Government of **Western Australia**
Curriculum Council

WACE
Western Australian Certificate of Education

Western Australian Certificate of Education Examination, 2009

Question/answer booklet

AVIATION

Written paper
Stage 3

Please place your student identification label in this box

Student Number: In figures | | | | | | | | |

In words _____

_____

Time allowed for this paper
Reading time before commencing work: ten minutes
Working time for paper: two and a half hours

Materials required/recommended for this paper
To be provided by the supervisor
This Question/Answer Booklet
Multiple-Choice Answer Sheet
Aviation Appendices Booklet comprising:
Appendix A WAC Excerpt
Appendix B PA-32 Fuel, Time, Distance to Climb Performance Chart
Appendix C PA-32 Fuel, Time, Distance to Descend Chart
Appendix D PA-32 Cruise Performance Chart
Appendix E PA-32 Take-Off Weight Chart
Appendix F Daylight Graph
Appendix G Time-Arc Conversion Chart

To be provided by the candidate
Standard items: pens, pencils, eraser, correction fluid, ruler, highlighters

Special items: a blue or black pen or a B or 2B pencil for the separate Multiple-Choice Answer Sheet, and calculators satisfying the conditions set by the Curriculum Council for this course, flight computer, navigational ruler and protractor

Important note to candidates
No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

2010/90[v2]
Web version of 2009/23974

Ref: 913

Structure of this paper

This paper is worth 80 per cent of the total marks for the WACE examination in this course. The remaining 20 per cent of marks will come from the practical component of this examination.

Section	Number of questions available	Number of questions to be attempted	Suggested working time (minutes)	Marks available
Section One: Multiple-Choice	20	20	25	20
Section Two: Short Answer	18	18	125	80
			Total marks	100

Instructions to candidates

1. The rules for the conduct of Western Australian external examinations are detailed in the *Year 12 Information Handbook 2009.* Sitting this examination implies that you agree to abide by these rules.

2. Answer all questions according to the following instructions:

   Section One: Answer **all** questions on the separate Multiple-Choice Answer Sheet. Use a blue or black pen or a B or 2B pencil.

   Section Two: Write your answers in the spaces provided in this Question/Answer Booklet. A blue or black pen should be used.

   Wherever appropriate, fully labelled sketch maps, diagrams and examples should be used to illustrate and support your answers.

3. Spare answer pages are provided at the end of this booklet. If you need to use them, indicate in the original answer space where the answer is continued, i.e. give the page number.

See next page

Section One: Multiple-Choice **20 Marks**

Record answers for Questions 1 to 20 on the separate Multiple-Choice Answer Sheet provided.

Select the single correct alternative in each of the following questions. Each question is worth one mark.

---

1. A Mercator chart is based on a projection that is

   (a) cylindrical.
   (b) conical.
   (c) spherical.
   (d) concentric.

2. An aircraft is cruising at A025 and the pilot decides to climb to FL125 at a constant 500 fpm. If the ground speed is 170 knots, what ground distance will be covered during this climb?

   (a) 35 nm
   (b) 57 nm
   (c) 28 nm
   (d) 71 nm

3. An error commonly associated with the NDB is Terrain Effect. Which of the following statements is correct?

   (a) Sandy/rocky terrain has high conductivity, greater attenuation and shorter range.
   (b) Salt water has high conductivity, less attenuation and a shorter range.
   (c) Attenuation has no bearing on the range of an NDB.
   (d) Sandy/rocky terrain has low conductivity, greater attenuation and shorter range.

4. When using a GPS, a position fix is obtained by

   (a) the aircraft's receiver measuring the phase angle of the signal received from a number of satellites in known positions.
   (b) measuring the time taken for a minimum number of satellites' transmissions in known positions to reach the aircraft's receiver.
   (c) the aircraft transmitting a coded signal to all satellites within range and a ground-based computer system relaying back a positive position fix to the aircraft.
   (d) measuring the time taken for an aircraft's transmission to travel to a number of satellites in known positions and return to the aircraft's receiver.

