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

AVIATION

ATAR course examination 2018

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.

2018/60309

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

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

Section Two: Short answer **80% (123 Marks)**

Question 21 **(2 marks)**

Calculate airfield pressure altitude. Show **all** workings

Description	Marks
(ISA QNH – Actual QNH) x 30 ft + elevation (1013 – 1007) x 30 ft + Elevation 1525 ft	1
180 + 1525 ft = 1705 ft 1705 ft	1
Total	2

Question 22 **(2 marks)**

Calculate airfield density altitude. Show **all** workings

Description	Marks
(ISA, temperature deviation x 120 ft) + PA = DA (35 °C -15 °C) x 120 ft + PA 175 ft = DA	1
20 °C x 120 ft + PA 175 ft = DA 2400 ft + 175 ft = 2575 ft 2575 ft	1
Total	**2**

Question 23 **(2 marks)**

Determine the **maximum** number of whole litres that can be added so as **not** to exceed these limitations. Show **all** workings.

Description	Marks
shows appropriate working	1
129 L	1
Total	**2**
Note: No other answers.	

Question 24 **(2 marks)**

Use your flight computer to resolve the following:

(a) What heading would be required to be flown to maintain the planned track? (1 mark)

Description	Marks
166° M (+ /–1)	1
Total	**1**

(b) What ground speed would the aircraft be maintaining? (1 mark)

Description	Marks
TAS 120 kt less headwind 17 kt GS 103 kt (+/–2)	1
Total	**1**

Question 25 **(4 marks)**

(a) Using **only** the 1 in 60 rule, determine the actual Track Made Good (TMG). Show **all** workings. (2 marks)

Description	Marks
distance off track: 5 nm in 75 nm = 4 nm in 60 nm 4 nm in 60 nm = 4° FPT 090° M so if 4° right of track then right drift	1
TMG = 094° M	1
Total	**2**

(b) On the basis of the data provided, describe the most plausible reason why the aircraft is off track at the 75 nm point. (2 marks)

Description	Marks
forecast winds were not as strong as forecast and did not eventuate and as a result the drift planned for caused the aircraft to be off track	1–2
Total	**2**
Note: must describe, single word response such as 'wind' unacceptable.	

Question 26 **(7 marks)**

(a) Determine the TAS for the flight conducted for best economy. Show **all** workings on the chart. (2 marks)

Description	Marks
124 kt (+/–1 kt) and shows workings	2
shows correct workings on chart but appears to have misread speed	1
Total	**2**

(b) Determine the new TAS if the aircraft was set up to fly 75% power for best power while still maintaining the advised altitude. (2 marks)

Description	Marks
152 kt (+/–1 kt) and shows workings	2
shows correct workings on chart but appears to have misread speed	1
Total	**2**

(c) The RPM and Manifold Absolute Pressure (MAP) limitations for Maximum Continuous Power (M.C.P) at 8000 ft pressure altitude in ISA would be: (3 marks)

RPM: 2575

MAP: 33 In.Hg

The resulting TAS would be closest to: 170 kt (+/–1)

Description	Marks
all three answers correct and in correct position	3
two answers correct and in correct position	2
one answer correct and in correct position	1
Total	**3**
Note: MAP answer must state unit 'In.Hg' to be correct	

Question 27 **(3 marks)**

(a) Calculate the planned ground speed. Give the correct unit of measurement. (1 mark)

Description	Marks
142 kt (+0/–1 kt)	1
Total	**1**

(b) The aircraft arrives over its second waypoint at UTC 0600. Calculate the actual ground speed (to the nearest whole unit) achieved for this flight. (2 marks)

Description	Marks
distance unchanged 260 nm new time interval 95 minutes 260/95 x 60 = 164 kt	2
164.2 kt or showed correct calculation above but made error	1
Total	**2**

Question 28 **(3 marks)**

Using the End of daylight chart below, calculate last light in LMT on 10 October for Albany (34° 57' S, 117° 49' E). Show **all** workings.

