

# 2021 HSC Engineering Studies Marking Guidelines

## Section I

### Multiple-choice Answer Key

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

## Section II

### Question 21 (a)

| Criteria   | Marks |
|--|-------|
| • Outlines TWO ways in which the construction of bridges affects society | 2     |
| • Provides some relevant information                                     | 1     |

**Sample answer:**

It allows easier and faster transport than catching a ferry or rowing a boat across the body of water thus reducing commuting time. Once built, you could simply walk, catch a bus or drive across the bridge allowing people to shop or be employed from one side of the bridge to the other.

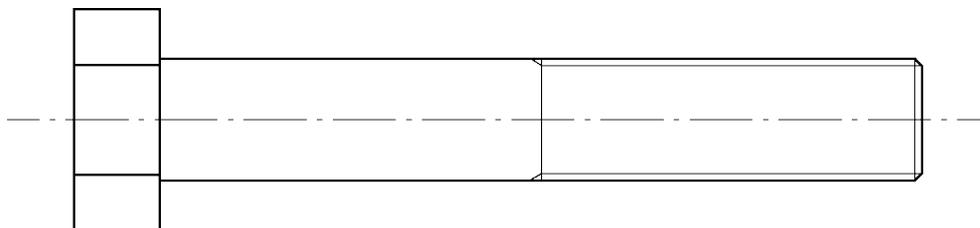
**Answers could include:**

- People from either side of the bridge could meet socially for lunch or dinner more frequently.
- Greater use of infrastructure such as hospitals and schools
- Allows trains to travel over the water and be used efficiently
- Reduces the number of ferries on the harbour to transport people
- Potential increase in leisure time.

### Question 21 (b) (i)

| Criteria  | Marks |
|---|-------|
| • Draws an orthogonal view to show the length of the bolt | 3     |
| • Draws a partially correct orthogonal view               | 2     |
| • Provides some relevant information                      | 1     |

**Sample answer:**



**Question 21 (b) (ii)**

| Criteria  | Marks |
|---|-------|
| • Shows relevant working in the correct calculation of the maximum load the bolt can resist | 3     |
| • Makes progress towards calculating the maximum load the bolt can resist                   | 2     |
| • Provides some relevant information  | 1     |

**Sample answer:**

- Yield stress = 476 MPa

$$\begin{aligned}\text{Allowable stress} &= 476 \text{ MPa} \div 2 \text{ (F of S)} \\ &= 238 \text{ MPa}\end{aligned}$$

- Area of 16 mm dia bolt =  $\pi r^2$   
Area = 201.1 mm sq

- Force = allow stress  $\times$  area

$$F = 238 \times 10^6 \text{ Pa} \times 201.1 \times 10^{-6} \text{ m}^2$$

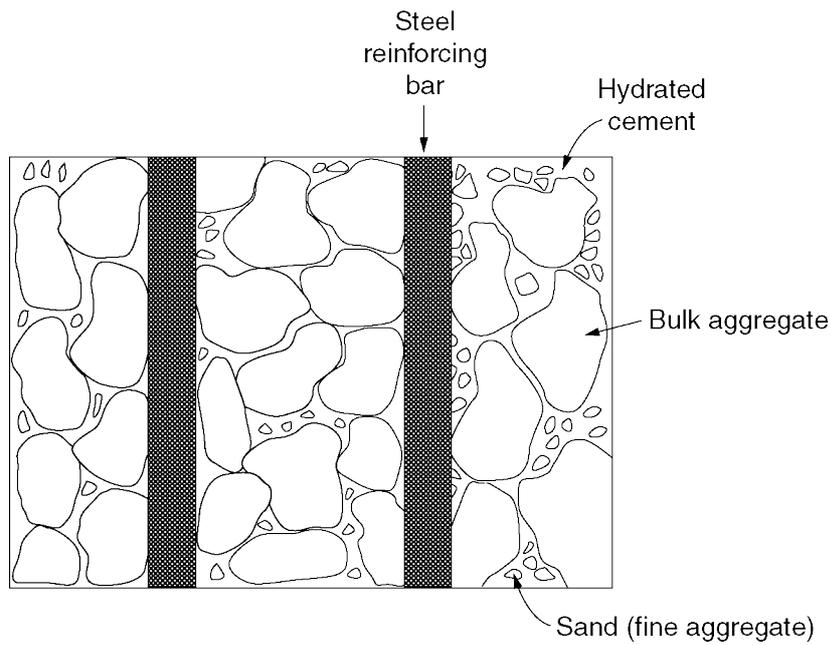
$$F = 47861.8 \text{ N}$$

$$\therefore F = 47.9 \text{ kN}$$

### Question 21 (c)

| Criteria  | Marks |
|---|-------|
| <ul style="list-style-type: none"> <li>Provides an appropriate sketch of the macrostructure, with correctly labelled component parts</li> </ul> | 3     |
| <ul style="list-style-type: none"> <li>Provides a partially correct sketch of the macrostructure</li> </ul> OR                                  | 2     |
| <ul style="list-style-type: none"> <li>Identifies correct component parts</li> </ul>  |       |
| <ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>  | 1     |

