HSC marking simulation videoconference: Engineering Studies

Technology Unit
Curriculum K-12 Directorate

NEW SOUTH WALES DEPARTMENT OF EDUCATION AND TRAINING
NEALS
Curriculum K-12

Video Conference overview

- The HSC Examination Development
- The Marking Process
- Structure of the HSC Engineering Studies Paper
- Samples of Exam Responses and Marking Guidelines
- Helpful Hints
- Resources
- Questions

Examination Development

- An Exam committee is established.
- The committee sets questions according to the HSC examination specifications
- A draft paper is developed
- Draft of paper is assessed by teachers, the Supervisor of Marking, a syllabus validity assessor and various internal assessors such as copy editors
- Marking Guidelines, Mapping Grid and sample answers are prepared
- Paper is finalised, proof read and checked prior to printing.

Marking Process

- Chief Examiner, Supervisor of Marking (SOM) and Senior Markers discuss each question and their marking guidelines
- Senior Markers read and pilot mark a range of student scripts, relating them to the marking guidelines. Senior Markers test the marking guidelines to ensure validity and reliability and appropriate discrimination in marking
- The marking guidelines can be fine-tuned with the agreement of the Chief Examiner

- Markers are allocated to marking groups.
- Each marking group consists of a team of markers and a Senior marker.
- Senior markers annotate benchmark scripts to guide markers as to how marks should be awarded.

Pilot marking

- Each marking group discusses the marking guidelines and the annotated benchmark scripts (the ‘marking kit’)
- Independently practice mark (based on the marking kit) several scripts selected by their Senior Marker.
- Marks are compared for each script, discrepancies discussed, expected answers refined in line with student responses.

- Process continues until all markers are consistent in the application of the *Marking guidelines* and discrepancies are minimised

- Marking commences when the Senior Marker is confident that all markers are aligned and can fully apply the *Marking kit*

Quality assurance

- Check marking by the Senior Marker.
- Control (common) scripts at regular intervals.
- Daily and cumulative marker statistics sheets.
- Revision marking of a proportion of scripts

Marking Guidelines

Marking Guidelines for past HSC examinations can be found on the Board of Studies website

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

Structure of the HSC Engineering Studies Paper

BOARD OF STUDIES
NEW SOUTH WALES

2008
HIGHER SCHOOL CERTIFICATE
EXAMINATION

Engineering Studies

General Instructions
- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A formulae sheet is provided at the back of this paper
- Write your Centre Number and Student Number at the top of pages 9, 11, 15, 17, 21, 25, 29 and 33

Total marks – 100

Section I Pages 2–7
10 marks
- Attempt Questions 1–10
- Allow about 20 minutes for this section

Section II Pages 9–27
70 marks
- Attempt Questions 11–16
- Allow about 2 hours for this section

Section III Pages 29–36
20 marks
- Attempt Questions 17–18
- Allow about 40 minutes for this section

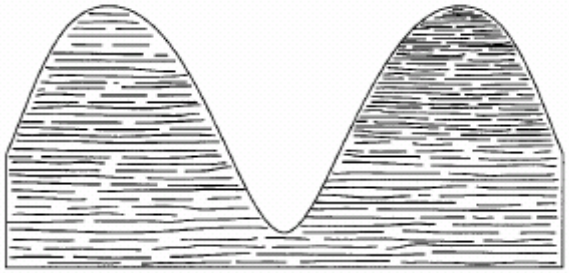
HSC Examination Paper Format

The examination is 3 hours plus 5 minutes reading time. All questions are compulsory. Make yourself familiar with this format and the timing that should allow for the formulation of optimum responses.

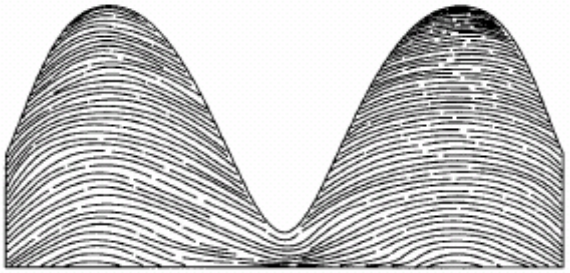
Sample Past questions and marking guidelines

The following are questions from the HSC Engineering Studies 2008 Examination paper. Questions 1 to 10 are multiple choice and are computer marked.

Deduce from the two microstructures what manufacturing processes were used to form thread shape *X* and thread shape *Y*.



