

2015 HSC Engineering Studies Marking Guidelines

Section I

Multiple-choice Answer Key

Question	Answer
1	D
2	D
3	B
4	A
5	C
6	C
7	B
8	D
9	A
10	C
11	C
12	D
13	D
14	C
15	B
16	A
17	D
18	B
19	B
20	A

Section II

Question 21 (a)

Criteria	Marks
• Explain how TWO relevant modifications have improved safety	3
• Outlines TWO relevant modifications OR • Outlines a modification and its effect on improving safety	2
• Identifies a relevant feature	1

Sample answer:

Windscreen: laminated and toughened glass. Reduces the number of shards when broken.
Bumper bar: integrated into body front end. Increases crumple zone/absorbs more energy on impact.

Question 21 (b)

Criteria	Marks
• Provides an outline of the operation of the system with TWO advantages	4
• Provides an outline of the system with an advantage OR • Provides an outline of TWO advantages of a hydraulic system but a limited outline of the operation of the system	3
• Identifies features of the hydraulic system	2
• Identifies a feature of the hydraulic system	1

Sample answer:

The brake pedal and connecting rod push a piston applying pressure to the fluid in the master cylinder. This pressure in the hydraulic fluid transfers force to the brake pad via a piston at the calliper. The brake pads then apply pressure to the disc.

Advantages

- Less maintenance (fewer moving parts)
- Greater mechanical advantage
- Greater efficiency (direct transfer of force).

Question 21 (c) (i)

Criteria	Marks
• Calculates the force using a correct process	2
• Applies an appropriate method	1

Sample answer:

In A:

Pressure = Force/area

$$P = 50/100$$

$$P = 0.5 \text{ N/mm}^2$$

$$P = 0.5 \text{ MPa}$$

In B:

$$P = F/A$$

$$0.5 = F/700$$

$$F = 350\text{N}$$

Question 21 (c) (ii)

Criteria	Marks
• Calculates the distance using a correct process	2
• Applies an appropriate method	1

Sample answer:

The ratio of piston areas X:Y is 1:7

area \times distance (X) = area \times distance (Y)

$$\begin{aligned} \text{Distance Y} &= (60 \times 100)/700 \\ &= 8.57 \text{ mm} \end{aligned}$$

Question 22 (a)

Criteria	Marks
• Names components A and B and outlines the function of each component	4
• Names component(s) and/or outline(s) functions	2–3
• Identifies a component or a function	1

Sample answer:

Component A: Diode rectifies AC signal.

Component B: Capacitor filters out the carrier wave.

Question 22 (b)

Criteria	Marks
• Identifies features of semiconductors that influence the design	2
• Identifies a feature of semiconductors that influences the design	1