5. Which of the following is **not** a component of the Instrument Landing System (ILS)?

   (a) localiser
   (b) glide path
   (c) marker beacons
   (d) VOR

See next page

6. A build-up of carbon monoxide in the cockpit of an aircraft is dangerous because it

(a) is poisonous and destroys the lining of the lungs.
(b) attaches preferentially to haemoglobin in the blood and reduces the supply of oxygen to the cells of the body.
(c) indicates to the pilot that the engine is faulty and that it may cease operating at any time.
(d) is highly acidic, can attack the pilot's eyes and can seriously affect vision.

7. A pilot is planning a flight with the following information

The flight planned track of 190ºT	W/V 085ºT/25 kt
Aircraft TAS 115 kt	Magnetic Variation 5ºE

Given the above conditions, the heading and ground speed are closest to

(a) 173ºM and 119kt.
(b) 183ºM and 119kt.
(c) 178ºT and 121kt.
(d) 173ºT and 121kt.

8. In the southern hemisphere, the geostrophic wind flows

(a) at 10º towards the higher pressure over land.
(b) along curved isobars.
(c) at 30º towards the lower pressure over land.
(d) along straight isobars.

9. Consider the following statements about the stratosphere:

I. The temperature in the lower levels is almost constant.
II. There are no strong winds.
III. The most common cloud is altostratus.
IV. HF radio signals are generally reflected from its layers.

Of the above statements

(a) only I is true.
(b) only II and III are true.
(c) only I, II and IV are true.
(d) only II and IV are true.

10. Under which of the following conditions is cumulus cloud **least** likely to form?

(a) smoke rising from a large bush fire
(b) cool, stable air blowing from the sea and rising over mountains
(c) a slow-moving cold front entering an area
(d) an afternoon sea breeze flowing over land that has been heated in the morning

See next page

11. Which of the following statements is **incorrect**?

    (a) Radiation fog does not form over the sea.
    (b) A warm, moist airflow over cold land can produce advection fog.
    (c) Fog will not form in an area beneath an inversion layer.
    (d) Steam fog often occurs when cool air flows over a warm ocean.

12. Updrafts are a feature of thunderstorms. In the 'life' of a thunderstorm, updrafts are **most** likely to exist in

    (a) all stages.
    (b) the developing stage.
    (c) in the developing and mature stages.
    (d) the mature and dissipating stages.

13. When an aircraft encounters a shock stall the pilot can best counteract the effects by

    (a) applying full throttle and lowering the nose.
    (b) applying full throttle and raising the nose.
    (c) closing the throttle and deploying speed brakes.
    (d) closing the throttle and deploying flaps.

14. The tail rotor on a helicopter

    (a) is used to nullify Coriolis effect.
    (b) is required to make a helicopter fly sideways.
    (c) is not needed if contra-rotating rotors are fitted.
    (d) is used to eliminate gyroscopic precession.

15. In supersonic flight, which of the following is **incorrect** when considering the behaviour of air passing through an expansion wave? The air behind the wave

    (a) maintains direction.
    (b) decreases in temperature.
    (c) accelerates.
    (d) decreases in pressure.

16. For a helicopter with a constant weight, rotor coning is greatest

    (a) on the ground with the collective pitch lever lowered.
    (b) on the ground with the collective pitch lever raised.
    (c) on the ground with the collective pitch lever neutral.
    (d) in level forward flight at its maximum speed.

17. A single-rotor helicopter has a tendency to move sideways when hovering with its nose into wind. This phenomenon is known as

    (a) tail rotor drift.
    (b) transverse flow effect.
    (c) Coriolis effect.
    (d) autorotation.

See next page

18. Which of the following situations is true regarding an aircraft that is on a collision course with your aircraft? The other aircraft will

    (a) appear to move downward in the windscreen relative to your aircraft.
    (b) appear to move upward in the windscreen relative to your aircraft.
    (c) appear to remain stationary in the windscreen relative to your aircraft.
    (d) could move in any direction relative to your aircraft.