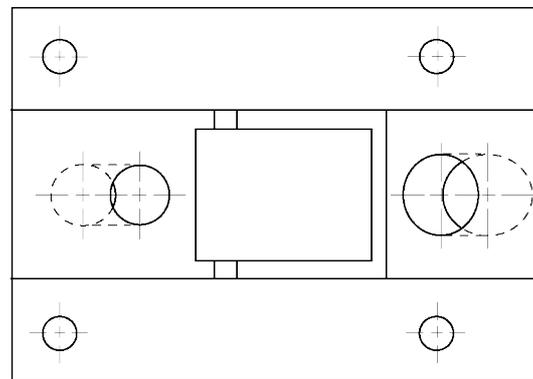
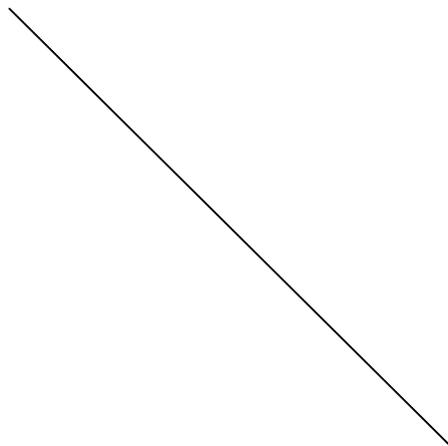
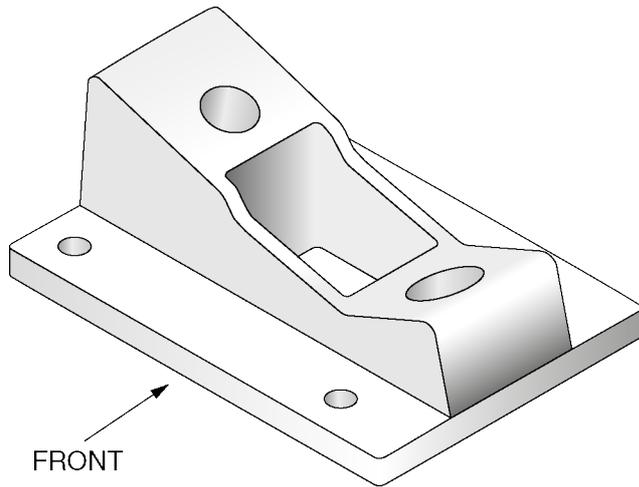
**Sample answer:**



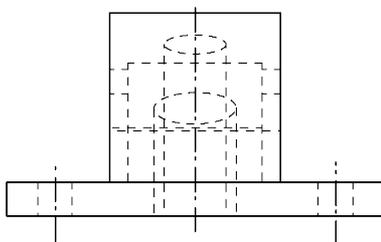
**Question 22 (a)**

| Criteria  | Marks |
|---|-------|
| • Provides a correct drawing of a top view of the baseplate           | 3     |
| • Provides a partially correct drawing of a top view of the baseplate | 2     |
| • Provides some relevant information                                  | 1     |

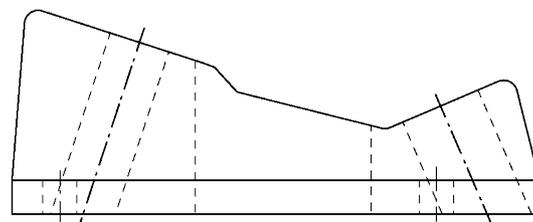
**Sample answer:**



TOP VIEW



SIDE VIEW



FRONT VIEW

### Question 22 (b)

| Criteria  | Marks |
|---|-------|
| <ul style="list-style-type: none"> <li>Provides advantages of pressure die casting over sand casting the baseplate</li> </ul> | 2     |
| <ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>  | 1     |

**Sample answer:**

Pressure die casting, when compared to sand casting, provides a superior, smoother surface finish. Pressure die casting provides better dimensional accuracy of the casting.

**Answers could include:**

Additionally, there is less potential to produce a casting with voids if an item is pressure die cast. A pressure die casting mould is a permanent mould, which allows for economies of scale. A metal mould allows for a chill cast grain structure and hence a harder surface.

### Question 22 (c)

| Criteria   | Marks |
|--|-------|
| <ul style="list-style-type: none"> <li>Shows relevant working in the correct calculation of capacity of the battery</li> </ul> | 3     |
| <ul style="list-style-type: none"> <li>Makes progress towards calculating the capacity of the battery</li> </ul>               | 2     |
| <ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>   | 1     |

**Sample answer:**

$$\text{Power} = 0.078 \text{ W}$$

$$\text{Volt} = 48 \text{ V}$$

$$P = VI$$

$$I = \frac{P}{V}$$

$$= \frac{0.078}{48}$$

$$\therefore \text{capacity} = \frac{0.078 \times 3600\text{v}}{48}$$

### Question 22 (d)

| Criteria  | Marks |
|---|-------|
| • Shows relevant working in the correct calculation of the speed of the rider | 4     |
| • Shows mostly correct working in the calculation of the speed of the rider   | 3     |
| • Makes progress towards calculating the speed                                | 2     |
| • Provides some relevant information  | 1     |