X



Y

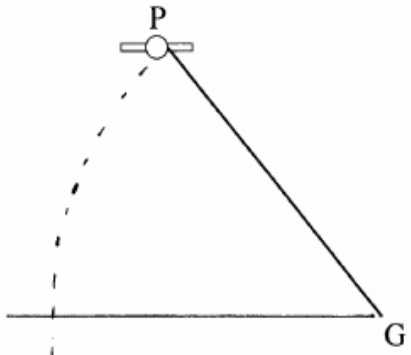
(A) *X* by cutting and *Y* by cutting

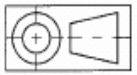
(B) *X* by rolling and *Y* by rolling

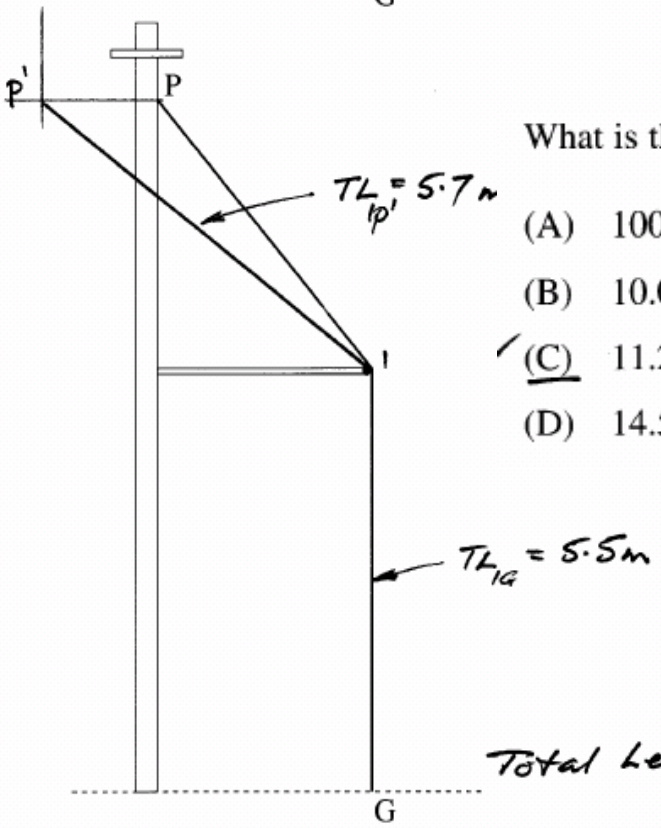
(C) *X* by cutting and *Y* by rolling

(D) *X* by rolling and *Y* by cutting

10 A pole is supported by a cable which joins point P to G. The drawing scale is 1:100.







What is the true length (TL) of cable PG?

(A) 100 mm

(B) 10.0 m

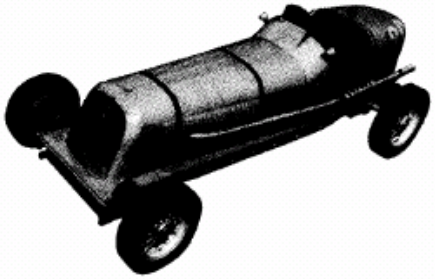
(C) 11.2 m

(D) 14.5 m

Total Length PG = 11.2m

estion 11 — Historical and Societal Influences, and the Scope of the Profession (10 marks)

An old and a new racing car are shown.



Car *X*

Car *Y*

(i) Describe TWO engineering innovations that have been applied in the design of the shape of Car *Y* that were not applied in Car *X*. **3**

1. Composite materials (carbon fibre) are readily formed into the aerodynamic body shape providing less air resistance.
2. Aerofoil (spoiler) at the rear of car Y provides down force to the car providing greater traction at high speeds.

Question 11 (a) (i)

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

MARKING GUIDELINES

Criteria Marks

- Describes TWO relevant innovations **3 marks**
- Describes ONE relevant innovation

OR

- Outlines TWO relevant innovations **2 marks**
- Identifies TWO relevant innovations **1 mark**

Sample answer/Answers could include:

Extensive use of wind tunnels to test aerodynamics allows fine tuning 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 (continued)

(ii) Name and describe a process used to join the body panels in car X.

Pop-Riveting. Two panels are over-lapped. Holes are drilled through the panels to suit the rivet size. Rivet is placed in the hole and set with a pop-rivet gun to hold the panels together.