19. The two different types of light-sensitive cells in the retina are the

    (a) rods, which are more sensitive to colour, and cones, which are more sensitive in dim light.
    (b) rods, which are more sensitive in dim light, and cones, which are more sensitive to colour.
    (c) rods and cones, which respond similarly in most lighting conditions.
    (d) rods, which are concentrated in the fovea area of the retina, and cones, which are concentrated in the outer region of the retina.

20. Which of the following statements is **not** true?

    (a) One symptom of hypoxia is a bluish discolouration of the lips and fingernail beds.
    (b) To avoid the detrimental effects of hypoxia, pilots in command of non-pressurised aircraft are required by law to ensure that they are suitably equipped and using supplemental oxygen when operating above 10 000 ft AMSL.
    (c) A person who regularly smokes cigarettes will suffer the effects of hypoxia at a lower altitude than a non-smoker.
    (d) A person may induce hypoxia by breathing too rapidly or deeply, particularly when under stress.

End of Section One

See next page

Section Two: Short Answer **80 Marks**

Answer in the space provided.

---

1. Given a pressure altitude of 9000 ft, an outside air temperature of -25ºC, a CAS of 200 knots, a tailwind of 30 knots and a fuel flow of 70 litres per hour, use your flight computer to determine the following:

   (a) Density altitude (1 mark)

   (b) TAS (1 mark)

   (c) Fuel burnt after 12 minutes of flight (1 mark)

2. When considering the form of the Earth, explain what is meant by a 'small circle' and give an example. (2 marks)

3. A private VFR flight is being planned from Curtin WA to Darwin NT, using CAAP234-1 guidelines for fuel requirements. Use the flight information provided below to answer the questions about the flight.

TAS	140 knots
Head wind	10 knots
Fuel flow	45 litres/hour
Taxi reserve	8 litres
Fixed reserve	45 minutes
Flight time	236 minutes

   (a) Determine the **minimum** fuel required to be on board prior to taxi. (1 mark)

See next page

(b) Determine the ground distance from Curtin to Darwin. (1 mark)

(c) Well into the flight, the **actual** head winds that had been experienced were calculated to be 20 kt and were expected to remain constant. Given the new conditions, calculate the new endurance expected on arriving overhead Darwin. (1 mark)

(d) After determining the actual winds and the available fuel, the aircraft is approaching the last suitable airport prior to Darwin. What would be the pilot's correct course of action? (1 mark)

4. An aircraft with a TAS of 155 knots is tracking 305ºM and is being affected by a wind from 160ºT at 20 knots. Given that the area has a magnetic variation of 5ºW, calculate the following:

(a) Drift (1 mark)

(b) Heading magnetic (1 mark)

(c) Ground speed (1 mark)

See next page

Refer to Kalgoorlie WAC excerpt in Appendix A to answer Questions 5 and 6

5. Kalgoorlie-Boulder Airport is located approximately SSW of Laverton Airport (28º 36'S 122º 25'E).

   (a) What is the **magnetic** bearing of Kalgoorlie-Boulder from Laverton? (1 mark)

   _____

   (b) Determine the latitude and longitude of Kalgoorlie-Boulder Airport. (1 mark)

   Latitude: _____ Longitude: _____

6. An aircraft departed from Laverton at 0330UTC to fly directly to Kalgoorlie. No allowance was made for any wind that might be blowing. After 31 minutes the aircraft was overhead Yerilla aerodrome (29º 28'S 121º 50'E).

   Using the 1 in 60 rule **and showing all your working**, calculate the:

   (a) track error. (1 mark)

   _____

   (b) track made good. (1 mark)

   _____

   (c) closing angle. (1 mark)

   _____

   (d) change of heading required to fly directly to Kalgoorlie-Boulder Airport. (1 mark)

   _____

See next page

(e) revised estimated time of arrival over Kalgoorlie-Boulder Airport, assuming that the ground speed remains constant. (1 mark)

7. (a) Explain two advantages of the VOR over the NDB as a navigational aid. Compare their respective principles of operation in your answer. (4 marks)

(b) Describe the basic principle of operation of ground-based primary radar used by Air Traffic Control to locate the position of an aircraft. (2 marks)

(c) An Air Traffic Controller is faced with ensuring the separation of two aircraft approaching each other on opposite headings. What is the main advantage to this controller in having secondary surveillance radar compared with another controller who has only primary radar? (1 mark)

See next page

Use Appendices G and H to help answer the following question.