**Sample answer:**

$$m = 80 \text{ kg}$$

$$F_r = 55 \text{ N}$$

$$PE = mgh$$

$$PE = 80 \times 10 \times 27.8$$

$$PE = 22,240 \text{ J}$$

Total work against skateboard due to friction:

$$W = fs$$

$$W = 55 \times 250$$

$$W = 13,750 \text{ J}$$

Final energy = Initial energy – frictional losses

$$\text{Final energy} = 22,240 - 13,750 \text{ J}$$

$$\text{Final energy} = 8490 \text{ J}$$

$$\frac{1}{2}mv^2 = 8490 \text{ J}$$

$$v^2 = 212.25$$

$$\text{Therefore } v = 14.57 \text{ m/s}$$

**Question 23 (a)**

| Criteria  | Marks |
|---|-------|
| • Provides a sound explanation of why the desert is a suitable place to store aircraft fleet    | 3     |
| • Demonstrates some understanding of why the desert is a suitable place to store aircraft fleet | 2     |
| • Provides some relevant information  | 1     |

**Sample answer:**

Aircraft, being historically constructed of aluminium, are susceptible to corrosion. Particularly, they are subject to crevice corrosion which occurs on the lap joints between aluminium sheeting. When aircraft are in long-term storage, they need a dry, warm climate to allow the aircraft to remain dry and to evaporate any moisture from crevices. A desert provides this climate at minimal cost and also by definition has minimal rainfall and sources of moisture ingress into the aircraft skin. Modern aircraft could be constructed from carbon fibre, which does not corrode, but still require engines to be stored in a low humidity environment.

**Answers could also include:**

- Fewer insects and wildlife, hence birds nesting in the airframe/engines. Fees for storing the aircraft would be much lower than those at an airport.
- It is dry and hard and does not require paving.

**Question 23 (b)**

| Criteria   | Marks |
|--|-------|
| • Demonstrates a sound understanding of how the work of aeronautical engineers has helped to improve aircraft safety | 3     |
| • Demonstrates some understanding of how the work of aeronautical engineers has helped to improve aircraft safety    | 2     |
| • Provides some relevant information   | 1     |

**Sample answer:**

Many safety features have been designed by aeronautical engineers. There are many built-in redundancies in case one system fails within the aircraft. For example, if one computer system fails there is another, and then if that one fails, another, etc. Aircraft use autopilot on landing at major airports, removing the risk of pilot error, but not removing the pilot from the equation. Changes in materials used have resulted in lighter and stronger aircraft, making them more durable and robust.

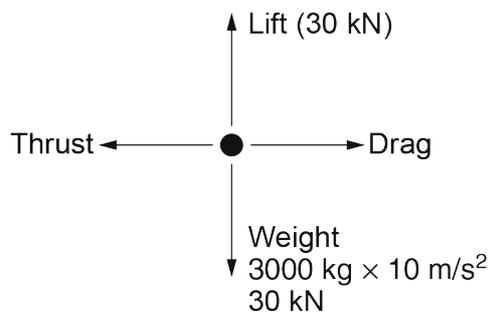
**Answers could include:**

- Vigilance devices in the cockpit ensure that the pilot is awake and aware.
- Aeronautical engineers design and develop safety and disaster mitigation equipment to reduce injury and loss of life in the unlikely event of an accident occurring.
- Knowledge and understanding of material failure can be used to mitigate mid-air incidents such as fatigue failure (this is known as remanent life analysis).
- Aeronautical engineers have a sound and current knowledge of materials available and use these in the design of new aircraft.
- Aeronautical engineers ensure that all maintenance work is completed to manufacturers' specifications to ensure safe aircraft operation.

### Question 23 (c)

| Criteria  | Marks |
|---|-------|
| • Shows relevant working in the correct calculation of the thrust on the plane, using a free-body diagram | 3     |
| • Makes progress towards calculating the thrust on the plane  | 2     |
| • Provides some relevant information  | 1     |

**Sample answer:**



$$\frac{L}{D} = \frac{11}{1}$$

$$\text{Lift} = 30\,000 \text{ N } \uparrow$$

$$\text{Drag} = ?$$

$$\frac{L}{D} = \frac{11}{1}$$

$$D = \frac{30\,000}{11}$$

$$D = \text{Thrust}$$

$$\therefore \text{Thrust} = 2.73 \text{ kN}$$

### Question 23 (d)

| Criteria   | Marks |
|--|-------|
| <ul style="list-style-type: none"> <li>Describes the benefits of the composite in terms of both manufacturing and in-service properties</li> </ul> | 3     |
| <ul style="list-style-type: none"> <li>Provides the benefits of composites in terms of manufacturing and/or in-service properties</li> </ul>       | 2     |
| <ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>   | 1     |

**Sample answer:**

Carbon fibre epoxy matrices are able to be formed into stronger and more complex shapes which result in improvements in aircraft performance.

Typically carbon fibre is added to resin to produce material that is stronger and lighter than the material it replaces. The corresponding loss of weight either decreases the fuel consumption or adds to the number of passengers that can be carried.

