
2022 HSC Engineering Studies Marking Guidelines

Section I

Multiple-choice Answer Key

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

Section II

Question 21 (a) (i)

Criteria	Marks
• Provides how toughened glass is manufactured	2
• Provides some relevant information	1

Sample answer:

Toughened glass is made by heating a sheet of annealed glass to 600 degrees and then rapidly cooling using jets of cool air.

Answers could include:

Toughened glass can be achieved by soaking the glass in potassium nitrate for an extended period.

Question 21 (a) (ii)

Criteria	Marks
• Describes the manufacturing process that has allowed (large sheets) windscreens of curved glass to be made	3
• Outlines the manufacturing process that has allowed (large sheets) windscreens of curved glass to be made	2
• Provides some relevant information	1

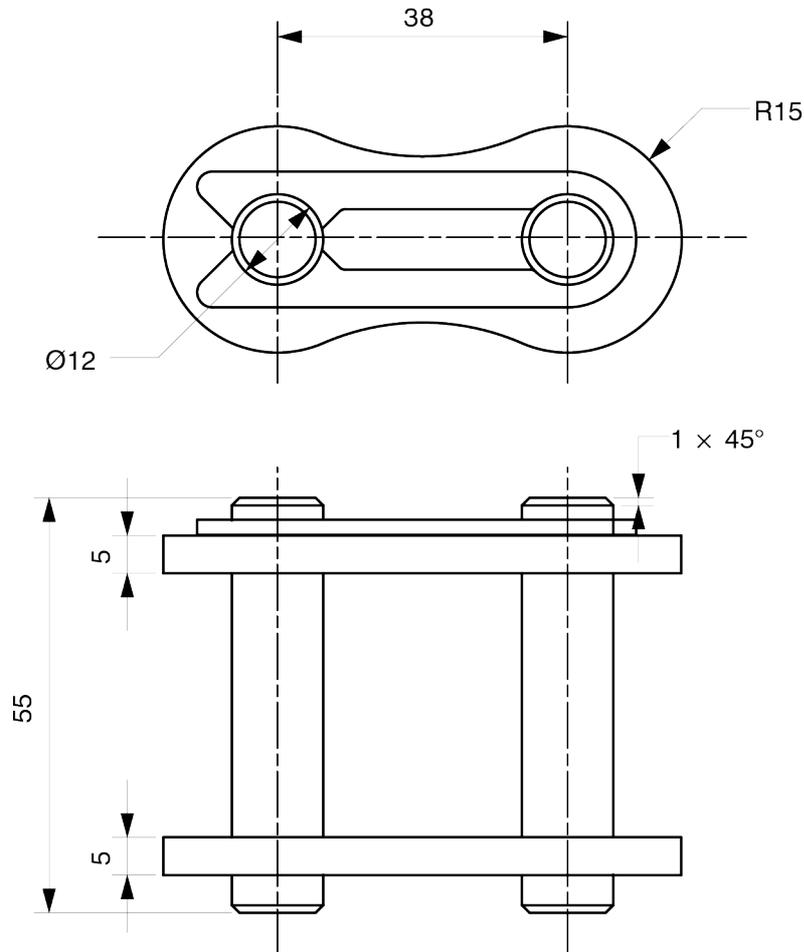
Sample answer:

Curved windscreen glass is produced by placing correctly shaped pieces of float glass across a metal mould. The glass is then evenly heated until it sags to take the shape of the mould. It is then left to cool. When cool enough they are removed and prepared for the lamination process.

