Government of **Western Australia**
School Curriculum and Standards Authority

AVIATION

ATAR course examination 2021

Marking key

Marking keys are an explicit statement about what the examining panel expect of candidates when they respond to particular examination items. They help ensure a consistent interpretation of the criteria that guide the awarding of marks.

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Section One: Multiple-choice **20% (20 Marks)**

Question	Answer
1	d
2	b
3	a
4	c
5	a
6	c
7	c
8	b
9	b
10	d
11	a
12	b
13	d
14	a
15	c & d
16	b
17	d
18	c
19	b
20	a

Section Two: Short answer **80% (129 Marks)**

Question 21 **(4 marks)**

Calculating pressure height and density altitude are essential to identifying aircraft performance.

Given the following data:
- airfield elevation 800 ft
- QNH 1003 hPa
- OAT 9 °C,

(a) calculate airfield pressure height. Show **all** workings. (2 marks)

Description	Marks
(ISA QNH – Actual QNH) × 30 ft + Elevation	
(1013 – 1003) × 30 ft + Elevation 800 ft	1
300 + 800 ft = 1100 ft	
1100 ft	1
Total	**2**
Showed above working but mathematical error 1 mark.	

Assume there has been a delay in departure and the pressure height is now calculated as 1500 ft.

(b) Calculate airfield density altitude. Show **all** workings. (2 marks)

Description	Marks
(ISA temperature deviation × 120 ft) + PA = DA	
(9 °C – 12 °C) × 120 ft + PA 1500 ft = DA	1
–3 °C × 120 ft + PA 1500 ft = DA	
–360 ft + 1500 ft = 1140 ft	1
Total	**2**
Showed above working but mathematical error 1 mark.	

Question 22 **(9 marks)**

Using the Graphical Area Forecast on page 9, identify the forecast:

(a) visibility and associated conditions at YTEF (2 marks)

Description	Marks
7000 metres in widespread light rain	1
2000 metres in scattered rain	1
Total	**2**
Note: Also accept 500 metres in isolated thunderstorm rain.	

(b) cloud at all levels for YPBO at 1100 UTC (3 marks)

Description	Marks
Scattered cumulus/stratocumulus 8000 feet to above 10 000 feet	1
Occasional cumulonimbus 8000 feet to above 10 000 feet	1
Occasional towering cumulus 8000 feet to above 10 000 feet	1
Total	**3**

(c) turbulence description at YBRM (2 marks)

Description	Marks
Moderate turbulence below 6000 feet	1
Severe turbulence in cumulonimbus and thunderstorms	1
Total	**2**

(d) issue time and date in plain language (1 mark)

Description	Marks
0443 UTC on 22 January 2021	1
Total	**1**

(e) freezing level at YBWX. (1 mark)

Description	Marks
Above 10 000 feet	1
Total	**1**

Question 23 **(6 marks)**

Although the magnetic compass is an instrument essential for flight, there are problems associated with its use. Explain how each of the following problems occurs when using a magnetic compass.

(a) Magnetic variation (3 marks)

Description	Marks
Earth's magnetic poles are not located at the geographic poles	1
Angle between magnetic North and true North need to be applied to compass headings	1
The difference between magnetic and true North is known as variation	1
Total	**3**
Accept other relevant answers.	

(b) Deviation (3 marks)

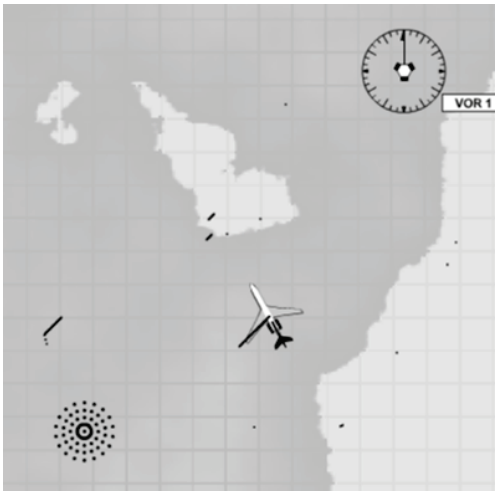
Description	Marks
Magnetic disturbances can cause the compass to deviate	1
Disturbances can include aircraft electrics and/or components	1
Deviation is indicated by compass card	1
Total	**3**
Accept other relevant answers.	

