acceptable method or gives a correct solution	2
• Uses an acceptable method with minor errors	1

Question 13 (c) (ii)

Outcomes assessed: H1.2, H2.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Names a suitable material and provides why it is an insulator with specific reference to the material's structure	2
• Names a suitable material OR • Names an unsuitable material but provides why it is an insulator with reference to the material's structure	1

Question 14 (a) (i)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria	Marks
• Uses a correct method or gives a correct answer	3
• Uses a correct method with minor errors	2
• Uses a correct method with significant errors	1

Question 14 (a) (ii)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• Provides how the commutator functions in a DC motor	2
• Demonstrates a limited knowledge of the function of the commutator	1

Question 14 (b) (i)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• Provides characteristics and features of the drop forging process	2
• Provides some characteristics and features of the drop forging process	1

Question 14 (b) (ii)

Outcomes assessed: H1.2, H2.1

MARKING GUIDELINES

Criteria	Marks
• Provides characteristics and features of a suitable heat treatment process and of the change in structure	3
• Provides characteristics and features of a suitable heat treatment process OR • Describes an unsuitable heat treatment process and provides characteristics of the relevant structural changes	2
• Names a suitable heat treatment process OR • Describes an unsuitable heat treatment process • Provides characteristics of the change in structure	1

Question 15 (a) (i)

Outcomes assessed: H1.2, H4.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Provides a relationship between the replaceable edge and the operation of propeller	2
• States a reason for the replaceable edge	1

Question 15 (a) (ii)

Outcomes assessed: H6.2

MARKING GUIDELINES

Criteria	Marks
• Provides a clear link between Bernoulli’s Principle, forward thrust and the shape of the blades	3
• Provides some link between Bernoulli’s Principle and the shape of the blades	2
• Limited description of Bernoulli’s Principle OR • Links shape to forward thrust	1

Question 15 (b)

Outcomes assessed: H3.3, H6.1

MARKING GUIDELINES

Criteria	Marks
• Provides correct assembly and proportion of components (some allowance for accuracy)	4
• Provides substantially correct assembly and proportion of components	3
• Provides basic assembly and proportion of components	2
• Provides poor assembly and proportion of components	1

Question 15 (c) (i)

Outcomes assessed: H3.2, H4.1, H4.3

MARKING GUIDELINES

Criteria	Marks
• Identifies two innovations and makes clear the relationship between the innovations and the effect(s) on society	4
• Identifies two innovations and makes some relationship between the innovations and the effect(s) on society	3
• Identifies one innovation and makes clear the relationship between the innovation and the effect on society	2
• Identifies one innovation and makes some relationship between the innovation and the effect on society OR • Identifies two innovations	1

Question 15 (c) (ii)

Outcomes assessed: H1.2, H2.2, H4.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Provides a clear relationship between the size of the force and the surface area of the ram	2
• Provides some link between the force and the surface area involved	1

Question 16 (a) (i)

Outcomes assessed: H1.2, H3.2, H6.2

MARKING GUIDELINES

Criteria	Marks
• Provides characteristics and features of the frequency modulation process	2
• Provides a characteristic or a feature of a modulation process	1

Question 16 (a) (ii)

Outcomes assessed: H1.2, H4.3

MARKING GUIDELINES

Criteria	Marks
• Provides benefits of frequency modulation over amplitude modulation OR • Provides a benefit and gives a cause of this benefit	2
• Provides a benefit or a reason why frequency modulation is preferred	1

Question 16 (b) (i)

Outcomes assessed: H1.2, H4.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Correctly differentiates between the two orbits and provides a use for each	3
• Correctly differentiates between the orbits OR • Correctly describes one orbit and provides its use	2
• Provides two correct uses	1

Question 16 (b) (ii)

Outcomes assessed: H4.3, H6.2

MARKING GUIDELINES

Criteria	Marks
• Provides characteristics and features of the resultant reception of the broadcast	2
• Provides some characteristics and features of the resultant reception of the broadcast	1

Question 16 (c) (i)

Outcomes assessed: H3.2, H3.3

MARKING GUIDELINES

Criteria	Marks
• Provides appropriate detail and shape using a pictorial method	3
• Provides a substantially correct sketch using a pictorial method	2
• Provides some aspects of the major components in relative position	1

Question 16 (c) (ii)

Outcomes assessed: H3.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Provides a correct method or correct answer	3
• Provides a correct method with minor errors	2
• Provides a correct method with significant errors	1

Section III

Question 17 (a)

Outcomes assessed: H1.2, H2.2, H4.3, H6.2

MARKING GUIDELINES

Criteria	Marks
• Indicates in general terms two social factors related to the design	2
• Indicates in general terms one social factor related to the design	1

Question 17 (b) (i)

Outcomes assessed: H1.2, H2.1, H4.2

MARKING GUIDELINES

Criteria	Marks
• Indicates in general terms valid reasons for the choice of material	2
• Indicates in general terms one valid reason for the choice of material	1

Question 17 (b) (ii)

Outcomes assessed: H1.2, H2.1, H3.2

MARKING GUIDELINES

Criteria	Marks
• Names a suitable material and supports the choice with valid engineering reasons	2
• Names a suitable material OR • Provides services properties of the material	1

Question 17 (c)

Outcomes assessed: H1.2, H3.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Provides why and/or how the two types of corrosion occur and correctly identifies an appropriate site for each	4
• Provides why and/or how one type of corrosion occurs and correctly identifies an appropriate site where this occurs, with some additional information on a second corrosion type or site	3
• Provides why and/or how one type of corrosion occurs and correctly identifies an appropriate site where this occurs	2
• Identifies one appropriate type of corrosion OR • Identifies one appropriate corrosion site	1

Question 18 (a)

Outcomes assessed: H1.2, H3.1, H6.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Selects the correct beam • Uses an appropriate method to correctly calculate the stress	3
• Selects the correct beam • Uses an appropriate method, with minor errors, to calculate the stress OR • Selects an incorrect beam and uses an appropriate method to correctly calculate the stress	2
• Selects the correct beam OR • Selects an incorrect beam and uses an appropriate method, with minor errors, to calculate the stress	1

Question 18 (b)

Outcomes assessed: H1.1, H5.2

MARKING GUIDELINES

Criteria	Marks
• Identifies issues and provides points for and/or against, in the use of tables in making engineering decisions	2
• Identifies issues and provides limited points for and/or against, in the use of tables in making engineering decisions	1

Question 18 (c) (i)

Outcomes assessed: H2.1, H2.2, H3.2

MARKING GUIDELINES

Criteria	Marks
• Compares the properties of tempered glass to the properties of both laminated glass and polycarbonate sheet	3
• Compares the properties of any two of these materials OR • Provides a basic comparison of the properties of tempered glass to the properties of both laminated glass and polycarbonate sheet	2
• Provides reasons for the selection of tempered glass	1

Question 18 (c) (ii)

Outcomes assessed: H2.1, H3.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Makes the relationship between the differential cross-sectional area and the stress in the beam apparent	2
• States a relevant property of the beam OR • Identifies a basic reason for the differential cross-sectional area	1