BOARD OF STUDIES
NEW SOUTH WALES

2011 Engineering Studies HSC Examination '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) (i)

Sample answer:

Innovations between the two bikes could include the use of aluminium alloy in the frame and the use of rubber in the tyres.

Answers could include:

Innovations could include:

- frame
  - material
  - shape (aerodynamic)
  - manufacturing methods
  - shape
- tyres
  - pneumatic
  - solid
- seat
  - material
  - shape
  - position.

Question 11 (a) (ii)

Sample answer:

One feature developed between the two bikes could be the improvement in gearing.
The penny-farthing had a large drive wheel which allowed little torque but high speed.
The more modern bike uses gears to extend torque when needed at low speed but, with the gears, the ratio of effort and load may vary for the most efficient means of propulsion.

Answers could include:

- gears
- chains or belts
- brakes in the penny farthing may have been a block of wood rubbing on the rim
  - modern bikes have caliper or disk brakes.

Question 11 (a) (iii)

Sample answer:

Production engineering – mass production, interchangeability of parts, assembly lines, robotics, specialisation of labour, quality control and tolerances.

Question 11 (b)

Sample answer:

Using bikes instead of motorised forms of transport would result in less air pollution. However, people's transport times would increase significantly, especially over long distances. A second environmental issue could be road congestion. With bikes, roads would/could become less congested, but mass transport of people may not be viable.

Answers could include:

- pollution – air
- road congestion – cars/buses/trains
- mass transport
- cost-effective transport
- need to travel long distances to get to work.

Question 11 (c)

Sample answer:

A project studied in Engineering Studies was the development of space travel. An ethical issue arose regarding the amount of money spent on the development of materials used in space. It could be argued that, without the spending on space materials, the modern materials would not have been developed. On the other hand, all the billions spent on space-age materials could have been spent improving the population's general standard of living.

Answers could include:

Selection of an ethical issue from a project studied in class or a situation detailed by the student, such as the release of water from dams driving recent floods.

Question 12 (a) (i)

Sample answer:

Walls pre-fabricated off site improve the speed at which industrial buildings can be constructed on site.

Answers could include:

- quality control
- reduced cost
- improved safety
- reduced construction traffic on site.

Question 12 (a) (ii)

Sample answer:

Name: compression test
Description: a standard-size, cylindrical sample of cured concrete is compressed until failure to determine its ultimate compressive strength. The sample is passed if it meets the design requirements.

Answers could include:

Candidates can also describe the compression testing process up to design requirements, rather than destructive testing.

Testing is carried out at 7 days, 14 days and 28 days.

Note: The slump test is not a viable answer.

Question 12 (b)

Sample answer:

Thermal toughening or tempering involves heating the glass until soft, then cooling the surface of the glass rapidly – using air blasts.

The surface of the glass cools quickly then, as the centre of the glass cools, it draws the outer surface into compression. This compression stress has to be overcome before the toughened glass fractures.

Application to building:
In comparison to ordinary glass, toughened glass has a higher resistant to applied loads and impact forces. It is safer to transport and install, and is less dangerous if failure occurs.

Question 12 (c) (i)

Sample answer:

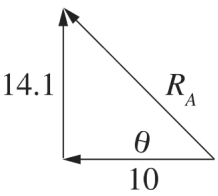
$$\overset{\curvearrowright}{+}\sum M_B = 0$$

$$\left(R_{AV} \times 16\right) - \left(15 \times 12\right) - \left(15 \times 4\right) + \left(10 \times 1.45\right) = 0$$

$$R_{AV} = \frac{180 + 60 - 14.5}{16} = \frac{225.5}{16} = 14.1 \text{ kN} \uparrow$$