**Answers could include:**

The in-service properties of composites include anisotropic (non-directional) strength or isotropic (highly directional) strength behaviour, depending on the nature of the composite and its layup.

### Question 24 (a)

| Criteria  | Marks |
|---|-------|
| <ul style="list-style-type: none"> <li>Shows how the signals differ in performance</li> </ul> | 2     |
| <ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>          | 1     |

**Sample answer:**

The 2.4 GHz and 5 GHz signals differ in bandwidth (specifically data transfer rate) and attenuation.

A 2.4 GHz signal carries less data per second (measured in kbit/s) but has lower attenuation than a 5 GHz signal and is able to transmit through more/thicker obstacles.

**Answers could include:**

A 5 GHz signal carries more data per second, but is subject to higher attenuation than a 2.4 GHz signal. This means that the signal does not penetrate obstacles such as walls or the atmosphere as well as a 2.4 GHz signal.

**Question 24 (b)**

| Criteria  | Marks |
|---|-------|
| • Outlines how voltage can be tested in a circuit | 2     |
| • Provides some relevant information              | 1     |

**Sample answer:****Voltmeter:**

A voltmeter is placed across two points in a circuit in parallel, enabling it to measure the voltage between these two points.

By having a high resistance, the voltmeter does not interfere with the current in the circuit, as the high resistance means it draws minimal current.

**Answers could include:**

If using a multimeter set to DC V– (choose the range) insert the test leads and measure by using the probes on the current to be tested.

- Multimeter
- Oscilloscope.

**Question 24 (c)**

| Criteria   | Marks |
|--|-------|
| <ul style="list-style-type: none"><li>Describes the basic principles of low orbit satellite telecommunication systems</li></ul>  | 3     |
| <ul style="list-style-type: none"><li>Demonstrates some understanding of low orbit satellite telecommunication systems</li></ul> | 2     |
| <ul style="list-style-type: none"><li>Provides some relevant information</li></ul>   | 1     |

**Sample answer:**

Low orbit satellite telecommunication systems have many satellites that pass overhead. They are not geostationary and they orbit Earth. It takes approximately 90 minutes for a satellite to complete a full orbit, and it is only within reception range of the satellite phone handset for a period of 5 minutes maximum. Because there are multiple satellites, when one is about to disappear from the reception range of the satellite telephone handset, another comes over the horizon and takes over communication.

**Answers could include:**

The satellite telephone handset broadcasts its individual identification number to the satellite, which then identifies this satellite as being in range. Once the satellite has received the signal, it then needs to pass the signal to a ground base station to be passed to its destination.

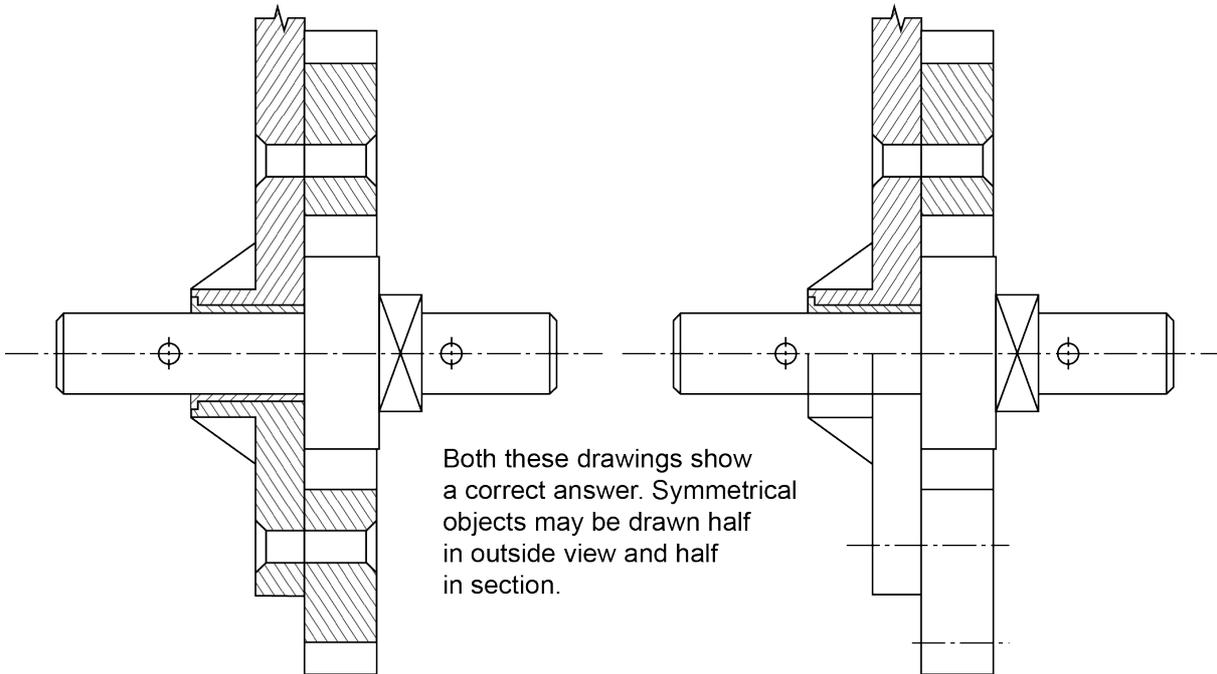
To connect to a base station, the phone signal is passed between satellites until one that is in contact with the ground (base) station comes in to view.