Question 24 **(3 marks)**

An aircraft is established on a bearing of 070° from an NDB and on the 210° radial from a VOR. The aircraft heading is 330°.

Draw a diagram to show the correct position of the aircraft relative to the navigation aids.

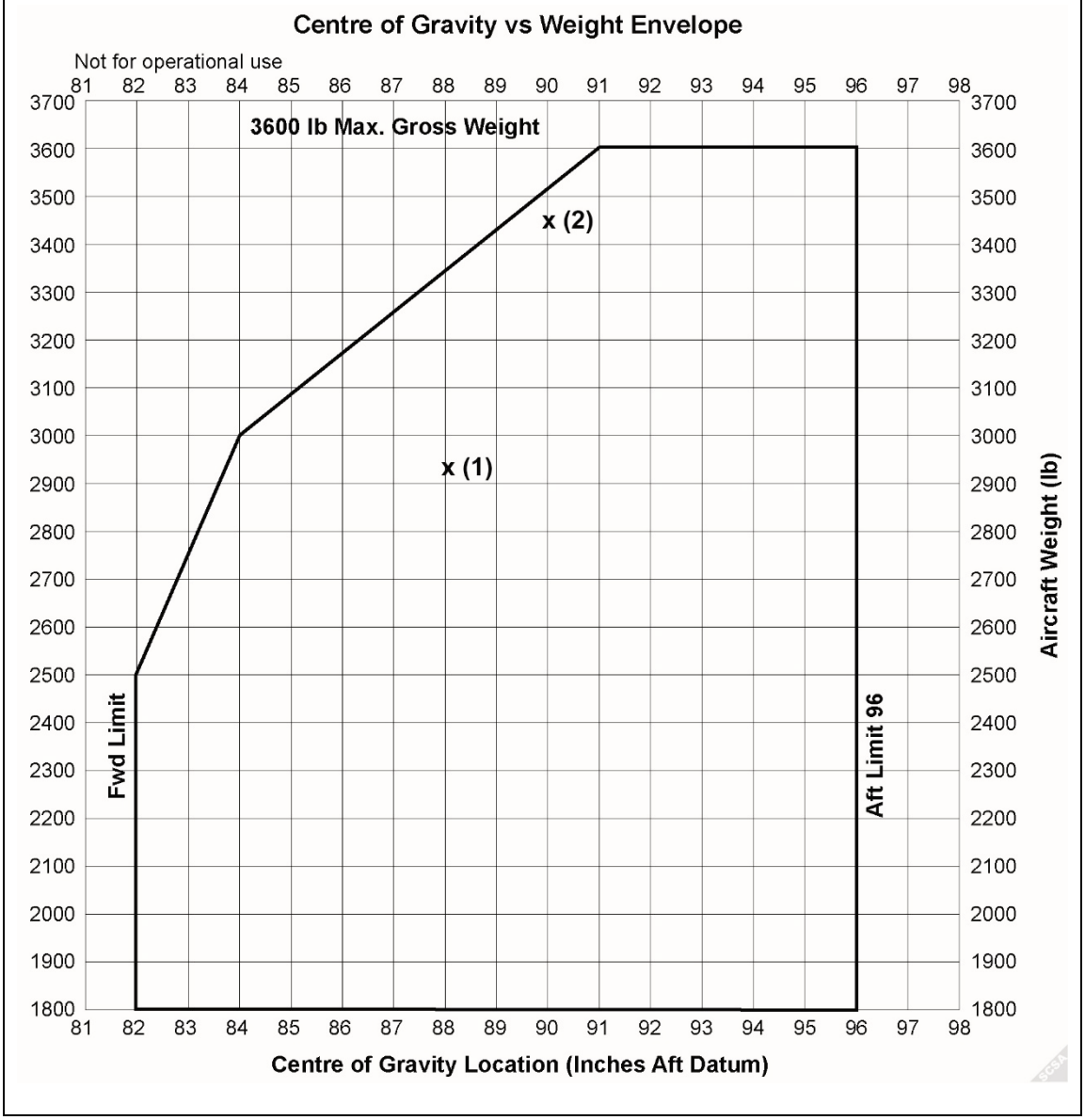
Description	Marks
Correct orientation of aircraft	1
Correct location of NDB	1
Correct location of VOR	1
Total	**3**