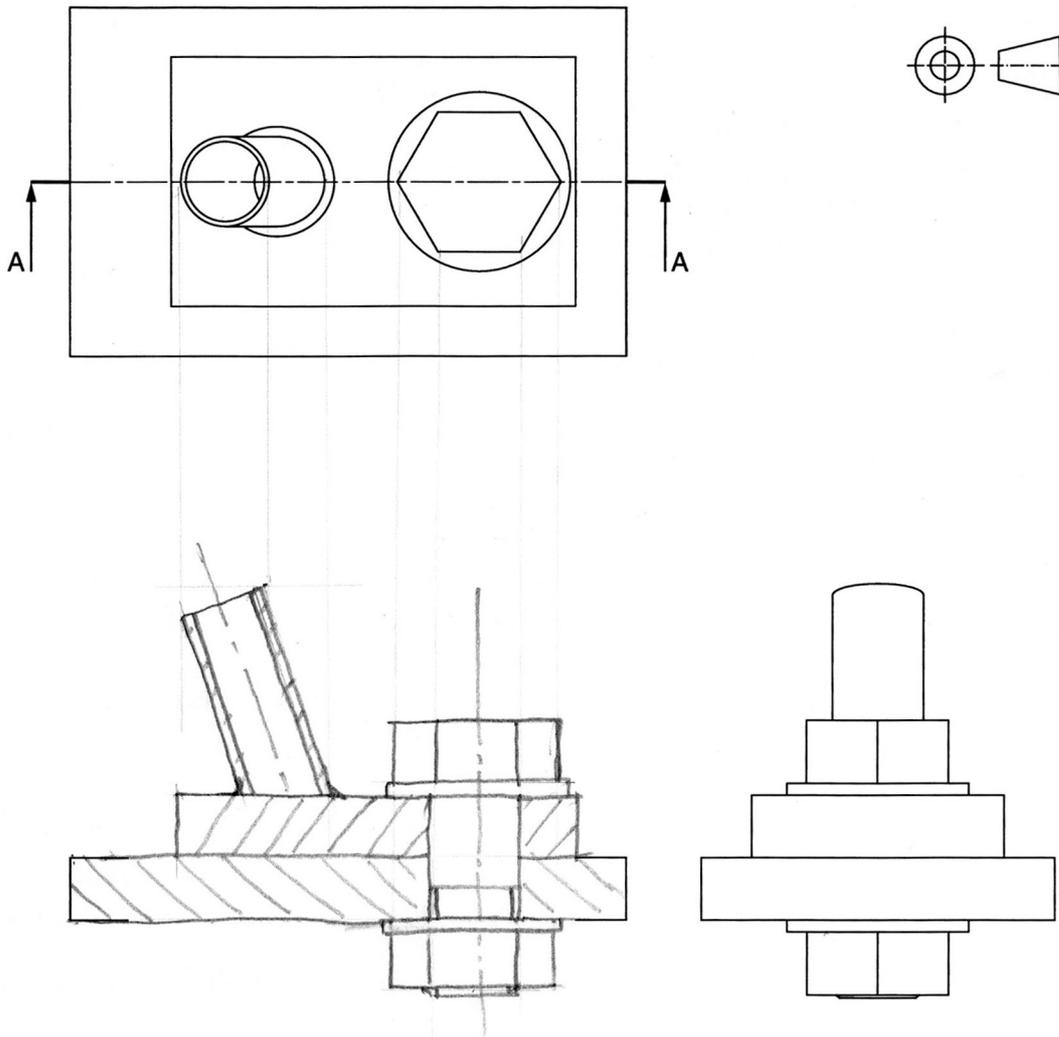
Sample answer:

The design of telecommunications products has been influenced through miniaturisation of components (smaller devices), using less power (more efficient), faster processing speeds, increased scale of integration, more robust construction and better in-service performance.

Question 22 (c)

Criteria	Marks
• Provides a projection with sectioning and applies AS1100 standards with no major errors	6
• Provides a projection with sectioning and demonstrates understanding of AS1100 standards	4-5
• Provides some correct projection from existing views with a significant component drawn to standard	2-3
• Provides some correct projection from existing views	1

Sample answer:



Question 23 (a) (i)

Criteria	Marks
• Lists two relevant properties	2
• Lists a relevant property	1

Sample answer:

- Corrosion resistant
- Ductile

Answers could include:

- Wear resistant

Question 23 (a) (ii)

Criteria	Marks
• Names and provides a description of a suitable manufacturing process	3
• Outlines a suitable manufacturing process OR	2
• Names and identifies a feature of a suitable manufacturing process	
• Identifies a feature of a suitable manufacturing process	1

Sample answer:

Injection moulding – polymer is liquefied and pumped under heat and pressure into a mould.

Question 23 (b)

Criteria	Marks
• Outlines the contrasting key features of fixed and mobile systems	3
• Outlines key features of fixed systems and/or mobile systems	2
• Identifies a feature of telephone systems	1

Sample answer:

Mobile systems use wireless communication towers and microwave technology; can be subject to dropout; can also be used in remote situations (rural, boats, planes).

Fixed systems use cable media; the signals experience minimal atmospheric interference; optical fibre in fixed systems provides greater bandwidth and security.

Question 23 (c)

Criteria	Marks
• Outlines the conversion process using sampling AND quantising	4
• Outlines features of the conversion process and/or sampling and/or quantising	2–3
• Identifies a feature of the conversion process	1

Sample answer:

An analogue signal is continuously variable and requires conversion to a range of set values to produce a digital signal using sampling and quantising. *Sampling* is taking a measurement at specified time intervals while *quantising* is assigning one of a set range of values at each time interval.

