2008 HSC Notes from the Marking Centre Engineering Studies

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Contents

2008 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 contains comments on candidate responses to the 2008 Higher School Certificate examination, indicating the quality of the responses and highlighting their relative strengths and weaknesses.

This document should be read along with the relevant syllabus, the 2008 Higher School Certificate examination, the marking guidelines and other support documents which have been developed by the Board of Studies to assist in the teaching and learning of Engineering Studies.

Teachers and candidates should be aware that some questions require candidates to respond by integrating the knowledge and skills they have developed through a comprehensive understanding of the entire course.

Section I

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

Section II

General comments

Candidates are advised that the answer space allocated and the marks available for each question part are a guide to the length of the required response. Marks are often awarded for a correct method, even when incorrect answers are given, so all working should be shown. Candidates are also advised that when drawings are labelled as being drawn 'to scale' they may be used for calculations or graphical solutions to problems. It is also acceptable to use the provided drawings as part of the solution.

Question 11 – Historical and societal influences, and the scope of the profession

(a)(i) Better responses referred to engineering innovations such as wind tunnels, CAD programming software applications and carbon fibre composite materials and then related these features to the car shape. Weaker responses often referred to the end result of an engineering innovation such as the aerodynamics of the car, relating this to reduced air resistance or the use of spoilers producing downward force.

(ii) Responses that correctly named riveting, spot welding or bolting were generally successful in describing the nominated process. Weaker responses had difficulty in describing welding processes and displayed only a rudimentary understanding of them.

(b) Better descriptions of a project manager's role included the oversight of design, construction and maintenance of a project. These included the management of workers, materials, budgets, scheduling and occupational health and safety. Weaker responses gave a basic outline of minor components of the role and then omitted the main features.

(c) Weaker responses identified environmental issues related to the race track without relating cause and effect that is required for an explanation.

Many mid-range responses successfully described issues, such as noise pollution, air pollution, the impact on global warming, deforestation or fuel run-off and then described the resultant effect on flora and fauna, but neglected to include the role of the engineer. Better responses explained the role the engineer would take to minimise these issues with ideas such as sound barriers, tree planting, catchment dams and silt traps.

Question 12 – Civil structures

(a)(i) Correct responses took moments about the roller support to find the horizontal reaction at the pinned support, *A*. Common errors included taking moments about the fixed support in an attempt to find the reaction, inverting answers after calculations or using incomplete calculations. In many weaker responses, candidates had difficulty analysing a truss with supports fixed to a vertical wall.

(ii) Correct responses predominantly used the 'method of joints' to calculate the force in member *XY*. This method proved to be the simplest in this case. Candidates who used the 'method of sections' had difficulty in finding the perpendicular distance from the point of rotation to the line of action of the force in the member.

(b)(i) Common errors in this part included the failure to convert the 72 kg to a force, failure to recognise the display sign as exerting two forces on the beam or not starting and finishing the diagram at zero.

(ii) A common error among weaker responses was the failure to use the correct bending moment – obtained from the bending moment diagram on the previous page. Another common error in weaker responses was the value y – the distance from the neutral axis of the outer edge of the beam.

(c) Weaker responses simply outlined the tensile strength of steel and the compressive strength of concrete in isolation or as a composite material, but failed to relate how their combined properties were appropriate for absorbing and resisting the impact forces the crash barrier might be subjected to.

Question 13 – Personal and public transport

(a) (i) Better responses included high starting torque as the advantage and higher maintenance as the disadvantage of the DC motor. Weaker responses generally compared DC and AC current.

(ii) Mid-range responses displayed a reasonable knowledge and correctly provided the role of the commutator and the brushes in the DC motor. Weaker responses indicated what the commutator does, but were then unable to correctly describe the function of the brushes. A number of weaker responses confused the components of the motor with those used in generating a current.

(b) (i) Better responses indicated a correct heat treatment process such as hardening and tempering or one of the surface-hardening processes. Weaker responses described a test for a mechanical property, such as a tensile test or outlined an inappropriate heat treatment process.

(ii) Better responses described all aspects of x-ray, ultrasound or penetrant dye tests as typical non-destructive tests.

(c) Better responses correctly substituted appropriate values from the question into the correct formula for work, obtained from the formula sheet. Common errors in weaker responses included using the mass of the tram as the rolling resistance force, not converting units to SI standards and calculating kinetic energy and using it as a work value.

Question 14 – Lifting devices

(a) (i) Better responses usually used the formula, $T=mg$ to correctly determine the tension in the cable. A significant number of weaker responses were from candidates who either failed to read the question or analyse it correctly, setting about an inappropriate moments calculation, or at times a graphical force triangle.

In many weaker responses, candidates failed to show any working for this question. Candidates are encouraged to write out a formula or statement of equilibrium and show all working.

(ii) The concepts of moments and equilibrium were not well understood by a large number of candidates. Better responses summed moments about *B*, substituted the data from the question and were able to find the maximum mass.