Description	Marks
1836 LMT (–1/+1 minutes)	2
showed workings correctly to support answer given	1
Total	**3**
Note: 1836 LMT (–2/+2 minutes) – one mark Showed workings correctly but incorrectly recorded result outside tolerance – one mark	

Question 29 **(4 marks)**

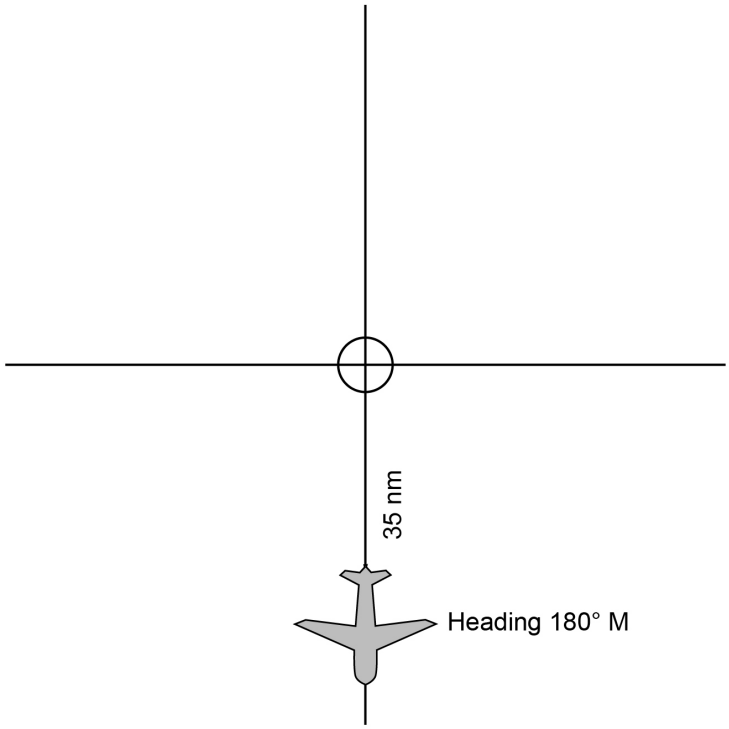
Determine the minimum onboard fuel requirements (in litres) at start up for a flight 276 nm at a planned ground speed of 150 kt. Show **all** workings.

Description			Marks
GS 276 nm @ 150 kt GS = 110.4 minutes Fuel 110.4 minutes @ 45 L/hr	= 82.8 L	(accept 83 L)	1
Fixed reserve 45 minutes @ 45 L/hr	= 33.8 L	(accept 34 L)	1
Taxi fuel	= 5.0 L		1
Total minimum fuel on board at start up	= 121.6 L	(accept 122 L)	1
		Total	**4**
Note: Total minimum fuel answer. One mark if they showed all workings to include all required fuel items with a single nominal identifiable error in mathematical calculations only. Working may be expressed in different layout provided data included can be identified i.e. 276 nm /150 kt = 1.84 hrs + 0.75 hrs fixed = 2.59 hrs x 45 L/hr = 116.556 + 5 L taxi = 121.6 L			

Question 30 **(3 marks)**

Plot the aircraft's position and orientation as accurately as possible using your navigational plotter and WAC scale ruler (1: 1 000 000) on the basic orientation diagram below.

Note: Circle represents collocated VOR/DME

Description	Marks
	
aircraft located on correct bearing	1
aircraft shown in correct orientation of heading	1
aircraft shown at correct distance	1
Total	**3**
Note: distance from VOR should be measures at 35 nm using a WAC ruler Check scale of exam map	

Question 31 **(4 marks)**

Use your flight computer to calculate and complete the following table.