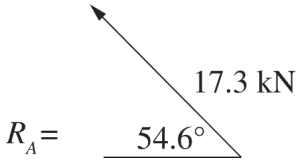
$$\overset{+}{\rightarrow}\sum H = 0$$

$$-R_{AH} + 5 + 5 = 0 \qquad \therefore R_{AH} = 10 \text{ kN} \leftarrow$$



$$R_A = \sqrt{(14.1)^2 + 10^2} = 17.3 \text{ kN}$$

$$\tan\theta = \frac{14.1}{10} \qquad \therefore \theta = \tan^{-1} = 54.6°$$



Question 12 (c) (ii)

Sample answer:

$$\rightarrow \sum M_A = 0$$
$$(15 \times 4) + (5 \times 1.45) + (\times \sin 20 \times 8) = 0$$
$$\therefore \times = \frac{-60 - 7.25}{8 \sin 20} = \frac{-67.25}{2.74} = -24.6 \text{ kN}$$
$$\times = 24.6 \text{ kN}$$
Compression

Question 13 (a) (i)

Sample answer:

$$\sum M = 0$$
$$(700 \cos 30 \times 250) - (T \times 120) = 0$$
$$T = 1262.9 \text{ N}$$
OR
1.263 kN

Question 13 (a) (ii)

Sample answer:

$$VR = \frac{250 \times 80}{120 \times 600}$$
$$= 0.28$$

Question 13 (b)

Sample answer:

Forging – where hot metal is forced into shape.

Note: other answers could include:

Casting – description of casting using a metal mould.

Die casting – liquid metal forced into a metal die, cooled and ejected.

Question 13 (c)

Answers could include:

DC motor – easy to control, high starting torque.

AC motor – small, relatively inexpensive, low maintenance.

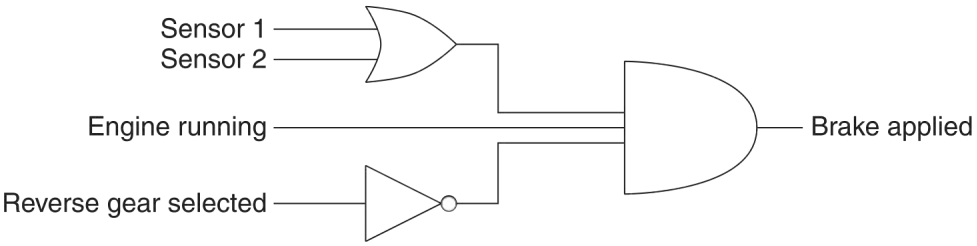
Question 13 (d)

Sample answer:

Vulcanisation is a process that, when applied to a rubber, causes controlled cross linking between the molecular chain, using sulphur as the link. The properties of hardness and toughness increase while elasticity decreases.

Question 14 (a)

Sample answer:



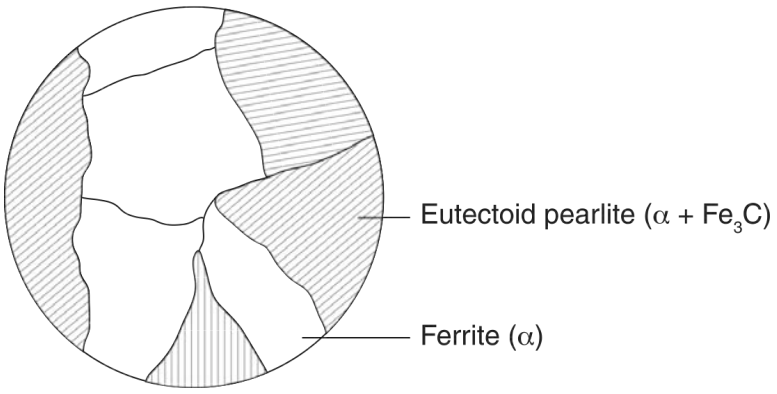
Question 14 (b)

Sample answer:

$$L = \frac{900 \times 1250}{950 \times 1.3} = 910\text{kg}$$

Question 14 (c) (i)

Sample answer:



Question 14 (c) (ii)

Sample answer:

$\overset{+}{\rightarrow}\sum M_{RL} = 0$

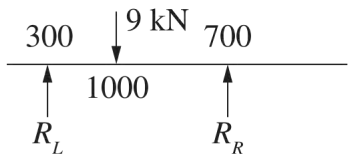
$(9 \times .3) - (R_R \times 1) = 0$

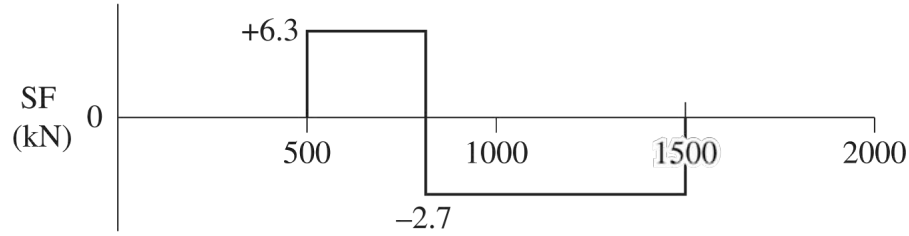
$\therefore R_R = 2.7 \text{ kN} \uparrow$

$+ \uparrow \sum V = 0$

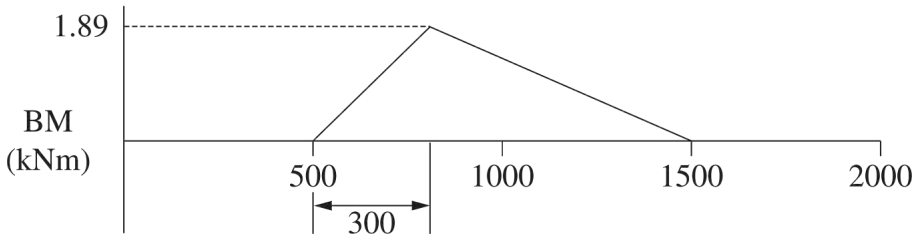
$R_L - 9 + 2.7 = 0$

$R_L = 6.3 \text{ kN} \uparrow$





Max BM at 800; 6.3 × .3 = 1.89 kN m



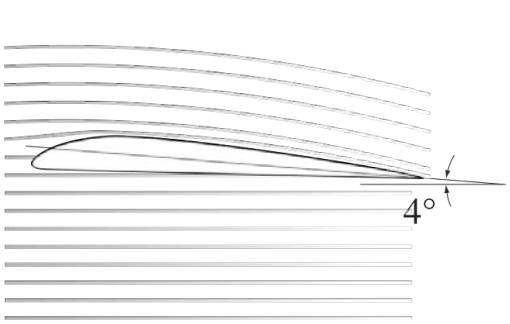
Question 14 (d)

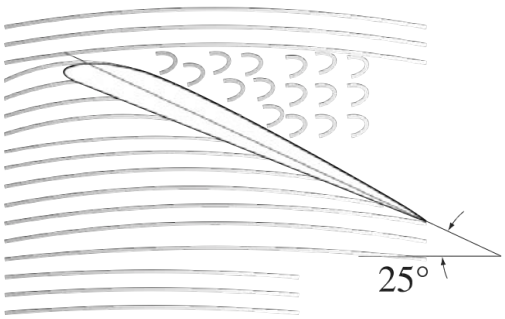
Sample answer:

The process can be controlled to leave open pores in the structure of the bearing. These voids can be filled with lubricant.

Question 15 (a) (i)

Sample answer:





Question 15 (a) (ii)

Sample answer:

As the aircraft is banking at 30°, the lift-force vector becomes split into vertical and horizontal components. If the lift-force magnitude remains the same, the force lifting the plane in the vertical direction will decrease and the plane will lose altitude.

Note: Candidates may include a mathematical explanation, such as

Lv = Lcos 30° ∴ lift in the vertical direction is reduced and the plane loses altitude.