Weaker responses poorly managed their working: taking moments about inconsistent points of rotation or adding in extra factors. A number of candidates summed moments about CG or *C* and failed to arrive at the correct solution. A number of candidates failed to realise that when the front wheels (point *C*) are on the verge of lifting off the ground, the reaction at *C* is zero.

Candidates are encouraged to carefully show all working with attention to stating the point where they are summing moments about. Furthermore, candidates should draw a free body diagram to assist in solving problems.

(b) (i) Better responses explained why a multi-strand cable would be the preferred choice by highlighting a cause and effect. Flexibility in the cable, as a reason for its choice, was not well understood. Most mid-range or even better responses failed to identify that a single-strand cable would not have sufficient flexibility to wrap around either the winch or pulley.

Weaker responses provided one or two reasons for the selection, but failed to link these to an effect. Other weaker responses indicated a lack of understanding that a multi-strand cable is made up of many smaller diameter cables to make up the 10 mm diameter.

(ii) Better responses used consistent units and recognised that 0.25% strain is equal to 0.0025. These responses managed to convert strain and use it to gain a correct solution.

Weaker responses managed units poorly and indicated a limited understanding of area to be used or were unable to use strain effectively in their equation. Some candidates determined the length of the cable from the scale diagram and made up a value for the permitted elongation of the cable to use the formula $E = \frac{PL}{eA}$. Consistency in units is essential if correct solutions are to be achieved. Poor setting out of the solution often exacerbated unit confusion.

(c) Better responses described the process of powder forming in great detail and provided a good reason for its use.

Weaker responses usually included a reason for using powder forming but were unable to provide a description of the process. Some weaker responses described incorrect processes or described melting the powder in the mould, which is an incorrect concept. Some weaker responses mistakenly combined the pressing and sintering operation.

Question 15 – Aeronautical engineering

(a) Better responses demonstrated a clear understanding of the suitability of jet power for heavy aircraft and piston engines for smaller aircraft. Weaker responses did not explain the suitability of piston engine for light aircraft.

(b) Better responses referred to cyclic stresses causing an increased susceptibility to corrosion and then related these to the harsh environments aircraft experience when in service. Weaker responses simply listed types of corrosion found on aircraft and failed to explain why corrosion was more susceptible on aircraft.

(c) Better responses stated an advantage, such as an improved strength to weight ratio, and a disadvantage, such as higher component costs. Weaker responses did not state, or elaborate, on the disadvantage associated with composite materials or failed to consider that the composite was used in aircraft.

(d) Most correct responses used a free body diagram to help clarify the situation and then used an analytical method to solve the question. Some better responses also used a graphical method to successfully determine a correct answer. The most common error in responses was the failure to realise that the lift force is perpendicular to the plane of the wings.

(e) Better responses explained clearly how wing shape affects lift and drag for the two different aircraft.

(f) Better responses correctly assembled the three components and then used either an oblique or isometric projection to complete the pictorial sketch. Common errors included the failure to assemble the components, sketching an assembled orthogonal drawing or not using the same scale as the orthogonal drawings provided.

Question 16 – Telecommunication

(a) (i) Mid-range responses correctly identified amplitude and frequency as variable parameters of modulation. Only the best responses correctly identified the phase of the wave. Many responses displayed a lack of understanding of the term 'parameter'.

(ii) Better responses recognised that Signal *X* was modulated using its frequency, and that the amplitude of the signal was constant.

(iii) Better responses identified a source of interference within the race car and then explained why FM signals are relatively immune to interference due to their being unaffected by changes in the amplitude of the signal.

Weaker responses did not identify a possible source of interference and failed to explain the link between the interference from the source and why it does not affect FM signals.

(b) (i) In better responses, candidates were very familiar with the electromagnetic spectrum used in satellite communications.

(ii) The reasons for signal loss in fibre-optic cables were not outlined well in weaker responses. Better responses identified a cause rather than a name of the attenuation and then outlined the reasons for the loss of signal based on the cause. Weaker responses identified incorrect causes of attenuation and struggled to outline suitable reasons for signal loss. Many weaker responses incorrectly identified bending or breaking of the cable or long distances as a suitable cause.

(c) Semiconductors are commonly used in electrical circuits. Better responses named one type from a large group and then described the function of that semiconductor. Weaker responses identified another electrical component other than a semiconductor and then described its function.

(d) Better responses displayed a good understanding of component assembly and sketched each part in proportion to the other parts. However, weaker responses gave incomplete sectioned

drawings or did not section the drawing at all. Responses generally revealed some confusion over Australian Drawing Standards, AS1100, particularly in relation to the sectioning of bolts, nuts and washers. However, drawing standards relating to screw threads have improved.

Section III

Question 17

(a) Better responses correctly identified and described three relevant criteria, such as impact strength, energy absorption, aerodynamics and the weight.