Description		Marks
Angle of drift	9° (+/–1)	1
Direction of drift	right	1
Heading	130° M (+/–1)	1
GS	156 kt (+/–2)	1
	Total	**4**

Question 32 **(11 marks)**

(a) Determine the minimum take-off distance required at Alpha. Show **all** workings clearly on the appropriate chart (2 marks)

Description	Marks
800 m (+/–10 m)	2
800 m (+/–20 m)	1
Incorrect answer or outside tolerances but workings on chart with nominal apparent error in reading final answer	1
Total	**2**

(b) Determine climb, cruise and descent data to complete the table below to find the
- total flight time.
- total flight fuel required, i.e. excluding reserves, taxi and unusable fuel.

Ignore all winds in the climb, cruise and descent. Show **all** workings clearly on the appropriate chart. (9 marks)

Description					Marks
One mark for each correct answer in the climb, cruise and descent columns only					
	Climb	**Cruise**	**Descent**	**Total**	
Fuel (gal)	4 (+/–1)	32 (+/–1)	1 (+1/–0)	37	1–3
Time (min)	7 (+/–1)	139 (+/–2)	2 (+1/–0)	148	1–3
Distance (nm)	14 (+/–1)	336 (+/–2)	5 (+/–1)	355 nm	1–3
				Total	**9**
Note: use the total column only to assist in resolving any issues with tolerances in each row					

Question 33 **(4 marks)**

Weight and balance are important parameters for aircraft.

Complete the table below for a Piper PA-32RT-300T Turbo Lance aircraft to show the weight, position of the centre of gravity and moment at zero fuel weight.

Position	Weight (lb)	Arm (in)	Moment (lb/in)
Aircraft (BEW)	2335.8		195086.0
Front row	322.0	85.5	27531.0
Centre row	225.0	118.1	26572.5
Rear row	140.0	157.6	22064.0
Forward baggage	5.0	42.0	210.0
Aft baggage	50.0	178.7	8935.0
Zero fuel weight	3077.8	91.1	280398.5

Description		Marks
Completed Moment column calculations correctly		1
Zero fuel weight total	3077.8 lb	1
Moment total	280389.5 lb/in (+/–1)	1
Arm	91.1 in (accept 91 in)	1
	Total	**4**
Note: Arm incorrect but has calculated using incorrect figures elsewhere in table and has demonstrated correct concept and procedure – one mark.		

Question 34 **(5 marks)**

An aircraft needs to be balanced in all stages of flight.

(a) Complete the table below to show the position of centre of gravity and moment for the aircraft at ramp prior to taxi. (2 marks)

Position	Weight (lb)	Arm (in)	Moment (lb/in)
Zero fuel weight	2950	93.0	274350
Fuel	325	93.6	30420
Ramp weight	3275	93.06	304770

Description	Marks
Moment 304770 (lb/in)	1
Arm 93.0 (accept within range 93.0 to 93.1)	1
Total	**2**

(b) In which direction does the loading of fuel move the centre of gravity on this occasion? Justify your answer. (3 marks)

Description	Marks
Direction of movement	
states COG moved backward or towards the rear of the aircraft or similar description of an aft moving COG	1
Justification	
fuel tanks loading station is behind the ZFW COG	1
weight added behind the ZFW COG must move the COG rearward	1
Total	**3**
Accept other relevant answers	

Question 35 **(3 marks)**

Given a time of 1129 Local Mean Time (LMT) and a position of 15° 25’ S 134° 20’ E, use the Conversion of Arc to Time chart below to convert LMT to Coordinated Universal Time (UTC). Show **all** workings.

Description	Marks
Showed correct workings from arc of conversion chart as above Less Arc conversion 134° = 8 hrs 56 min 20” = 1 min 20 secs	1
Total 8 hrs 57 mins	1
11:29 – 8:57	
UTC 0232 +0/–1 (accept UTC 02:31:46s)	1
Total	**3**