Question 15 (b)

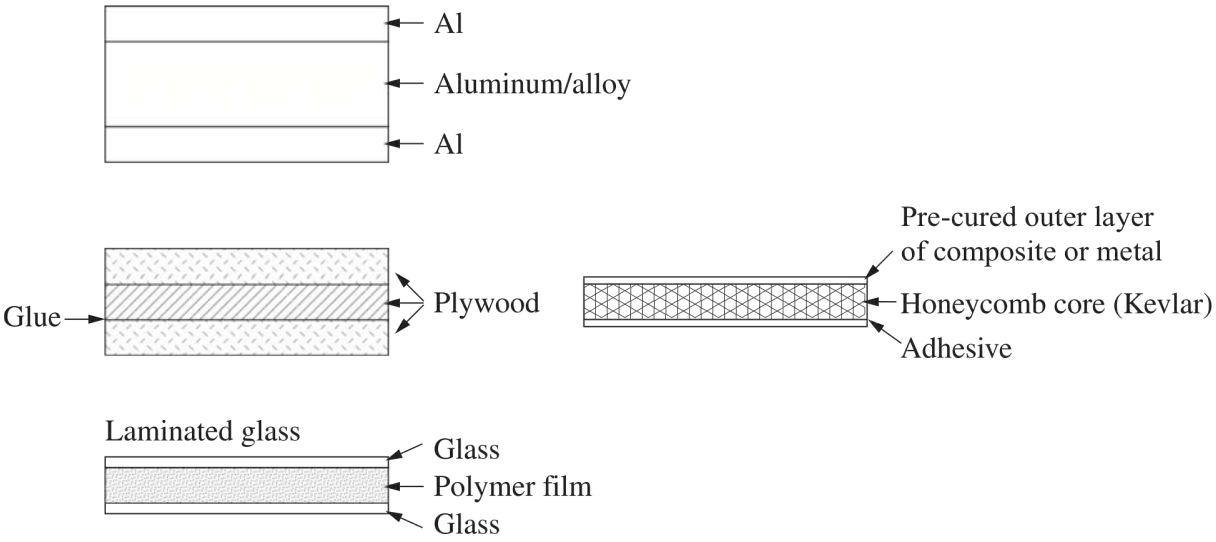
Sample answer:

An altimeter works on the principle of having a flexible diaphragm (aneroid) surrounded by static air pressure. With altitude, the diaphragm expands and movement is indicated by a gear system on a read out (dial).

Question 15 (c) (i)

Answers could include:

- epoxy resin and carbon fibre
- polyester resin and glass fibre
- glass laminate aluminium reinforced epoxy, eg GLARE
- pure aluminium pressure welded to the surface of alloy aluminium, eg Alclad
- laminated glass – two layers of glass with a polymer sheet between them
- plywood.



Question 15 (c) (ii)

Sample answer:

Properties that are enhanced by creating a laminate could be rigidity, corrosion resistance, appearance, strength and hardness. The corrosion resistance is enhanced by placing a more highly resistant material, eg stainless steel, over a core of less resistant material, such as low-C steel. Another enhancement could be pure Al on a core of Al alloy. The pure Al has a higher corrosion resistance than the alloy, enhancing the laminate of Al to Al (Alclad) alloy.

Answers could include:

- flexibility
- corrosion resistance
- rigidity
- strength
- appearance
- hardness
- higher temperature resistance
- toughness
- tailored directional properties
- fatigue resistance
- dimensional stability
- durability.

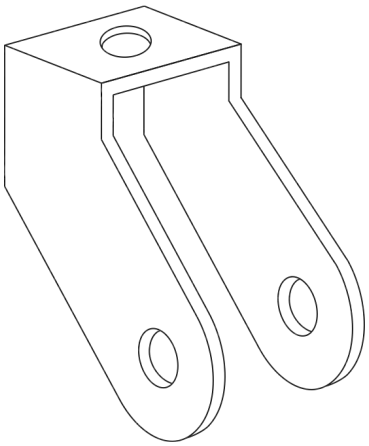
Question 15 (d)

Answers could include:

- X-ray inspection
- nuclear inspection
- ultrasonic test
- magnetic particle test.