(b) Better responses correctly identified a tensile test as being the best one to determine whether the strap system meets requirements. Other correct responses described proving and impact tests. Weaker responses named a test, but failed to provide the characteristics and features of the named test.

(c) Better responses calculated the correct thickness of the polycarbonate visor by using the right shear area in the calculation. The shear area is found by multiplying the perimeter of the punch by the thickness of the sheet. The most common error was using an incorrect method of determining this area, such as the cross-sectional area of the square punch or using a circular area formula.

Candidates are reminded that answers of 500 mm, for example, are simply not realistic for the thickness of the helmet visor. Candidates are encouraged to consider their solution and whether it is realistic.

(d) Better responses provided an explanation of both the in-service and manufacturing properties of acrylonitrile butadiene styrene (ABS). Mid-range responses explained an in-service property but had difficulty identifying or explaining the manufacturing property. Candidates are reminded that thermo-softening polymers are easily melted and moulded into complex shapes, suitable for mass production.

Question 18

(a) Better responses clearly identified at least two safety considerations that would be included in the report and discussed the engineering properties that related to the airship's skin, the gas used and its flammability, the tethering system and the electrical motor. Weaker responses discussed the principles of attaching the aerial camera platform and the location of the camera man.

(b) Better responses correctly calculated the total length of the wire, but many of these then failed to realise that the wire needed to go up to the balloon and then return to the ground, leading to a height of half the length of wire. Common errors included the failure to use the formula provided as part of the question and not determining the voltage drop (45 V) across the system.

(c) (i) Weaker responses demonstrated a lack of understanding of friction related problems. Common errors included the failure to consider the weight force, the direction of friction forces in the system and simple calculation errors in the analysis.

Better responses typically used a free body diagram to assist in the clarification of the problem. These candidates then used either an analytical or a graphical method to find an answer. Graphical solutions were generally more successful.

(ii) Better responses identified and discussed the advantages of each system using criteria such as mechanical advantage (effort), horizontal/vertical space required and simple versus complex mechanisms.

Weaker responses simply listed the advantages of each and assumed that the block and tackle was a frictionless device.

Engineering Studies

2008 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus outcomes
Section I			
1	1	Lifting devices – engineering materials	H1.2, H2.1
2	1	Personal and public transport – engineering materials	H1.2, H2.1
3	1	Lifting devices – engineering mechanics and hydraulics	H3.1
4	1	Civil structures – engineering materials	H1.2, H2.1
5	1	Lifting devices – engineering materials	H1.2
6	1	Personal and public transport – engineering, electricity/electronics	H3.1, H6.1
7	1	Civil structures – engineering mechanics	H3.1
8	1	Personal and public transport – engineering, electricity/electronics	H6.1, H6.2
9	1	Personal and public transport – engineering, electricity/electronics	H3.1, H6.1
10	1	Civil structures – communications	H3.1, H3.3
Section II **Question 11 — Historical and Societal Influences, and the Scope of the Profession**			
11 (a) (i)	3	Historical and societal influences	H1.2, H2.1, H4.1
11 (a) (ii)	2	Historical and societal influences	H1.2, H4.1
11 (b)	2	Scope of the profession	H1.1
11 (c)	3	Historical and societal influences	H4.3
Section II **Question 12 — Civil Structures**			
12 (a) (i)	2	Engineering mechanics	H3.1
12 (a) (ii)	2	Engineering mechanics	H3.1
12 (b) (i)	2	Engineering mechanics	H3.1, H6.2
12 (b) (ii)	2	Engineering mechanics	H3.1, H6.2
12 (c)	2	Engineering materials	H1.2, H2.1
Section II **Question 13 — Personal and Public Transport**			
13 (a) (i)	2	Engineering electricity/electronics	H1.2, H6.2
13 (a) (ii)	2	Engineering electricity/electronics	H1.2
13 (b) (i)	2	Engineering materials	H1.2, H2.1
13 (b) (ii)	2	Engineering materials	H1.2, H6.2
13 (c)	2	Engineering mechanics	H3.1