Question 36 **(4 marks)**

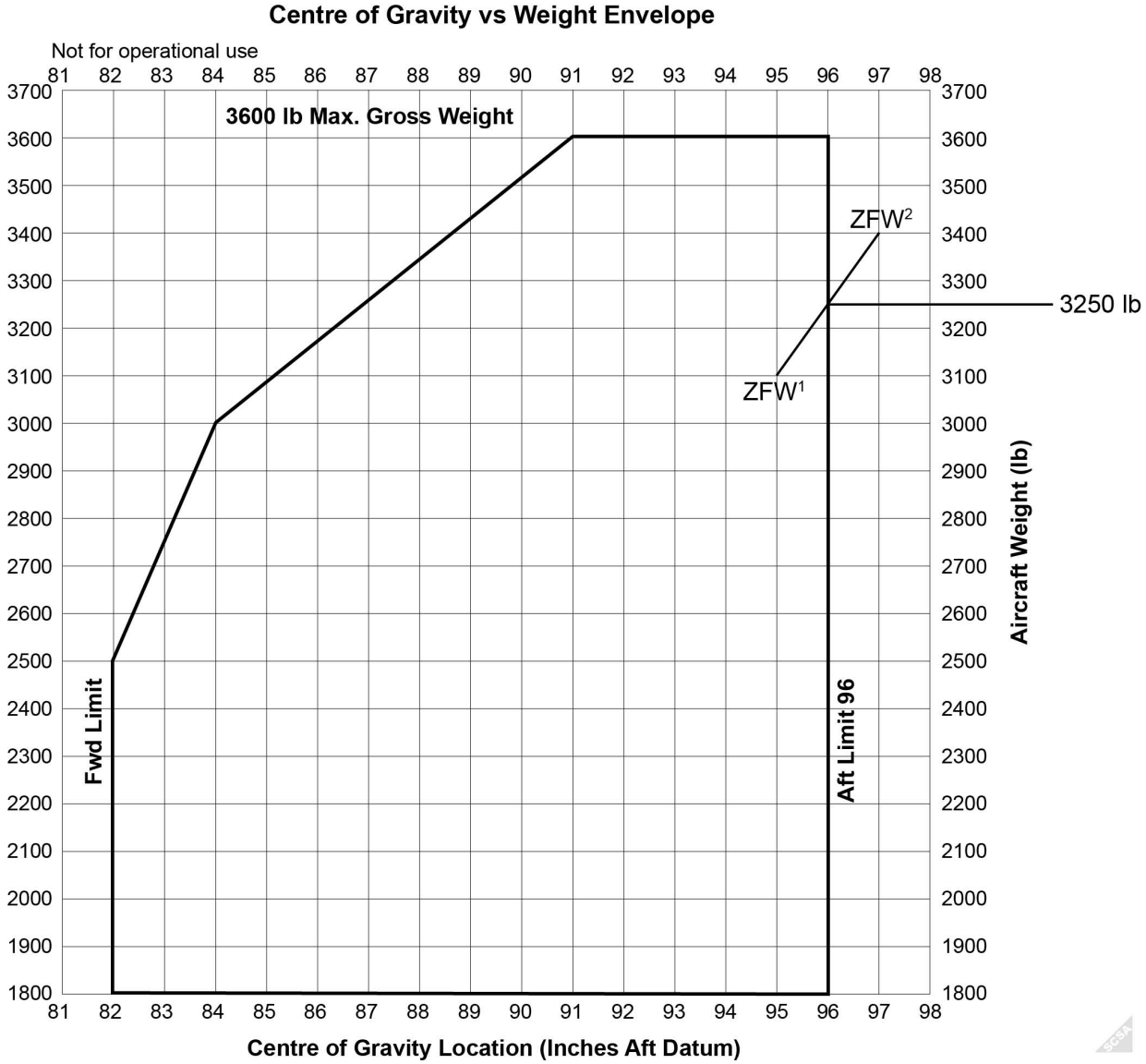
Using the formula provided, determine the **maximum** theoretical amount of additional baggage that could be added to the aft baggage compartment for both zero fuel weight and take-off weight to load the aircraft to a desired maximum aft centre of gravity position of 96 in. Show **all** workings.

$$\text{Weight to add} = \frac{\text{Gross weight x desired change of centre of gravity}}{\text{Distance between loading station and desired centre of gravity}}$$