Question 25 **(5 marks)**

(a) Use the centre of gravity vs weight envelope chart provided to plot and label the zero fuel weight (1) and take-off weight (2). (2 marks)

Description	Marks
Plots zero fuel weight (1) and take-off weight correctly (2)	1
Labels zero fuel weight (1) and take-off weight correctly (2)	1
Total	**2**



(b) Additional unexpected luggage is now required to be carried. If the luggage is to be stored at 90 inches aft datum, calculate the maximum amount that can be carried. (1 mark)

Description	Marks
60 lb (±10)	1
Total	**1**
Award 1 mark if answer correct based on incorrect working from part (a).	

Question 25 (continued)

(c) Given the following data:

- cruise pressure altitude 16 000 ft
- outside air temperature –15 °C
- 75% best power,

use the performance chart below to determine cruise TAS and cruise power settings required for best economy. (2 marks)

Description	Marks
TAS 170 kt (±3)	1
Power setting mixture leaned to 50 °F rich of peak EGT (1650 °F maximum)	1
Total	**2**

Question 26 **(6 marks)**

An aircraft is approaching landing and its speed reduces to below stall speed.

(a) Use a diagram to show the airflow above and below the wing once the aircraft has stalled. Describe the pressure alterations because of the stall. (3 marks)

Description	Marks
Flow separation (turbulent) flow above the wing behind leading edge	1
Normal flow below wing	1
Increased pressure on top of the aerofoil	1
Total	**3**

Accept other relevant answers.

(b) State **three** ways in which a pilot can identify an approaching stall. (3 marks)

Description	Marks
Any **three** of the following (1 mark each)	
High nose attitude	1
Aircraft controls feel loose or sloppy	1
Stall warning is activated	1
Reduced air noise	1
Aircraft experiences buffeting	1
Total	**3**
Accept other relevant answers.	

Question 27 **(2 marks)**

Using the chart below, calculate the Beginning of daylight time (LMT) on 17 May for the position 22° 35’S, 125° 25’E. Show **all** workings.

Description	Marks
Calculates Beginning of daylight 0603 ± 3 minutes	1
Shows working with minimal errors	1
Total	**2**

Question 28 **(5 marks)**

(a) Identify **four** ways in which negative longitudinal stability might be incorporated into the design of an aircraft. (4 marks)

Description	Marks
Small fuselage or ventral surfaces	1
Small horizontal stabiliser	1
Longitudinal anhedral	1
Aft centre of gravity	1
Total	**4**
Accept other relevant answers.	

(b) Outline the concept of a statically-unstable aircraft. (1 mark)

Description	Marks
When the aircraft is disturbed it will move in the direction of disturbance	1
Total	**1**

Question 29 **(4 marks)**

Positive and negative acceleration forces (G-forces) can have a significant effect on the human body. Outline **four** effects the human body can experience as a result of these forces.

Description	Marks
Any **four** of the following (1 mark each)	
Grey out (positive) where the vision loses definition	1
Tunnel vision (positive) where peripheral vision is gradually lost	1
Blackout (positive) loss of vision while remaining conscious caused by lack of blood to the head	1
G-LOC (positive) loss of consciousness	1
Death (positive) due to excessive forces	1
Burst or swelling blood vessels (negative) or increased blood pressure causing degraded sight/blindness	1
Total	**4**
Accept other relevant answers.	

Question 30 **(8 marks)**

Understanding the different ways in which clouds form is essential to the safety of aviation operations. Explain the processes involved in cloud formation in relation to the following terms.

