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 2

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 ERSA Extract
Appendix B Loading System
Appendix C Take-Off Chart
Appendix D Landing 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, calculators satisfying the conditions set by the Curriculum Council for this course

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.

2010/88[v2]
Web version of 2009/23926

Ref: 911

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	30	20
Section Two: Short Answer	28	28	120	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**

Attempt all questions in this section. Each question is worth one mark.

Record your answers for Questions 1–20 on the separate Multiple-Choice Answer Sheet using a blue or black pen or a B or 2B pencil.

If you make an error, follow the instruction given to you on the Multiple-Choice Answer Sheet.

Suggested working time for this section is 30 minutes.

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1. Lift, which acts through the centre of pressure

   (a) remains stationary over all flight regimes.
   (b) is opposite to the centre of gravity.
   (c) moves rapidly forward at the point of the stall.
   (d) moves forward as the angle of attack is increased.

2. A single-engine aircraft has a lift/drag ratio of 15 to 1. If it experiences an engine failure at a height of 3000 feet, how far would it glide in nil wind conditions? (1 nautical mile is approximately 6000 feet.)

   (a) 15 nautical miles
   (b) 1 nautical mile
   (c) 7.5 nautical miles
   (d) 3 nautical miles

3. A manifold pressure gauge should indicate

   (a) 2500 RPM during the take-off roll.
   (b) airfield atmosphere pressure prior to engine start.
   (c) zero prior to engine start.
   (d) airfield QNH.

4. The use of a lower-grade fuel than that specified for an aircraft engine may cause

   (a) detonation.
   (b) fouling of the spark plugs.
   (c) low cylinder head temperature.
   (d) pre-ignition.

5. The holder of a private pilot's licence has just completed an aeroplane flight review (AFR) with an approved testing officer. This flight was 1.0 hr in duration and included two take-offs and two landings. The pilot wishes to conduct a joy flight carrying passengers the next day. What further recency requirements if any, must the holder of this licence undertake before this flight? Assume that no other flights have been conducted within last 120 days.

   (a) a minimum of at least another three take-offs and three landings
   (b) a minimum of at least another one take-off and one landing
   (c) no further requirement as the AFR replaces recency requirements
   (d) a minimum of at least another two take-offs and two landings

See next page

6. An aircraft on finals is required to be lined up not nearer to the aerodrome perimeter than

   (a) 500 feet.
   (b) 1000 metres.
   (c) 1000 feet.
   (d) 500 metres.

7. Very high frequency (VHF) radio waves travel at

   (a) the speed of light.
   (b) the speed of sound.
   (c) 3×10^8 metres per minute.
   (d) the speed of sound in ISA conditions.

8. 'Three' on the communications readability scale of 1 to 5, indicates that a radio transmission is

   (a) perfectly readable.
   (b) readable.
   (c) readable but with difficulty.
   (d) unreadable.

9. An aerodynamic or design feature that ensures that the stall will occur on the inboard section of the mainplane first and assists the pilot in recovery is known as

   (a) washout.
   (b) washin.
   (c) a winglet.
   (d) a vortex generator.

10. If the weight of an aeroplane is reduced, an increase in range while maintaining a constant airspeed may be achieved by

    (a) reducing speed and reducing power.
    (b) increasing speed and increasing power.
    (c) reducing speed and increasing power.
    (d) increasing speed and reducing power.

11. Differential ailerons are designed and fitted to some aircraft to

    (a) balance the drag on the upgoing aileron.
    (b) counter the natural tendency of an aircraft to yaw into a turn.
    (c) counter the natural tendency of an aircraft to yaw out of a turn.
    (d) aerodynamically balance the ailerons to reduce pilot input.

See next page

12. Sweepback is a design feature that primarily aids in

    (a) control.
    (b) lateral stability.
    (c) longitudinal stability.
    (d) directional stability.

13. The effect of the centre of gravity being ahead of the forward limit will be noticed most during

    (a) climb.
    (b) take-off.
    (c) cruise.
    (d) approach to land.

14. The term ‘empty weight’ refers to the weight of the aircraft with

    (a) no oil and no fuel.
    (b) unusable oil and full oil.
    (c) full fuel and no oil.
    (d) unusable fuel and undrainable oil.