Description	Marks
Calculate for zero full weight	
114.1 lb (+0 /–1)	2
showed workings using formula but made mathematical error	1
Subtotal	**2**
Calculated for take-off weight	
47.8 lb (+0 /–1)	2
showed workings using formula but made mathematical error	1
Subtotal	**2**
Total	**4**

Question 37 **(3 marks)**

(a) Use the centre of gravity vs weight chart provided to plot and label both the zero fuel weight (1) and proposed zero fuel weight (2). (2 marks)



Description	Marks
correctly plotted both positions	2
correctly plotted only one position	1
did not plot any position	0
Total	**2**

(b) Purely on the basis of your observation from the positions plotted on the graph, determine the maximum permissible zero fuel weight for this aircraft if the weight was adjusted so the aircraft remained loaded to the maximum aft limit only. (1 mark)

Description	Marks
3250 lb (+/–10)	1
If the candidate made a plotting error in part (a) review the graph and if the answer given is correct in accordance with the graph award 1 mark.	1
Total	**1**

Question 38 **(4 marks)**

Anhedral is an aerodynamic design feature fitted to some aircraft.

(a) State the purpose of this design feature. (1 mark)

Description	Marks
Anhedral can be incorporated into design of an aircraft to reduce the lateral stability of an aircraft to a more acceptable and manoeuvrable level.	1
Total	**1**
Note: must state 'reduce' lateral stability	

(b) Explain why an anhedral would be required to be fitted to a high wing heavy transport aircraft with sweptback wings such as the Antonov AN-225. Use diagrams to assist with your answer.

(3 marks)

Description	Marks
Any of the following:	
• aircraft with sweepback wings increases lateral stability • high keel surface low cog increase lateral stability • aircraft has become too laterally stable with high directional stability and may result in now suffering from Dutch roll if lateral stability not reduced • aircraft modification required to reduce overall lateral stability so as to make the aircraft manoeuvrable in the roll	1–3
Total	**3**

Question 39 **(3 marks)**

Calibrated air speed (CAS) is a term referred to in the aviation environment.

(a) What is CAS? (1 mark)

Description	Marks
Calibrated air speed is indicated air speed corrected for position and instrument error.	1
Total	**1**

(b) What **two** factors need to be taken into consideration in order to calculate a CAS on a light general aviation fixed-wing propeller driven aircraft? (2 marks)

Description	Marks
positioning of the static port and pitot tube may be influenced by disruptive airflow and cause error in readings. This can be measured.	1
any calculated instrument error detected in design or manufacturing	1
Total	**2**

Question 40 **(8 marks)**

(a) What is the pressure at position A? (1 mark)

Description	Marks
1028 hPa	1
Total	**1**

(b) Which meteorological feature is shown by the dashed line between positions E and F? (1 mark)

Description	Marks
trough	1
Total	**1**

(c) The frontal system passing over central New Zealand, below position F is moving in which direction and at what speed? (1 mark)

Description	Marks
direction: easterly	
speed: 30 kt	
must have both direction and speed correct	1
Total	**1**

(d) Describe the frontal system incorporating the line from position C to position D. (2 marks)

Description	Marks
warm front	1
(warm air mass) moving in a westerly direction	1
Total	**2**
Note: direction is required for one mark.	

(e) Identify the system and describe conditions associated with the feature between positions B and C as it passes over the south-west of Western Australia. (3 marks)

Description	Marks
Identify: cold front	1
Describe using any **two** of the following:	
• possible thunderstorms and rain • temperature reducing as front moves past • air colder and drier • pressure increases after front has passed • winds will back in direction	1–2
Total	**3**

Question 41 **(4 marks)**

Good ergonomic design performs a pivotal role in assisting with aviation safety.