(a) Convection (3 marks)

Description	Marks
Air is forced to rise as a result of the Earth's surface being heated	1
Vertical extent of cloud depends on atmospheric stability	1
Cumuliform cloud most common	1
Total	**3**

(b) Mechanical turbulence (5 marks)

Description	Marks
Caused by air moving over Earth's surface in the friction layer	1
Usually within 3000 ft of Earth's surface	1
Air is mixed causing uniform temperature and humidity	1
Stratus and stratocumulus cloud most common	1
Generally accompanied by turbulence	1
Total	**5**

Question 31 **(7 marks)**

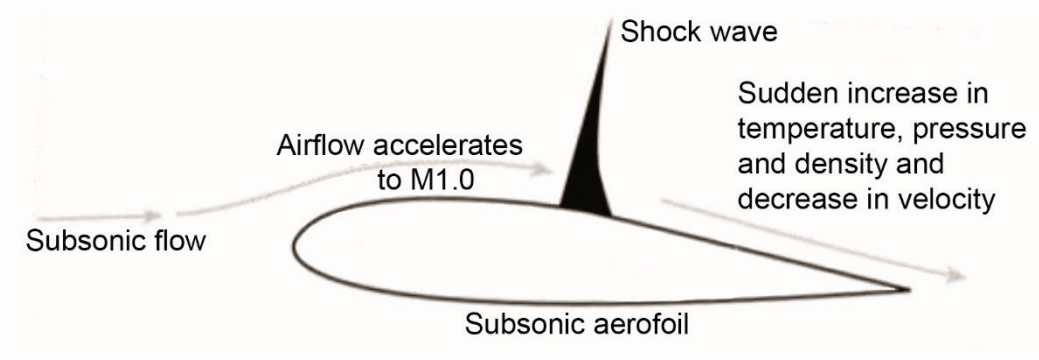
Using the scenario below, identify **four** threats and **three** errors.

Description	Marks
Threats	
Short or gravel runway	1
Time pressure or late passengers	1
Inability to communicate with company	1
No assessment of aircraft damage by an engineer	1
Subtotal	**4**
Errors	
Joining non-standard right base	1
Not assessing wind via approved source	1
Flying unstable or fast approach	1
Subtotal	**3**
Total	**7**
Accept other relevant answers.	

Question 32 **(6 marks)**

Use the diagram below to demonstrate the effect on the airstream over the aerofoil when the aircraft encounters a normal shock wave at subsonic speed.

Description	Marks
Shows airflow increasing to Mach 1	1
Shows shock wave at right angles and perpendicular to wing	1
Subtotal	**2**
Any **four** effects (1 mark each)	
Identifies increased temperature after shock wave	1
Identifies increased pressure after shock wave	1
Identifies increased density after shock wave	1
Identifies decreased velocity after shock wave	1
Identifies increased drag after shock wave	1
Subtotal	**4**
Total	**6**



Question 33 **(8 marks)**

The requirement for instrument flight rules (IFR) pilots to be aware of the aircraft's position at all times is vital to safe aircraft operations. Explain the operating process and state a limitation of the following.

(a) Inertial Navigation System (INS) (4 marks)

Description	Marks
Operating process	
Consists of accelerometers aligned to the Earth's surface	1
Stable platform maintains vertical alignment of accelerometers	1
Accelerometers use acceleration or deceleration to identify aircraft position	1
Subtotal	**3**
Any **one** limitation (1 mark)	
Requirement for the pilot to include accurate geographical coordinates prior to departure	1
Accuracy degrades over time	1
Subtotal	**1**
Total	**4**

(b) Global Positioning System (GPS) (4 marks)

Description	Marks
Operating process	
Satellite sends signals outwards	1
Aircraft receiver measures distance from satellite (using signal)	1
The distance from several satellites is used to establish accurate position	1
Subtotal	**3**
Any **one** limitation (1 mark)	
Requirement for minimum four satellites for position fix	1
Atmospheric interference	1
Subtotal	**1**
Total	**4**
Accept other relevant answers.	

Question 34 **(3 marks)**

Aircraft have an expected life span. Provide **three** considerations for an owner when deciding between extending the life of an existing airframe or purchasing a new aircraft.

Description	Marks
Any **three** of the following (1 mark each)	
Cheaper cost than purchasing new aircraft	1
Expected life after extension	1
Increased maintenance post life extension	1
Availability of aircraft parts	1
Total	**3**
Accept other relevant answers.	

Question 35 **(5 marks)**

Using a flight computer, determine each of the following.

