BOARD OF STUDIES
NEW SOUTH WALES

2012 HSC Engineering Studies
'Sample Answers'

When examination committees develop questions for the examination, they may write 'sample answers' or, in the case of some questions, 'answers could include'. The committees do this to ensure that the questions will effectively assess students' knowledge and skills.

This material is also provided to the Supervisor of Marking, to give some guidance about the nature and scope of the responses the committee expected students would produce. How sample answers are used at marking centres varies. Sample answers may be used extensively and even modified at the marking centre OR they may be considered only briefly at the beginning of marking. In a few cases, the sample answers may not be used at all at marking.

The Board publishes this information to assist in understanding how the marking guidelines were implemented.

The 'sample answers' or similar advice contained in this document 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.

Section II

Question 11 (a)

Sample answer:

The pilot adjusted the rudder to turn the plane. By pulling on ropes the pilot twisted or warped the wings to bank the plane.

Question 11 (b)

Sample answer:

Aircraft frame materials changed from wood and fabric to lightweight materials such as aluminium alloys and carbon fibre. This reduced the weight of the plane but allowed an increase in the amount of cargo or the number of passengers that the plane could carry or allowed the plane to fly faster. Old piston-driven propeller engines have been replaced by jet engines that have more thrust and operate at higher altitudes, leading to higher velocities and an increase in range.

Question 11 (c)

Sample answer:

The engineer would, after testing and analysis, decide if the plane was considered safe to fly. The engineer would then continue to monitor the crack in the wing or propose and oversee repairs if the crack was likely to affect performance or safety. The engineer would also report the appearance of the crack in the plane so that other planes could be inspected for similar problems.

Question 11 (d)

Answers could include:

Increased traffic on the roads around the airport could be catered for by improving the local road system or introducing public transport options. Increased noise pollution could be minimised by constructing noise barriers around the runways similar to those used alongside major roads. The availability of the land needed for the airport expansion would concern the local community. An engineer could propose that land could be reclaimed, as they did in Botany Bay for the third runway at Sydney Airport.

Question 12 (a) (i)

Sample answer:

$$E = \frac{F\,L}{A\,e}$$

$$E = \frac{13 \times 10^{3} \times 0.12}{40 \times 10^{-6} \times 0.00019}$$

$E = 205 \times 10^{9}$ Pa

E = 205 GPa

Question 12 (a) (ii)

Sample answer:

$$UTS = \frac{Load}{Area}$$

$$UTS = \frac{18 \times 10^{3}}{40 \times 10^{-6}}$$

UTS = 450×10^{6} Pa

UTS = 450 MPa

Question 12 (b)

Sample answer:

Prestressed reinforced concrete would be suitable as concrete is strong when undergoing compression loading and the steel reinforcing would allow it to undergo tensile loading from passing traffic without failure.

Question 12 (c) (i)

Sample answer:

$\sum MH = 0$

$0 = (RBv \times 18) - (19 \times 15) - (11 \times 9) + (14 \times 5.2)$

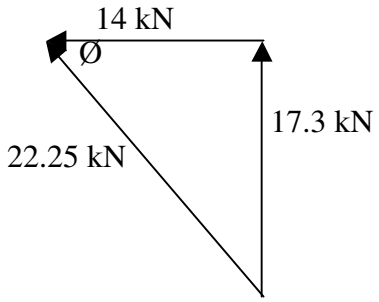
$18\ RBv = 311.2$

$RBv = 17.3\ kN \uparrow$

$\sum Hor = 0 + \rightarrow$

$0 = 14 - RBh$

$RBh = 14 kN \leftarrow$



$\tan Ø = \frac{17.3}{14}$

$Ø = 51°$

Question 12 (c) (ii)

Sample answer:

$\sum Md = 0$

$0 = -(19 \ x \ 3) + (17.3 \ x \ 6) + \ (5.2CE)$

$0 \ = -57 + 103.8 + 5.2CE$

$CE = 9kN$ in Compression

Question 12 (d)

Sample answer:

Composite	*Component*
Asphalt	Bitumen
	Aggregate
Reinforced Concrete	Cement
	Sand

Question 13 (a) (i)

Sample answer:

Loss in PE = Gain KE

$$mgh = \frac{1}{2}mv^2$$

$$v^2 = 2 \ gh$$

$$= 2 \times 10 \times 700 \sin 40$$

$$v = \sqrt{8999}$$

$$= 94.86 \text{ m/s}$$

$$= 341.5 \text{ km/h}$$

Question 13 (a) (ii) 1

Sample answer:

$$P = \frac{\text{work}}{\text{time}} = \frac{\Delta KE}{\text{time}}$$

$$= \frac{\frac{1}{2}4000 \times 16.66^2}{45}$$

$$= 12.345 \ kW$$

Question 13 (a) (ii) 2

Sample answer:

$$\text{Work done} = F.s = DKE$$

$$s = \frac{\frac{1}{2}4000 \times 16.66^2}{12 \times 10^3}$$

$$= 46.2 \text{ m}$$

Question 13 (b) (i)

Answers could include:

Laminated glass
Increased strength
Better visibility for driver
Aerodynamics

Question 13 (b) (ii)

Sample answer:

Laminations prevent the glass from completely shattering into pieces on impact. Each layer shatters individually, keeping the glass panel intact. This is more suitable than tempered glass which will shatter on impact and sheet glass which breaks into large sharp pieces.

Question 13 (c)

Answers could include:

- High starting torque
- Ability to run directly off the battery without the need for additional electronics

Question 14 (a)

Answers could include:

While the hydraulic elevator uses compressed fluids and a ram in compression to push the lift, the cable elevator uses motors to pull the lift with tensioned cables. The hydraulic system must provide power to lift the entire mass from underneath, while the cable elevator uses a counterweight to lower the energy used by the motor. Hydraulic elevators are limited by the length of the ram whereas cable elevators can operate over a larger range of heights and are used in taller buildings.

Question 14 (b) (i)

Sample answer:

$$\sum V = 0$$
$$3T = 22440$$
$$T = 7480N$$

$$A = \frac{\pi d^2}{4}$$
$$= \frac{\pi 30^2}{4}$$
$$= 706.9 \text{ mm}^2$$

$$\sigma = \frac{E}{A}$$
$$= \frac{7480}{706.9}$$
$$= 10.6 \, MPa$$
$$F \text{ of } S = \frac{\text{yield stress}}{\text{allowable stress}} = \frac{200}{10.6} = 18.8$$

Question 14 (b) (ii)

Sample answer:

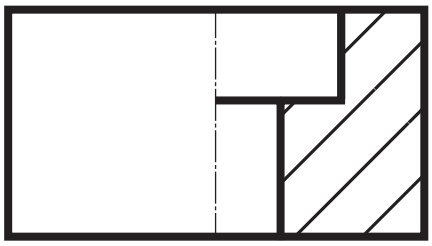
$$E = \frac{\delta}{\varepsilon}$$
$$210 \times 10^9 = \frac{10.6 \times 10^6}{\varepsilon}$$
$$\varepsilon = 0.000050$$
$$\frac{\Delta l}{lo} = 0.000050$$
$$\Delta l = 0.000050 \times 19$$
$$\Delta l = 0.000958 \text{ m}$$
$$\Delta l = 0.96 \text{ mm}$$

OR

$$e = \frac{FL}{EA}$$
$$= \frac{7480 \times 19}{210 \times 10^9 \times 706.9 \times 10^{-6}}$$
$$= 0.96 \times 10^3 \text{ m}$$
$$\text{e} = 0.96 \text{ mm}$$

Question 14 (c)

Sample answer:



Front View

Question 15 (a)

Sample answer:

Glider wings have very high aspect ratios (span is very long compared to width).
Drag created during the production of lift (induced drag) can account for a significant portion of the total drag. One way to increase the efficiency of a wing is to increase the aspect ratio. Glider wings are very long and slender, which makes them efficient. They produce less drag for the amount of lift they generate.

Question 15 (b)

Sample answer:

(i) Ailerons: operate in opposite directions on trailing edge of wing to control primary direction of plane by creating rolling movement about long axis.

(ii) Elevator: moveable horizontal stabiliser on tail. It is used to control pitching movement allowing the pilot to point the nose of the plane up and down.

(iii) Rudder: moveable vertical stabiliser on the tail. It is used to control yawing movement allowing the pilot to point the nose left or right. Also used to maintain nose altitude during a turn.