(a) What is meant by the term 'ergonomics'. (1 mark)

Description	Marks
study of human/machine interface **or** interaction between human operator and machine through controls gauges and levers	1
Total	**1**
Note: any other relevant answer based on the above interaction	

(b) Using an example, explain how the implementation of ergonomic principles can enhance safety. (3 marks)

Description	Marks
Plausible example provided	
Response: similar to cockpit instruments design/seating position/cockpit layout. Colour usage/shapes of control switches/usage in the correct sense.	1
Explanation	
• making the interaction uniform so that a change of (similar) aircraft does not introduce different design layouts and operating procedures • operator becomes familiar with design layout and operating methods and the operation of equipment levers and controls work in the correct sense (example) undercarriage lever has knob end that looks and feels similar to a wheel and operating in correct sense lever down gear down/lever up gear up	1–2
Total	**3**
Note: Any plausible description example and operating method described. Explanation must highlight design aspects and its relationship to human interface.	

Question 42 **(11 marks)**

Cyclones are a serious hazard to aviation in the Southern Hemisphere.

(a) Outline **three** prerequisite conditions necessary for the formation of a cyclone in the Southern Hemisphere. (3 marks)

Description	Marks
warm water temperature in excess of 27 °C	1
a tropical disturbance between latitude 5° S and 15° S	1
pressure gradient force greater than Coriolis force to initiate rotation	1
Total	**3**

(b) Describe conditions within a cyclone and the area immediately around it (out to 50 nm) as the cyclone travels over an ocean and overland. In each of your answers outline what happens to its intensity and why these changes occur.

(i) Ocean: (4 marks)

Description	Marks
Intensity	
Increases intensity as a result of incoming moisture from the warm oceans.	1
Subtotal	**1**
Why changes occur	
• develop a balanced circulation pattern • strong surface convergence that triggers unstable spiral clouds formations • increases in intensity as a result of incoming moisture from the warm oceans • pressure reducing below 1000 hPa • wind speeds reach 64 kt or more • strongest winds in the forward left quadrant	1–3
Subtotal	**3**
Total	**4**
Note: reference **must** be made to the cyclone increasing intensity.	

(ii) Overland: (4 marks)

Description	Marks
Intensity	
Loses intensity and starts to decay becoming a tropical intense rain-bearing depression.	1
Subtotal	**1**
Why changes occur	
• moisture loss overland not being replaced • friction layer ground greater slowing rotation velocity • wind speeds reduce • loses intensity • heavy rainfall • pressure stops falling	1–3
Subtotal	**3**
Total	**4**
Note: reference **must** be made to the cyclone losing intensity.	

Question 43 **(9 marks)**

Visual illusions and other natural tendencies of the human eye can cause problems for pilots in flight. Explain the effects of the following, including how they occur and how they may be reasonably managed.

(a) Empty-field myopia: (3 marks)

Description	Marks
Effect occurs via	
natural tendency for the eye to focus on a point one to two metres ahead	1
occurs when not visually focusing on a specific item	1
Reasonably managed	
best managed by maintaining a constant scan technique	1
Total	**3**

(b) Auto kinesis: (3 marks)

Description	Marks
Effect occurs via	
a lighted object appears to move or oscillate against a dark background	1
most common at night; may cause loss of spatial awareness	1
Reasonably managed	
avoid focusing on a fixed point; scan the horizon	1
Total	**3**

(c) False horizon: (3 marks)

Description	Marks
Effect occurs via	
• sloping layers of cloud by day	1
• angled lines on the ground	
• area of lights by night	
• areas of ragged lowering cloud base and associated drizzle or rain obscuring the horizon	
• mislead the pilot as to the positioning of the horizon or that wings may not be level	1
Reasonably managed	
be aware of the illusion and verify horizon with instruments	1
Total	**3**

Question 44 **(4 marks)**

Some aircraft are fitted with an engine manifold pressure gauge.