The phone signal is modulated using phase shift keying because of the transmission distances involved.

### Question 24 (d)

| Criteria  | Marks |
|---|-------|
| • Produces a correct sectioned assembly drawing to AS 1100 from the given direction               | 6     |
| • Produces a substantially correct sectioned assembly drawing to AS 1100 from the given direction | 5     |
| • Produces a partially correct assembly drawing to AS 1100 from the given direction               | 3–4   |
| • Makes some progress towards producing an assembly drawing                                       | 2     |
| • Provides some relevant information  | 1     |

**Sample answer:**



**Question 25 (a)**

| Criteria  | Marks |
|---|-------|
| <ul style="list-style-type: none"><li>• Outlines the basic principle behind the operation of one control technology used in modern vehicles</li></ul> | 2     |
| <ul style="list-style-type: none"><li>• Provides some relevant information</li></ul>  | 1     |

**Sample answer:**

The basic principle of control technology involves a signal input to a processor which then provides an output (action to be taken). For example, a camera monitors the position of the car in a lane. If the car drifts out of the lane, the processor detects this movement and outputs an alarm and provides (haptic) feedback to the driver.

**Answers could include:**

Semi-autonomous driving, where the car activates brakes without the driver's intervention if it detects an imminent collision.

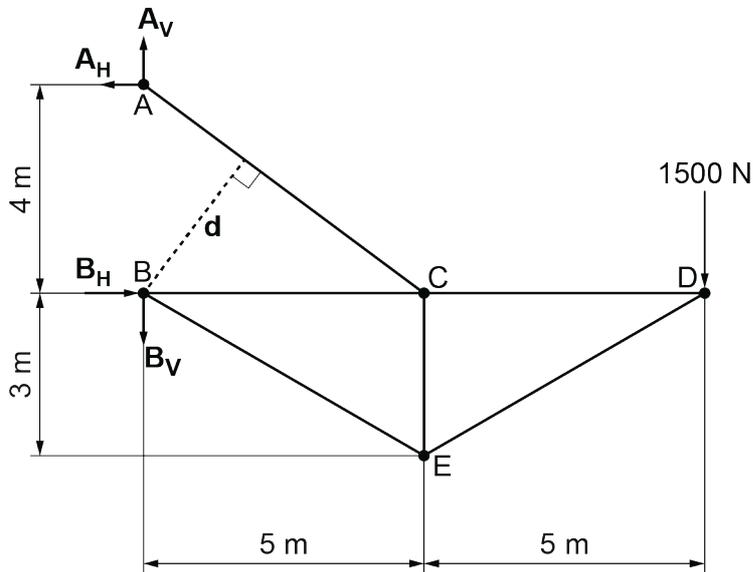
Fully autonomous vehicle operation: cruise control, which has speed as an input and fuel rate to the engine as an output.

PID control: adaptive cruise control, which also uses input from an on board LIDAR and cameras to determine the presence of obstacles and the speed of cars ahead.

### Question 25 (b) (i)

| Criteria                                  | Marks |
|---|-------|
| • Determines the horizontal reaction at A | 2     |
| • Provides some relevant information      | 1     |

**Sample answer:**



$$\circlearrowleft \sum M_B : 0 = -(A_H \times 4 \text{ m}) + (1500 \text{ N} \times 10 \text{ m})$$

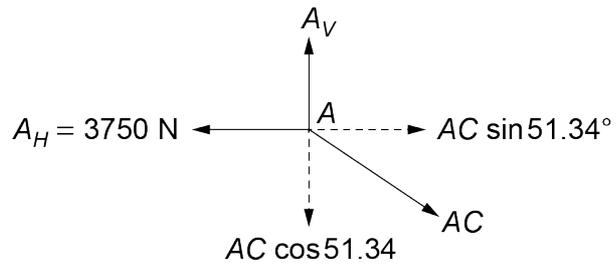
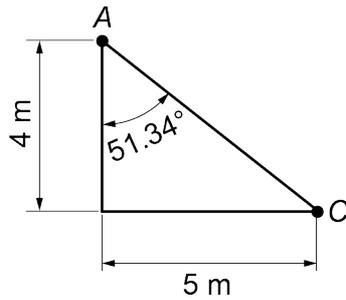
$$\therefore A_H = 3750 \text{ N} \leftarrow$$

$$A_H = 3.75 \text{ kN}$$

**Question 25 (b) (ii)**

| Criteria  | Marks |
|---|-------|
| <ul style="list-style-type: none"> <li>Shows relevant working in the correct calculation of the internal reaction acting in member AC</li> <li>Indicates the nature of the force</li> </ul> | 3     |
| <ul style="list-style-type: none"> <li>Makes progress towards calculating the internal reaction in AC</li> </ul>  | 2     |
| <ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>  | 1     |