Question	Marks	Content	Syllabus outcomes
Section II Question 14 — Lifting Devices			
14 (a) (i)	1	Engineering mechanics	H3.1
14 (a) (ii)	2	Engineering mechanics	H3.1, H6.2
14 (b) (i)	2	Engineering materials	H2.1, H6.2
14 (b) (ii)	2	Engineering materials	H3.1
14 (c)	3	Engineering materials	H1.2
Section II Question 15 — Aeronautical Engineering			
15 (a)	2	Engineering mechanics and hydraulics	H1.2
15 (b)	2	Engineering Materials	H1.2
15 (c)	2	Engineering materials	H1.2
15 (d)	2	Engineering mechanics and hydraulics	H3.1
15 (e)	3	Engineering mechanics and hydraulics	H1.2, H6.2
15 (f)	4	Communication	H3.2
Section II Question 16 — Telecommunication			
16 (a) (i)	2	Engineering electricity/electronics	H1.2, H6.2
16 (a) (ii)	1	Engineering electricity/electronics	H1.2, H2.2
16 (a) (iii)	2	Engineering electricity/electronics	H1.2, H2.2
16 (b) (i)	1	Engineering electricity/electronics	H1.2
16 (b) (ii)	2	Engineering electricity/electronics	H1.2
16 (c)	2	Engineering materials	H1.2
16 (d)	5	Communication	H3.2
Section III Question 17 — Engineering and the Engineering Report			
17 (a)	2	Engineering report	H1.2, H2.1
17 (b)	2	Engineering materials	H1.2, H2.1
17 (c)	3	Engineering mechanics	H3.1
17 (d)	3	Engineering materials	H1.2, H2.1
Section III Question 18 — Engineering and the Engineering Report			
18 (a)	2	Scope of the profession	H1.1, H2.1, H6.2
18 (b)	3	Engineering electricity/electronics	H3.1, H6.1, H6.2
18 (c) (i)	2	Engineering mechanics	H3.1
18 (c) (ii)	3	Engineering mechanics	H3.1, H6.2

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2008 HSC Engineering Studies
Marking Guidelines

The following marking guidelines were developed by the examination committee for the 2008 HSC examination in Engineering Studies, and were used at the marking centre in marking student responses. For each question the marking guidelines are contained in a table showing the criteria associated with each mark or mark range. For some questions, 'Sample Answers' or 'Answers may include' sections are included. These are developed by the examination committee for two purposes. The committee does this:

(1) as part of the development of the examination paper to ensure the questions will effectively assess students' knowledge and skills, and

(2) in order to provide some advice to the Supervisor of Marking about the nature and scope of the responses expected of students.

The examination committee develops the marking guidelines concurrently with the examination paper. The 'Sample Answers' or similar advice are not intended to be exemplary or even complete answers or responses. As they are part of the examination committee's 'working document', they may contain typographical errors, omissions, or only some of the possible correct answers.

The information in the marking guidelines is further supplemented as required by the Supervisor of Marking and the senior markers at the marking centre.

A range of different organisations produce booklets of sample answers for HSC examinations, and other notes for students and teachers. The Board of Studies does not attest to the correctness or suitability of the answers, sample responses or explanations provided. Nevertheless, many students and teachers have found such publications to be useful in their preparation for the HSC examinations.

A copy of the Mapping Grid, which maps each question in the examination to course outcomes and content as detailed in the syllabus, is also included.

Section II

Question 11 (a) (i)

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

MARKING GUIDELINES

Criteria	Marks
• Describes TWO relevant innovations	3
• Describes ONE relevant innovation OR • Outlines TWO relevant innovations	2
• Identifies TWO relevant innovations	1

Sample answer/Answers could include:

Extensive use of wind tunnels to test aerodynamics allows fine turning of different shapes for different tracks.

Position of engine – greater understanding of engineering concepts, ie; mass distribution, forces, loads to maximise stability at high speeds. Composite materials, (lightweight/strong), aerofoils, body skirts, driver position, engine/gearbox position, low mass, suspension, driver protection.

Question 11 (a) (ii)

Outcomes assessed: H1.2, H4.1

MARKING GUIDELINES

Criteria	Marks
• Names and describes an appropriate process	2
• Names OR describes an appropriate process	1

Sample answer/Answers could include:

Gas welding – Edges of two panels brought together, heated with blow torch, filler metal added, fuse both edges, allow to cool

Arc welding – As above – but using electric arc welder

Riveting – Two panels overlap, holes drilled to suit rivet size. Rivet placed and hammered over OR ‘pop’ rivets used in pop rivet gun

Folding – Two panels folded to form interlocking joint which is pressed together

Nuts and Bolts – Two panels overlap, holes drilled to suit bolt size. Nuts placed on bolts and tightened with spanners.

Question 11 (b)

Outcomes assessed: H1.1

MARKING GUIDELINES

Criteria	Marks
• Provides a good outline of the project manager's work	2
• Provides a basic outline of the project manager's work OR • Names features of the project manager's work	1

Sample answer/Answers could include:

An engineer as a project manager – The project manager would be responsible for directing staff during the design process, working out the order in which work needs to be done, working out timeframe. The project manager could oversee the supply of materials for a job and possibly some components of the budget. The project manager would supervise programs on the job through to completion.

Question 11 (c)

Outcomes assessed: H4.3

MARKING GUIDELINES

Criteria	Marks
• Explains several environmental issues	3
• Explains ONE environmental issue OR • Lists several issues without an explanation	2
• Lists ONE environmental issue	1

Sample answer/Answers could include:

Environmental issues for new race track; Noise abatement, control of waste water, protection of native flora, drainage, control of pollution from toxic chemicals (fuel, oil), control of human waste.