Question 21 (b)

Criteria	Marks
• Adds most dimensions to AS 1100	3
• Adds some dimensions to AS 1100	2
• Provides some relevant dimensions	1

Sample answer:



Question 21 (c)

Criteria	Marks
• Shows relevant working in the correct calculation of the effort required	3
• Makes progress towards calculating the effort required	2
• Provides some relevant information	1

Sample answer:

$$W = 950 \text{ N}$$

VR = number of ropes to load

$$VR = 4$$

$$\eta = \frac{MA}{VR}$$

$$MA = VR \times \eta$$

$$MA = 4 \times 0.8$$

$$MA = 3.2$$

$$MA = \frac{L}{E}$$

$$E = \frac{L}{MA}$$

$$E = \frac{950}{3.2}$$

$$E = 296.875 \text{ N}$$

Question 22 (a)

Criteria	Marks
• Demonstrates a thorough knowledge and understanding of one legal or ethical issue	3
• Demonstrates sound knowledge and understanding of one legal or ethical issue	2
• Provides some relevant information	1

Sample answer:

If the smart watch does not work as described or intended, then this becomes a legal and ethical concern as lives are at risk if the product functions incorrectly, eg the ramifications of the GPS signal not transmitting correctly in an emergency situation could include the user not being found.

Answers could include:

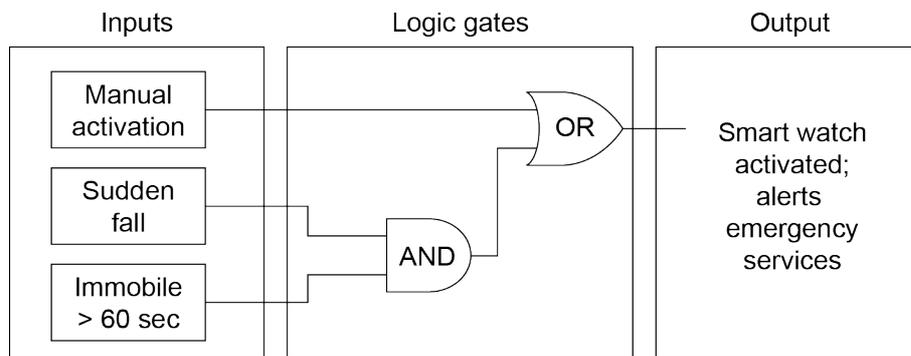
Examples of ethical implications that could be discussed:

- Privacy
- Ease of use and instructions
- Rescue, disaster survival
- Smart watch does not work as intended.

Question 22 (b)

Criteria	Marks
• Completes the diagram with the three inputs and the appropriate logic gates	3
• Partially completes the diagram with the inputs and/or logic gate(s)	2
• Provides some relevant information	1

Sample answer:



Question 22 (c)

Criteria	Marks
• Provides a sound justification of the material properties that should be considered	3
• Describes appropriate material property(ies)	2
• Provides some relevant information	1

Sample answer:

The engineer should consider the material’s hardness so as to resist abrasion/scratching; toughness so as to resist damage from impact. The impact resistance needs to be able to withstand breakage during falls.

Answers could include:

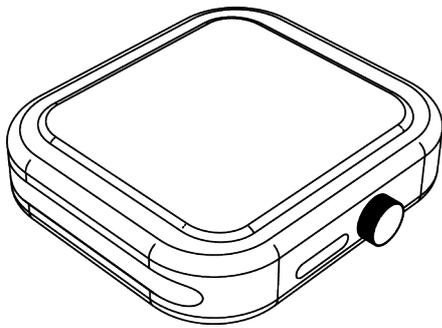
Other suitable properties could include:

- Water resistance
- Chemical stability
- Hypoallergenic
- Water resistance so as to resist water swell and/or erosion.

Question 22 (d)

Criteria	Marks
• Provides a correct freehand pictorial sketch of the smart watch	3
• Demonstrates substantial progress towards producing an appropriate pictorial sketch of the smart watch	2
• Provides some aspects of a pictorial sketch	1

Sample answer:



Question 23 (a)

Criteria	Marks
• Gives reasons for using an LVL beam instead of a steel beam	2
• Provides some relevant information	1

Sample answer:

An LVL beam has a better strength to weight ratio than a steel beam and it is easier to attach other framing members in a timber-framed structure.