Question 24 (a) (i)

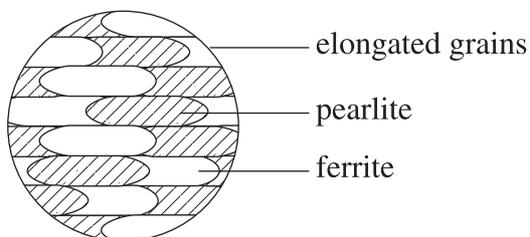
Criteria	Marks
• Provides a suitable corrosion protection method with relevant explanation	2
• Provides a corrosion protection method	1

Sample answer:

Coating with paint (or galvanising) prevents moisture and oxygen from contacting the surface, reducing oxidisation.

Question 24 (a) (ii)

Criteria	Marks
• Provides a sketch with correct grain structure, composition and appropriate labels	2
• Provides a sketch with an appropriate grain structure/composition	1

Sample answer:

Question 24 (b) (i)

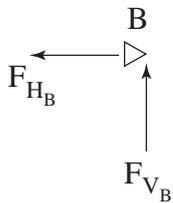
Criteria	Marks
• Determines the magnitude of the reaction using a correct process	2
• Applies an appropriate method	1

Sample answer:

$$\begin{aligned}\overset{+}{\Sigma}M_B = 0 &= (1200 \times 1.5) + (750 \times 4.5) - (A \times 1.5) \\ \therefore A &= \frac{5175}{1.5} \\ &= 3450 \text{ N}\end{aligned}$$

Question 24 (b) (ii)

Criteria	Marks
• Determines the magnitude and direction of the reaction using a correct process	3
• Determines a magnitude and/or direction of the reaction with minor errors	2
• Applies an appropriate method	1

Sample answer:

$$\uparrow \Sigma F_V = 0$$

$$R_{V_B} - 1200 - 750 = 0$$

$$\therefore R_{V_B} = 1950 \text{ N } \uparrow$$

$$\rightarrow \Sigma F_H = 0$$

$$3450 - R_{H_B} = 0$$

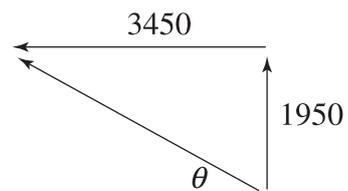
$$\therefore R_{H_B} = 3450 \text{ N}$$

$$R_B = \sqrt{(3450)^2 + (1950)^2} = 3963 \text{ N}$$

$$\tan \theta = \frac{1950}{3450}$$

$$\theta = \tan^{-1} 0.565$$

$$= 29.5^\circ$$



Reaction at B: 3963 N Direction 29.5°

Question 24 (b) (iii)

Criteria	Marks
• Determines the magnitude and nature of the force using a correct process	3
• Determines a magnitude and/or nature of the force with minor errors	2
• Applies an appropriate method	1

Sample answer:

Method of sections

$$(\oplus \Sigma M_E = 0 \quad \text{RHS})$$

$$(AC \sin 45 \times 3) + (1200 \times 3) = 0$$

$$\therefore AC = \frac{-1200}{\sin 45} = -1697 \text{ N}$$

\therefore AC in compression

Force in AC: 1697 N Nature: Compression

Question 25 (a)

Criteria	Marks
• Identifies TWO propulsion systems and provides a reason why each is appropriate	3
• Identifies a propulsion system and provides a valid explanation of why it is appropriate OR	2
• Identifies a suitable propulsion system for each aircraft	
• Identifies a relevant propulsion system	1

Sample answer:

Business aircraft has a jet engine, the recreational aircraft has a propeller driven piston engine.

Jet engines are more suited for business aircraft due to their greater speed and longer range. Propeller engines are more suited to recreational aircraft, as they need shorter runways, less sophisticated maintenance systems.

Question 25 (b)

Criteria	Marks
• Outlines TWO relevant adjustments that can be made to vary the lift force	3
• Outlines ONE relevant adjustment that can be made to vary the lift force OR • Identifies TWO relevant adjustments	2
• Shows a basic understanding of lift force	1

Sample answer:

Adjusting the angle of attack, which changes the amount of air a wing forces down. The maximum angle of attack is about 15° .