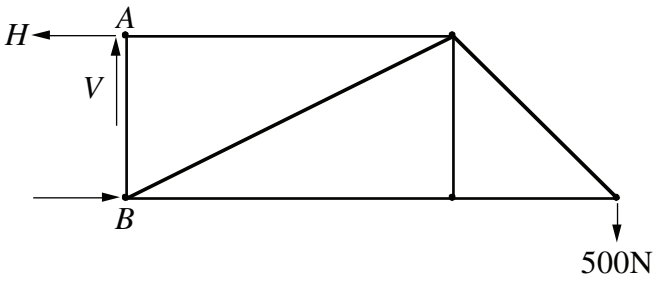
Question 12 (a) (i)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria	Marks
• Both reactions calculated correctly	2
• Uses correct method but with minor error	1

Sample answer/Answers could include:



$\Sigma Fy = 0 \quad \uparrow + ve$

$V - 500 = 0 \quad \boxed{V = 500N}$

$\Sigma M_A = 0$

$500 \times 3 - H = 0 \quad \boxed{H = 1500N}$

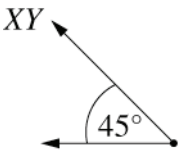
Question 12 (a) (ii)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria	Marks
• Calculates force in *XY* correctly	2
• Uses a correct method but with ONE error	1

Sample answer:



500 N

$\Sigma Fy = 0 \uparrow + ve$

$XY \sin 45° - 500 = 0$

$XY = 500/\sin 45°$

$XY = 707.1 \text{ N}$

Answers could include:

Could be rounded to 707 N

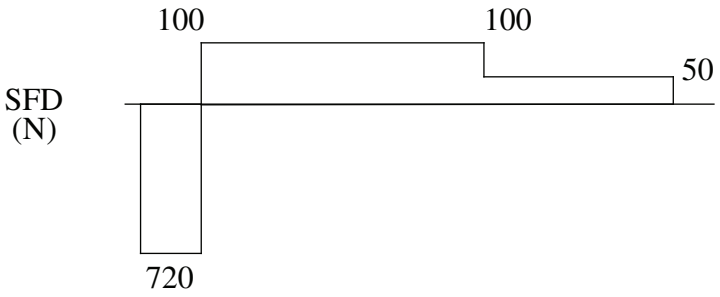
Question 12 (b) (i)

Outcomes assessed: H3.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Draws the shear force diagram of the correct shape with correct magnitude of shear forces indicated	2
• Uses suitable method but makes a minor error	1

Sample answer:



Question 12 (b) (ii)

Outcomes assessed: H3.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Bending stress calculated correctly	2
• Uses a suitable method but makes minor error	1

Sample answer:

$$\sigma = \frac{My}{I} = \frac{216 \times 10^{-3} \times 50}{1.55 \times 10^{-6}} = 6.97\ MPa$$

(Could round answer up to 7 MPa)

Question 12 (c)

Outcomes assessed: H1.2, H2.1

MARKING GUIDELINES

Criteria	Marks
• Explains how steel and concrete work together in the crash barrier	2
• Explains only the steel or the concrete's effectiveness in the crash barrier OR • States only properties of both steel and concrete not relating to crash barrier	1

Sample answer:

- Same thermal expansion for both materials
- Concrete providing corrosion protection for the steel
- Concrete used to predominantly absorb compressive loads
- Steel used to predominantly absorb tensile loads

Question 13 (a) (i)

Outcomes assessed: H1.2, H6.2

MARKING GUIDELINES

Criteria	Marks
• States ONE relevant advantage and ONE relevant disadvantage	2
• States ONE relevant advantage OR • States ONE relevant disadvantage	1

Sample answer:

Advantage: Simple drive and controls, higher torque at low speed

Disadvantage: Higher maintenance, higher cost, lower power-to-weight ratio

Question 13 (a) (ii)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• Explains the role of the brushes and commutator	2
• Outlines the roles of the brushes and commutator OR • Explains either the role of the brushes or of the commutator	1

Sample answer:

Explain the role of brushes: To supply current to the coils on the armature such that a stationary magnetic field with respect to the field windings is maintained when the armature rotates.

Coils on the armature have to be engineered with electric current as they rotate. Brushes (carbon) run on the surface of the commutator to enable current to pass into the armature.

Question 13 (b) (i)

Outcomes assessed: H1.2, H2.1

MARKING GUIDELINES

Criteria	Marks
• Outlines a suitable heat treatment process	2
• Names a suitable heat treatment process	1

Sample answer:

Heat treatment of drive shaft:

i. Through heat treatment – shaft has carbon content > 0.4 and < 0.8%. Shaft is heated to approximately 850°C, soaked, quenched in water, immediately reheated to 400°C, soaked and cooled. Produces tempered martensite.