Question 15 (e)

Sample answer:



Question 16 (a)

Sample answer:

Geostationary orbit is where a satellite is always over the same point of the earth. It is also known as a synchronous orbit. The orbit altitude is 35785 km and is over the equator.

Asynchronous orbit is where a satellite orbits the earth at a much lower altitude than a geostationary orbit. A satellite in this type of orbit passes over parts of the earth at varying times.

Polar orbit is where a satellite passes over the poles of the earth. This orbit is also at an altitude less than the geostationary orbit.

Question 16 (b)

Sample answer:

(a) Frequency division multiplexing is where specific frequency bands are allocated to a user.

(b) Time division multiplexing is where a user is allocated specific times for the transmission of data.

Question 16 (c)

Sample answer:

This early material allowed complex shapes to be produced. Mass production allowed cost reduction. Bakelite remained stable when exposed to the heat of the valves.

Thermal and electrical insulation is a characteristic of Bakelite.

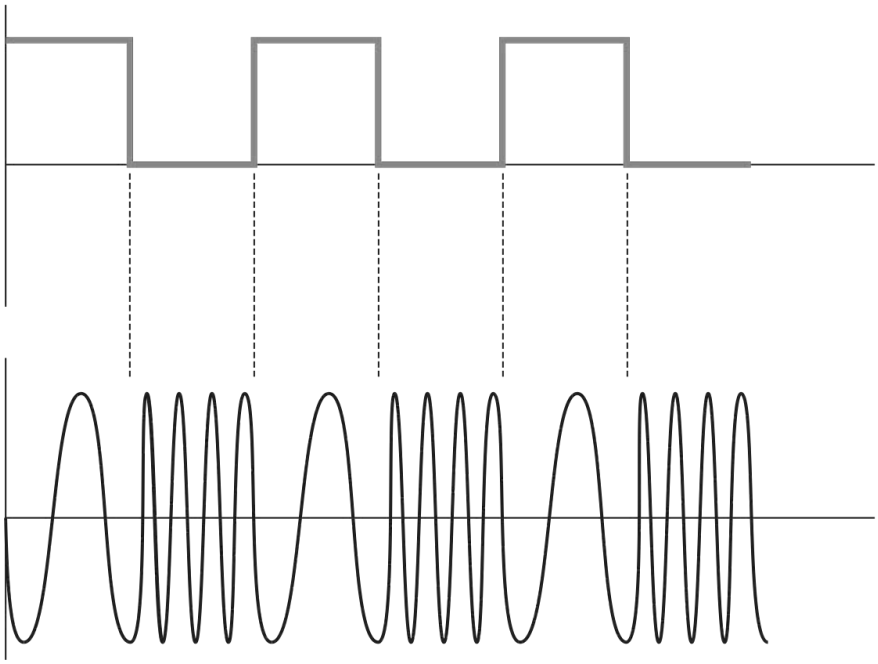
Question 16 (d) (i)

Sample answer:

An advantage of FM over AM for radio transmission is its immunity to electrical noise. Most noise affects the amplitude of a signal. As the information in FM is contained in the frequency, it is far less susceptible to interference than AM, where the information is contained in the amplitude.