Answers could include:

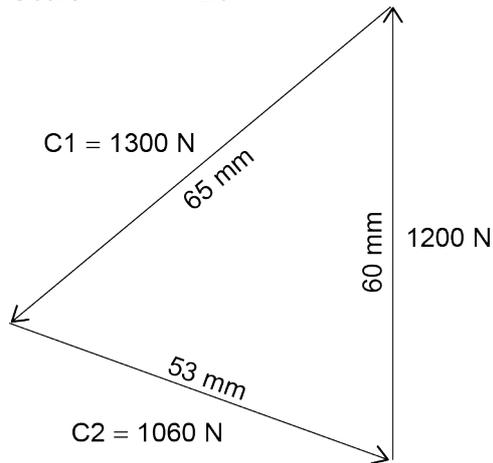
- Uses timber that would otherwise be thrown away as waste
- Can use timber with defects as the surrounding lamellar layers will support the adjacent layer
- Lower cost.

Question 23 (b)

Criteria	Marks
<ul style="list-style-type: none"> Shows relevant working in the correct calculation of the tension in the two cables applying a graphical method 	3
<ul style="list-style-type: none"> Makes progress towards calculating tension in two cables using a substantially correct method 	2
<ul style="list-style-type: none"> Provides some relevant information 	1

Sample answer:

Scale 1 mm = 20 N

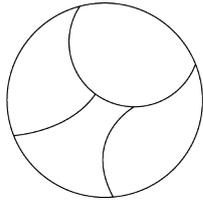


Tension in C1 = 1.3 kN
 Tension in C2 = 1.06 kN

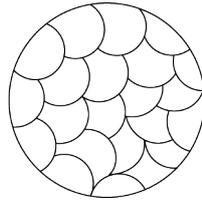
Question 23 (c)

Criteria	Marks
<ul style="list-style-type: none"> Explains how the process of dynamic recrystallisation results in refined, smaller, equiaxed grains 	4
<ul style="list-style-type: none"> Describes the process of hot rolling with reference to the resulting grain size or shape 	3
<ul style="list-style-type: none"> Provides some description of the grain change as a result of hot rolling 	2
<ul style="list-style-type: none"> Provides some relevant information 	1

Sample answer:



Before hot rolling



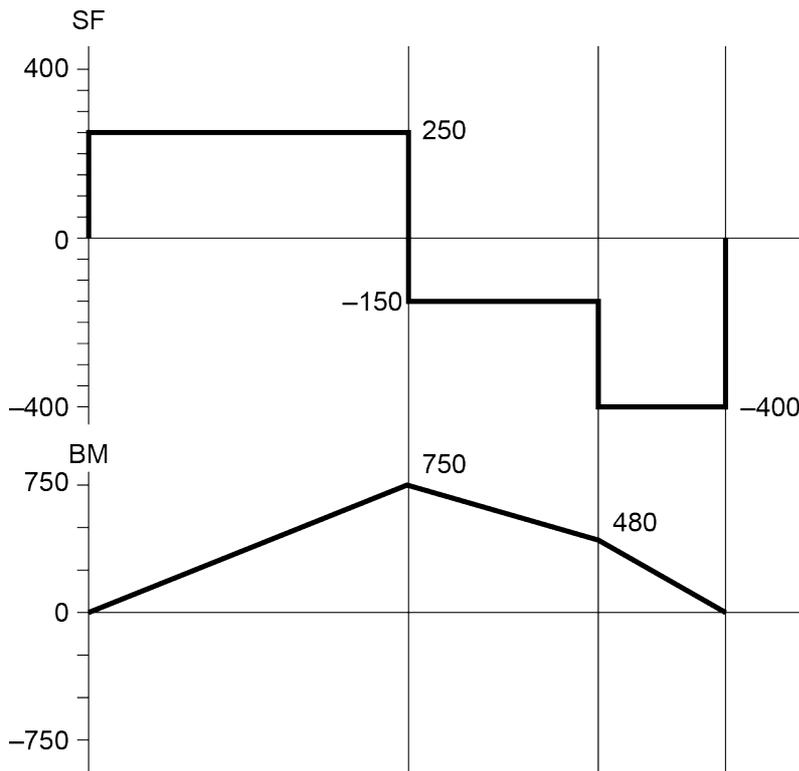
After hot rolling

The steel is heated to above its recrystallisation temperature. The grains change from their 'as-cast' state to become elongated. As the steel exits the mill, it is still over the recrystallisation temperature which results in the recrystallisation of the elongated grains, resulting in finer, equiaxed grains.

Question 23 (d)

Criteria	Marks
• Produces correct diagrams using an appropriate scale	4
• Produces substantially correct diagrams	3
• Completes partially correct diagrams OR • Completes ONE diagram correctly	2
• Provides some relevant information	1

Sample answer:



Question 24 (a)

Criteria	Marks
• Identifies and outlines benefits of using the prototype	3
• Identifies and outlines a benefit of using the prototype	2
• Provides some relevant information	1

Sample answer:

An aeronautical engineer could choose to produce the prototype of the new propeller on a CAD software package. The design could then be test simulated on the CAD software and 3D printed to scale.

Answers could include:

- 3D Printing
- CAD Production
- CNC Milling
- Scaled physical model.

Question 24 (b)

Criteria	Marks
• Identifies the type of corrosion and explains how it can occur	3
• Describes the type of corrosion or how corrosion can occur	2
• Provides some relevant information	1

Sample answer:

The type of corrosion evident on the plane surface is galvanic corrosion. This has occurred because the metal used for the bolts is different from the metal used for the fuselage. This causes galvanic corrosion as the bolts become an anode to protect the fuselage (the cathode) from rusting.

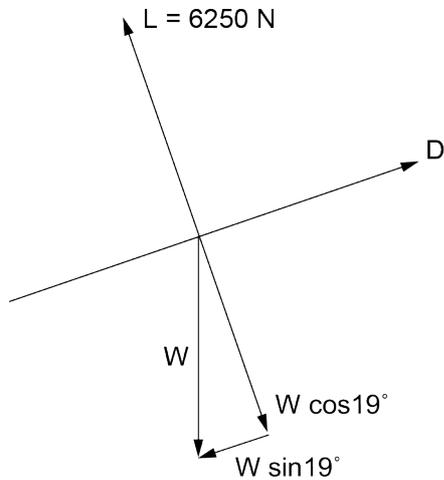
Answers could include:

- Dissimilar metals in contact
- Components assembled incorrectly leading to differentiation corrosion
- Pit corrosion
- Crevice corrosion
- Stress corrosion.

Question 24 (c) (i)

Criteria	Marks
• Draws a free-body diagram, indicating all forces acting on it	1

Sample answer:



Question 24 (c) (ii)

Criteria	Marks
• Shows relevant working in the correct calculation of the mass of the glider	3
• Shows some relevant working in the correct calculation of the mass of the glider	2
• Provides some relevant information	1

Sample answer:

$$\sum F \uparrow = 0$$

$$L - W \cos 19^\circ = 0$$

$$W = \frac{L}{\cos 19^\circ}$$

$$= \frac{6250}{0.9455}$$

$$= 6610 \text{ N}$$

$$\text{mass} = \frac{6610 \text{ N}}{10}$$

$$= 661 \text{ kg}$$

$$\text{mass of glider} = 661 \text{ kg} - 95 \text{ kg} = 566 \text{ kg}$$

OR

$$\cos 19^\circ = \frac{6250}{W}$$

$$W = \frac{6250}{\cos 19^\circ}$$

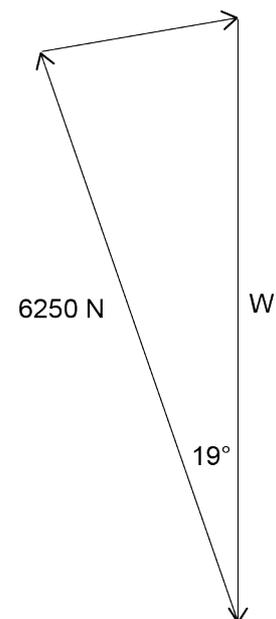
$$W = 6610.13 \text{ N}$$

$$m = \frac{6610.13}{10}$$

$$m = 661.01 \text{ kg}$$

$$m_G = 661.01 - 95$$

$$m_G = 566.01 \text{ kg}$$



Question 24 (c) (iii)

Criteria	Marks
• Shows relevant working in the correct calculation of the lift-to-drag ratio	2
• Provides some relevant information	1

Sample answer:

Glider thrust = 0

$$\sum F \rightarrow = 0$$

$$D - W \sin(19^\circ) = 0$$

$$D = 6610 \times 0.32557 = 2152$$

$$L : D = 6250 : 2152$$

$$L : D = 2.9 : 1$$

OR

$$L : D = \frac{\text{Lift}}{\text{Drag}}$$

$$L : D = \frac{W \cos 19^\circ}{W \sin 19^\circ}$$

$$L : D = \frac{1}{\tan 19^\circ}$$

$$L : D = 2.9 : 1$$

Question 25 (a)

Criteria	Marks
• Describes how an insulation test can be performed on a cable	3
• Outlines an insulation test	2
• Provides some relevant information	1

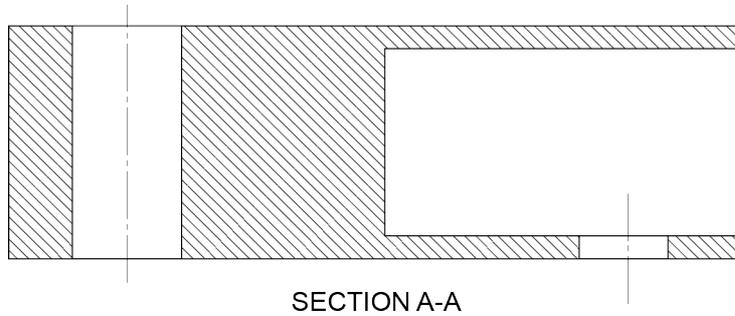
Sample answer:

One method of insulation testing (often called continuity testing) involves the use of a megohmmeter. A megohmmeter is connected across the insulation material to be tested. The megohmmeter applies a test voltage for a sample period (usually 60 seconds). This allows for the megohmmeter to determine the amount of current leakage. The current leakage is measured in ohms.

Question 25 (b)

Criteria	Marks
• Provides a completed sectioned top view	3
• Provides a substantially completed sectioned top view	2
• Provides some aspects of a correct section	1

Sample answer:



Question 25 (c)

Criteria	Marks
• Demonstrates comprehensive understanding of how engineers have used their knowledge of both mechanics and hydraulics in aircraft design	5
• Demonstrates some understanding of how engineers have used their knowledge of both mechanics and hydraulics in aircraft design OR	4
• Demonstrates comprehensive understanding of how engineers have used their knowledge of either mechanics or hydraulics in aircraft design	
• Demonstrates some understanding of mechanics and/or hydraulics in aircraft design	2–3
• Provides some relevant information	1

Sample answer:

Modern aircraft are the balanced amalgamation of advancements in mechanical principles and hydraulic systems. This has led to changes in design and performance.

Understanding of lift, drag and thrust through the use of wind tunnels led to a better understanding of aerodynamics and flight. This then led to changes in aircraft design and shape allowing for increase in passenger capacity, less fuel consumption and introduction of winglets to decrease wingtip vortices.