   - shaft has carbon content of > 0.4 and < 0.8%. Shaft heated to ≈ 850°C, soaked, quenched in oil, reheated to 200°C and cooled. Produces tempered bainite.

ii. Case hardening – induction hardened

   Shaft has carbon content > 0.4% and < 0.8%. Placed in induction ring which heats outer surface of steel to ≈ 900°C, leaving core at much lower temperature. Water spray quenches the hot metal forming a martensite skin with a ferrite/pearlite core.

iii. Case hardening – case carburised – shaft has carbon content < 0.2%, heated and soaked in a carbon rich atmosphere furnace. Case of shaft increases in carbon content, core remains low. Job is quenched to produce martensite case and fine pearlite core.

Question 13 (b) (ii)

Outcomes assessed: H1.2, H6.2

MARKING GUIDELINES

Criteria	Marks
• Describes an appropriate non-destructive method	2
• Names a suitable test	1

Sample answer:

Check for non-visible flaws – non-destructive testing

i. X-Ray – X-ray unit placed on one side of job, photo plate on the other. X-rays penetrate job and expose the photo plate that is developed. Small cracks etc show up on film.

ii. Ultrasonic – Ultrasonic (high frequency sound waves) are passed into the job and picked up by a sensor. Cracks etc affect the waves that are stored in a computer and shown as an image on a screen.

iii. Nuclear isotopes used on one side of component, radiation sensors on the other. Flaws show up on screen.

Question 13 (c)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria	Marks
• Determines power	2
• Uses correct method but makes a minor error	1

Sample answer:

$$P = \frac{Fs}{t}$$
$$= \frac{15 \times 10^3 \times 2700}{240}$$
$$= 168.75 \text{ kW}$$

Question 14 (a) (i)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria	Marks
• Determines value of force	1

Sample answer:

$F = mg$

$= 853 \times 10$

$F = 8530 \text{ N}$

$= 8.53 \text{ kN}$

Question 14 (a) (ii)

Outcomes assessed: H3.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Uses a correct method and/or determines correct solution	2
• Uses a correct method but with minor errors	1

Sample answer:

$\Sigma M_B = 0 \quad \curvearrowright + ve$

$(3200 \times 2) - (2.9 \times W) = 0$

$W = 22069 \text{ N}$

$m = 2207 \text{ kg}$

Question 14 (b) (i)

Outcomes assessed: H2.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Explains why multi-strand cable is used	2
• States a reason why multi-strand cable is used	1

Sample answer:

A 10 mm diameter single strand would be quite rigid and difficult to form over a pulley. If formed over a pulley it would bend. If the cable is overloaded it would fail.

Multi-stranded cable is much more flexible and would form over a pulley. If the cable is overloaded individual strands would fail.

Question 14 (b) (ii)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria	Marks
• Uses a correct method and/or gives correct solution	2
• Uses a correct method but with minor errors	1

Sample answer:

$$E = \frac{4P}{\pi d^2 \varepsilon}$$

$$= \frac{4 \times 1.5 \times 10^3 \times 100}{\pi \left(2 \times 10^{-3}\right)^2 \times 0.25}$$

$$E = \frac{600{,}000}{3.142 \times 10^{-6}} = 190\ 985 \text{ MPa}$$

$$= 191 \text{ GPa}$$

(Could round to 191 000 MPa or 191 GPa)

Question 14 (c)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• Describes the process and states ONE advantage	3
• Describes the process OR • Outlines the process and states ONE advantage	2
• States ONE advantage OR • Outlines the process	1

Sample answer:

Powder forming:
A punch and die is produced in the shape of the final gear.

Powders of the alloy itself are prepared with a lubricant powder. These are placed in the die and compressed with the punch. The composed pre-form is then placed in a controlled atmosphere furnace at a temperature at which the powders diffuse together to produce an almost homogenous and impervious component.

Advantages: Lends itself to very complex shapes and produces components to very high tolerances – the machinery can have porous components if needed.

Question 15 (a)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• Explains why BOTH engine types are suitable	2
• Explains why ONE engine type is suitable OR • States a reason why BOTH engine types are suitable	1

Sample answer:

Long haul international jets carry greater load, fly at higher altitude (for time and efficiency) and require greater velocities.

Piston engines normally drive propellers that are less efficient, are not capable of flying at high altitude and therefore cabin areas do not need to be pressurised.

Question 15 (b)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• Explains reasons for increased susceptibility to corrosion	2
• Lists ONE appropriate reason	1

Sample answer:

Metals that are susceptible to corrosion tend to perform poorly in aircraft due to the following.

i. Presence of many crevices between spars and skin
ii. As aircraft take off and land they pass through the dew point where moisture condenses on the metals and the crevices
iii. Vibration in the aircraft causes minute movement that can remove any protective coating from the metal surface
iv. Often different composition alloys are in contact with one another causing galvanic reactions
v. Aircraft components can be highly stressed which may lead to stress corrosion cracking

Question 15 (c)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• States ONE advantage and ONE disadvantage	2
• States ONE advantage	1

OR • States ONE disadvantage	

Sample answer:

Composites

Advantages – Light weight, high strength to weight ratio (specific strength), easily shaped to complex shapes, readily joined to other materials, high specific stiffness (E ÷ density)

Disadvantages – Typically composites have a lower working temperature range than metals and can deteriorate/fail without warning.