15. During the course of a pre-flight inspection, the pilot notices a large ‘nick’ (an imperfection) in the propeller. This defect should be recorded in the

    (a) flight manual.
    (b) maintenance release.
    (c) propeller log book.
    (d) certificate of airworthiness.

16. Setting the subscale of an altimeter to 1013 hPa will cause the altimeter to indicate

    (a) aerodrome elevation.
    (b) pressure height.
    (c) density height.
    (d) altitude above mean sea level.

17. During a flight, the pilot of a light aircraft determines that the attitude indicator is providing erroneous information. Which of the following instruments should the pilot also suspect of displaying false information?

    (a) altimeter
    (b) airspeed indicator
    (c) vertical speed indicator
    (d) direction indicator

See next page

18. During a turn through North in the southern hemisphere, the magnetic compass will indicate a reading that is

    (a) greater than the direction indicator.
    (b) less than the direction indicator.
    (c) same as the direction indicator.
    (d) constant until the aircraft has rolled wings level.

19. In most aircraft hydraulic systems, a simple yet effective design feature for absorbing sudden changes in pressure is known as

    (a) a reservoir.
    (b) a relief valve.
    (c) an accumulator.
    (d) a pressure regulator.

20. Which of the following statements about a turbofan engine is **incorrect**?

    (a) It is fitted to most modern passenger aircraft.
    (b) It expels a greater percentage of air past the engine than through it.
    (c) It is not fitted to military jet fighters.
    (d) It is more fuel efficient at altitudes above 30 000 feet.

End of Section One

See next page

Section Two: Short Answer **80 Marks**

Attempt all questions in this section. Write your answers in the spaces provided.

Suggested working time: 120 minutes

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1. A wing that has a short chord and a long span is said to have a high

_____

(1 mark)

2. Most light aircraft stall at a similar angle of attack. From your understanding of the stall, outline the

   (a) aerodynamic characteristics or symptoms of a stall. (3 marks)

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   (b) recommended recovery technique. (2 marks)

   _____

   _____

   _____

   _____

   _____

3. High-powered conventional (tailwheel) aircraft are more susceptible to ground-looping than tricycle aircraft. List **three** factors that contribute to this occurrence during take-off. (3 marks)

   Factor 1: _____

   Factor 2: _____

   Factor 3: _____

See next page

4. When an aircraft engine is first started, the oil pressure reading is higher than normal. After several minutes, the oil pressure usually indicates a normal reading. Explain this occurrence. (2 marks)

5. What, if any, are the limitations of operating an aircraft within the 'yellow arc' as displayed on the air speed indicator? (1 mark)

6. Light aircraft are usually fitted with an exhaust gas temperature (EGT) gauge. The EGT is used by the pilot to determine the most economical mixture setting during cruise configuration. With reference to the EGT, briefly explain how the pilot achieves this outcome. (2 marks)

7. Pilots operating light aircraft at sea level elevation aerodromes generally do not lean the mixture prior to take-off and climb. State two reasons for this practice. (2 marks)

Reason 1: _____

Reason 2: _____

See next page

8. Most light aircraft are fitted with alternators rather than generators. Give one reason why this is the case. (1 mark)

9. The internal combustion aircraft engine generates a significant amount of heat during operation.

   (a) How are most light aircraft engines cooled? (1 mark)

   (b) Describe two methods engine manufacturers have used to reduce engine operating temperatures. (2 marks)

   Method 1: _____

   Method 2: _____

10. A VHF antenna is positioned at mean sea level (MSL). Calculate the theoretical range (in nautical miles) of this station, given that the receiving aircraft is cruising at an altitude of 5000 feet. (2 marks)

    State the formula for VHF range: _____

    Working space: _____

    Answer: _____ nautical miles

See next page

11. Communication in the high frequency (HF) band is possible because of the propagation of radio signals over large distances. Explain how this communication occurs, detailing the differences between night and day communication. A diagram may assist your answer. (4 marks)

How the communication occurs: _____

_____

_____

_____

_____

_____

_____

_____

Differences between night and day communication: _____

_____

_____

_____

_____

_____

See next page

12. On approach to Moorabbin Aerodrome (GAAP), you obtain the ATIS and make your initial radio call at the designated reporting point. However, it is your belief that the transmission was not received and, after repeated attempts, you draw the conclusion that the VHF radio is inoperative. Your intention is to land on the duty runway. List **three** options available to you that will assist you in landing the aircraft in a safe manner.