The increased understanding of hydraulics has improved the braking power of systems in the plane, allowing larger masses to be stopped safely. It has also allowed for quick, computer-controlled adjustments of control surfaces.

Answers could include:

Developments in the piston engine with respect to the control of the pitch of the propeller has led to an increase in efficiency. At take off, pitch is set to coarse for maximum torque, whereas in flight, pitch is set finer for speed and fuel efficiency. The development of these designs also means larger aircraft can travel further with less fuel consumption.

Question 26 (a) (i)

Criteria	Marks
<ul style="list-style-type: none"> Shows relevant working in the correct calculation to determine the correct number of concrete blocks 	2
<ul style="list-style-type: none"> Applies an appropriate method 	1

Sample answer:

$$x \text{ kN} \downarrow \times 50 \text{ units} = 9.23 \text{ kN} \downarrow \times 65 \text{ units}$$

$$50x = 600$$

$$x = \frac{600}{50}$$

$$x = 12 \text{ kN} \downarrow$$

$$x = 12\,000 \text{ N}$$

$$\therefore \text{mass} = 1200 \text{ kg}$$

\therefore 12 concrete blocks are needed for the counterweight.

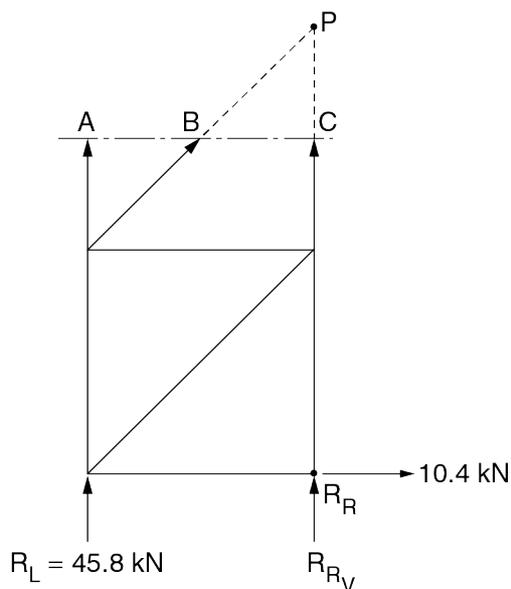
Question 26 (a) (ii)

Criteria	Marks
<ul style="list-style-type: none"> Shows relevant working in the correct calculation of the magnitude of the force States its nature 	6
<ul style="list-style-type: none"> Calculates the magnitude of the force using a substantially correct method States its nature 	4–5
<ul style="list-style-type: none"> Makes substantial progress towards calculating the reaction in A 	3
<ul style="list-style-type: none"> Makes some progress towards calculating a reaction 	2
<ul style="list-style-type: none"> Applies an appropriate method 	1

Sample answer:

$$\begin{aligned} \circlearrowleft + \sum M_R 0 &= -(6 \times 5.5) + (R_L \times 1) + (10 \times 6) - (10.4 \times 7) \\ R_L &= 45.8 \text{ kN } \uparrow \end{aligned}$$

Then take horizontal section as shown in sketch.



$$\begin{aligned} \circlearrowleft + \sum M_P 0 &= (A \times 1) + (45.8 \times 1) - (10.4 \times 2) \\ A &= -25 \text{ kN} \\ \therefore A &= 25 \text{ kN in compression} \end{aligned}$$

Magnitude of internal reaction in member A : 25 kN

Nature of reaction A : compression

Question 26 (b)

Criteria	Marks
• Describes engineering innovations that have led to lower CO ₂ emissions from electric transportation	3
• Outlines engineering innovations that have led to lower CO ₂ emissions	2
• Provides some relevant information	1

Sample answer:

An electric powered car does not need heavy engine components to propel it as the energy comes from an electric source. Additionally, there are fewer moving parts and hence a net reduction in weight. Lighter engineering materials are used that contribute to the decrease in CO₂ emissions. Furthermore, a combustion engine in and of itself produces large volumes of CO₂ emissions.