(a) Identify the required heading and ground speed given a required track of 070° T, true airspeed of 140 kt and wind of 270° T/18 kt. (2 marks)

Description	Marks
068° T (±1) heading	1
157 kt (±1) groundspeed	1
Total	**2**

(b) How many minutes will it take an aircraft travelling at 140 kt to travel 250 nm? (1 mark)

Description	Marks
107 minutes	1
Total	**1**

(c) An aircraft uses 25 litres in 40 minutes of flying. Calculate the hourly fuel flow to the nearest half litre. (1 mark)

Description	Marks
37.5 litres per hour	1
Total	**1**

(d) An aircraft is established at a pressure height of 4000 ft, outside air temperature of 15° C and an indicated airspeed of 135 kt. Calculate the true airspeed. (1 mark)

Description	Marks
145 kt (±2)	1
Total	**1**

Question 36 **(5 marks)**

An aircraft has travelled 100 nm on a heading of 090° M and a position fix has been established 7 nm north of the planned track.

(a) Using the 1 in 60 rule, identify to the nearest degree the track error. Show **all** workings. (2 marks)

Description	Marks
Shows appropriate working (100 ÷ 60 = 1.6, 7 ÷ 1.6)	1
Track error 4°	1
Total	**2**

The final destination is a further 150 nm from the aircrafts present position.

(b) Use the 1 in 60 rule to identify the required closing angle and new required heading. Complete all answers to the nearest degree and show **all** workings. (3 marks)

Description	Marks
Closing angle = 150 ÷ 60 = 2.5, 7 ÷ 2.5 = 2.8, rounded = 3°	1
New heading = track error (4°) + closing angle (3°) + old heading (090° M)	1
New heading = 097° M	1
Total	**3**
If calculation error in part (a) is used with correct marking for part (b) then award marks as appropriate.	

Question 37 **(12 marks)**

Vision is critical to a pilot's situational awareness as well as their ability to make command decisions.

(a) Describe the following eye deficiencies and state their effect on the pilot experiencing the condition. (4 marks)

Description	Marks
Hypermetropia	
Light rays coming from closer distances are focussed past the retina	1
Effect on a pilot	
Results in close objects being out of focus	1
Subtotal	**2**
Astigmatism	
The cornea is oval shaped instead of the usual spherical shape	1
Effect on a pilot	
Results in blurred vision	1
Subtotal	**2**
Total	**4**

(b) Identify **three** characteristics of the following optical illusions experienced by a pilot and state how their impact can be reduced.

(i) Empty field myopia (4 marks)

Description	Marks
Characteristics	
Any **three** of the following (1 mark each)	
Experienced when flying above cloud or at night	1
The eye has no object to focus on	1
The eye (or lens) focuses on a point 1 or 2 metres from the eye	1
This results in tunnel vision with other objects not being seen	1
Subtotal	**3**
Impact reduction	
Reduced effect by refocussing vision regularly	1
Subtotal	**1**
Total	**4**

(ii) Autokinesis (4 marks)

Description	Marks
Characteristics	
Experienced at night when the pilot fixes gaze on a distant light	1
There are no other visual cues	1
The light appears to randomly move	1
Subtotal	**3**
Impact reduction	
Resolved by using peripheral vision instead of direct vision	1
Subtotal	**1**
Total	**4**

Question 38 **(4 marks)**

Alcohol can have a significant effect on the human body, resulting in impaired performance by flight crew. Identify **four** effects of alcohol consumption that are detrimental to flight crew performance.

Description	Marks
Any **four** of the following (1 mark each)	
Reduced decision making ability/reasoning/concentration	1
Decreased reflexes/coordination	1
Decreased efficiency of eye movements	1
Increased errors	1
Decreased peripheral vision/ability to read in dull light	1
Reduced sense of touch	1
Misplaced self confidence	1
Total	**4**
Accept other relevant answers.	

Question 39 **(2 marks)**

When a helicopter transitions from a hover to forward flight, an aerodynamic phenomenon occurs.