(3 marks)

Option 1: _____

_____

Option 2: _____

_____

Option 3: _____

_____

13. You have recently undergone a medical examination with an approved CASA (Civil Aviation Safety Authority) doctor, who informs you that you are fit to hold a Class 2 Aviation medical. The following day, your flight instructor deems you competent to be sent on your first solo.

(a) Is this possible? (1 mark)

_____

_____

(b) Justify your answer. (2 marks)

_____

_____

_____

_____

14. Complete the sentence below.

During refuelling operations, the aircraft and ground fuelling equipment shall be so located that no fuel tank or vent outlet is within _____ metres of any other stationary aircraft. (1 mark)

15. Which component of a piston engine converts straight line motion to rotational or 'turning' motion? (1 mark)

_____

See next page

16. Refer to the Lockhart River (YLHR) ERSA extract (see Appendix A).

Assume you are the pilot of a single engine piston aircraft on the downwind leg for runway 12. Derive the following operational information.

(a) What is the circuit direction? (1 mark)

(b) What altitude should the altimeter read on this leg? (1 mark)

(c) To what frequency should you be tuned? (1 mark)

(d) What is the FIA call sign? (1 mark)

17. Some aircraft engines utilise a dry sump lubrication system, while others use a wet sump.

(a) State which type of aircraft would use a dry sump. (1 mark)

(b) Briefly explain the differences between the two lubrication systems. (2 marks)

See next page

18. A number of aircraft with reaction engines are fitted with afterburners.

(a) Outline the purpose of an afterburner. (1 mark)

(b) Explain the principle of operation of an afterburner. A labelled diagram may assist your answer. (2 marks)

19. Besides activating brakes, pilots of large passenger jet aircraft employ an additional braking system upon landing. Name this system. (1 mark)

See next page

20. Most aircraft use flaps during the approach and landing phase. List **three** major advantages for deploying flaps during this stage of the flight. (3 marks)

Advantage 1: _____

_____

_____

Advantage 3: _____

_____

_____

Advantage 3: _____

_____

_____

21. Complete the following statements.

Induced drag is greatest at _____ angles of attack. (1 mark)

Profile drag is greatest at _____ airspeed. (1 mark)

The best glide speed corresponds to _____ drag. (1 mark)

See next page

22. Manufacturers fit elevator trim tabs in order to reduce some of the force required to move the elevator during various flight regimes such as climbing and descending,

(a) Explain the advantage to the pilot in having trim tabs. (1 mark)

(b) With the aid of a diagram, show the position of the tab (assuming it was trimmed correctly) if the aircraft was in a climb. (3 marks)

See next page

23. Refer to the Loading System **Charlie** data provided in Appendix B. Use the table provided below to assist you in determining the

(a) maximum take-off weight.
(b) maximum baggage that can be legally carried.
(c) C of G position (mm aft of datum).

For operational purposes the:

- pilot has elected to place the two lighter passengers in Row 2.
- baggage comprises 5 kg packages and cannot be divided.
- seats are not removed.

Pilot	90 kg
Passenger weights	70 kg, 80 kg, 75 kg
Fuel	140 litres

	Weight (kg)	**Moment (kg mm)/100**
Empty weight	687	19 522
Oil	7	
Pilot and passenger (Row 1)		
Rear passengers (Row 2)		
Fuel		
Baggage		
Take-off weight		

1 kg = 2.2 lbs
SG = 0.71

(a) Take-off weight _____ (2 marks)

(b) Maximum baggage _____ (2 marks)

(c) C of G position (_____ mm aft of datum) (2 marks)

24. On a given day, an aerodrome whose elevation is 2000 feet and QNH is 1020 hPa, experiences an environmental temperature of 20ºC. Calculate the

(a) pressure height (**show working**) (2 marks)

_____

_____

_____

_____

Answer _____

See next page

(b) density height (round your answer to the nearest whole degree, and show your working) (2 marks)

Answer _____

25. Refer to the Cessna 172 take-off chart (Appendix C) and to the data given below.

Runway	Temp (ºC)	Pressure Height (feet)	Take off Distance Available (m)	Surface	Slope (%)	Wind (kt)	Take-off Weight (kg)
08/26	+30	3000	1100	short wet grass	2% down to the east	170/15	1000 kg