8. If an aerodrome is located at 30°15’S,122º40’E, calculate the time for the end of daylight on July 10. Show all your workings and give your final answer in WST. (3 marks)

9. Use a labelled diagram to show how a double wedge aerofoil creates lift in supersonic flight when it is at its optimum angle to the airflow. (4 marks)

See next page

10. The swash plate is an important component in the control system of a helicopter. How does it respond when the pilot moves the cyclic pitch forwards - and how does the helicopter then respond? (4 marks)

Swash plate response: _____

Helicopter response: _____

11. (a) What is the value of *Standard Pressure* in the ISA? (1 mark)

(b) What will be the effect (if any) on the density of air as the relative humidity of the air rises? (1 mark)

(c) What is meant by the statement that a 'temperature inversion' exists in a region? (1 mark)

See next page

12. The data below relate to a parcel of moist air that rises from sea level. Use it to answer the questions below.

Sea level temperature	22ºC
Initial temperature of rising air	23ºC
Dew point	11ºC
Environmental lapse rate	Sea level to 4000 ft: 5ºC/ 1000 ft 4000 ft to 6000 ft: -2ºC/ 1000 ft 6000 ft to 12000 ft: 1ºC/ 1000 ft
DALR & SALR	Standard

(a) Determine the height of the cloud base. (1 mark)

(b) Determine the height of the cloud top. (1 mark)

(c) What is the type of cloud formed? (2 marks)

See next page

13. Read the following forecast and answer the questions below it.

LAVERTON (YLTN)
TAF YLTN 221915Z 2221/2311
02010KT 9999 LIGHT SHOWERS OF RAIN BKN110 FM230100 27010KT 9999 LIGHT SHOWERS OF RAIN BKN110 PROB30 INTER 2221/2306 VRB20G45KT 4000 THUNDERSTORMS WITH RAIN SCT025 FEW100CB
RMK T 26 25 29 32 Q 1009 1011 1011 1009

METAR YLTN 230600Z AUTO 26012KT //// // ////// 33/01 Q1009
RMK RF00.0/000.0

(a) Between what times (UTC) is the above forecast valid? (2 marks)

(b) What is the forecast temperature at Laverton at 1100WST? (1 mark)

(c) What was the observed wind strength at Laverton at 1400WST? (2 marks)

14. Briefly explain the purpose and importance in the development of air navigation of the following equipment:

(a) Non-directional beacon (2 marks)

Purpose:

Importance:

See next page

(b) Distance measuring equipment (DME) (2 marks)

Purpose: _____

Importance: _____

15. Explain the role of the vestibular apparatus (semi-circular canals and the otolith organs) in sensing turning, acceleration and deceleration effects on the human body. Use diagrams to support your answer. (4 marks)

See next page

16. For more than a decade ‘glass-cockpit’ technology has become increasingly prevalent in general aviation aircraft, reflecting similar developments in the design of modern airliners and military aircraft.

(a) Explain what is meant by a ‘glass cockpit’. In your answer, describe how it differs from a traditional cockpit. (2 marks)

(b) With reference to basic general aviation aircraft, explain two advantages and two disadvantages of glass-cockpit technology compared with conventional cockpit technology. (4 marks)

Advantage One:

Advantage Two:

Disadvantage One:

Disadvantage Two:

See next page

17. Use the information table below, together with the take-off weight chart and the performance charts provided in the Appendices, to answer the following questions that relate to a proposed flight in a Piper PA-32RT-300T Turbo Lance from Kalgoorlie to Laverton.