Question 11 (a) ii
MARKING GUIDELINES
Criteria Marks
• Names and describes an appropriate process
2 marks
• Names OR describes an appropriate process
1 mark
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.

(c) Explain environmental issues that an engineer would need to consider in the design of a proposed new car race track.

The engineer must consider the impact on local flora and fauna from earthworks during building of the track. Some native animals may need to be relocated from any damaged habitat. Pollution from exhaust fumes and fuel/oil spills may also damage the environment if allowed to enter waterways or the habitat of sensitive animals once the track is opened.

Question 11 (c)
Outcomes assessed: H4.3

MARKING GUIDELINES

Criteria Marks

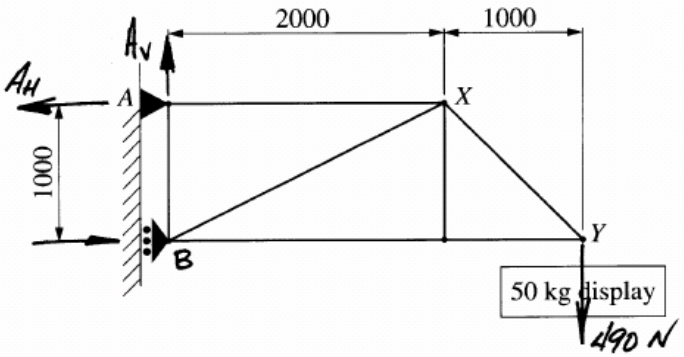
- Explains several environmental issues **3 marks**
- Explains ONE environmental issue OR
- Lists several issues without an explanation **2 marks**
- Lists ONE environmental issue **1 mark**

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 — Civil Structures (10 marks)

A truss, loaded as shown, is used to support a 50 kg electronic display.



(i) Calculate the horizontal and vertical reactions at the support *A*.

$+\uparrow \Sigma F_V = 0 = +A_V - 490$

$A_V = 490\ N \uparrow$

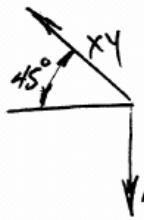
$\circlearrowleft \Sigma M_B = 0 = +(A_H \times 1) - (490 \times 3)$

$A_H = 1470\ N \leftarrow$

Horizontal reaction ..... 1470 ..... N ←

Vertical reaction ..... 490 ..... N ↑

(ii) Calculate the tensile force in member *XY*.



$+\uparrow \Sigma F_V = 0 = +XY\sin 45 - 490$

$XY = \frac{490}{\sin 45} = 693N$

Tensile force ..... 693 ..... N

Question 12 (a) (i)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria Marks

• Both reactions calculated correctly

2 marks

• Uses correct method but with minor error **1 mark**

when g= 10m/s². 1500 N 500 N

Question 12 (a) (ii)

Outcomes assessed: H3.1

MARKING GUIDELINES

Criteria Marks

• Calculates force in *XY* *correctly* ***2 marks***

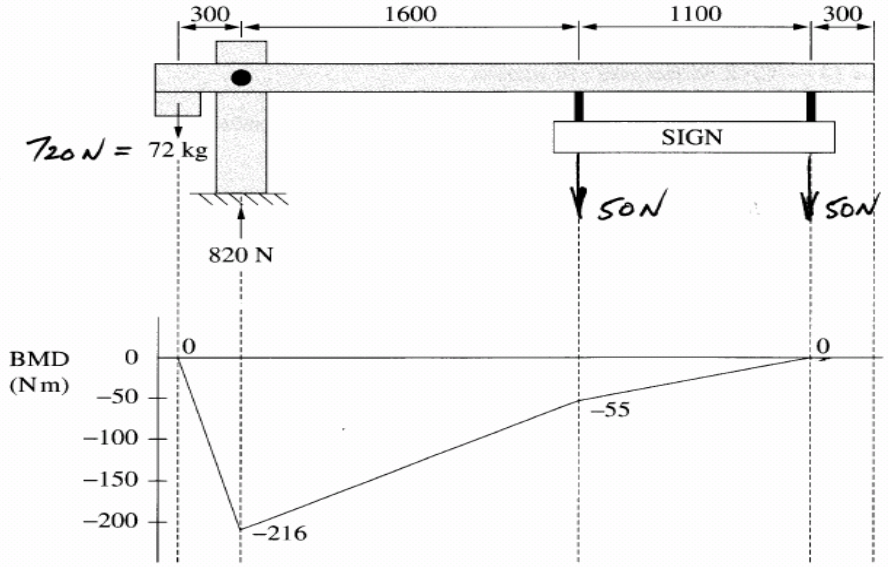
• Uses a correct method but with ONE error **1 mark**