Answers could include:

Electric powered bikes generally place lower energy demands on a cyclist, resulting in less CO₂ expenditure by the cyclist, thus reducing overall energy demand and hence CO₂ emissions. Battery technology makes longer distance travel feasible by increasing the bike's range hence a decrease in CO₂ emissions.

Question 27 (a)

Criteria	Marks
• Provides a clear description of two different uses of polymers within telecommunications	4
• Provides some description of two different uses of polymers within telecommunications	3
• Demonstrates some understanding of the use of polymer(s) within telecommunications	2
• Provides some relevant information	1

Sample answer:

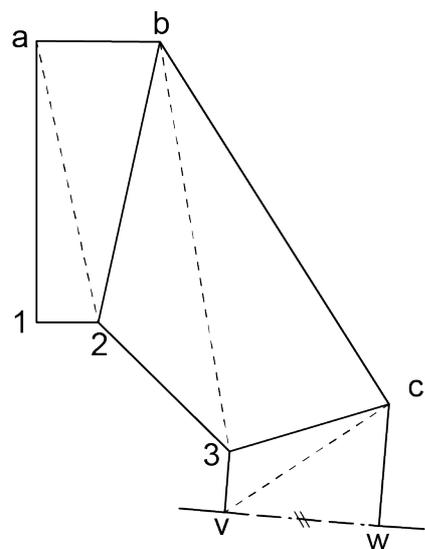
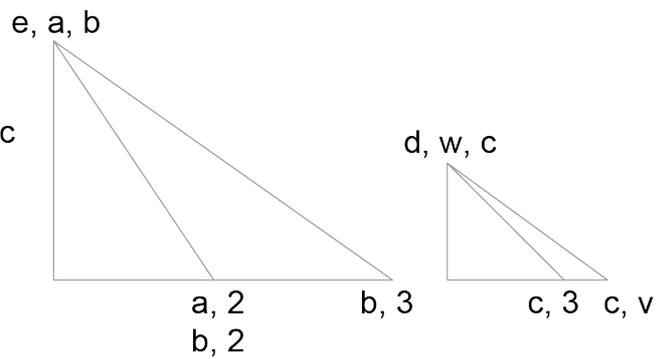
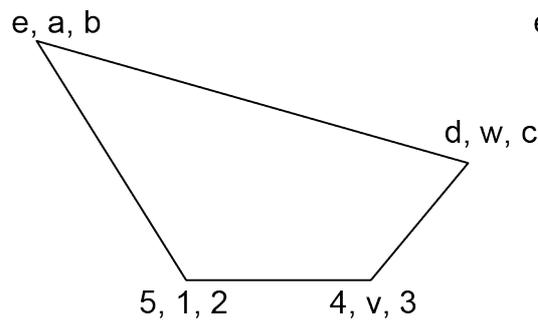
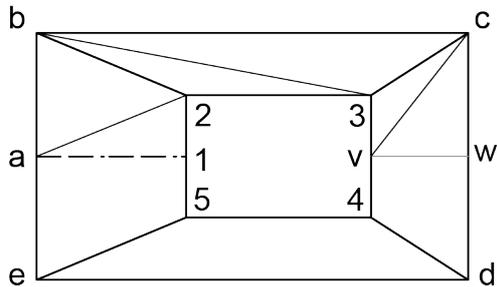
Polymers have a wide use in telecommunications from circuit components, device casings and cable insulation.

The most extensive use of polymers in telecommunications is in cabling. Polymer coatings are used in cabling to insulate the cabling and offer excellent protection against electrical conductivity.