Conditions	**Kalgoorlie**	**Laverton**	**En-route**
Pressure Height:	1200 feet	1500 feet	Cruise Level: FL120
Runway Surface:	Bitumen		TAS 150 kt
Runway Slope:	2% Down		Fuel flow 15.7 gph
Take Off Weight:	1630 kg		10 kt head-wind
Temperature:	30 ºC	35 ºC	OAT: –3 ºC
Wind:	Nil	Nil	
Distance: Kalgoorlie – Laverton 138 nm			

(a) Determine the minimum take-off distance required at Kalgoorlie. (3 marks)

See next page

(b) Calculate

- the total flight time, and
- the total flight fuel required, i.e. excluding reserve fuel, taxi fuel and unusable fuel.

Use the Kalgoorlie wind for the climb calculation, en-route wind for the cruise and Laverton wind for the descent.

Insert your answers in the table below, and show all working clearly in the working space below the table. (6 marks)

	Climb	**Cruise**	**Descent**	**Total**
Fuel (gal)				
Time (min)				
Dist. (nm)				

See next page

18. The article 'Mags on Both', relating to aviation safety was submitted by a private pilot and published in the September–October 2006 edition of *Flight Safety Australia* magazine. The article has been modified. Read the article and answer the questions that follow.

'Mags on Both'

Our local airfield has a wide, smooth runway that is not far short of 1000 m. We joke that the council engineer was briefed that it had to be long, flat and straight but nobody told him it would be better if it did not have a mountain at one end.

The runway runs east-west with a 150 ft high ridge a relatively short distance from the eastern end of the strip. As you could imagine, landing to the west requires an unusually steep approach, while taking off to the east requires a short-field takeoff.

Our local flying school has two Cessna 152s available for hire. Although they are almost identical to look at, one of them is quick to accelerate but rather slow in cruise, while the other is slow to get going but some 10 kt faster overall. Presumably one propeller is finer than the other.

On the day in question, the only aircraft available was the one that was slower to accelerate. I pre-flighted, started the engine and began a slow taxi to the runway. The only taxiway at our airfield joins the runway at the far eastern end; so departures to the east require a full-length backtrack. A light easterly was blowing so I was in for a long taxi to reach the takeoff point.

To avoid a long interval between the engine checks and the takeoff run – and because there was nobody else in the circuit – I decided to defer the run-up checks until I'd lined up for takeoff. I soon reached the end of the runway, turned the aircraft around to line up and started the engine checks. I was part way through the checks when I noticed a large flock of seagulls settling just a few metres down the runway in front of the aircraft.

Conscious of the damage that could be caused by a bird strike, I opened the window and did my best impersonation of a seagull alarm call. The gulls were unfazed. I tried slapping the side of the fuselage with my palm to scare them off. Still no luck. I ran the engine up to full static RPM and still they didn't budge. Finally I rolled the aircraft forward a few metres. This worked, but they only moved a few metres further along the runway and settled back down again. I am not sure how many times I rolled towards them but they eventually got the message and took their party elsewhere.

I was ready to depart. I had taken off over the same ridge hundreds of times and I knew there was sufficient margin, even with a few metres of runway behind me. Full power, brakes off. Oil temperature and pressure were in the green. The RPM was lower than normal but the speed was creeping up. So too was the ridge at the end of the runway. By the time we were airborne, it was much more conspicuous in my field of view than usual.

Too low: I quickly trimmed for best angle-of-climb speed but the damage was already done. We were too low and it looked as if we were on a collision course with a house on top of the ridge. It's remarkable how difficult it is in such a situation to resist the temptation to increase angle of attack – even though you know it will decrease, rather than increase the aircraft's rate of climb.

Our ground clearance was slowly increasing but it was clear our little bird had lost the will to fly. I made plans to get back on the ground and while holding the best-angle-of climb speed, carefully began a turn to make a very compact downwind leg to land again.

Established on a low-level downwind leg it was time to investigate the problem. Carburettor heat was cold, mixture set to rich and the throttle fully open. What about the mags? I reached down to the key and immediately realised it was on 'Left'. I quickly switched it to 'Both' and the engine gained another 150 RPM. Concepts like 'accelerate' and 'climb' became realities again.