(a) What does the manifold pressure gauge actually measure and where is the measurement taken? (2 marks)

Description	Marks
• the manifold pressure gauge is an engine instrument typically used in piston aircraft engines to measure the pressure inside the induction system of an engine **or** • the manifold pressure gauge senses the pressure (or vacuum) inside the intake manifold	1
manifold pressure is measured between the throttle valve and the intake manifold of the engine cylinders	1
Total	**2**

(b) Describe how manifold air pressure would be adjusted/controlled by the pilot. (2 marks)

Description	Marks
the throttle controls the engine's power output which is indirectly indicated on the manifold pressure gauge	1
advancing the throttle increase the intake manifold pressure allowing more air/fuel mixture to enter the cylinders. Creates larger pressure differential between intake manifold and cylinder creating suction into the system	1
Total	**2**

Question 45 **(7 marks)**

Carbon monoxide poisoning poses a real risk to pilots.

(a) Explain how carbon monoxide affects the body. (2 marks)

Description	Marks
carbon monoxide inhibits the blood system from carrying oxygen	1
effects are primarily hypoxia	1
Total	**2**

(b) Give **two** symptoms a pilot could experience if exposed for prolonged periods of carbon monoxide. (2 marks)

Description	Marks
Any **two** of the following:	
• headache, dizziness, nausea • deterioration of vision • impaired judgement • personality change • impaired memory • slower breathing rate • cherry red complexion • loss of muscular power • convulsions • coma	1–2
Total	**2**

(c) How can a pilot detect carbon monoxide in flight? (2 marks)

Description	Marks
Carbon monoxide cannot normally be detected (colourless and odourless). However; it may be mixed with exhaust fumes, these fumes smell and may be detectable by the pilot.	1
aircraft need to have carbon monoxide detectors visible in the cockpit	1
Total	**2**

(d) What would be the best immediate treatment for a person suffering from carbon monoxide poisoning? (1 mark)

Description	Marks
Any of the following:	
• provide fresh air • provide oxygen	1
Total	**1**

Question 46 **(7 marks)**

Research continues into practical alternative means of operating an aircraft's motor.

Discuss the factors influencing the ongoing development of both alternative fuels and implementation of electric aircraft motors. Highlight the likely positive and negative impact these developments might have on the aviation industry.

Description	Marks
Discussion of factors	
• aviation accounts for a large proportion of CO_2 emissions from the burning of fuels • potential to reduce CO_2 emissions (by up to 80%) • consideration of economics of alternate fuels to fossil fuels and as the supply of fossil fuels reduces demand will cause a premium increase in pricing to be no longer economically • some fossil fuels contain no aromatics and sulphur leading to a reduction of soot and sulphur oxides emissions • potential fuels from agricultural waste by products may be a viable source of fuels without negative impact on current food stocks and adversely effecting existing land use • public pressure to reduce pollution • market edge – cheaper fuel stocks, can offer lower prices to capture market share and advertise as a green company • large financial commitment in conducting research and testing are a negative • unproven technology and potential long term maintenance issues may arise Existing fuel driven engines • engine is proven reliable in existing format and should continue to perform well with alternate fuels	1–5
Electric aircraft engine • should state unproven technology a long way from development however still relies on charge from electrical source (currently majority are coal/fuel power stations) • battery based storage adds significant weight	1–2
Total	**7**
Accept other relevant answers. Note: One mark for each plausible fact up to a maximum of seven.	

ACKNOWLEDGEMENTS

Question 39(a) Text under 'Description' adapted from: Airspeed. (2018). In *Wikipedia.* Retrieved August, 2018, from https://en.wikipedia.org/wiki/Airspeed Used under Creative Commons Attribution-ShareAlike 3.0 Unported licence

Question 44(a) Text under 'Description' (1st dot point) from: Tocknell, P. (2009). *What is manifold pressure?* [Web log post]. Retrieved August, 2018, from http://www.askacfi.com/421/what-is-manifold-pressure.htm

Question 44(b) Text under 'Description' (1st row) from: Federal Aviation Administration (1980). *Flight training handbook* (Ch. 2). Seattle, WA. Retrieved August, 2018, from http://avstop.com/ac/flighttrainghandbook/manifold.html

Published by the School Curriculum and Standards Authority of Western Australia
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