**Sample answer:**



Method of joints at A:

$$\rightarrow \sum F_H = 0$$

$$0 = -3750 + AC \sin 51.34^\circ$$

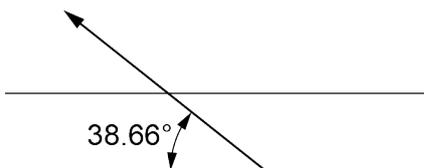
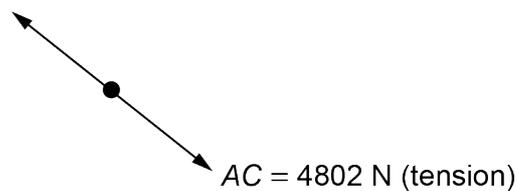
$$AC = 4802 \text{ N (tension)}$$

**Answers could include:**

By observation: Reaction A = Internal reaction AC

$\therefore$  External reaction at A = 4802 N

$$R_A = 4802 \text{ N}$$

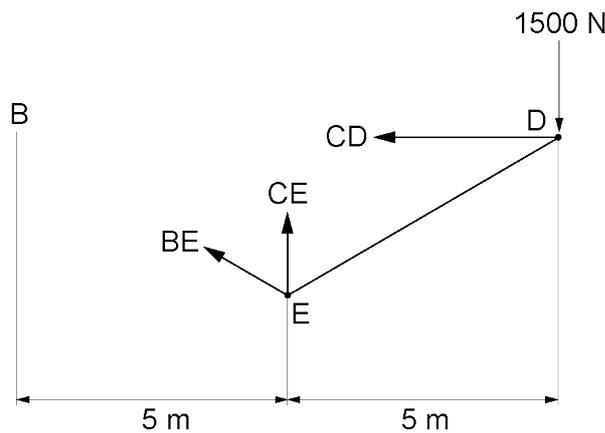


**Question 25 (b) (iii)**

| Criteria  | Marks |
|---|-------|
| <ul style="list-style-type: none"> <li>Shows relevant working in the correct calculation of the internal reaction acting in member CE</li> <li>Indicates the nature of the force</li> </ul> | 3     |
| <ul style="list-style-type: none"> <li>Makes progress towards calculating the internal reaction in CE</li> </ul>  | 2     |
| <ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>  | 1     |

**Sample answer:**

Using method of sections



Consider RHS of section plane

$$\begin{aligned} \circlearrowleft \sum M_B : 0 &= (CD \times 0 \text{ m}) + (BE \times 0 \text{ m}) - (CE \times 5 \text{ m}) + (1500 \text{ N} \times 10 \text{ m}) \\ + \circlearrowright \sum M_B &= 0 \quad \therefore CE = 3000 \text{ N (tension) } 3\text{kN (tension)} \\ 0 &= (CE \times 5) + (1500 \times 10) \\ CE &= \frac{15000}{5} \\ CE &= 3000 \text{ N} \\ CE &= 3 \text{ kN (tension)} \end{aligned}$$

**Question 25 (c)**

| Criteria  | Marks |
|---|-------|
| <ul style="list-style-type: none"> <li>Provides how the process of normalising affects the material properties of the pins</li> </ul> | 2     |
| <ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>  | 1     |

**Sample answer:**

Normalising involves heating a mild steel to the austenitic region and cooling quickly in air to produce fine, equiaxed grains of pearlite and ferrite. This results in a material with optimum toughness and tensile strength.

### Question 26 (a)

| Criteria  | Marks |
|---|-------|
| • Outlines a change in technology that has led to fuel efficiency | 2     |
| • Provides some relevant information                              | 1     |

**Sample answer:**

Lighter and more streamlined cars are generally more fuel efficient.

This has been achieved by improving the manufacturing methods and technology, such as replacing heavy steel bumpers and trim with lighter ABS (polymer) bumpers to decrease weight and make aerodynamic shapes easier to manufacture.

**Answers could include:**

- Using improved materials technology to produce aluminium engine blocks instead of cast iron engine blocks to decrease weight
- Using mathematical modelling in design to improve the aerodynamics of a car (reducing its drag and therefore its fuel efficiency).
- HYBRID cars and regenerative braking.
- A shift towards fuel injection and higher compression ratio (to give higher torque at lower revs) or other technical engine modifications.
- Cruise control which has improved acceleration/deceleration to maintain better average fuel economy.
- More efficient gearboxes and differentials that have lower friction and less torque.
- Improvements in lubrication technology to reduce internal friction.
- Similar valid reasoning.