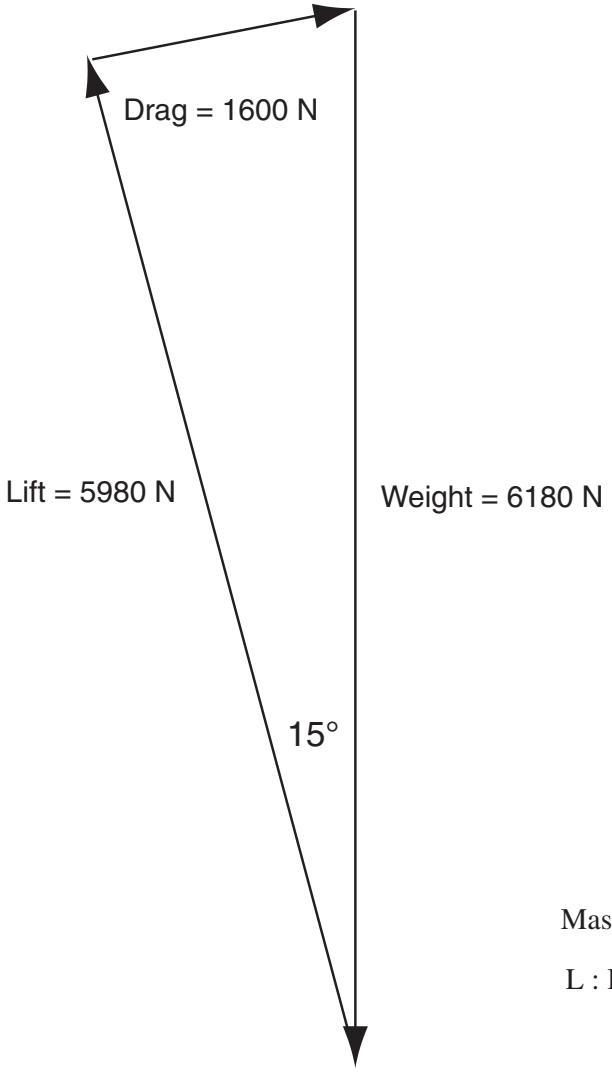
Question 15 (c)

Sample answer:

Chopped strand or woven fabric (fibres) are formed in a mould which has a release agent to prevent sticking during hand lay-up. A gel coat is added to the mould to produce a smooth surface. A liquid thermosetting resin is then mixed with a catalyst (or hardener) and applied with a brush. A roller is applied to the composite to blend resin and fibres and force out any air bubbles.

Question 15 (d)

Sample answer:



Graphical Solution
Scale: 1 cm = 400 N

$$\frac{\text{Lift}}{\text{Drag}} = \frac{5980}{1600}$$

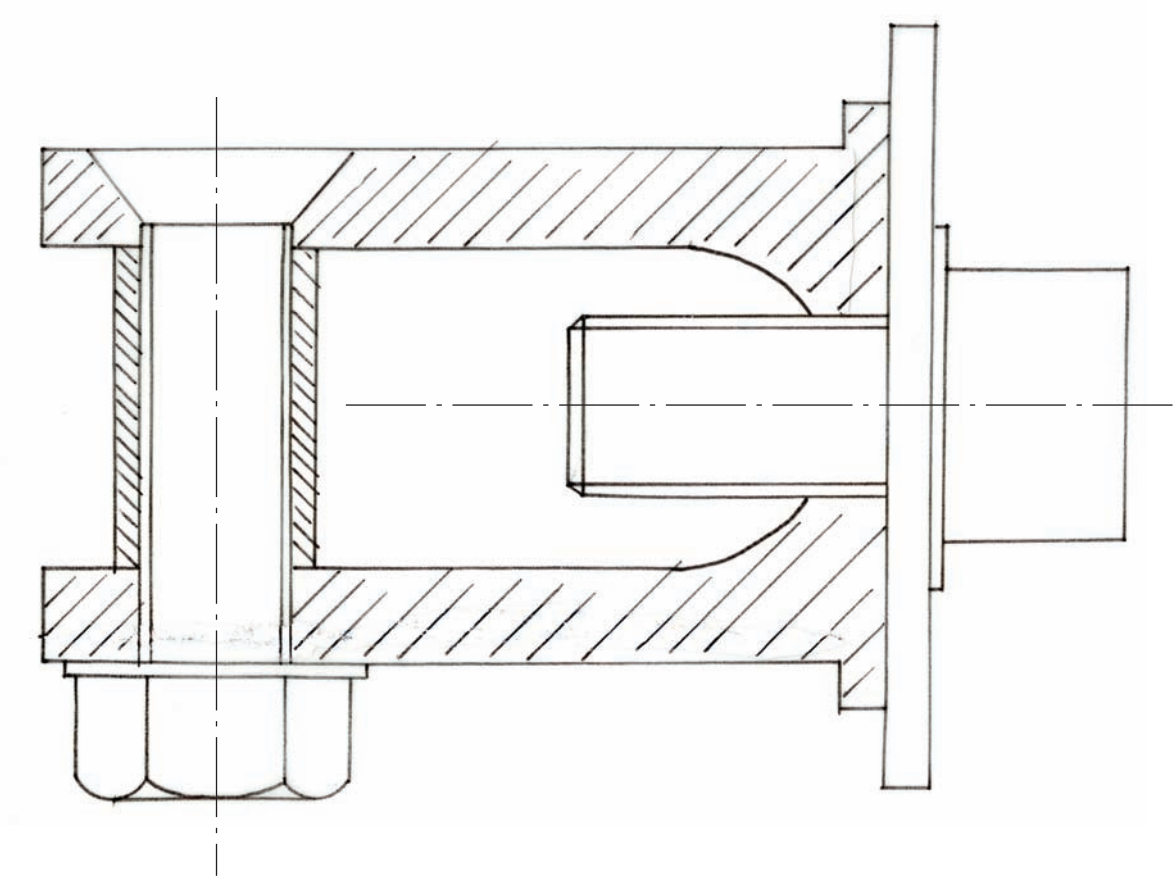
$$= 3.73$$

Mass ..... 535.2 ..... kg

L : D ratio ..... 3.7 : 1 .....

Question 15 (e)

Sample answer:



Question 16 (a)

Sample answer:

The complexity of components has increased as their physical size has decreased. This has led to faster circuits with greater capacity.

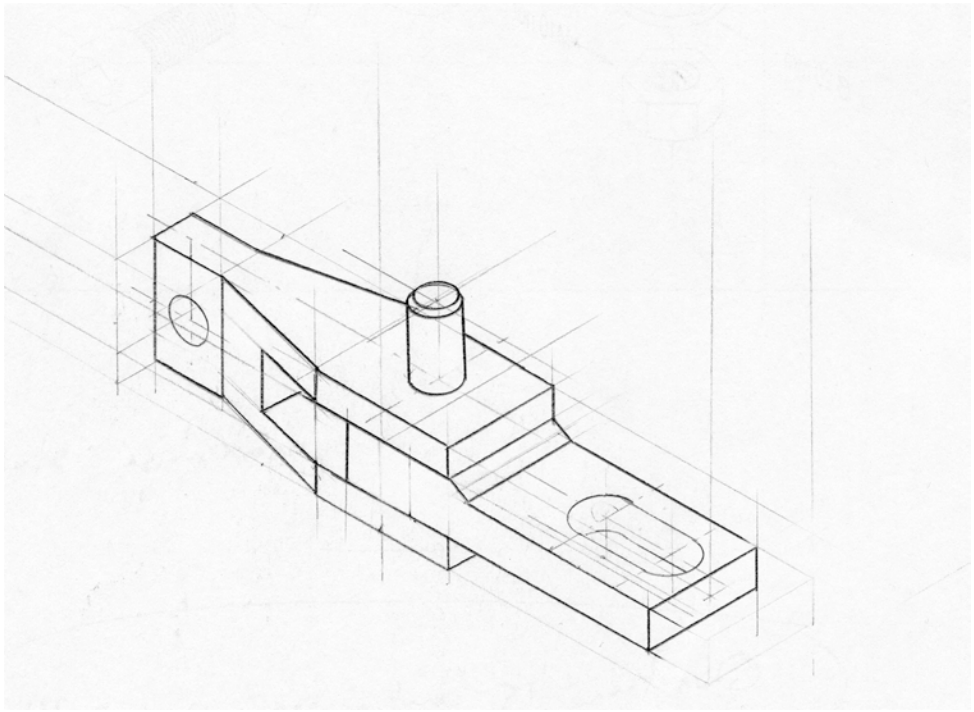
Question 16 (b)

Sample answer:

Polyvinylchloride (PVC) is extruded over the wire by forcing the viscous polymer through a die with the copper wire.

Question 16 (c)

Sample answer:



Question 16 (d) (i)

Sample answer:

The purpose of demodulation in a radio system is to remove the carrier wave, leaving only the information signal.

Question 16 (d) (ii)

Sample answer:

The diode and the 100 pf capacitor act as the demodulating stage. The diode allows current to flow in one direction only, while the 100 pf capacitor acts as a filter for the signal.

Question 16 (d) (iii)

Sample answer:

The coil and variable capacitor form a tuned circuit. The ‘tuned’ frequency is that of the carrier. This part of the circuit allows the user to ‘tune-in’ the carrier.

Section III

Question 17 (a)

Answers could include:

Factors included may be: environmental effects, structural considerations due to the height and span, access for construction and the wind loads to which it is subjected.