Adjusting the thrust (power) supplied by aeroplane engines directly changes the amount of air a wing forces down. An increase in power increases lift but requires an adjustment to the angle of attack.

Answers could include:

Adjusting the surface area of a wing directly reduces the differential pressure of the air passing over the top of the wing compared with the bottom of the wing.

Wing spoilers can be used to dump lift – especially upon landing.

Question 25 (c)

Criteria	Marks
• Calculates the lift to drag ratio using a correct process	2
• Applies an appropriate method	1

Sample answer:

$$\begin{aligned}\text{Lift} &= F_r \cos 10^\circ \\ &= 350 \times \cos 10^\circ\end{aligned}$$

$$\begin{aligned}\text{Drag} &= F_r \sin 10^\circ \\ &= 350 \times \sin 10^\circ\end{aligned}$$

Lift : Drag

$$= 1:5.67$$

Question 25 (d)

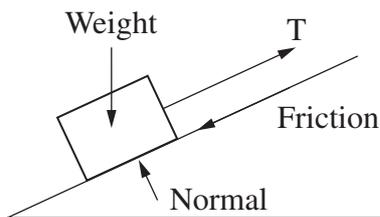
Criteria	Marks
• Outlines the testing process and provides relevant advantages	4
• Outlines the testing process and/or the advantages	2–3
• Identifies a relevant feature	1

Sample answer:

Ultrasonic inspection operates on the principle of ‘transmitted’ and ‘reflected’ HF sound waves. It measures the change in the velocity of sound waves passing through a substance. This produces an ‘echo’ if there is a flaw in a material being tested. Ultrasonic inspection is used for aircraft maintenance because it can be used to test parts while they are still in ‘place’.

Question 26 (a) (i)

Criteria	Marks
• Correctly indicates normal, weight and friction forces	2
• Indicates two of the forces	1

Sample answer:

Question 26 (a) (ii)

Criteria	Marks
• Calculates tensile force using a correct process	3
• Calculates tensile force using one opposing force	2
• Applies an appropriate method	1

Sample answer:

$$T = (150 \times 9.8 \times \sin 25^\circ) + 0.3(150 \times 9.8 \cdot \cos 25^\circ)$$

$$T = 1021.93 \text{ N}$$

Question 26 (a) (iii)

Criteria	Marks
• Calculates a force using correct process	2
• Applies an appropriate method	1

Sample answer:

$$F \times 0.35 = 910 \times 0.05$$

$$\therefore F = 130$$

$$\frac{130}{0.85}$$

$$= 152.9 \text{ N}$$

Question 26 (b) (i)

Criteria	Marks
• States the significance of THREE key points	3
• States the significance of TWO key points	2
• States the significance of ONE key point OR • Identifies TWO key points	1

Sample answer:

X: (Elastic limit) – maximum load that can be applied without permanent deformation

Y: (Ultimate Tensile Strength) – maximum tensile stress the material can withstand without failing

Z: (Failure Point) – point at which the specimen breaks

Question 26 (b) (ii)

Criteria	Marks
• Calculates Young's Modulus using values within the elastic limit	3
• Calculates a value for Young's Modulus using incorrect data	2
• Applies an appropriate method	1

Sample answer:

$$E = \frac{(18 \times 10^3) \times (55 \times 10^{-3})}{(5 \times 10^{-4}) \times (9.6 \times 10^{-6})}$$

$$E = 206.25 \text{ GPa}$$

Question 27

Criteria	Marks
• Outlines the responsibilities the three engineering specialists should exercise in the design and construction of the new structure	8
• Outlines the responsibilities that at least two of the engineering specialists should exercise in the design and construction of the new structure	6–7
• Outlines the responsibilities that at least two of the engineering specialists should exercise in the design or construction of the new structure	4–5
• Outlines the responsibilities of engineers and/or requirements of the project	2–3
• Provides some relevant information	1

Answers could include:

- Civil Engineer
 - structural design drawing for the bridge
 - structural and cost calculations for the bridge
 - ensuring a hazard free working environment
 - site management
- Electrical Engineer
 - design and cost electrical systems for the bridge
 - supervise installations on the bridge
 - final safety testing and certification
- Environmental Engineers
 - prepare an Environmental Impact Statement for the council/consenting authority
 - conduct environmental audits
 - minimise environmental impact of construction of the bridge
 - site rehabilitation