See next page

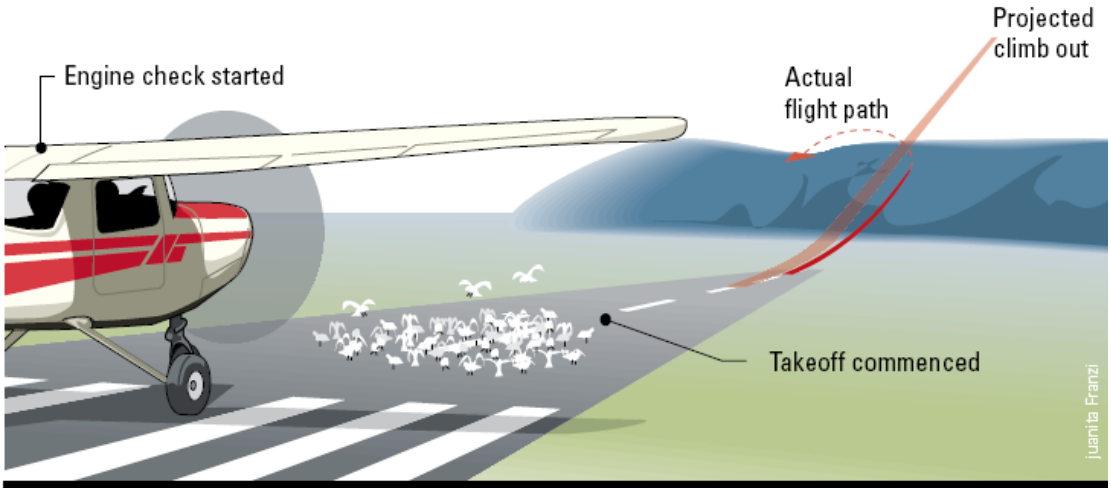
I cancelled the early landing and completed the flight without incident.

With hindsight, it's easy to see there were things I could have done better. At the time, my one airmanship-like thought was to get rid of the gulls before takeoff. My experience of easterly take-offs indicated that there was still plenty of room to clear the ridge from the point where we eventually started. Of course, I had not counted on taking off on just one magneto.

My dislike for taking off to the east now borders on paranoia. If the wind is light enough from the east, I take off to the west with a small downwind component. If it is blowing a gale from the east so that the takeoff profile matches that of a Harrier, I will happily take off to the east. Otherwise, especially if it is hot, I will wait for a westerly that almost always comes in with the sea breeze later in the day. I also learned that the adage about 'runway behind you' is not to be taken lightly. If I ever have to use the aircraft as a mobile bird scarer again, you can be sure that I will backtrack afterwards to use the full runway length.

Most importantly, I learned that memorised checklists must be completed without interruption. Nowadays, if there is ever an interruption from an ATC call, a question from a passenger, or something distracting out the window, I always go back to the top and start again. And now, when I get to the point just before I push the throttle forward to start the take off roll, my wife always murmurs 'Mags on both?'

BLOCKED TAKEOFF



Gullible: A series of attempts to scare off a flock of seagulls that had settled on the runway may have distracted the Cessna 152 pilot sufficiently to trigger a chain of errors.

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(a) Use your knowledge of human factors in aviation to explain what is meant by a 'chain of errors' in relation to aircraft accidents and incidents. List the chain of errors evident from the scenario described in the article. (4 marks)

'Chain of errors' explanation: _____

_____

_____

_____

_____

_____

List: _____

_____

_____

_____

(b) Identify two significant errors made by the pilot in this scenario and explain how these errors could have been avoided. (4 marks)

Error 1: _____

Explanation: _____

_____

_____

_____

_____

_____

Error 2: _____

Explanation: _____

_____

_____

_____

_____

_____

End of questions

Check that you have written your Student Number on the front cover of this booklet.

ACKNOWLEDGEMENTS

Section Two

Question 18

Article from: Civil Aviation Safety Authority (CASA). (2006, September-October). Mags on both. *Flight Safety Australia.* Retrieved March 20, 2009 from http://www.casa.gov.au/fsa/2006/oct/sept-oct06.pdf
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Published by the Curriculum Council of Western Australia
27 Walters Drive
OSBORNE PARK WA 6017