### Question 26 (b)

| Criteria  | Marks |
|---|-------|
| • Shows relevant working in the correct calculation of the height the ramp must be raised | 3     |
| • Makes progress towards calculating the height the ramp must be raised                   | 2     |
| • Provides some relevant information  | 1     |

**Sample answer:**

The ramp is 3 m long

$$\mu = 0.5 = \tan \theta_R$$

$$\theta_R = \tan^{-1}(0.5) = 26.57^\circ$$

$$\sin 26.57^\circ = h/3$$

$$h = 3 \sin 26.57^\circ$$

$$h = 1.34 \text{ m}$$

### Question 26 (c)

| Criteria   | Marks |
|--|-------|
| <ul style="list-style-type: none"> <li>Provides a sound explanation of how a mobile phone maintains a communication link with the network</li> </ul> | 3     |
| <ul style="list-style-type: none"> <li>Demonstrates some understanding of a mobile phone maintaining a communication link</li> </ul>                 | 2     |
| <ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>   | 1     |

**Sample answer:**

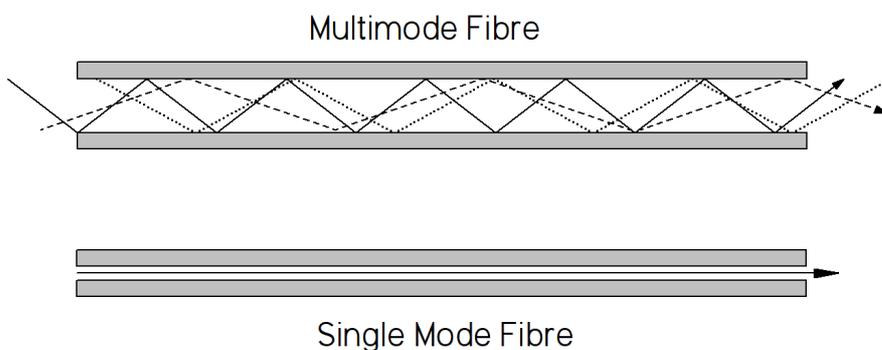
A mobile phone transmits an identifying code frequently to base stations. The base station that receives the strongest signal then transmits the phone location throughout the network. The network routes received calls from one base station to the next as the user changes location. This way, the mobile phone maintains a communication link as the operator moves location.

### Question 26 (d)

| Criteria   | Marks |
|--|-------|
| <ul style="list-style-type: none"> <li>Provides a clear comparison of multimode optical fibre and single mode optical fibre in terms of both light paths and materials</li> </ul>  | 4     |
| <ul style="list-style-type: none"> <li>Demonstrates some understanding of the difference(s) and/or similarity in multimode optical fibre and single mode optical fibre in terms of light paths and/or materials</li> </ul> | 3     |
| <ul style="list-style-type: none"> <li>Demonstrates some understanding of multimode optical fibre and/or single mode optical fibre</li> </ul>  | 2     |
| <ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>   | 1     |

**Sample answer:**

Multimode optical fibre is used to transmit data short distances and can be made from glass or acrylic (PMMA), surrounded by a cladding. Light can take many paths (modes) through this fibre. A single mode optical fibre has a central core made of glass. Light only takes one path along the central core of the fibre and does not internally refract along the length of the fibre, so it suffers less attenuation (signal loss) as each refraction results in a slight loss in signal strength.



## Question 27

| Criteria   | Marks |
|--|-------|
| • Demonstrates a comprehensive understanding of the use of the different drawing methods in engineering practice, with relevant examples | 8     |
| • Demonstrates a sound understanding of the use of the different drawing methods in engineering practice, with some examples             | 6–7   |
| • Demonstrates some understanding of the use of the different drawing methods in engineering practice, may provide example(s)            | 4–5   |
| • Demonstrates some understanding of the use of drawing(s) in engineering  | 2–3   |
| • Provides some relevant information   | 1     |

### **Sample answer:**

Freehand sketching allows complicated concepts to be transferred visually rather than using complicated equipment including computers. Freehand sketching is still used today because it only requires paper and pencil (no special equipment is necessary). It is a rapid form of communication that makes it suitable to use during the design development process to assist in communicating ideas to others quickly. Freehand drawing can be used on site to resolve issues as they might arise. Examples may include an engineer producing concept sketches, of new designs or sketching to illustrate a modification to an existing design.

Designers need to ensure that designs are built to exacting standards and sizes within specified tolerances. Technical drawings can be used to communicate engineering specifications. Applying technical drawing standards, such as AS 1100, creates clear, unambiguous graphical communication that transcends language barriers and means that technical information can be conveyed precisely and exactly. An example may be the production of formal technical drawings that may be provided to manufacturers so they can make production examples of the design.

Computer Aided Drawing (CAD) can be used to quickly create technical drawings, allows for rapid editing and ease of collaboration and for remote access to drawings solving an array of engineering problems. Additionally, CAD extends the capabilities of the engineer beyond simply drawing. With CAD an engineer can do detailed structural analysis of a component, calculate volumes of complex shapes quickly and link to a database of material costs, so as to allow for automatic calculation of cost of components 'on-the-fly'. CAD allows an engineer to develop a design entirely "virtually", for example aircraft are now fully designed in CAD without the need for models before making a flying prototype.

### **Answers could include:**

CAD

- CAD allows 3D modelling eg finite element analysis
- Architectural drawing has a 'library' which includes windows, doors etc that additionally can be used to calculate costing of buildings eg quantity surveying
- CAD drawings also allow electronic transfer of drawings
- CNC / CAM
- 3D Printing
- Allows for ease of collaboration (sabotage).