NB method of sections could also be used

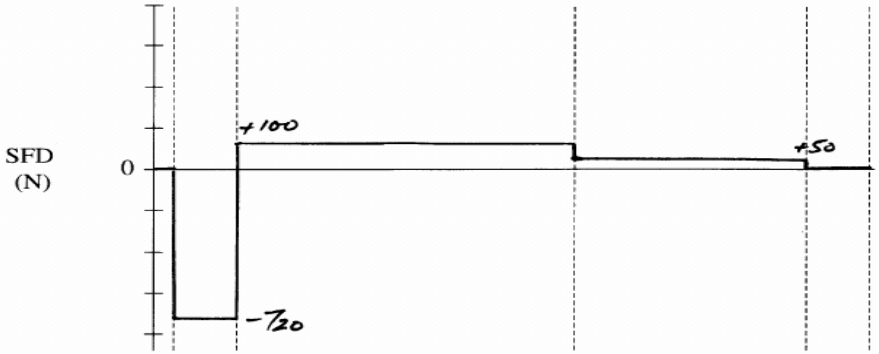
707N

Question 12 (continued)

(b) A boom gate at a car park supports a 10 kg sign. The bending moment diagram (BMD) for the boom gate in this situation is shown. The mass of the boom gate is not being considered.



(i) Draw the shear force diagram (SFD), on the axis provided, for the boom gate. Assume $g = 10\ \text{m s}^{-2}$.



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 marks**

• Uses suitable method but makes a minor error **1 mark**

Question 12 (continued)

(ii) The boom is made from a 100 mm square hollow section with a second moment of area of 1.55×10^{-6} m^4. 2

Calculate the maximum bending stress in the beam.

$I_{xx} = 1.55 \times 10^{-6}$ m^4

$y = 0.05$ m

$M = 216$ Nm

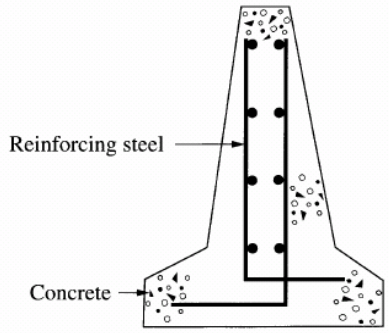
(taken from BMD on previous page)

$\sigma = \frac{My}{I_{xx}} = \frac{216 \times 0.05}{1.55 \times 10^{-6}}$

$= 6.97$ MPa

6.97 MPa

(c) The cross-section of a reinforced concrete crash barrier used to protect spectators is shown. 2



Explain how steel and concrete work together effectively in the crash barrier.

The combined properties of concrete & steel are required to effectively absorb the tensile and compressive loads that result from the impact of a crash. The steel absorbs the tensile forces while the concrete absorbs the compressive forces. The concrete also binds the steel and protects it from corrosion.

Question 12 (b) (ii)

Outcomes assessed: H3.1, H6.2

MARKING GUIDELINES

Criteria Marks

- Bending stress calculated correctly **2 marks**
- Uses a suitable method but makes minor error/s **1 mark**

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 marks**
- Explains only the steel or the concrete's effectiveness in the crash barrier

OR

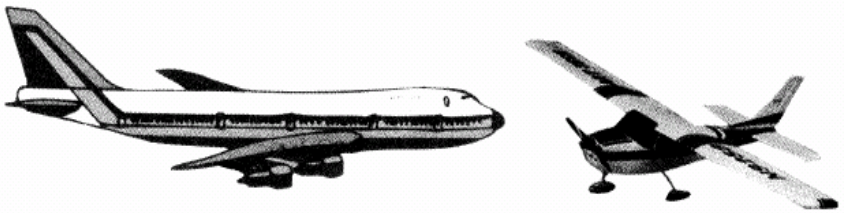
- States only properties of both steel and concrete not relating to crash barrier **1 mark**

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 15 — Aeronautical Engineering (15 marks)

(a) Both jet and piston engines can be used on aircraft. 2



Explain why these different engine types are suitable for the aircraft shown above.