(a) What is this aerodynamic change called? (1 mark)

Description	Marks
Translational or effective translational lift	1
Total	**1**

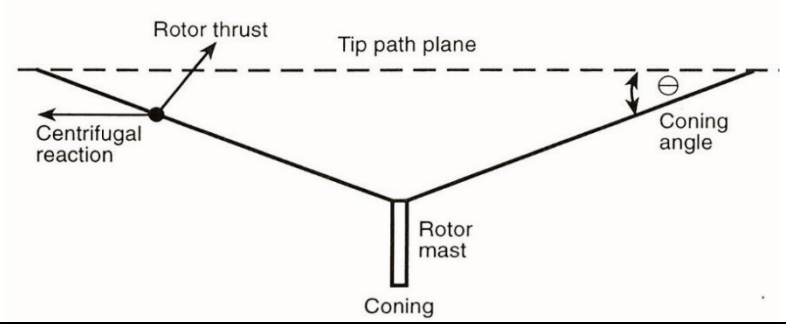
(b) State why this change occurs. (1 mark)

Description	Marks
The rotors break free of recirculating air **or** the blades bite clean air	1
Total	**1**

Question 40 **(4 marks)**

(a) With the aid of diagram, explain what is meant by 'coning' in relation to helicopters. (2 marks)

Description	Marks
Diagram shows helicopter blades flexing upwards	1
Coning is the upwards flexing of rotor blades in flight due to the weight of the aircraft	1
Total	**2**



(b) Explain the meaning of the expression 'hovering in the dead man's zone', when applied to helicopter operations. (2 marks)

Description	Marks
Range of airspeed-altitude combinations, from which survival from an autorotation, in the event of engine failure, is not likely. It is 'dangerous to hover there'.	2
Partial indication of the above response	1
Total	**2**

Question 41 **(7 marks)**

A propeller-driven, piston-engined aircraft with a constant speed propeller is at top of climb and the pilot commences establishing cruise performance.

(a) Explain the sequence of actions or the process of controls the pilot undertakes to establish cruise power settings. (4 marks)

Description	Marks
Actions in the correct relative order	
Aircraft needs to be level and established	1
Reduce throttle	1
Increase propeller pitch	1
Reduce mixture	1
Total	**4**

(b) When completing the actions identified in part (a), state which instrument is affected by each control. (3 marks)

Description	Marks
Throttle controls manifold pressure gauge	1
Propeller pitch controls RPM or tachometer	1
Mixture controls exhaust gas temperature gauge (EGT)	1
Total	**3**
Award 1 mark if answer correct based on incorrect responses from part (a).	

Question 42 **(8 marks)**

Aircraft are designed with many different propulsion systems, depending on their desired purpose and performance.

(a) Explain the operation of a turbojet engine. (6 marks)

Description	Marks
Air is sucked into the intake	1
Air pressure is increased by a compressor	1
Air is mixed with fuel and then burnt	1
The burning air then drives the compressor turbine which in turn drives the compressor	1
Remaining air is discharged via exhaust	1
Aircraft forward motion achieved through Newtons third law of motion	1
Total	**6**

(b) Describe the difference between a turbojet and a turboprop engine. (2 marks)

Description	Marks
Turboprop engine has extra turbine driven by the exhaust gases	1
This turbine drives propeller	1
Total	**2**

Question 43 **(6 marks)**

As air traffic increases in the Asia region as the post 2020 recovery phase occurs, significant differences will be evident. Explain the likely impact of this traffic increase on the aviation industry, the community and the environment.

Description	Marks
Any **six** of the following (1 mark each)	
Impact on the aviation industry: • more jobs available • increased airport/airspace congestion • use of underutilised airports or requirements to build new airports or expand existing airports • increased delays. Impact on the community: • increased noise or different noise areas • increased unusual hours flights • new airports being built • different airports being utilised. Impact on the environment: • increased carbon dioxide emissions • increased pollutants into ground/water sources • increased land clearing or dredging to establish new airports.	1–6
Total	**6**
Accept other relevant answers. Note: Candidates must include a correct response from each category for full marks.	

ACKNOWLEDGEMENTS

Question 26(a) Yeo, M., Bowers, G., & Bennett, K. (2001). Fig. 1.74 turbulent airflow over a stalled wing [Diagram]. *Handbook of flight* (2nd ed.). WestOne Services, p. 35. Not for operational purposes.

Question 32 Yeo, M., Bowers, G., & Bennett, K. (2001). Fig. 8.6 normal shock wave formation on an aerofoil in a subsonic airstream [Diagram]. *Handbook of flight* (2nd ed.). WestOne Services, p. 180. Not for operational purposes.

Question 40 Yeo, M., Bowers, G., & Bennett, K. (2001). Fig. 1.88 coning [Diagram]. *Handbook of flight* (2nd ed.). WestOne Services, p. 43. Not for operational purposes.

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