Question 27 (b)

Criteria	Marks
<ul style="list-style-type: none"> Constructs a correct half-pattern development of the transition piece 	6
<ul style="list-style-type: none"> Correctly determines the true length (TL) of non TL lines Constructs a substantially correct development 	5
<ul style="list-style-type: none"> Correctly determines the TL of non TL lines Makes an attempt to complete a half development 	4
<ul style="list-style-type: none"> Demonstrates some understanding of the requirements of half development 	2-3
<ul style="list-style-type: none"> Provides some relevant information 	1

Sample answer:



Half-pattern development

2022 HSC Engineering Studies Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	Personal and public transport – engineering materials – p28	H1.2
2	1	Telecommunications engineering – historical and societal influences – p36	H1.1, H4.2
3	1	Telecommunications engineering – communication – p37	H3.3
4	1	Personal and public transport – engineering mechanics – p28	H3.1
5	1	Aeronautical engineering – historical and societal influences – p32	H1.1
6	1	Civil structures – engineering materials – p25	H2.1
7	1	Civil structures – communication – p26	H3.3
8	1	Aeronautical engineering – communication – p33	H3.3
9	1	Civil structures – communication – p26	H3.3
10	1	Aeronautical engineering – mechanics and hydraulics – p32	H3.1
11	1	Telecommunications engineering – engineering electricity/electronics – p37	H1.2
12	1	Civil structures – engineering materials – p26	H2.1
13	1	Telecommunications engineering – engineering electricity/electronics – p37	H1.2, H4.1
14	1	Telecommunications engineering – engineering materials – p37	H2.1
15	1	Aeronautical engineering – engineering mechanics – p32	H2.1
16	1	Personal and public transport – engineering materials – p29	H3.1
17	1	Aeronautical engineering – engineering materials – p32	H2.1
18	1	Personal and public transport – communication – p29	H3.3
19	1	Personal and public transport – engineering mechanics – p28	H3.1
20	1	Civil structures – engineering mechanics – p25	H3.1

Section II

Question	Marks	Content	Syllabus outcomes
21 (a) (i)	2	Personal and public transport – engineering materials – p29	H1.2
21 (a) (ii)	3	Personal and public transport – historical and societal influences – p29	H4.3
21 (b)	3	Personal and public transport – communication – p29	H3.3
21 (c)	3	Personal and public transport – engineering mechanics – p28	H3.1
22 (a)	3	Telecommunications engineering – scope of the profession – p36	H1.1

Question	Marks	Content	Syllabus outcomes
22 (b)	3	Telecommunications engineering – engineering electricity/electronics – p37	H3.1
22 (c)	3	Telecommunications engineering – engineering materials – p36	H1.2
22 (d)	3	Telecommunications engineering – communications – p37	H3.3
23 (a)	2	Civil structures – engineering materials – p25	H1.2
23 (b)	3	Civil structures – engineering mechanics – p25	H3.1
23 (c)	4	Civil structures – engineering materials – p25	H2.1
23(d)	4	Civil structures – engineering mechanics – p25	H3.1
24 (a)	3	Aeronautical engineering – scope of profession – p31	H1.1
24 (b)	3	Aeronautical engineering – engineering materials – p33	H1.2
24 (c) (i)	1	Aeronautical engineering – engineering mechanics –p32	H3.1
24 (c) (ii)	3	Aeronautical engineering – engineering mechanics –p32	H3.1
24 (c) (iii)	2	Aeronautical engineering – engineering mechanics –p32	H3.1
25 (a)	3	Telecommunications engineering – engineering materials – 36	H1.2
25 (b)	3	Personal and public transport – communication – p29	H3.3
25 (c)	5	Aeronautical engineering – historical and societal influences – p32	H1.1
26 (a) (i)	2	Civil structures – engineering mechanics – p25	H3.1
26 (a) (ii)	6	Civil structures – engineering mechanics – p25	H3.1
26 (b)	3	Personal and public transport – historical and societal influences – p27	H1.1
27 (a)	4	Telecommunications engineering – engineering materials – p37	H1.2
27 (b)	6	Aeronautical engineering – communication – p33	H3.3