Jet engines are suitable for heavy long-haul aircraft that cruise at high altitudes. They provide high thrust for heavy loads and high velocity flight. Piston engines are used for propeller driven light aircraft that need less thrust as they travel at lower velocities and at lower altitudes.

(b) Explain why metals are more susceptible to corrosion when used in aircraft. 2

Corrosion is increased due to both the enviroment that aircraft operate in - significant temperature variations including freezing, high air moisture and impacts - and the cyclic loading applied to the craft - causing stress zones that are more susceptible to corrosion.

Vibration may create movement and rubbing of component surfaces which may initiate a corrosion cell.

Question 15 (a)

Outcomes assessed: H1.2

MARKING GUIDELINES

Criteria Marks

• Explains why BOTH engine types are suitable **2 marks**

• Explains why ONE engine type is suitable

OR

• States a reason why BOTH engine types are suitable

1 mark

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

• Explains reasons for increased susceptibility to corrosion **2 marks**

• Lists ONE appropriate reason **1 mark**

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

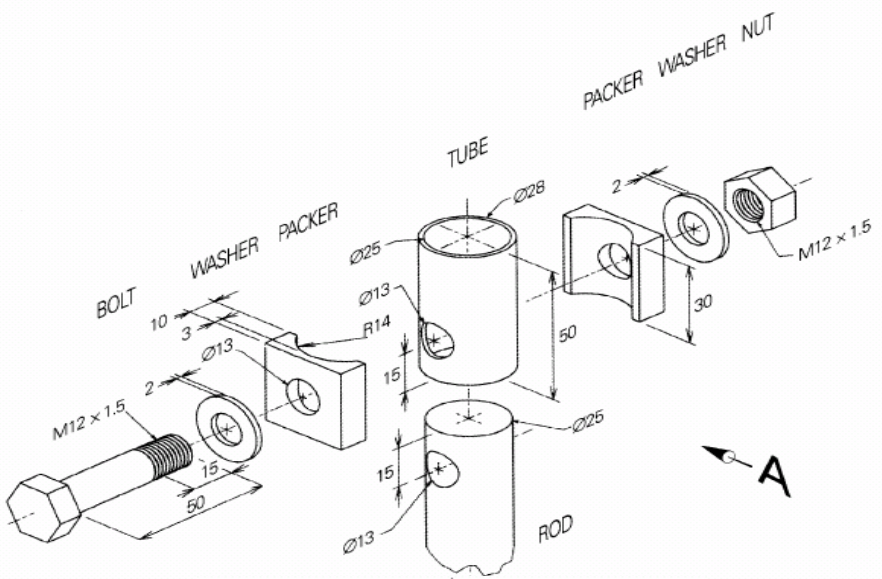
iii. Vibration in the aircraft causes minute movement that can remove any protective coating from the metal surface

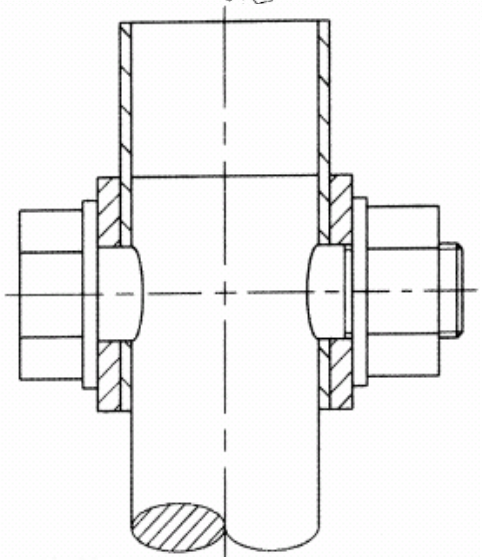
iv. Often different composition alloys are in contact with one another causing galvanic reactions

v. Aircraft components can be highly stressed which may lead to stress corrosion cracking

Question 16 (continued)

(d) On the vertical and horizontal axes provided, draw a fully assembled section view of the parts from direction A.