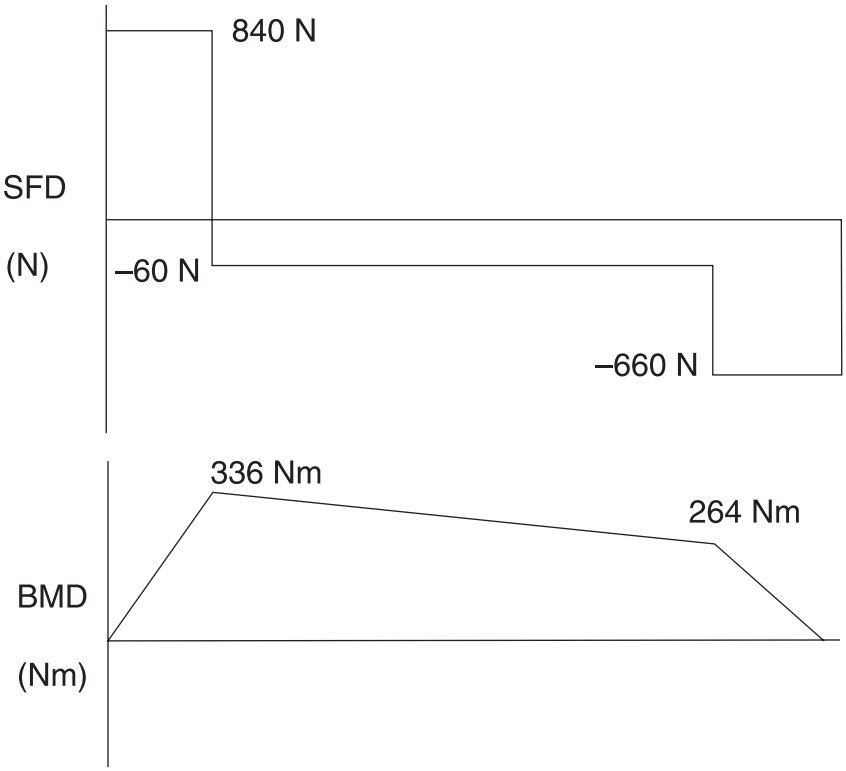
Question 17 (b)

Sample answer:

The flanges allow the circular members of the walkway's sections to be joined together.

Question 17 (c) (i)

Sample answer:



Question 17 (c) (ii)

Sample answer:

The straight angled line of the current bending moment diagram will be replaced with curved (parabolic lines).

Question 17 (c) (iii)

Sample answer:

$$\sigma_b = \frac{My}{I}$$

M=336 Nm
y=0.075 m
$I=14\times10^{-6}$ m^4

$$\sigma_b = \frac{336 \times 0.075}{14 \times 10^{-6}}$$

$$\sigma_b = 1{,}800{,}000 \text{ Pa}$$

$$\sigma_b = 1.8 \text{ MPa}$$

Question 17 (d)

Sample answer:

Hot dip galvanising applies a zinc coating that is strong and durable. It also has the advantage that if chipped or damaged the zinc will corrode preferentially over the steel, hence providing sacrificial protection.

Question 18 (a)

Sample answer:

Engineering reports should provide a clear, concise and objective outline of facts. They can include, for example analysis of existing situations, original research, relevant calculations, the result of investigative studies or the solution to a design problem.

They should be written for the quick, unambiguous and easy communication of information to a selective readership.

Question 18 (b)

Sample answer:

IP rights provide an individual with exclusive legal right to take advantage of their IP and help them prevent others infringing it. There are different types of IP in Australia relevant to engineers, each with its own legislation:

- Patents – for new or improved products or processes
- Trademarks – for letters, words, phrases, sounds, smells, shapes, logos, pictures, aspects of packaging or a combination of these, to distinguish the goods and services of one trader from those of another
- Designs – for the shape or appearance of manufactured goods
- Copyright – for original material in literary, artistic, dramatic or musical works, films, broadcasts, multimedia and computer programs
- Circuit layout rights – for the three-dimensional configuration of electronic circuits in integrated circuit products or layout designs
- Confidentiality/trade secrets – including know-how and other confidential or proprietary information.

Question 18 (c) (i)

Sample answer:

Silicon/copper/magnesium/zinc

Question 18 (c) (ii)

Sample answer:

Reasons include:

- weight (compared to steel)
- strength
- improved fatigue behaviour at high temperatures
- relative ductility
- low maintenance expense
- high thermal conductivity.

Question 18 (d)

Sample answer:

$F = 2 \times 0.4 \times 3$
2.4 kN

$T = 2400 \times 0.16 = 384$ Nm