Question 15 (d)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria	Marks
• Determines the magnitude of the lift	2
• Uses a correct method but with a minor error	1

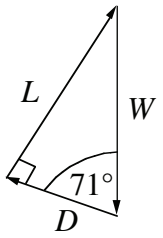
Sample answer:

$$\sin 71^\circ = \frac{L}{W}$$

$$L = W \sin 71^\circ$$

$$= 85 \times 10^3 \times 10 \times 0.94$$

$$= 799 \text{ kN}$$



Answers could include:

Full graphical solution

Question 15 (e)

Outcomes assessed: H1.2, H6.2

MARKING GUIDELINES

Criteria	Marks
• Explains how shape affects lift and drag	3
• Makes a link between lift and drag	2
• Any correct statement regarding lift, drag or shape	1

Sample answer:

Lift and drag vary with aircraft shape, velocity and altitude. Some aircraft are shaped specifically to be most efficient at particular velocities and altitudes. Both the shape of the aircraft wings and the fuselage affect lift and drag.

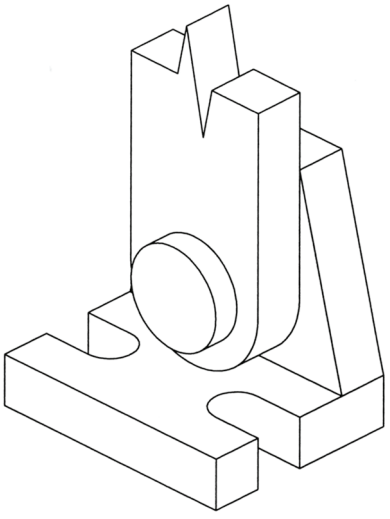
Question 15 (f)

Outcomes assessed: H3.2

MARKING GUIDELINES

Criteria	Marks
• Provides a pictorial drawing to correct (or almost correct) size and shape	4
• Provides a substantially correct pictorial drawing, mostly complete	3
• Provides a pictorial drawing with some aspects correct OR parts not assembled	2
• Provides a limited AND/OR incomplete (pictorial) sketch	1

Sample answer:



Question 16 (a) (i)

Outcomes assessed: H1.2, H6.2

MARKING GUIDELINES

Criteria	Marks
• Lists THREE parameters	2
• Lists TWO parameters	1

Sample answer:

Amplitude
Phase
Frequency

Question 16 (a) (ii)

Outcomes assessed: H1.2, H2.2

MARKING GUIDELINES

Criteria	Marks
• Correctly identifies the form of modulation	1

Sample answer:

Signal X: Frequency modulation

Question 16 (a) (iii)

Outcomes assessed: H1.2, H2.2

MARKING GUIDELINES

Criteria	Marks
• Identifies a source of interference and provides an explanation	2
• Identifies a source of interference OR • Provides an explanation	1

Sample answer:

Source: Ignition System
Explanation: Interference mostly affects amplitude. FM involves varying the frequency hence relatively immune to interference.

Answers could include:

Source: Electronics

Question: 16 (b) (i)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• Provides frequency range	1

Sample answer:

Microwave

Answers could include:

2 – 40 GHz

Question 16 (b) (ii)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• Names and/or gives a cause of attenuation AND outlines a reason for signal loss	2
• Names and/or gives a cause of attenuation OR • Outlines a reason for signal loss	1

Sample answer:

Name: absorption
Cause: imperfections in the fibre

Answers could include:

Name: – scattering
– joint losses

Causes: – cable joins

Question 16 (c)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria	Marks
• Names a semiconductor AND describes the function it performs	2
• Names a semiconductor device OR • Describes the function	1

Sample answer:

Name: Diode

Function: Allows flow of electricity in one direction only
Used to rectify AC → DC

Answers could include:

Name: Transistor
Function: amplifies and switches

Other semiconductor devices:

- Phototransistor
- Photodiode
- Thyristor
- SCR

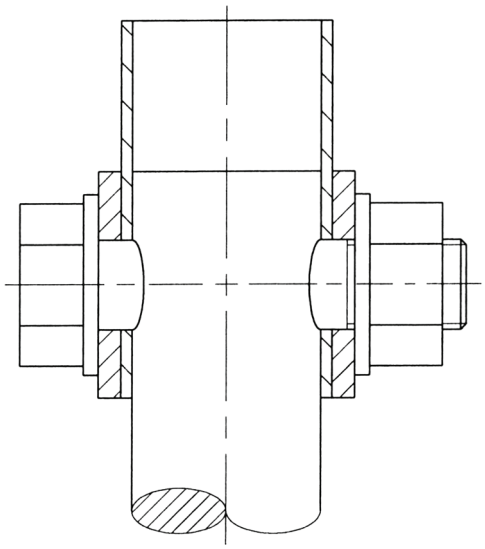
Question 16 (d)