# 2021 HSC Engineering Studies Mapping Grid

## Section I

| Question | Marks | Content  | Syllabus outcomes |
|----------|-------|--|-------------------|
| 1        | 1     | Civil structures — communications – p26                                    | H3.3              |
| 2        | 1     | Aeronautical engineering — historical and societal influences – p32        | H2.2              |
| 3        | 1     | Telecommunications engineering — engineering electricity – p37             | H1.2              |
| 4        | 1     | Personal and public transport — communication – p29                        | H3.2              |
| 5        | 1     | Aeronautical engineering — scope of the profession – p31                   | H1.1              |
| 6        | 1     | Personal and public transport — engineering mechanics – p28                | H3.1              |
| 7        | 1     | Civil structures — engineering mechanics – p25                             | H6.2              |
| 8        | 1     | Personal and public transport — mechanics – p28                            | H3.1              |
| 9        | 1     | Aeronautical engineering — engineering mechanics – p32                     | H2.2              |
| 10       | 1     | Aeronautical engineering — engineering materials – p33                     | H2.2              |
| 11       | 1     | Telecommunications engineering — engineering electricity/electronics – p37 | H2.2              |
| 12       | 1     | Civil structures — engineering mechanics – p25                             | H3.1              |
| 13       | 1     | Aeronautical engineering — engineering mechanics and hydraulics – p32      | H3.1              |
| 14       | 1     | Civil structures — engineering mechanics – p25                             | H3.1              |
| 15       | 1     | Telecommunications engineering — engineering materials – p36               | H1.2              |
| 16       | 1     | Telecommunications engineering — engineering electricity/electronics – p37 | H3.1              |
| 17       | 1     | Civil structures — engineering materials – p25                             | H2.1              |
| 18       | 1     | Personal and public transport — engineering electricity/electronics – p29  | H3.1              |
| 19       | 1     | Civil structures — communication – p26                                     | H3.1              |
| 20       | 1     | Civil structures — engineering materials – p26                             | H1.2              |

## Section II

| Question    | Marks | Content   | Syllabus outcomes |
|-------------|-------|---|-------------------|
| 21 (a)      | 2     | Civil structures — historical and societal influences – p24 | H4.1, H4.2        |
| 21 (b) (i)  | 3     | Personal and public transport — communication – p29         | H3.3              |
| 21 (b) (ii) | 3     | Civil structures — engineering mechanics – p25              | H3.1              |
| 21 (c)      | 3     | Civil structures — engineering materials – p26              | H1.2              |

| Question     | Marks | Content   | Syllabus outcomes |
|--------------|-------|---|-------------------|
| 22 (a)       | 3     | Aeronautical engineering — communication – p33  | H3.3              |
| 22 (b)       | 2     | Personal and public transport — engineering materials – p26   | H2.1              |
| 22 (c)       | 3     | Personal and public transport — engineering electricity/electronics – p29                             | H3.1              |
| 22 (d)       | 4     | Personal and public transport — engineering mechanics – p28   | H3.1              |
| 23 (a)       | 3     | Aeronautical engineering — engineering materials – p33  | H1.2              |
| 23 (b)       | 3     | Aeronautical engineering — scope of the profession – p31  | H1.1              |
| 23 (c)       | 3     | Aeronautical engineering — engineering mechanics and hydraulics – p32; graphical mechanics – p33      | H3.1, H3.3        |
| 23 (d)       | 3     | Aeronautical engineering — engineering materials – p33  | H1.2              |
| 24 (a)       | 2     | Telecommunications engineering — engineering electricity/electronics – p37                            | H1.2              |
| 24 (b)       | 2     | Telecommunications engineering — engineering materials – p36  | H3.1              |
| 24 (c)       | 3     | Telecommunications engineering — engineering electricity/electronics – p37                            | H3.1, H2.2        |
| 24 (d)       | 6     | Aeronautical engineering — communication – p33<br>Personal and public transport — communication – p29 | H3.3              |
| 25 (a)       | 2     | Personal and public transport — engineering electricity/electronics – p29                             | H2.1, H3.1        |
| 25 (b) (i)   | 2     | Civil structures — engineering mechanics – p25  | H3.1              |
| 25 (b) (ii)  | 3     | Civil structures — engineering mechanics – p25  | H3.1              |
| 25 (b) (iii) | 3     | Civil structures — engineering mechanics – p25  | H3.1              |
| 25 (c)       | 2     | Personal and public transport — engineering materials – p28   | H1.2              |
| 26 (a)       | 2     | Personal and public transport — historical and societal influence – p27                               | H4.2              |
| 26 (b)       | 3     | Personal and public transport — engineering mechanics – p28   | H3.1              |
| 26 (c)       | 3     | Telecommunications engineering — engineering electricity/electronics – p37                            | H2.2              |
| 26 (d)       | 4     | Telecommunications engineering — engineering materials – p37  | H1.2              |
| 27           | 8     | Communication – p26, p29, p30, p33, p34 and p37   | H1.1, H2.2, H4.1  |