Question 16 (d)

Outcomes assessed: H3.2

MARKING GUIDELINES

Criteria Marks

- Provides correct assembly and proportion of components with correct standards **5 marks**
- Provides correct assembly and components with substantial proportion of components with correct standards **4 marks**
- Provides correct assembly and proportion of components with some correct standards **3 marks**
- Provides basic assembly and proportion of components **2 marks**
- Provides limited assembly and proportion of components **1 mark**

Helpful Hints

When attempting this examination students need to:

- Allocate time effectively thereby eliminating the risk of not completing the paper. The following timing for each section is suggested:

Section I: 20 minutes
Section II: 2 hours
Section III: 40 minutes

Use the five minutes reading time effectively

FORMULAE SHEET

Force, Moments

$F = ma; \quad M = Fd$

If a body is in equilibrium, then $\sum F_x = 0; \quad \sum F_y = 0; \quad \sum M = 0$

Friction

$F = \mu N; \quad \mu = \tan\phi$

Energy, Work, Power

$KE = \frac{1}{2}mv^2; \quad PE = mgh; \quad W = Fs = \Delta PE + \Delta KE; \quad P = \frac{W}{t}$

Pressure

$P = \frac{F}{A}; \quad P = P_o + \rho gh$

Stress and Strain

$\sigma = \frac{F}{A}; \quad \varepsilon = \frac{e}{L}; \quad E = \frac{\sigma}{\varepsilon}; \quad \sigma = \frac{My}{I}$

$\sigma_{\text{allowable}} = \frac{\sigma_{yield}}{F \text{ of } S}$ (Ductile); $\quad \sigma_{\text{allowable}} = \frac{\sigma_{UTS}}{F \text{ of } S}$ (Brittle)

Machines

$MA = \frac{L}{E}; \quad VR = \frac{d_E}{d_L}; \quad \eta = \frac{MA}{VR}$

- Use the formulae sheet attached to the back of the examination. It is recommended that you detach this page and refer to it as necessary during the examination. If you are not familiar with any of these formulae consult your teacher.

- Read all questions carefully, underlining the main ideas, words and numbers. Write legibly and check that your response addresses the question.

Common words used in past examinations include discuss, explain, describe, outline, identify, calculate, compare, sketch, draw and justify. Become familiar with the Glossary of key words at:

http://www.boardofstudies.nsw.edu.au/syllabus_hsc/glossary_keywords.html

- Use subject-specific terminology eg - good tensile strength, corrosion resistant, ductile etc. Avoid terms such as strong, tough, cheap.
- Label diagrams clearly.
- Set out mechanics solutions clearly starting with the formula and the necessary data. It may be necessary to rearrange the formula to make the missing value the subject. Marks are gained by sensible substitution into the correct formula leading to a solution. By showing all your workings, part marks may be gained for an incorrect answer.

- Assume gravity = 10 m/s^2. To calculate the force applied by a mass just multiply by 10.
- Use a graphical solution when solving questions involving concurrent forces as it is generally quicker to apply than an analytical response.
- Remember all drawings on the examination paper are to scale unless otherwise stated.
- Make sure the units are consistent eg if elongation is in millimetres and length in metres - one of these values needs to be converted so they both have the same units

- Use SI system of units
- Become familiar with the SI prefixes and engineering notations such as :
  $k = 10^3$, $M = 10^6$ and $G = 10^9$
- Look at the units supplied in the answer space to help determine the formula to be used if you are unsure.
- Develop an understanding about the structure, properties, uses and forming processes of various materials such as metals – ferrous and non ferrous, ceramics, polymers and composite materials.

- Know the difference between service and manufacturing properties of materials.
- Understand the roles of the various types of engineers. Be aware of the safety, environmental and legal and ethical issues that confront engineers and the effects of these issues on society.
- Know how to complete an orthogonal drawing, including the use of a sectional view. Be aware of AS1100 drawing standards that apply to threads, nuts and bolts.
- Know how to produce isometric and oblique pictorial drawings.

- Spend an appropriate amount of time on questions. DO NOT spend excessive time on questions that you are unsure of the correct answer. Make a note of the question number and move onto the next question. Come back to the question/s later if time permits.
- Respond to questions fully, for example, by providing two or more examples or reasons when a plural term is used in the question.

- Practise answering past HSC examination papers in order to become familiar with the format of the examination and build confidence in responding to a range of questions.
- Do not use liquid paper, draw one line through work that you believe to be erroneous, so it may still be read by the examiners.
- Request extra books if you do not have sufficient space to complete your answer.

Resources

HSC Online

http://www.hsc.csu.edu.au/engineering_studies

BOARD OF STUDIES

http://www.boardofstudies.nsw.edu.au/syllabus_hsc/engineering-studies.html

The Technology Unit of Curriculum K-12 Directorate

http://www.curriculumsupport.education.nsw.gov.au/secondary/technology/index.htm

Questions

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