Outcomes assessed: H3.2

MARKING GUIDELINES

Criteria	Marks
• Provides correct assembly and proportion of components with correct standards	5
• Provides correct assembly and proportion of components with substantially correct standards	4
• Provides correct assembly and proportion of components with some correct standards	3
• Provides basic assembly and proportion of components	2
• Provides limited assembly and proportion of components	1

Sample answer:



Question 17 (a)

Outcomes assessed: H1.2, H2.1

MARKING GUIDELINES

Criteria	Marks
• Describes THREE criteria	2
• Indicates some knowledge of criteria	1

Sample answer:

Impact resistance, weight, aerodynamic shape, ability to absorb impact energy etc.

Answers could include:

- Comfort
- Colour (safety)
- Visibility (visor)
- Impact/energy absorption (padding)

Question 17 (b)

Outcomes assessed: H1.2, H2.1

MARKING GUIDELINES

Criteria	Marks
• Describes a suitable test	2
• Indicates some knowledge of a suitable test	1

Sample answer:

Tension test: Specimen mounted in tensometer. Force and extension measured up to limit.

Question 17 (c)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria	Marks
• Determines the correct thickness	3
• Uses a correct method but with minor errors	2
• Uses correct method but with significant errors	1

Sample answer:

$$\partial = \frac{P}{A}$$

$$A = p \times t = 5 \times 10^{-3} \times t \times 4$$

$$A = \frac{P}{\partial} = \frac{290}{9.67 \times 10^{6}}$$

$$= 2.998 \times 20^{-5}$$

$$t = \frac{2.998 \times 10^{-5}}{4 \times 5 \times 10^{-3}}$$

$$= 1.499 \times 10^{-3}\text{m}$$

(Accept 1.5 mm)

Question 17 (d)

Outcomes assessed: H1.2, H2.1

MARKING GUIDELINES

Criteria	Marks
• Explains in-service and manufacturing properties ie ONE in-service and ONE manufacturing property	3
• Outlines ONE in-service and ONE manufacturing property	2
• Explains either an in-service or a manufacturing property	1

Sample answer:

Exterior shell of the helmet – ABS

In-service properties:
- Light
- Relatively strong
- Relatively tough
- Relatively flexible

Manufacturing properties:
- Thermo-softening polymer
- Readily coloured
- Easily moulded to complex shape
- Lends itself to mass production

Question 18 (a)

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

MARKING GUIDELINES

Criteria	Marks
• Discussion of significant safety considerations	2
• Indicates some knowledge of appropriate criteria	1

Sample answer:

1. Material flammability
2. Reliability of cable system
3. Integrity of skin to maintain seal

Answers could include:

- Stability under high wind conditions
- Security of camera fastening system

Question 18 (b)

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

MARKING GUIDELINES

Criteria	Marks
• Determines the maximum operating height	3
• Uses correct method but with minor errors	2
• Uses correct method but with significant errors	1

Sample answer:

$$\text{Voltage drop} = 240 - 195$$

$$= 45 \text{ V}$$

$$\text{Maximum } R = \frac{V}{I}$$

$$= \frac{45}{5}$$

$$= 9\Omega$$

$$\text{Height } h = \frac{1}{2} \times \frac{9}{0.02}$$

$$= 225 \text{ metres}$$

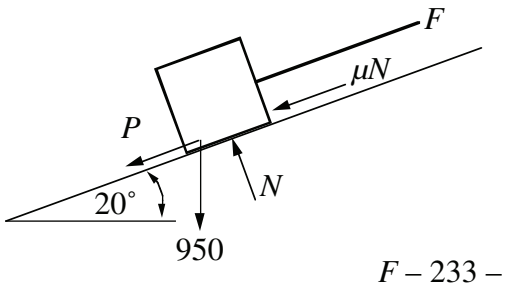
Question 18 (c) (i)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria	Marks
• Determines correct force	2
• Uses a correct method but with minor errors	1

Sample answer:



$N = 950 \cos 20°$

$\mu N = 0.25 \times 950 \cos 20°$

$= 233$ N

$P = 950 \sin 20°$

$P = 324.9$ N

$\Sigma F// = 0 \uparrow + ve$

$F - 233 - 324.9 = 0$

$F = 547.9$ N

$F = 548$ N

Question 18 (c) (ii)

Outcomes assessed: H3.1, H6.2

MARKING GUIDELINES

Criteria	Marks
• Discusses advantages of BOTH lifting systems	3
• Describes advantages of ONE lifting system OR • Outlines advantages of BOTH lifting systems	2
• Outlines advantages of ONE lifting system	1

Sample answer:

Block and tackle:

- Mechanical advantage
- Operates in small space
- Varied angle of applied force

Ramp:

- Can operate in most environments ie does not need frame or external structure for support/outdoors
- Simple to operate ie uncomplicated
- Parts easy to assemble