Determine the

(a) minimum take-off distance for the above conditions; (2 marks)

(b) runway that will enable the minimum take-off distance; and (1 mark)

(c) take-off safety speed for this aircraft, given these conditions. (1 mark)

26. Refer to the Cessna 172 landing chart (Appendix D) and to the data given below.

Temp (º C)	Pressure Height (feet)	Landing Distance available (m)	Slope (%)	Surface	Wind Component (kt)	Landing Weight (kg)
0	6000	600	level	bitumen	10 kt head	

Determine the maximum landing weight for this aircraft given these conditions. (2 marks)

27. Outline **three** minimum requirements a person must meet to be considered eligible as a prospective pilot with a major airline company such as QANTAS. (3 marks)

Requirement 1: _____

Requirement 2: _____

Requirement 3: _____

See next page

28. Read the article below.

Centurion diesel engine

Centurion Engine
Thielert Aircraft Engines GmbH offers CENTURION® 2.0, a kerosene piston engine for general aviation with a take off power of 99 kW (135 hp). The CENTURION® 2.0 is a turbocharged 4-cylinder in-line engine which is EASA certified since August 2006 and FAA certified since October 2006. Its predecessor, CENTURION® 1.7, is certified by the European Aviation Authorities since May 2002 and FAA certified since October 2003.

The CENTURION® 2.0 surpasses conventional avgas engines in fuel efficiency, handling and quality. It is also safer and more reliable. In addition, the CENTURION® 2.0 is equipped with a redundant electronic engine management system, known as FADEC (Full Authority Digital Engine Control). This system controls and monitors piston engine functions using two independently operating systems which health check each other continuously. The advantage is that the healthier of the two systems takes control automatically. FADEC also enables the use of a single lever control for all operating parameters including propeller pitch control, and logs all relevant engine data for analysis.

The CENTURION® 2.0 is certified for the use of both kerosene and diesel (DIN EN590) and can run with the two fuels in any mixture ratio.

CENTURION® 2.0 – Features
The CENTURION® 2.0 is a state-of-the-art kerosene piston aircraft engine that shows important development achievements: electronic engine management FADEC; gearbox with torsional damper; and adaptation of the fuel system for kerosene. For these reasons the CENTURION® 2.0 offers increased safety, comfort, cost effectiveness and performance in comparison to conventional avgas engines.

Safety
- Electronic engine and prop management with single lever control.
- Electronic data logging to record all the engine data during flight. The data recording and storage is comparable with the black box used in jets. The electronic engine management thus saves data that is required for the maintenance, fault analysis and the ongoing improvement of the engine.
- Ease of maintenance.
- Modern technology in the overall design, components, materials and production process (traceability back to molten mass).

Comfort
- Single lever control enables low workload for pilot. The pilot is his own flight guest because adjustments of levers for load, mixture, revs, prop settings, etc. are no longer necessary.
- Automatic run up check.
- Kerosene and diesel (DIN EN590) are usable in any mixture ratio.
- Availability of fuel (kerosene represents over 99.5 per cent of delivered aviation fuel worldwide).
- Faster maintenance, repair and overhaul (meaning no aircraft is grounded for weeks).

Cost Effectiveness
- Reduction of operating cost by up to 60% because of low consumption and lower fuel price.
- Lower training costs.

Performance
- Excellent climb performance up to 13 500 ft (approved to 18 000 ft).
- 135 hp take off power with 122 hp available at 10 000 ft.
- 97 hp cruise power at 17 500 ft.
- Longer range.

STC for Cessna 172
We received Supplemental Type Certifications (STC) for various Cessna 172 models in 2006 and we are working on further STCs.

See next page

From your previous research into engine development and the information contained in this article

(a) List **three** advantages of this engine over existing gasoline engines. (3 marks)

Advantage 1: _____

Advantage 2: _____

Advantage 3: _____

(b) List **three** problems and/or concerns you consider could be an issue with fitting this engine to existing aircraft such as the Cessna 172. (3 marks)

Problem 1: _____

Problem 2: _____

Problem 3: _____

End of questions

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

ACKNOWLEDGEMENTS

Section Two

Question 28 Article from: Thielert Aircraft Engines GmbH. Adapted from the Centurion Engines website. Retrieved March 22, 2009, from http://www.centurion-engines.com/

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