2015 HSC Engineering Studies

Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	Civil Structures – Mechanics p25	H3.1
2	1	Aeronautical Engineering – Materials p33	H1.2
3	1	Personal and Public Transport – Mechanics p28	H3.1
4	1	Personal and Public Transport/ Aeronautical Engineering – Communications p29, 33	H3.1, H3.3
5	1	Personal and Public Transport – Materials p28	H1.2, H2.1
6	1	Personal and Public Transport/Telecommunications – Electronics p29, 37	H1.2, H2.1, H3.1
7	1	Civil Structures/Aeronautical Engineering – Mechanics p25, 32	H3.1
8	1	Personal and Public Transport – Materials p28	H1.2
9	1	Personal and Public Transport – Electronics p29	H3.1
10	1	Personal and Public Transport – Electronics p29	H2.1, H3.1
11	1	Telecommunications – Electronics p37	H3.1, H3.3
12	1	Civil Structures/ Personal and Public Transport – Mechanics p25, 28	H3.1, H3.3
13	1	Personal and Public Transport – Materials p29	H1.2, H2.1
14	1	Personal and Public Transport – Materials p28	H1.2
15	1	Personal and Public Transport/ Aeronautical Engineering – Materials p32, 33	H1.2, H 2.1
16	1	Aeronautical Engineering – Communications p33	H3.1, H3.3
17	1	Civil Structures – Materials p25	H1.2, H2.1
18	1	Personal and Public Transport – Materials p28	H1.2, H2.1
19	1	Personal and Public Transport – Communications p29	H3.1, H3.3
20	1	Civil Structures – Mechanics p25	H1.2, H3.1

Section II

Question	Marks	Content	Syllabus outcomes
21 (a)	3	Personal and Public Transport – Materials p27, 29	H1.2, H 2.1, H4.1
21 (b)	4	Personal and Public Transport/ Aeronautical Engineering – Mechanics p28, 32	H2.1, H3.1
21 (c) (i)	2	Personal and Public Transport – Mechanics p28, 32	H2.1, H3.1
21 (c) (ii)	2	Personal and Public Transport – Mechanics p28, 32	H2.1, H3.1

22 (a)	4	Personal and Public Transport – Electronics p29	H1.2, H2.1
22 (b)	2	Telecommunications – Electronics p37	H1.1, H1.2
22 (c)	6	Personal and Public Transport – Communications p29	H3.1, H3.3
23 (a) (i)	2	Telecommunications – Materials p36	H1.2
23 (a) (ii)	3	Personal and Public Transport – Materials p29	H1.2, H2.1
23 (b)	3	Telecommunications – Electronics p37	H1.2, H4.1
23 (c)	4	Telecommunications – Electronics p37	H1.1, H4.1, H4.3
24 (a) (i)	2	Civil Structures – Materials p26	H1.2, H2.1
24 (a) (ii)	2	Personal and Public Transport – Materials p28	H1.2, H2.1
24 (b) (i)	2	Civil Structures – Mechanics p25	H3.1
24 (b) (ii)	3	Civil Structures – Mechanics p25	H3.1
24 (b) (iii)	3	Civil Structures – Mechanics p25	H3.1
25 (a)	3	Aeronautical Engineering – Mechanics p32	H1.2, H2.2, H4.1
25 (b)	3	Aeronautical Engineering – Mechanics p32	H3.1
25 (c)	2	Aeronautical Engineering – Mechanics p32	H3.1
25 (d)	4	Aeronautical Engineering – Materials p32	H1.2, H4.1
26 (a) (i)	2	Personal and Public Transport – Mechanics p28	H3.1
26 (a) (ii)	3	Personal and Public Transport – Mechanics p28	H3.1
26 (a) (iii)	2	Personal and Public Transport – Mechanics p28	H3.1
26 (b) (i)	3	Civil Structures – Materials p25	H3.1, H3.3
26 (b) (ii)	3	Civil Structures – Mechanics p25	H3.1, H3.3
27	8	Civil Structures – Engineering Report p26	H4.3, H5.1, H6.1