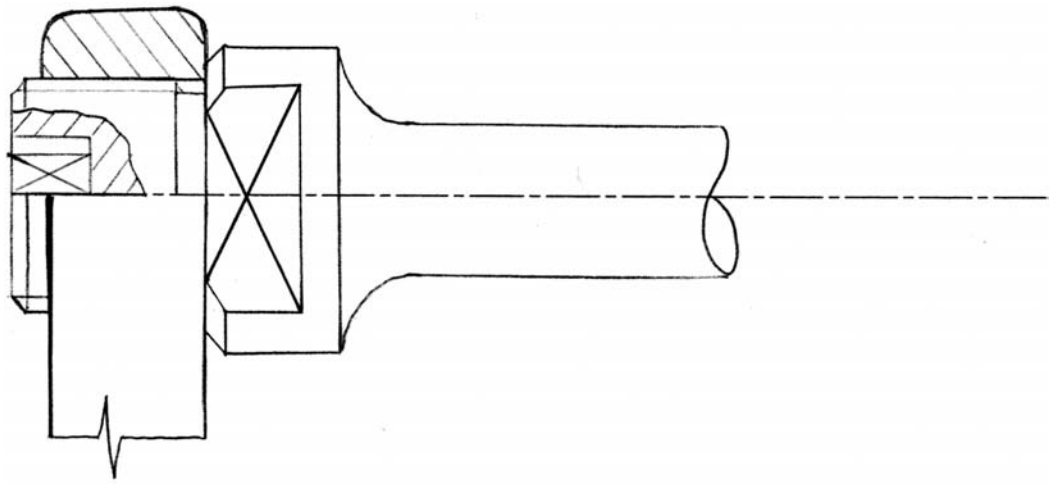
Question 16 (d) (ii)

Sample answer:



Question 16 (e)

Sample answer:



Question 17 (a) (i)

Sample answer:

Any conclusions drawn in the engineering report MUST be backed by evidence and conform to accepted practice. This needs to be substantiated by referring to identified standards texts.

Question 17 (a) (ii)

Answers could include:

Design	Social	Environmental
• ease of manufacture • maintenance • corrosion resistance • general finish • storage	• ease of use • safety • ergonomics • ethical concerns • anti-social behaviour	• sustainability • recyclability of material • design for life cycle

Question 17 (a) (iii)

Sample answer:

Tests that could be used:

- crash test
- stability test
- durability test
- safety test
- load test
- tensile test
- Izod test.

Note: include a description and some relevant reason why each chosen test is suitable.

Question 17 (b) (i)

Sample answer:

$$P = \frac{115 \times 10 \times 9}{25}$$
$$= 414 \text{ Watts}$$

Question 17 (b) (ii)

Sample answer:

$P = 240 \times 3 = 720$ W

Actual power produced is 720 W

$$\text{Loss} = \frac{720 - 620}{720} \times 100 = 13.9\%$$

Question 18 (a)

Sample answer:

Increased access to telecommunications has led to faster access to information that enables improved work productivity. One disadvantage of faster and more extensive communication networks is the reduction in privacy.

Answers could include:

- access for information
- quality of communication
- privacy issues
- energy consumption
- the information age
- speed of communication.

Note: Each could be discussed as an advantage or disadvantage.

Question 18 (b) (i)

Sample answer:

Optical fibre allows increased bandwidth of transmission, enabling more information transfer than copper wire. Optical fibre also resists corrosion, leading to greatly reduced maintenance over copper wire.

Answers could include:

Describe the advantages of optical fibre in relation to:

- bandwidth
- power consumption
- corrosion resistance
- raw material availability (ie limited copper resources).

Question 18 (b) (ii)

Sample answer:

Steel strands: carry the tension force of the cable, preventing excessive strain on the optical fibres.

Outer sheath: prevents water penetrating the cable, limiting corrosion in the steel cables.

Answers could include:

Steel cable:

- details on tension loads
- resistance to bending
- impact resistance.

Outer sheath:

- corrosion protection
- binding of steel cabling, etc.

Question 18 (b) (iii)

Sample answer:

$$I = \frac{16 \times 1000}{800} = 20 \text{ mA}$$

Question 18 (c)

Sample answer:

$$SL = \frac{PL}{EA} = \frac{300 \times 8}{111 \times 10^9 \times 0.5 \times 10^{-6}} = \frac{300 \times 8}{111 \times 10^3 \times 0.5}$$

$$= \frac{2400}{0.5 \times 111 \times 10^3} = 43.2 \text{ mm}$$